uncontinental

PROCEEDINGS

CVC

smart
easy
affordable

veterinarycontinuingeducation

SAN DIEGO

DECEMBER
3–6, 2015

Powerful. Convenient. Easy.

MERIAL
A SANOFI COMPANY

2015 CVC San Diego

Proceedings

San Diego Convention Center
San Diego, CA
December 3-6, 2015

CVC San Diego brought to you by

dvm360.com Veterinary medicine Veterinary economics firstline

The 2015 CVC San Diego Proceedings Book is also available to attendees on a CD-ROM or a downloadable format. For ordering or for more information, contact The CVC Group at (800) 255-6864, ext. 6.

The ideas, content, and conclusions presented in the 2015 CVC San Diego Proceedings, in whole or part, are those of the speakers and do not necessarily represent the viewpoint, position, or endorsement of the CVC Group or Advanstar Communications Inc.

Published by Advanstar Communications Inc., 8033 Flint, Lenexa, KS 66214.

ISBN13: 978-1-60759-289-1

ISBN10: 1-60759-28-4

Bronchi-Shield® ORAL is making a happy vaccine experience the new normal.

BRONCHI-SHIELD ORAL is the first to redefine *Bordetella* vaccination without needle sticks, sneeze-backs, or initial boosters![1]

"I think the oral vaccine is probably nicer for everybody in the room."
—Rebecca Ruch-Gallie, DVM, MS

Give dogs and their owners an enjoyable vaccine experience – only with BRONCHI-SHIELD ORAL.

Bronchi-ShieldORAL.com

Reference: 1. Data on file, BRONCHI-SHIELD ORAL package insert, Boehringer Ingelheim Vetmedica, Inc.

Table of Contents

Anesthesia

Andrew Claude, DVM, DACVAA

Current fluid therapy topics and recommendations during anesthetic procedures 1
Anesthesia ventilators and ventilation techniques 4
Acute pain management: Local and regional anesthesia 6
Acute pain management: Pharmaceutical options 8
Analgesic considerations in cats 10
Neonatal, pediatric, and geriatric anesthesia 12
Postanesthetic care of small animal patients 15

Learn then Earn

Pain medication: A win-win situation for you, patients, and clients - with Dr. K. Felsted 17

Avian Medicine/ Backyard Poultry Medicine

Cheryl Greenacre, DVM, DABVP (Avian, ECM)

Avian emergency coming in? An overview of common presentations 18
Avian euthanasia: Incorporating compassion and the new AVMA guidelines 21
It's black and white: Taking and interpreting avian radiographs 23
Backyard poultry are coming in for an appointment! Overview of general care and husbandry 26
Good layer gone wrong: Backyard hens with reproductive diseases 29
Rales? Snicking? Diagnosing and treating respiratory diseases of backyard poultry 31
Let's work up some backyard poultry diseases together! 34

Behavior

Jeannine Berger, DVM, DACVB, DACAW, CAWA

Asking the right questions: Taking a behavior history 36
Feline dictionary: Understanding feline body language 38
How I treat about everything: Behavior treatment plan 41
Rambunctious, jumpy, mouthy dogs: The quick fix for RJM dogs 43
Dealing with the shelter CAT-astrophy: Behavior problems of shelter cat 46
What to do about shelter cats with inappropriate urination 49
Separation-related behavior problems in dogs: What happens when dogs miss us when we're gone 51
Science, non-science, and nonsense in dog training: Why should a veterinarian care? 53
BYO behavior cases ..... ATE Luncheon ..... No Proceedings Required

Martin Godbout, DVM, MS, DACVB

Dog aggression: Assessing the risk (Part 1) ..... Proceedings not submitted
Dog aggression: Assessing the risk (Part 2) ..... Proceedings not submitted
Cat fight: Diagnosis and treatment ..... Proceedings not submitted
Detecting puppy behavior problems at the clinic ..... Proceedings not submitted
Detecting kitten behavior problems at the clinic ..... Proceedings not submitted
It's all about personality! Meeting the needs of cats ..... Proceedings not submitted
Is your dog a special addition? (Part 1) ..... Proceedings not submitted
Is your dog a special addition? (Part 2) ..... Proceedings not submitted
Is your dog a special addition? (Part 3) ..... Proceedings not submitted

Canine Sports Medicine

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR

Cruciate rupture: What should I recommend? 55
Nonsurgical cranial cruciate ligament rupture management 58
Soft tissue injuries: It's not just about rest 60
Orthopedic exam tips and tricks 61
Splints and casts: Pros and cons 63
Minimizing chaos and complications in practice 65

Cardiology

Barret Bulmer, DVM, MS, DACVIM

Radiographic review of cardiovascular disease 67
Wrapping your head around the pericardium: A review of pericardial disease 69
Reacquainting yourself with the ECG and treatment of arrhythmias 71
A unified perspective on managing congestive heart disease 74
Dilated cardiomyopathy: Boxers and dobies, oh my! 76
Comprehending common congenital cardiac disorders: Examination findings, diagnostics, and treatment 78

Clinical Pathology

Steve Stockham, DVM, MS, DACVP

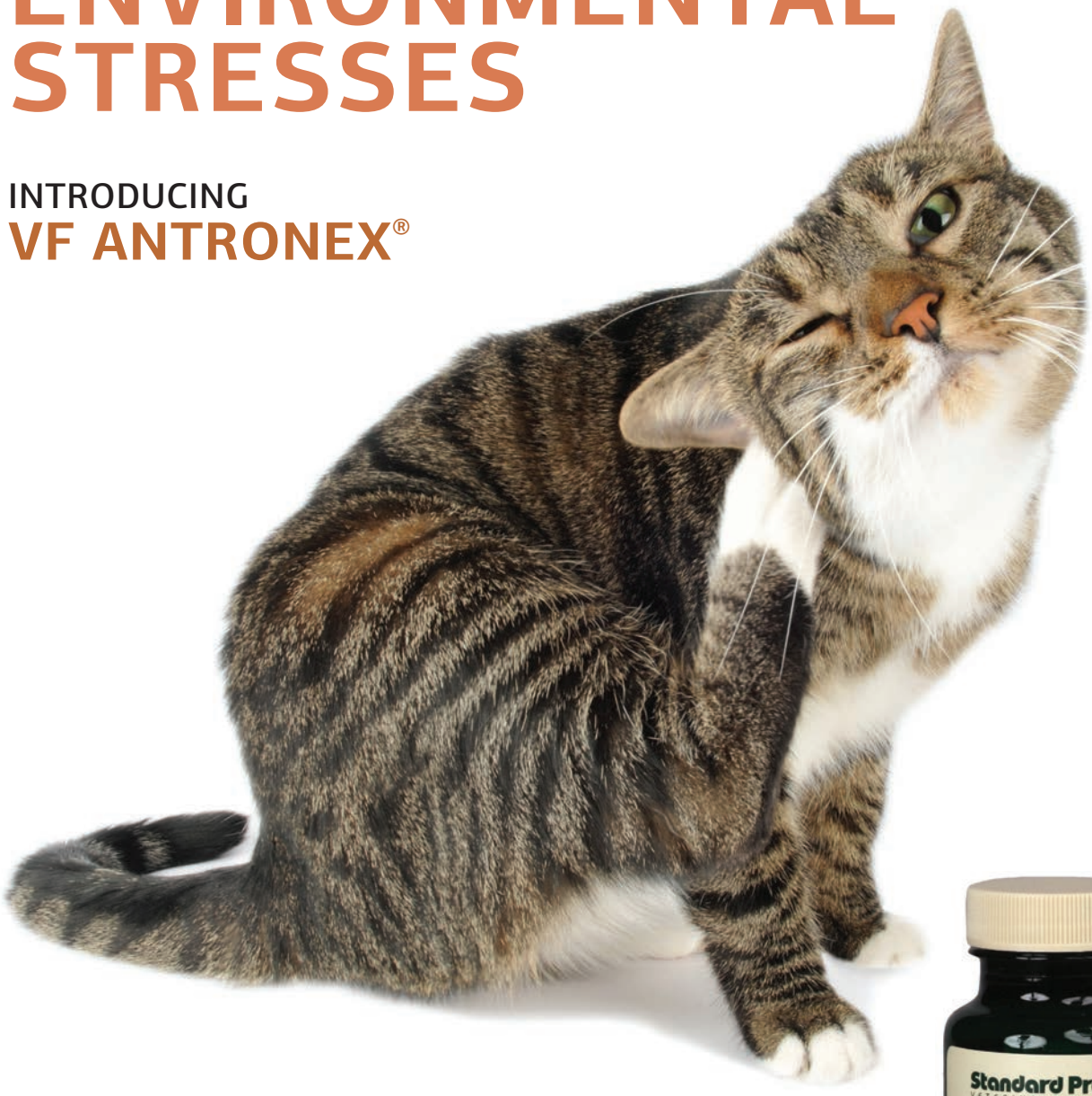
Dogmas of clinical pathology: Adjusted calcium, modified transudates, acidemias of acidoses, and more 81
Rights and wrongs of acid-base — let's get it right! 85
How (and why) did that get there? Pathogenesis of cavitary effusions 89
What analysis of cavitary effusions can tell you: A case discussion (Part 1) 93
What analysis of cavitary effusions can tell you: A case discussion (Part 2) 93

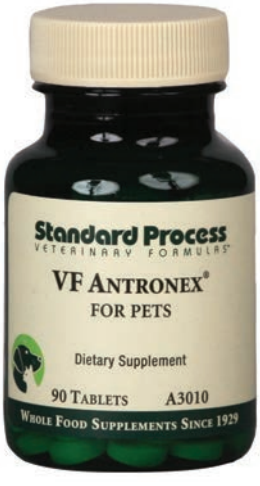
Expert²: The Power of Interaction

Virtual microscopy of lumps and bumps (Part 1): Let's look at the cells 99
Virtual microscopy of lumps and bumps (Part 2): Let's look at more cells 101
Virtual microscopy of lymph nodes: Lymphoma or just reactive? 102

DEFEND AGAINST ENVIRONMENTAL STRESSES

INTRODUCING
VF ANTRONEX®





Build the Body's Defenses with Whole Food Nutrient Solutions*

Sold Through Veterinary Professionals

WHOLE FOOD NUTRIENT SOLUTIONS
STANDARDPROCESS.COM

Standard Process®

*These statements have not been evaluated by the Food and Drug Administration. These products are not intended to diagnose, treat, cure, or prevent any disease.

Clinical Pharmacology

Sidonie Lavergne, DVM, PhD

Adverse drug reactions: A general introduction for clinicians 106
Environmental toxicants and immune disorders 108
Immunomodulatory therapy: Can clinicians play the immune system to their advantage? 110
Drug interactions in the life of a clinician 113
Antioxidant therapy 115
Antibiotic stewardship: Antibiotic resistance crises and veterinary medicine 117

Critical Care

Ari Jutkowitz, VMD, DACVECC

Where there's smoke, there's fire: Emergency treatment of house-fire victims 119
Reproductive emergencies 124
Managing difficult urethral obstructions 129
Diagnosing and treating pericardial effusion 133
The Addisonian crisis 137
Cardiopulmonary resuscitation: Current guidelines 141
Clinical approach to anemia 144
Immune-mediated hemolytic anemia: Current perspectives 148
Hypercoagulation in canine IMHA 152

Garret Pachtinger, VMD, DACVECC

Respiratory complications of trauma 155
Emergency management of DKA 159
Emergency management of hepatic lipidosis 165
Emergency approach to the hemoabdomen 171
Practical fluid therapy: It's more than just water and salt 175
ER life-saving procedures 178
Emergency management of cardiac disease 183
ER tools: Techy and non-techy ways to assess your patient 187

Dentistry

Heidi Lobprise, DVM, DAVDC

Periodontal basics: What not to forget 190
Advanced periodontal management for every clinic 193
Dental emergencies: A misnomer? 196
Oral tumors - the hidden challenge 200
Is seven the new senior? Realities of senior care 203
Senior dental care: Never too old for good dental health 206
Interactive oral radiograph reading session 209
Extractions: Headache or triumph? 212
Learn the Earn
Intraoral radiography: Not just a fancy coat rack- with Dr. K. Felsted 216

Dermatology

Paul Bloom, DVM, DACVD, DABVP

Diagnosing and managing cutaneous adverse food reactions 219
Autoimmune skin diseases 222
Update on diagnosing and treating Malassezia dermitidis and demodicosis in dogs 227
New drugs in veterinary dermatology 231
Diagnosing and managing non-pruritic alopecia in dogs 234
Expert²: The Power of Interaction
Dermatology disasters: What would you do? 239
Dermatology dilemmas: What would you do? 239
Dermatology difficulties: What would you do? 239

Rudayna Ghubash, DVM, DACVD

How taking a great history can make you a great dermatologist 240
Cutaneous manifestations of internal diseases 242
Dermatophytosis: Dealing with Typhoid Mary 243
What to do with those challenging dermatology cases 245
Toes and nose: Approach to diseases of the footpads and nasal planum 246
Approach to the pruritic cat 250
Approach to the pruritic dog 253

Craig Griffin, DVM, DACVD

Otitis: The complete diagnosis 256
Otitis: The first step in treatment 259
Otitis: Tips you can use 262
Ears: What you need to know 264
Food allergy: When to suspect it ..... No proceedings required
Diet trials: Getting success 267
Pruritus: What's new? 272
Pyodermatitis: Another perspective 275
Pyoderma: How complex is it? 277

dvm360 Leadership Challenge

Portia Stewart, Mindy Valcarcel, and Sarah Wooten, DVM

What's keeping you from loving your job? ..... No proceedings required

Steve Noonan, DVM, CPCC

The evidence-based power of mindfulness 280
Vaccines for happiness: Ten tips to take home today for practice positivity 283

dvm360 Full Circle

Andrew Roark, DVM, MS and Meghan Leigh Pierson

The angry client experience: When and where to say it ..... No proceedings required
The angry client experience: How to make it right ..... No proceedings required
The angry client experience: What to say and how to say it ..... No proceedings required

Heidi Lobprise, DVM, DAVDC; Bash Halow, LVT, CVPM; and Vickie Byard, CVT, VTS (Dentistry), CVJ

Dentistry: A team sport! Fumbles, penalties or touchdowns? ..... No proceedings required

Elizabeth Colleran, DVM, MS, DABVP; Ruth MacPete, DVM; and Heather Prendergast, RVT, CVPM

Catering to cats: Medicine, management, and money ..... No Proceedings Required

Jeannine Berger, DVM, DACVB, DACAW, CAWA; Karen Felsted, CPA, MS, DVM, CVPM; and Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP

The down-low on going slow: How low-stress benefits everyone ..... No proceedings required

Endocrinology

David Bruyette, DVM, DACVIM

The sometimes tricky art of diagnosing hyperadrenocorticism in dogs 287

The Right Dose for
Every Condition, Every Patient, Every Time

Accuracy, Engineered by Companion®

Meet the Future of Laser Therapy

The NEW feature-rich Companion CTX combines advanced features with re-designed approaches to dosing that give you an unmatched level of versatility and control over your treatments. Featuring 0.5 to 15 watts of therapeutic power and three different dosing solutions, the CTX is the perfect platform for the new, intermediate, and expert therapy laser user.

Call 302.709.0408 for an in-office, educational demonstration.

CompanionAnimalHealth.com
1.877.627.3858 | info@companiontherapy.com

COMPANION ANIMAL HEALTH
LiteCure, LLC

Exploring treatment options for canine hyperadrenocorticism 291
How I treat diabetes in cats 293
Insulin-resistant diabetes: What to do when insulin therapy stops working 298
A fool-proof method for managing hypothyroidism in dogs 300
Feline hyperthyroidism: Management and options for treatment 303
Getting to the bottom of polyuria and polydipsia 307
Learn then Earn
Canine diabetes: Acute care and long-term management and helping clients pay for it - with Dr. K. Felsted 310

Exotic Animal Medicine

Mark Mitchell, DVM, PhD, DECZM

Drink up! Fluid therapy considerations for exotic pets 315
Anesthetic considerations for exotic pets: It's about more than just passing gas 317
Infectious and parasitic diseases of captive reptiles: What is lurking under those scales? 319
Opening up Pandora's shell: Medical and surgical considerations for chelonians 321
Understanding the bowel wrapped in fur: Gastrointestinal diseases of rabbits and rodents 324
Ornamental fish 101: Managing pet fish without getting all wet 326
What's your diagnosis? Interactive exotic small mammal cases ATE Luncheon 329
Diagnostic imaging in reptiles: Am I supposed to see that? 331
Burned! Ultraviolet B radiation for exotic pets: The good, the bad, and the photokeratitis 333
Ring the bell, dinner's served: Nutritional considerations for captive reptiles 335

Fear-Free Practice

Jonathan Bloom, DVM

Modern love - Making pets happy at the veterinary hospital 337

Feline Medicine

Cindy Charlier, DVM, DAVDC

The simple tooth: Feline skull and tooth anatomy 339
Oral surgery to extract teeth in cats: Tips and techniques to avoid complications 344
Bad sound, bad word: Complications during tooth extraction 347
Shades of gray: Interpretation of feline dental radiographs 350
Feline oral tumors: Diagnosis and treatment 353
Feline gingivostomatitis: What we know and how we treat it 357

Dennis Chew, DVM, DACVIM

Feline urinalysis update 361
Diagnosing and treating urinary tract infections in cats 366
Managing cats with idiopathic/interstitial cystitis (Part 1) 372
Managing cats with idiopathic/interstitial cystitis (Part 2) 372
Updates on managing male cats with urethral obstruction 379
Acute kidney disease in cats: Diagnosing, managing, and preventing 385
Special aspects of diagnosing and managing chronic kidney disease in cats 392
Treating idiopathic hypercalcemia in cats: Case studies - diet or drugs 398

Elizabeth Colleran, DVM, MS, DABVP

Navigate bumps in the road: Steps to create a thriving Cat Friendly Practice 404
Communications boot camp: See more cats! 407
Old thin cats: Is it really just old age? 409
Complicated senior cats: Managing multiple conditions in one patient 411
Death and dying: The blessing and curse of euthanasia 414
Fat cats: New therapy and dietary management 416
Pandora syndrome: Not just the bladder anymore 418
The kidney and the parathyroid: A tale of substance and longevity 423
Acute and chronic pancreatitis: What to do? 425

Gastrointestinal Medicine

Michael Leib, DVM, MS, DACVIM

GI endoscopy in cats: What can we learn? 427
Acute pancreatitis in dogs: An update 431
Therapy of GI diseases: What's new with antiemetics, antacids, and probiotics? 434
Chronic diarrhea in dogs and cats: A practical diagnostic approach 437
Chronic vomiting in dogs and cats: The roles of ultrasonography in diagnosis and Helicobacter in treatment (Part 1) 445
Chronic vomiting in dogs and cats: The roles of ultrasonography in diagnosis and Helicobacter in treatment (Part 2) 445
Icterus in dogs and cats: A practical diagnostic approach 452
Giardia and Tritrichomonas foetus: An update 456
GI grab bag: Cool stuff not covered elsewhere 461
Dietary management of diarrhea 465

Craig Ruaux, BVSc, PhD, DACVIM

The "GI Panel": Use, abuse, and interpretation 469
IBD, FRD, SIBO…WTH? Rational management of chronic GI disease 473
Diagnosing and managing pancreatitis in the era of PLI 477
Protein-losing enteropathies: The black diamond cases 481
Blastocystis: A new pathogen, or just a 'thing'? 485
Exocrine pancreatic insufficiency: An old friend with some new tricks 489
Let's just monitor it: The pitfalls and problems with serial serum chemistries 493
Finicky feline: Pancreatitis in cats 496

Imaging

Anthony Pease, DVM, MS, DACVR

Urogenital imaging: Can I do a contrast procedure in practice? 500
Aggressive versus non-aggressive bone lesions 502
Radiographic assessment of developmental bone disorders 504
Exploring the pleura and mediastinum 505
Thoracic radiography cases: Real world examples that make you think 506

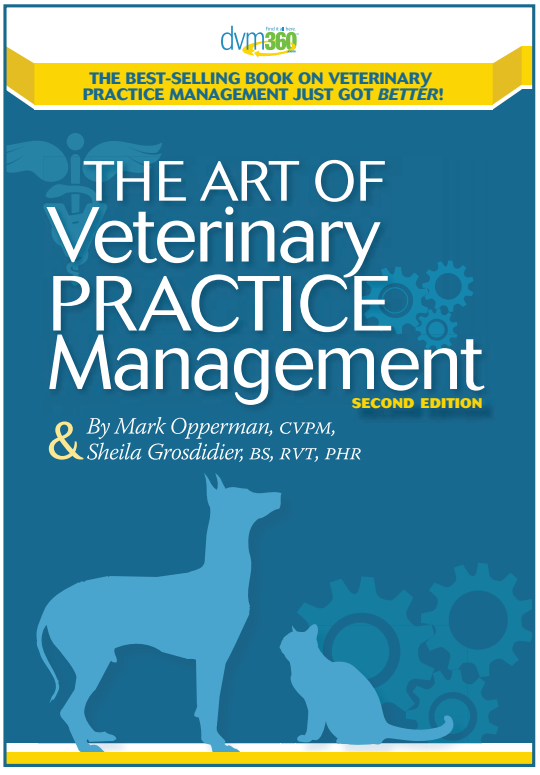
Meet Mark and Sheila at a book-signing!

They'll be at **Booth 421,** the **dvm360 Relax and Recharge Lounge**, on Sunday, from 12:00 PM to 1:00 PM. Bring your book or buy a copy on hand. See you there!

The best-selling book on veterinary practice management just got better.

Mark Opperman
CVPM

Sheila Grosdidier
BS, RVT, PHR



Take your practice to new heights with the 2nd Edition!

Written for practice managers, veterinarians managing their practice, and graduating veterinarians, **The Art of Veterinary Practice Management, 2nd Edition** combines Mark and Sheila's wealth of insights and practical experience with outside-the-box, big-picture thinking.

This isn't just *any* update. It packs a hundred pages more than the best-selling original! On top of more than 20 freshly written chapters, the 2nd Edition includes checklists, permission forms, report cards, opposition research reports, performance evaluations and phased training for modern team positions, sample marketing, personnel file guidelines, employee contracts, and more!

Go to industrymatter.com/opperman

(use discount code **CVCSAVINGS** before December 11, 2015 and save 30%!)

or call 1-800-598-6008

dvm360 Find it all here. dvm360.com

Veterinary economics The business of client and patient care

industrymatter comprehensive information for professionals

UBM

Musculoskeletal radiography: When is a fracture a tumor?....508
Radiography's role in the acute abdomen case....509
Learn then Earn
Ultrasound cases: What can I really see with some practice and how to communicate value to pet owners - with Dr. K. Felsted....510

In This Case

David Bruyette, DVM, DACVIM and Ellen Behrend (online collaborator), VMD, PhD, DACVIM
Hormones from Hell! So you thought Cushing's was easy? ....No proceedings required

Bash Halow, LVT, CVPM
HR Rounds: How to tell colleagues what you really think without someone quitting or getting fired ....No proceedings required

Garret Pachtinger, VMD, DACVECC and Justine Lee (online collaborator), DVM, DACVECC, DABT
Endocrine Emergencies: When not to sugarcoat it ....No proceedings required

Neurology

William Bush, VMD, DACVIM
Upper *vs* lower motor neuron: Never miss again after this videocase presentation....512
Central *vs* peripheral vestibular disease: A matter of life or death....515
Common and deadly: Recognizing and treating inflammatory disease of the brain, spinal cord, and meninges....518
Nonconvulsive seizure: Clandestine, common, and important....522
Idiopathic *vs* structural epilepsy: Clinical guidelines for making this vital distinction....525
When and how to treat acute and chronic seizures, optimizing new-generation antiepileptics....527
Why dog is man's best friend: Exciting results of neurologic clinical trials....532
Ouch! Recognizing and treating neck or back pain....535
Diagnosing and treating the five disk diseases: Why is MRI so important?....540

Nutrition

Sean Delaney, DVM, MS, DACVN
Feeding the food-allergic patient successfully....543
Be the biggest winner with weight loss....544
So many foods, so little time, money, and space - help!....548
What I have learned from 20,000+ therapeutic homemade diets....550
When dietary fat is just too much fat....552
Urolithiasis: Is nutritional management written in stone?....553

Oncology

Timothy Fan, DVM, PhD, DACVIM
Nuts and bolts of canine osteosarcoma - with Dr. K. Wycislo....555
Canine lymphoma: What's on the horizon – with Dr. K. Wycislo....557
Canine hemangiosarcoma: Rational future targets - with Dr. K. Wycislo....559
Mast cell tumors: The good, the bad, and the ugly - with Dr. K. Wycislo....561
Transitional cell and prostate carcinomas: Best therapeutic options - with Dr. K. Wycislo....564
Plasma cell tumors: The interesting cancer - with Dr. K. Wycislo....566
Nasal tumors: Differentials and treatment options - with Dr. K. Wycislo....569

Kathryn Wycislo, DVM, DACVP
Nuts and bolts of canine osteosarcoma - with Dr. T. Fan....555
Canine lymphoma: What's on the horizon – with Dr. T. Fan....557
Canine hemangiosarcoma: Rational future targets - with Dr. T. Fan....559
Mast cell tumors: The good, the bad, and the ugly - with Dr. T. Fan....561
Transitional cell and prostate carcinomas: Best therapeutic options - with Dr. T. Fan....564
Plasma cell tumors: The interesting cancer - with Dr. T. Fan....566
Nasal tumors: Differentials and treatment options - with Dr. T. Fan....569

Ophthalmology

Reuben Merideth, DVM, DACVO
Corneal disease (Part 1)....Proceedings not submitted
Corneal disease (Part 2)....Proceedings not submitted
Ophthalmic exam....Proceedings not submitted

Emily Moeller, DVM, DACVO
Ocular emergencies....572
Funduscopic exam....575
Anterior uveitis....576

Rustin Sturgeon, DVM, DACVO
Glaucoma: Initial diagnosis and medical management ....Proceedings not submitted
Glaucoma: Surgeries of comfort and vision preservation ....Proceedings not submitted
How to approach the squinty cat....Proceedings not submitted

Orthopedics

Jennifer Wardlaw, DVM, MS, DACVS
Evidence-based approach to cranial cruciate repair surgery....578
Surgical options for repairing luxating patellas....580
Managing hip dysplasia in young dogs....582
Managing hip dysplasia in old dogs....585
Cats get arthritis too....587
Bad hips and bad knees — now what?....589
Developmental orthopedic diseases....591
Learn then Earn
Laser use in physical rehabilitation and adding it to your practice – with Dr. K. Felsted....593


Hill's
STRESS-RELATED GI UPSET
Relax,
you've got this
PROPRIETARY ANTI-STRESS FORMULA WITH HYDROLYZED CASEIN
PREBIOTIC FIBER TO SUPPORT INTESTINAL MICROBIOME
SOOTHING INGREDIENTS, INCLUDING GINGER, TO CALM THE GI TRACT
NEW PRESCRIPTION DIET®
i/d® Stress
FIRST and ONLY GI nutrition to help alleviate stress-related GI upset in dogs up to 30 lbs.
Together we can take the stress out of GI problems.
Hill's PRESCRIPTION DIET
Digestive Care
i/d
Stress
CLINICAL NUTRITION
Chicken Flavor
For more information, talk to your Hill's Representative.
©2015 Hill's Pet Nutrition, Inc. ®/™ Trademarks owned by Hill's Pet Nutrition, Inc.
HillsVet.com

Pain Management

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA

Osteoarthritis in dogs and cats: Why it is so important to know what's going on in there 594
Managing the pain of osteoarthritis in dogs and cats 597
Nonpharmaceutical treatment of osteoarthritis: Rehaviligation, acupuncture, and more 600
Emerging modalities in the treatment of pain 603
Pain in cats: An integrative approach 605
Myofascial pain: What's all the buzz? 609
Nutraceuticals for pain – ATE Luncheon 611

Parasitology

Richard Gerhold, DVM, MS, PhD

Poop in the coop: What it tells you about backyard chicken parasites 615
Worm in the brain: Update on meningeal worm infection in goats, sheep, and camelids 617
How to identify and treat Toxoplasma, Isospora, and other coccidial infections 618
Ticks and the diseases they cause in pets — ehrlichiosis, anaplasmosis, cytauxzoonosis, and more 621
Ticks and the diseases they cause in pets and people: Lyme borreliosis, tick paralysis, Rocky Mountain spotted fever 624
Non tick-borne diseases: Avian and swine influenza, bartonellosis, leptospirosis, rabies, and more 627

Professional Issues

Tony Bartels, DVM, MBA and Paul Pion, DVM, DACVIM

Student Debt: Base Camp. What every new graduate and seasoned veterinarian should know about veterinary student debt ..... No proceedings required
Climbing and surviving Mt. Student Debt: Real-world experiences and insights ..... No proceedings required

Tony Bartels, DVM, MBA; Paul Pion, DVM, DACVIM; and Alice Villalobos, DVM, FNAP

The Practical and Emotional Impact of Student debt: Surviving the pain without the shame ..... No proceedings required

Shelter Medicine

Jeanette O'Quin, DVM, MPH

Animal hoarding is hazardous to all: How to keep your staff safe ..... Proceedings not submitted
Animal hoarding is hazardous to all: Prosecution, intervention, or both ..... Proceedings not submitted
Investigating nonaccidental trauma ..... Proceedings not submitted
Humane euthanasia: Reducing shelter animal stress ..... Proceedings not submitted
Health risks for shelter workers: Caring for the caregivers ..... Proceedings not submitted
Planning an outbreak response: Fun with policies and protocols ..... Proceedings not submitted

Soft Tissue Surgery

Philipp Mayhew, BVM&S, DACVS

Introduction to laparoscopy: Achieving big things through small holes 631
Ear surgery: Pick the right technique and avoid complications 635
Gall bladder mucoceles: The kiwi inside 638
Thyroid and parathyroid surgeries 640
Gastric dilation and volvulus 643
Rectal tumors: The good, the bad, and the ugly 646
Hernias of the diaphragm: Traumatic, pericardioperitoneal, and hiatal 648
Hemostasis and electrosurgery: When to use what where 651

Toxicology

Tina Wismer, DVM, DABT, DABVT

Managing the mystery poisoning patient 653
Mood-altering drugs and serotonin syndrome 655
Hot topics in clinical toxicology 657
Toxicology case studies ..... ATE Luncheon ..... No proceedings required
New antidotal therapies 660
Toxicology of herbal medications 664
Managing toxicosis in exotic species 667

Urology

Joe Bartges, DVM, PhD, DACVIM, DACVN

Urine pain: UTI 671
Urine agony: Urolithiasis 677
Urine a mess: Micturition disorders 685
Urine a losing situation: Proteinuria 690
Getting the most out of liquid gold: Urinalysis 697
Urine a quandary: Feline idiopathic cystitis 700
The skinny on fat: Obesity 707

Practice Management

Karen Felsted, CPA, MS, DVM, CVPM

Forget profit - here's what really adds value to a practice 716
Smart ways to help clients pay 719
Financial horror stories and how to avoid them 722
Learn then Earn
Diabetes in dogs: Acute care and long-term management and how you can help clients pay for it – with Dr. D. Bruyette 723
Ultrasound cases: What can I really see with practice and how to communicate value to pet owners - with Dr. A. Pease 728
Laser use in physical rehabilitation and adding it to your practice - with Dr. J. Wardlaw 730
Intraoral radiography - Not just a fancy coat rack - with Dr. H. Lobprise 731
Pain medication: A win, win situation for you, your patients, and your clients – with Dr. A. Claude 734

Sheila Grosdidier, BS, RVT

Ideal outpatient visits - from check-in to check-out - with M. Opperman, CVPM 735
Associate case studies: Who gets hired and fired - and why – with M. Opperman, CVPM 736
Salary, production, ProSal: What's best for your practice? – with M. Opperman, CVPM 737

Bash Halow, LVT, CVPM

Stop the day-to-day time suckers and start managing for the future 740

From Eureka to Action

Why and How to Create a Fear-Free™ Practice

Dr. Marty Becker is on a mission to make Fear-Free veterinary visits a reality for pets. He's outspoken about the need, and his message is eye-opening. In this symposium, you'll learn how to use Fear-Free concepts to:

- put animals and owners at ease
- deliver a higher level of compassionate care
- earn repeat visits.

You will also receive a copy of the new brochure *"Top 10 Ways to Get Started with Fear-Free Veterinary Visits."*

7:15 – 8:15 AM Marty Becker, DVM
Fear-Free tools to transform patient interactions, boost visits, and enhance your practice

8:25 – 9:25 AM Richard LeCouteur, BVSC, PhD, DACVIM (Neurology), DECVN
The science of fear in animals: It's real. It's damaging. It's our responsibility.

10:00 – 11:00 AM Lisa Radosta, DVM, DACVB
Fear-Free techniques: Clinical behavioral evidence that they work

11:20 AM – 12:20 PM Jonathan Bloom, DVM
Modern love — Making pets happy at the veterinary hospital

FEAR-FREE™ PRACTICE SYMPOSIUM

Saturday, December 5, 2015
*7:15 AM - 12:20 PM
San Diego Convention Center
Room 33 AB

*Eye Opener Breakfast will open at 6:45 AM in Ballroom 20 A.

Proud sponsors of the **Fear-Free™** Initiative

Boehringer Ingelheim
Ceva
Elanco

For the practice owner or manager who's tried everything: Management, marketing, growth centers, and client education that will genuinely impact revenue
ATE Luncheon ..... Proceedings not required
Build a new business model for the 21st century 742
Case study: Veterinary phone call disasters 744
Leaders, you are not alone: Top tips from the nation's top veterinary leaders 746
5 sure-fire ways to improve your bottom line 748
Conquering the cold shoulder: Fixing team communication 751
"Right up": Employee discipline that shows results 754
Why your team is mad at you - and how to fix it 757
Building a shopaholic-friendly pharmacy 758
10 take-home marketing tactics to try today 761

Jeremy Keen, DVM
Stop receptionists from turning clients away 764
Small things technicians do to congest clinics 766
How DVMs drive clients crazy - and how to avoid it 768

Ruth MacPete, DVM
Say this, not that: The art of a great recommendation 770
5 secrets to lifelong clients 772
How to deal with Dr. Google 773
How to build a great clinic team 774
What to do with a bad online review 776

Shawn McVey, MA, MSW
The case for emotional intelligence in practice 777
Commando conversations: Becoming conflict-competent 782
How to build a conflict-competent team 787
Leaders or managers: What's the difference? 791
How to rally your associates to be practice leaders 794

Dave Nicol, BVMS
Digital marketing immersion: A sales funnel that brings clients ..... Proceedings not submitted
Feedback: Putting client and team member feedback to work ..... Proceedings not submitted
Dr. Who: Be a Time (Management) Lord ..... Proceedings not submitted
Practice Management Happy Hour: Hiring, firing, and thriving in between - with Dr. A. Roark ..... No proceedings required
Marketing ninja: Build business in 2 hours a week ..... Proceedings not submitted
Top 20 exam room mistakes - and how to avoid them ..... Proceedings not submitted
What you can learn from The Lord of the Rings ..... Proceedings not submitted

Mark Opperman, CVPM
Stop the price war and show value to clients (Part 1) 798
Stop the price war and show value to clients (Part 2) 798
Setting fees you're comfortable with 806
Ideal outpatient visits - from check-in to check-out - with S. Grosdidier, BS, RVT 807
Associate case studies: Who gets hired and fired - and why - with S. Grosdidier, BS, RVT 808
Salary, production, ProSal: What's best for your practice? - with S. Grosdidier, BS, RVT 809

Heather Prendergast, RVT, CVPM
Associate skills: Why leadership and personality matters 812
How to be the leader your team needs 814
It could be you: Protect yourself from embezzlement 816

Andrew Roark, DVM, MS
Practice Management Happy Hour: Hiring, firing, and thriving in between- with Dr. D. Nicol ..... No proceedings required

Denise Tumblin, CPA
Shake things up to grow your practice 818
It's time to get serious about the budget 823
What Well-Managed Practices pay - Are you in the ballpark? 826
Write an Rx for your success (Part 1) 828
Write an Rx for your success (Part 2) 828
Find practice health - Get LEAN! 832

Technician Program

Joe Bartges, DVM, PhD, DACVIM, DACVN
Pebbles in the stream: Nephroureterolithiasis 834
Why cats are not small dogs: Feline nutrition 838

Jeannine Berger, DVM, DACVB, DACAW, CAWA
Bringing your dog to work 842

David Bruyette, DVM, DACVIM
Thyroid disease in dogs and cats 844

Barret Bulmer, DVM, MS, DACVIM
Managing expectations and maximizing patient outcome with cardiovascular disease 850

William Bush, VMD, DACVIM
Neurolocalization: Why does this dog walk so funny? 851

Vickie Byard, CVT, VTS (Dentistry), CVJ
Dental equipment maintenance and technician safety 853
Dental charting: It is more than just Xs and Os 856
Out of sight! Are intraoral radiographs important for a complete dental assessment? 858
Pain management and regional nerve blocks in small animal dental patients 860
Periodontal disease: The most prevalent veterinary disease 862
Gaining compliance: Getting those dentistries to the table 865

Rudayna Ghubash, DVM, DACVD
Approach to cutaneous cytology 867

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Pain: Detection and management 869

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
Overview of practical avian parasitology for technicians 871

Craig Griffin, DVM, DACVD
Ears: What is that structure? ..... Proceedings not submitted

Boehringer Ingelheim

MINIMALISM CAN BE MAGNIFICENT.

The ULTRA line of 0.5 mL vaccines* offers:

- Pet owners effective protection with minimal injection volume for their pet
- Veterinarians the opportunity to provide a better vaccine experience for their patients

And that's a beautiful thing.

Contact your Boehringer Ingelheim Vetmedica, Inc. sales representative or visit ULTRAvaccines.com to learn more.

ULTRA™ VACCINES

Vaccines reimagined.

*The ULTRA vaccine line includes ULTRA™ Duramune® and ULTRA™ Fel-O-Vax®.

Sheila Grosdidier, BS, RVT
Video lessons: Be an exam room hero 874
Video lessons: Technician tools that really work 877
Video lessons: Making the first 90 days count - in any job..... 880

Ari Jutkowitz, VMD, DACVECC
Transfusion Medicine..... 881

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Pain management in the ER: The fifth vital sign..... 885
Critical care patient monitoring 888
Traumatic brain injury management: Not just the head needs treating..... 892
Critical care nursing: Tales from the trenches..... 895
Gut drugs: GI pharmacology..... 896
Understanding endocrine testing..... 900

Mark Mitchell, DVM, PhD, DECZM
Clinical pathology and the exotic pet: Where do I stick the needle and what's with all those nucleated cells?..... 904

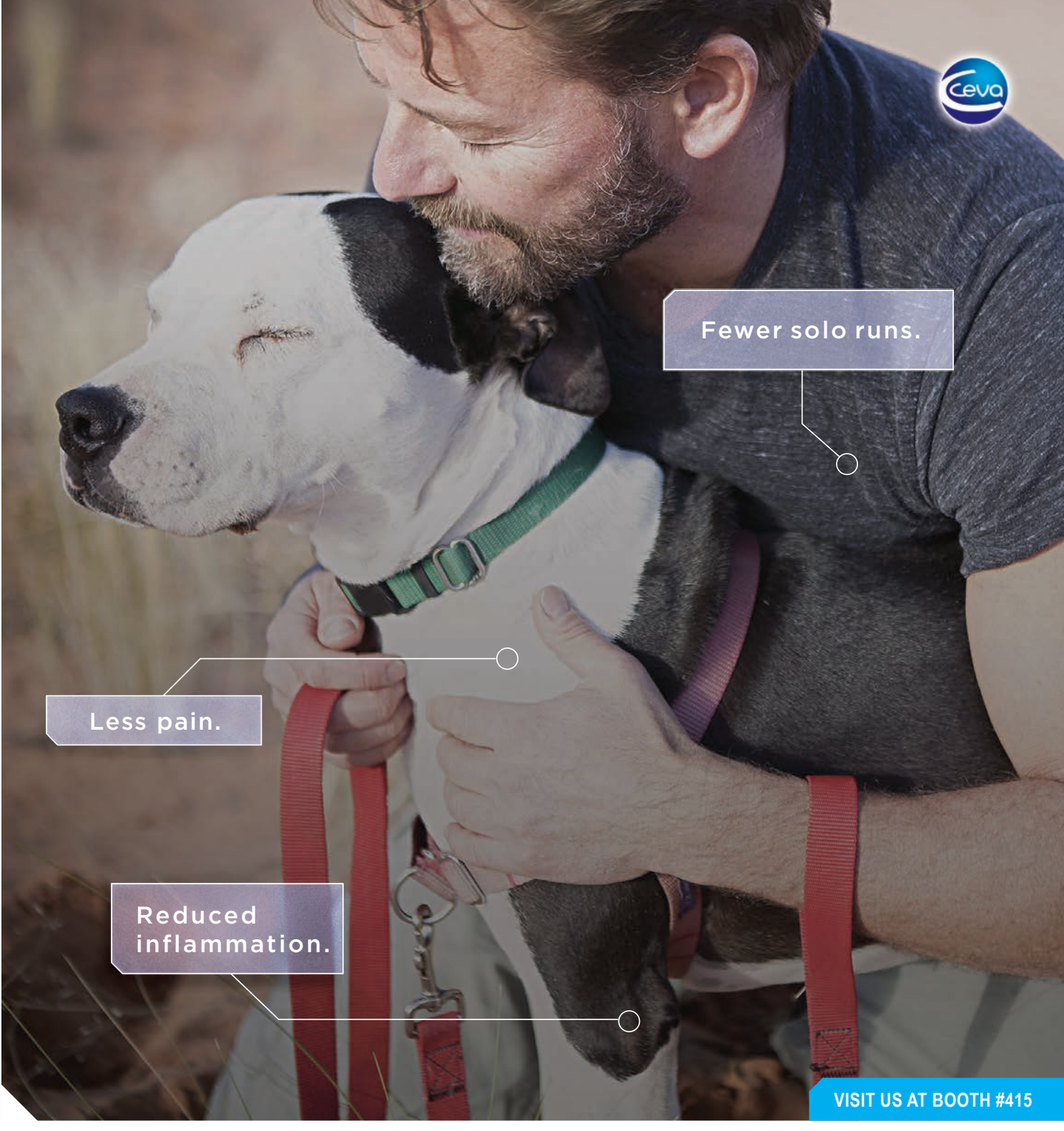
Jeanette O'Quin, DVM, MPH
Don't get caught by a zoonotic disease ..... Proceedings not submitted

Garret Pachtinger, VMD, DACVECC
Pediatric and reproductive emergency room pearls..... 906

Anthony Pease, DVM, MS, DACVR
Digital Imaging: Is it time to make the switch? 909

Heather Prendergast, RVT, CVPM
Making the move from technician to lead technician..... 910
Technician accountabilities that enhance productivity 912
Becoming the indispensable team member..... 914

Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP
How anthropomorphism, communication, and learning theory change patient perceptions of common procedures (Part 1) 917
How anthropomorphism, communication, and learning theory change patient perceptions of common procedures (Part 2) 917
What is socialization anyway? ..... Proceedings not submitted
10 things technicians can do to improve animal behavior 920
Behavior therapies: From natural supplements to pharmaceuticals 925



When dogs have osteoarthritis, everyone suffers. But at Ceva, we think nobody should have to feel that pain. Which is why we created Meloxidyl® (meloxicam), a trusted NSAID to control the pain and inflammation associated with osteoarthritis. In addition to relieving pain with Meloxidyl®, dietary changes, supplements, as well as lifestyle changes may help manage osteoarthritis in the long term. Contact your Ceva Distributor or Sales Representative to learn more about Ceva's solutions for osteoarthritis.

DO NOT USE MELOXIDYL ORAL SUSPENSION IN CATS. Acute renal failure and death have been associated with the use of meloxicam in cats. Dogs with known hypersensitivity to meloxicam or other NSAIDs should not receive Meloxidyl Oral Suspension. Meloxidyl Oral Suspension is not recommended for use in dogs with bleeding disorders. If vomiting, diarrhea, decreased appetite or other signs of illness are seen, discontinue treatment immediately.

617786 USA 921849

Osurnia

(florfenicol•terbinafine•betamethasone acetate)

Otic gel
Antibacterial, antifungal, anti-inflammatory

For Otic Use in Dogs Only

Caution:
Federal (USA) law restricts this drug to use by or on the order of a licensed veterinarian.

Description:
OSURNIA contains 10 mg florfenicol, 10 mg terbinafine and 1 mg betamethasone acetate per mL and the inactive ingredients propylene carbonate, glycerol formal, hypromellose, phospholipid, oleic acid and BHT in an off-white to slightly yellow translucent gel.

Indication:
OSURNIA is indicated for the treatment of otitis externa in dogs associated with susceptible strains of bacteria *(Staphylococcus pseudintermedius)* and yeast *(Malassezia pachydermatis).*

Dosage and Administration:
OSURNIA should be administered in the clinic. Clean and dry the external ear canal before administering the initial dose of the product. Administer one dose (1 tube) per affected ear(s) and repeat administration in 7 days.
Do not clean the ear canal for 45 days after the initial administration to allow contact of the gel with the ear canal. Cleaning the ear may affect product effectiveness (see **Effectiveness**). If alternative otic therapies are required it is recommended to clean the ear(s) before application.
Open tube by twisting the soft tip. Insert the flexible tip into the affected external ear canal(s) and squeeze entire tube contents into the external ear canal(s). After application, gently massage the base of the ear to allow the gel to penetrate to the lower part of the ear canal.

Contraindications:
Do not use in dogs with known tympanic perforation (see **Precautions**).
Do not use in dogs with a hypersensitivity to florfenicol, terbinafine or corticosteroids.

Warnings:
Not for use in humans. Keep this and all medications out of reach of children. Consult a physician in case of accidental ingestion by humans. In case of accidental skin contact, wash area thoroughly with water. Avoid contact to the eyes.

Precautions:
Do not administer orally.
The use of OSURNIA in dogs with perforated tympanic membranes has not been evaluated. The integrity of the tympanic membrane should be confirmed before administering this product. Reevaluate the dog if hearing loss or signs of vestibular dysfunction are observed during treatment.
Use of topical otic corticosteroids has been associated with adrenocortical suppression and iatrogenic hyperadrenocorticism in dogs (see **Animal Safety**).
Use with caution in dogs with impaired hepatic function (see **Animal Safety and Adverse Reactions**).
The safe use of OSURNIA in dogs used for breeding purposes, during pregnancy, or in lactating bitches, has not been evaluated.

Adverse Reactions:
The following adverse reactions were reported during the course of a US field study for treatment of otitis externa in dogs treated with OSURNIA with 1 tube per affected ear(s) and repeated after 7 days:

Frequency of Adverse Reaction by Treatment

Adverse Reaction		
	OSURNIA (n=190)	Placebo (n=94)
Elevated Alkaline Phosphatase	15 (7.9%)	3 (3.2%)
Vomiting	7 (3.7%)	1 (1.1%)
Elevated AST, ALT, ALP*	2 (1.1%)	0 (0.0%)
Weight loss (>10% body weight)	1 (0.53%)	0 (0.0%)
Hearing Decrease/Loss	1 (0.53%)	1 (1.1%)

*Aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP). Two dogs with pre-existing elevations in ALP were reported to have an increase in liver enzymes (ALP, ALT and/or AST) at study exit. Subsequent clinical chemistries returned to pre-treatment levels in one dog, while no follow up was performed for the second dog.

To report suspected adverse drug events, contact Novartis Animal Health at 1-800-332-2761. For additional information about adverse drug experience reporting for animal drugs, contact the FDA at 1-888-FDA-VETS or http://www.fda.gov/AnimalVeterinary/SafetyHealth
For technical assistance, contact Novartis Animal Health at 1-800-332-2761.

Clinical Pharmacology:
OSURNIA is a fixed combination of three active substances: florfenicol (antibacterial), terbinafine (antifungal) and betamethasone acetate (steroidal anti-inflammatory).
Florfenicol is a bacteriostatic antibiotic which acts by inhibiting protein synthesis. Its spectrum of activity includes Gram-positive and Gram-negative bacteria.
Terbinafine is an antifungal which selectively inhibits the early synthesis of ergosterol.
Betamethasone acetate is a glucocorticosteroid with anti-inflammatory activity.
OSURNIA dissolves in ear wax and is slowly eliminated from the ear mechanically. Ear inflammation can increase the percutaneous absorption of active substances in OSURNIA. In a laboratory study conducted in healthy dogs (see **Animal Safety**), low plasma concentrations of florfenicol, terbinafine, and betamethasone acetate were measurable during the first 2-4 days after administration of 1X dose, and during the first 2-7 days after administration of 5X dose. No quantifiable plasma concentrations of any of the three active ingredients were observed in the pre-dose samples of most dogs prior to second and third administrations. Although total and peak exposure in the blood tended to be highly variable between dogs, systemic drug concentrations tended to increase in a less than dose-proportional manner as the administered dose increased from 1X to 5X.

Microbiology:
The compatibility and additive effect of each of the components in OSURNIA was demonstrated in a component effectiveness and non-interference study. An *in vitro* study of organisms collected from clinical cases of otitis externa in dogs determined that florfenicol and terbinafine inhibit the growth of bacteria and yeast commonly associated with otitis externa in dogs. No consistent synergistic or antagonistic effect of the two antimicrobials was demonstrated. The addition of betamethasone acetate to the combination did not impair antimicrobial activity to any clinically significant extent.

In a field study (see **Effectiveness**), the minimum of 10 isolates from successfully treated cases with OSURNIA was met for *Staphylococcus pseudintermedius, Malassezia pachydermatis,* and *Pseudomonas aeruginosa.* However, there were only three dogs where *P. aeruginosa* was the only pathogen cultured and they were all treatment failures. Therefore, OSURNIA may not be effective in treating otitis externa in which *P. aeruginosa* is the only pathogen present.

Effectiveness:
Effectiveness was evaluated in 235 dogs with otitis externa. The study was a double-masked field study with a placebo control (vehicle without the active ingredients). One hundred and fifty-nine dogs were treated with OSURNIA and seventy-six dogs were treated with the placebo control. All dogs were evaluated for safety. Treatment (1 mL) was administered to the affected ear(s) and repeated 7 days later. Prior to the first administration, the ear(s) were cleaned with saline but not prior to the Day 7 administration. Six clinical signs associated with otitis externa were evaluated: pain, erythema, exudate, swelling, odor and ulceration. Total clinical scores were assigned for a dog based on the severity of each clinical sign on Days 0, 7, 14, 30 and 45. Success was determined by clinical improvement at Day 45. The success rates of the two groups were significantly different (p=0.0094); 64.78% of dogs administered OSURNIA were successfully treated, compared to 43.42% of the dogs in the placebo control group.

Animal Safety:
In a target animal safety study, 24 mixed breed dogs (4 dogs/sex/group) were aurally administered 0X, 1X (1 mL/ear or 2 mL/dog with repeated administration in 7 days) or 5X (5 mL/ear or 10 mL/dog with repeated administration in 7 days) doses of OSURNIA for a total of 6 administrations in 5 weeks. All dogs remained in good health with normal hearing throughout the study. Decreased weight gain was noted in the 1X and 5X groups compared to the control group. Clinical findings included post-administration ear wetness in 1X and 5X groups and unilateral, transient brown/red discharge from one ear each in two 5X dogs, with erythema in one dog after the 4th application. Local microscopic changes in ears (without clinical effects) included: slight or moderate unilateral vesicle formation within the epithelium of the tympanic membrane in two 1X and four 5X dogs, and unilateral mucosal ulceration in the lining of the middle ear cavity in three 5X dogs. Three 5X dogs had slightly elevated ALT activity, accompanied by minimal or mild microscopic hepatocellular vacuolation (in two dogs). Cortisol response to ACTH stimulation was decreased, but within the normal reference range, in 1X dogs. The 5X dogs had a decrease in serum cortisol levels after ACTH stimulation (below normal reference range) accompanied by decreased adrenal gland and thymic weights with minimal adrenal cortical atrophy and slight (in three dogs) or moderate (in one dog also noted with slightly lower lymphocyte counts) lymphoid depletion of the thymus. The ACTH stimulation test results are consistent with systemic absorption of betamethasone resulting in a likely reversible suppression of the hypothalamic-pituitary-adrenal axis as seen with administration of exogenous corticosteroids.

Storage Conditions:
OSURNIA should be stored under refrigerated conditions between 36° - 46° F (2° - 8° C). To facilitate comfort during administration, OSURNIA may be brought to room temperature and stored for up to three months.

How Supplied:
OSURNIA is a gel in a single use tube with a flexible soft tip, supplied in cartons containing 2 or 20 tubes.

NADA # 141-437, Approved by FDA

Manufactured for:
Novartis Animal Health US, Inc., Greensboro, NC 27408 USA

Made in UK

NAH/OSU-GEL/VI/2

NOVARTIS

617745

Treating otitis externa just got easier.

Just two doses per ear, dosed one week apart

done.

The simple treatment for otitis externa*, with easy application.

- Just two doses per ear, dosed one week apart
- Same dose for every dog
- Single-dose tube with soft, flexible tip is gentle on a dog's ears
- Easy application may lead to better compliance

Ask your Elanco Animal Health sales representative about OSURNIA today.

NEW

Osurnia®

(florfenicol•terbinafine•betamethasone acetate)

To learn more visit the Elanco Booth 500.

Important Safety Information

OSURNIA® (florfenicol/terbinafine/betamethasone acetate) is for otic use only under veterinary supervision. Do not use in dogs with known tympanic perforation or a hypersensitivity to florfenicol, terbinafine or corticosteroids. Adverse reactions observed during clinical trials include vomiting, increased liver enzymes and transient loss of hearing. Please see product insert on page xviii for additional information.

*Associated with susceptible strains of bacteria (*Staphylococcus pseudintermedius*) and yeast (*Malassezia pachydermatis*).

Elanco™

Meet The Speakers

Exhibit Hall Hours

Friday, December 4: 10:00 AM - 6:45 PM
Saturday, December 5: 9:00 AM - 5:00 PM
Sunday, December 6: 9:00 AM - 2:00 PM

Anesthesia
Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

Avian Medicine
***Cheryl Greenacre, DVM, DABVP (Avian, ECM)**
University of Tennessee
Knoxville, TN

Behavior
***Jeannine Berger, DVM, DACVB, DACAW, CAWA**
San Francisco SPCA
San Francisco, CA

Martin Godbout, DVM, MS, DACVB
Daubigny Veterinary Group
Quebec, Canada

Canine Sports Medicine
***Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR**
Wisconsin Veterinary Referral Center
Waukesha, WI

Cardiology
***Barret Bulmer, DVM, MS, DACVIM**
Tufts Veterinary Emergency Treatment and Specialties
Walpole, MA

Clinical Pathology
Steven Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

Clinical Pharmacology
Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

Critical Care
***Ari Jutkowitz, VMD, DACVECC**
Michigan State University
East Lansing, MI

****Justine Lee, DVM, DACVECC, DABT**
VetGirl, LLC
St. Paul, MN

***Garret Pachtinger, VMD, DACVECC**
Veterinary Specialty and Emergency Center
Levittown, PA

**Participating in the Technician Program*
***Online Collaborator*

Dentistry
Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

Jennifer Mathis, DVM, CVMA, CVPP, CVJ
Family Pet Veterinary Center
West Des Moines, IA

Dermatology
Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin, and Ear Clinic for Pets
Livonia, MI

***Rudayna Ghubash, DVM, DACVD**
Animal Dermatology Clinic
Marina del Rey, CA

***Craig Griffin, DVM, DACVD**
Animal Dermatology Clinic
San Diego, CA

dvm360 Leadership Challenge
Steve Noonan, DVM, CPCC
Effecti-Vet Corporation
Ontario, Canada

Portia Stewart
Firstline
Lenexa, KS

Mindy Valcarcel
Veterinary Medicine
Lenexa, KS

Sarah Wooten, DVM
Sheep Draw Veterinary Hospital
Greeley, CO

Endocrinology
****Ellen Behrend, VMD, PhD, DACVIM**
Auburn University
Auburn, AL

***David Bruyette, DVM, DACVIM**
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Exotic Animal Medicine
***Mark Mitchell, DVM, PhD, DECZM**
University of Illinois
Urbana, IL

Feline Medicine
Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

Gastrointestinal Medicine
Michael Leib, DVM, MS, DACVIM
Virginia-Maryland College of Veterinary Medicine
Blacksburg, VA

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

Imaging
***Anthony Pease, DVM, MS, DACVR**
Michigan State University
East Lansing, MI

Neurology
***William Bush, VMD, DACVIM**
Bush Veterinary Neurology Service
Frederick, MD

Nutrition
Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

Oncology
Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Ophthalmology
Reuben Merideth, DVM, DACVO
Eye Care for Animals
Tucson, AZ

Emily Moeller, DVM, DACVO
Eye Care for Animals
Tucson, AZ

Rustin Sturgeon, DVM, DACVO
Eye Care for Animals
Overland Park, KS

Orthopedics
Sean Aiken, DVM, MS, DACVS
Veterinary Specialty Hospital San Diego
San Diego, CA

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Pain Management
Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

Parasitology
Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Practice Management
Karen Felsted, CPA, MS, DVM, CVPM
PantheraT Veterinary Management Consulting
Dallas, TX

Eric Garcia
Simply Done Tech Solutions
Lutz, FL

***Sheila Grosdidier, BS, RVT**
Veterinary Management Consultants
Evergreen, CO

Bash Halow, LVT, CVPM
Halow Tassava Consulting
New York, NY

Jeremy Keen, DVM
Jackson Animal Clinic
Jackson, TN

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Dave Nicol, BVMS
Dave Nicol Veterinary Services Pty Ltd
North Ryde, Sydney, Australia

Mark Opperman, CVPM
Veterinary Management Consultants
Evergreen, CO

Meghan Leigh Pierson
Greenville, SC

***Heather Prendergast, RVT, CVPM**
Synergie, LLC
Las Cruces, NM

Andrew Roark, DVM, MS
Cleveland Park Animal Hospital
Greenville, SC

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

Professional Issues
Tony Bartels, DVM, MBA
Voorhees, NJ

Paul Pion, DVM, DACVIM
Veterinary Information Network
Davis, CA

Alice Villalobos, DVM, FNAP
Hermosa Beach, CA

Shelter Medicine
***Jeanette O'Quin, DVM, MPH**
The Ohio State University
Columbus, OH

Soft Tissue Surgery
Sara Colopy, DVM, DACVS
University of Wisconsin
Madison, WI

Katy Fryer, DVM, DACVS
Veterinary Specialty Hospital San Diego
San Diego, CA

Matthew Keats, DVM, DACVS
Chesapeake Veterinary Surgical Specialists
Towson, MD

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Technician Program
Vicki Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP
Leader Dogs for the Blind
Bloomfield Hills, MI

Toxicology
Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

Urology
***Joe Bartges, DVM, PhD, DACVIM, DACVN**
Cornell University Veterinary Specialists
Stamford, CT

USDA/NVAP
Donald Beckett, DVM, MPH
USDA APHIS Veterinary Service
Tulare, CA

Gary Brickler, DVM
USDA APHIS Veterinary Service
Sacramento, CA

Maura Gibson, DVM
USDA APHIS Veterinary Service
Ontario, CA

Jeffery Lee, DVM
USDA APHIS Veterinary Service
Monrovia, CA

Veterinary Leadership
Karen Bradley, DVM
Onion River Animal Hospital
Middlesex, VT

Sarah Wooten, DVM
Sheep Draw Veterinary Hospital
Greeley, CO

CLARO™

(florfenicol, terbinafine, mometasone furoate)
Otic Solution

Antibacterial, antifungal, and anti-inflammatory
For Otic Use in Dogs Only

CAUTION: Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian.

DESCRIPTION:
CLARO™ contains 15.0 mg/mL florfenicol, 13.3 mg/mL terbinafine (equivalent to 15.0 mg/mL terbinafine hydrochloride) and 2.0 mg/mL mometasone furoate. Inactive ingredients include purified water, propylene carbonate, propylene glycol, ethyl alcohol, and polyethylene glycol.

INDICATIONS:
CLARO™ is indicated for the treatment of otitis externa in dogs associated with susceptible strains of yeast (*Malassezia pachydermatis*) and bacteria (*Staphylococcus pseudintermedius*).

DOSAGE AND ADMINISTRATION:

Shake before use.
CLARO™ should be administered by veterinary personnel.
Administer one dose (1 dropperette) per affected ear. The duration of effect should last 30 days.

1. Clean and dry the external ear canal before administering the product.
2. Verify the tympanic membrane is intact prior to administration.
3. Remove single dose dropperette from the package.
4. While holding the dropperette in an upright position, remove the cap from the dropperette.
5. Turn the cap over and push the other end of the cap onto the tip of the dropperette.
6. Twist the cap to break the seal and then remove cap from the dropperette.
7. Screw the applicator nozzle onto the dropperette.
8. Insert the tapered tip of the dropperette into the affected external ear canal and squeeze to instill the entire contents (1 mL) into the affected ear.
9. Gently massage the base of the ear to allow distribution of the solution.
10. Repeat with other ear as prescribed.

Cleaning the ear after dosing may affect product effectiveness.

CONTRAINDICATIONS:
Do not use in dogs with known tympanic membrane perforation (see **PRECAUTIONS**).
CLARO™ is contraindicated in dogs with known or suspected hypersensitivity to florfenicol, terbinafine hydrochloride, or mometasone furoate.

WARNINGS:
Human Warnings: Not for use in humans. Keep this and all drugs out of reach of children. In case of accidental ingestion by humans, contact a physician immediately. In case of accidental skin contact, wash area thoroughly with water. Avoid contact with eyes. Humans with known hypersensitivity to florfenicol, terbinafine hydrochloride, or mometasone furoate should not handle this product.

PRECAUTIONS:
Do not administer orally.
The use of CLARO™ in dogs with perforated tympanic membranes has not been evaluated. The integrity of the tympanic membrane should be confirmed before administering the product. Reevaluate the dog if hearing loss or signs of vestibular dysfunction are observed during treatment.
Use of topical otic corticosteroids has been associated with adrenocortical suppression and iatrogenic hyperadrenocorticism in dogs (see **ANIMAL SAFETY**).
Use with caution in dogs with impaired hepatic function (see **ANIMAL SAFETY**).
The safe use of CLARO™ in dogs used for breeding purposes, during pregnancy, or in lactating bitches has not been evaluated.

ADVERSE REACTIONS:
In a field study conducted in the United States (see **EFFECTIVENESS**), there were no directly attributable adverse reactions in 146 dogs administered CLARO™.
To report suspected adverse drug events and/or obtain a copy of the Safety Data Sheet (SDS) or for technical assistance, contact Bayer HealthCare at 1-800-422-9874.
For additional information about adverse drug experience reporting for animal drugs, contact FDA at 1-888-FDA-VETS or online at http://www.fda.gov/AnimalVeterinary/SafetyHealth.

PHARMACOLOGY:
CLARO™ Otic Solution is a fixed combination of three active substances: florfenicol (antibacterial), terbinafine (antifungal), and mometasone furoate (steroidal anti-inflammatory). Florfenicol is a bacteriostatic antibiotic which acts by inhibiting protein synthesis. Terbinafine is an antifungal which selectively inhibits the early synthesis of ergosterol. Mometasone furoate is a glucocorticosteroid with anti-inflammatory activity.

MICROBIOLOGY:
The compatibility and additive effect of each of the components in CLARO™ solution was demonstrated in a component effectiveness and non-interference study. An *in vitro* study of organisms collected from clinical cases of otitis externa in dogs enrolled in the clinical effectiveness study determined that florfenicol and terbinafine hydrochloride inhibit the growth of bacteria and yeast commonly associated with otitis externa in dogs. No consistent synergistic or antagonistic effect of the two antimicrobials was demonstrated. The addition of mometasone furoate to the combination did not impair antimicrobial activity to any clinically significant extent.
In a field study (see **EFFECTIVENESS**), at least 10 isolates from successfully treated cases were obtained for *S. pseudintermedius* and *M. pachydermatis*.

EFFECTIVENESS:
In a well-controlled, double-masked field study, CLARO™ was evaluated against a vehicle control in 221 dogs with otitis externa. One hundred and forty six dogs were treated with CLARO™ and 75 dogs were treated with the vehicle control. All dogs were evaluated for safety. Treatment (1 mL) was administered once on Day 0 to the affected ear(s). Prior to treatment, the ear(s) was cleaned with saline. The dogs were evaluated on Days 0, 7, 14, and 30. Blood work and urinalysis were obtained on Day 0 pre-treatment and Day 30 at study completion. Four clinical signs associated with otitis externa were evaluated: erythema, exudate, swelling, and ulceration. Success was based on clinical improvement at Day 30. Of the 183 dogs included in the effectiveness evaluation, 72.5% of dogs administered CLARO™ solution were successfully treated, compared to 11.1% of the dogs in the vehicle-control group (p=0.0001).

ANIMAL SAFETY:
In a target animal safety study, CLARO™ was administered aurally to 12-week-old Beagle puppies (4 dogs/sex/group) at 0X, 1X, 3X, and 5X the recommended dose once every 2 weeks for a total dosing period of 28 days (3 times the treatment duration). No clinically relevant treatment-related findings were noted in hearing tests, body weight, weight gain, or food consumption. CLARO™ administration was associated with post-treatment ear wetness or clear aural exudate, increased absolute neutrophil count, decreased absolute lymphocyte and eosinophil counts, suppression of the adrenal cortical response to ACTH-stimulation, decreased adrenal weight and atrophy of the adrenal cortex, increased liver weight with hepatocellular enlargement/cytoplasmic change, and decreased thymus weight. Other potentially treatment-related effects included mild changes to AST, total protein, inorganic phosphorus, creatinine, and calcium.

STORAGE INFORMATION:
Store between 20ºC-25ºC (68ºF-77ºF), excursions permitted 10ºC-30ºC (59ºF-86ºF).

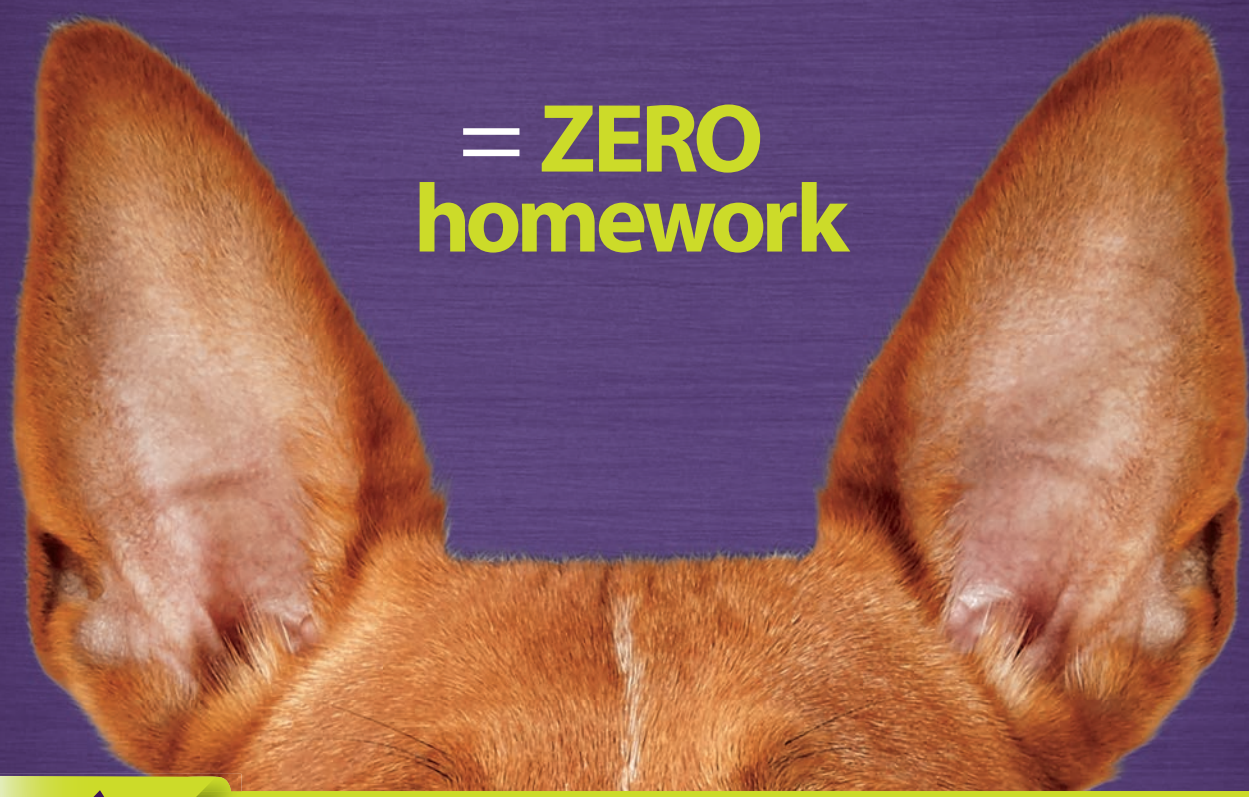
HOW SUPPLIED:
CLARO™ solution is supplied in a single-use dropperette in a blister. Each dropperette contains one 1 mL dose.
CLARO™ is available in cartons of two, ten, or twenty dropperettes.

Bayer

Distributed by: Bayer HealthCare LLC Animal Health Division Shawnee Mission, Kansas 66201 USA NADA 141-440, Approved by FDA.

BAYER

3 active ingredients + 2 ears + 1-dose regimen



= ZERO homework

NEW

Introducing **CLARO™**

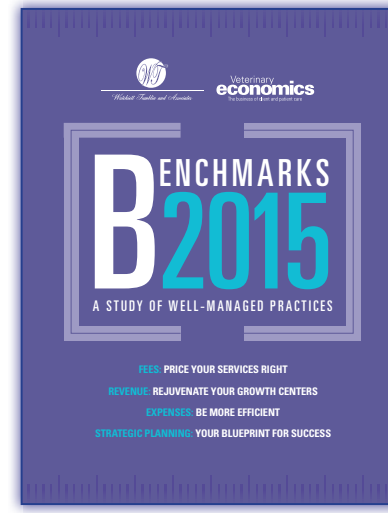
(florfenicol, terbinafine, mometasone furoate)
Otic Solution

the **only veterinarian-administered, single-dose regimen** for canine otitis externa.

CAUTION: Federal (U.S.A.) law restricts this drug to use by or on the order of a licensed veterinarian. CONTRAINDICATIONS: Do not use in dogs with known tympanic membrane perforation. CLARO™ is contraindicated in dogs with known or suspected hypersensitivity to florfenicol, terbinafine hydrochloride, or mometasone furoate.

OneDoseZeroHomework.com

here's to **success.**



Numbers don't lie. And they're *all here*.

Veterinary Economics and Wutchiett Tumblin and Associates are back with another edition in our Benchmarks series for veterinary practice owners and managers. This year we reveal the **fees**, **revenue** and **cost control** key to running a well-managed practice!

Fees. Survey's in, with more than 200 median fees for services and procedures animal hospitals perform every day — plus data and analysis putting it all into context.

Revenues. Bringing in revenue can be like completing a puzzle. We lay all the pieces out for you. See what opportunities well-managed practices are tapping to make more money.

Expenses. From wages & compensation and facility costs, to fixed and variable items and capital improvement, up-to-date figures from practices are in one place.

Benchmarks 2015 is the one practice owners and managers can't wait to see. Order yours now!

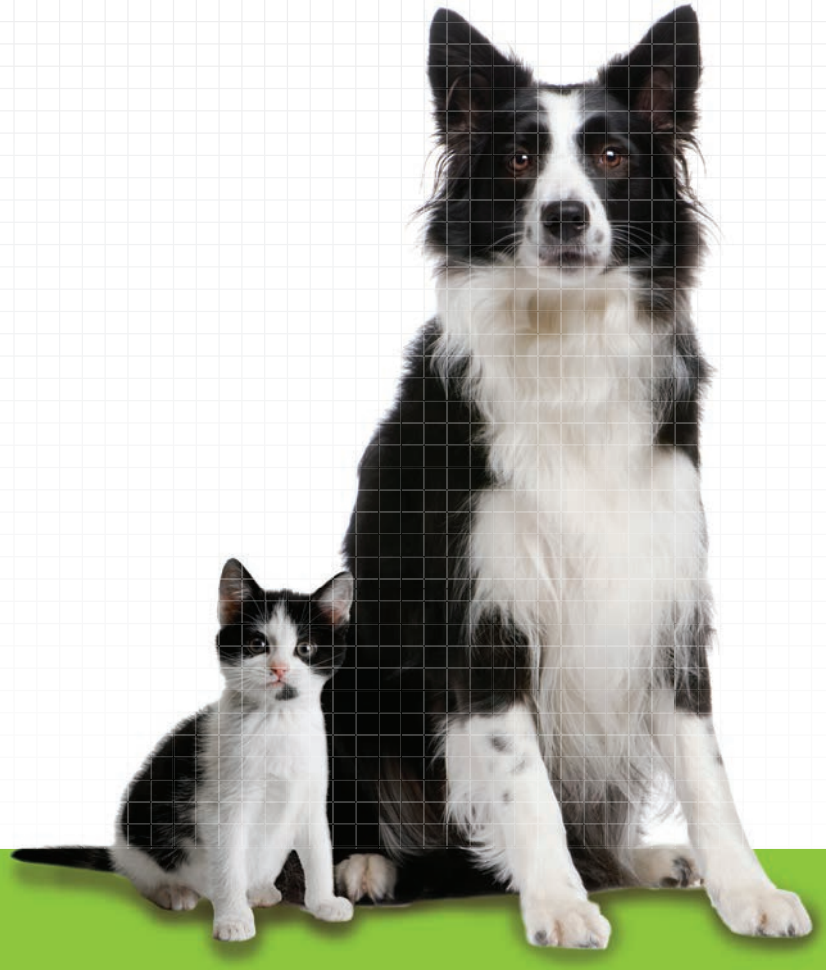
Go to industrymatter.com/benchmarks
or call 1-800-598-6008

dvm360 Find it all here. | Veterinary economics The business of client and patient care | industrymatter comprehensive information for professionals | WT | UBM

Nobody knows your practice needs like you.

Nobody knows supplements sourced from whole foods like us.

Together, we can make all the difference for your patients.



Excellence in Complementary Nutrition

Sold Through Veterinary Professionals

Standard Process®

Visit standardprocess.com or call 800-558-8740 to learn more!

VIRGINIA BEACH MAY 12-15, 2016

KANSAS CITY AUGUST 26-29, 2016

SAN DIEGO DECEMBER 8-11, 2016

CVC unconventional

UBM Life Sciences, Veterinary

UBM

800.255.6864, ext. 6 TheCVC.com cvc@advanstar.com

smarteasyaffordable
veterinarycontinuingeducation

Thank You to our 2015 CVC San Diego Sponsors

The CVC Group recognizes the generous support of these companies for their sponsorship of activities, events, and programming at CVC San Diego.

Premier Sponsors

Boehringer Ingelheim
Ceva
Elanco
Merial — A Sanofi Company

Distinguished Sponsors

Hill's
Standard Process

Elite Sponsors

Bayer
Companion Therapy Laser — LiteCure, LLC
K-Laser

Supporting Sponsors

Nutramax Laboratories Veterinary Sciences, Inc.
orthomed

Participating Sponsors

Capital One | Spark Business
VetMatrix — An iMatrix Company
Voyce Pro — Wellness Monitoring Program

Clinical Techniques Course Sponsors

Silver Sponsors

cuattro
Hot Dog
Sound — A Midmark Company

Participating Sponsors

Cara Life Inc.
Covidien
Dan Scott & Associates
Ellman International Inc.
Eye Care for Animals
iM3
Medical Illumination International
Midmark Corporation
MWI Veterinary Supply/ SECUROS
Patterson Veterinary

The CVC Group recognizes the generous support of these companies. All CVC seminars and Clinical Technique Courses are developed independent of commercial input; sponsorship support allows us to provide the value you want in your progressive educational experience. We also thank Veterinary Specialty Hospital San Diego for their assistance with our Clinical Techniques Courses.

List current at time of printing.

AWWW

Too cute for adjuvants.

Trust the only complete line of nonadjuvanted feline vaccines.

***Trust* PUREVAX®.**

MERIAL
A SANOFI COMPANY

PUREVAX® PUREVAX® Rabies PUREVAX® FeLV

K-LASER® USA

HEALING POWER IN YOUR HANDS

Attract the best customers with your technology!

The applications are limitless...

tomyositis Pyotraumatic Dermatitis Post-Surgical Incisions Infected Wounds Chronic Wounds Rhinitis Sinusitis Otitis
omas Infectious Tracheo-Bronchitis Ivdd Arthritis Hip Dysplasia Chronic Pain Lameness Anal Saculitis Trauma Tail
rthopedic Rehabilitation Tendonitis Non-Surgical/Partial Acl Lick Granulomas Calcaneal Tendon Tear/ Trauma Neuropathy
Feline Asthma Bicipital Bursitis Bicipital Tendonitis Infra-Supraspinatus Tendonitis Acral Lick Granulomas Pododermatitis
res Sprains/Strains Egc Snake Bites Tooth Extractions Gingivitis Periodontitis Stomatitis Inter-Digital Cysts Facet Jo
tomyositis Pyotraumatic Dermatitis Post-Surgical Incisions Infected Wounds Chronic Wounds Rhinitis Sinusitis Otitis
omas Infectious Tracheo-Bronchitis Ivdd Arthritis Hip Dysplasia Chronic Pain Lameness Anal Saculitis Trauma Tail
rthopedic Rehabilitation Tendonitis Non-Surgical/Partial Acl Lick Granulomas Calcaneal Te
uma Neuropathy Cystitis Ibd Feline Asthma Bicipital Bursitis Bicipital Tendonit
pinatus Tendonitis Acral Lick Granulomas Pododermatitis Arthritis Fr
s/Strains Egc Snake Bites Tooth Extractions Gingivitis Periodontitis
igital Cysts Facet Joints Dermatomyositis Pyotraumatic Post-Surgical
d Wounds Chronic Wounds Rhinitis Sinusitis Aural Hematom
ous Tracheo-Bronchitis Ivdd Arthritis Chronic Pain
aculitis Trauma Tail Fractures Rehabilitation
urgical/Partial Acl Lick Granulomas Tendon Neu

MAKE SURE TO VISIT US AT CVC, BOOTH #607!

Or call now to learn more about our comprehensive K-Laser launch program!

866.595.7749 | www.k-laserusa.com | info@k-laserusa.com

DON'T MISS: LUNCH & LEARN

Emerging Trends in Veterinary Laser Technology: Revolutionizing Pain Management and Wound Healing

Saturday, December 5th, 2015, 12:00 - 1:30pm, Room 20B

FOOD SENSITIVITIES WITH GI UPSET

Let's address **more than the mess**

- 1:1 — CAREFULLY SELECTED SINGLE PROTEIN & GENTLE CARB SOURCE
- HIGHLY DIGESTIBLE FOR IMPROVED STOOL QUALITY
- LIMITED INGREDIENTS TO AVOID FOOD SENSITIVITIES

NEW PRESCRIPTION DIET®

i/d® Sensitive

Our most gentle GI solution for your most sensitive cases.

FREE OF wheat • gluten • soy protein • lactose

For more information, talk to your Hill's Representative.

HillsVet.com

Current Fluid Therapy Topics and Recommendations During Anesthetic Procedures

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Intravenous fluid administration is recommended during general anesthesia, even during short procedures.
- The traditional IV fluid rate of 10 mls/kg/hr during general anesthesia is under review.
- Knowledge of a variety of IV fluids, and their applications, is essential when choosing anesthetic protocols for different medical procedures.

Anesthetic drug effects on the cardiovascular system

- Almost all anesthetic drugs have the potential to adversely affect the cardiovascular system.
- General anesthetic vapors (isoflurane, sevoflurane) cause a dose-dependent, peripheral vasodilation.
- Alpha-2 agonists initially cause peripheral hypertension with reflex bradycardia leading to a dose-dependent decreased patient cardiac index. As the drug effects wane, centrally mediated bradycardia and hypotension are common side effects.
- Phenothiazine (acepromazine) tranquilizers are central dopamine and peripheral alpha receptor antagonists. This family of drugs produces dose-dependent sedation and peripheral vasodilation (hypotension).
- Dissociative NMDA antagonists (ketamine, tiletamine) increase sympathetic tone soon after administration. When dissociative NMDA antagonists are used as induction agents in patients with sympathetic exhaustion or decreased cardiac reserve (morbidly ill patients), these drugs could further depress myocardial contractility.
- Propofol can depress both myocardial contractility and vascular tone resulting in marked hypotension. Propofol's negative effects on the cardiovascular system can be especially problematic in ill patients.
- Potent mu agonist opioids can enhance vagally induced bradycardia.

Why is IV fluid therapy important during general anesthesia?

- Cardiac output (CO) equals heart rate (HR) X stroke volume (SV); IV fluids help maintain adequate fluid volume, preload, and sufficient cardiac output.
- Oxygen delivery to the tissues (DO2) equals CO X arterial blood oxygen content (CaO2); without adequate blood volume (relative and/or absolute hypovolemia) cardiac output decreases, which results in decreased peripheral oxygen delivery, thus tissue ischemia.
- General anesthesia, by nature, depresses (shocks) autonomic, cardiovascular responses and homeostasis. Cardiovascular problems related to general anesthesia occur even with ASA status 1 patients. Intra-operative blood loss will contribute to total circulatory volume loss and therefore exaggerate the cardiovascular depressant effects of general anesthesia.
- In response to hypovolemia, the body preferentially centralizes blood circulation toward the vital organs and away from peripheral tissues.
- Subcutaneous fluid administration during general anesthesia does not replace IV administration as a means to maintain blood volume. Subcutaneous fluids are absorbed poorly during general anesthesia due both to a circulatory shift away from peripheral circulation and an inevitable hypothermia.
- Intravenous fluids can help maintain a patent IV catheter during general anesthesia, which allows for emergency drug administration, if needed.

Perioperative fluid therapy should be tailored to patient requirements

- Appropriate fluid type, rate, and volume should be considered important elements of a patient's overall anesthetic protocol. Each patient is unique and every anesthetic protocol should be tailored to individual patient anesthetic requirements.
- Patient history, thorough physical exam, and subjective and objective data (laboratory, radiographic) are necessary to plan appropriately an anesthetic protocol.
- Ideally, patient stabilization, including fluid losses, electrolyte imbalances, trauma, and respiratory and cardiovascular diseases should occur prior to anesthesia; however, in emergency situations, anesthetic patient stabilization may not be possible.

Anesthesia fluid therapy; crystalloids (Dibartola)

- Isotonic, polyionic replacement fluids, such as LRS, are popular IV fluids used during general anesthesia
- Replacement fluids resemble extra-cellular fluid composition and are designed to resupply body fluids and electrolytes within the cardiovascular and interstitial spaces. Within 30 minutes after replacement fluid administration, nearly 80% is lost from the vascular space into the interstitium.
- Replacement fluids can be used to help alleviate acute hypovolemia.
- Maintenance fluids are designed to fill rapidly the interstitial space. Maintenance fluids should NOT be used for volume resuscitation.
- There are many different formulations of crystalloid fluids available. Indications of each kind depend on individual patient needs such as hypovolemia, dehydration, illness, electrolyte, and acid-base imbalances.
- In the last six years the volume of perioperative crystalloid administration has come under scrutiny. An article written in 2008 by Chappell, et al., questioned the existence of a third space and the research that first established fluid rates during general anesthesia. Traditionally, perioperative fluid administration for veterinary patients has largely mimicked, without solid scientific basis, human recommendations. A publication in 2010 by Boscon, et al., in demonstrated that not only did urine production in healthy, anesthetized dogs consistently decrease, it was coupled with an increase in body water weight. In 2013 an article in JAHAA provided new recommendations for fluid therapy with veterinary anesthesia patients. Based on these recommendations, canine fluid rates should start at 5 ml/kg/hr, feline rates at 3 ml/kg/hr, and fluid formulation, volumes, and rates should be adjusted according to individual patient needs.

Anesthesia fluid therapy; colloids

- Replacement crystalloids are beneficial to help expand rapidly the vascular space when increased blood volume is needed. Unfortunately large volumes of crystalloid potentially can lead to issues such as dilutional hypoalbuminemia, dilutional coagulopathies, decreased pulmonary function, decreased tissue oxygenation, and increased water weight. Approximately 80% of the volume of intravenous crystalloids equilibrate with the interstitial space within 30 to 45 minutes after administration. Unless the underlying cause of hypovolemia is corrected, more crystalloid therapy will be required to help maintain cardiac output, which, in turn, worsens tissue edema.
- Colloids are fluids that contain large, complex molecules. Like crystalloids, colloids can be used for intravenous fluid expansion; however, unlike crystalloids, colloids remain intravascular as long as the endothelial barrier remains intact.
- There are two major categories of colloids, natural and synthetic. Natural colloids are blood components including packed RBCs, plasma, platelet-rich plasma, etc. Generally, the primary synthetic colloids used in modern medicine are hydroxyl ethyl starches (HES). The two most common HES products used in veterinary medicine are Hetastarch® and Vetstarch®. Vetstarch® is the only HES colloid approved for veterinary use.
- There are two principles the general practitioner should understand regarding HES colloids: molecular weight (MW) and C2/C6 substitution ratios. HES colloids are divided into 3 groups according to their average molecular weights: high MW (>400 kDa); medium MW (200-400 kDa); and low MW (<200 kDa) solutions. The molecular weight determines duration of action, the larger the MW the longer the duration of action. The C2/C6 ratio is the ratio of carbon position 2 substitutions to carbon position 6 substitutions. The C2/C6 ratio determines the adverse side effects. The larger the C2/C6 ratio the greater the coagulopathic potential. An ideal HES product would be one with a large MW (long DOA) and small C2/C6 ratio (fewer side effects). Unfortunately, the MW of the product mirrors the C2/C6 ratio. Larger MW products have larger C2/C6 ratio and vice versa for smaller MW products.
    - Hetastarch®: 450/0.7 (MW = 450 kDa, C2/C6 ratio = 0.7)
    - Vetstarch®: 130/0.4 (Mw = 130 kDa, C2/C6 ratio = 0.4)
- Indications for colloid administration include hypovolemia, hypoalbuminemia, and hypotension. Because HES colloids are large molecules, similar to albumin, they tend to remain in the vascular space adding to the colloidal oncotic pressure. Administration of HES will contribute its own volume, plus a third of its volume in water drawn from the interstitial space, to the total blood volume. Some practitioners prefer to use HES plus a crystalloid combination (50:50), which can be very effective for rapid IV volume loading. Another option, which provides even more rapid vascular expansion, is HES plus hypertonic saline.
- HES can be used as the primary fluid therapy in hypoalbuminemic patients during general anesthesia with or without crystalloids. HES can also be given as intermittent IV boluses to help mitigate hypotension.
- Coagulopathies are the primary, adverse effects of HES products dictated by the C2/C6 molecular substitution ratio. All HES products have the potential to inhibit the Von Willdebrand factor (vWF) and factor VIII resulting in platelet dysfunction, or type 1 Von Willdebrand-like syndrome. Because of these concerns, an anecdotal, maximum dose HES colloids of 20 ml/kg/day was established for human patients. Veterinary medicine simply borrowed this dose and

applied it to animal patients. Based on the principle of the C2/C6 molecular substitution ratio, an across-the-board, "maximum" dose for all HES products in all patients does not make medical sense. In addition, multiple studies have demonstrated the coagulopathic effects of HES products are clinically irrelevant unless the patient has a preexisting coagulopathy (vWD in Doberman Pinschers).

- Recently, there have been concerns with the administration of HES in human, septic patients, which resulted in acute renal failure. Although there has not been a cause and effect established, the FDA has issued a warning regarding HES use in humans with septicemia. Acute renal failure associated with HES use in septic veterinary patients has NOT been documented. The FDA warning does NOT apply to veterinary medical practice.
- Acute fluid overload, especially in cardiac patients, can occur when colloids are administered rapidly in large volumes. Care should be taken when using colloids (any IV fluids) in patients with known cardiac disease.

Mitigating hypotension during anesthesia in the small animal patient

- Most organ systems in the body autoregulate their own blood perfusion within a systemic mean arterial pressure (MAP) range of 60 – 150 mmHg. Outside this range blood perfusion autoregulation becomes a product of systemic blood pressure. When MAPs fall below 60 mmHg, the risk of tissue ischemia increases.
- The number one cause of hypotension in anesthetized veterinary patients is excessive anesthetic depth. Having one person dedicated to monitoring the anesthetized patient and who understands how to assess depth of anesthesia is essential for safe anesthetic practice.
- Bradycardia can contribute to hypotension because CO is a function of HR X SV. Several factors contribute to bradycardia during general anesthesia, including hypothermia and the pharmacodynamics of anesthetic drugs. Patients should be kept warm (> 97 ^{o}F) during general anesthesia, and an anticholinergic can be administered to help treat bradycardia resulting from high vagal tone.
- Absolute hypovolemia results in systemic hypotension. Ongoing surgical blood loss should be treated with IV fluid administration, including crystalloids and colloids. Extensive hemorrhage (> 20% patient blood volume) can be managed with IV hypertonic saline, HES, and crystalloids until replacement blood therapy can be conducted.
- One cause of relative hypovolemia is systemic vasodilation and/or depressed myocardial contraction. It is advisable to secure adequate blood volume (rule out absolute hypovolemia) before treating hypotension pharmaceutically. Systemic vasodilatation can be treated with a vascular pressor agent (ephedrine, dopamine, vasopressin), whereas depressed mycocardial contractility can be treated with a positive inotrope (dobutamine).

References

Boscan P, Pypendop BH, Siao KT, Fluid balance, glomerular filtration rate, and urine output in dogs anesthetized for an orthopedic surgical procedure, AJVR, 2010, May:71(5): 501-07

Branson K: Injectable anesthetics, In Adams R, editor: Veterinary Pharmacology and therapeutics, ed 8, Ames, IA, Blackwell Publishing Professional, pp 213-67.

Chappell D, Matthias J, Hofmann-Klefer K, Conzen P, Rehm M, A rational approach to perioperative fluid management, Anesthesiology, 2008; 109: 723-40.

Davis H, Jensen T, Johnson A, 2012 AAHA/AAFP fluid guidelines for dogs and cats, JAAHA, 2013, May/June:43(3): 149-59

Hughes D, Boag A: Fluid therapy with macromolecular plasma volume expanders, In DiBartola S, editor: Fluid, electrolyte and acid-base disorders, ed 4, St. Louis, MO, 2012, Elsevier-Saunders, pp 647-64.

Pascoe P, The cardiopulmonary effects of dexmedetomidine infusions in dogs during isoflurane anesthesia, JVAA, 2014, July 31. doi: 10.1111/vaa.12220. [Epub ahead of print].

Anesthesia Ventilators and Ventilation Techniques

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Intermittent positive pressure ventilation using mechanical ventilators has not been used traditionally in veterinary practice.
- Modern mechanical ventilators have become more affordable and easier to operate, allowing an increase use in clinical practice.
- Understanding the mechanics, function, and physiological effects of mechanical, intermittent, positive pressure ventilation is necessary in order to safely, and effectively, ventilate anesthetized veterinary patients.

Terminology and physiology

- Minute ventilation (VE) = Respiratory rate (f) X Tidal volume (T_V).
- Under normal physiological conditions PCO2 dictates minute ventilation (V_E). Oxygen has little effect on V_E unless the PO2 falls below 60 - 70 mmHg.
- CO2 crosses the blood brain barrier where it combines with water in the CSF. Carbonic anhydrase in the CSF facilitates the formation of carbonic acid which then dissociates into hydrogen and bicarbonate ions. The hydrogen ions then interact with the chemoreceptors of the dorsal respiratory group:

  $CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO3^-$
- Hypoventilation is synonymous with increased PCO2 whereas hyperventilation is synonymous with decreased PCO2.
- With increased PCO2, respiratory drive will increase, with decreased PCO2, respiratory drive will decrease.
- IPPV = intermittent positive pressure ventilation, PIP = peak inspiratory pressure, PEEP = positive end expiratory pressure
- There are many ways one can control ventilation with anesthetized patients: the reservoir bag, a demand valve, or a mechanical ventilator to name a few.

Indications for controlled ventilation

- Hypoventilation: Hypercapnea, drug induced respiratory depression, trauma, disease, and others.
- Poor oxygenation: Five causes of hypoxemia include: low fraction/pressure of inspired oxygen; inadequate V_T; O2 diffusion impairment; ventilation to perfusion mismatch (V/Q mismatch), and pulmonic/anatomic cardiac shunt.
- Depth of inhalant anesthesia: Anesthetized patients, while breathing anesthetic vapors spontaneously, cycle naturally between levels of light and deep planes of general anesthesia. Controlled ventilation provides a constant rate of inhaled anesthetics, thus eliminating the variability of inhalant general anesthesia.
- Surgeries that involve the loss of negative pressure and mechanical tethering between the visceral and parietal pleurae require intermittent positive pressure ventilation.
- Specific pulmonary diseases require assisted ventilation during general anesthesia, examples include: chest trauma, diaphragmatic hernia repair, severe alveolar diseases, and pleural diseases.
- Patients with conditions that may significantly limit V_T, such as pregnancy or obesity, should receive ventilatory support during general anesthesia.
- In reality, indications for controlled ventilation are not always well defined. Ventilators are useful tools during general anesthesia, however; they should be used according to each patient's individual and should never replace human intervention. Always monitor patients under general anesthesia receiving mechanical ventilation closely. Mechanical ventilators can induce serious patient pulmonary damage, even death, if not set-up and monitored correctly

Controlled ventilation

- Mechanical ventilation is based on V_E, which is function of f X V_T
- Adjustment of V_E requires changes in ventilation frequency and or volume.
- Volume mode: Volume mode ventilator will deliver a controlled volume of gas (patient's V_T), regardless of the peak inspiratory pressure. The variable factor is pressure. Small animal patient V_T is approximately 10-20 ml/kg. Most anesthetic mechanical ventilators are set volume mode or have a volume mode option. During long periods of mechanical ventilation volume mode ventilators can cause pathological changes to the pulmonary tissues.
- Pressure mode: Pressure mode ventilator will deliver a volume gas until a set pressure is reached. The variable factor is volume. Most mechanical ventilators that have pressure mode also have volume mode option. Pressure mode ventilation causes fewer pathologic changes to pulmonary tissues than volume mode ventilation.

- Time-cycled ventilation: Despite volume vs. pressure mode ventilation, almost all mechanical ventilators are time-cycle controlled based on respiratory frequency (breaths per minute). Typically, timing is controlled electronically.

Basic anatomy of an anesthesia mechanical ventilator

- Most anesthetic mechanical ventilators have two gas sources. The driving gas is any type of high pressure gas that drives the bellows, from outside, thus pushing (positive pressure) the tidal volume into the patient (compressed O2, medical gas, N_2 CO_2). Maximum pressure of the driving gas should not exceed 50 psi. The breathing system gas is on the inside of the bellows and is continuous with the patient's breathing circuit. Remember, the driving gas and breathing gas are two, separate gases and should not mix.
- Bellows. Most anesthetic mechanical ventilators use a bellows to push the breathing gas V_T into the patient. Bellows are classified as ascending or descending, based on the direction the bellows move during exhalation.
- Control panel. Anesthetic mechanical ventilators have a control panel that allows adjustment of patient V_T, breathing frequency, and sometimes I:E ratios.
- Scavenging system. Because the inside of the ventilator bellows is continuous with the patient's breathing gases, the ventilator attaches to the anesthetic machine scavenging system for evacuation of waste gases.
- Connecting hose and wall plug-in. Anesthetic mechanical ventilators have a hose that connects to the high pressure gas driving the bellows. The hose should be color-coded according to the driving gas; for example, oxygen is green, and medical air is yellow.

Capnography

- Under normal physiological conditions the primary indication for mechanical ventilation during general anesthesia is patient CO2. There are two ways to monitor patient PCO2: arterial blood gas analysis and/or end-tidal PCO2 (P_{ET}CO2, capnography). Although arterial blood gas analysis is more accurate, it is also expensive and impractical. Capnography provides a useful, and practical, means to monitor patient PCO2, and is recommended for all anesthetized patients undergoing mechanical ventilation under general anesthesia.
- There are two categories of capnographs: main-stream, which analyzes the patient's exhaled breath adjacent to the endotracheal tube, and side-stream, which removes a sample of the patient's breath and delivers it to an analyzer away from the patient.
- Capnography is based on the principle that end-tidal exhaled PCO2 (PACO2) is roughly equal to pulmonary arterial PCO2 (PaCO2)
- Graphical illustration of the P_{ET}CO2 over time is called a capnogram. Capnograms are useful for visually monitoring an anesthetized patient's PCO2 and other problems that can develop, such as a leak in the breathing system.

Final considerations

- A patient's delivered V_T should be set according to a desired PIP and P_{ET}CO2 rather than to the calculated V_T.
- Maximum PIP for small animal patients is 20 cm H2O; otherwise, barotrauma could occur to the patient's pulmonary tissues (alveoli).
- IPPV causes a decrease in mean arterial pressure due to a reversal of the physiological thoracic blood pump.
- Positive end-expiratory pressure can be used to help facilitate oxygenation via maintaining opened alveoli.

References

Hammond R: Automatic ventilators, In Seymour C, Duke-Novakovski T, editors: BSAVA Manual of Canine and Feline Anaesthesia and Analgesia, ed 2, BSAVA Gloucester, pp 49-60.

Hartsfield S, Airway management and ventilation, In Tranquilli W, Thurmon J, Grimm K, editors: Lumb & Jones' Veterinary Anesthesia and Analgesia, ed 4, Ames IA Blackwell, pp 512-31.

Mosley C: Anesthesia equipment, In Grimm K, Tranquilli W, Leigh L, editors: Essentials of Small Animal Anesthesia and Analgesia, ed 2, Ames IA Wiley-Blackwell, pp 187-96.

Acute Pain Management:
Local and Regional Anesthesia

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Local and regional anesthesia are common practices in large animal veterinary medicine. In the past, locoregional techniques have been underutilized in small; however, recently there has been a surge in their use with small animal practice.
- Most common locoregional anesthetic techniques used for large animal surgery can also be adapted to small animals.
- A good understanding of basic anatomy, pharmacology of local anesthetic drugs, and patient physiology is essential in order to safely, and effectively, utilize local and regional anesthetic techniques.
- Combining local and regional anesthetic techniques with parenteral analgesics can provide small animal practitioners more flexibility and better options for pre-, intra- and post-operative pain management.

Physiology of and concepts regarding pain

- Acute pain is considered a normal, healthy, and protective physiological response to noxious stimuli. Chronic, centralized pain, or wind-up pain is considered a pathological, abnormal expression of pain.
- The dose of general anesthetics needed to abolish the effects of nociception is close to that which can abolish autonomic responses. High doses of general anesthetic drugs significantly depress the cardiovascular, respiratory, and thermoregulatory systems in the body. Analgesic modalities before, and during, surgery help decrease the dose of general anesthetics needed to provide immobility without loss of autonomic tone.
- Transduction: Mechanical, chemical, or thermal injury is converted to an electrical impulse by Aβ (quick pain) and C nociceptors (slow pain).
- Transmission: The noxious electrical impulse is transmitted from the periphery to the spinal cord via Aβ and C sensory neurons. The synapse between the sensory neurons and the spinal cord occurs at lamina II (substantia gelatinosa) in the dorsal spinal horn.
- Primary (spinal) modulation: Within the spinal cord the afferent, noxious sensory impulse undergoes initial analysis. The spinal cord upgrades or downgrades the severity of the noxious stimulus and communicates that information to the brain. An unconscious reflex arc is the result of primary (spinal) modulation.
- Projection: After primary modulation, the noxious information is then projected to the brain via several tracts: two examples are the spinocervicothalamic (fast pain) and spinoreticular (slow pain) tracts.
- Secondary (cerebral) modulation: Within the conscious brain noxious afferent input is perceived as pain. Unconsciousness (anesthesia) blunts, or abolishes, secondary nociceptive modulation.
- Animals and humans share similar anatomical and physiological nociceptive structures for the production, conduction, and modulation of pain.
- Pain assessment in animals is based on anthropomorphic comparisons, subjective, and objective criteria.
- Pain is the conscious perception of nociception. Nociception is the physiological processes that involves the conversion of a noxious stimulus to an electro-chemical impulse and modulation in the CNS.
- The perception of pain does not occur during general anesthesia; however, without analgesic modalities the process of nociception still occurs, which can lead to centralized, or wind-up pain.
- Providing analgesics before surgery is called pre-emptive analgesia. Studies have shown that preemptive analgesia significantly decreases the likelihood of hypersensitiity associated with surgical pain.
- Preventive analgesia is a term that describes a comprehensive pain control plan that includes pre-, intra- and postoperative therapies. Preventive analgesia has been well established in human medicine but not yet in veterinary medicine.

Local and regional anesthetic techniques in small animal practice

- Lidocaine and bupivacaine are the most common local anesthetics used in small animal practice.
- Local anesthetics are fast-sodium channel blocking agents. In their bottles local anesthetics are acidic and inactive. When injected into the body (comparatively alkaline), the local anesthetic molecules dissolve into HCl salts and active bases. The active bases diffuses across the nerve epineurium and cell membrane into the cytoplasm and block sodium channels.

- Toxic effects of local anesthetic depend on the drug. Lidocaine causes dose-dependent neuro- and cardio-toxic effects. Bupivacaine has potent cardio-toxic effects. Inadvertent intravenous injection of local anesthetics must be avoided; therefore, always aspirate before injecting.
- Most locoregional anesthetic techniques can be performed blindly; however, a peripheral nerve locating device (nerve stimulator) can help increase the success and safety of the procedures.
- Quincke needles are designed specifically for locoregional techniques. Quincke needle bevels are blunter which allows for a better feel as the needle dissects through tissue planes.
- Common regional techniques for dental procedures include mental, infra-orbital, maxillary, and mandibular nerve blocks. Auriculopalpebral and the greater auricular nerve blocks can be useful for procedures involving the ear such as, ear flushes and surgery.
- The brachial plexus infiltration block can be used for surgeries involving the distal forelimb. A carpal ring block can be used for surgeries involving the forepaw such as declaws and digit amputations.
- Lumbosacral epidural regional techniques are very useful for surgeries involving the hips and distal rear legs. The most common drugs used for lumbosacral epidurals is the combination of preservative free (PF) morphine and PF bupivacaine. Feline lumbosacral epidurals using PF morphine and PF bupivacaine can be done also; however, it is important to remember the feline spinal cord ends at S1 compared with the canine spinal cord, which ends at L5-6.
- Caudal epidural techniques can be used to provide regional anesthesia during perineal surgeries and facilitate urethral relaxation for catheter placement in blocked male cats.
- Infiltration catheters (soaker catheters) have manufactured fenestrations at their distal ends so that, when buried in the surgical wound, local anesthetics can be injected into the tissues providing a field of anesthesia.

References

Muir W, Physiology and pathophysiology of pain, In Gaynor J, Muir W, editors: Handbook of Veterinary Pain Management, ed 2, St. Louis MO, Mosby Elsevier, pp13-41.

Acute Pain Management: Pharmaceutical Options

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Systemic analgesic drugs are the mainstay of small animal veterinary pain management.
- Options regarding parenteral analgesics in small practice are often governed by cost and clinician experience.
- Utilizing the same analgesic drugs, regardless of the surgical procedures, is not good analgesic case management. Having a good understanding of a variety of analgesic options, for dogs and cats, can be a valuable addition to help expand clinical practice.

Rules of thumb

- Animals share similar anatomical and physiological nociceptive properties as humans; therefore, animals likely have similar pain experiences as humans.
- Pain in animals is difficult to quantify and evaluation is based on a combination of objective and subjective anthropomorphic attributes.
- Pain is the conscious perception of nociception. General anesthesia abolishes consciousness; therefore, pain is not perceived during general anesthesia. Nociception is the physiological process by which a noxious stimulus is transduced into an electro-chemical impulse and carried to the central nervous system. Nociceptive, physiological processes continue to occur during general anesthesia unless analgesics are employed.
- According to the Veterinarian's Oath, veterinarians have an obligation to prevent and relieve animal suffering, including pain.
- If there is a suspicion an animal patient is painful, it is better to treat for pain than to ignore the concern.

Concepts regarding nociception and pain management in veterinary patients

- Transduction: Mechanical, chemical, or thermal injury is converted to an electrical impulse by Aβ (quick pain) and C nociceptors (slow pain).
- Transmission: The noxious electrical impulse is transmitted from the periphery to the spinal cord via Aβ and C sensory neurons. The synapse between the sensory neurons and the spinal cord occur at lamina II (substantia gelatinosa) in the dorsal spinal horn.
- Primary (spinal) modulation: Within the spinal cord the afferent, noxious sensory impulse undergoes initial analysis. The spinal cord upgrades or downgrades the severity of the noxious stimulus and communicates that information to the brain. An unconscious reflex arc is the result of primary (spinal) modulation.
- Projection: After primary modulation the noxious information is then projected to the brain via several tracts; two examples are the spinocervicothalamic (fast pain) and spinoreticular (slow pain) tracts.
- Secondary (cerebral) modulation: Within the conscious brain noxious afferent input is perceived and translated into pain. Unconsciousness (anesthesia) blunts, or abolishes, secondary nociceptive modulation.
- Providing analgesics before surgery is called pre-emptive analgesia. Studies have shown that preemptive analgesia decreases significantly the likelihood of hypersensitivity associated with surgical pain.
- Preventive analgesia is term that describes a comprehensive pain control plan, which includes pre-, intra-, and postoperative nociceptive therapies. Preventive analgesia has been well established in human medicine but not yet in veterinary medicine.
- Analgesic drugs help reduce/abolish pain by interfering with the nociceptive process(es).
- The dose of general anesthetics needed to produce unconsciousness is far less than what is required to abolish the effects of nociception. The dose of general anesthetics needed to abolish the effects of nociception is close to that which can abolish autonomic responses. High doses of general anesthetic drugs significantly depress the cardiovascular, respiratory and thermoregulatory systems in the body. Analgesic modalities before, and during, surgery help decrease the dose of general anesthetics needed to provide immobility without loss of autonomic tone.
- A pre-emptive pain scale evaluation can help the clinician formulate a patient's analgesic therapy plan. A pre-emptive pain scale is a subjective pain assessment done pre-operatively based on the anticipated degree of pain. Analgesic drug potency, dose, and frequency of administration can be tailored according to the pre- and post-operative pain evaluation.

Parenteral analgesics in veterinary small animal practice

- Common concerns with parenteral analgesic drugs in small animal practice include unwanted sedation, extra expense, controlled drug issues, unpredictable results, drug knowledge of the attending veterinarian, and client compliance.
- Opioids are the primary parenteral analgesic used for human and veterinary surgery. Mu agonist opioids are an excellent choice to help provide effective pre- intra- and post-operative pain relief for animal patients. There are many mu agonist opioid drugs available, including opioid products that are absorbed transdermal.
- Butorphanol, a mu antagonist, kappa agonist opioid, has limited analgesic capabilities and a short duration of action. Butorphanol should not be considered a primary analgesic for surgical pain, especially in dogs.
- Buprenorphine is a partial mu agonist opioid, has a good analgesic profile, and long duration of action for both dogs and cats.
- NSAIDs relieve pain via their anti-inflammatory abilities making them extremely versatile analgesic drugs. There are many NSAID options for both dogs and cats; however, judicial use of these drugs should be limited to normal, healthy patients. Contraindications for NSAID include concurrent steroid administration, concurrent other NSAIDs, renal and hepatic diseases, gastrointestinal diseases, coagulopathies, pregnancy, dehydration, and other circulatory diseases.
- Common, and effective, adjunctive analgesic choices include lidocaine, ketamine, and alpha 2 agonists.

References

Muir W, Physiology and pathophysiology of pain, In Gaynor J, Muir W, editors: Handbook of Veterinary Pain Management, ed 2, St. Louis MO, Mosby Elsevier, pp13-41.

Analgesic Considerations in Cats

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- The pharmacokinetic and pharmacodynamic effects of anesthetic and analgesic drugs differ between dogs and cats. Cats are NOT small dogs.
- Unfortunately, analgesic options for feline patients are limited compared with analgesic options for canine patients.

Important points regarding feline patients

- Due to feline aloof behavior, it can be difficult for clients to notice subtle changes with their cat's health. Cats typically do not show obvious signs of pain; instead, they become withdrawn and hide.
- Generally speaking, feline responses to anesthetic and analgesic drugs are unpredictable compared with canine responses.

Physiology of nociception and feline pain

- Transduction: Mechanical, chemical, or thermal injury is converted to an electrical impulse by Aβ (quick pain) and C nociceptors (slow pain).
- Transmission: The noxious electrical impulse is transmitted from the periphery to the spinal cord via Aβ and C sensory neurons. The synapse between the sensory neurons and the spinal cord occurs at lamina II (substantia gelatinosa) in the dorsal spinal horn.
- Primary (spinal) modulation: Within the spinal cord the afferent, noxious sensory impulse undergoes initial analysis. The spinal cord upgrades or downgrades the severity of the noxious stimulus and communicates that information to the brain. An unconscious reflex arc is the result of primary (spinal) modulation.
- Projection: After primary modulation, the noxious information is then projected to the brain via several tracts: two examples are the spinocervicothalamic (fast pain) and spinoreticular (slow pain) tracts.
- Secondary (cerebral) modulation: Within the conscious brain noxious afferent input is perceived as pain. Unconsciousness (anesthesia) blunts, or abolishes, secondary nociceptive modulation.
- Providing analgesics before surgery is called pre-emptive analgesia. Studies have shown that preemptive analgesia significantly decreases the likelihood of hypersensitiity associated with surgical pain.
- Preventive analgesia is term that describes a comprehensive pain control plan which includes pre-, intra- and postoperative therapies. Preventive analgesia has been well established in human medicine but not yet in veterinary medicine.
- The Brondani multi- dimensional composite feline pain scale was recently validated for the English language. Before the Brondani feline pain scale there was no validated pain scale for cats.
- Pain is not always considered a major component of many feline diseases. Saddle thrombosis, for example, is a clinical condition secondary to feline cardiac disease and causes extensive, acute ischemic muscle pain. Regardless of the disease, pain evaluation, and therapy, should always be part of the clinical plan.
- Identifying pain in cats can be difficult. Cats do not outwardly express pain. Sometimes an owner noticing a change in his or her cat's behavior is the only indication of discomfort. Clinical signs of acute pain in cats include a tucked or crouched posture, reluctance to move, ears facing forward, focused eyes, lip licking, guarding, and purring.

Analgesic options for feline patients

- Opioids are considered the backbone of analgesia in both human and veterinary medicine. Mu agonist opioids have been known to cause opioid-related hysteria (dysphorea) and hyperthermia in cats. Although both conditions merit concern their clinical relevance is questionable and both can be reversed using naloxone. Morphine and hydromorphone are mu agonist opioids that are most likely to cause side effects in cats whereas oxymorphone, methadone, and fentanyl are the least likely.
- Butorphanol is a mu antagonist, kappa agonist opioid and has good effects in cats; however, its duration of action is only 30 – 45 minutes.
- Buprenorphine is a partial mu agonist opioid and, in cats, provides excellent analgesia for up to 6 to 8 hours in cats.
- Alpha 2 agonists provide both sedation and analgesia. Dexmedetomidine is an excellent major tranquilizer for cats because it provides predictable results, good analgesia, can be combined with other drugs, and is the choice tranquilizer for cats with hypertrophic cardiomyopathy (HCM).

- Dissociative NMDA antagonists (ketamine, tiletamine) also provide consistent sedation and analgesia in cats; however, this family of major tranquilizers is contra-indicated in cats with HCM.
- NSAIDs are good analgesic choices in healthy cats. It is recommended practitioners administer these drugs judiciously, monitor their patients closely, and communicate to their clients regarding potential adverse side effects from NSAIDs.
- In addition to parenteral analgesics, locoregional techniques can be extremely valuable when used for pain management in cats. Examples of common locoregional procedures in cats include nerve blocks of the mouth and eyes, brachial plexus blocks, forepaw and rear-paw ring blocks, and lumbosacral and caudal epidurals.

References

Brondani J, Khursheed M, Luna S, Validation of the English version of the UNESP-Botucatu multidimensional composite pain scale for assessing postoperative pain in cats, BMC Vet Res, 2013, 143(9)2-15.

Muir W, Physiology and pathophysiology of pain, In Gaynor J, Muir W, editors: Handbook of Veterinary Pain Management, ed 2, St. Louis MO, Mosby Elsevier, pp13-41.

Neonatal, Pediatric, and Geriatric Anesthesia

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Neonates are not considered routine candidates for veterinary anesthesia. Due to their size and anatomical and physiological differences, puppies and kittens be challenging to anesthetize safely.
- Early spays and neuters before adoption is a common practice, and knowledge regarding pediatric physiology and pharmacokinetics of anesthetic drugs is essential for successful anesthesia.
- Like us, our pets are living longer. Although most of the customary principles of veterinary general anesthesia are applicable to geriatric patients; there are important differences that should be considered.

Definitions: neonatal, pediatric puppies and kittens

- In humans, the neonatal period is from birth to 4 weeks and the pediatric period is 4 weeks to approximately 2 years old. Adults are considered twenty years and older.
- In small animal veterinary medicine, puppies and kittens are considered neonates from birth to 2 to 4 weeks old, and pediatric patients are 4 to 8 weeks old. Beyond 8 to 12 weeks, puppies and kittens are considered young adults.

Physiological differences of neonatal and pediatric small animal patients.

- Respiratory system: Neonatal puppies and kittens have a greater prevalence of upper airway obstruction due to their large tongues and small airway openings. As they age and tissues grow, these unique anatomical challenges improve in most species except in brachycephalic breeds.
- Rapidly growing puppies and kittens have a high oxygen demand; therefore, they require a high minute ventilation compared with adults. Their tidal volume and functional residual capacity are fixed; therefore they depend on respiratory frequency to meet metabolic oxygen demands. Respiratory control and autonomic responses are immature and easily depressed by anesthetic drugs. Puppies and kittens under the age of 8 weeks old are highly susceptible during anesthetic procedures to apnea and hypoxia.
- Cardiovascular system: Neonates and puppies/kittens (<8 – 12 weeks old) depend on HR to alter cardiac output. They have limited ability to adjust their mycocardial contractility, thus stroke volumes are fixed. Unfortunately, they are also prone to bradycardia due to immature sympathetic responses and susceptibility to hypoxemia. Because of their immature vascular and autonomic systems, they cannot rely on vascular tone to help regulate mean arterial pressures (MAP) or tissue perfusion. Neonatal and pediatric blood pressure is almost entirely a function of cardiac output.
- Bottom line: Neonatal and pediatric puppies and kittens require oxygen supplementation and ventilation support, whereas bradycardia should be avoided during general anesthesia.
- Hematology: Neonatal and especially pediatric puppies and kittens under 12 weeks old, do not tolerate blood loss. Hematopoesis does not begin effectively until approximately 12 weeks of age and fetal hemoglobin is rapidly being removed, making these young patients highly susceptible to anemia. Adult small animal patients can tolerate up to a 20% surgical blood loss, while neonatal and pediatric patients are limited to a loss of 4%.
- Renal and hepatic systems: Although neonatal, pediatric puppy/kitten kidneys and livers are anatomically developed, they are immature functionally until 8 to 12 weeks of age. Their ability to biodegrade anesthetic drugs is slow, resulting in rapid pharmacodynamic effects and slow recoveries. Their renal function, fluid balance, and ability to concentrate urine are undeveloped, making these young animals susceptible to dehydration and intolerant of excessive fluid administration. Glycogen production and storage are inadequate making them susceptible to hypoglycemia.
- Thermoregulation: Neonatal and pediatric small animal veterinary patients have a high surface area with underdeveloped ability to thermoregulate. Severe hypothermia is of great concern during general anesthesia in small patients and may cause brady-arrhythmias, delayed recoveries and possibly death.

Anesthetic considerations for neonatal and pediatric small animal patients

- Do not fast neonatal and pediatric patients before anesthesia; otherwise, there is a risk of hypoglycemia. The current recommendations are to allow the baby to nurse or feed until anesthesia for patients < 6 weeks old, withhold food no more than 2-3 hours for 6 to 8 week olds, monitor blood glucose at least every 30 to 60 minutes, and administer IV 2.5% dextrose if blood glucose drops below 80-100 mg/dl.
- Anesthetic drugs will produce profound effects and last longer in neonatal and pediatric veterinary patients. Use injectable and premedications judicially. More often it is better to mask induce neonatal patients, intubate, and place an IV catheter without using premedications.

- When using injectable drugs, it is recommended to avoid those known to have slow half-lives and require extensive biodegradation (acepromazine for example). Water soluble, short acting drugs, with known antagonists (midazolam, methadone, butorphanol, for example), at lower doses are better choices. Due to the risk of marked bradycardia and decrease cardiac output, alpha two agonists are not recommended in puppies and kittens under 8 weeks old.
- Avoid blood loss and use caution when administering IV fluids so as to not overload delicate cardiovascular systems.
- Monitor heart rate, ventilation, and oxygenation, body temperature, and blood glucose closely during general anesthesia. Employ external warming devices and bubble wrap extremities to help maintain body temperatures near normal.
- Post-operative care should include supplemental oxygen and heat, monitor blood glucose, and supplemental dextrose, as needed, and provide appropriate analgesics.

Definitions: geriatric dogs and cats

- Dorland's Medical Dictionary (27th ed.) defines geriatric as "old age" or elderly. Most people consider human geriatrics as 65 years old because Medicare eligibility begins. Technically, there is no specific age that defines "geriatric" in humans.
- Dogs that have lived 75 – 80% of their lifespan are considered geriatric, which for small breeds is greater than 10 years old, large breeds 6 – 10 years old.
- Cats are considered geriatric when they are 12 years old and older.

Important considerations for veterinary geriatric anesthesia patients

- Increased age is NOT equivalent to increased risk of general anesthesia unless there are concurrent disease processes. Brodbelt, et al., estimated the risk of anesthetic depth increased up to 7 times for veterinary geriatric patients greater than 12 years old.
- Biological and physiological age is more important than chronological age when considering anesthesia in older patients.
- Geriatric veterinary patients have blunted homeostatic responses, including autonomic and somatic reflexes.
- Underlying disease processes and urgent care should be treated before commencing to general anesthesia.

Physiological/pharmacological considerations for veterinary geriatric anesthesia patients

- Due to decreased metabolic demand, minute ventilation and cardiac output are reduced. The geriatric pulmonary system is less compliant, resulting in an increased work of breathing. Assisted ventilation during general anesthesia is recommended.
- Increased age results in a greater influence of vagal tone and reduced cardiac sympathetic responses. Myocardial and/or degenerative cardiac changes are seen more frequently in elderly veterinary patients, including valvular endocardiosis in small breed dogs and HCM in hyperthyroid cats.
- Although renal and hepatic organ systems continue to work sufficiently in older patients, with age there is a gradual loss of functional capacity. It is advisable to include a CBC and plasma chemistries as part of the pre-anesthetic work-up with geriatric patients. Decreased cardiac output results in decreased hepatic blood flow, which can lead to prolonged drug metabolism and slower patient recoveries.
- Geriatric veterinary patients generally handle most anesthetic drugs and protocols without concern. Clinical differences include increased sensitivities to anesthetic drugs, decreased MAC of inhalant anesthetics, and prolonged recoveries. The exact cause of increased sensitivities to anesthetic drugs seen with geriatric patients is unknown.
- Anesthetic drug recommendations for veterinary geriatric anesthesia patients include lower drug doses and use of short acting, water soluble anesthetic drugs that have known antagonists. Examples of anesthetic drugs used commonly with geriatric veterinary patients include benzodiazepines, opioids, propofol, alfaxalone, isoflurane, sevoflurane, and others.
- Low doses of alpha two agonists are safe to use in geriatric dogs with normal cardiac function. Dexmedetomidine is the drug of choice for elderly cats with HCM; however, ketamine should be avoided.
- Geriatric patients have a higher risk of cognitive dysfunction, which may make them more susceptible to emergence delirium and confusion during anesthesia recovery.
- Judicial dosing of Tramadol is necessary for geriatric patients receiving serotonin/norepinephrine uptake, or MAO inhibitors (selegiline), to avoid serotonin syndrome.

References

Baetge C, Matthews N, Anesthesia and Analgesia for Geriatric Veteterinary Patients, Vet Clin Small Anim 42 (2012) 643–653
Holden, D: Paediatric patients, In Seymour C, Duke-Novakovski T, editors: BSAVA Manual of Canine and Feline Anaesthesia and Analgesia, ed 2, BSAVA Gloucester, pp 293-301.

Magrini F, Haemodynamic determinants of the arterial blood pressure rise during growth in conscious puppies. Cardiovasc Res. 1978 Jul;12(7):422-8.
Neiger-Aeschbacher: Geriatric patients, In Seymour C, Duke-Novakovski T, editors: BSAVA Manual of Canine and Feline Anaesthesia and Analgesia, ed 2, BSAVA Gloucester, pp 303-09.

Postanesthetic Care of Small Animal Patients

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- The recovery period is not always regarded as a vital component of an anesthetic procedure.
- In veterinary anesthesia the majority of adverse events occur during recovery.

Anesthetic recovery

- Anesthetic recovery is the interval from the cessation of anesthetic drug delivery to the point at which the patient is extubated and has voluntary motor control.
- Factors that affect the length of recovery include patient health, length of the anesthetic procedure, anesthetic protocol, and patient, post-anesthetic body temperature.
- According to a Brodbelt, et al., study in 2007, greater than 50% of the canine and feline anesthetic related adversities occur during recovery.
- Thorough planning of the anesthetic event, anticipating problems, and keeping good anesthetic records during the pre-, intra-, and post-operative periods is essential.
- All anesthetic patients have the potential for poor recoveries. Difficult anesthetic recoveries can be due to multiple factors, including emergence delirium, dysphoria, inadequate analgesia, and general patient discomfort. In these cases, it is often advisable to delay the recovery to avoid further stress or injury to the recovering patient.

Anesthetic recovery: patient monitoring

- In the 2008, Brodbelt, et al., article, the authors speculated that inadequate patient monitoring may have been the primary factor behind anesthetic recovery periods being over represented by increased mortality rates in small animal anesthetic procedures.
- Anesthetic monitoring should NOT end at recovery; instead, it should continue until the patient is extubated and has returned voluntary muscle control.
- The degree of monitoring, and parameters evaluated, depend on the procedure performed and the patient's health. Patient monitoring should include at least cardiovascular and respiratory status, body temperature, analgesia, and patient (dis)comfort. Post anesthetic, patient monitoring parameters should be included within the patient's anesthetic records.

Anesthetic recovery: extubation

- Indications for patient intubation include decreasing the risk of aspiration, securing the patient's airway, and providing a means for assisted ventilation. Patient intubation should be included with any procedure that involves a level of sedation or anesthesia in which the patient has lost motor control and therefore the ability to guard the larynx.
- Extubation should be performed when the recovering patient has regained laryngeal or pharyngeal sensation and reflexes, such as gagging, swallowing and chewing.
- Brachycephalic breeds have an increased risk of post-extubation, upper airway obstruction. During sedation and anesthesia excessive peri-laryngeal tissues and hypoplastic tracheas predispose these patients to pharyngeal obstruction. Ventilatory function should be monitored closely with brachycephalic breeds during pre-operative sedation and post-operative recovery, and it is prudent to have induction agent, a laryngoscope, and an endotracheal tube immediately available in case of upper airway obstruction.

Anesthetic recovery: other breed/species issues

- Alaskan malamutes, Siberian huskies and Labrador retrievers have a genetic polymorphism that predisposes these breeds to a high incidence of opioid-related dysphoria. Problems related to opioid use in those breeds tend to be individualistic; however, it is advisable to use lower doses, especially in Nordic breed dogs. Opioid dysphoria in any breed (or species) can be reversed using naloxone.
- Post-anesthesia related feline blindness (deafness) was reported as early as 2001. Unlike the dog, which has two arterial blood supplies to the brain (internal carotid and basilar arteries), cats have only one cerebral blood supply (maxillary artery). Spring-loaded mouth gags, used during procedures requiring mandibular extension (dentals), in cats can result in obstruction of the maxillary arterial blood flow causing cerebral ischemia, central blindness, and/or deafness.

Anesthetic recovery: supplemental oxygen

Post-operative oxygen supplementation is most beneficial in patients with compromised respiratory function, sick patients, obese and pregnant patients, and brachycephalic breeds.

Anesthetic recovery: patient welfare

- Post-anesthetic monitoring goes beyond recording a patient's physiological and analgesic parameters. Post-anesthetic monitoring, more importantly, includes observing the patient's general welfare.
- Post-anesthetic patient welfare considerations encompass the entire patient-condition during recovery, including physiological, analgesic, patient comfort, body temperature, and human interaction.
- Human touch and voice have a calming effect on animal patients recovering from general anesthesia. It is important that an individual remain with the recovering animal patient in order to maintain post-anesthetic monitoring and provide patient comfort.

Anesthetic recovery: body temperature

- Post-anesthetic patient hypothermia is the number one complication related to general anesthesia in human and veterinary medicine. The combination of dose dependent depression of the thermoregulatory centers, due to anesthetic drugs, and a cold surgical environment can result in significant loss of body heat.
- In human medicine, the discomfort of post-anesthetic hypothermia and uncontrollable shivering is well documented.
- Hypothermia can predispose to bradycardia, delayed recovery, and post-operative shivering.
- It is imperative to mitigate patient hypothermia throughout the entire anesthetic event, including recovery, by employing external heat sources such as warm water circulating blankets and forced warm air blowers.
- Intra- and post-operative patient hyperthermia is uncommon in veterinary medicine. Primary causes of anesthesia-related hyperthermia in animal patients include preoperative fever and iatrogenic sources such as excessive external heating.
- Malignant hyperthermia-like syndrome (MH) has not been proven to be a genetic condition in dogs or cats; however, there have been documented cases involving grey hounds and a Siberian husky that demonstrated a clinical condition similar to MH in humans.

Anesthetic recovery: reversal agents

There are times when it is beneficial to reverse anesthetic drugs and hasten recovery; however, judgment is necessary weighing the advantages of drug reversal versus allowing slower recoveries. When reversing the sedative effects of some anesthetic drugs, opioids and alpha 2 agonists for example, analgesic properties will be reversed also.

References

Adami C, Axiak S, Raith K, Spadavecchia C. Unusual perianesthetic malignant hyperthermia in a dog. J Am Vet Med Assoc. 2012 Feb 15;240(4):450-3.

Barton-Lamb L, Marin-Flores M, Scrivani P, et al., Evaluation of maxillary arterial blood flow in anesthetized cats with the mouth closed and open, Vet J, 2013, 196:325-31.

Brodbelt C, Blissitt K, Hammond R, et al., The risk of death: the confidential enquiry into perioperative small animal fatalities, Vet Anaesth Analg, 2008, 35:365-73.

Hawley A, Wetmore L, Identification of single nucleotide polymorphisms within exon 1 of the canine mu-opioid receptor gene, Vet Anaesth Analg, 2010, 37:79-82.

Jurk IR, Thibodeau MS, Whitney K et al. Acute vision loss after general anesthesia in a cat. Vet Ophthalmol, 2001, 4:155-58.

Pain Medication:
A Win, Win Situation for You, Your Patients, and Your Clients

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Historically, it was believed animals did not feel pain or perceived pain differently than did humans. An example of a misconception regarding post-operative pain in animal patients was that pain following surgery benefited animals because it limited movement thus preventing further injury.
- Animals and humans share similar anatomical and physiological nociceptive structures for the production, conduction, and modulation of pain.
- Pain assessment in animals is based on anthropomorphic comparisons, subjective, and objective criteria.

Ethical principles of pain management in veterinary medicine

- The Veterinarian's Oath states, "...the protection of animal health and welfare, the prevention and relief of animal suffering..." Does the Veterinarian's Oath still apply today?
- Since recorded history humans have consistently demonstrated a keenness toward domesticating and caring for animals. Unfortunately, the historical relationship between humans and animals is tainted with various forms of animal cruelty.
- Modern biology presented similarities between humans and animals, thus proving animals were not distinct from humans.
- Charles Darwin's theory of evolution transformed the perception of the relationship between animals and humans.
- In United States, the 1966 Animal Welfare Act and The National Institutes of Health Reauthorization Acts set the stage for social, economic, and legislative actions leading to the modernization of the concept of animal welfare.
- As modern medicine became more scientifically based, pain, although always recognized as an entity of pathology, was difficult to accept because it never completely had a scientific explanation.
- Veterinary medicine was founded originally to benefit the animal agricultural industry and military use of horses. Anesthesia and analgesia were primarily means to help control large animals, protect personnel, and the value of the patient.
- Although human medicine has made tremendous advancements in pain management veterinary medicine still lags behind.
- Society's views of animal pain and welfare have changed dramatically since the Animal Welfare Act was passed in 1966. Today, society no longer tolerates unnecessary animal suffering. The ease of information from the world-wide internet allows people to self-educate on subjects in pet health and welfare. Clients no longer consider pain management options as a luxury for their pet but instead as a mandatory part of an overall procedure.
- Two primary factors that will contribute to the veterinary industry losing significance in society are refusal to change and refusal to charge. Each one of us, as a representative of the veterinary industry, has an obligation to remain educated regarding pet health issues (including pain management), and be the primary source of information about pet welfare for clients, and clients have an obligation to realize financially the importance of veterinarians' expertise in the health and welfare of their pets.

References

ACVAA website: http://www.acvaa.org, American College of Veterinary Anesthesiologists' position paper on the treatment of pain in animals, 2006 http://www.acvaa.org/docs/Pain_Treatment

Carroll G, Analgesics and pain, Vet Clin North Am Small Anim Pract. 1999 May;29(3):701-17

Fajt V, Wagner S, Norby B, Analgesic drug administration and attitudes about analgesia in cattle among bovine practitioners in the United States, JAVMA, 2011, March, 238(6):755-67

Hellyer P, Rodan I, Downing R, AAHA/AAFP Pain Management Guidelines for Dogs and Cats, JAAHA, 2007, Sept/Oct, 43:235-48

Hewson C, Dohoo I, Lemke K, Perioperative use of analgesics in dogs and cats by Canadian veterinarians in 2001, Can Vet J, 2006, Apr;47(4):352-9.

Avian Emergency Coming In?
An Overview of Common Presentations

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Etiologies

The causes for a bird to have an emergency visit to the veterinarian are similar to those for mammals, but may vary slightly, for example: trauma (hit by ceiling fan, toe closed in door, big bird/little bird incidents, dog/cat attack, burns), toxins (lead, zinc, PTFE fumes from Teflon), metabolic (hypovitaminosis A, hypocalcemia in African Grey Parrots), or infection (due to bacteria, virus, fungus or chlamydophila usually involving the liver, GI or respiratory tract). Unlike mammals, birds usually present with a terminal manifestation of chronic disease that has just recently showed overt acute signs. Subtle clues of disease have often gone unrecognized by the owner. This is because birds hide signs of disease to avoid being ostracized by the flock; i.e. the flock doesn't want to be around a bird that is attracting a predator. A common avian emergency is egg binding (dystocia) due to low total body calcium from a long term calcium deficient diet (such as a seed diet).

Clinical goals

First, if possible, obtain a history over phone so as to be as prepared as possible when the bird arrives.

Be familiar with common species problems (i.e. for a seizuring African Grey parrot have hypocalcemia at the top of your rule-out list). Evaluate the history, cage and husbandry, droppings, and observe the bird for clues as to the etiology before stressful restraint. Perform a rapid, but thorough PE, and diagnostic collection (+/- cbc, profile, radiographs, fecal gram stain); sometimes the bird may be so stressed that the exam may need to be performed in less than one minute. Obtain an accurate weight with a gram scale so as to administer accurate drug dosing Provide supportive therapy to stabilize the patient including providing a warm (85-90^{0}F) and stress free environment (no barking dogs), +/- O_2, offer familiar/favorite foods and water that are elevated to sit right in front of the bird, provide 10 hours of daylight and 14 hours of dark, provide a low perch (birds insist on perching on the highest available perch, even when severely debilitated.

ABC's (airway, breathing and cardiovascular system) for the unconscious patient

Airway

First check to see that the patient has a patent airway. Is the airway patent or is there a mass or foreign body in the trachea? Examples of a mass include, aspergillus granuloma, neoplasia, diptheritic membrane. Examples of a foreign body include a millet seed in a cockatiel trachea (this can be directly visualized in the trachea with a rigid 1.0 mm endoscope.

Breathing

Second check to see if the animal is breathing, and if not then intubate (use uncuffed ET tubes in birds since they have complete tracheal rings). Provide intermittent partial pressure ventilation (IPPV) in birds at 1 breath/5sec. Due to the unique respiratory system in birds an air sac tube can be placed in caudal thoracic or abdominal air sac and oxygenated air will flow through the lung. An air sac tube can be connected to O_2 or anesthesia, and left in place 5 days. To place an air sac tube, make a skin incision over the sternal notch area (borders are the last rib, the femur and the lateral processes of the vertebrae) and use a pair of hemostats to penetrate body wall, and then insert an ET tube.

Cardiac arrest

Third, check to see if there is a heartbeat present. If a bird experiences cardiac arrest, then the prognosis to reverse this situation is poor/grave due to a bird's high metabolic rate and oxygen demands. The following treatments can be attempted to reinitiate heart beat: rapid heart massage and ventilate (100 beats per minute and 1breath/5 seconds), epinephrine IV or IT (intratracheally), atropine (usually used to prevent bradycardia), dopram IV or IT (stimulates respirations), bolus IV fluids +/- 2.5 – 5% dextrose and/or colloids.

Common emergency situations and their treatments

Blood loss

The average blood volume of a bird is approximately 10% of its body weight (BW). For example a 1.0 kg blue and gold macaw has an average blood volume of about 100ml. A healthy bird can lose up to 10% of their blood volume (or 1% of BW) without any adverse side affects. Again our healthy 1.0 kg blue and gold macaw could lose up to 10 ml without any adverse side effects. Unlike mammals, a healthy bird can usually lose up to 30% of their blood volume without dying due to compensatory mechanisms. Because of the these compensatory mechanisms, it is important to realize that the PCV in a bird is not accurate (i.e. not equilibrated) for 24 hours after a hemorrhagic incident because birds can compensate their PCV during blood loss by shunting blood from large skeletal muscle capillary beds and away from the kidneys via the renal portal system to increase blood to central areas. Therefore, an equilibrated PCV <15%, or an immediate PCV <20% are similar and serious enough to contemplate a blood transfusion. Fluids, hetastarch, oxyglobin or

a blood transfusion (5% of BW) will help a bird with severe blood loss. The anemic patient may require vitamin B complex, iron dextran and vitamin $K_{1.}$

Dehydration

Most sick birds are 5-10% dehydrated. Severe dehydration is usually > 10%. Clinical signs of dehydration include depression, reduced skin elasticity over digits, sunken eyes, cool digits, decreased refill time of the basilic (cutaneous ulnar) vein. A general rule of thumb is that a normally hydrated bird will have a basilic vein refill time that is instantaneous, such that you cannot see the vein refill after applying digital pressure to the vein. If you can see the vein refill then the bird is at least 5% dehydrated, and if the vein takes 1 second or more to refill then the bird is over 5% dehydrated.

Therapy for severe dehydration

Maintenance fluids are the same for birds as they are for mammals at 50 ml/kg/day.

- For example, maintenance fluid calculations for a 500 gram Amazon parrot:
  - 0.5 kg X 50 ml/kg/day = 25 ml/day
- For example, dehydration fluid replacement needed for a 500 gram Amazon parrot that is 6% dehydrated:
  - dehydration replacement in liters is BW (in kg) X % dehydration (expressed as a decimal amount)
- -0.5 kg X 0.06 = 0.030 liters = 30 ml
  - the calculated dose for dehydration replacement (30 ml) should be administered over a 48 hour period
- For example, maintenance and dehydration fluids given to above bird in 48 hours:
  - day 1: 25 ml for maintenance + 15 ml for half the dehydration replacement = 40 ml
  - day 2: 25 ml for maintenance + 15 for the 2nd half of dehydration replacement =40 ml

Fluid therapy

Fluid therapy is a critical component of emergency therapy. The most commonly used fluids are lactated Ringer's solution or Normosol-R since they most closely resemble the fluid lost. WARM (about 100^0F) FLUIDS are imperitive, realize the body temperature of most birds is 104-109^0F. Sometimes 2.5 % dextrose is added to the SQ or IV fluids. Mild dehydration may only require conservative management such as oral or SQ fluids. SQ fluids are generally administered into the inguinal area in birds. Severe dehydration or shock requires rapid circulatory expansion with IV or IO (intraosseous) fluids since oral or SQ are inadequate in these cases due to lack of absorption at the administration site. Peripheral indwelling catheters have been avoided in birds since they have small fragile veins that easily form hematomas, their dermis is highly mobile causing difficulties in stabilizing the catheter, and they have refractory temperaments and a powerful beak. Repeated IV bolusing can be attempted, but it is stressful to the birds to be repeatedly restrained and it is damaging to the veins. Switch to oral fluids as soon as possible.

Intraosseous (IO) catheters

IO catheters allow continuous access to peripheral circulation, and they provide the ability to administer drugs, fluids, or total parenteral nutrition (TPN). The use of IO catheters is safe, rapid and practical.

IO catheters are most commonly placed in the distal ulna or proximal tibiotarsus. IO catheters should not be placed in a pneumatic bone as this may drown the bird when fluids are administered, since pneumatic bones communicate with the respiratory system. Likewise, intracoelomic fluids should not be administered as this may also drown the bird if fluids get into an air sac.

IO catheter placement

1) pluck and aseptically prepare the carpus, 2) position needle in center of distal ulna, 3) support ulna and rotate catheter, 4) past cortex the catheter passes easily, 5) aspiration produces a small amount of blood, 6)anchor to soft tissue of carpus, 7) apply a figure-8 bandage.

Avian therapy

Therapy overview

Most infections in parrots are due to Gram negative organisms. Most drugs are used empirically, since very few if any pharmacodynamic and pharmacokinetic studies have been performed in any species of bird, or a few species of birds (realize there is no generic bird, different parrot species react differently to different drugs so research on each species would take forever). The goal is to achieve antimicrobial tissue levels at the site of infection that are greater than theMIC, but realize tissue penetrations vary. Also realize that drug excretion is rapid in birds compared to mammals. Antibiotics can cause immunosuppression and change normal flora producing a secondary fungal infection, therefore only use antibiotics when indicated so as not to upset the delicate balance of normal flora. Choose bacteriocidal instead of bacteriostatic antibiotics.

Water additives

Advantages of adding medications to the water are that thry easy to administer, the bird medicates itself, and it reduces specific water borne disease. Disadvantages are inexact dose, poor palatability reduces water and drug intake, medications unstable in water, underdosing increases organism resistance, and they are poorly or slowly absorbed.

Food additives

Advantages of adding medications to the food are that they are easy to administer, food consumption is fairly consistant, and it is easy to treat hand fed nestlings. Disadvantages are same as for water above, except realize that sick birds are often anorectic or hyporectic.

Direct oral

Advantages of direct oral medications are that they are easy to give a precise dose (unless they spit the drug out or don't swallow), human pediatric suspensions are available, and you can tube feed at the same time. Disadvantages include stress of capture and restraint, aspiration of drug, drug may be poorly or slowly absorbed, and possible malabsorption (if for example the bird is in shock or has a GI disorder).

IM - pectoral muscles

Advantages of IM injections are that an exact dose is given, they are quick and easy to administer and they are quickly absorbed. Disadvantages include that not all drugs are available as IM, and pain and necrosis.

IV - jugular, etc.

Advantages of IV dosing include that an exact dose is given, and rapid therapeutic levels are reached.

Disadvantages include the stress of prolonged restraint and the fragile veins of birds.

IO – ulna or tibiotarsus

Advantages are a precise dose can be given and the IO catheter can be left in place up to 5 days. Disadvantage would be discomfort/pain.

SQ - inguinal

Advantages are a precise dose is given and it is quick and easy to administer. Disadvantages include some drugs are irritating SQ and severely debilitated birds may not absorb SQ fluids or drugs.

Other methods of treatment

Topical

In birds, avoid greasy topical compounds because this reduces the insulation of the feathers. If ointments must be used in birds, then use sparingly. It is better to use water soluble creams.

Nebulization

Nebulization is used to deliver medications for respiratory infections. Nebulization is the atomization of a liquid into small (< 3 microns) droplets that can be inhaled. Usually nebulization is performed for 10 - 30 minutes by forcing oxygen through a solution (containing antibiotics or antifungals, etc.).

Sinus/nasal flushing

Sinus flushing can be diagnostic (cytology, culture) and/or therapeutic. Remember to use WARM saline. Also, it is imperative to hold the bird completely vertically upside-down so as to avoid aspiration of fluid into the trachea. Flushing can be performed in an awake bird or an anesthetized, intubated bird.

Tube feeding

Tube feeding is controversial in critically ill patients (will they process it?). First make sure the bird is hydrated. Usually start with a thin carbohydrate supplement (such as Emeraid) and later use a juvenile parrot hand feeding formula or specially made avian critical care diet (high calorie, easy to digest). Birds have a high basal metabolic rate with very little in reserves, therefore if a bird is losing weight, then it needs to be tube fed. While hospitalized a bird is weighed daily in the morning on a gram scale. Tube feeding is necessary if a bird is not maintaining or gaining weight in the hiospital. Generally birds are tube feed 1-4 times/day. Technique:1) restrain the bird in a normal upright position so as to avoid regurgitation and aspiration. 2)I prefer a stainless steel feeding needle with ball tip, others use a red-rubber catheter and a speculum to prevent the bird biting the tube in two. 3)aim from left commisure to right crop area. 4) avoid the large trachea and avoid excessive force so as not to puncture the esophagus. 5)be absolutely sure of placement by palpating/visualizing tube in crop before administering the formula. 6)if the bird regurgitates, then place it on the floor immediately.

Approximate feeding quantities (start with small amounts, then increase to amount below)

- budgie - 1 ml
- cockatiel - 3 -5 ml
- Amazon parrot- 15 - 30 ml
- cockatoo - 20 - 40 ml
- macaw - 30 - 60 ml

Avian Euthanasia:
Incorporating Compassion and the New AVMA Guidelines

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Recently, the *AVMA Guidelines for the Euthanasia of Animals: 2013 Edition* was released. This new, expanded version is 102 pages long and includes sections on species that were not addressed in earlier versions, section on how to handle animals before and during euthanasia, and disposal of carcasses. It also includes an avian section pertaining to pet birds, aviary birds, and birds used in falconry, racing, zoos, and educational facilities. The new Guidelines emphasize evidence based medicine and research, but unfortunately in the area of euthanasia of birds, there is little, if any, research or evidence based medicine published compared to mammals. What scientific literature is available pertains to chickens in a commercial environment, otherwise it is anecdotal information. There are separate sections in the Guidelines for wild birds under "Captive and Free-ranging Nondomestic Animal" section of the Guidelines", and for birds raised for food under "Animal Farmed for Food and Fiber" section" of the Guidelines.

Some peer-reviewed reports are available in the literature regarding euthanasia of individual or small groups of birds, but most of the information consists of anecdotal reports in book chapters, guidelines from various associations, journal roundtable discussions and editorials. The method of euthanasia depends on species, size, anatomic and physiologic characteristics, environment, degree of domestication, clinical state, and anticipated and actual response to restraint. People performing the euthanasia should be knowledgeable about what is normal behavior for a bird compared to what is considered a stressed or fearful bird and handle the bird appropriately to reduce stress before and during euthanasia.

According to the 2013 AVMA Guidelines for Euthanasia acceptable methods of euthanasia of birds include injection of a sodium pentobarbital euthanasia solution IV with or without the bird being unconscious or under anesthesia, or intracoelomic, intracardiac or intraosseous injection of a sodium pentobarbital euthanasia solution while unconscious or under anesthesia. Anesthesia is defined as either halothane, isoflurane, or sevoflurane with or without nitrous oxide. Acceptable methods of euthanasia of birds with conditions include inhalant anesthetics alone at high concentrations (isoflurane, sevoflurane, halothane with or without nitrous oxide), carbon dioxide (>40%), carbon monoxide, nitrogen, argon, and the physical methods including cervical dislocation (<200 grams), decaptitation (<200 grams), gunshot (field conditions), and the following only as a secondary methods if unconscious or under anesthesia: potassium chloride, exsanguination and thoracic compression. Realize that barbiturate salts are alkaline and irritating and that intracoelomic injections are irritating, especially if they inadvertently get into an air sac. Also realize that intraosseous injections should not be given in pneumatic bones such as the femur or humerus because these are lined with respiratory epithelium and connect to the respiratory tract.

Overview of methods

Acceptable

Intravenous (IV) injection with an injectable euthanasia agent (such as sodium pentobarbital) is the quickest and most reliable means of euthanizing birds when it can be performed without causing undue stress. Most birds get stressed with handling so I personally prefer to gently restrain them in a towel while mask inducing with isoflurane or sevoflurane with or without prior sedation with midazolam given intramuscularly (IM) or intranasally (IN) 15 prior to induction. Other sedatives can be used.

Acceptable with conditions

The Guidelines are clear to state that "Methods acceptable with conditions are equivalent to acceptable methods when all criteria for application of a method are met".

Inhaled anesthetics – Birds given high concentrations of inhaled gas anesthetics lose consciousness rapidly and then death occurs after they are rendered unconscious. The condition is that a high concentration of gas be used and the restraint cause little to no stress. This method usually induces minimal tissue damage in case a necropsy is needed.

Carbon Dioxide – Birds require comparatively high (>40%) concentrations of carbon dioxide to induce anesthesia followed by loss of consciousness. There is much scientific literature available on the use of carbon dioxide for the use of euthanasia of chickens, ducks and turkeys. It is important that the application rate of carbon dioxide is just right so that the increase in carbon dioxide is rapid enough to have a short time to loss of posture and unconsciousness, but slow enough that there is less aversion or reaction to the gas. Even though birds are unconscious, they tend to flap with carbon dioxide and this can damage tissue if needed for necropsy.

Carbon monoxide – Not generally used in clinical settings due to risk to personnel.

Argon and Nitrogen – Not generally used in clinical settings due to availablity.

Cervical dislocation – Sometimes needed in a field situation, say an emergency at an aviary. Cervical dislocation is typically done in birds that are <200 grams, but has been described in birds as large as 2.3 kg. Acceptable with the condition that the person performing the cervical dislocation is experienced in performing the procedure.

Decapitation – Again, sometimes in a field situation, may need to use this method. Again, decapitation is typically done in birds that are <200 grams, but has been described in birds as large as 3.5 kg. Acceptable with the condition that the person performing the decapitation is experienced in performing the procedure and the device used is very sharp and kept in good working order. One study showed that visual evoked responses were present up to 30 seconds after decapitation.

Gunshot – Not used in a clinical setting due to obvious dangers to personnel and other, better methods area available.

Adjunctive methods are those methods that can be used only if the bird is unconscious and anesthetized prior to their use, and include IV or intracardiac potassium chloride, exsanguination, or thoracic compression. These methods are unacceptable if performed in a conscious bird. Exsanguination is useful if the blood is needed for further testing in the bird.

Unacceptable

In the conscious bird it is unacceptable to perform thoracic compression, exsanguinate, or administer potassium chloride.

Eggs

Bird embryos that are >50% through incubation should be euthanized by above acceptable methods or acceptable with conditions methods including anesthetic overdose, decapitation, or prolonged (>20 minutes) exposure to carbon dioxide. Eggs that are less than 50% through incubation can be destroyed by prolonged (>20 minutes) exposure to carbon dioxide, cooling (< 4 degrees C for 4 hours), freezing, or egg addling.

References

AVMA Guidelines for the Euthanasia of Animals: 2013 Edition.

Bennett RA. AAV Opposes thoracic compression. *J Amer Vet Med Assoc*, Apr 15, 2001, p 1262.

Blackshaw JK, Fenwick DC, Beattie AW, Allan DJ. The behavior of chickens, mice and rats during euthanasia with chloroform, carbon dioxide and ether. *Lab Anim*, 1998:22(1):67-75.

Close B, Banister K, Baumans V, et al. Recommendations for euthanasia of experimental animals: part 1. Laboratory Animals 1996;30:293-316.

Close B, Banister K, Baumans V, et al. Recommendations for euthanasia of experimental animals: part 2. Laboratory Animals 1997;31:1-32.

Coenen AML, Lankhaar J, Lowe JC, McKeegan DEF. Remote monitoring of electroencephalogram, electrocardiogram, and behavior during controlled atmosphere stunning in broilers: implications for welfare. *Poultry Sci*, 2009:88(1):10-19.

Erasmus MA, Lawlis P, Duncan IJ, Widowski TM. Using time to insensibility and estimated time of death to evaluate a nonpenetrating captive bolt, cervical dislocation, and blunt trauma for on-farm killing of turkeys. *Poultry Science*, 2010; 89(7):1345-1354.

Franson JC. Euthanasia. In: Friend M, Franson JC, (eds). *Field Manual of Wildlife Diseases. General Field Procedures and diseases of birds.* US Geological Survey, Biological Resources Division, Washington, D.C., BRD Information and Technology Report, 1999:49-51.

Gregory NG, Wotton SB. Comparison of neck dislocation and percussion of the head on visual evoked responses in the chicken's brain. *Vet Rec*, 1990;126(23):570-572.

Hess L. (Assoc ed.)Euthanasia Techniques in Birds – Roundtable Discussion. *J Av Med and Surg*, 19(3):242-245, 2005.

Ludders JW. Another reader opposing thoracic compression for avian euthanasia. *J Amer Vet Med Assoc*, June 1, 2001, 218(11), p.1721.

Mason C, Spence J, Bilbe L, Hughes T, Kirkwood J. Methods for dispatching backyard poultry. *Vet Rec*, 2009;164(7):220.

Miller EA (ed.). Minimum *Standards for Wildlife Rehabilitation, 3rd ed.*, St. Cloud MN, National Wildlife Rehabilitators Association, 2000, (Sec.7.3), 77 pages. 4. Euthanasia of nonconventional species: zoo, wild, aquatic, and ectothermic animals.

Ornithological Council. *Guidelines to the use of Wild Birds in Research*. 1997.

Orosz S. Birds. In: *Guidelines for Euthanasia of Nondomestic Animals. American Association of Zoo Veterinarians*. 2006; 46-49.

Raj ABM. Aversive reactions to argon, carbon dioxide and a mixture of carbon dioxide and argon. *Veterinary Record*, 1996, 138(24):592-3.

Raj ABM. Recent developments in stunning and slaughter of poultry. World's Poultry Science Journal 2006;62:462-484.

It's Black and White:
Taking and Interpreting Avian Radiographs

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Taking and interpreting radiographs of birds is different than it is for mammals for various reasons: they are usually smaller, their anatomy is different, and usually they need to be anesthetized for ideal positioning and interpretation of radiographs. First determine the goals of your imaging study. In order to do this, it is important to obtain a thorough history and physical examination, develop and problem list with primary rule-outs for the problems, and develop and diagnostic and treatment plan. Radiographs alone can make a diagnosis in some cases, but this is not the case all the time. Other diagnostics will most likely be necessary for a complete diagnosis. Obtain high quality images. This is especially important with avian patients since they are so small and fine detail is necessary. Consider if you want to anesthetize or restrain your patient for radiographs and how positioning may affect your ability to determine if a radiographic lesion is present or not. Can the bird withstand the diagnostic test you have planned? And lastly, interpret your radiographic images. There are many texts available to help in evaluating avian radiographs.

Restraint

To obtain the best quality radiographs without artifact from movement of fast respiratory rates or struggling it is best to sedate or anesthetize the bird. So a choice needs to be made regarding whether to use physical or chemical restraint. Considerations include: stress to patient, suspected disease process, pain level and stability of patient, the degree of correct positioning needed, and staff exposure to radiation and anesthetic gas. It is my opinion that it is best to briefly anesthetize at a light plane of anesthesia with either isoflurane or sevoflurane +/- the use of midazolam, +/-intubating. It is my opinion that physical restraint is incredibly stressful to the bird and that positioning is less than ideal. There are plexiglass restraint boards available to tape or Velcro the bird to the board. There are times that the bird is too debilitated for restraint or anesthesia, and if the goal is ascertain whether there is an egg present or whether there is heavy metal present, then a "bird in the box" radiograph can be taken where positioning doesn't matter as much. Always be prepared to monitor the bird via multiple methods (stethoscope, pulse oximeter, Doppler, ECG), provide thermal support (forced heated air blanket for example), be ready in case of an emergency (have ET tubes there with you that will fit the bird, epinephrine, atropine), and have all equipment available that you think you will need, especially if you are going to combine radiography with another, even if it is brief, procedure.

Positioning and radiographic technique and interpretation

Typically whole body orthogonal views are taken (ventrodorsal and right lateral). For the VD view, the bird is laid in dorsal recumbancy with both wings extended equally laterally, and both legs extended equally caudally. The keel should be superimposed over the vertebral column, and the femurs, scapula and acetabula should be parallel. The focal point of the beam should be at the caudal point of the sternum. For the lateral view, the bird is laid in right lateral recumbancy, with the wings extended dorsally (either evenly if body is of interest, or staggered with dependent wing slightly cranial if a wing or shoulder is of interest), and the legs are equally extended caudally (equally if body of interest to move knee caudal to ventriculus, or staggered with the dependent leg slightly cranial if legs are of interest). The acetabula, ribs, shoular joints, and kidneys should be superimposed. Again, the focal spot for the beam is just cranial to the caudal tip of the sternum. If the wing is to be evaluated an additional view is needed, specifically the craniocaudal view, in order to obtain orthogonal views. The bird is placed in dorsal recumbancy and horizontal beam is used. If the foot is to be evaluated, then a caudopantar view of the foot is also needed. For skull radiogarphs the views include both lateral views, obliques, DV and rostrocaudal. A standard radiograph machine and film can be used, or mammography film can be used, or digital. The ideal focal film distance is 40 inches. Table top is usually used unless the width of the bird is greater than 10 cm. Short exposure times are used (<1/120 sec.) and a high mA (>300mA) with a low kVp (45-65 kV). Develop your own systematic approach to viewing radiographs so as not to miss anything (remember there can be more than one lesion). Learn normal avian anatomy in order to recognize abnormal findings. Follow the SOAP (Subjective, Objective, Assessment, Plan) format to be thorough in evaluation of any radiographic abnormalities identified by developing a differential diagnosis list. Develop a plan for further diagnostic tests and/or treatments.

Musculoskeletal system

The musculoskeletal system includes the skull, spine, pectoral girdle, wings, pelvis, and pelvic limbs. The skull is mainly composed of sinuses. The eye itself has bones to support the eye called scleral oscicles. Realize that in parrots, but not all birds, there is a true joint called the craniofacial hinge (or nasofrontal joint depending on who you read) where the beak joins the frontal bone. Unlike mammals, birds have a variable number of cervical vertebrae, varying between 8 and 25 cervical vertebrae. This allows their beak to reach many places and to be used for preening the entire body, prehending food, biting, and for stabilization. The notarium is a fusion of the first

thoracic vertebrae. The synsacrum is a fusion of the caudal thoracic, lumbar, sacral, and caudal vertebrae. Together, the notarium and synsacrum stabilize the spine. The pygostyle is a distal fusion of the caudal vertebrae making a structure for tail muscle attachment. The tail muscles are used for steering during flight.The sternum usually has a prominent keel for pectoral muscle attachment, unless it is a flightless bird (such as an ostrich) that has no need for strong pectoral muscles. Ratites like ostrich have a flat boat shaped keel with no keel. The pectoral girdle in birds consists of three bones including the coracoid bone (which acts as a strut enabling flight), the clavicle and the scapula. The bones of the wing include the humerus, radius, ulna, ulnar and radial carpal bones and major and minor metacarpals, phalanges, and alula (remnants of a thumb). The bones of the hind limb include the femur, tibiotarsus, tarsometatarsus, and phalanges. The digits are numbered from medially to laterally and the number of phalanges in each digit is one more than the digit number. The femur, humerus and some vertebrae are pneumatic bones, meaning they are air filled and connect directly to the respiratory tract. The medullary cavities of these bones are covered in respiratory epithelium and respiratory tumors have been documented within the medullary cavity of the humerus. Musculoskeletal diseases in birds include arthritis, osteomyelitis, fractures (it is OK to see air in nearby soft tissue is a pneumatic bone is freshly fractured!), polyostotic hyperostosis (from hyperestrogenism in females, from oviductal tumors, breeding hen, Sertoli cell tumors).

Respiratory system

Birds possess an extensive infraorbital sinus, in fact most of their head is sinus. Compared to mammals, birds have a very large trachea, and therefore birds can inhale more air (and bring in more oxygen) than mammals. This helps to enable the energy required for flight. Birds have complete tracheal rings, and that is why the use of uncuffed endotracheal tubes are recommended in birds to avoid pressure necrosis of the trachea. Birds lack a diaphragm, therefore they must be allowed to move their sternum up and down or they will suffocate. The syrinx is responsible for sound generation in the bird, they do not possess a larynx. The syrinx is right at the bifurcation of the trachea just cranial to the heart in a bird. Some male ducks, such as the male Mallard duck, have a bony syringeal bulla coming off the right side of the trachea just cranial to the heart to allow them to have a loud quack. Other strange anatomical structures in some birds include a coiled trachea found in swans, cranes, spoonbills, and birds of paradise. Also, penguins have a trachea that bifurcates very cranially compared to other birds. The pathway of inspired air in the bird is as follows: trachea > primary bronchus > secondary bronchus > parabronchi > air capillaries. On radiographs, the lung itself normally looks spongy or has a honeycomb appearance and that is the end on parabronchi being visualized. Birds have air sacs that store and warm air, and they also act as a bellows. Parrots have 9 air sacs (2 cervicocephalic, 1 clavicular, 2 cranial thoracic, 2 caudal thoracic and 2 abdominal). The air sacs directly communicate with the repiratory system, therefore a tube can be placed in the side of a bird directly into the caudal thoracic or abdominal air sac and the bird can breathe through this tube or can even be anesthetized through this tube. Remember that some bones (femur, humerus, some vertebrae) are pneumatic and not only communicate with the respiratory system, but are also lined with respiratory epithelium.Respiratory diseases include pneumonia (where the fine detail of the lung is lost), air sacculitis (where the thickened walls can actually be seen radiographically), and SQ emphysema (possibly from a ruptured air sac).

Cardiovascular system

Birds, like mammals, have a 4 chambered heart, the apex of which is surrounded by the liver (remember there is no diaphragm in a bird). The avian heart is comparatively larger than a mammalian heart at about 1.5 to 2 times larger than a mammalian heart. This allows more oxygen flow for the tremendous work performed during flight. The cardiac silhouette usually lies between the 2nd and 5th rib and constitute 50% of the width of the cranial coelomic cavity on the VD view. The apex of the heart silhouettes with the cranial part of the liver to make a hour glass shape on the VD view called the cardiohepatic silhouette. It is abnormal to see calcification in the greater vessels, so watch for it in older and obese birds.

Gastrointestinal system

Since birds lack a diaphragm they possess a “coelomic cavity”, not an abdominal cavity. Birds do not have teeth, instead they have a beak that is variable between species. Parrots are sometimes called hookbills because of their strong, hooked beak. The esophagus of birds is divided into two sections, the cervical esophagus and thoracic esophagus. The two sections are divided by an out-pouching of the esophagus called the crop (ingluvies). The ingluvies stores food to be digested later when the bird is up in a tree where it is safe. On VD radiographs the crop lies to the right just cranial to the thoracic inlet. Birds possess a proventriculus, also known as the true glandular stomach (on VD overlies the left liver lobe, on lateral is dorsal to the liver), and a ventriculus (on VD slightly to the left, can have grit pieces in it, on lateral is caudoventral to the proventriculus), also known as the gizzard which grinds food such as grains. Birds like raptors that eat soft prey items have a softer, more flaccid ventriculus, whereas birds like chickens that eat hard grain whole without shelling it first, have a firm, thick muscled ventriculus for grinding the grain. On the VD radiograph the liver should not extend beyond a line drawn from the corocoid to the acetabulum and on the lateral it should not extend much past the sternum. Also on the lateral radiographic view there should be a dark triangle with the base being the liver, the cranial edge the lungs, and the caudal edge the intestines. On the lateral view of the radiographs, the round spleen is usually seen slightly dorsal to the proventriculus. The cloaca of birds is the end point for three systems: the GI, reproductive and urinary systems**.** The most common gastrointestinal disease

is a metallic foreign body within the ventriculus. Sometimes a piece of paint can have enough lead or zinc in it to be toxic to the bird, but only show up as a mineral dense particle on radiographs because of how thin it is. Loss of the cardiohepatic “waist” can be due to hepatomegaly, cardiomegaly, enlargement of proventriculus-ventriculus, air sac disease, splenomegaly, enlargement of reproductive tract, or ascites.

Genitourinary system

Parrots have 3 divisions to their kidney; the cranial, middle and caudal divisions. They are not lobes. The kidneys of birds are located dorsally in a concavity of the sacrum and surrounded on three sides by bone, therefore any swelling of the kidney can only expand ventrally or increase pressure within the kidney or increase the pressure on structures running through the kidney such as the sciatic nerve. This is why a budgerigar with a common renal tumor will present lame in one leg. Radiographs of kidneys are best viewed on the lateral view, but they are summated. The gonad (left ovary or both testicles) are located just cranial to the cranial pole of the kidneys (testicle usually summated) on the lateral view. Genitourinary diseases include renomegally, ureteroliths, egg binding, gout, radiodense deposits, renal calcinosis,

Advanced avian imaging

This talk is focused on radiographs of birds, but just a word on advanced imaging that is available for use in birds with normal described in the literature include contract studies either awake or under anesthesia and intubated (barium GI or iodinated material in excretory urograms, etc.) fluoroscopy, ultrasound (difficult due to extensive air sacs in coelomic cavity of birds), echocardiography, CT (computed tomography) or microCT, MRI (magnetic resonance imaging), and PET (positron emission tomography).

Backyard Poultry are Coming in for an Appointment! Overview of General Care and Husbandry

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Backyard poultry are very popular and they are presenting to veterinarians for basic as well as advanced care. People own chickens for a variety of reasons, either for companionship, to have fresh eggs for their own consumption, or small scale meat and egg production, and the level of care requested varies considerably. Some owners may only want to know what dose of dewormer they should use in their egg laying hen (none are supposed to be used in an egg laying hen by the way), whereas some owners will OK a referral for an MRI (yes, we had a seizuring pet turkey that got an MRI). The old adage of "always offer the best care possible" is also true when offering care to owners of backyard poultry, with the understanding that the owner will be quick to let you know how much they are willing to spend. As veterinarians we can also provide educational information to the public at various venues including co-ops, feed stores, chicken shows, etc., and inform owners about salmonellosis risks, the laws and regulations governing a food animal, the importance of vaccinating against Marek's disease, how to provide proper care, and what signs to look for that may indicate disease. We can also field questions that the public has about avian influenza. The diseases and care of backyard flocks is different than that of commercial broilers, breeders or layers and the following is an overview of how to provide the best care possible to backyard poultry.

Where to get information?

First and foremost backyard chickens are birds and all of our knowledge of avian medicine can be used in their care including general husbandry and care, handling, approach to medicine and surgery , and anatomy and physiology. Consult an avian textbook for general information on birds. Most information will concentrate on the chicken, although the term backyard poultry also includes turkeys, pheasants, ducks, geese, swans, quail, and other species. There are several websites and books available on the care of backyard poultry.

Examples of websites and books with information on backyard or production poultry

1. Backyardpoultrymag.com
2. Backyardchickens.com
3. CDC's information sheet on Salmonella, http://www.cdc.gov/features/salmonellapoultry/
4. Information on drugs and dosages from FARAD, http://www.farad.org/vetgram/search.asp
5. University of Florida Extension, http://edis.ifas.ufl.edu/an239
6. University of Minnesota Extension, http://www1.extension.umn.edu/food/small-farms/livestock/poultry/backyard-chicken-basics/
7. University of Connecticut Extension, http://web.uconn.edu/poultry/poultrypages/diseasefactsheet.html
8. Cooperative extension system, http://www.extension.org/poultry
9. Purdue Extension , http://ag.ansc.purdue.edu/poultry/extension.htm
10. North Carolina State University Extension, http://www.ces.ncsu.edu/depts/poulsci/tech_manuals/small_flock_resources.html

Chick and chicken care

Diet

A chick that is destined to become a laying chicken should be fed the following as they age: 0-6 weeks of age feed chick starter (18-20% protein); 6-14 weeks of age feed chick grower (16-18% protein); 14-20 weeks of age feed developer (14-16% protein); 20-24 weeks of age start layer ration (16-18% protein). Some advocate adding some scratch (dried cut up corn) to the diet so that they do not grow too fast and develop valgus limb or wing deformities. Scratch and fresh greens provide enrichment as well. Always provide clean, fresh drinking water in waterers that are constructed such that the birds cannot roost on them to defecate in the water. Use chick starters rations containing a coccidiostat. Always purchase the best feed you can afford. Perosis, or slipped gastrocnemius tendon is caused by a deficiency of choline, manganese or biotin. Valgus limb deformities can be caused by a manganese deficiency or improper substrate.

Medications used in chickens

Any questions regarding use of a drug in a chicken or egg laying hen can be answered by viewing the FARAD website and/or contacting them. In general terms, there are drugs that are prohibited, drugs that are considered off-label, and then drugs that are approved for use in some specific instances (certain drug at certain concentration, at certain does, given to certain poultry at a certain age for a certain duration and frequency), all of which makes it near impossible to develop a formulary for backyard poultry.

Space

Adult chickens need a minimum of about 2-3.5 square feet per chicken. Chicks up to 2 weeks of age need at least 10 square inches per chick. By 4-8 weeks of age they need at least 1 square foot. Crowding or flocks of 4-6 birds can cause stress and lead to cannibalism. Red lights sometimes decrease cannibalism in chicks since apparently it makes the red color of blood or hyperemic tissue less enticing to peck.

Temperature

Chicks initially need 95^{o}F, then decrease by 5^{o}F weekly (usually done by raising heat lamp 3 inches weekly) until reach room temperature. An excellent method to determine if the chicks are at the proper temperature is to observe their behavior. If they are all huddled under the lamp then their environment is too cold. If they are all hanging out at the periphery of the enclosure away from a central heat lamp then their environment is too warm, and if they are scattered about an enclosure with a central heat lamp then the temperature is just right.

An adult chicken is most comfortable and efficient at producing eggs when at 70-75^{o}F. Hot chickens eat less. Chickens may die of heat stress at temperatures over 95^{o}F. Adequate ventilation is absolutely necessary.

Bedding and flooring

Many people use pine shavings or for chicks, then pine shavings, straw, or well-drained soil when older. The flooring of coops can have dirt, wooden slats, concrete, or wire. A variety of products are available. A “chicken tractor” is simply an enclosure that can be moved around a yard over a new substrate (usually grass). These can be very simple structures or very elaborate. A nest for a Leghorn –type chicken can be constructed of wood at 12” wide, 14” high, by 12” deep, with a perch just in front of the entrance. Construct fences and coops strong enough to keep predators, such as raccoons, from getting to the chickens. One of the most common presentations of chickens in private practice is attack by a predator whether it be a dog, raccoon, etc. Sometimes the trauma is from other chickens (cannibalism). When dogs attack chickens there is usually loss of feathers and scratches and/or bite wounds over the dorsum and sides. The chickens usually present in shock. Treatment consists of treating the shock with fluids (usually SC is sufficient), antibiotics to prevent/treat infection, and repair of damaged tissues including debridement of necrotic tissue. Chickens seem to recover well and heal quite severe wounds, so do give them the benefit of the doubt and treat, but do control their pain with either NSAIDs or butorphanol. Various techniques used in other species for wound management can be used in chickens.

Pododermatitis

Ulcerative pododermatitis tends to occur if the chicken is overweight, on a roughened surface, or if one leg and foot bears more of the body weight than the other, or a combination of all these factors. There are varying grades of ulcerative pododermatitis from mild with hyperemia of the skin, to severe with osteomyelitis of underlying bone. A radiograph is the best method to determine if there is underlying osteomyelitis, a condition that requires long term antibiotic therapy and probably debridement of necrotic tissue. Most cases of ulcerative pododermatitis are somewhere in between mild and severe and consist of a thickened area of skin on the plantar surface of the foot usually over the metatarsal pad, but can also be seen on the phalangeal pads. There are differing opinions as to how aggressive to be with debriding the tissue or not – usually if there is necrosis, then debridement is necessary. Soaking the foot will greatly soften the tissue and ease surgery. Surgery should be performed under general anesthesia with administration of a pain reliever such as butorphanol since this is inherently a painful procedure. An aspirate or tissue sample is often needed to culture the area and prescribe the appropriate antibiotics. The substrate should be made as soft as possible and kept clean. Underlying lameness should be corrected. Pain relief should be addressed.

Salmonellosis

There are several organisms responsible for salmonellosis in poultry and people including S. pullorum = Pullorum dz, S. gallinarium = Fowl Typhoid, S. typhimurium = Paratyphoid infection, S. arizona = Arizoanosis (turkeys only). In poultry salmonellosis causes lethargy, diarrhea, pasty vent. Salmonella can be normal GI flora in poultry providing a source of infection for humans, but it is significant (and indicate disease) if a salmonella is cultured from anywhere other than intestines in poultry. Salmonellosis is almost eliminated in US commercial flocks. Treatment = antibiotics. See the USDA and CDC handouts on the zoonotic implications of salmonellosis. Veterinarians should educate owners on the risk of salmonellosis in humans from handling poultry. The elderly, those under 5 years of age, and immunosuppressed individuals are most at risk for a fatal infection. There have been deaths recently in young children after handling chicks and ducklings.

Coccidiosis

Coccidiosis is caused by coccidia, protozoan organism. The are many species (9 in chickens, 7 in turkeys at least 4 in quail) and they are host specific and not zoonotic. In other words a chicken cannot infect a turkey and visa versa. A flock may develop resistance to one species only to be infected with another species. Cecal coccidiosis is worse in that it typical causes bloody droppings and is associated with higher mortality, whereas intestinal coccidiosis is typically more chronic in nature and is associated with a lower mortality. The clinical signs of coccidiosis are severe in young (4-16 weeks of age) chickens by having bloody diarrhea, pale combs, lethargy, tendancy to huddle, partial anorexia, weight loss, dehydration, and death. The typical clinical signs are diarrhea, unthriftyness, and variable levels of mortality. As chickens get older they become more resistant and show little to no clinical signs, but can act as carriers to later expose young chicks. Transmission is through direct or indirect contact with droppings from infected

birds (fomites, free-flying birds, insects and rodents). The oocysts shed in feces are not immediately infective, they have to first go through a maturation phase (sporulation) which can take as little as 1-3 days in warm, damp litter. The disease is most common in the springtime. Diagnosis is based on a fecal float. There are many species of coccidian with varying areas of the intestine affected and various clinical signs. *Eimeria tenella*, the cecal coccidian, is one of the most common species and is associated with bloody droppings, and shows a typical hemorrhage of the ceca on histopathology. The other species (E. acervulina and E. necatrix) affect the intestine and are less severe. The key is prevention. Wet litter, poor sanitation, poor nutrition, and concurrent immunosuppressive diseases are the most common triggers of a coccidiosis outbreak. Treatment is with a coccidiostat such as amprolium or sulfamethazine. The best recommendation is to prevent the disease by feeding medicated feed between the ages of 0 and 16 weeks. Commercial broilers don't typically live long enough for this disease to be enough of a problem. There is a coccidia vaccine available for use in 1-3 days old chicks, but it is only useful in certain poultry operations, since it uses live organisms and re-ingestion at 4-25 days is necessary as a booster.

References

Saif,YM. Diseases of Poultry, 12th edition, Blackwell Publishing, 2008.
Carpenter JW. Exotic Animal Formulary, 4th edition, Elsevier Saunders, 2012.
Damerow G. The Chicken Health Handbook, Storey Communications, Inc., 1994.
Damerow G. A Guide to Raising Chickens, Storey Books, 1995.
Greenacre CB and Morishita TM. Backyard Poultry: A Guide for Veterinary Practitioners, 2014.

Good Layer Gone Wrong:
Backyard Hens with Reproductive Diseases

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

The number of backyard poultry is increasing as more people own chickens for either companionship or small scale meat and egg production, and more municipalities allow urban and suburban chicken ownership. Avian practitioners are increasingly being asked to care for backyard poultry and are seeking practical information on husbandry, medicine, and surgery in order to provide state of the art medical care for their patients. The diseases and care of backyard flocks is different than than that of commercial broilers, breeders or layers and the following is a an overview of the how to identify and treat some of the most commonly encountered non- infectious diseases of backyard poultry.

Egg related coelomitis

Egg related coelomitis is an acute or chronic, coelomitis involving all or part of an egg. It can be septic or not. It is common for chickens to have some degree of egg related coelomitis, and mild cases are commonly encountered at necropsy in production hens. Generally chickens tolerate mild peritonitis better than parrots. Causes usually involve retrograde flow of shelled or shell-less eggs from the oviduct back into the coelomic cavity due to oviductal bacterial infection, oviductal impaction, or abnormal confirmation of the oviduct. Heavy production hens or those with inadequate calcium in their diet can have calcium depletion and uterine inertia leading to retrograde flow of egg material. Bacterial infections commonly involve *E. coli* migrating up the oviduct from the vent.

Clinical signs of egg related peritonitis can be obvious such as a sudden drop or cessation in egg laying, or can be vague or seem unrelated to the reproductive tract such as lethargy, partial anorexia, weight loss, and lameness. Physical examination findings can include a thin bird, increased respiratory and heart rates, crackles of lower respiratory tract, a large doughy coelomic cavity, fluctuant coleomic fluid, and a lameness not explained by other obvious reasons

Diagnosis is based on typical clinical signs and radiographs. Endoscopy is possible but may be hampered or risky due to coelomic fluid and limited air sac space. Radiographically a large variety of findings can be encountered such as the ground glass appearance of ceolomic fluid, multiple or single shelled or shell-less eggs inside or outside the oviduct, hernia or expanded coelomic wall, thickened air sacs, and masses in the caudal thoracic and abdominal air sac area. (Figure 1, and other rad pics of ERC) A CBC and chemistry profile including total and ionized calcium can be performed to determine the degree of infection or inflammation, amount of dehydration, if there is concurrent liver or kidney disease, or if calcium depletion is present.

Treatment can involve fluids, antibiotics, non-steroidal anti-inflammatory drugs (NSAID), butorphanol, and/or surgery. (Figure 2 and 3) The difficult decision is whether surgery will provide a better outcome than antibiotics and pain relievers alone. Generally the more severe the egg related coelomitis then the more likely surgery will provide a better outcome, but I have had a few clients not chose surgery for their hens what I thought to be a moderate egg related peritonitis (lameness, large fluctuant coelomic cavity, cessation of egg laying, but no shelled eggs in the coelomic cavity) cleared up with just oral trimethoprim sulfa and meloxicam. Oviductal impaction should be resolved with surgery to remove the egg material before it adheres to the oviduct. Calcium injection for oviductal inertia is usually not needed since the egg related coelomitis is rarely due to calcium depletion in backyard hens, but it can be given as there is minimal to no adverse effects from giving one calcium injection.

References

http://ohioline.osu.edu/vme-fact/0018.html
http://www.poultry.msstate.edu/extension/pdf/coccidiosis.pdf
http://www.umext.maine.edu/onlinepubs/pdfpubs/2259.pdf
http://web.uconn.edu/poultry/poultrypages/diseasefactsheet.html
http://www.ces.ncsu.edu/depts/poulsci/eduopp/disease_biosecurity.html
http://www.ansci.umn.edu/poultry/resources/diseases.htm
http://edis.ifas.ufl.edu/pdffiles/PS/PS03900.PDF
http://animalscience.ucdavis.edu/avian/mareks2.pdf
http://www.michigan.gov/dnr/1,1607,7-153-10370_12150_12220-26362--,00.html
http://www.peafowl.org/ARTICLES/15/
Saif,YM. Diseases of Poultry, 12th edition, Blackwell Publishing, 2008.
Carpenter JW. Exotic Animal Formulary, 4th edition, Elsevier Saunders, 2012.
Damerow G. The Chicken Health Handbook, Storey Communications, Inc., 1994.
Damerow G. A Guide to Raising Chickens, Storey Books, 1995.
Ussery H. The Small-Scale Poultry Flock. Chelsea Green Publishing, 2011.

Cattoli G, Susta L, Terregino C, Brown C. Newcastle disease: a review of field recognition and current methods of laboratory detection. J Vet Diagn Invest, 2011, 23(4):637-56.

Rales? Snicking?
Diagnosing and Treating Respiratory Diseases of Backyard Poultry

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Backyard poultry are increasing in popularity as more people own chickens for either companionship or small scale meat and egg production, and more municipalities allow urban and suburban chicken ownership. People are rediscovering that chickens have personality! Practitioners are increasingly being asked to care for backyard poultry and are seeking practical information on husbandry, medicine, and surgery in order to provide state of the art medical care for their patients. The diseases and care of backyard flocks is different than that of commercial broilers, breeders or layers and the following is an overview of the how to identify and treat some of the most commonly encountered respiratory diseases of backyard poultry, or those diseases that are highly pathogenic that you need to know how to recognize.

Mycoplasmosis (MG)

Mycoplasmosis is a very common, chronic respiratory disease. There are three different species of Mycoplasma that can infect chickens. *Mycoplasma gallisepticum* causes respiratory disease in chickens, but an infectious sinusitis in turkeys. *Mycoplasma meleagridis* causes an air sacculitis and skeletal deformaties in turkeys. *Mycoplasma synoviae* causes air sacculitis and synovitis /lameness in chickens. *Mycoplasma gallisepticum* (MG) is seen in backyard flocks and is of concern because it can easily spread to nearby commercial flocks and cause economic devastation for that commercial flock. Most commercial flocks are MG free. To participate in the National Poultry Improvement Plan (NPIP) a flock needs to be MG free. Transmission is through fomites. Clinical signs of MG in chickens includes an upper respiratory disease with swelling of the infraorbital diverticulum of the infraorbital sinus with caseated pus. The best prevention is to depopulate and repopulate with clean stock, but for special birds, teatment can be attempted with antibiotics (spectinomycin, lincomycin, erythromycin, or typlosin), but birds remain carriers for life.

Infectious bronchitis virus (IBV)

Infectious Bronchitis virus, caused by a coronavirus, affects only chickens and has a worldwide distribution. Younger, immunosuppressed chickens show worse clinical signs than older immunocompetant chickens. Clinical signs include upper respiratory signs including sneezing, gasping, rales, and nasal discharge. Young are affected worse than adults showing gasping and labored breathing. In an affected flock of chicks, all birds will typically develop clinical sings within 36-48 hours and the clinical disease will typically last approximately 4 days (longer if secondary infections develop). Older chickens show a 5-10% drop in egg production for about 10-14 days. The reproductive tract can also be affected by this virus resulting in irregular and roughened eggshells with watery albumin and decreased egg production. Also newer strains may affect the kidneys. Tests include virus neutralization, hemagglutination inhibition or ELISA. The best method to control is to disinfect, repopulate and use live vaccine. This disease is highly contagious that easily spreads via airborne particulate matter and via fomites. There is no treatment, but antibiotics can be given to prevent secondary bacterial infection, especially with Infectious Coryza. The virus is easily destroyed by disinfectants, sunlight and heat. Increasing the environmental brooder temperature by 5 degrees Farenheit helps chicks to recover. There is a vaccine available, but it is not used in backyard flocks since there are numerous serotypes.

Infectious coryza

Infectious coryza affects mainly chickens (it can affect pheasants and guinea fowl as well). The causative agent is *Haemophilus paragallinarium*., a Gram negative rod. The incubation period is 1-3 days and the course of the disease is approximately 4-12 weeks. Clinical signs include upper respiratory signs and swelling of the face with foul smelling (hallmark) and sticky nasal and ocular discharge, dyspnea and rales. Clinical signs also include decreased egg production. Birds that recover are lifetime carriers. Transmission is through direct or indirect contact. Mortality is about 20-50%. Treatment consists of giving antibiotics such as sulfa drugs, erythromycin or tetracycline, but since affected birds are lifetime carriers, the only way to control the infection is through depopulation and leaving the premises vacant for at least 30, preferably 60 days after cleaning and disinfecting before repopulating. Avoid mixing flocks or mixing different ages and sources of birds. There is a vaccine available, but it is seldom used in backyard flocks.

Fowl pox

There are many species of poxvirus. The Fowl Pox virus affects chickens, turkeys and quail. Clinical signs include erosive, proliferative scabs on the exterior surface of the face and feet in the form of the disease called dry, or cutaneous, pox. When there are ulcerative and proliferative lesions in the oropharynx and tracheal area it is called wet, or diptheritic, pox and it is associated with much more severe clinical signs such as difficulty breathing and swallowing and can cause death. Histopathologically,

intracytoplasmic inclusion bodies (Bollinger bodies) are seen in infected skin or mucosa. Transmission is through mosquitos or broken skin (conspecific pecking, etc.) The disease can also be spread by ingestion of the virus in scabs that infect food, etc. The virus is highly resistant to drying and may survive months to years in the dried scabs. Inhalation of pox virus has also been shown. There is no specific treatment. Antibiotics can help with any secondary infection that occurs. There is a live quail pox vaccine available and can be used during an outbreak to prevent further spread since the disease spreads slowly through a flock.

Avian influenza

Avian influenza affects many species. The causative agent is an Orthomyxovirus. It is also known as "Fowl Plague". The clinical signs are variable since there are mild and highly pathogenic forms, but include anorexia, decreased egg production and respiratory disease with the mild form to respiratory distress, facial swelling, diarrhea and neurological signs with the highly pathogenic form. Usually the mild form of the disease is associated with high morbidity and low mortality. Basically coughing, sneezing and sudden death are the typical sugns of this disease. This a highly contagious disease associated with high mortality of both domestic and wild birds. There is no treatment. Testing usually involves virus isolation. This is a reportable disease. A killed vaccine is available, but not used in backyard flocks. Depopulation is usually the recommended action during an outbreak and the disease should be reported to the state veterinarian.

Newcastle's disease

Newcastle's disease affects many species of birds. The causative agent is a Paramyxovirus. There are 4 different forms that vary in severity. The least pathogenic form is the Lentogenic form which causes a mild upper respiratory disease and usually only affects the young. The mesogenic form also causes a mild upper respiratory disease, decreased egg laying, and has a low mortality. The Neurologic/velogenic form causes a sudden onset of upper respiratory disease followed by neurological signs with approximately a 50 to 90% mortality. The worst form, which is a foreign animal disease for the US, is the "Exotic Newcastle's Disease" END or also known as the viscerotrpic velogenic form that is associated with neurological signs and high mortality. In the US there is a vaccine for the first three forms listed here, but in the US we do not vaccinate against END, we test and eradicate since it is a foreign animal disease. There is a serology test available at California's San Bernardino County Laboratory for PMV 1,2 and 3. A paramyxovirus; many different kinds of Newcastle disease; mostly mild disease in poultry and they are vaccinated at one day of age; causes mild conjunctivitis in people; test at US Quarantine stations. Exotic Newcastle's Disease (aka VVND or viscerotropic-velogenic Newcastle's Disease) is a foreign animal disease and millions are spent to eradicate all exposed birds when there is an outbreak in the US (last one was in California, 2002/2003 – 3.5 million birds)

Infectious laryngotracheitis (ILT)

Infectious laryngotracheitis affects only chickens (and pheasants). The causative agent is a Herpesvirus. Chickens older than 14 weeks are more affected than younger chickens, so the disease is usually seen in mature chickens. There is a mild form in the US that is associated with decreased egg production, conjunctivitis, nasal discharge, swollen infraorbital sinus and in more severe cases moist rales. Shaking of the head and flinging necrohemorrhagic material from the trachea is a hallmark of this disease including an inspiratory dyspnea and death. At gross necropsy a mucoid to necrohemorrhagic tracheitis is present. Diagnosis is confirmed via virus isolation, ELISA, or Indirect fluorescent antibody test. Prevention is through the use of a live vaccine. The disease can be spread by fomites. Properly dispose of dead birds to prevent spread (incinerate). Antibiotics can be used, but it is better to depopulate and then vaccinate new birds.

Avian cholera (*Pasteurella multocida)*

Clinical signs include: Drop dead in good flesh. Hemorrhage on heart, lungs, fat and intestinal mucosa seen at necropsy. Free flying waterfowl are source. Incinerate or bury carcasses ASAP. Killed and live vaccines available for chronic problems.

References

http://ohioline.osu.edu/vme-fact/0018.html
http://www.poultry.msstate.edu/extension/pdf/coccidiosis.pdf
http://www.umext.maine.edu/onlinepubs/pdfpubs/2259.pdf
http://web.uconn.edu/poultry/poultrypages/diseasefactsheet.html
http://www.ces.ncsu.edu/depts/poulsci/eduopp/disease_biosecurity.html
http://www.ansci.umn.edu/poultry/resources/diseases.htm
http://edis.ifas.ufl.edu/pdffiles/PS/PS03900.PDF
http://animalscience.ucdavis.edu/avian/mareks2.pdf
http://www.michigan.gov/dnr/1,1607,7-153-10370_12150_12220-26362--,00.html
http://www.peafowl.org/ARTICLES/15/
Saif,YM. Diseases of Poultry, 12th edition, Blackwell Publishing, 2008.

Carpenter JW. Exotic Animal Formulary, 4th edition, Elsevier Saunders, 2012.
Damerow G. The Chicken Health Handbook, Storey Communications, Inc., 1994.
Damerow G. A Guide to Raising Chickens, Storey Books, 1995.
Ussery H. The Small-Scale Poultry Flock. Chelsea Green Publishing, 2011.
Cattoli G, Susta L, Terregino C, Brown C. Newcastle disease: a review of field recognition and current methods of laboratory detection. J Vet Diagn Invest, 2011, 23(4):637-56.
Greenacre CB and Morishita TM. Backyard Poultry Medicine and Surgery – A Guide for the Veterinary Practitioner, 2015, Wiley Publishing.

Let's Work Up Some Backyard Poultry Diseases Together!

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Case 1

Six days prior to presentation a group of 17 Barred Rock adult (2 years old) hens and 3 adult (one was 2 years old, the other two were 2 years old) roosters were purchased from a man who had said they were raised on his farm. Two days prior to presentation the chickens exhibited varying degrees of rales, mild coughing, periorbital swelling and edema of the head. A mild serous nasal discharge was also present and some of the hens had laid eggs with abnormal shells. At presentation approximately half the birds had died and the owner brought three for euthanasia and testing.

Video of birds will be shown.

While under isoflurane anesthesia, but prior to euthanasia with pentobarbital IV, a choanal swab was taken and blood was collected from the right jugular vein.

What tests would run?

Samples were submitted to the Poultry Disease Research Center in Athens, Georgia. The birds were found to be negative for Avian Influenza, Infectious Laryngotracheitits, Infectious Coryza, and Mycoplamsosis, but were positive for Infectious Bronchitis Virus.

Infectious Bronchitis virus, caused by a coronavirus, affects only chickens and has a worldwide distribution. Younger, immunosuppressed chickens show worse clinical signs than older immunocompetant chickens. Clinical signs include upper respiratory signs including sneezing, gasping, rales, and nasal discharge. Young are affected worse than adults showing gasping and labored breathing. In an affected flock of chicks, all birds will typically develop clinical sings within 36-48 hours and the clinical disease will typically last approximately 4 days (longer if secondary infections develop). Older chickens show a 5-10% drop in egg production for about 10-14 days. The reproductive tract can also be affected by this virus resulting in irregular and roughened eggshells with watery albumin and decreased egg production. Also newer strains may affect the kidneys. Tests include virus neutralization, hemagglutination inhibition or ELISA. The best method to control is to disinfect, repopulate and use live vaccine. This disease is highly contagious that easily spreads via airborne particulate matter and via fomites. There is no treatment, but antibiotics can be given to prevent secondary bacterial infection, especially with Infectious Coryza. The virus is easily destroyed by disinfectants, sunlight and heat. Increasing the environmental brooder temperature by 5 degrees Farenheit helps chicks to recover. There is a vaccine available, but it is not used in backyard flocks since there are numerous serotypes.

Case 2

A case of Grade II pododermatitis. Let's have a discussion of the various ways people treat this condition and what can be done to prevent it.

Ulcerative pododermatitis tends to occur if the chicken is overweight, on a roughened surface, or if one leg and foot bears more of the body weight than the other, or a combination of all these factors. There are varying grades of ulcerative pododermatitis from mild with hyperemia of the skin, to severe with osteomyelitis of underlying bone. A radiograph is the best method to determine if there is underlying osteomyelitis, a condition that requires long term antibiotic therapy and probably debridement of necrotic tissue. Soaking the foot will greatly soften the tissue and ease surgery. Surgery should be performed under general anesthesia with administration of a pain reliever such as butorphanol since this is a painful procedure. Culture and prescribe appropriate antibiotics. The substrate should be made as soft as possible and kept clean. Underlying lameness should be corrected.

Case 3

A 2 year old Welsummer hen presents with a left leg lameness. She has recently stopped laying eggs. On physical examination your only abnormal finding is an enlarged doughy coelomic cavity that is more firm than you would expect in an egg laying hen.

Video will be shown.

What diagnostic tests can you run?

What treatments would you consider in an egg laying hen?

Egg related coelomitis is an acute or chronic, coelomitis involving all or part of an egg. It can be septic or not. It is common for chickens to have some degree of egg related coelomitis, and mild cases are commonly encountered at necropsy in production hens. Generally chickens tolerate mild peritonitis better than parrots. Causes usually involve retrograde flow of shelled or shell-less eggs from the oviduct back into the coelomic cavity due to oviductal bacterial infection, oviductal impaction, or abnormal confirmation of the oviduct. Heavy production hens or those with inadequate calcium in their diet can have calcium depletion and uterine inertia leading to retrograde flow of egg material. Bacterial infections commonly involve *E. coli* migrating up the oviduct from the vent.

Clinical signs of egg related peritonitis can be obvious such as a sudden drop or cessation in egg laying, or can be vague or seem unrelated to the reproductive tract such as lethargy, partial anorexia, weight loss, and lameness. Physical examination findings can

include a thin bird, increased respiratory and heart rates, crackles of lower respiratory tract, a large doughy coelomic cavity, fluctuant coleomic fluid, and a lameness not explained by other obvious reasons

Diagnosis is based on typical clinical signs and radiographs. Endoscopy is possible but may be hampered or risky due to coelomic fluid and limited air sac space. Radiographically a large variety of findings can be encountered such as the ground glass appearance of ceolomic fluid, multiple or single shelled or shell-less eggs inside or outside the oviduct, hernia or expanded coelomic wall, thickened air sacs, and masses in the caudal thoracic and abdominal air sac area. (Figure 1, and other rad pics of ERC) A CBC and chemistry profile including total and ionized calcium can be performed to determine the degree of infection or inflammation, amount of dehydration, if there is concurrent liver or kidney disease, or if calcium depletion is present.

Treatment can involve fluids, antibiotics, non-steroidal anti-inflammatory drugs (NSAID), butorphanol, and/or surgery. (Figure 2 and 3) The difficult decision is whether surgery will provide a better outcome than antibiotics and pain relievers alone. Generally the more severe the egg related coelomitis then the more likely surgery will provide a better outcome, but I have had a few clients not chose surgery for their hens what I thought to be a moderate egg related peritonitis (lameness, large fluctuant coelomic cavity, cessation of egg laying, but no shelled eggs in the coelomic cavity) cleared up with just oral trimethoprim sulfa and meloxicam. Oviductal impaction should be resolved with surgery to remove the egg material before it adheres to the oviduct. Calcium injection for oviductal inertia is usually not needed since the egg related coelomitis is rarely due to calcium depletion in backyard hens, but it can be given as there is minimal to no adverse effects from giving one calcium injection.

Asking the Right Questions: Taking a Behavior History

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

The goal of this presentation is to improve history taking skills which are necessary for examination and creating a behavior problem list. Communication skills as well as knowledge about how and what to ask during an appointment are discussed. Specific questions vary depending on what type of problem will be addressed; however, the general framework provided in this presentation will allow a clinician to create a complete behavior problem list.

History taking

Taking a history from a client is a necessary skill for any practicing veterinarian, whether you are a specialist, or not. Specifically within behavioral medicine, compiling a complete history and detailing the results of behavioral observations are the main aspects for reaching a conclusion. Hence, a large portion of any behavior appointment is dedicated to getting the complete history. A good history will allow the practitioner to identify all the problems, continue on the path to create a list of differentials, which will eventually lead to the road that takes the clinician to the destination – the diagnosis, hopefully. History taking skills require communication skills as well as knowledge about what to ask and how to ask it. Not only, but especially within behavior medicine, asking the right question or asking the question in the right way will help tremendously in reaching a diagnosis, because fancy diagnostic tests are not (yet) available to the veterinary behaviorist. Most veterinary behaviorists require the clients to fill out a lengthy history form (example: https://www.sfspca.org/behavior-training/behavior-consultations) and will review them prior to meeting with the client and the patient to save on appointment time. This process also helps greatly for asking specific questions in order to arrive at a diagnosis more efficiently. The goal of this presentation is to lead the practitioner to the path of a behavior diagnosis with the treatment as an outcome goal.

A: Opening

Introduce yourself. Chances are the client knows who they are coming to see; however, it is good "bed-side manners" to introduce yourself first and explain to the client how the appointment will be structured. You are setting the expectations from the start.

Signalment: Identify your patient: age, breed, and weight are important data and can affect your differentials, diagnosis and/or your prognosis.

B: Exploration

Presenting complaint (PC)

This is what the client tells you is wrong with the patient.

History of presenting complaint (HPC)

Gain as much information you can about the specific complaint(s).

1. Determine trigger(s) that elicit the behavior(s): try to be as specific as possible, (e.g. a large male wearing a hat and carrying a garbage bag coming from the front)
2. Determine the threshold: at what level does the behavior NOT occur? This is just as important as at what level the behavior does occur. Clients will often tell you the behavior happens "all the time" or "unpredictably"; it is your job to ask the questions to determine the situations or circumstances as to when the behavior does or does not occur. Open ended questions are preferred in the beginning stages of an interview as not to "lead" the client.
3. Body language: the description of the body language before, during, and after the behavior problem occurs is very important. This information can be provided by verbal description from the client, observation of a video and/or pictures as well as by direct observation. However, aggressive incidents do not need to be "reenacted". In most cases it would be unsafe and irresponsible to do so and it is not needed in order to develop a problem list or a list of differentials.

Past medical history (PMH)

Gather information about the patients other medical problems (if any) and vaccine history. Past or concurrent medical problems can directly affect your problem list, differentials and diagnosis.

Drug history (DH)

Find out what medications the patient had been taking in the past or is currently taking, including dosage and how often they are taking them e.g. once-a-day, twice-a-day, etc. including any OTC, herbal, homeopathic or other products which have or have not worked for the patient. Past or concurrent medications can directly affect your differentials and your treatment plan.

Find out if the patient has any food restrictions or other allergies.

Family history (FH)

Gather some information about the patients and the family's daily routine such as feeding schedule, sleeping location, exercise.

Training history (TH)

This is the opportunity to find out a bit more about the patient's training background. What commands and tricks can the patient do and what training methods were used to train. The use of confrontational techniques used in the past can directly affect your differentials and diagnosis.

C. Summary of history

Complete your history by reviewing what the client has told you. Repeat back the important points which lead you to creating your problem list, so that the client can correct you if there are any misunderstandings or item missing. This does not mean that you will be addressing each and every problem in your initial appointment but it does allow you to discuss priorities of the problems. Often the priorities of the client and the priorities of the severity of the problems are not the same and the client needs to be educated. By summarizing the important points you will be able to find any discrepancies and will avoid non-compliance, or even frustration.

Review the client's goals and expectations for the consultation. It is often a good idea to ask what the precipitating event for this consultation is. Many problems have been ongoing for years and a change in environment, routine or social events might elicit the consult with specific needs for the client. A good acronym for this is ICE - Ideas, Concerns and Expectations.

Patient questions/feedback

During or after taking the history, encourage the client to ask any questions they may have.

D. Closing

When you are satisfied that you have all of the information you require in order to complete your problem list and reach a diagnosis, you will summarize your assessment and explain your diagnosis. You will discuss the steps of the treatment plan. You must consider the safety issues and recognize the client's limitations (emotional, environmental, financial, time restrictions, other family member's views). Client's compliance, or lack thereof, should be acknowledged and understood, otherwise might lead to frustration of everybody involved. A client that fully understands all aspects of the treatment plan has increased chances for compliance. You need to set expectations and a schedule for any required recheck visits. Thank the client for their time and encourage them to follow up with you with any questions or concerns. I tell my clients that I assume "No news is good news"!

Feline Dictionary:
Understanding Feline Body Language

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Nonverbal communication is fascinating to most humans, especially to animal lovers. Body language, behavior, and vocalizations are key elements to understanding our feline friends, patients and shelter animals. Just as we have to improve our knowledge to communicate with each other, we should place effort on learning to use a feline dictionary, similarly to learning any foreign language. Such a feline dictionary should include 3 chapters including 1. Vocalization; 2. Facial expressions, and 3. Body language. Failure to read these signals correctly can lead to injury to human handlers, break in human-animal bond, and decrease in animal welfare.

Feline dictionary: Understanding feline body language

Nonverbal communication is fascinating to most humans, especially to animal lovers. Humans rely heavily on verbal communication, but misunderstandings between us happen at times. In fact, we are much better prepared to read body language than one might think. Interestingly, modern scientists cannot agree when vocal language first appeared, the range spans anywhere between 100,000 to 200,000 years ago. This might be the reason that important emotions and intentions are processed by the limbic system and expressed through body language. There are recent studies which show that the expression of such feelings in humans is universal. If we are at times unsure about interpreting our own species body language, how much more difficult might it be to understand the body language of a different species such as our feline friends? We attempt to translate facial expression, body postures, tail position and many other small details into human understandable signals. It should be no surprise that this can easily fail. Failure to read these signals correctly can lead to injury to human handlers, break in human- animal bond, and decrease in animal welfare.

Compared to dogs, cats are not as obviously vocal. However, certain cats are more vocal than others and cats can learn to use vocalization to communicate with humans. Body language, behavior, and vocalizations are key elements to understanding our feline friends, patients and shelter animals. Just as we have to improve our knowledge to communicate with each other, we should place effort on learning to use a feline dictionary, similarly to learning any foreign language. Indicators such as the look in your cat's eyes, the tone of her vocalization, the position of her ears, and the motion of her tail can provide important clues that reveal certain intentions. You can learn to "read" these signals to get a better idea of what's on your cat's mind. Such a feline dictionary should include 3 chapters including 1. Vocalization; 2. Facial expressions, and 3. Body language. However, keep in mind that no feline language can be completely interpreted without taking into account the entire body language and the situation and surroundings the cat is in.

Chapter 1: Vocalization

Many different feline vocalizations exist and experts have tried to describe the repertoire, a daunting task when trying to classify the different acoustic variations. Most cat owners know when to give their cat attention or when it is time to feed her (at least in the cat's opinion). Most people can tell when a cat is happy and most veterinarians have heard a really distraught cat – those emotions are differentiated by the different tones and noises the cat makes. The following tables are adapted from "Domestic Animal Behavior" Chapter 1 and do not claim to be complete. The presenter recommends consulting the recommended reading list for further details.

Vocalization	Phonetics	Translation
Murmur	Soft, rhythmical pulsed given on exhalation	Request or greeting
Meow	Characteristic feline call "mee-ah-oo"	An all-purpose greeting, epimeletic situations
Purr	Soft, buzzing, rapid contractions of the muscle of the larynx	Social situations, sign of contentment, may also purr when he's anxious or sick
Growl, hiss and spit	Harsh, low pitched, open mouth, explosive sound	Agonistic, defensive, frightened, stressed or aggressive. Leave this cat alone!
Squeak	High pitched, raspy cry	Play, feeding, female after copulation
Shriek	Loud, Harsh, high pitched	Intensive aggressive or painful – stop - what you are doing is not working for the cat
Chatter	Teeth chatter	Hunting sound or when restrained from hunting

Estrus call	Long lasting, variable pitch, open mouth then gradually close	Female in estrus
Howl and Yowl	Loud harsh drawn out calls	Aggressive, distress. Elderly cats with cognitive disorder
Mowl or caterwaul	Variable pitch call	Male sexual
Mew	High pitched, medium amplitude, long "eee"	Mother – kitten interactions
Moan	Low frequency, long duration "oo" or "uu"	Epimeletic, or before coughing up a hairball

Chapter 2: Facial expression

Facial part	**Expression**	**Translation**
Eyes	Pupils constricted	Content, offensively aggressive
	Pupils dilated	Nervous, submissive (somewhat dilated); defensively aggressive (fully dilated); playful, aroused
Ears	Forward	Alert, interested, happy, relaxed
	Erect, swiveled, opening point to the side	Irritable, stressed, aggressive
	Flat, backward, sideways	Fearful, frightened, irritable, stressed
	Swiveling	Attentive, listening to every little sound, alert
Mouth	Closed	Relaxed
	Open tight and showing teeth; wide open with hissing or spiting	Fearful, aggressive
	Gape, flehmen: Head lifted, mouth open slightly, tongue is flicking, lips curled back slightly, eyes squinting	Strange smell

Chapter 3: Body posture

Body part	**Expression**	**Translation**
Body	Back arched, fur standing on end (Halloween cat)	Very frightened and defensive aggressive
	Back arched, fur flat	Welcoming your touch
	Lying on back, purring	Relaxed, may be asking for a tummy rub, or it may be a "Venus fly trap"
	Lying on back, growling, upset	Ready to strike with teeth and claws
Head	High	Neutral, confident, happy, aggressive
	Low or backwards	Fearful, submissive
Tail	Erect, fur flat	Alert, inquisitive, happy
	Horizontal	Relaxed or unsure
	Straight up, quivering	Excited, really happy, ready to urine mark
	Straight up, tense, fur standing on end	Angry, frightened, fearful
	Held very low or tucked between legs	Insecure, anxious, fearful
	Thrashing back and forth	Agitated, watch out!

Distance increasing signs are signals that tell us it is safe to approach and interact

When the cat is happy and content, she is sitting or lying down, has the eyes half-closed and her pupils are narrow. The tail is mostly still, the ears relaxed and forward and the cat could be purring.

The cat is playful when her ears are forward, the tail is up, the whiskers are directed forward and the pupils somewhat dilated, usually seen in young cats. Of course different forms of play exist such as object play, social play or predatory play.

When your cat rubs her chin and body against you, she is telling you she is comfortable with you, because she wants to exchange scent, similarly rubbing the couch and other things in the home. It is a sign of comfort or marking the territory.

The cat is kneading when she uses both paws with a massage like motion mostly on a soft surface, some people call it "making biscuits", similarly to a kitten when suckling. This signals a really happy cat.

Distance decreasing signals are telling us to keep some distance and not to proceed with reaching or touching!

In an irritated or over-stimulated cat the pupils are dilating, the ears turning back, the tail is twitching or waving. The cat may growl or put her teeth on you as a warning to stop any further approaches. Even intense play can quickly turn to overstimulation in some cats, resulting in biting and scratching.

The nervous, insecure or fearful cat has her ears sideways or back, the pupils are dilated and the tail is low or tucked between legs. The body posture is lowered and she wants to turn away or hide.

The frightened or startled cat has her ears back and flat against head, the whiskers are back, the back can be arched. The fur might be standing up on the back, the tail can be erect or low. She might yowl, growl, hiss, and spit in some cases.

The fearfully aggressive cat displays a crouched body position with ears flattened and dilated pupils. The whiskers are back. The tail is between legs or wrapped around body. She may meow loudly, growl, hiss, swat, scratch, bit or spit.

The offensive aggressive cat has her ears back with very constricted pupils. Her tail is up or down with fur standing on end. She may display a hard stare or growl, hiss or swat.

References and further reading

Houpt, Domestic Animal Behavior, 4th edition, Blackwell Publishing, Iowa USA, 2005, 21- 26.
Bradshaw, Casey, Brown, The behavior of the domestic cat, 2nd edition, CABI, Boston, USA, 2012, 91-112.
Beaver, Feline Behavior, A guide for Veterinarian, 2nd edition, Saunders, Missouri USA, 2003.

How I Treat About Everything: Behavior Treatment Plan

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

This presentation offers general practitioners a quickly reference for the treatment for any patient with behavioral problems. We will discuss the 5 steps needed for a complete behavioral treatment plan employed by specialist for any behavior problem.

Behavior treatment plan

The treatment of any behavioral problem includes a multi-facetted approach consisting of a 5-Step process. You might chose to implement some, or all of the 5 steps involved depending on the case, the circumstances, and your level of skills; however, any veterinarian should be able to recommend steps 1 and 2. An example of a generic discharge or treatment template for any behavior diagnosis could look as follows:

1. Management: Safety and avoidance

In order to set up the patient for success, strict management is needed at the beginning of every plan. Initially, the owner will have to set the stage and manage the pet's environment so as to avoid any situations in which the pet has displayed the unwanted behavior in the past. Initially, the treatment process can be slow; hence, in the meantime, the owner must prevent those events from reoccurring. Every time a pet displays this behavior, the behavior is further rehearsed and this might be inadvertently reinforcing the behavior problem you try to treat. Therefore, as you are in the process of treating, the patient should not be exposed to the trigger(s) which cause the unwanted or unacceptable behavior(s). The owner should begin by mentally taking note of all situations where the pet displays the(se) behavior(s). In addition to supporting the overall success of the behavior modification, avoidance may also be a safety recommendation in some cases.

2. Structuring the relationship with the pet and strengthening the human-animal-bond
Aware – affirm – award approach

There are many advantages to using such a program as part of a training program for a pet. First, it is a program that fits all pets and all people, regardless of breed, age, size, gender or personality-type. It is a non-confrontational technique which is designed to never put the people or pets involved at risk. It will help to teach pets how to be better prepared to live within human society. It will help improve behavior and teach the pet to learn to trust people due to the predictable interactions with positive outcomes. The pet will learn to consistently follow commands at home or other low stress situations which makes it easier for him/her to follow commands in potentially challenging situations such as when distracted, anxious or perhaps even while aggressive. Finally, it will help build confidence by providing clear communication and enjoyable outcomes for desired behaviors. This approach uses only positive, reward-based training methods to teach these valuable lessons. The program consists of 2 principles.

1. Predictable interactions with the pet based in Command – Response – Reward (C-R-R)
2. Awareness of the good/desired behaviors that will be affirmed (marked) and awarded

3. Tools

This is any equipment that will help with the implementation of the management plan and the reward-based training program. Specific recommendations should be provided to the client. The list is endless, but could include items such as baby gates, kennels, crates, screen doors, window covers, leashes, tethers, head halters, front buckle harness, basket muzzle, clicker, target stick, MannersMinder, treat pouch, treats, relaxation mat, feed dispensing toys and puzzles, interactive toys, Relaxation music (Thru the dogs ear), visual entertainment (DOGTV), litterboxes and litter type, nail caps for cats, scratching posts and many more.

NOTE: My list does NOT include anti-bark devices, shock collars, prong collars, shaker cans, throw chains and other pain and fear eliciting items – tools that help suppress behaviors rather than help teaching new positive behaviors and emotions can lead to increased fear, anxiety and aggression.

http://avsabonline.org/resources/position-statements

https://vet.osu.edu/assets/pdf/hospital/behavior/trainingArticle.pdf

4. Reintroduction: Positive emotional response and incompatible behaviors

First, the animal has to be prepared for the reintroduction to the triggers or situations that have to be avoided initially (see Step 1, 2 and 3). The positive emotional response and behaviors that will be practiced and rewarded should be simple and incompatible with the unwanted behavior. (Example: sitting quietly is a positive behavior that is incompatible with lunging). Thus, the pet associates the low level of negative stimulus with the positive reward for a relaxed state and behavior. The pet will gradually learn to associate good

things happening and have a positive response. The Command – Response – Reward (C-R-R) approach helps the dog to perform trained commands reliably in various types of situations and therefore the pet can then be reintroduced to previously challenging situations in a step by step process, where the unwanted behavior is never displayed – this is called desensitizing and counter-conditioning (DS/CC). It is a technique that all people, regardless of age, size, or personality-type can do. It is a non-confrontational technique which is designed to never put the people or dogs involved at risk. Finally, it will help build a dog's confidence by providing clear rules and enjoyable outcomes for good behavior. Having a pet consistently follow commands at home, in low stress situations, makes it easier for him/her to follow commands when distracted, anxious or perhaps even while aggressive. The program also acknowledges the animal consistently with a marker and reward when performing any behaviors that are incompatible with the unwanted behavior without a prior cue.

Give the client Homework and be specific. Ensure that the client understands the exercises, this will enhance owner's compliance and overall success of the treatment plan.

The stimulus that was identified during the appointment as causing the pet's unwanted emotional reaction and subsequent problem behaviors will then be reintroduced in a series of gradual steps/intensities. The common gradients that are used for DS/CC are altering the intensity and changing the distance to the stimulus. The intensity can be changed by altering the location, loudness, speed of movement, duration, types of stimuli, or components and response of the stimulus. DS/CC needs to start at the lowest intensity that results in no signs of anxiety or concern. The stimulus (at the lowest intensity and/or at the furthest distance) is presented and the pet is rewarded for the new, relaxed attitude and behaviors. The stimulus is repeated over multiple sessions, while the pet is rewarded for the positive behavior. Every session should be brief and always end by rewarding the display of positive behavior(s).

Key points

DS/CC takes time and requires that the process be gradual. Since progress is often slow, maintaining a journal of the behavior to track the progress is helpful. Problems usually arise from progressing too quickly and not taking small, incremental steps. Don't progress faster than what the pet can accept. It is also vital that every positive behavior be rewarded and that the reward is truly rewarding to your dog. Each step will need to be planned out and it is important to have all tools needed ready before starting each DS/CC session. Remember, since the problem behavior took time to develop, to look for small, incremental improvements rather than instant results.

5. Medications

Medications can be part of the treatment of behavior problems. Medications should only be used with a concomitant diagnosis and preferably full laboratory testing (CBC, Chem and T4, UA, Urine culture). It can help lower the anxiety level, so that the behavior modification can be more effective. It is not a cure for the problem, nor should medications be used without concurrent behavior modification plan. Most medications are "off label" use and the client needs to be informed about the potential side effects and adverse effects with any other medication(s).

Rambunctious, Jumpy, Mouthy Dogs: The Quick Fix for RJM Dogs

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Nuisance behaviors—jumping, stealing things, trash diving, charging through the door, begging, and all the other things dogs do that drive us crazy—are deeply frustrating and can eat into the enjoyment of sharing your life with a dog. The good news is that nuisance behaviors are also easily preventable. Once we move away from the myths that every behavior is motivated by the dogs bidding for dominance, and understand what truly motivates the dog to behave the way he does, we can use this motivation to train any alternate behavior we prefer. In this presentation we discuss training solutions to train/reward opposite or competing behaviors.

Rambunctious, jumpy, mouthy dogs: The quick fix for RJM dogs

So many of our dog's behaviors are normal and have evolved because of their close relationship to humans. Nonetheless, some of these behaviors can be annoying to the point of breaking the human- animal bond. It can be difficult to see how to change your course of action to get back on track with the dog. In this presentation we will discuss how to address basic issues of some common nuisance behaviors seen every day in practice (for example jumping, stealing and pulling on leash). Emphasis is placed on properly understanding and applying learning theory to improve your communication and training skills.

Nuisance behaviors—jumping, stealing things, trash diving, charging through the door, begging, and all the other things dogs can be deeply frustrating and can eat into the enjoyment of sharing our life with a dog. The good news is that nuisance behaviors are also utterly preventable and easy to fix. Once we move out of the realm of myths, like dominance, and understand what truly motivates the dog to behave the way he does, we can use this motivation to train an alternate behavior we prefer.

Jumping up, for example, is not based in dominance but normal canine greeting behavior. Most dogs are happy to see their owners and have no idea how they would prefer to be greeted. Most of the time the jumping behavior has been inadvertently and intermittently rewarded and hence strengthened the jumping over time. Owners have to understand that what is perceived as punishment, such as pushing or scolding, rarely works because attention is still given and attention is precisely what the jumping dog wants. So how are behaviors such as jumping up while being greeting decreased if we don't want to punish, which might inadvertently break the human-animal-bond or have other unintended consequences? We want the dog to be happy to see us, but we don't want the jumping. First, we have to understand that dogs have evolved a greeting ritual specifically to interact with humans. They use this ritualized "I'm happy to be meeting a familiar human" greeting to communicate varying degrees of recognition and attachment.

Mouthiness and chewing are other examples of misunderstood canine behaviors that have evolved for good reasons. Dogs have evolved using their mouth and teeth to gain access to most desirable things; chewing begins in the first few weeks of puppyhood and never stops. Food may be served once or twice a day in a bowl now, but the chewing needs still strongly exists, especially in some dogs. Initially all items in a home are fair game to a puppy, until the dog has learned to understand what is acceptable chew material to the human and what isn't.

In order to change unwanted nuisance behavior (keep in mind they are only nuisances to us, for the dog they are perfectly fine and strongly motivated behaviors – greeting, jumping, chewing) we need to understand canine motivation and learning theory. Instead of seeking to decrease these behaviors using punishment, a much preferred approach is to focus on helping our dogs learn what we would like them to do instead. For example very simply: greeting us by sitting.

How do we fix RJM?

Management first

In order to set up the dog for success, strict management is needed in the beginning. Initially, the owner will have to set the stage and manage the pet's environment so that the behaviors that we attempt to decrease do not get rehearsed and inadvertently, or intermittently reinforced. Managing includes having the tools and equipment ready that will help with the implementation of the management plan and the reward based training program. The list is endless, but could include items such as baby gates, kennels, crates, screen doors, window covers, leashes, tethers, head halters, front buckle harness, basket muzzle, clicker, target stick, MannersMinder, treat pouch, treats, relaxation mat, feed dispensing toys and puzzles, interactive toys, Relaxation music (Thru the dogs ear), visual entertainment (DOGTV), and many more.

NOTE: My list does NOT include anti-bark devices, shock collars, prong collars, shaker cans, throw chains and other pain and fear eliciting items – tools that help suppress behaviors rather than help teaching new positive behaviors and emotions can lead to increased fear, anxiety and aggression.

http://avsabonline.org/resources/position-statements

https://vet.osu.edu/assets/pdf/hospital/behavior/trainingArticle.pdf

Management plan examples

To avoid:	Manage:
Jumping on visitors at the door	Put the dog in another room before they arrive
Jumping on you when entering	Place a baby gate to deny direct access to the front door
Barking at passers-by outside	Draw the curtains or restrict the dog's access to the front window
Pulling on leash	Use an anti-pull head halter or harness
Attacking the water hose	Put the dog inside while watering your plants
Chewing on furniture	Do not allow access – use a baby gate or crate

Structuring the relationship with the pet and strengthening the human-animal-bond

Aware – affirm – award approach

There are many advantages to using this program as part of a training program for any pet. First, it is a program that fits all pets and all people, regardless of breed, age, size, gender or personality-type. It is a non-confrontational technique which is designed to never put the people or pets involved at risk. It will help to teach pets how to be better prepared to live within human society. It will help improve behavior(s) and teach the pet to learn to trust and understand people due to the predictable interactions with positive outcomes. The pet will learn to consistently follow commands at home or other low stress situations which makes it easier for him/her to follow commands in potentially challenging situations such as when guests are at the door when stranger pass by the home. Finally, it will help build confidence by providing clear communication and enjoyable outcomes for desired behaviors. This approach uses only positive, reward-based training methods to teach these valuable lessons. The program consists of 2 principles.

1. Predictable interactions with the pet based in Command – Response – Reward (C-R-R)
2. Awareness of the good/desired behaviors that will be affirmed (marked) and awarded

Training plan examples

To replace:	Train:
Jumping on visitors at the door	Sit on a mat next to the door before the door opened
Jumping on you when entering	Always mark and reward when he approaches and stands or sits
Barking at passers-by outside	Go get your favorite toy
Attacking the water hose	Fetch or hide-and-seek with dog toys
Chewing on furniture	Go get your favorite toy

Note the difference between managing and training the unwanted behaviors. Managing is NOT training, but nonetheless important for setting the dog up for success.

Physical and mental stimulation

Physical exercise is fundamental and should be age appropriate.

Mental stimulation is just as crucial as physical exercise and can be implanted for a dog of any size, breed, and age and includes anything from working for food, to using food puzzles and other interesting games that engage a dog's brain and learning tricks or commands in a different language. Dogs are natural hunters and problem solvers, so the closer we can mimic this process, the less troublesome the dog will be to live with. Serving all the dog's meals in a stuffed Kong or treat ball, in a food-dispensing device, or through a game such as hide-and-seek or busy box toys can relieve many nuisance behaviors quickly.

Helpful hints

1. Remove all rewards/reinforcement for nuisance behaviors, i.e. ignore the dog completely and instead praise and treat the dog for sitting, being quiet, chewing on his toys, etc.
2. Be consistent. If jumping up on people is allowed some days and not on others, the dog won't understand that the rules change during the week.
3. Be persistent. After repeated reinforcement (however unintended) of a nuisance behavior, the dog won't immediately abandon his original strategy, he might even try harder first before he gives it up. This is called an extinction burst. .
4. Appreciate your dog's cleverness; some things can easily be ignored, not every unwanted behavior needs immediate intervention. Sometimes not making a big deal out of something is already enough to decrease the behavior. Get off the couch and play with your dog when he gets the old slipper you were ready to toss out anyways, if you don't he will get your expensive Italian leather shoes and that will make you jump off the couch very fast in turn you have just taught your dog that he should not bother with the slippers (or his own toys for that matter) but go directly to those yummy smelling soft leather shoes!

Some important terms from learning theory

Motivation

This is the force that drives all behaviors. Food, treats, attention, praise, toys, play, walks, coming along for a car ride, etc. – these can be used to reward the behaviors we like, we give them anyways it is just a questions of timing when we dish it out – when they jump or when they sit?

Dominance

Good news; no need to assert our dominance during training. It has been established for many thousands of years now that *Homo sapiens sapiens* is the dominant species and dogs don't challenge us for that position. We already control all the resources and we can now, once and for all, move on. The notion of dominance in dog training, commonly interpreted as a dog wanting to be the alpha of the pack and thus acting aggressively or assertively in some way, has been thoroughly and successfully debunked by research. Furthermore, it has been shown that implementing training techniques that employ such antiquated dominance training theory methods increase aggression.

Positive reinforcement

Any stimulus that is added after a behavior occurs that increases the likelihood of that behavior happening again.

Intermittent reinforcement

Rewarding a behavior only sometimes. Think Las-Vegas gambling effect. Intermittent reinforcement is a powerfully motivating force to all animals, including humans.

Positive punishment

Any aversive or painful stimulus that is added after a behavior occurs that decreases the likelihood of that behavior happening again.

Attention seeking/getting behaviors

Social creatures like dogs do many things to get and hold our attention. They might jump on us, paw, or steal the Italian leather shoe—obviously a high-value object guaranteed to get attention. The good news is, any dog that is highly motivated by interactions with us is in general easy to train.

Dealing with the Shelter CAT-astrophy: Behavior Problems of the Shelter Cat

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Feline aggression is a very common behavior problem and can pose a challenge due to limited resources, space and time. More often than not a visitor or handler can easily become the target of the aggression. Bites to handlers pose a big problem in the shelter, as these animals will then have to be quarantined, which not only increases their length of stay, but further decreases their positive interactions with humans. In this presentation we will discuss approaches to feline aggression.

Dealing with the shelter CAT-astrophy: Behavior problems of the shelter cat

Feline aggression is very common behavior problem not only in shelter animals. Aggression can involve unsolicited attacks towards people or other animals. The injuries can range from mild scratches with claws to strong inhibited bites that break the skin. Bites to human handlers pose big problem in the shelter, as these animals will then have to be quarantined for 10 days, which not only increases their length of stay, but further decreases their positive interactions with humans during this time. This can then lead to a significant rebound effect of the aggression (quarantine = no visits). At the SPCA we have noticed that a numbers of bite cases involves young cats with a high play drive. Naturally, all young cats have the need to play, explore and "hunt"; however, some cats have a stronger need to perform these types of behaviors than others. To offer such opportunities in a shelter type situation can pose a challenge due to limited resources, space and time. The size of housing is often restricted, in addition to limited mental and physical enrichment opportunities. More often than not, a volunteer visitor or a handler is the only moving object and can easily become the target of the aggression. Play–related aggression sounds benign, but can still result in severe injuries depending on the bite inhibition. Different approaches to play aggression is needed in the young shelter cat, which starts with assessing young cats to determine play motivation and the initiation of a behavior plan specifically tailored to the needs of these young cats. In addition to implementing a behavioral treatment plan with proper mental and physical enrichment, it is equally crucial to teach handler and volunteers to read feline body language carefully. Body language, behavior, and vocalizations are key elements to understanding our feline friends, patients and shelter animals and continuous education is needed to improve communication. Indicators such as the look in cat's eyes, the tone of her voice, the position of her ears, and the motion of her tail can provide important clues that reveal her feelings and intentions. One can learn to "read" these signals so as to get a better idea of what's on a cat's mind. However, keeping in mind that no feline mood can be completely interpreted without taking the entire body postures, vocalization and the situation the cat is in, into account.

Vocalization

The cat has indeed many different forms of vocalization. Most cat owners know when to give their cat attention or when it is time to feed her (at least in your cat's opinion). They know when the cat is happy and most veterinarians have heard a really angry cat – those emotions are differentiated by the different tones and noises.

Facial expression

Eyes, ears and the mouth should be observed closely, as they can give important clues as to the mood of the cat. Pupils can be either constricted or dilated, but in general, fully dilated pupils can show either fearfulness or extreme playful arousal, either way not a good time to approach a cat. Fast swiveling ears for example signal a highly alert cat that might be very attentive and listening to every little sound and might readies itself to pounce. An open mouth with a lifted head and slightly flicking tongue is a cat that is doing the "Flehmen" response and is intent on taking in new smells. Most people can determine the difference between a fearful and a very confident cat's body language.

Distance increasing signs to look for!

- Happy and Content: Sitting or lying down, eyes half-closed, narrow pupils, tail mostly still, ears forward, purring.
- Playful: Ears forward, tail up, whiskers forward, pupils somewhat dilated. Usually young cats. Different forms of play exist: object play, social play, predatory play.
- Rubbing: Chin and body against a person, tells us that the cat wants her smell on you, similarly as she rubs the couch and other things in her home. It is a sign of comfort and she might be marking her territory.
- Kneading: The cat uses both paws with a massage like motion mostly on a soft surface, some people call it "making biscuits", similarly to a kitten when suckling. When a cat does this, she is really happy.

Distance decreasing signals are not to be ignored!

- Irritated, over-stimulated: Pupils dilating, ears turning back, tail twitching or waving. The cat may growl or initiate biting as a distinct warning. Intense play can quickly turn to overstimulation in some cats, resulting in biting and scratching. Redirection is needed immediately before it escalates.
- Nervous, insecure, fearful: Ears sideways or back, pupils dilating, tail low or tucked between legs. Low body posture, wants to hide, turns away
- Frightened, startled: Ears back and flat against head, whiskers back, back arched, fur standing on end, tail erect or low. May yowl, growl, hiss, and spit.
- Fearful, aggressive: Crouched position, ears flattened, whiskers back, tail between legs or wrapped around body, pupils dilated. May meow loudly, growl, hiss, and spit.
- Aggressive, offensive: Ears back, pupils very constricted, tail up or down with fur standing on end. Hard stare or growl, hiss and swat.

Aggression towards people is a common feline behavior problem and can be roughly classified into fear-related, play-related, petting-induced, redirected and pain-related. Understanding feline-specific needs are crucial to prevent or treat human-directed aggression. Especially in a shelter environment stress needs to be recognized as a major element in aggression; however, exactly how stress mechanisms interact during feline aggression is yet poorly understood. Nonetheless, it is important to understand that the hypothalamic–pituitary–adrenal (HPA) axis is activated by behavioral responses. It is important to keep this in mind when addressing human directed aggression in the shelter, because often times exposure to unfamiliar people is perceived as a stressor or threat, and therefore the presence of a person can activate the physiological stress response.

When faced with the history of aggression in the shelter the veterinarian needs to determine whether the aggression is caused by medical or internal (metabolic/organic), psychological, or external triggers (people, animal, noises, smells, etc.). Pathological reasons for aggression have been reported to be more common in cats than in dogs. Medical problems can lead to irritable, pain-induced, or truly pathological aggression; therefore, a detailed medical work-up based on clinical signs is of utmost importance when treating any form of aggression. This can be a limiting factor in a shelter environment due to allocation of the resources.

Forms of aggression

Fear aggression

Cats with fear-aggression towards humans view humans as a threat. The triggers can include tactile, visual, auditory, and olfactory stimuli of humans. Fear behaviors are triggered by the "Flight or Fight" nervous system and are not under voluntary control. This from or aggression can be seen frequently in the shelter or at a veterinarian's office. Due to the physiological aspect, these cats can show high arousal (dilated pupils, tense body language, hiss, piloerection) and when not given an opportunity to flee might attack in a defensive or even offensive manner. Most cats with this form of aggression display avoidance, or freeze-responses, and overt attacks are their last resort. There is no age or breed predilection for this forms of aggression. This behavior can be within the range of normal cat behavior, and is mostly determined by genetics and by environmental factors.

Play aggression

This a commonly reported form of aggression in young shelter cats due to confinement and can involve unsolicited attacks, anywhere from light scratches to hard uninhibited skin breaking bites. This form of aggression does often not include overt warning signs due to the nature of the aggression being play also thought to serve predatory practice. The postures of these cats include low body posture, hiding, stalking, chasing and pouncing. Shelter staff and volunteers should be educated as to play using their hands or feet, but rather, should use appropriate wand or string toys from the beginning.

Petting induced aggression

Feline social interactions often include the solicitation of attention by rubbing against humans and a cat might appear to accept or even enjoy physical affection from people but then suddenly becomes over-stimulated by these interactions and might turn towards the hand and bite. This is a common presentation in the shelter and is to some degree normal cat behavior, but might be seen due to deprivation of physical interactions and over stimulation during visits by volunteers. Underlying pain and discomfort to touch in certain areas must be ruled out.

Other forms of aggression include redirected-aggression where by aggressive arousal is elicited by any trigger other than the target and can include the sound, sight or smell of other animals or people, as well as any underlying pain and discomfort. The aggression is directed towards a seemingly irrelevant, but close-by target. This can be seen in a shelter with a cat displaying primary intercat aggression and handling or visiting staff or volunteers are the victims.

Rarely and often over-diagnosed is territorial and status aggression during which valuable resources such as territories, resting spots, food, mates or litter boxes are being defended. Territorial and status aggression is displayed by a very confident cat and it can occasionally be directed at humans, but most likely will be directed towards other cats.

The treatment of any form of human-directed aggression should combine management strategies, behavior modification, and can in some cases involve the use of medications.

Treatment plan

1. Management: Safety and Avoidance
    a. Identify trigger(s): Avoid and Redirect, Watch closely for playful body postures and redirect to appropriate play, Environmental Enrichment
2. Behavior modification:
    a. De-escalate aggressive behavior and reward for calm and relaxed behavior, never use physical punishment, implement multiple short visits (log outside the room)
3. Other treatments:
    b. Psychotropic medications, Pheromone or neutraceutical therapy, regular nail trims and clicker training

What to do about Shelter Cats with Inappropriate Urination

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

House soiling is a common behavior problem in cats leading to a break in the human- animal-bond, and consequently to relinquishment or euthanasia. A diagnosis is needed to successfully address these problems and their underlying causes. In this presentation, we discuss approaches and treatment plans for the most common inappropriate elimination problems with an emphasis on prevention: keeping animals in the home, and intervention: treatment plans for cats in order to maintain the human - animal bond.

"UR- in trouble" – thinking outside the box

House soiling problems are very common with cats, and can be divided into two general categories – urine marking, and inappropriate elimination. Cats diagnosed with either type of house soiling problem are at a higher risk for surrender and/or euthanasia. Both of these behaviors are normal behaviors for cats; however, a correct assessment has to be made to successfully address, treat, or manage these problems as well as their underlying cause.

Urine marking

Urine marking can be done either in response to a territorial reaction and/or anxiety. It is often related to tension and/or aggression between household cats or other stressors in the home, or shelter, and is therefore considered a "social communication problem". Cats that mark, deposit small amounts of urine on vertical surfaces with social significance. Their litter box behavior is unchanged and when they urinate outside the box, they back up against a vertical surface and stand with their tail up straight to deposit a small amount of urine.

Inappropriate elimination

Inappropriate elimination, which can include urine and/or feces, is a "voiding problem" and is not done out of spite like some owners might think, but merely to empty the bladder in an area that is considered inappropriate to us. Those cats might soil on a specific surface, or in a specific location. They deposit a large amount of urine (void the bladder) on a horizontal surface. Their litter box use might be decreased or altered, but when they urinate outside the box they squat and many show pre- and post-voiding behaviors such as digging and covering.

As a first assessment for any urination problem a history needs to be taken, which is not always possible, especially at the shelter. However, when counseling owners for surrender prevention or for owner surrendered cats to the shelter, it is critical to obtain a history form. The minimal amount of information should include location, surface, amount of urine voided and posture of the cat while urinating. If a full history can be attained from a surrendering owner, it should include questions as to location, substrate, amount of urine and frequency of the soiling problem and the posture of the cat if observed while urinating. In addition to information on husbandry and environmental information such as the number and location of litter boxes in the home, litter type, litter box cleaning schedule, number of cats in the home or the presence of any outside cats and any past medical history.

Surrender prevention counseling: Marking and inappropriate elimination alike

Management

1. Because many medical problems can cause a cat to urinate outside the litter box, owners must be counseled to seek help from their veterinarian.
2. Because the odor of urine draws cats back to previously soiled areas, cleaning of all previously soiled areas with an enzymatic and bacterial combination cleanser is strongly recommended. This is of course especially important in the home, but also needs to be considered for shelters and includes items such as cat trees, bedding and any room furniture.
3. Excellent litter box hygiene has been proven to significantly decrease the incidence of any form of soiling. The boxes should contain non-scented, fine granulated, clumping litter and be scooped at least once daily and completely emptied and cleaned every one to two weeks. Strong smelling detergents, such as Pine-Sol®, ammonia, bleach should be avoid when cleaning the boxes, since cats typically do not like strong-smelling odors. Instead, it is recommended to use mild dish soap and rinse well. It is also worth pointing out that most cats do not like litter box covers, or liners.
4. Number of litter boxes: The magic number is N+1. There should be one more litter box than the total number of cats in the household. These boxes should be placed in multiple, easily accessible locations, including those locations that have been previously soiled.
5. Previously soiled locations should be made inaccessible. It is recommended to limit the cat's access to rooms that have been soiled in the past. This can easiest be done by closing doors to those rooms. Alternatively, previously soiled locations could

be covered with an aversive substance. Some recommendations are: foil, plastic carpet runner material turned upside down so that the nubby side is up, Scat Mat®, contact paper with the sticky side up, double-sided sticky tape, etc.

6. Cats should only be interrupted if the owner actually sees the cat sniffing an area and is preparing to urinate, but never after the act. Never should any form of direct punishment (yell, stomp your feet, physically hit, etc.) be applied, as this only makes the cat either more nervous and fearful, or sneakier, and learn to urinate if the owners are not present.
7. All forms of environmental enrichment should be encouraged and recommended. This is good for any cat and might help to alleviate any anxiety or social tension that may be contributing to these problems. Some ways to do this are by providing more resting and hiding places, multiple feeding locations, and interactive toys. Meal times can be made more interesting by hiding small quantities of food around the house (on shelves, in bedding, in boxes, etc.) and in toys (with holes for food to fall out from). Toys can be made more challenging by hanging the containers just above the cat's head height. There are many commercially available interactive toys for cats. For older cats it can be helpful to place a litter box close to their favorite resting spot.

Inappropriate elimination in the shelter

At the SF SPCA we have treated/managed many cats with house soiling problems. Inappropriate elimination is more common than marking, and many cats have medical problems including renal failure, urinary tract infections, crystals, stones and neurological problems. Most cats are successfully treated, managed and adopted.

Shelter protocol for house soiling used at the SF SPCA

1. Diagnose the problem by attaining history from the previous home and observations in the shelter. However, even cats with a known history of either inappropriate elimination or marking might not show this behavior in the shelter due to change in environment. Therefore, it is important to attain as much history from a previous owner as possible.
2. A full medical work up including physical exam, blood analysis, urine analysis and urine culture and in some cases x-rays will be performed.
3. All cats with a history of house-soiling will be housed individually to treat elimination problems.
4. Behavior modification: Re-establish litter box use by offering a litter box trails: Depending on space two or more litter boxes with different litter type is provided for a minimum of 7-10 days. Daily use is recorded. Once a preference can be determined the other boxes are removed and the cat can be “challenged” by moving to a larger confinement space in addition to adding other types of substrates for example pillows or bedding.
5. Once solid litter box use has been established the cat will be made available for adoption with special behavior counseling and post adoption support is provided.

Key points for counseling

- Are there enough boxes? The magic number (n+1) is one box per cat in the household, plus one extra.
- Offer different types of litter to find the cats preferred litter type. Always offer a fine granulated, clumping and non-scented type of litter.
- Always keep the litter box clean. The box might be dirty and the laundry basket is the only “clean alternative”. Scoop out the litter box daily.
- Use mild dishwashing liquid to wash the box weekly.
- Location: Place the litter box in the same room the cat is eliminating outside the box.
- Please **do not** place litter box right next to food and water or your washer and dryer.
- If you have a multi-stored house, have litter boxes on each level, especially on the level where your older cat likes to rest.

Troubleshooting litter box problems

1. Always recommend to begin by consulting a veterinarian to rule out any medical causes.
2. Check all the above guidelines.
3. VERY IMPORTANT: Do not punish your cat for soiling, as this can make the problem worse and your cat more anxious.
4. In some cases the triggers cannot be found or avoided and medication is needed to control anxiety.

Separation-Related Behavior Problems in Dogs: What Happens When Dogs Miss Us When We're Gone

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Most dogs generally don't enjoy alone time. They are highly social animals, genetically having evolved to want to be with humans; some individuals would love this 24 hours a day, 7 days a week. Dogs can learn however to be alone for moderate periods of time, but this doesn't come naturally and some dogs can develop separation-related behavior problems.

Separation anxiety

The complex presentation of separation-related behavior problems will be discussed in this presentation. Separation distress and subsequent separation anxiety are serious problems and this welfare impairing disorder is probably similarly under and over-diagnosed. The reason I say this is under-diagnosed is that if a dog is having signs of anxiety, but not displaying signs that leave behind evidence such as urination, defecation and destruction, the owner might not know their dog is anxious when left alone. On the other hand, not every dog that house-soils, vocalizes or is destructive in the owner's absence is necessarily suffering from separation anxiety. But still, that is often the first "diagnosis" that owners or trainers reach with such symptoms. It can be challenging to diagnose even for a specialist. Dogs who suffer from separation anxiety experience the canine equivalent of panic attacks every time they are left alone. They might display a variety of stress-related symptoms such as pacing, panting, hyper-salivation, anorexia, urination, defecation, vocalization, and frantic attempts to escape or destructive behaviors, often around doorframes in an attempt to find social company.

First and foremost, it is important to understand that these dogs are not "getting back" at their owners for leaving, or behaving the way they are out of spite or anger. Rather, they are experiencing a state of panic and fear, and to them these behaviors are a matter of survival.

Treatment possibilities for anxiety may include various medications and a formal program of systematic desensitization to change the dog's deeply ingrained emotional reaction to departure. Some dogs with severe separation anxiety need to be on medication if circumstances require them to be left alone. Medications can be part of the treatment of behavior problems. Medications should only be used with a concomitant diagnosis and preferably full laboratory testing (CBC, Chem and T4, UA, Urine culture). It can help lower the anxiety level in order for the behavior modification to be more effective. It is not a cure for the problem, and medications should not be used without a concurrent behavior modification plan. Most medications are "off label" use and the client should be informed about the potential side effects and adverse effects with any other medication(s).

What can trigger problems?

Separation-related problems in dogs have no breed or gender predilection. However, the onset of symptoms is found to be before 3 years of age in the majority of dogs (55%). Older dogs might present with age-related onset of other types of anxieties and cognitive dysfunctions should be considered and ruled out. The etiology is unknown and certain risk factors have been discussed such as changes in routine or lifestyle; for example re-homing, a stay at a boarding kennel, a death of a key family member, or a major change in routine, such as months of the owner being home all day followed by sudden eight-hour absences. Other contributing factors might include single owners, lack of attendance at obedience classes, "velcro" dog syndrome (over attachment), and displays of excessive greeting rituals upon return of the owner.

Know what you're dealing with

The first step is to get an accurate diagnosis of your patient's behavior. A dog that barks or destroys things while left alone might do so due to reaction to environmental stimuli, territorial behaviors or aggression, play, other fear-related problems, lack of mental of physical stimulation, or unfulfilled social needs. Medical issues or a lack of or break-in house training can cause house-soiling. To find out for sure what the dog does and why, encourage the client to set up a video or web camera and record the dog when left alone.

What can be done?

Prevention is the best way to head off separation-related problems, and is a must for puppies, young dogs, and newly adopted dogs. Again, dogs have to learn to handle being alone.

Arrange for many brief absences

Puppies and newly adopted dogs, should be given time to adjust to the new home and the routine and should be gradually prepared for alone time. It is much better to leave for brief periods (from a few seconds to a few minutes) more often so the dog is learning that departures predict short, tolerable absences: "Whenever she leaves, she comes back."

Break up the day

It is almost never acceptable to leave a dog alone for an 8 hour workday for 5 days a week. If everyone in the home works a full schedule and is out of the house, recommend arranging for the dog to go to work with a family member, hiring a dog walker, or enrolling the dog in a doggie daycare. This breaks up your dog's day, provides him with needed social interactions and leaves him nice and tired when he gets back.

Exercise mind and body

Every dog needs age-appropriate physical and mental stimulation. Not only does problem solving increase confidence and independence, it is mentally tiring and so increases the likelihood the dog will rest quietly when left alone. Teach a dog to play hide-and-seek with his toys, teach him tricks, get him involved in a sport like flyball or agility, let him play with other dogs, feed him all his meals in Kongs or other food-dispensing toys, or teach him how to play fetch and tug. The more activities and toys are incorporated into his life, the less he will depend on human social contact as his sole stimulation.

References and resources

See our handouts and resources such as Independence Training, Crate Training, and Kong Stuffing https://www.sfspca.org/behavior-training/dog-behavior-resources

Separation Anxiety: canine and feline. In: Blackwell's Five- Minute Veterinary Clinical Companion, Canine & Feline Behavior. D. Horwitz and Nielson J., (2007). Chapter 56, pg 446-457.

Separation anxiety disorders. In: Behavior problems of the dog and cat. G. Landsberg, Hunthausen W. and Ackerman L., 3rd edition (2013). Chapter 12, pg. 201-208.

Science, Non-Science, and Nonsense in Dog Training: Why Should a Veterinarian Care?

Jeannine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Knowledge of canine behavior, medicine, and learning theory is needed in everyday veterinary practice to avoid injuries to staff, to provide good customer service and to practice welfare-centered medicine. We all want the best for our canine patients. We want them to succeed, and even more so, we want to succeed with them. When holding on to one end of a leash with a dog attached to the other end, a handler has to be aware that he/she is constantly teaching that dog new skills and behaviors, both intended and unintended. You might have noticed that some handlers seem more successful at handling animals than others. While not denying that some dogs are more difficult to handle than others, it seems that some handlers tend to end up fighting with their patients more often than others during exams or procedures. This lecture is written with the intent of helping any dog enthusiast, and any professional handler, improve their handling skills by helping them understand what is science and what is myth when it comes to training and handling, in order to set your practice up to be welfare-centered.

Most dogs are quick learners and will do almost anything you ask them to if you can present it to them while they are in an emotionally receptive state. This allows for much smoother and safer handling, and will not only improve your safety and the safety of those around you, but will also increase the pleasure of working in veterinary medicine. Resistance always creates tension for you and your patient that will ultimately lead to physical and/or psychological problems - at the very least your canine patient will not enjoy a visit to your veterinary office.

Learning in dogs

Learning is crucial for survival and behaviors need to be continuously adapted. Changes in the environment function as stimuli and the animal reacts to these with a physiological or psychological response. Learning leads to ongoing change in behaviors based on experiences. Emotions play a crucial role in learning and memory forming; negative experiences usually have long-lasting effects.

Non-associative learning

This "single event learning" is leading to adaptation to a repeated stimulus in which the animal is exposed to only one stimulus. The animal either decreases it's response toward the stimulus over time (habituation), or increases its response over time (sensitization).

A decrease in response to the stimulus is known as **Habituation**, which could also be described as "getting used to it". The animal no longer reacts to the stimuli. This is the simplest form of learning. An example would be a puppy that over time habituates to the feeling of wearing a collar.

Habituation can be achieved by two different processes

- Flooding: The animal is exposed to the stimulus above the threshold of reacting to it and is exposed until habituation has occurred. It is important to not let the animal escape from the stimulus. This can be a dangerous process as there is not much control over how the animal will react to the stimulus once exposed. With this process, it is crucial to continue exposing the animal to the stimulus until it has habituated.
- Desensitizing: The animal is exposed to the stimulus in small increments and exposure is gradually increased after the animal has gotten used to or has habituated to the lower level of exposure. This process is slow and the animal is exposed below or just at the threshold of reacting to the stimulus. There is much more control over the process by the handler with this type of exposure and it is therefore the safer option for habituation in many circumstances.

An increase in response to a stimulus is known as **Sensitization** – getting more sensitive. It is the opposite of habituation, as the reaction increases with the same amount of exposure to the stimulus. Example: a painful area that elicits a withdrawal response BEFORE someone touches the area.

Associative learning

A type of learning in which there will be an association made between two or more stimuli.

There are two different types of conditioning described below, both of them crucial to learning:

Classical (Pavlovian) conditioning

In classical conditioning, a conditioned stimulus (CS) is paired with an unconditioned stimulus (US). The conditioned stimulus (CS) is a neutral stimulus (e.g., the sound of a clicker) that does not elicit a response before the pairing. The unconditioned stimulus (US) is a stimulus that elicits a biological response (e.g., the taste of a treat). The unconditioned response (UR) to the unconditioned stimulus is a reflex response that does not have to be learned and it is not under voluntary response (e.g., salivation). Over time after pairing of the CS with the US is repeated, the animal will display a conditioned response (CR) to the conditioned stimulus CS when the conditioned stimulus is presented alone.

Sounds complicated? Just remember that if the bell reliably predicts food then after a few pairings the bell alone elicits the salivation – no food is required. Classical conditioning is learning that a before neutral sign can elicit a response due to pairing with a stimulus that elicits that same response automatically.

Operant (instrumental) conditioning (E. Thorndike and BF Skinner)

In operant conditioning, the behavior is modified by its consequences. Behavior either reliably increases, or decreases, due to its immediate consequence.

The 5 basic concepts include:

Positive reinforcement

Leading to the likelihood that a behavior ***increases*** in frequency and this happens if the behavior is immediately followed by a ***rewarding*** stimulus – think money!

Negative reinforcement

Leading to the likelihood that a behavior ***increases*** in frequency due to the removal of an ***aversive*** stimulus – think of your car beeping annoyingly until you fasten your seatbelt!

Positive punishment

Leading to the likelihood that a behavior ***decreases*** in frequency and it happens if the behavior is immediately followed by an ***aversive/punishing*** stimulus – think speeding ticket!

Negative punishment

Leading to the likelihood that a behavior ***decreases*** in frequency due to the removal of a ***rewarding*** stimulus – think timeout!

Extinction

Occurs when a behavior (response) which was previously reinforced is no longer effective. For example, a dog is jumping on the counter to find occasional leftovers. Then, during "extinction", the counter will be cleaned consistently of all food pieces and smells so that no food is found ever. Typically, the dog will continue to check out the counter for scraps but eventually stops, at which time the behavior is said to be "extinguished." Often they will try harder at first before giving up - called an extinction burst - and this can lead to certain frustration behaviors initially such as barking or scratching – think no coke is coming out of the coke machine after putting your money in!

Cruciate Rupture: What Should I Recommend?

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

Cruciate disease can be a confusing and difficult to explain to clients especially if they are financially constrained. However it is the number one cause of hind limb lameness in dogs and costs Americans $1.32 billion dollars per year. It effects almost all breeds of dogs and is surrounded by controversy regarding which surgical procedure is most beneficial.[1] There have been several iterations of surgical procedures that have come and gone over the years, and new procedures continue to be tested in research settings. Over the last 20 years, as the incidence of cruciate disease increased so have the specialty and referral options for owners. There are now multiple opinions with little scientific evidence increasing the confusion for primary veterinarians and owners. In fact, the controversy started to erode the confidence that the public has placed in veterinarians. Many articles in the lay press have noted that there was a disconnect between the evidence and the recommendations for a more invasive and more expensive technique thus fueling the suspicion that veterinarians were making recommendations to promote monetary gain over animal welfare.[2,3,4] There have been recent strides in veterinary medicine to fill some of the knowledge gap.

Cruciates can be addressed either surgically or conservatively. The magic cutoff for dogs treated conservatively versus surgically is 30 pounds based on a 1972 paper where most small breed dogs recovered satisfactorily with rest whereas working dogs and large breed dogs required surgical intervention for a satisfactory outcome.[5] Since then, very little has been published on conservative therapy. Dogs with experimentally created cruciate ruptures improve over time but do not return to normal weight bearing, and they are used as an induced osteoarthritis model.[6] More recently, the University of Minnesota compared dogs receiving institutional rehabilitation, weight loss program, and an NSAID to those receiving a TPLO. The surgery group did better, but 2/3 of the conservatively treated dogs had successful outcomes.[7] More aids in conservative management have become available including braces. These range in types and expense and have little to know evidence for their use.

Surgical management falls under the following categories: reconstruction/replacement, extracapsular stabilization, and biomechanical alteration. All the methods have the same goal: to stabilize the knee or eliminate cranial tibial thrust. We have used humans as a model for the reconstruction/replacement techniques using tissue autografts or allografts as replacements for the cruciate ligament. These techniques do not alter the range of motion of the stifle or the femorotibial contact, but results have been disappointing thus far.[8]

Extracapsular stabilization techniques are those that require a direct cranial tibial thrust opposing force outside the joint. This would include fibular head transposition (the lateral collateral ligament is moved into a position to counteract thrust), lateral fabellar suture (or its multiple variations), or tightrope. The lateral fabellar suture and tightrope more widely used than the fibular head transposition in general. The technique for the lateral fabellar suture has improved with crimp clamps decreasing knot size and irritation; however, the nylon suture is not expected to last the lifetime of the dog and has been shown to stretch, loosen or break; however, rehabilitation of the muscles which can assist in stifle stabilization with the help of scar tissue can still end in a good result. The tightrope is stronger material when compared in mechanical testing, and it is placed using bone anchors or tunnels rather than around the fabella. However, the suture still cycles and therefore is unlikely to last a lifetime. The bone can also remodel and allow loosening of the tightrope. The fibular head transposition depends on the fixation of the fibular head cranial to its original position and fixation failure is not uncommon allowing fibular head movement caudally. These techniques in general also decrease flexion of the stifle by decreasing the ability of the tibia to internally rotate. The tightrope procedure uses landmarks that help ameliorate this as much as possible.

The remaining category is biomechanical alteration of the joint to eliminate the cranial tibial thrust. This includes the tibial plateau leveling osteotomy (TPLO), tibial tuberosity advancement (TTA), and Closing Wedge Osteotomy (CWO). These techniques have been developed based on biomechanical investigation of the canine knee and aim at altering the stifle to allow a mechanical advantage for the muscles, and other tendons and ligaments to counteract cranial tibial thrust.

Which is the best technique?

The best technique would be minimally invasive, re-establish the biomechanics and kinematics of the knee prior to injury, low complication rate, and be inexpensive. Unfortunately, this is not the case with current techniques. To date, the TPLO has the best evidence for the best outcome.[9,10] This includes a recent meta-analysis that came to this conclusion.[9] The highest level of evidence is a randomized controlled clinical trial. Recent trials comparing TPLO to lateral fabellar sutures and TPLO to TTA have been performed. In the TPLO to lateral fabellar suture trial, the TPLO group had a better outcome based on owner satisfaction (93% of dogs in the TPLO were rated a 9 or 10 compared to 75% in the LFS group) and gait analysis (11% better in the TPLO group at a trot).[10] In the

trial comparing TTA to TPLO, presented but not published in a peer – reviewed journal,[11] dogs receiving a TPLO did slightly better than dogs receiving a TTA. There may be several reasons for this including a steep learning curve for TTA's.[12]

Complications can also be used to compare the procedures, but similar rates have been reported ranging from 19-28%. The majority of major complications such as implant failure are much lower and superficial skin infections are higher.[13,14] This is also likely associated with experience with the procedure which is typically not addressed in the largely retrospective studies.

If TPLO is the best why offer other procedures?

1. Small size. There is still very little evidence in dogs under 30lbs that a TPLO would be better than any other procedures in dogs that fail conservative therapy.
2. Aftercare issues. Ocasionally, owner will openly refuse to do the aftercare needed for a TPLO. In those cases, implant failure in a TPLO is much more catastrophic than a tightrope or lateral fabellar suture. Also, since controlled exercise is permitted after suture techniques, some will choose based on the personality of the dog.
3. Financial cosiderations. Some owners want the least expensive option regardless of "best".
4. Age. Some owners do not want the invasiveness, or the long term differences in the procedures don't matter as much to them.

What should the owners expect for aftercare?

Tightrope and LFS require controlled exercise for 6-8 weeks at least. Rehabilitation makes a big difference in the outcome.[15,16,17] TPLO and TTA require rest to prevent implant failure. No running jumping playing and limited walking to prevent implant complications associated with fatigue until the bone is healed (6-8 weeks). Then slowly increasing exercise over time to rebuild muscle.[16]

Managing long-term expectations

Dogs with cruciate ruptures have osteoarthritis.[18] Unfortunately, there is no cure for osteoarthritis. Surgical intervention is designed to slow it down, but it is not uncommon for dogs to have occasional flare ups of the osteoarthritis.

References

1. Wilke VL, Robinson DA, Evans RB, Rothschild MF, Conzemius MG. Estimate of the annual economic impact of treatment of cranial cruciate ligament injury in dogs in the United States. J Am Vet Med Assoc. 2005;227(10):1604-7.
2. "TPLO – Not a Good Choice." Website: http://home.earthlink.net/~tiggerpoz/id4.html, accessed 10/26/07
3. "Veterinary care without the bite." Consumer reports 2003. Website: http://www.terrierman.com/vetcost.htm, accessed 10/26/07
4. Helliker K. This Joint Problem Makes Dogs, Owners, Weak In the Knees A Human Jock's Ailment Also Plagues Pooches; An $80 Pet's $6,000 Bill. The Wall Street Journal.2006;Apr 11:A1.
5. Pond, M. J., and J. R. Campbell. "The canine stifle joint I. Rupture of the anterior cruciate ligament." Journal of Small Animal Practice 13.1 (1972): 1-10.
6. Budsberg SC. Long-term temporal evaluation of ground reaction forces during development of experimentally induced osteoarthritis in dogs. Am J Vet Res 2001;62:1207–1211
7. Wucherer, Katja L., et al. "Short-term and long-term outcomes for overweight dogs with cranial cruciate ligament rupture treated surgically or nonsurgically." Journal of the American Veterinary Medical Association 242.10 (2013): 1364-1372.
8. Conzemius MG, Evans RB, Besancon MF, Gordon WJ, Horstman CL, Hoefle WD, Nieves MA, Wagner SD.Effect of surgical technique on limb function after surgery for rupture of the cranial cruciate ligament in dogs. J Am Vet Med Assoc. 2005;226(2):232-6.
9. Bergh, Mary Sarah, et al. "Systematic Review of Surgical Treatments for Cranial Cruciate Ligament Disease in Dogs." Journal of the American Animal Hospital Association (2014): jaaha-6356.
10. Gordon-Evans, Wanda J., et al. "Comparison of lateral fabellar suture and tibial plateau leveling osteotomy techniques for treatment of dogs with cranial cruciate ligament disease." Journal of the American Veterinary Medical Association 243.5 (2013): 675-680.
11. Proceedings of the 2013 ACVS Symposium, San Antonio, TX October 2013.
12. TTA LEARNING CURVE
13. Pacchiana PD, Morris E, Gillings SL, Jessen CR, Lipowitz AJ.Surgical and postoperative complications associated with tibial plateau leveling osteotomy in dogs with cranial cruciate ligament rupture: 397 cases (1998-2001). J Am Vet Med Assoc. 2003;222(2):184-93.

14. Stauffer KD, Tuttle TA, Elkins AD, Wehrenberg AP, Character BJ.Complications associated with 696 tibial plateau leveling osteotomies (2001-2003). J Am Anim Hosp Assoc. 2006;42(1):44-50.
15. Au KK, Gordon-Evans WJ, Dunning D, et al. Comparison of short- and long-term function and radiographic osteoarthrosis in dogs after postoperative physical rehabilitation and tibial plateau leveling osteotomy or lateral fabellar suture stabilization. Vet Surg 2010;39(2):173-80.
16. Monk ML, Preston CA, McGowan. CM.Effects of early intensive postoperative physiotherapy on limb function after tibial plateau leveling osteotomy in dogs with deficiency of the cranial cruciate ligament. Am J Vet Res. 2006 Mar;67(3):529-36
17. Marsolais GS, Dvorak G, Conzemius MG. Effects of postoperative rehabilitation on limb function after cranial cruciate ligament repair in dogs. J Am Vet Med Assoc. 2002 May 1;220(9):1325-30.
18. Lazar TP, Berry CR, deHaan JJ, Peck JN, Correa M. Long-term radiographic comparison of tibial plateau leveling osteotomy versus extracapsular stabilization for cranial cruciate ligament rupture in the dog. Vet Surg. 2005;34(2):133-41.

Nonsurgical Cranial Cruciate Ligament Rupture Management

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

Cruciate disease is the number one cause of hind limb lameness in dogs and costs Americans $1.32 billion dollars per year. It effects almost all breeds of dogs and is surrounded by controversy regarding which surgical procedure is most beneficial.[1] The majority of the cost is in surgical interventions; however, not all dogs are surgical candidates.

Cruciates can be addressed either surgically or conservatively. The magic cutoff for dogs treated conservatively versus surgically is 30 pounds based on a 1972 paper where most small breed dogs recovered satisfactorily with rest whereas working dogs and large breed dogs required surgical intervention for a satisfactory outcome.[5] Since then, very little has been published on conservative therapy. Dogs with experimentally created cruciate ruptures improve over time but do not return to normal weight bearing, and they are used as an induced osteoarthritis model.[6] More recently, the University of Minnesota compared dogs receiving institutional rehabilitation, weight loss program, and an NSAID to those receiving a TPLO. The surgery group did better, but 2/3 of the conservatively treated dogs had successful outcomes.[7] More aids in conservative management have become available including braces. These range in types and expense and have little to no evidence for their use. The anecdotal evidence of brace use points to possible increased proprioception therefor allowing better active stabilization of the knee.

Physical rehabilitation has grown out of human physical therapy profession. It is still in its infancy in veterinary medicine. To rehabilitate is to restore health or normalcy. Sometimes the goal is to maximize function as full rehabilitation is not possible. In veterinary medicine, rehabilitation is typically used to treat dogs after orthopedic or neurologic surgery to increase the rate of return to normal activity, and those dogs that have significant osteoarthritis. However, it is increasing in popularity as an adjunct treatment to affect weight loss, improve ambulation with non-surgical neurologic disease, prevent muscle atrophy and maintain strength in a variety of disease states.

The most researched area of rehabilitation in the dog is after stifle surgery rather than for cruciate disease. Both TPLO and lateral fabellar suture benefit from rehabilitation post-operatively. It is possible that the disparity in the results of the 2 procedures is mitigated by rehabilitation. Rehabilitation has also shown to be beneficial in treating dogs with cruciate ruptures that are not surgical candidates. Weight loss is also a benefit of most rehabilitation programs. This may be the SINGLE most important aspect of conservative therapy.

Treatment modalities

Icing

Applying a cold minimizes inflammatory processes and provides analgesia. Lowering the temperature of skin and underlying tissue causes vasoconstriction, reduces blood flow, and decreases sensory and motor nerve conduction velocity. This is tolerated well in pets and can start immediately after surgery. Twenty minutes of icing decreases the temperature in the effected tissue 1-4° C. Cold water compression with a cold water circulating compression blanket is arguably the best modality for post-operative swelling reduction.

Warm packing

This can be performed after 3days to a week after surgery. Warm packing can be used to warm muscle up prior to stretching. Use immediately after surgery may increase vasodilation and swelling.

Ultrasound

Therapeutic ultrasound units are designed to emit sound waves into tissue, which heats the deep tussues and causes vasodilation and increased blood flow, and intern increased healing. Typically this is used in treating chronic tendonitis, limited ROM secondary to tissue contracture, myositis, bicipital tendonitis, and muscle spasm. This is generally tolerated well in awake patients.

Shockwave ultrasound is a more intense burst of energy that may cause microdamage or irritation to deep structures. This temporary increase in inflammation promotes long-term healing. This has been shown to be helpful in dogs with patellar tendonitis after TPLO and may even speed bone healing. Dogs receiving shockwave therapy typically require sedation during treatment.

Massage

Massage is the gentle manipulation of muscles and soft tissues. It is used most often to help decrease swelling by promoting lymphatic drainage and to help warm up muscle prior to exercise. This modality is often well tolerated in dogs even within the first 24 hours of surgery.

Passive range of motion and stretching

The standard of care in humans after cruciate repair is to start passive range of motion and icing immediately after surgery. This helps to decrease swelling, and decrease cartilage damage and muscle contracture. It can also be used as a muscular warm up prior to activity later in the treatment program. Many dogs tolerate these exercises by occasionally they must be delayed for a few days as the dog may anticipate pain.

Neuromuscular electrical stimulation

This modality is designed to increase muscle strength/ decrease atrophy and muscle spasm. Used correctly, it should not be painful, but shaving is usually necessary.

Pulsed signal therapy

Can be used in acute pain situations or for chronic osteoarthritic pain. This modality consists of the generation of a magnetic field that encourages vascularity and healing. There is some evidence of the efficacy for this modality in patients with osteoarthritis.

Cold laser therapy

This is used to stimulate tissues without heating them. This is very controversial in both human and veterinary rehabilitation.

Therapeutic exercise

This is the largest and one of the most important modalities for rehabilitation. Dogs are encouraged to exercise the appropriate muscle groups in a safe manor. Since dogs will not sit on an exercise making and lift weights, creativity is needed to develop appropriate exercises. The goals are often it increase range of motion, increase function or weight bearing, decrease the risk of reinjury, build muscle mass, or prepare for return to work. Loosing weight may also be a positive side effect.

Realistic goals are tantamount for success. These are tailored to the individual patient based on fitness level, degree of dysfunction, stage of healing, and risk of complications. Depending on the goal, exercise can be changed based on the speed, difficulty, or duration of the activity.

Owners, practitioners, or technicians can perform exercises with or without aids. Some examples of therapeutic exercises that do not need special equipment/aids include sit to stand, leash walks, hills, figure 8's, and natural obstacles (like tall grass). Therapeutic exercises that do need special equipment include thera-bands for lateral muscle work or resistance training, underwater treadmill therapy, balance boards, treadmills, and exercise balls. Some of these exercises will be demonstrated at the presentation.

Swimming

This is great exercise for most minimally debilitated and healthy patients. Swimming burns calories, encourages use of multiple muscle groups and core muscle activation. From an orthopedic standpoint, the primary benefit is the elimination of concussive forces to the body and joints. Swimming is often used to help restore normal function, stamina, and muscle mass.

Treatment plans are fluid and should be re-evaluated as changes occur with the pet. Some owners do a superb job with therapeutic exercises at home and others do not. There are social (owners time, patience, and life style) and pet factors (aggressive, fractious, or difficult to control) that may go into the home performance. Institutional rehabilitation has more guidance and rapid application of changes in the treatment plan.

References

Johnson, J. M., et al. "Rehabilitation of dogs with surgically treated cranial cruciate ligament-deficient stifles by use of electrical stimulation of muscles." American journal of veterinary research 58.12 (1997): 1473-1478.

Monk, Michelle L., Christopher A. Preston, and Catherine M. McGowan. "Effects of early intensive postoperative physiotherapy on limb function after tibial plateau leveling osteotomy in dogs with deficiency of the cranial cruciate ligament." American journal of veterinary research 67.3 (2006): 529-536.

Canapp Jr, Sherman O. "The canine stifle." Clinical techniques in small animal practice 22.4 (2007): 195-205.

Au, Kevin K., et al. "Comparison of short-and long-term function and radiographic osteoarthrosis in dogs after postoperative physical rehabilitation and tibial plateau leveling osteotomy or lateral fabellar suture stabilization." Veterinary Surgery 39.2 (2010): 173-180.

Kvist, Joanna. "Tibial translation in exercises used early in rehabilitation after anterior cruciate ligament reconstruction: Exercises to achieve weight-bearing." The knee 13.6 (2006): 460-463.

Millis, Darryl L. "Getting the dog moving after surgery." Journal of the American Animal Hospital Association 40.6 (2004): 429-436.

Harasen, Greg. "Postoperative physical therapy in orthopedic patients." The Canadian Veterinary Journal 42.8 (2001): 655.

Marsolais, Gregory S., Glenda Dvorak, and Michael G. Conzemius. "Effects of postoperative rehabilitation on limb function after cranial cruciate ligament repair in dogs." Journal of the American Veterinary Medical Association 220.9 (2002): 1325-1330.

Conzemius, Michael G., et al. "Effect of surgical technique on limb function after surgery for rupture of the cranial cruciate ligament in dogs." Journal of the American Veterinary Medical Association 226.2 (2005): 232-236.

Marsolais, Gregory S., et al. "Kinematic analysis of the hind limb during swimming and walking in healthy dogs and dogs with surgically corrected cranial cruciate ligament rupture." Journal of the American Veterinary Medical Association 222.6 (2003): 739-743.

Soft Tissue Injuries:
It's Not Just About Rest

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

Soft tissue injury is the all-encompassing term we use for an injury to a muscle, tendon, or ligament. Unfortunately, in our veterinary patients, it can also be used as a non-specific diagnosis for cause of lameness that is not recognizable on examination or simple imaging.

We are relatively successful in treating these injuries in dogs with rest and pain management. However, there are subcategories of dogs that improve with rest but relapse after that period is over. Additionally, there are dogs that are expected to return to work ASAP after an injury.

Rehabilitation at an institution with trained CCRP personnel is always recommended for these patients but not always geographically or economically feasible. There are some exercises that can be performed at home safely in patients with soft tissue injuries. The presentation will demonstrate the exercises and the conditions in which they are safe.

Passive range of motion exercises

- The owner flexes and extends all joints for 10 repetitions holding the joint at the end of extension or flexion for a count of 10. The owners should flex and extend to the pain threshold and not go over. This should not hurt.
- This helps to keep the joints lubricated, reduce stiffness, and maintain or improve the overall range of motion of the joint.
- Safe in general for injuries that do not require splints or slings
- THIS IS NOT STRETCHING (stretching is avoided in the first 3 weeks of minor muscle or tendon tears)

Balancing exercises

- Several different methods starting with gently nudging the pet to cause a weight shift while standing. These can be stepped up to uneven surfaces like couch cushions to wobble boards.
- Can help improve coordination and hopefully, therefore decrease recurrence
- Isometric contractions are also good for most injuries as a way of maintaining function without straining the injured tissue
- Balancing exercises are safe for multiple soft tissue injuries

Controlled exercise

- Short, frequent walks are best initially. Control is key. Walk, not trot is important
- Patient/client selection is important
- Walking in water can also be encouraged though swimming is sometimes too much depending on the injury
- Start flat and hills can be added later at end of rest/rehab period (Assuming no lameness
- Good for muscle strains (i.e. iliopsoas) or tendonitis (i.e. patellar)

Core strengthening

- Alternating leg lifts on rear or front help to strengthen the core leg muscles
- Sit to stand
- Down to stand
- Sit/Down to stand on uneven surfaces
- Roll to sternal position from lateral recumbancy
- Appropriate for the majority of soft tissue injuries

Many of the exercises described have videos that owners can view on Youtube. The problem with many of them is that they also are advertising medications or other products.

Orthopedic Exam Tips and Tricks

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

A good orthopedic examination is imperative in helping animals with lameness. Imaging may show incidental problems or no problems and should be interpreted in light of the clinical signs and examination findings. The following are tips and tricks to improve examination skills

Tip #1 Keep the goal in mind/ find the pain

The goal depends on the patient (eg. New puppy/pre-purchase exam vs dog with a lameness) although there is some overlap.

The goal of the most common type of orthopedic examination is to find the cause of lameness. This means finding the source of pain. Finding pain is the most helpful in identifying the cause and developing a treatment plan. This is physical and can feel mean.

1A. Examine off of pain medications
1B. REPEAT if you cannot tell
1C. Repeat exam in different position or circumstances. Some dogs will show more in front of or away from owners.
1D. If it is worse with exercise, re-examine after exercise

Tip #2 Start with the "good" legs and end with the "bad" legs

Starting with the "good" legs gives a baseline for behavior to help judge pain. Does the pet just not like the toes touched? or is it pain? It also helps if multiple limbs are affected which helps in diseases like polyarthritis, metastatic cancer, or infectious disease. This occurs sometimes when other limbs are less effected allowing a single limb to appear lame

Tip #3 Start at the toes and move up

This helps because joints can be better isolated in that order. For instance, the knee can be flexed and extended without moving the hip, but when the hip is extended the knee is extended. If the knee is not painful on extension without moving the hip but there is painful on hip extension, the pain is isolated to the hip or hip flexors. Done in the opposite order, it is difficult to determine if the pain is associated with the hip or the knee

Tip #4 Don't forget about the spine

Nerve root signatures cause referred pain in the limb. A disc rupture in the neck can cause a forelimb lameness and a lumbar disc rupture can cause a rear limb lameness.

Tip #5 Don't forget about the digits and digital pads

If initial exam does not produce pain response, try again with emphasis on each individual toe, digit joint, and pad.

Tip #6 Don't forget about symmetry

For the most part, muscles, tendons and joints are symmetrical. Muscle atrophy can be especially helpful. If it is very quick and severe, think neurogenic. If it is mild and ongoing, it is more likely orthopedic but it can give you an idea of chronicity even if owner has not noticed a lameness.

Tip #7 Try things not taught in vet school (after initial flexion and extension of the effected joints

7A. Medial shoulder instability test – With pet in lateral recumbancy, place one hand on the scapula to stabilize and lift the limb laterally. It should move 45 degrees or less
7B. Biceps test – flex shoulder with digital pressure on the biceps tendon, flex shoulder with elbow extended and digital pressure on the tendon
7C. Iliopsoas test – extend hip and externally rotate knee, or direct pressure on the iliopsoas muscle
7D. Patellar tendonitis test – flex stifle and place digital pressure on the patellar tendon

Tip #8 Big dogs are more difficult and can be difficult to overpower especially if they are worked up

Use an assistant for restraint. This is why the gold standard for cranial drawer is under sedation. Cranial tibial thrust is easier than cranial drawer in larger dogs even under sedation.

Tip #9 Sometimes owner are wrong!

In forelimb lameness, owners are often wrong as to which leg is the lame leg because the fast leg is eye catching but virtually always the normal side. Owners also will tell you their right rather than the dog's right.

Tip #10 Sometimes owners are right!

Especially owners that is very cognizant of small changes in gait (i.e. agility, field trial, etc). Sometimes really subtle problems are recognized early. In these dogs, sometimes its necessary to watch them do the activity that is “off” like go down an A-frame or zig-zag through the poles.

Splints and Casts: Pros and Cons

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

The major function of splints and casts are immobilization of a joint, bone, muscle group or combination. Immobilization has secondary unintended consequences and significant complication rates. Skin wounds are reported as high as 63% in casts. Splints are easier to maintain and potentially have fewer complications than casts, but casts are stiffer and provide more support.

General pros of splints/casts

1. Less expensive than surgery (most of the time)
2. Less morbidity than surgery
3. Possible faster healing if stability maintained (callous is not disrupted by surgery)
4. Decrease pain quickly when instability is made stable

General cons of splints/casts

1. Bandage sores which can be quite serious
2. Dermatitis
3. Cartilage atrophy- can become permanent especially in growing animals with long term coaptation
4. Muscle atrophy
5. Joint stiffness
6. Decreased tendon and ligamentous strength

The following are guidelines with associated pros and cons given different clinical situations.

Fractures

Patient selection

- Young animals heal faster
- Transverse fractures are easier to reduce and keep reduced
- Oblique and comminuted fractures are difficult to keep reduced
- Owner control and compliance of the pet makes a big difference
- Fracture

Tibia/fibula

Recommend splint if fracture is only fibula only with intact tibia, if it is a greenstick fracture, or non-displaced fracture in a young dog. Tibial fracture only with intact fibula is a grey area that depends on the patient/client factors.

Pros

1. Generally heals well (inherently good blood supply)
2. Lateral splint relatively easy to make and apply
3. Some indications are very short period of time (greenstick and nondisplaced puppy fractures)
4. Decreases pain

Cons

1. Some breeds are difficult/impossible anatomically– i.e. Corgi
2. The thigh muscles are cone shaped and therefore extending above the knee is difficult (Often green stick and fibula only fractures only need splints that extend to just below the stifle)
3. Splints/casts above the stifle cause ambulation difficulty
4. Bandage sores common on lateral digits, calcaneus, and patella
5. Sedation may be required for changes

Radius/ulna

Recommend splint if it is an ulna only fracture with intact radius or greenstick fracture. Fractures of the radius with an intact ulna and combined radius and ulna fractures that are transverse or non-displaced depend on patient/client factors. SURGERY IS RECOMMENDED IS SMALL BREED DOGS WITH RADIUS AND ULNA FRACTURES because they have decreased blood supply to the radius and therefore a higher rate of non-union in splint or cast.

Pros

1. Easy application and maintenance generally
2. Less bandage sores if placed caudally

3. Decreases pain

Cons

1. Increased non-unions in small breed dogs
2. Bandage sores on olecrananon may be difficult to get to heal
3. Deep chested dogs more difficult to stabilize the elbow

Metacarpals/metatarsals

Splinting recommended when <2 metatarsals affected, open fractures with associated infections (i.e. dog bite), or if fractures are minimally or non-displaced. Extend splint past toes (typically caudally) to assure metacarpo/tarsophalangeal joint immobilization.

Pros

1. Easy applications
2. Good ability to heal

Cons

1. Bandage sores on accessory carpal bone or calcaneus
2. Risk of malunion because easy to put pressure on toes to cause rotational malunion

Digital fractures

Splint recommended when combined with a wound from the trauma or if multiple toes effected.

Pros

1. Decreases pain
2. Less expensive than toe amputation

Cons

1. Have to immobilize the carpus also to get the bandage to stay on
2. More expensive than not splinting

Humeral or femur fractures

Surgical intervention recommended but if that is not an option, the pros and cons can be weighed with the patient factors

Pros

1. Can be pain relieving
2. Can theoretically improve healing rate
3. Can theoretically decrease the chances of non-union over no treatment

Cons

1. Malunion if heals although this is likely with cage rest alone also
2. Bandage sores – multiple areas including flank and axilla
    a. The splint must extend over the shoulder or pelvis which (Spica)
    b. This increases the risk of urination contamination or bandage sores
3. Still difficult to stabilize bone
4. Difficult to ambulate
5. Heavy especially in large dogs
6. Quadriceps contracture (“tie down”) risk increases dramatically with femur fracture

Tips for cases without surgical options

1. Sometimes a Spica is necessary to get bandage to stabilize the stifle
2. Sponge donuts over boney prominences
3. Can incorporate rods in splints to avoid cast
4. Can change/remake splint if wounds occurring
5. Metasplints are not good enough unless it is a small dog and it fits perfectly

References

Meeson RL, Davidson C, Arthurs GI. Soft-tissue injuries associated with cast application for distal limb orthopaedic conditions. A retrospective study of sixty dogs and cats. *Vet Comp Orthop Traumatol*. 2011;24(2):126-31.

Minimizing Chaos and Complications in Practice

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

Complications are a necessary part of practicing veterinary and human medicine. However, there are significant environmental factors that add to chaos and predispose to complications. Many of these things are avoidable in practice. Implementing many of the strategies designed to decrease chaos and complications results in higher job satisfaction for staff.

It is a fact that we practice on patients, and it is a necessary evil. As people train, mistakes are made, complications occur, and outcomes are affected. This training can add to chaotic environments. This has been published in both veterinary and the human literature. For example, dogs presenting to the University of Illinois Veterinary Teaching Hospital for unilateral cruciate disease were entered into a trial in which their gait was analyzed before surgery (lateral fabellar suture or TPLO) and at 6 weeks, 12 weeks, and 6 months after surgery. The data was analyzed to determine if a single resident was affecting outcome or if experience effected outcome. The data showed that a single resident didn't affect outcome but the year of training mattered. The first and third year residents had statistically better outcomes than the second year residents. At the time, first year residents were supervised heavily with more autonomy the second year. It is likely that the resident had mastered the skills necessary for those particular surgeries by the third year given the caseload. In a second similar cruciate study with the same procedures, the residents were analyzed for the effect on outcome and the level of experience did not affect outcome. In this second study, direct supervision of the residents during the cruciate study regardless of experience level was required. It is possible that the added supervision decreased the incidence of small errors effecting outcome. The sample size is low and has a historic bias for direct comparison of the 2 groups of residents, but it is certainly an interesting observation.

Mehmet Oz said "As a surgeon you have to have a controlled arrogance. If it's uncontrolled, you kill people, but you have to be pretty arrogant to saw through a person's chest, take out their heart and believe you can fix it." In general, surgeons and those training to be surgeons are known for their confidence, and this reputation has spilled over into veterinary medicine. Confidence is good but overconfidence is bad. Overconfidence is a type of cognitive bias that can effect recommendations that surgeons make. For example, human orthopedic surgery residents were given several sets of radiographs to review. They gave a diagnosis and a probability of being correct. The residents overwhelmingly gave high probabilities of being correct, even when they were wrong leading to missed fracture diagnoses. Understanding human limitations, practice, follow-up, and re-evaluation can help to alleviate these types of mistakes.

It is reasonable to assume that training technical staff or adding new procedures to a practice has the same type of learning curve. In our practice, new surgery technicians are 3 times more likely to make a mistake than the experienced staff. This has lead to some changes in training of technicians once hired. They are trained with direct supervision for weeks and slowly allowed to become more independent.

Complications and chaos in the work place can lead to a vicious cycle of poor outcomes, poor owner satisfaction and poor staff job satisfaction. Keeping these to a minimum is easier said than done in the majority of veterinary practices. There are doctors and technical staff at all levels of training and competency. Distractions, multi-tasking, and noise pollution from mechanical devices and patients that contribute to miscommunications and even potentially short tempers of doctors and staff.

In human medicine, it is estimated that more than 1,000,000 people are injured by preventable medical injuries with 100,000 deaths as a result in the US as reported by the National Coalition on health Care. These are injurious errors, not including those mistakes that contribute to a bad experience or do not cause morbidity (i.e. radiograph view that has to be retaken). Also only 20 states have mandatory reporting of medical errors, and even in those 20 only a small percentage are reported. There is every reason to believe that there are similar error rates in veterinary medicine.

One area of particular concern in human medicine is the noise pollution in the intensive care units. Multiple false alarms desensitize nursing staff to alarms that matter. They also contribute to general stress, distraction, and can negatively impact staff job performance. Decreasing the number of alarms and tailoring them to the individual patient can reduce the desensitization and distraction that the noise can cause. This can be a problem in veterinary medicine as well especially in large multi-doctor practices. Not only can distracted or stressed staff cause complications and add to chaos, but if much of the chaos can be attenuated, often times they can catch errors and substantially add to positive patient care. Fostering technical staff as team members can act as a safety catch for short cuts that clinicians may be tempted to take even if it is not the best idea.

There are some other lessons that veterinarians can learn from research into the human field. There are some hospitals with lower than average complications rates for specific surgeries. This is possible by subspecialization. For instance, if the only surgery that one performed was a TPLO, the complication rate would likely be a lot lower than that reported in the literature. Another possibility is a rehearsal. In one hospital, surgical procedures that are rarely performed are practiced first. The surgical team rehearses the procedure with everyone going over his or her part. I have used this technique to minimize the complications experienced at the University of Illinois with total hip replacement surgeries. The nature of the teaching hospital was such that I only performed about 6 total hips

replacements per year. In addition, the surgical team was different each time varying levels of expertise from technical staff, student to third year resident. Since the procedure was performed rarely, the total hip replacement was practiced (typically on a cadaver or pelvic specimen) so that the team had a refresher course on the procedure. Although there is no comparative data on the success of this practice, on average, the rehearsal was about 2 times longer than the surgical procedure.

The Checklist Manifesto by Atul Gawande brought to the forefront a major push in human medicine to use checklists to decrease patient complications. Checklists have been instituted in multiple institutions with overall success in reducing complications and medical errors. The most notable is the implementation world wide of the World Health Organizations Surgical Safety checklist. In 2 hospitals studied, there was an 8.4% decrease in risk reduction, and the mortality rate went from 1.9% to 0.2% after implementation of the checklist. This has spawned other checklists in a wide variety of areas as well as support form organizations all over the world. The checklist has also been well received by patients and families that participate in the pre-operative portion.

Although the World Health Organizations Surgical Safety Checklist does not directly translate to veterinary medicine, it can be adapted or the principles behind it can be used to create one that works for any practice. In my practice, I kept track of the chaos that occurred and to which patients prior to implementing a checklist and afterward. These anarchies that contributed to chaos and complications included errors in prescriptions that could have caused injury to missing instruments in packs that delayed surgical time. Prior to implementation of the checklist, the rate was reduced by half from 36.3% to 16.7% after the checklist was added. This is a simple checklist that involved each surgical patient. The technical staff uses this checklist to make sure that the patient is ready for surgery.

Since implementation, other checklist specific to the way a specific clinician works have been developed at our practice. The technical staff have also embraced the idea and use them now and developed their own for cleaning, stocking, and sterilization purposes. However, there was considerable push back in the beginning with the thought that it was just “more paperwork” to fill out. However, knowing our rate of chaos and errors helped in that the staff understood that it was unacceptable. Once in the habit of using the checklist, they do not want to live without it.

The World Health Organization Surgical Safety Checklist can be found online at http://www.who.int/patientsafety/safesurgery/tools_resources/SSSL_Checklist_finalJun08.pdf or by googling WHO SSC. This website also contained information on implementations of websites.

References

Konkani A, Oakley B, Bauld TJ. Reducing hospital noise: a review of medical device alarm management. Biomed Instrum Technol. 2012 Nov-Dec;46(6):478-87.

Gawande AA, Arriaga AF. A simulation-based trial of surgical-crisis checklists. N Engl J Med. 2013 Apr 11;368(15):1460.

Oskam J, Kingma J, Klasen HJ. Clinicians' recognition of 10 different types of distal radial fractures. Percept Mot Skills. 2000 Dec;91(3 Pt 1):917-24.

Schwaitzberg SD, Scott DJ, Jones DB, McKinley SK, Castrillion J, Hunter TD, Michael Brunt L. Threefold increased bile duct injury rate is associated with less surgeon experience in an insurance claims database : More rigorous training in biliary surgery may be needed. Surg Endosc. 2014 Jun 6.

Schwaitzberg SD, Scott DJ, Jones DB, McKinley SK, Castrillion J, Hunter TD, Michael Brunt L. Threefold increased bile duct injury rate is associated with less surgeon experience in an insurance claims database : More rigorous training in biliary surgery may be needed. Surg Endosc. 2014 Jun 6.

Gillespie BM, Chaboyer W, Thalib L, John M, Fairweather N, Slater K. Effect of using a safety checklist on patient complications after surgery: a systematic review and meta-analysis. Anesthesiology. 2014 Jun;120(6):1380-9.

Russ SJ, Rout S, Caris J, Moorthy K, Mayer E, Darzi A, Sevdalis N, Vincent C. The WHO surgical safety checklist: survey of patients' views. BMJ Qual Saf. 2014 Jul 18. pii: bmjqs-2013-002772. doi: 10.1136/bmjqs-2013-002772.

Haugen AS, Søfteland E, Almeland SK, Sevdalis N, Vonen B, Eide GE, Nortvedt MW, Harthug S. Effect of the World Health Organization Checklist on Patient Outcomes: A Stepped Wedge Cluster Randomized Controlled Trial. Ann Surg. 2014

Gawande A. Better: A Surgeon’s Notes on Performance. New York: Metropolitan Books, 2007.

Gawande A. Complications: A Surgeon’s Notes on an Imperfect Science. New York: Metropolitan Books, 2007.

Gawande A. Better: A Surgeon’s Notes on Performance New York: Metropolitan Books, 2002.

Gawande A. Checklist Manifesto. New York: Metropolitan Books, 2009.

Radiographic Review of Cardiovascular Disease

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

Meaningful evaluation of the heart is predicated on a sound knowledge of normal anatomy, physiology, and breed variations and adherence to principles of standardized technique and positioning to eliminate non-pathologic variables. Digital radiography has helped improve radiographic technique but appropriate animal positioning remains critical. The ribs and spine should be penetrated well enough to show some bony detail (trabeculation) on the lateral view. On the VD or DV view, the thoracic vertebrae should be just visible but not show detail where they overlie the heart. One should also be able to trace the course of the descending aorta along the left side of the spine on the VD or DV view. Always consider the possibility of noncardiac anatomic or pathophysiologic factors that can alter the appearance of the heart including congenital anomalies of the spine, sternum, or rib cage, intrathoracic masses or fluid, megaesophagus, pneumothorax, lung collapse, a diaphragmatic hernia, trauma (including broken ribs, lung contusion), and pneumonia or other parenchymal lung densities overlying the heart. Chest radiographs are fairly accurate for identifying left atrial (lateral view), left ventricular and right ventricular enlargement (DV view). Right ventricular and right atrial enlargement are often over-interpreted. Left ventricular eccentric hypertrophy is more visible than concentric hypertrophy.

Lateral view

The normal heart occupies approximately 2.5 to 3.5 intercostal spaces, and the height of the heart is approximately 2/3rds the height of the chest. The trachea typically diverges ventrally from the spine at an angle of about 20°. The caudal waist should be distinctly visualized. The shape of the heart conforms to the general shape of the thoracic cavity. In brachycephalic and other barrel-chested dogs, the heart appears rounder and larger than in the "normal" dog. The trachea may run nearly parallel to the spine on the lateral view. In these dogs, the heart often occupies nearer to 3 1/2 intercostal spaces and it contacts more of the sternum ventrally. In narrow, deep-chested breeds, the heart is more "upright" and slender appearing on the lateral view. Cats have a slender conical-appearing heart that tends to be tipped slightly on the lateral view with the base of the heart lying more anteriorly. In older cats, the heart is less upright and may be inclined almost horizontal to the sternum. Older cats also often have an elongated, tortuous aorta on the lateral view.

An alternative method of evaluating heart size developed by James Buchanan may prove helpful. If the long and short axes of the heart are measured in the lateral views using the thoracic vertebrae as a scale (starting with the cranial margin of the 4th thoracic vertebra), the sum of these measurements (vertebral heart score = VHS) should not exceed 10.5 vertebrae. In 100 normal dogs the average measurement was 9.7 vertebrae. Most normal cats have a short axis dimension of 3.1 to 3.4 vertebrae, and a VHS of 7.2 to 7.8 vertebrae.

Dorsoventral or ventrodorsal view

The width of the heart is approximately 1/2 to 2/3rds the width of the thorax. The right and cranial borders are rounded and the left border nearly straight. The apex points to the left side of the thorax. On the DV view the heart occupies at least 2/3rds of the width of the thorax and the apex of the heart is sometimes directed more to the left. In narrow, deep-chested breeds the heart often appears small and round due to the upright position of the heart.

Radiographic signs of cardiac chamber enlargement

1) Right atrial enlargement

Right atrial enlargement is encountered rarely as an isolated abnormality in the form of congenital tricuspid valve stenosis. It is observed most often with RV enlargement as a result of acquired (valve degeneration) or congenital tricuspid valve insufficiency (tricuspid dysplasia). Right atrial enlargement also develops in dogs with right heart failure due to heartworm disease or dilated cardiomyopathy.

2) Right ventricular enlargement

Right ventricular enlargement develops as a consequence of pressure overload - pulmonic stenosis, tetralogy of Fallot, pulmonary hypertension; as a consequence of volume overload -tricuspid valve insufficiency or an atrial septal defect; and it enlarges in concert with the left ventricle in dogs with dilated cardiomyopathy.

3) Main pulmonary artery enlargement

The main pulmonary artery segment is located between 1:00 and 2:00 o'clock using the clock-face analogy. It enlarges as a consequence of pulmonary hypertension, pulmonic valve stenosis (post-stenotic dilatation), and as a result of volume overload - left to right shunting defects (ASD, VSD, PDA), and pulmonic valve insufficiency.

4) Left atrial enlargement

Left atrial enlargement is usually seen together with LV enlargement as most acquired disorders, such as mitral regurgitation and dilated cardiomyopathy affect both chambers. LA enlargement with no or minimal LV enlargement may be seen with mitral valve stenosis and with those disorders causing concentric LV hypertrophy, e.g. aortic stenosis and hypertrophic cardiomyopathy. Cats frequently display solely left auricular enlargement, a finding that is often absent on the lateral radiograph because of the anatomic location of the left auricle.

5) Left ventricular enlargement

Left ventricular enlargement develops as a consequence of pressure overload (concentric hypertrophy) due to valvular or subvalvular aortic stenosis or systemic hypertension or as a consequence of volume overloading (eccentric hypertrophy) due to mitral valve insufficiency or a left to right shunting VSD or patent ductus arteriosus. Concentric LV hypertrophy also occurs due to hypertrophic cardiomyopathy. The LV undergoes eccentric hypertrophy in concert with the right ventricle in dogs with dilated cardiomyopathy. Some cases of severe concentric hypertrophy have minimal radiographic changes because the sarcomeres are in parallel, thereby increasing the wall thickness but decreasing the radius of the left ventricle.

6) Aortic arch enlargement

The aorta is located between 11:00 and 1:00 o'clock using the clock-face analogy. It enlarges as a consequence of subvalvular aortic stenosis (post-stenotic dilatation), as a result of aortic valve insufficiency, and, more rarely as an idiopathic disorder or secondary to systemic hypertension. The aortic arch is also enlarged in dogs with a patent ductus arteriosus or tetralogy of Fallot.

Radiographic evaluation of the pulmonary arteries and veins

On the lateral view, the pulmonary arteries lie dorsal to the bronchus while the veins are located ventral to the bronchus. In the lateral view, vessels in the cranial and middle lung lobes are most easily seen. The arteries and veins should be approximately the same size. On the dorsoventral view, the pulmonary arteries lie lateral to the bronchus while the pulmonary veins are medial to the bronchus.

The vessels in the cranial and caudal lung lobes are usually easily seen in this view.

1) Enlarged pulmonary arteries and veins

Left to right shunts cause enlargement of both the pulmonary arteries and the pulmonary veins together with an overall increase in pulmonary density. Expiratory radiographs can accentuate the size of the pulmonary vessels and can falsely suggest pulmonary edema.

2) Diminutive pulmonary arteries and veins

Right to left shunts cause a decrease in the size of the pulmonary arteries and veins and a generalized decrease in pulmonary density. Also consider the possibility of hypovolemia.

3) Enlarged pulmonary veins with normal arteries

This finding usually indicates left heart failure or iatrogenic over-hydration. This sign is more reliable in dogs than in cats.

4) Enlarged pulmonary arteries with normal veins

With pulmonary hypertension (heartworms), the proximal branches of the pulmonary arteries are often noticeably larger than the veins. The arteries are also often more tortuous and truncated in appearance.

Wrapping Your Head Around the Pericardium: A Review of Pericardial Disease

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

Congenital and acquired pericardial disease may be encountered in a variety of situations ranging from the asymptomatic animal to the patient in acute shock. Therefore the possibility of pericardial disease should remain at the forefront of many different clinical presentations.

Pathophysiology

The most important pathophysiologic effect of pericardial disease is the reduction of diastolic filling of the heart. Diastolic dysfunction causes a reduction of ventricular stroke volume and cardiac output. The severity of clinical signs usually depends on the rate of fluid accumulation. It is important to realize that the pericardial pressure volume relationship is such that there is a progressively greater rise in pericardial pressure as pericardial volume increases.

History and clinical signs

Rapidly developing cardiac tamponade can cause acute hypotension, weakness, dyspnea, collapse, and sudden death. Animals with slowly developing and chronic pericardial effusion may present with signs of right-heart failure including abdominal distension, respiratory difficulty associated with pleural effusion, or exertional syncope. The heart sounds are usually muffled, careful examination will often reveal jugular venous distension or a positive hepatojugular reflux, and femoral arterial pulses are often reduced in strength or exhibit pulsus paradoxus.

Diagnostics

1) Electrocardiogram: ECG alterations are variable and non-specific but may often include low amplitude QRS complexes in all leads, sinus tachycardia, ventricular premature complexes (depending on the etiology of the effusion), nonspecific ST segment elevation or depression, and electrical alternans.
2) Thoracic radiographs: Although we often describe a large globular cardiac silhouette rounded in all views as the characteristic finding of pericardial effusion, most studies suggest there are no steadfast radiographic findings for distinguishing cardiac tamponade from various other cardiovascular diseases. With small effusions, changes may be minimal and animals with pleural effusion may have an obscured cardiac silhouette.
3) Echocardiography: Echocardiography is the most sensitive method of detecting pericardial effusion and it often permits visualization of neoplastic lesions that may serve as the etiology for cardiac tamponade.

Pericardiocentesis

Usually with the dog in left lateral recumbency, the right fifth intercostal space at the costochondral junction is clipped and surgically prepared. While monitoring the ECG, an over-the-needle catheter is advanced toward the heart and when fluid is obtained, the catheter is advanced into the pericardial sac. The stylet is withdrawn and most often the catheter is attached to an IV extension set, three-way stopcock and syringe for aspiration. The catheter may be fenestrated to make aspiration of fluid easier. Aspirated fluid can be compared to peripheral blood and monitored for clotting to make certain accidental cardiac catheterization has not occurred. Routine cytology and fluid analysis is generally performed to try and exclude bacterial, fungal, or obvious neoplastic etiologies. But with most hemorrhagic effusions it is impossible to distinguish the neoplastic effusates from idiopathic effusions.

Diseases of the pericardium

Congenital diseases of the pericardium are infrequently encountered but their recognition is gratifying because they are often amenable to surgical correction. These lesions include pericardial defects, peritoneopericardial diaphragmatic hernia and intrapericardial cysts. Acquired pericardial disease is typically manifest as pericardial effusion of neoplastic or idiopathic/inflammatory origin. Less common etiologies for pericardial effusion include uremia, left atrial tear, rodenticide toxicity/coagulopathy, infectious disease, heart failure, hypoalbuminemia, trauma or pericardial foreign bodies. The prognosis and treatment varies with the underlying etiology but in general hemangiosarcoma and mesothelioma carry poor prognoses, while idiopathic disease and effusion related to chemodectoma often carry a better prognosis depending on response to therapy.

References/suggested reading

Cagle LA, Epstein SE, Owens SD, et al. Diagnostic yield of cytologic analysis of pericardial effusion in dogs. J Vet Intern Med. 2014 Jan-Feb;28(1):66-71.

Cote E, Schwarz L, Sithole F. Thoracic radiographic findings for dogs with cardiac tamponade attributable to pericardial effusion. J Am Vet Med Assoc. 2013 Jul 15;243(2):232-5.
MacDonald KA, Cagney O, Magne ML. Echocardiographic and clinicopathologic characterization of pericardial effusion in dogs: 107 cases (1985-2006). J Am Vet Med Assoc. 2009 Dec 15;235(12):1456-61.

Reacquainting Yourself with the ECG and Treatment of Arrhythmias

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

A systematic approach to the evaluation of the ECG will prevent overlooking important abnormalities. The following characteristics should be evaluated in every ECG. Familiarity with the normal parameters for the ECGs of the various species is, of course, essential for accurate interpretation.

1) Determine the heart rate

If the heart rate is regular, the number of small boxes (mm) between QRS complexes can be divided into 3,000 (at 50 mm/sec) or 1,500 (at 25 mm/sec) to find the instantaneous heart rate. The heart rhythm in animals, especially in dogs, is frequently irregular. In this circumstance the more accurate average heart rate is found by counting the number of beats in a known time interval and multiplying appropriately. Single channel ECG paper on analog recorders is usually marked by a vertical line at the top of the paper at 75 mm (1 mm = 1 small box) intervals. At a paper speed of 50 mm/sec, 75 small boxes (equivalent to 15 large boxes) represent 1.5 seconds so the heart rate per minute can be calculated by counting the number of QRS complexes in 1.5 seconds and multiplying by 40. At a paper speed of 25 mm/sec, 75 small boxes (15 large boxes) represent 3.0 seconds and the number of QRS complexes in 3.0 seconds is multiplied by 20. Many of the newer digital ECG machines calculate heart rate automatically.

2) Determine the cardiac rhythm

The heart's rhythm is evaluated by inspection of the ECG and the findings are correlated with the physical findings. Analysis of the heart's underlying rhythm should include the following steps.

A. What is the rhythm (including the regularity and the relationship among complexes)?
   a. Regular?
   b. Regularly irregular with a consistent and repeating pattern to the variation in the rate?
   c. Irregularly irregular where the rhythm is chaotic and there is no pattern to the irregular nature of the rhythm?
   d. Paroxysmal (which is defined as a sudden outburst)? When applied to the ECG, a paroxysm refers to a series of rapid ectopic beats, which begins and ends abruptly. The series may be as short as 3 beats or may last for minutes to hours.
   e. What is the relationship between the P and QRS complex? Is there a P wave for every QRS complex? Is there a QRS complex for every P wave? Is the duration of time between the various components (P-R interval, Q-T interval) normal? Is the duration of time between the various complexes consistent?

B. Where do the cardiac impulses originate (site of origin)? The four possible choices include:
   a. The sinoatrial (SA) node
   b. The atria
   c. The atrioventricular (AV) node/junctional
   d. The ventricles and His-Purkinje system

Impulses originating from the SA node, atria or AV node are grouped together under the heading *supraventricular* while impulses from the ventricles or His-Purkinje system are termed *ventricular*. Supraventricular beats should maintain a relatively tall, upright and narrow QRS complex because the impulse must utilize the His-Purkinje system to transmit the impulse to the ventricles. Therefore the ventricular muscle depolarizes uniformly with a set activation sequence. But when impulses arise from the ventricles or terminal branches of the His-Purkinje system they are slowly transmitted from individual myocardial cell to myocardial cell. This produces a relatively wide and bizarre QRS-T complex.

C. What are the ventricular and atrial rates?
   a. Too fast (tachycardia)
   b. Too slow (bradycardia)

D. What is the temporal relationship between any ectopic beats and the underlying heart rhythm?
   c. Premature beats are defined as ectopic beats that occur early in the sequence of normal beats, meaning the R-R interval from the preceding normal beat to the ectopic beat is shorter than the prevailing R-R interval. Premature beats are formed when the ectopic focus depolarizes more rapidly than normal, overrides the sinus node and assumes control of the heart rate for one or more beats.
   d. Escape beats are defined as ectopic beats that occur after a pause in the sequence of normal beats, meaning the R-R interval from the preceding normal beat to the ectopic beat is longer than the prevailing R-R interval. The ectopic site assumes control of the electrical activity of the heart by default because the SA node fails to discharge or the sinus impulse is not properly conducted to the rest of the heart.

3) Calculate the mean electrical axis (MEA)

One of the most useful applications of vector principles is the calculation of the MEA for the QRS complex in the frontal plane. The MEA is the average of all the instantaneous vectors recorded during the QRS complex. Each species has a range of normal values, for example the MEA of normal dogs is between +40° and +103°. When the MEA is greater than +103° right ventricular enlargement is suggested. The mean electrical axis may be derived in two ways:

- Method 1: Using any two leads in the frontal plane, take the difference between the height of all positive QRS deflections and all negative QRS deflections in the two chosen leads. This calculates the vector for each lead. Plot the appropriate number of units, either positive or negative, on the lead axes. Draw perpendicular lines to the axes at these two points and then draw a vector from the origin of the figure to the point of intersection of these lines. The direction of this vector is the mean electrical axis.
- Method 2: Since the line of the mean electrical axis should have half of the total forces of ventricular depolarization on either side of it, a reasonable estimate of the MEA can be obtained by finding the limb lead which is the most isoelectric (i.e. the difference between the positive and negative QRS deflections in that lead is near 0). The MEA must then be perpendicular to that lead. To determine which direction the MEA takes, look at the lead whose axis is perpendicular to the isoelectric lead. If the lead has mainly positive QRS deflections, the MEA points toward the positive pole of that lead axis, just the opposite if the lead is mostly negative. Occasionally all of the limb leads are equally isoelectric and the MEA is said to be *indeterminate* in the frontal plane.

4) Measure the ECG waves and intervals.

The duration and amplitudes of the waves of the ECG are important in determining whether chamber enlargement is present. When one or more of the cardiac chambers enlarge, the processes of depolarization and/or repolarization may be altered in 1) magnitude of the vectors, 2) direction of the vectors, 3) rate of activation (duration), and 4) sequence of activation. These changes are reflected in the surface electrocardiogram as alterations in 1) the amplitude in the various leads, 2) the direction of the deflections in the various leads (i.e. change in MEA), 3) the width (duration) of the waves in various leads, and 4) the development of certain abnormal patterns of activation (i.e. S waves with RVH). The duration of the various intervals is important to determine if conduction or electrolyte disturbances are present. By convention the first negative deflection, preceding a positive deflection is termed a Q wave and the first positive deflection is called the R wave. A negative deflection occurring after a positive deflection is called an S wave. A second R wave is termed an r′ wave, etc.

Management of arrhythmias

Arrhythmias are clinically important because of their ability to compromise cardiac output and oxygen delivery to the body. The level of cardiac performance during an arrhythmia is dependent on the rate, site of origin, and duration of the arrhythmia, as well as the presence of underlying cardiac or systemic diseases that may adversely affect the patient. Thus, the consequences of an arrhythmia may be clinically undetectable, may produce signs of inadequate cardiac output (weakness, fainting, shock), or may lead to the complete collapse of the circulatory system and sudden death.

Depending on the underlying cause of the arrhythmia, administration of antiarrhythmic drugs may not be needed. Metabolic abnormalities (acid/base or electrolyte disturbances, hypoxia) can contribute to arrhythmia formation and should be corrected. Arrhythmias in patients with concurrent congestive heart failure will often resolve spontaneously once the heart failure is successfully treated. Finally, the clinician must be familiar with the actions and potential side effects of the antiarrhythmic drugs, and must carefully weigh the risks and benefits of treatment. Administration of antiarrhythmics is not a benign procedure. Every agent has the possibility to induce further and perhaps more dangerous arrhythmias (pro-arrhythmia).

Ventricular tachyarrhythmias (VPCs, ventricular tachycardia)

1) No therapy may be required if the VPCs are infrequent and the patient is asymptomatic. However Holter monitoring is often required to confirm the true frequency of the arrhythmia.
2) Withdraw or adjust offending drugs (digitalis) if toxicity is suspected.
3) When associated with congestive heart failure, therapy with positive inotropes under close supervision is indicated along with other measures to treat the CHF.
4) Antiarrhythmic therapy is indicated when VPCs are frequent, multifocal, or occur in rapid groups (ventricular tachycardia). The most commonly employed oral antiarrhythmics include mexiletine and sotalol. Amiodarone may be used in select cases.
5) If life threatening ventricular tachycardia develops, intravenous therapy with lidocaine or procainamide is most often used.

Supraventricular tachyarrhythmias (frequent APCs, atrial tach, atrial fib)

1) No therapy may be required if the APCs are infrequent and the patient is asymptomatic. However Holter monitoring is often required to confirm the true frequency of the arrhythmia.
2) When frequent APCs are observed in patients with congestive heart failure, digitalis or diltiazem therapy can be considered (may be a precursor for atrial fibrillation).
3) Termination of atrial tachycardia may be accomplished by vagal maneuvers, precordial (chest) thump, or control of the ventricular response rate utilizing digoxin, atenolol, diltiazem, or sotalol. The same agents may be useful for preventing recurrence.
4) Atrial fibrillation.
    a. The usual goal in patients with heart disease is to slow the ventricular response rate. This is often achieved by digitalization +/- the addition of diltiazem, atenolol or sotalol if appropriate rate control is not achieved with digoxin alone. Amiodarone may be used in select cases.
    b. Conversion to sinus rhythm is usually only attempted in patients with a reasonable probability of remaining converted (those with minimal underlying heart disease). Oral quinidine, IV procainamide, or electrical defibrillation have been employed. Intravenous administration of diltiazem, amiodarone or sotalol is occasionally effective.

A Unified Perspective on Managing Congestive Heart Disease

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

Myocardial disease is the most frequently diagnosed heart disease in the cat. A study from southwestern Virginia published in 2009 identified 16% of apparently healthy cats (16/103) had echocardiographically demonstrable cardiomyopathy. The prevalence of DCM in cats has drastically declined with identification that most cases were attributable to taurine deficiency. Therefore hypertrophic cardiomyopathy (HCM) is now the most commonly identified feline myocardial disease. Cats with HCM may range from one to 16 years of age, with a large percentage ranging from 4 to 7 years. A genetic alteration in cardiac myosin binding protein C has been identified as a cause of familial HCM in some Maine Coon cats. Similarly an alteration in cardiac myosin binding protein C has been found in Ragdolls with familial hypertrophic cardiomyopathy. There are mutations in 11 or more genes producing >1,400 variants in humans with familial HCM, therefore it is likely there are many additional genetic modifications responsible for feline HCM. Other forms of endomyocardial disease described in cats include arrhythmogenic right ventricular cardiomyopathy, restrictive cardiomyopathy, and endocardial fibroelastosis. Many of these forms of myocardial disease in cats are difficult to distinguish from one another clinically or therapeutically and many cases do not fit neatly into any category. Therefore in many instances the objectives of therapy are uniform across myocardial disease and include (1) to treat the underlying cause, if one can be established, (2) to medically manage congestive heart failure, (3) to control arrhythmias, and (4) to treat or prevent thromboembolic complications.

Treatment of asymptomatic cats

Treatment of any form of cardiomyopathy in the asymptomatic patient is controversial and often depends on the severity of underlying echocardiographic changes, the presence and severity of left ventricular outflow tract obstruction, the rate of disease progression (if known), the presence and severity of other underlying systemic diseases, and the likelihood that medications can be administered easily and with good compliance. 1) Atenolol may be administered to try and resolve significant left ventricular outflow tract obstruction. 2) ACE inhibitors may be used in an effort to blunt the rennin-angiotensin-aldosterone system. 3) Anticoagulant therapy may be administered in an effort to prevent thromboembolism.

Treatment of cats with congestive heart failure

Independent of the form of myocardial disease, many of the priorities and agents used to treat heart failure in cats are similar. These often include: 1) Thoracocentesis is performed to remove large volumes of pleural fluid. 2) Furosemide is used to control edema. Additional diuretics may ultimately be required. 3) ACE inhibitors are used to blunt the activation of the renin-angiotensin-aldosterone system. 4) Anticoagulant therapy is administered in an effort to prevent thromboembolism. 5) Depending on the circumstances atenolol may be used to slow the heart rate and to reduce or eliminate dynamic obstruction in cats with hypertrophic obstructive cardiomyopathy. However caution should be exercised in cats that have active congestive heart failure. 6) Alternatively, diltiazem has been suggested to improve filling (positive lusitropic effect) and to decrease the heart rate in cats with HCM. 7) Pimobendan should be considered experimental therapy at this time but in some cases with myocardial dysfunction, presumed low output, and/or significant renal dysfunction we may use it in cats with HCM and heart failure. Contraindications may include significant left ventricular outflow tract obstruction. But interestingly one potential benefit is the PDE inhibitor action of pimobendan may enhance diastolic function.

Treatment of cats with aortic thromboembolism

Many approaches to this difficult problem have been suggested and none is very satisfactory. The site of thrombosis and duration of the event is critical in determining the clinical outcome. Cats with thrombi occluding the renal arteries or with gastrointestinal infarction have an extremely poor prognosis. Although surgical removal of the clot sounds ideal many cats die when surgery is attempted because of underlying heart disease, from anesthetic depression of the heart, or during the washout phase (of toxins, potassium, etc.) if perfusion is reestablished. Thrombolytic therapy may be accomplished with streptokinase or recombinant tissue plasminogen activator (TPA). Aggressive attempts to dissolve emboli using thrombolytic drugs should be reserved for cats with more serious thromboembolic events. Pion, et. al. reported successful thrombolysis, defined as evidence of reperfusion within 36 hours of TPA (Activase, Genentech) treatment, in 50 per cent of cats with spontaneous aortic thromboembolism that were treated with tissue plasminogen activator. Forty-three percent of the cats walked within 48 hours of presentation. However, 50 per cent of the cats died from either reperfusion syndrome, heart failure, or suddenly.

Many cats with saddle thrombi will regain function of the hind limbs, albeit slowly, with conservative therapy. Recovery takes several weeks to months and residual deficits (peripheral neuropathy, muscle contracture) are common. Conservative management consists of pain management, anticoagulant therapy to prevent additional clot formation and therapies aimed at resolving concurrent heart failure. Pain management is one of the most important goals of treating cats with systemic thromboembolism. Butorphanol,

buprenorphine and oxymorphone are used frequently but more aggressive measures, e.g. morphine epidurals, may be required in some cases.

Prognosis

The prognosis for cats with HCM is variable often depending on the stage of disease. Cats with minimal hypertrophy and normal left atrial size may live asymptomatically for many years without institution of medications. However once myocardial disease of any form has progressed to congestive heart failure there is overall a guarded to poor long-term prognosis. Some cats respond favorably to drug administration and may live several years, however most others die within 6 to 12 months following development of heart failure.

Dilated Cardiomyopathy: Boxers and Dobies, Oh My!

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

The cause(s) of dilated cardiomyopathy (DCM) in dogs is (are) unknown. Some of the proposed causes of DCM include: genetic defect(s), viral infection, microvascular spasm, chemical toxin(s), dietary deficiency, and immune-mediated processes. There appears to be a familial predisposition to the development of DCM in some breeds of dogs, and many investigators suspect a heritable defect in the metabolic processes of myocardial cells. It is quite possible that DCM is not a single disease, and that there are many etiologies. Taurine deficiency has been convincingly shown to be a reversible cause of DCM in cats and is also a suspected cause of DCM in foxes, but is not an important cause of DCM in dogs-except in Cocker spaniels. A number of chemical toxins (anthracycline antibiotics, gossypol, monensin) have been shown to cause myocardial failure. There is evidence that Adriamycin exerts at least some of its toxic myocardial effects by inducing histamine and catecholamine-mediated microvascular spasm.

One of the most frustrating aspects of attempts to identify the etiology behind DCM is determining if changes in protein expression are primary or secondary in nature. Up-regulation and down-regulation of proteins responsible for cardiac contraction (β_1, β_2, and α receptors), ventricular relaxation (SERCA2, phospholamban) and energy production (carnitine transport, creatine kinase) occur to equivalent degrees in volume overload, pressure overload, and cardiomyopathy. "In this respect the intracellular biochemical specificity of the response of the myocyte to a chronic insult appears to be relatively restricted. The foremost question remains, which, if any, are the true pathogenic alterations and which are cellular adaptations."

Dilated cardiomyopathy is a diagnosis arrived at by a process of exclusion. Causes such as infectious myocarditis, chronic volume overload (A-V fistula, valvular insufficiency), heartworm disease (and other causes of cor pulmonale), pericardial disorders, and toxic cardiomyopathy (doxorubicin) must be ruled out before a diagnosis of dilated cardiomyopathy is offered. A provisional diagnosis can be based on the history, physical findings, and typical radiographic and electrocardiographic changes, but echocardiographic evaluation is necessary to establish the diagnosis with certainty.

Most dogs with DCM have an abnormal electrocardiogram, although the changes may be subtle. Dogs may display criteria for left ventricular or left atrial enlargement. There is also a high prevalence of cardiac rhythm disturbances in dogs with DCM. Atrial fibrillation, ventricular premature complexes (VPCs) and ventricular tachycardia are commonly identified. Ventricular rhythm disturbances are most common in Boxer dogs and Doberman pinschers, both of which suffer a high rate of sudden death associated with the development of DCM. Using 24-hour ambulatory EGG (Holter) recordings, 81 percent of asymptomatic Doberman Pinschers with DCM had complex ventricular arrhythmias and almost 30 percent had sustained or non-sustained ventricular tachycardia. The prevalence of ventricular tachycardia and VPCs in Boxer dogs is similar to or greater than that observed in Dobermans.

Radiographic changes in dogs with moderate to severe disease almost always include biventricular or left ventricular and left atrial enlargement as well as evidence of right or left sided heart failure. Pleural effusion is common in dogs with biventricular failure, obscuring thoracic detail and preventing critical evaluation of heart size. Pulmonary edema is present in many dogs with DCM, and is often particularly severe in Boxers and Doberman Pinschers.

Echocardiographic alterations often include larger than normal end-systolic and end-diastolic dimensions of the left ventricle. The interventricular septum and ventricular free walls are hypokinetic, often thinner than normal in diastole, and they fail to thicken normally in systole. The left atrial dimension is increased, and the left atrial to aortic dimension ratio is increased. Fractional shortening, the percent change in short-axis diameter of the contracting left ventricle, is usually markedly decreased. The distance between the interventricular septum and the mitral valve at its maximal opening point in early diastole (EPSS) is increased as a reflection of a reduced ejection fraction.

Breed-specific idiosyncrasies.

Most dogs with dilated cardiomyopathy (classic cardiomyopathy) present with signs of right, left, or biventricular failure, in atrial fibrillation, and with marked weight loss and muscle wasting. In affected Boxers, approximately 20% are presented in predominately left-sided failure, 40% are presented for syncope or collapse secondary to a rhythm disturbance, and 40% are asymptomatic but have rhythm disturbances (primarily ventricular arrhythmias). Doberman pinschers usually present in severe left-sided heart failure, have a slightly lower incidence of atrial fibrillation than other breeds, have a higher incidence of ventricular arrhythmia, and experience a higher incidence of syncope and collapse.

Therapy

Treatment of heart failure in dogs with dilated cardiomyopathy often mimics that of dogs with valvular heart disease and heart failure. Diuretics help control congestion, angiotensin converting enzyme inhibitors are used to blunt activation of the renin angiotensin system, and positive inotropes (pimobendan) are used to enhance systolic performance. Dogs with dilated cardiomyopathy often

require antiarrhythmics to manage ventricular or supraventricular arrhythmias. Caution must be exercised with many of the antiarrhythmics because of their negative inotropic properties.

Prognosis

Dogs with echocardiographic evidence of dilated cardiomyopathy, but with no clinical signs of congestive heart failure, may live for a very long period of time. However, most affected dogs with congestive heart failure die within 6 months. Some very ill dogs improve to a remarkable degree with treatment and live comfortably for months or years. Others dogs do not survive the initial 48 hours of hospitalization.

Comprehending Common Congenital Cardiac Disorders: Examination Findings, Diagnostics, and Treatment

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

The primary objectives of the cardiovascular evaluation for animals with congenital heart disease are to define the nature and severity of the anatomic defect present. Familiarity with the available therapeutic options, their efficacy and limitations is necessary before an accurate prognosis can be offered to the owner.

Acyanotic congenital heart defects: Left to right shunts

Patent ductus arteriosus (PDA) including right to left shunting lesions

In the fetus the ductus arteriosus serves to shunt the majority of the right ventricular output away from the non-functioning lungs. Expansion of the lungs, increased oxygen concentrations and removal of the umbilical circulation at the time of birth promotes ductal closure. Failure of ductal closure usually results in a left to right shunt from the descending aorta to the pulmonary artery with an excess volume load placed on the pulmonary arteries and veins, left atrium, left ventricle and aortic arch. Histology of the patent ductus reveals a wall structure resembling that of the aorta rather than that of a normal ductus. In the presence of a very large, wide PDA the magnitude and direction of shunted blood is determined by the relative resistance of the pulmonary and systemic circulations. In these dogs the elevated pulmonary vascular resistance present at birth does not fall normally and results in right to left shunting or bidirectional shunting. On rare occasion pulmonary hypertension develops later in life thereby truly reversing the direction of the shunt (Eisenmenger's physiology).

Clinical features

1. Historically the most common congenital heart defect in dogs although the recent popularity of large breed dogs has resulted in increased prevalence of SAS. PDA is much less common in cats.
2. Females are over-represented.
3. Physical examination findings include:
    a. A continuous "machinery" murmur that is heard best at the left heart base. The continuous murmur may be confined to the heart base while a systolic murmur of mitral insufficiency is ausculted over the left apical region.
    b. Bounding (or waterhammer) pulses are frequently identified because of the increased systolic and decreased diastolic aortic pressures (widened pulse pressure).
    c. Common clinical signs include stunted growth or evidence of left sided heart failure (dyspnea, tachypnea, coughing, exercise intolerance.)
    d. PDA with pulmonary hypertension has no murmur but may have a split S2, differential cyanosis, and hindleg weakness. These dogs often display "differential cyanosis" where the hindlimbs are affected while the forelimbs are normal. This develops because of the communication of the pulmonary artery with the descending aorta.
4. Electrocardiographic findings:
    a. Variable but often marked left ventricular enlargement pattern, possible left atrial enlargement and secondary ST segment changes associated with hypoxia.
    b. Advanced cases may show supraventricular tachyarrhythmias (APCs, A fib) or less frequently ventricular arrhythmias.
    c. A right ventricular enlargement pattern is almost always evident in cases of right to left shunting with pulmonary hypertension.
5. Thoracic radiography:
    a. Enlargement of the left atrium, left ventricle, aortic arch, main pulmonary artery along with pulmonary vascular overcirculation (enlargement of both pulmonary arteries and veins).
    b. Evidence of left sided heart failure may be present.
    c. Dogs with right to left shunting often display pulmonary vascular undercirculation (hypovascularity of pulmonary arteries and veins), a prominent right heart pattern, dilation of the main pulmonary artery and localized dilation of the proximal aorta.
6. Echocardiography: Serves to evaluate the severity of volume overload as reflected by changes in the left heart chamber dimensions, detect other coexisting congenital heart defects, and assess myocardial function.

7. Prognosis:
    a. In dogs with left to right shunts the prognosis is excellent with surgical or transcatheter closure of the defect prior to the development of left-sided heart failure. Without correction puppies with large shunts may die before four weeks of age, dogs with intermediate sized shunts may live for several years although the majority will be dead by 2 years of age. Dogs with small shunts (uncommon) may live normal lives.
    b. In dogs with right to left shunts the prognosis is guarded. Some dogs may survive for long periods of time with exercise restriction and periodic phlebotomy or agents utilized to decrease red blood cell production.
8. Treatment: Ideally involves surgical correction of left to right shunts via thoracotomy or less invasive embolization procedures prior to the development of clinical signs. In cases of left to right shunts with congestive heart failure stabilization is achieved with standard medical therapy followed by closure. Surgery is contraindicated in dogs with right to left PDAs and instead efforts are aimed at preventing hyperviscosity via periodic phlebotomy.

Acyanotic congenital heart defects: Obstructive malformations

Obstructive lesions produce their effects by impeding normal blood flow and causing an increased pressure proximal to the obstruction. The two clinical syndromes identified in small animals include pulmonic stenosis and aortic stenosis. Four anatomic types of obstruction can occur at each location and include: supravalvular, subvalvular, valvular and infundibular. All result in similar degrees of functional impairment but their distinction is important if surgical correction is contemplated.

Pulmonic stenosis

Pathology of the pulmonic valves typically includes variable thickening of cusps and fusion of the cusps at their commissures. Pulmonic stenosis may occur as an isolated lesion or may be combined with other complex defects of the conotruncal septum (Tetralogy of Fallot). The resistance to ejection of blood from the right ventricle induced by the stenotic valve produces elevated RV systolic pressures, right ventricular concentric hypertrophy and in some cases increased right atrial pressure. A post-stenotic dilatation is usually present in the main pulmonary artery.

Clinical features

1. The second or third (because of the increased prevalence of SAS) most commonly diagnosed congenital heart defect in dogs. Uncommon in cats.
2. Physical examination findings include:
    a. Systolic, ejection (crescendo-decrescendo) murmur heard best over the left heart base. A split second heart sound may be obscured by the murmur.
    b. Arterial pulses are usually normal unless severe heart failure is present.
    c. Dogs may be asymptomatic, exhibit exercise intolerance, or in severe cases may exhibit dyspnea and cyanosis from low cardiac output. Syncopal episodes with exercise are occasionally reported. Signs of right-sided heart failure may be present in severe cases.
3. Electrocardiographic findings:
    a. A right ventricular enlargement pattern is usually evident while the rhythm is usually normal. In severe cases complicated by tricuspid dysplasia/insufficiency supraventricular tachyarrhythmias may be identified.
4. Thoracic radiography: Characteristic findings include right ventricular enlargement and dilation of the main pulmonary arterial segment. The pulmonary vasculature is usually normal.
5. Echocardiography: Serves to evaluate the extent of hypertrophy of the papillary muscles, septum and ventricular free wall of the right ventricle. The site of obstruction (valvular, subvalvular, etc.) may be identified via two-dimensional echocardiography and Doppler studies can evaluate the integrity of the tricuspid valve. Spectral Doppler can measure the peak blood flow velocity through the stenotic area and the modified Bernoulli equation ($4V^2$) can estimate the pressure gradient and hence the severity of the stenosis.
6. Prognosis: Many dogs with mild disease appear to do well without therapy while most agree that dogs with a pressure gradient over 80 - 100 mm Hg have a more guarded prognosis without therapy. Dogs with gradients between 40 and 80 mm Hg are more difficult to characterize.
7. Therapy: Balloon valvuloplasty is effective at reducing the pressure gradient significantly in approximately 70% - 85% of cases. In the presence of congestive heart failure exercise restriction and medical therapy are employed followed by consideration for surgery.

Subvalvular aortic stenosis (SAS)

SAS may be the most commonly identified congenital lesion in some regions because of the vast popularity of Golden Retrievers and other large breed dogs predisposed to SAS. In dogs a subvalvular fibrous ring or band partially or completely encircles the left ventricular outflow tract. Small nodules may also occur on the aortic valve cusps. Valvular obstruction results in elevated left ventricular systolic pressures, concentric hypertrophy of the left ventricle and post-stenotic dilatation of the ascending aorta. Increased oxygen requirements of the concentrically hypertrophied left ventricle and disturbances in coronary blood flow may lead to

myocardial ischemia. Histologically, arteriosclerosis of the small coronary arteries, fibrosis, necrosis, and calcification of the myocardium may be observed. SAS usually occurs as an isolated lesion although mitral valve dysplasia has been reported to occur concurrently.

Clinical features

1. A common defect in dogs although it is infrequently recognized in other species.
2. Physical examination findings:
    a. A systolic ejection murmur (crescendo-decrescendo) at the left heart base. It frequently radiates to the carotid arteries at the thoracic inlet and may radiate to the right hemithorax.
    b. Pulses may be weak and late rising due to retarded ventricular ejection.
    c. Young dogs are frequently asymptomatic but may have history of fatigue, dyspnea, or syncope. Sudden death (presumably from ventricular arrhythmias) is one of the most commonly reported events in young dogs with severe SAS.
    d. Arrhythmias (usually ventricular) may be present.
3. Electrocardiographic findings: The ECG may be normal in mild cases or it may display a left ventricular enlargement pattern in more severe cases. ST segment depression may be present due to myocardial hypoxia and arrhythmias (usually ventricular) are common.
4. Thoracic radiography: frequently unremarkable because the left ventricle hypertrophies concentrically. Findings may include left ventricular enlargement, post-stenotic dilatation of the aorta with variable left atrial enlargement. The pulmonary vasculature is normal unless left sided heart failure has developed.
5. Echocardiography: Serves to evaluate the severity of the left ventricular hypertrophy, the area of the obstruction may be directly visualized by two-dimensional echocardiography, and Doppler evaluation can categorize the severity of the stenosis via the modified Bernoulli equation. Myocardial fibrosis, presumably due to ischemia, may be identified as hyperechoic areas within the myocardium. Echocardiography also helps to evaluate for the presence of combined congenital defects. Differentiating normal dogs from dogs with very mild SAS can be difficult even with echocardiography because the subvalvular lesion may be so discrete.
6. Prognosis: The prognosis is guarded in cases of severe SAS (pressure gradient over 80 mm Hg). Owners should be made aware of the possibility of sudden death. SAS appears to be the one cardiac malformation that predisposes dogs to the development of bacterial endocarditis and standard antibiotic administration should be instituted whenever dogs with SAS undergo elective surgical procedures. Congestive heart failure may occur when mitral dysplasia is concurrently present or if myocardial failure develops after long-standing SAS.
7. Treatment: To date surgical resection of the stenotic lesion has not decreased the incidence of sudden death. Balloon valvuloplasty has also proved unrewarding in most cases as the obstruction tends to recur shortly after the valvuloplasty. A cutting balloon technique has started to be employed more recently. Current medical management may include administration of beta-blocking drugs to decrease the heart rate and cardiac contractility thereby decreasing myocardial oxygen demands and hopefully the risk of sudden death. The effectiveness of this therapy is unknown. Arrhythmias should be appropriately treated if present.

Dogmas of Clinical Pathology: Adjusted Calcium, Modified Transudates, Acidemias of Acidoses, and More

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

Ken Jenning's wrote *Because I Said So! The Truth Behind the Myths, Tales, and Warnings Every Generation Passes Down to its Kids*. In his book, he considered the evidence that supports or refutes common dogmas within the United States. For example, "Was the nail you stepped on rusty? You'll get tetanus!" Is the statement true, sometimes true, sometimes false, or false? Or, "Your first answer is usually the right one." Is the statement true, sometimes true, sometimes false, or false?

A dogma is "a settled or established opinion, belief, or principle." "Blind belief in authority is the greatest enemy of truth." (Albert Einstein) "Education has failed in a very serious way to convey the most important lesson science can teach: skepticism." (David Suzuki) "Most institutions demand unqualified faith; but the institution of science makes skepticism a virtue." (Robert King Merton)

Are dogmas of clinical pathology valid? The following sections explore a few dogmas that have been or are being passed down from one generation to the next generation of veterinarians.

Adjusted calcium formula can be used to determine if the hypocalcemia is due to hypoalbuminemia.

This dogma initially arose from a retrospective study that was published in 1982 (JAVMA 180: 63-67, 1982) in which two formulas were derived from measured concentrations of serum tCa^{2+}, albumin, and total protein (values expressed in non-SI units).

- Canine-adjusted $[tCa^{2+}]$ = measured $[tCa^{2+}] - [Alb] + 3.5$
- Canine-adjusted $[tCa^{2+}]$ = measured $[tCa^{2+}] - 0.4 \times [TP] + 3.3$

The proposed concept for the calculated adjusted $[tCa^{2+}]$ values was that if the value was within the reference interval for $[tCa^{2+}]$, the hypocalcemia was due to hypoalbuminemia (or hypoproteinemia) and there is not a decrease in the $[fCa^{2+}]$. If the calculated adjusted $[tCa^{2+}]$ was decreased, then there was a decreased $[fCa^{2+}]$. [Note: fCa^{2+} (free calcium ion) is frequently called *ionized calcium* even though all calcium in the body is ionized; some Ca^{2+} ion exists as free ions; other Ca^{2+} ions are bound to a variety of anions.]

There are three major aspects of the 1982 article that are frequently ignored. The derived formulas represented the regression lines for the raw data that contained considerable individual animal variation. Considering the 95 %–confidence intervals for the regression line, the formulas should be as follows. Accordingly, there is considerable variability in the calculated adjusted $[tCa^{2+}]$ values.

- Canine-adjusted $[tCa^{2+}]$ = measured $[tCa^{2+}] - [Alb] + 3.5 \pm 1.3$
- Canine-adjusted $[tCa^{2+}]$ = measured $[tCa^{2+}] - 0.4 \times [TP] + 3.3 \pm 1.6$

Second, the authors stated that about one-third of the variability in the $[tCa^{2+}]$ was due to changes in albumin concentrations. Lastly, the formulas were derived from data obtained in one clinical laboratory many years ago and people use the formulas for data obtained from different analytical methods without establishing analytical agreement.

Some of the same authors of the 1982 article wrote another article that was published in 2005 (Am J Vet Res 66: 1330 – 1336, 2005). They concluded that adjusted total Ca^{2+} concentrations are unacceptable for predicting free Ca^{2+} (ionized calcium) status in dogs.

The adjusted calcium statement is mostly false. However, adjusted calcium formulas do emphasize that the total protein and albumin concentrations do influence a patient's $[tCa^{2+}]$ and thus should be considered when interpreting laboratory data.

Pseudohypocalcemia is present when the hypocalcemia is due to hypoalbuminemia (or hypoproteinemia).

This more recent statement should not be used. When the $[tCa^{2+}]$ is decreased, there is a hypocalcemia if there is or is not a hypoalbuminemia or hypoproteinemia present. Those who wish to use the term "pseudohypocalcemia" in this context should consider what they should call the neutrophilia that occurs due to shifting of cells from marginated to circulating pools, or the hyperproteinemia that occurs due to decreased plasma water, or the erythrocytosis that occurs due to splenic contraction. Just because there is not a convenient term for a decreased $[fCa^{2+}]$, let's not use terms that are incorrect.

In acute inflammation, the release of endogenous cortisol causes the lymphopenia or Stress of the acute inflammatory disease causes a lymphopenia.

These statements have been in the veterinary literature for decades – but where is the evidence that they are true? The statements reflect the concept that the inflammatory state stresses the animal sufficiently to cause a release of cortisol which induces the movement of lymphocytes from the circulating blood and thus a lymphopenia develops.

Increased cortisol activity (or activity of other glucocorticoids) are known to create a lymphopenia. If the lymphopenia in an acute inflammatory state is due to excess cortisol, should we also see other evidence of excess cortisol such as mature neutrophilia,

monocytosis, hyperglycemia, increased ALP activity (dogs), hypercholesterolemia, or polyuria? Why do we accept stress as the cause of the lymphopenia when we do not find other clinical abnormalities that are attributable to excess cortisol?

In a 1995 article in *Adv. Immunol.*, B.A. Imhof described the effects of inflammatory cytokines on blood leukocytes. There is evidence that the cytokines promote the homing of blood lymphocytes to lymph nodes and the migration of lymphocytes to inflamed tissues; these processes can create the inflammatory lymphopenia.

We have evidence that the acute inflammatory reaction alters the movement of blood lymphocytes to create a lymphopenia. To my knowledge, we do not have evidence that inflammation creates a sufficient increase on plasma cortisol to cause a lymphopenia.

A transudate occurs because of hypoalbuminemia; usually when plasma [albumin] is < 1.5 g/dL (or < 1.2 g/dL, or < 1.8 g/dL) Or A pure transudate is hypocellular (< 1000/μL) and has a TS concentration < 2.5 g/dL.

First, let's consider the statement that "a *transudate occurs because of hypoalbuminemia*." An inherited disorder is recognized in people in which there is no synthesis of albumin by hepatocytes; i.e., analbuminemia. Their albumin concentrations are < 0.1 g/dL and they typically do not develop pleural or peritoneal transudates. How can we attribute the formation of transudates to hypoalbuminemia when people with analbuminemia do not have transudative effusions? Also, how can we state that certain albumin concentrations lead to transudation when analbuminemia does not lead cavitary transudates?

A transudate is an effusion produced by changes in mechanic factors such as oncotic pressure or hydraulic pressure in capillary beds. Basically, the determining factor for the accumulation of cavitary transudates is the difference between the hydraulic pressure gradient (hydraulic pressure within vessels – hydraulic pressure in interstitial fluid) and the oncotic pressure gradient (oncotic pressure within vessels – oncotic pressure in interstitial fluid). When this difference leads to more fluid leaving the vascular bed than what can be removed by lymphatic vessels, a transudate forms. If transudation occurs in blood vessels that have minimal protein permeability, then a protein-poor transudate accumulates.

It is important to recognize that the plasma oncotic pressure is due to both albumin and globulins; albumin molecules are the major contributors to oncotic pressure but combined contributions of the globulin molecules are also important.

Two common canine disorders that cause the formation of protein-poor transudates are protein-losing nephropathies and hepatic cirrhosis. In these disorders, hypoproteinemia does reduce the plasma oncotic pressure but there also is an increased hydraulic pressure gradient in the portal blood vessels created by the retention of Na^+ and H_2O. The combination results in transudation and the formation of protein-poor transudates; the transudation is not solely caused by hypoalbuminemia.

A less common reason for the formation of a protein-poor transudate is presinusoidal portal hypertension. In this state, there is an increased hydraulic pressure gradient in the portal blood vessels but not a hypoproteinemia. Accordingly, the transudation is not caused by hypoalbuminemia.

For the second statement, (*A pure transudate is hypocellular (< 1000/μL)* is typically true as there is no reason for the migration of leukocytes from blood to the cavitary fluid. However, the second portion of the statement (*TS concentration < 2.5 g/dL)* may or may not be true.

It is important to recognize that a serum or plasma "total solids concentration" is not equal to a "total protein concentration." The total protein concentration is due to the concentrations of albumin and globulins. The total solids concentration includes the total protein concentration plus the concentrations of all other solids in the serum or plasma; i.e., glucose, urea, electrolytes, and other solutes. This data in the following table was extracted from a complete table in Wolf AV:

Aqueous solutions and body fluids. their concentrative properties and conversion tables, 1966.

Human plasma [TP] (g/dL)	0.8	1.0	2.0	3.0
Human plasma [TS] (g/dL)	2.5	2.7	3.6	4.7

There are clinical refractometers that have a calibrated total solids scale (e.g., TS Meter Refractometer Model 10400B, Leica Microsystems). Most clinical refractometers have a calibrated total protein scale (even those that are called "TS Meters") and the lowest unit commonly on the scale is 2.5 g/dL. The [TS] for a protein-poor transudate may be < 2.5 g/dL, but that should not be confused with a [TP] of < 2.5 g/dL.

A modified transudate is a transudate that has been modified by the addition of cells or protein.
A modified transudate has a higher TS concentration than a pure transudate and moderate cellularity.
A modified transudate has 1,000–7,000 cells/μL and a variable protein concentration (2.5–5.0 g/dL).

Using one or more of these definitions or criteria, a variety of cavitary effusions have been classified as modified transudates including the effusions of heart failure, feline infectious peritonitis, noninfectious exudates, hemorrhagic effusions, chylous effusions, uroperitoneum, neoplastic effusions, and bilious exudates. If we define a transudate as "an effusion produced by changes in mechanic factors such as oncotic pressure or hydraulic pressure in capillary beds," then only the heart failure effusion qualifies as a transudate. None of the other effusions form via transudation and thus should not be called transudates or modified transudates.

The heart-failure effusions form when there is an increased hydraulic pressure gradient within blood vessels that are permeable to proteins. The classic mechanism occurs when central vein or hepatic vein congestion lead to increased hydraulic pressure with hepatic

sinusoids and the pressure forces out an excess amount of protein-rich fluid. When lymphatic vessels are not able to compensate adequately, then a protein-rich transudate accumulates. Pulmonary vessels are also protein-permeable, but not to the same degree as the hepatic sinusoids.

The acidemia of a lactic acidosis is due to increased production of lactic acid by cells.

This statement sounds logical but it does not reflect the true changes in biochemical pathways that occur in lactic acidosis. The cause of the acidemia was addressed in an article by S.C. Dennis, et al (J. Mol. Cell Cardiol. 23: 1077–1086, 1991).

When tissues have an inadequate supply of oxygen (i.e., when hypoxia is present), the cells attempt to generate ATP via anaerobic respiration (fermentation) (also called anaerobic glycolysis). In the final reaction and for each glucose molecule, this reaction occurs and is catalyzed by lactate dehydrogenase: $2\ pyruvate^- + 2\ NADH + 2\ H^+ \rightarrow 2\ L\text{-}lactate^- + 2\ NAD^+$. It should be noted that L-lactate (an anion) is formed and not lactic acid; it should also be noted that H^+ is consumed in the reaction and thus makes the medium more alkaline, not more acidic.

Anaerobic respiration is an inefficient method of generating ATP from glucose; only 2 ATP molecules are produce for each glucose molecule. When there is an inadequate formation of ATP, the cells start the rapid hydrolysis of ATP to ADP and finally AMP. For each ATP molecule that is converted to AMP, 2 H^+ ions are formed.

One might say – if there is excessive formation of L-lactate and the excessive formation of H^+, doesn't that mean there is excessive formation of lactic acid? Considering the pK_a of lactic acid is 3.86, the ratio of lactate to lactic acid at a physiologic pH is greater than 1000:1.

The acidemia that occurs in animals with a lactic acidosis is due to excessive ATP hydrolysis in hypoxic tissues; not excessive formation of lactic acid.

The acidemia of a ketoacidosis is due to increased production of ketoacids by hepatocytes.

This statement sounds logical but it does not reflect the true changes in biochemical pathways that occur in ketoacidosis. The cause of the acidemia was addressed in an article by K.G. Alberti (Ciba Found. Symp. 87: 1–19, 1982).

The process called ketogenesis involves the conversion of 3-hydroxy-3-methylglutaryl-CoA (3HMGCoA) to acetoacetate, β-hydroxybutyrate, and acetone (the traditional ketone bodies). This process actually consumes H^+ and the molecules formed are not acids (i.e., not acetoacetic acid or β-hydroxybutyric acid).

As explained by Alberti, the excess generation of H^+ it ketoacidosis occurs before ketogenesis and not during ketogenesis. The greatest amount of H^+ is formed from triglyceride molecules when there is β-oxidation of fatty acids to AcCoA in hepatocytes. The processes of triglyceride lipolysis in adipose tissue and the conversion of AcCoA to 3HMGCoA also generate H^+.

The acidemia in animals with a ketoacidosis is due to the excessive formation of H^+ during the mobilization and catabolism of triglycerides when there is a negative energy status; not due to ketogenesis or the formation of ketoacids.

The increased anion gap seen with renal failure is due the accumulation of uremic acids.

This statement sounds logical. When there is a true increase in the anion gap concentration, there is an increased concentration of anions other than Cl^- or HCO_3^- in the serum/plasma. Are the acids anions?

When an animal is in renal failure, the decreased glomerular filtration rate leads to an accumulation of phosphates, sulfates, and citrate in plasma. At a pH of 7.4, most of the phosphates exist as HPO_4^{2-} and a lesser amount of $H_2PO_4^-$ (both anions and both acids). The sulfates exist mostly as SO_4^{2-} and a minute amount of HSO_4^- (both anions, SO_4^{2-} is not an acid). Citrate exists as an anion, there is very little citric acid present at a pH of 7.4; citric acid is not an anion.

As some of the "uremic acids" do exist as anions at a pH of 7.4, the statement is partially true. However to reduce confusion, I attempt to consistently state that increased anion gap concentration is due to anions other than Cl^- and HCO_3^-.

The increased serum osmolality is due to dehydration (i.e., ↓ plasma H2O).

It is important to recognize that serum osmolality represents the total concentration of the solutes in the serum and usually dehydration is not the reason for an increase concentration of solutes. The three major reasons for hyperosmolal serum are azotemia (increase urea concentration), hyperglycemia, and presence of exogenous solutes (e.g., ethylene glycol or mannitol). Dehydration does not cause hyperglycemia or an excess of exogenous solutes. Dehydration can lead to azotemia, but only when dehydration creates sufficient hypovolemia to lead to a prerenal azotemia. Decreased plasma H_2O by itself does not create a significant increase in urea concentration.

When dehydration results in hypernatremia and hyperchloremia, then dehydration is the cause of the increased serum osmolality. However, most dehydrated animals do not have hypernatremia and hyperchloremia. Hypernatremic dehydration occurs when there is a loss of "pure water" as it occurs in central and renal diabetes insipidus and when there is an insensible loss of water via respiration. Another cause of hypernatremic dehydration occurs when an animal does not have access to water (e.g., frozen water tank).

A measured or a calculated osmolality should not be used to establish the presence or absence of dehydration in an animal. Dehydration is usually not the cause of hyperosmolal serum.

An increase in [Pi] will cause the [tCa2+] to decrease because of the calcification of tissues. Or When Ca X P is > 70, soft tissue calcification is likely; mineralization occurs if when > 90.

The concept of the Ca/P product is based on the mass-law concepts in which higher concentrations of Ca^{2+} or PO_4 will shift this reaction ($Ca^{2+} + PO_4^{3-} \rightarrow Ca_3(PO_4)_3$) to the right and thus more $Ca_3(PO_4)_3$ forms. On the surface, this concept is flawed because not all of the measured [tCa^{2+}] is present as free Ca^{2+} and thus is not available to participate in the reaction. Second, very little of the serum inorganic phosphorus concentration exists as PO_4^{3-}. Also, when Ca^{2+} & PO_4^{3-} were added to human plasma, precipitation did not occur until the Ca/P product was > 200 (O'Neill W.C.: *Kidney International* 72: 2007). If the Ca/P product concept is not valid, is it true that "An increase in [Pi] will cause the [tCa^{2+}] to decrease"?

If there is a prolonged increase in plasma [PO_4] (as it occurs in chronic renal disease), the PO_4 inhibits renal 1-hydroxylase and thus there is less conversion of calcidiol to calcitriol. Lower calcitriol concentrations do lead to lower [fCa^{2+}] (thus lower [tCa^{2+}]) due to less intestinal absorption of Ca^{2+}, less mobilization of Ca^{2+} from bone, and more renal excretion of Ca^{2+}.

If there is a rapid increase in plasma [PO_4], colloidal complexes of Ca^{2+} and PO_4 form in plasma and the complexes are engulfed by macrophages and the plasma [tCa^{2+}] decreases.

Rights and Wrongs of Acid-Base- Let's Get it Right!

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

Clinical instruments for generating blood gas data and common electrolytes became available in the 1950's and ion-selective electrodes became available in the 1970's. For veterinary medicine, these instruments were almost exclusively used within veterinary schools and thus methods to control the quality of the patient samples and sample analysis were achievable. In the early 1990's, a few point-of-care instruments became available for use in veterinary practices and they have become common within the past 10 years. These instruments can be purchased and used by individuals who have minimal training regarding appropriate sample collection and handling or of a quality assurance program. Easier access to blood gas and electrolyte data does not automatically lead to better patient care.

When reading current veterinary literature, when listening to discussions of clinical cases, or when addressing questions from residents and students, there is frequently a need to revisit major concepts of acid-base data and the renal aspects of acid-base disorders. This presentation will address a few of the preanalytical errors that are too common and major acid-base concepts that are sometimes incompletely explained in veterinary literature.

Preanalytical errors

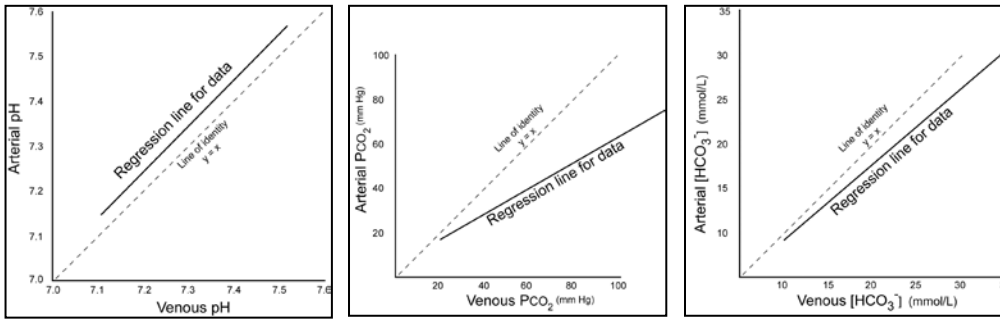
A 6-yr-old Dachshund was presented because of weight loss and recent vomiting and diarrhea. Physical examination findings included 7 % dehydration, petechiae, tachycardia, and tachypnea. Blood gas results for a heparinized venous blood sample were the following.

	Patient	Units	Ref. Int.
pH	7.07	---	7.38 – 7.47
P_{CO_2}	22	mmHg	25 – 40
HCO_3^-	6	mmol/L	15 – 24

$$pH = 6.1 + \log \frac{[HCO_3^-]}{[H_2CO_3]} = 6.1 + \log \frac{[HCO_3^-]}{P_{CO2} \times 0.03}$$

$$pH = 6.1 + \log \frac{24}{40 \times 0.03} = 6.1 + \log \frac{24}{1.2} = 7.4$$

The data represent the findings of acidemia, metabolic acidosis (↓ $[HCO_3^-]$), and a compensatory respiratory alkalosis (↓ P_{CO_2}) (traditional classifications in which metabolic states are defined by HCO_3^- concentrations and respiratory states are defined by P_{CO_2} values). It is important to remember the relationship between pH, P_{CO_2}, and HCO_3^- as defined by the Henderson-Hasselbalch equation. When the ratio of $[HCO_3^-]$ to the product of $P_{CO_2} \times 0.03$ is 20, the pH must be 7.4. If the $[HCO_3^-]$ changes and the P_{CO_2} does not, the pH must change. If the P_{CO_2} changes and the $[HCO_3^-]$ does not, the pH must change.



W.E. Wingfield and colleagues reported a comparison of blood gas data obtained from the analysis of paired samples – arterial blood and central venous blood (*J Vet Emerg Crit Care*, 1994).

For arterial and venous pH values (left graph), there was a constant bias with the venous blood being more acidic than arterial blood. This expected finding occurs because H^+ is being produced by metabolic pathways in tissues and is being transported to lungs and kidneys for removal. For P_{CO_2} values (center graph), there was a marked proportional bias with the venous blood having higher P_{CO_2} values. This expected finding occurs because $CO_{2(g)}$ is being produced by metabolic pathways in tissues and is being transported to lungs for removal. For $[HCO_3^-]$ (right graph), there was a slight proportional bias with the venous blood having higher concentrations. This occurs because of the relationship between H^+, HCO_3^-, and P_{CO_2}. It should be noted that the differences between venous and arterial HCO_3^- concentrations are less at lower concentrations – this observation supports the concept that a venous $[HCO_3^-]$ may be adequate for characterizing metabolic acidoses but may not be adequate for metabolic alkaloses.

It is clearly evident that the venous P_{CO_2} does not reflect the ability of the respiratory system to remove $CO_{2(g)}$ from blood. For diagnostic decisions, do we really need to consider respiratory function when the patient clearly has a metabolic disorder and there is no evidence of pulmonary dysfunction?

The patient's [HCO_3^-] was decreased compared to the provided reference interval, but is the reference interval valid? Using the lower reference limit of [HCO_3^-] (i.e., 15 mmol/L) and a common P_{CO_2} of 40 mmHg, the calculated pH is 7.2 which is too low for a physiologic pH value.

A common reason for a falsely low [HCO3−] in a blood sample (a pseudometabolic acidosis) is exposure to air that has a Pco2 < 1 mmHg. If the samples collected for establishing reference intervals were not handled appropriately, can we confidently conclude that the patient's [HCO3−] is correct? The blood sample's Pco2 value is additional evidence for a pseudometabolic acidosis – the low Pco2 could be present because the sample was not handled anaerobically. If one concludes that the Pco2 and HCO3− values are not valid, then the sample's pH is not valid.

Pseudometabolic acidoses are too common because blood samples are not being handled anaerobically. This is especially true for serum [HCO3−] (or [tCO2]) when blood is collected into a Vacutainer tube or serum is exposed to air prior to analysis. Data from one of several published studies illustrate the erroneous results. R.D. Herr & T. Swanson completed a study in which blood samples were collected into clot tubes (red tops) (Ann Em*erg Med*, 1992). Blood samples (1 mL, 3 mL, and 10 mL) were collected in 10-mL clot tubes. Samples were processed and analyzed within 1 hr; caps were removed during processing of some samples whereas others remained capped. The measured HCO_3^- concentrations are shown in the following table.

Blood volume collected	10 mL	3 mL	1 mL
Avg. [HCO_3^-] mmol/L (capped)	22	19	16
Avg. [HCO_3^-] mmol/L (uncapped)	23	20	17

It is clearly evident that $CO_{2(g)}$ escapes from incompletely filled clot tubes and causes falsely low HCO_3^- concentrations. "Short samples" are submitted to laboratories – it should not be surprising to find falsely low HCO_3^- concentrations in those samples.

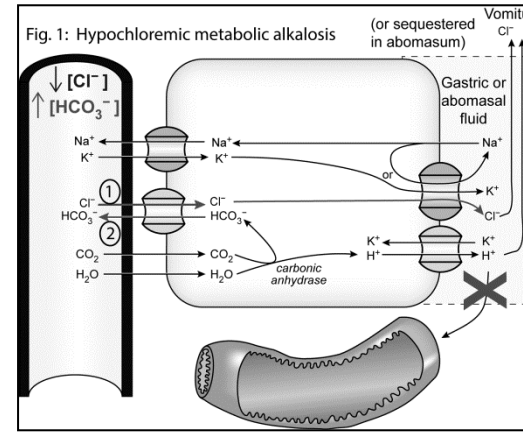
As the serum HCO_3^- concentration is used in the calculation of the anion gap, a falsely low [HCO_3^-] leads to a falsely increased anion gap. How many animals have a "metabolic acidosis with an increased anion gap" because of preanalytical errors? How often are reference intervals for serum HCO_3^- and anion gap concentrations established using samples that are not handled anaerobically?

Renal compensation in metabolic alkalosis

A 5-yr-old Holstein cow had clinical signs indicative of a displaced abomasum; she was mildly dehydrated. Serum electrolyte concentrations were determined to assess her disorder.

Analyte	Patient	Units	Ref. Int		Analyte	Patient	Units	Ref. Int.
Na^+	136	mmol/L	135–153		HCO_3^-	40	mmol/L	21–31
K^+	1.8	mmol/L	3.9–6.0		tCO_2	41	mmol/L	22–32
Cl^-	80	mmol/L	92–117		Anion gap	18	mmol/L	10–15

The data represent the classic findings of a displaced abomasum: hypochloremic metabolic alkalosis and hypokalemia. The [Na^+] in a dehydrated cow reflects a Na^+-depleted state. The reason for the mildly increased anion gap is not recognized at this point; it could represent the error created when four values (each with inherent analytical imprecision) are used to calculate a concentration or there could be a mild ketonemia. It is commonly stated that the hypochloremic metabolic alkalosis is due to the sequestration of H^+ and Cl^- in the abomasum. Is that statement completely true? A concurrent finding is an alkalemia. What is the pathogenesis of the alkalemia? Is it the sequestration of H^+ in the abomasum? When gastric secretions are lost (vomiting) or when the abomasal secretions do not enter the intestine, then the physiologic cycling of H^+, HCO_3^-, and Cl^- is broken (Fig. 1)



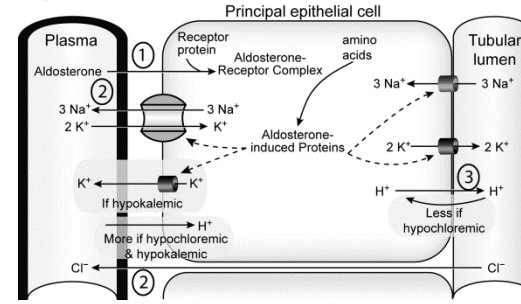
1. The Cl^- that entered the parietal cell from the plasma is not replaced and thus hypochloremia occurs.
2. The HCO_3^- that entered the plasma from the parietal cell is not used to produce CO_2 & H_2O and thus HCO_3^- accumulates to contribute to the metabolic alkalosis.
3. But why is the animal typically alkalemic? The described processes do not cause a loss of H^+ from plasma.

One reason for the alkalemia involves the renal principal epithelial cells when the animal is hypovolemic, hypochloremic, and hypokalemic (Fig 2).

1. Hypovolemia activates the renin-angiotensin systems (RAS) to stimulate the release of aldosterone from the adrenal glands which then enters the principal epithelial cells. The aldosterone-receptor complex stimulates the synthesis of aldosterone-induced proteins, which include components of the Na^+-K^+-ATPase pump and membrane channels for Na^+ and K^+.
2. The peritubular exchange of 3 Na^+ for 2 K^+ creates an electrical gradient that promotes paracellular resorption of Cl^-.

3. In the presence of hypochloremia, less Cl^- is available in the tubular fluid and thus the electrical gradient created by Na^+ and K^+ movements promotes less H^+ from being passively resorbed – thus, more H^+ is excreted (a contribution to the paradoxical aciduria).
4. The excreted H^+ came from the peritubular fluid and thus this process contributes to the alkalemia.
5. The current hypokalemia also contributes to the aciduria because more K^+ returns to the peritubular fluid (thus plasma) through an open channel and thus there is less K^+ available to exchange for Na^+ of the tubular fluid. With less K^+ exchange, more H^+ must be excreted to maintain electrical neutrality.

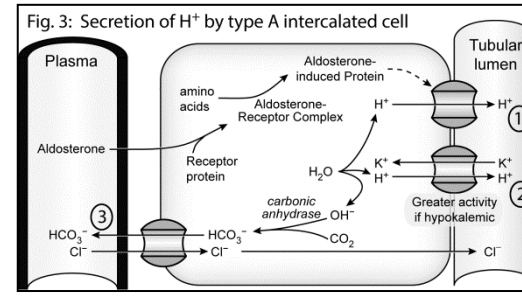
Fig. 2: Actions of aldosterone



The Type A intercalated cells in the renal collecting ducts also participate in the renal response to hypovolemia and hypokalemia (Fig 3).

1. Aldosterone-induced proteins include an H^+-ATPase pump that actively secretes H^+ into the renal tubule.
2. An H^+-K^+ pump also actively secretes H^+ when hypokalemia is present. Both of these processes contribute to the aciduria, but the source of the H^+ ions is H_2O, and thus the secretion does not directly contribute to the alkalemia.
3. Carbonic anhydrase in the cells promotes the formation of HCO_3^- that is exchanged with Cl^- from the plasma; the Cl^- is excreted in urine. This process contributes to the hypochloremia and the metabolic alkalosis (↑ $[HCO_3^-]$).

Fig. 3: Secretion of H^+ by type A intercalated cell



It is important to recognize that the gastric/abomasal parietal cells (as part of the primary pathologic process) and the Type A intercalated cells (as part of the renal response to hypovolemia and hypokalemia) produce HCO_3^- ions that enter the plasma. As noted earlier, an increase in $[HCO_3^-]$ without a change in the P_{CO_2} requires the pH to increase (see earlier Henderson-Hasselbalch equation). Thus, the major reason for the alkalemia is the marked increase in HCO_3^- concentration in this animal; there also is some renal excretion of H^+ (see principal epithelial cells). In addition to the gastric/abomasal secretion of Cl^-, the renal response also contributes to the hypochloremia (see Type A intercalated cell).

Renal compensation in metabolic acidosis

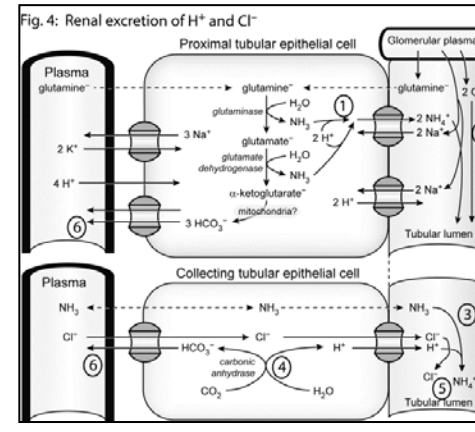
A vomiting 7-yr-old dog had clinical signs indicative of diabetes mellitus; she was mildly dehydrated. Serum electrolyte concentrations were determined to assess her disorder.

Analyte	Patient	Units	Ref. Int		Analyte	Patient	Units	Ref. Int.
Na^+	135	mmol/L	141–156		HCO_3^-	12	mmol/L	20–26
K^+	3.2	mmol/L	3.8–5.5		tCO_2	13	mmol/L	21–27
Cl^-	98	mmol/L	109–124		Anion gap	28	mmol/L	12–20

The data represent classic findings of ketoacidotic diabetes mellitus: hypochloremic metabolic acidosis, hyponatremia, hypokalemia, and increased anion gap concentration. The metabolic acidosis is frequently explained to be the result of increased generation of ketoacids and the subsequent reduction of $[HCO_3^-]$ as it buffers the excess H^+ (note: this topic will be addressed in the "Dogmas revisited" presentation). The hypochloremia is frequently attributed to vomiting – even when there is minimal historical or current evidence of significant vomiting. When functional, the kidneys are major contributors to the development of hypochloremia.

When an animal is acidemic due to nonrenal disorders, the kidneys attempt to compensate by excreting more H^+. When Type A intercalated cells (illustrated above) are stimulated by acidemia, they secrete H^+ and produce HCO_3^-. However, the major method of removing H^+ from plasma is increased excretion of NH_4^+ (Fig. 4)

Fig. 4: Renal excretion of H^+ and Cl^-



1. The response of the proximal tubular epithelial cells to acidemia includes the uptake of glutamine and its subsequent deamination to form NH_3. The NH_3 quickly combines with H^+

that entered the cell from plasma to form NH_4^+. The NH_4^+ enters the tubular fluid in a Na^+ exchange.

2. The presence of NH_4^+ in the tubular fluid obligates the excretion of an anion – the major anion in the tubular fluid is Cl^-. This process leads to increased renal excretion of Cl^- (without a corresponding Na^+) and contributes to the hypochloremia.
3. In the collecting duct epithelial cells, there is a diffusion of NH_3 from plasma to tubular fluid.
4. As a response to acidemia, there is increased carbonic anhydrase activity that generates H^+ ions that are secreted with Cl^- via a membrane pump.
5. The H^+ ions combine with NH_3 to form NH_4^+ that is excreted with Cl^-. This process leads to increased renal excretion of Cl^- (without a corresponding Na^+) and contributes to the hypochloremia.
6. In response to the acidemia, the proximal tubular epithelial cells and the collecting duct epithelial cells produce HCO_3^-; this production represents a compensatory metabolic alkalosis to the nonrenal acidemic state.

Vomiting may contribute to the hypochloremia in an animal that has a metabolic acidosis. However, the expected renal compensation for an acidemia of nonrenal origin is the excretion of NH_4^+ and Cl^-; the increased renal Cl^- excretion contributes to the hypochloremia.

Calculated electrolyte data: SID, anion gap, and others

The measured electrolyte concentrations frequently are used to calculate other data; i.e., Na^+: K^+ ratio, anion gap, SID, corrected Cl^- concentration. However, there are reasons for interpreting the calculated data cautiously.

True changes in the strong-ion difference (SID) basically represent changes in plasma/serum HCO_3^- concentrations. As it not clinically practical to measure the true SID, a variety of formulas have been proposed to estimate the SID. However, the formulas are based on assumptions that may or may not be true and thus the calculated SIDs may or may not be reliable estimates. Another factor that should be considered is that the validity of calculated results is dependent on the accuracy of the measured concentrations used for the calculation. The simplest SID formula is: $SID = [Na^+] + [K^+] – [Cl^-]$. Considering the analytical precision of the Na^+ and Cl^- methods, the measured concentrations should be considered the reported values ± 1 mmol/L (or perhaps ± 2 mmol/L); the precision of the K^+ methods are better. For a cautious perspective, the calculated SID is the value ± 4 mmol/L. Thus, any minor difference when compared to appropriate SID reference intervals (or interpretive guidelines) should be interpreted cautiously.

The potential for imprecision to affect the calculated value increases with each added variable. For example, a common formula for anion gap is: anion gap = $([Na^+] + [K^+]) – ([Cl^-] + [HCO_3^-])$. The addition of patient's HCO_3^- concentration (again, at best ± 1 mmol/L) adds to the uncertainty of the calculated anion gap concentration. And as mentioned earlier, the HCO_3^- concentration can easily be falsely decreased if the blood/plasma/serum samples are not collected and processed properly.

How (and Why) Did That Get There?
Pathogenesis of Cavitary Effusions

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

Results from the analysis of an effusion and other clinical information are used to determine the process or processes that are creating effusions. Interpretation of fluid analysis results is based on the knowledge of the factors that contribute to the composition of the effusion.

The chemical composition of a body cavity fluid is primarily determined by permeability of capillaries to H_2O and solutes and, to a lesser extent, permeability of pleural and peritoneal mesothelium. Capillaries are permeable to H_2O, electrolytes (e.g., Na^+, K^+, Cl^-, Ca^{2+}, bicarbonate, and phosphates) and small nonprotein solutes (e.g., glucose, urea, and creatinine) and thus most effusions have electrolyte, urea, glucose, and creatinine concentrations similar to plasma; the major exceptions to the concept are chylous effusions and uroperitoneum.

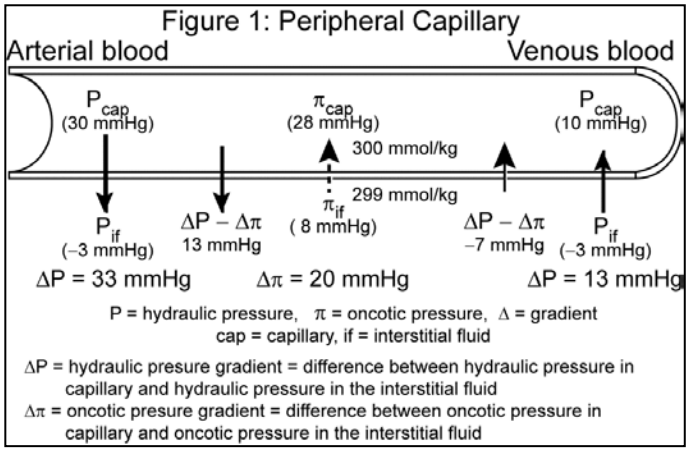
For some effusions, the major alteration in chemical composition is the protein concentration. Interstitial fluid is the source of most pleural and peritoneal fluid proteins. Variations in capillary permeability to plasma proteins cause variations in interstitial total protein concentration. In people, the interstitial fluid total protein concentration is near 1.5 g/dL in skeletal muscle, near 2.0 g/dL in subcutaneous tissue, near 4 g/dL in intestine, and near 6 g/dL in liver.

If there is one pathologic process causing a pleural or peritoneal effusion, then basically there are five types of cavitary effusions. Knowing the pathologic processes that produce the effusion allows the veterinarian to appropriately interpret results of a cavitary fluid analysis.

1. Transudates form when there are changes in oncotic or hydraulic pressure gradients within capillary beds. In transudates, vascular permeability is not altered and vascular damage is not present.
2. Exudates form when inflammatory mediators increase the vascular permeability to plasma proteins which leads to altered oncotic pressure gradients; there may be concurrent alterations in the hydraulic pressure gradients.
3. Hemorrhagic effusions (hemothorax, hemoperitoneum) form when blood enters a body cavity because of blood vessel damage or a defective hemostasis system.
4. Lymphatic effusions (chylous and nonchylous thorax or abdomen) form when lymph accumulates in a body cavity because of lymphatic vessel damage or impaired lymph drainage.
5. Uroperitoneum occurs when damage to the urinary tract allows urine to enter the peritoneal cavity.

Before the pathogeneses of effusions are described, a basic review of the flow of fluid in an out of capillaries is needed.

Starling's law of capillaries



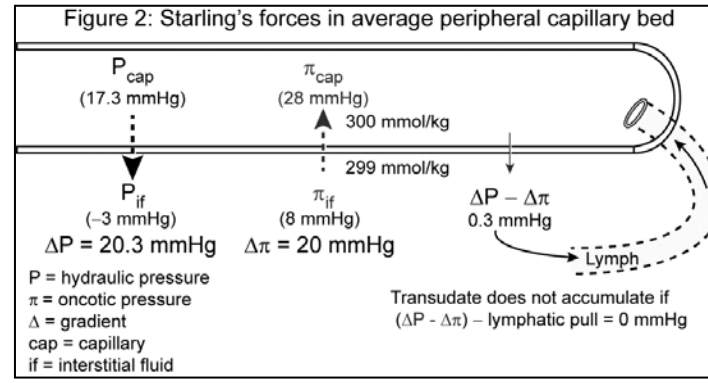
In the healthy peripheral capillary beds, there is a net flow of fluid out of the blood on the arterial side of the capillary bed and a net flow of fluid into the blood on the venous side of the capillary bed. This flow out of and back into the blood is governed by the differences between the hydraulic pressure gradient and the oncotic pressure gradient (Fig. 1).

- On the arterial side, the hydraulic pressure gradient (ΔP) is greater than the oncotic pressure gradient (Δπ) and thus fluid moves out of the blood. In Fig. 1, $\Delta P - \Delta\pi = 13$ mmHg.
- On the venous side, the hydraulic pressure gradient (ΔP) is less than the oncotic pressure gradient (Δπ) and thus fluid moves into blood. In Fig. 1, $\Delta P - \Delta\pi = -7$ mmHg.

Because there is essentially no change in the plasma protein concentration in the capillary blood or in the surrounding interstitial fluid, the oncotic pressure gradient is nearly constant across the capillary bed and thus the movement of fluid out of and into the capillary blood is because of higher blood pressure in arterial blood than venous blood.

The capillary beds have more vessels on the venous side of the bed. The overall result is a slight loss of fluid from blood which is removed by lymphatic vessels. This net effect is illustrated in Fig. 2; the key concepts are as follows.

- H_2O, electrolytes, and small molecules (e.g., glucose, urea, and creatinine) freely pass out of and into the capillary blood and thereby providing nutrients to tissues and removing metabolic waste from tissues.
- Any major changes in either the ΔP or $\Delta\pi$ can result in an accumulation of fluid outside of the capillaries and thus can cause edema or a cavitary effusion.
- Proteins create the oncotic pressure and thus hypoproteinemia will lower the oncotic pressure within the capillary. However as long as the $\Delta\pi$ does not change, extravascular fluid will not accumulate. When there is a mild hypoproteinemia, the oncotic pressure in the vessel and outside the vessel both decrease and thus there is no change in the $\Delta\pi$. This is part of the "Safe Zone" in which effusions do not form. When there is a marked hypoproteinemia (& especially hypoalbuminemia), this "Safe Zone" is exceeded and the $\Delta\pi$ decreases. Increased lymph drainage may prevent formation of a transudate.



Transudates

Transudates form when there are changes in oncotic or hydraulic pressure gradients within capillary beds. Depending on the blood vessels involved, the transudates can be protein-poor or protein-rich.

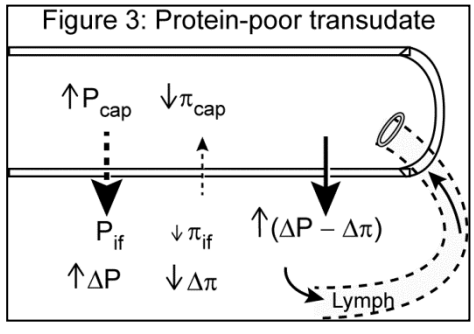
Protein-poor transudates (aka, pure transudates) form primarily in the peritoneal cavity in animals with hepatic cirrhosis, protein-losing nephropathy, and protein-losing enteropathy. They are formed because of two factors:

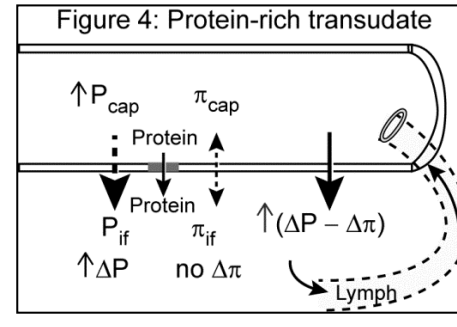
- Multiple factors lead to renal retention of Na^+ and H_2O which results in an expanded plasma volume which creates increased capillary hydraulic pressure and thus an $\uparrow \Delta P$.
- Concurrently, each disorder results in a hypoproteinemia (especially hypoalbuminemia) which decreases the capillary oncotic pressure and thus a $\downarrow \Delta\pi$.

The combination of $\uparrow \Delta P$ and $\downarrow \Delta\pi$ results in the extravasation of protein-poor fluid and eventually a protein-poor transudate (Fig. 3); usually just in the peritoneal cavity.

A less common protein-poor transudate forms when a disorder causes a noncirrhotic portal hypertension. The increased hydraulic pressure within the portal veins results in the extravasation of protein-poor fluid and an accumulation of a protein-poor transudate in the peritoneal cavity,

Hypoalbuminemia is frequently stated as the cause of protein-poor transudates. An inherited defect in people results in the inability of hepatocytes to produce albumin and their albumin concentration is less than 0.1 g/dL – and they do not have cavitary effusions. By itself, hypoalbuminemia will not cause the formation of a transudate.





Protein-rich transudates form when there is increase hydraulic pressure within blood vessels that are naturally permeable to plasma proteins; i.e., hepatic sinusoids and pulmonary capillaries (Fig. 4). Protein-rich transudates in the peritoneal cavity form when there is postsinusoidal hypertension caused by disorders such as right-sided heart failure, constrictive pericarditis, and hepatic vein thrombi. Protein-rich transudates in the pleural cavity form primarily when there is left-sided heart failure which results in congestion in pulmonary capillaries. These effusions have been called "modified transudates," but they are formed simply by transudation and thus there is no "modification."

In heart failure, the increased hydraulic pressures created by defective cardiac function are complicated by increased Na^+ and H_2O retention. A vicious cycle develops as the kidneys perceived hypovolemia which results in Na^+ and H_2O retention which causes increased extravasation of plasma water which creates hypovolemia which initiates Na^+ and H_2O retention, etc.

Exudates

Exudates form when inflammation causes increased vascular permeability to plasma proteins which results in a decreased oncotic pressure gradient within capillary beds and thus less fluid returning to blood from interstitial space. The same events result in the exudation of plasma whether it is an infectious exudate or noninfectious exudate; typically, the infectious process causes greater vascular permeability to proteins and thus a greater movement of fluid from capillaries to body cavities.

The major event in the formation of an exudate is the oozing of plasma proteins from the capillaries to the interstitial space (Fig. 5). This causes the extravascular (interstitial) fluid's oncotic pressure to increase, when reduces the oncotic pressure gradient – which reduces the "suck" of fluid into the vessel on the venous side of the capillary bed. Concurrently, inflammatory mediators may be causing vasodilation to allow increase blood flow to the inflamed tissue – and thus increased intravascular hydraulic pressure which will increase the flow of fluid out of the capillaries.

For most exudates, there will be chemokines in the cavitary effusion which will induce the movement of inflammatory cells into the effusion – thus increasing the total nucleated cells count (TNCC).

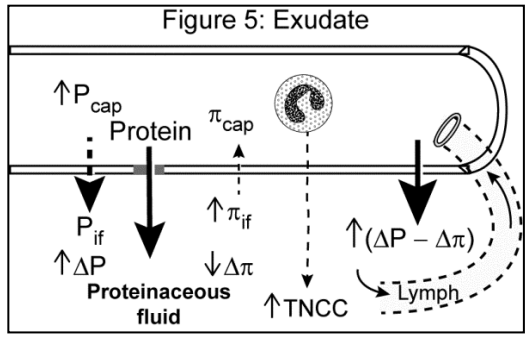


Figure 5: Exudate

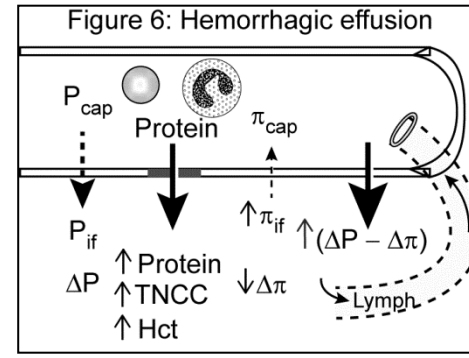


Figure 6: Hemorrhagic effusion

Hemorrhagic effusions

The formation of hemorrhagic effusions is simple – damage to blood vessels or a defective coagulation system results in blood escaping from blood vessels and entering the pleural or peritoneal cavities (Fig. 6). However after the initial bleeding, the properties of the fluid change because of multiple factors.

- The extravasation of plasma proteins reduces the oncotic pressure gradient and thus fluid may be added from other blood vessels.
- Lymphatic vessels return RBCs, WBCs, and proteins to blood (autotransfusion)
- Cells are removed from the fluid by macrophages (leukophages, erythrophages)

Lymphatic effusions

The most commonly recognized lymphatic effusion is the chylothorax in which chylomicron-rich lymph leaks from the thoracic duct and accumulates in the pleural cavity. If the leakage occurs in the abdomen, then a chyloabdomen forms.

It is much more difficult to recognize lymphatic effusions when chylomicrons are not present. These effusions may result from damage of other lymphatic vessels or when there is impaired lymph drainage because of lymph node or other lymphatic system disorder.

Effusion of uroperitoneum

Uroperitoneum simply occurs when urine leaks from the urinary tract into the peritoneal cavity and initially the fluid has the chemical properties of urine. With time, electrolytes and small molecules (e.g., urea and creatinine) diffuse down concentrations to alter concentrations in the peritoneal fluid and plasma. Also, a mild secondary inflammatory process results in exudation.

Neoplastic effusions

Effusions caused by the neoplastic process can result from transudation, exudation, hemorrhage, lymphatic damage, or a combination of factors.

Modified transudates

Modified transudates have been a part of the effusion classifications in veterinary literature for nearly 30 years; there is not a similar category in the human effusions. The classification has been based on the results of fluid analysis; that is, the fluid had a total protein concentration or total nucleated cell count “too high” for a pure transudate and it did not have the features of an exudate. Thus, it became a “catch all” or “lumper” classification for effusions that were not “pure transudates” or exudates.

One “modified transudate” is the effusion of heart failure – that effusion is a protein-rich transudate described above. Other “modified transudates” described in textbooks include the FIP exudate, hypocellular exudates, chylous effusions, uroperitoneum, bilious peritonitis, and uroperitoneum – these are not transudates; they are not transudates modified by the addition of protein or cells.

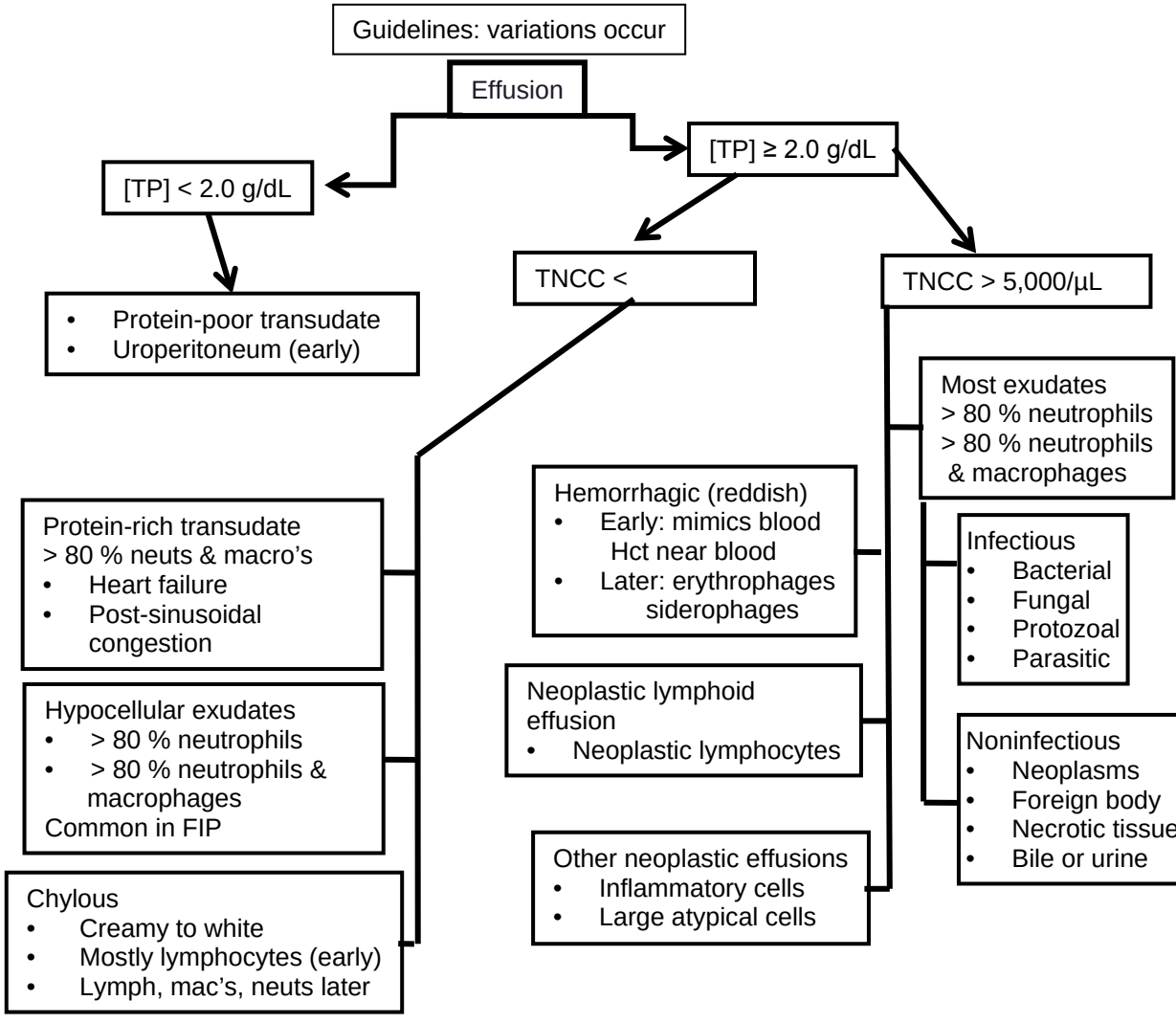
Nucleated cells in effusions

The total nucleated cell concentration in an effusion and the type of nucleated cells also aid in the identification of effusions. Their value will be described in the case analyses in subsequent presentations.

What Analysis of Cavitary Effusions Can Tell You: A Case Discussion (Parts 1 and 2)

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

Pleural or peritoneal fluid analysis will be classified by evaluating the results of routine fluid analysis and virtual microscopy of digital slides.



1-1 Effusion CVC: Peritoneal fluid; direct smear **Case 315135**
Cat, DSH, female (spayed), 8 yr

The cat was presented because of a sudden onset of lethargy, anorexia, and more recently, vomiting. Physical examination revealed an increased rectal temperature, mild dehydration, depression, abdominal tenderness, and abdominal distension. Radiographs revealed a peritoneal effusion – fluid was collected for analysis.

	Patient			**Patient**
Color, precentrifugation	Tan		TNCC	115,000/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Colorless		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	5.1 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-2 Effusion CVC: Peritoneal fluid, direct smear Case 028595
Cat, DSH, male (neutered), 9 mo

The cat was presented because of a progressive lethargy and inappetence during the past week. Physical examination revealed an increased rectal temperature, mild dehydration, and abdominal distension; the abdomen did not appear tender or painful. Radiographs revealed a peritoneal effusion – fluid was collected for analysis.

	Patient			**Patient**
Color, precentrifugation	Yellow		TNCC	**
Clarity, precentrifugation	Hazy		Neutrophils	%
Color, postcentrifugation	Yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Almost clear		Lymphocytes	%
Total protein (ref)	5.1 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

** The viscosity of the fluid prevents accurate pipetting and thus a total nucleated cell concentration cannot be determined accurately.

1-3 Effusion CVC: direct smear and cytocentrifuge Case 040896
Cat, DSH, female (neutered), 8 yr

The cat was presented because it was having a hard time breathing. Physical examination revealed muffled heart sounds. Radiographs revealed a pleural effusion – fluid was collected for analysis.

	Patient			**Patient**
Color, precentrifugation	White		TNCC	3.200/µL
Clarity, precentrifugation	Opaque		Neutrophils	%
Color, postcentrifugation	White		Monocytes/macrophages	%
Clarity, postcentrifugation	Opaque		Lymphocytes	%
Total protein (ref)	5.3 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-4 Effusion CVC: Pleural fluid, sediment smear. Case 175950
Dog, Irish setter, male (neutered), 4 yr

The dog was presented because of difficult breathing. The owner reported intermittent inappetence for the past two weeks; also, the dog did seemed to tire easily. Physical examination revealed a lethargic dog with muffled heart sounds. Radiographs revealed a pleural effusion – fluid was collected for analysis.

	Patient			**Patient**
Color, precentrifugation	Pale yellow		TNCC	35,000/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	None		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	3.8 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-5 Effusion CVC: Peritoneal fluid Case 028757
Dog, Yorkshire terrier, female (spayed), 9 years old

The dog was presented because of an acute onset of vomiting. Physical examination revealed icteric mucous membranes and intense abdominal pain. Peritoneal fluid was collected for analysis.

	Patient			**Patient**
Color, precentrifugation	Icteric		TNCC	32,100/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Icteric		Monocytes/macrophages	%
Clarity, postcentrifugation	Nearly clear		Lymphocytes	%
Total protein (ref)	4.3 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-6 Effusion CVC: Peritoneal fluid 12-115895
Dog, German shepherd, female, 8 years old

The dog was presented because of an acute onset of vomiting. Physical examination revealed intense abdominal pain. Peritoneal fluid was collected for analysis.

	Patient			Patient
Color, precentrifugation	Dark yellow		TNCC	Clot in sample
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Dark yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Nearly clear		Lymphocytes	%
Total protein (ref)	4.0 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-7 Effusion CVC: Peritoneal fluid, cytocentrifuge prep Case 075542
Dog, Cairn terrier, female (spayed), 3 years old

The dog was presented because icterus and difficult breathing. Physical examination revealed a distended abdomen due to a peritoneal effusion. Peritoneal fluid was collected and submitted for analysis.

	Patient			Patient
Color, precentrifugation	Blood-tinged		TNCC	< 1,000/µL
Clarity, precentrifugation	Hazy		Neutrophils	%
Color, postcentrifugation	Light yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	0.5 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

1-8 Effusion CVC: Peritoneal fluid direct smear Case ASVCP 10-9
Dog, miniature Australian shepherd, female (spayed), 8 months old

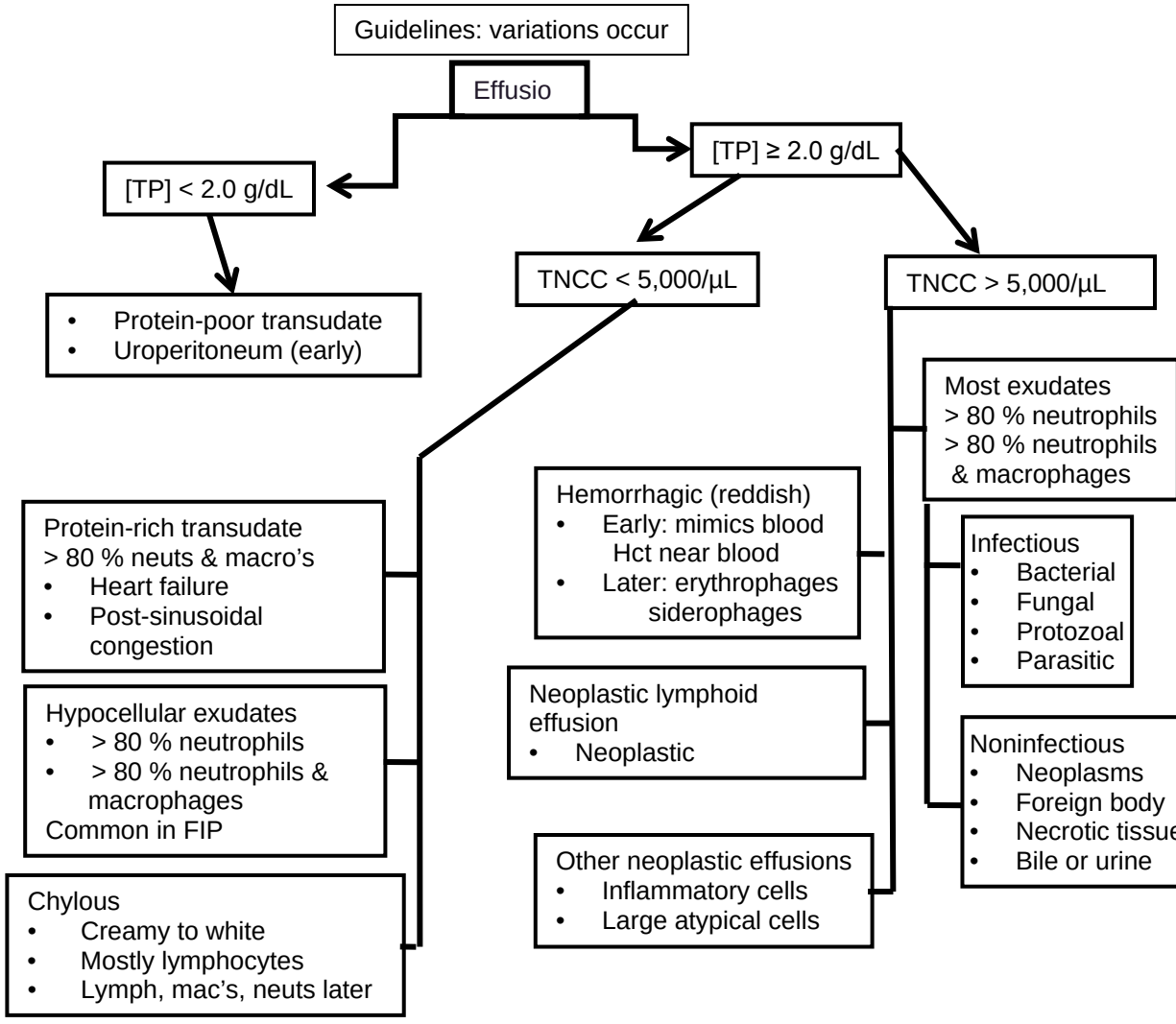
One week after intestinal resection, the dog was presented because of anorexia.. Physical examination revealed a distended abdomen due to a peritoneal effusion. A direct smear of peritoneal fluid was prepared and submitted for evaluation (fluid for analysis was not available)

1-9 Effusion CVC: Peritoneal fluid, cytocentrifuge prep Case ASVCP 08-9
Dog, Nova Scotia Duck-tolling retriever, male (neutered), 5 years old

The dog was presented because hematemesis and melena. Physical examination revealed pale mucous membranes. Abdominal ultrasound demonstrated multiple enlarge abdominal lymph nodes and a peritoneal effusion. Peritoneal fluid was collected and submitted for analysis.

	Patient			Patient
Color, precentrifugation	Light yellow		TNCC	49,500/µL
Clarity, precentrifugation	Hazy		Neutrophils	%
Color, postcentrifugation	Light yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	3.2 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

Pleural or peritoneal fluid analysis will be classified by evaluating the results of routine fluid analysis and virtual microscopy of digital slides.



2-1 Effusion CVC: Pleural fluid, cytocentrifuge prep. Case 07923; (2-2 Peritoneal fluid -- next slide, same animal)
Dog, Labrador retriever, male (neutered), 8 years old

The dog was referred because of an acute onset of a distended abdomen and a hypoproteinemia (TP = 4.2 g/dL, Alb = 2.2 g/dL). Physical examination revealed a distended abdomen due to a peritoneal effusion and muffled heart sounds. Pleural and peritoneal fluid samples were collected and submitted for analysis.

	Patient			**Patient**
Color, precentrifugation	Blood-tinged		TNCC	< 1,000/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Colorless		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	2.9 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-2 Effusion CVC: Peritoneal fluid, cytocentrifuge prep. Case 079234

Dog, Labrador retriever, male (neutered), 8 years old

See CVC 2-1 information

	Patient			Patient
Color, precentrifugation	Blood-tinged		TNCC	< 1,000/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Colorless		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	3.0 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-3 Effusion CVC: Peritoneal fluid, cytocentrifuge prep. Case 079660

Horse, quarter horse, male (neutered), 20 years old

The horse was referred because of an acute colic that now is of 24-hours duration. Physical examination revealed pawing and kicking of abdomen, tachycardia, and very few gut sounds.

	Patient			Patient
Color, precentrifugation	Yellow		TNCC	< 1,000/µL
Clarity, precentrifugation	Hazy		Neutrophils	%
Color, postcentrifugation	Yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	1.8 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-4 Effusion CVC: Peritoneal fluid, direct smear Case 507605

Horse, Thoroughbred cross, male (castrated), 14 yr

The horse was presented because of colic of 12-hr duration. The referring veterinarian reported that the horse passed a small amount of mucoid feces yesterday, rectal palpation revealed gas-distended loops of intestine, and gut sounds were absent. A small amount of peritoneal fluid was collected and submitted for analysis.

	Patient			Patient
Color, precentrifugation	yellow		TNCC	202,000/µL
Clarity, precentrifugation	cloudy		Neutrophils	%
Color, postcentrifugation	yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	clear		Lymphocytes	%
Total protein (ref)	5.5 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-5 Effusion CVC: Peritoneal fluid, direct smear Case 051233

Dog, Labrador retriever, male (neutered), 6 yr

Owner first noticed abdominal distension about one week ago; the dog's appetite and activity has not changed. Physical examination revealed a fluid-filled, distended abdomen and possibly a peripheral lymphadenopathy.

	Patient			Patient
Color, precentrifugation	Red		TNCC	7,500/µL
Clarity, precentrifugation	Opaque		Neutrophils	%
Color, postcentrifugation	Pink		Monocytes/macrophages	%
Clarity, postcentrifugation	Hazy		Lymphocytes	%
Total protein (ref)	5.0 g/dL		Reactive mesothelial cells	%
Hct	30 %		Other	%

2-6 Effusion CVC: Peritoneal fluid, cytocentrifuge prep. Case 079781

Dog, Anatolian shepherd, male (neutered), 8 yr

The dog had intermittent episodes of diarrhea for about 2 months. About 2 weeks ago, it was dribbling urine and the referring veterinarian treated for a urinary tract infection. Urine dribbling continued up to yesterday; no urine passed in last 24 hours. Physical examination revealed a depressed dog with a distended and painful abdomen.

Initial laboratory data included a mild inflammatory leukocytosis, mild hyperproteinemia, almost an erythrocytosis, azotemia (UN 105 mg/dL, Crt 3.6 mg/dL), mild hyperphosphatemia, mild hyponatremia, almost hyperkalemia, and metabolic acidosis (HCO_3^- 14 mmol/L)

	Patient			Patient
Color, precentrifugation	Blood-tinged		TNCC	2,700/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Pink		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	1.3 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-7 Effusion CVC: Peritoneal fluid, line prep. Case 08-69874
Dog, mixed breed, female, 1 yr

A veterinarian in NE Kansas submitted pleural and peritoneal fluid from a dog. Historical or physical examination findings were not provided.

	Patient			Patient
Color, precentrifugation	Blood-tinged		TNCC	10,200/µL
Clarity, precentrifugation	Cloudy		Neutrophils	%
Color, postcentrifugation	Colorless		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	4.7 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%
Other microscopic findings:				

Note: A line prep. tends concentrate cells in the line, but also makes that area thick.

Note: The analysis of pleural fluid yielded essentially the same results except the TNCC was 5,000/µL.

2-8 Effusion CVC: Pleural effusion, cytocentrifuge preparation Case 047859
Cat, Birman, male (neutered), 16 yr

The cat was presented because of dyspnea. The owner reported intermittent inappetence during past week. Physical examination revealed muffled heart sounds. Radiographs revealed a pleural effusion – fluid was collected for analysis.

	Patient			Patient
Color, precentrifugation	Pink		TNCC	8,000/µL
Clarity, precentrifugation	Hazy		Neutrophils	%
Color, postcentrifugation	Light yellow		Monocytes/macrophages	%
Clarity, postcentrifugation	Clear		Lymphocytes	%
Total protein (ref)	2.6 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

2-9 Effusion CVC: Peritoneal fluid, cytocentrifuge prep. Case 080190
Dog, fox terrier, male (neutered), 6 yr

The dog was referred because of abdominal ascites that might be due to heart failure. Physical examination revealed a grade 2-3, left-sided systolic murmur and a fluid-filled abdomen.

Preliminary laboratory data found UN of 16 mg/dL, Crt 3.6 mg/dL), hypoproteinemia (TP 2.5 g/dL, albumin 1.2 g/dL), hypocalcemia (tCa^{2+} 5.7 g/dL), mild hyponatremia (144 mmol/L), normochloremia, decreased anion gap, and urine with a specific gravity of 1.009, and negative chemistry results.

	Patient			Patient
Color, precentrifugation	colorless		TNCC	< 1,000/µL
Clarity, precentrifugation	clear		Neutrophils	%
Color, postcentrifugation	colorless		Monocytes/macrophages	%
Clarity, postcentrifugation	clear		Lymphocytes	%
Total protein (ref)	0.1 g/dL		Reactive mesothelial cells	%
Hct	< 3 %		Other	%

Virtual Microscopy of Lumps and Bumps (Part 1): Let's Look at the Cells

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

A cytologic biopsy (aka, fine needle biopsy or fine needle aspiration biopsy or "cytology") of cutaneous and subcutaneous lesions (lumps and bumps) can result in a specific diagnosis or perhaps can better characterize a lesion. For nearly all lesions, the cytologic biopsy will not be as definitive as an incisional or excisional biopsy with a histopathological examination; but will be less expensive and yield results quicker.

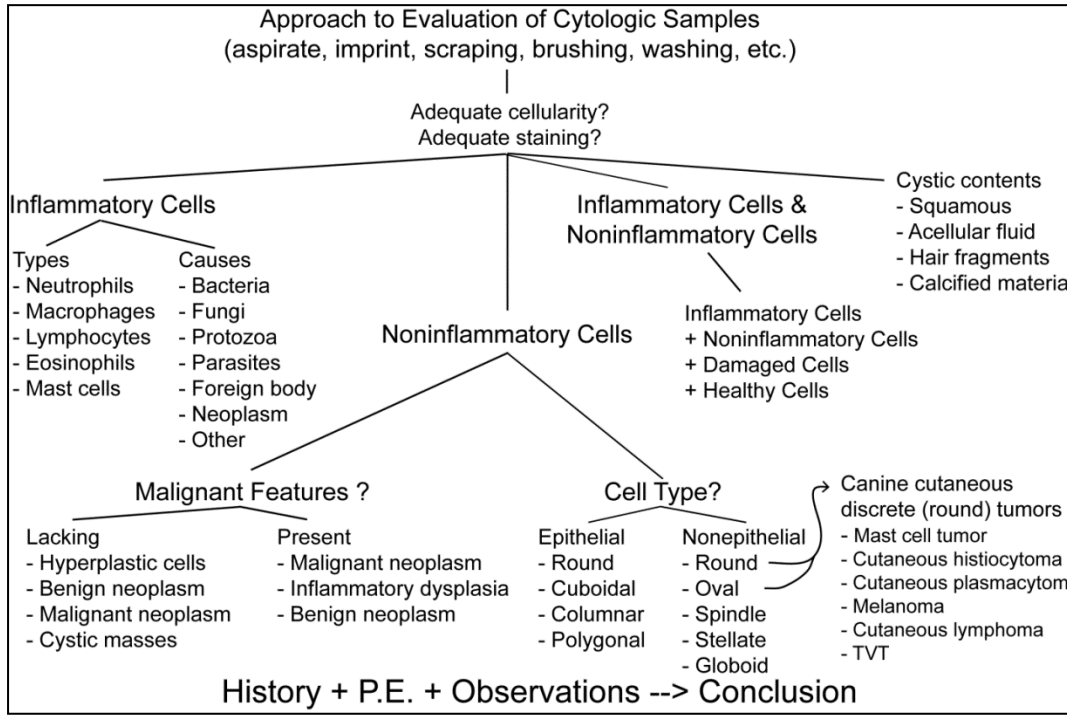
For some lesions (e.g., lipoma), it takes minimal expertise and diagnostic methods to arrive at a correct diagnosis; but other lesions require extensive knowledge gained through experience and excellent equipment. For those who wish to develop their cytologic biopsy skills, the following should be considered essential.

- Develop techniques to obtain cytologic preparations that have monolayers of cells
- Have a quality cytologic stain that can provide reproducible results; quick stains can be acceptable
- Have a quality microscope that has excellent 40x- or 50x-oil and 100-x oil objectives (these objectives might cost $3000 to $5000 each)
- Have excellent textbooks and atlases for the species of interest
- Have knowledge of the types of lesions that can be found and the many variations of each disorder

During the microscopic examination of aspirates, scrapes, imprints, or other cytologic preparations, general goals are to arrive at one of these conclusions or opinions:

- Definitive diagnosis: can be achieved with a few neoplasms and some inflammatory lesions
- Consistent with _____: cells populations are seen in this condition but the findings are not unique to one diagnosis; additional diagnostic efforts are needed to confirm
- Suspicious of _____: findings are suggestive stated diagnoses but definitive evidence is not seen; additional diagnostic efforts are needed
- Not consistent with _____: A preliminary diagnosis had been made; the findings in this sample are not likely to be found in that disorder; or, the findings do not support the preliminary diagnosis

The following flowchart provides a basic guideline for the evaluation of a cytologic preparation. The concepts of the flow chart will be used during the virtual microscopy of several lesions involving the skin and subcutaneous tissues of dogs and cats.



1-1 L&B CVC: Smear of fluid from subcutaneous lesion Case: 176517
Dog, mixed breed, 3-yr-old, female (spayed)

A smear of serosanguineous to purulent fluid was submitted; the fluid was collected from a subcutaneous swelling that had a draining tract.

1-2 L&B CVC: fine-needle aspirate of cutaneous mass Case: 02-1975
Dog, Labrador retriever, 4-yr-old

A 2x4x3 cm mass was located in the lateral skin of the left hind thigh or hip. The owner first noticed the mass a few weeks ago and it has been getting larger. The mass protruded slightly and felt like it extended into the subcutaneous tissue. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

1-3 L&B CVC: fine-needle aspirate of cutaneous mass Case: 02885
Dog, Golden retriever, male, 12-year-old

The dog was presented because of a mass located on the dorsal aspect of the tail head. Physical examination revealed 2-cm, soft mass in the dermis and was covered with haired skin. A fine-needle aspirate of the rear leg mass was collected and a smear was prepared for examination.

1-4 L&B CVC: fine-needle aspirate of cutaneous mass Case: 030056
Dog, basset hound, male (neutered), 7-year-old

The dog was presented because of perianal masses. Physical examination revealed a small perianal mass and possibly enlarged regional lymph node. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

1-5 L&B CVC: fine-needle aspirate of cutaneous mass Case: 02-2357
Dog; breed, age, and gender not provided

A smear of an aspirate obtained from a mass in the skin of a foot was submitted for evaluation.

1-6 L&B CVC: fine-needle aspirate of cutaneous mass Case: 024854
Dog, schipperke, male (neutered), 15-yr-old

The dog had been coughing for 2-3 weeks. During a physical exam, a mass was found in the subcutaneous tissues of the left lateral thoracic; it appeared to be firmly attached to underlying tissues. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

1-7 L&B CVC: Imprint of moist cutaneous lesion Case: 256285
Dog, mixed breed, male (neutered), 4-yr-old

The dog was presented because of a swelling of the left flank that broke open yesterday and yellowish red material oozed out. The preparation is an imprint of the ulcerated area after superficial debris and hair were removed.

1-8 L&B CVC: Imprints of cutaneous mass Case: ASVCP 1988-11
Cat, domestic short hair

The cat was presented because of skin lesions. Physical examination revealed several, pea-size, cutaneous masses. One mass was excised and imprints of the mass were submitted for evaluation. .

Additional slides will be reviewed if time permits

Virtual Microscopy of Lumps and Bumps (Part 2): Let's Look at More Cells

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

A cytologic biopsy (aka, fine needle biopsy or fine needle aspiration biopsy or "cytology") of cutaneous and subcutaneous lesions (lumps and bumps) can result in a specific diagnosis or perhaps can better characterize a lesion. For nearly all lesions, the cytologic biopsy will not be as definitive as an incisional or excisional biopsy with a histopathological examination; but will be less expensive and yield results quicker.

Please see previous proceeding's document (Part 1) for an introduction to the goals and approach of a cytologic biopsy.

2-1 L&B CVC: fine-needle aspirate of vulvar mass Case: 026163
Dog, mixed breed, female, 5-yr-old

A 1x1 pink mass was protruding slightly from the vulvar mucosa. The owner first noticed the mass yesterday. The mass protruded into the vaginal vault; it might be extending into the submucosa. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

2-2 L&B CVC: fine-needle aspirate of cutaneous mass Case: 02-7821
Dog, boxer, 1-yr-old

A 1x1x1 cm, pink mass was located in the lateral skin of the right shoulder. The owner first noticed the mass a few days ago. The mass seemed to involve the dermis and epidermis and did not extend into the subcutaneous tissues. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

2-3 L&B CVC: fine-needle aspirate of cutaneous mass Case: 028857
Dog, Golden retriever, male (neutered), 5-yr-old

The dog was presented because of a 2x2x1 cm mass located in the lateral thoracic skin. The preparation is a smear of the sample aspirated from the mass.

2-4 L&B CVC: fine-needle aspirate of cutaneous mass Case: 039973
Cat, domestic short hair

The preparation is a smear of a sample aspirated from one of several small (< 1 cm) cutaneous masses.

2-5 L&B CVC: fine-needle aspirate of cutaneous mass Case: 56535-98
Dog, mixed breed

A smear of serosanguineous to purulent fluid was submitted; the fluid was collected from a subcutaneous swelling that had a draining tract.

2-6 L&B CVC: fine-needle aspirate of cutaneous mass Case: 028729
Dog, terrier-mix, female (spayed), 14-year-old

A 5x4x23 cm mass was found in the dorsal thoracic skin. The dog has several other similar masses in its thoracic and abdominal skin. The mass extends above the skin surface, the surface is ulcerated, and appears to involve dermal and possibly subcutaneous tissues. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

2-7 L&B CVC: fine-needle aspirate of cutaneous mass Case: 029402
Cat, Persian, female (spayed), 19-year-old

The cat was presented because of a large (about 8 cm), broad-based mass located in the area of the 3rd to 4th left mammary gland. Physical examination revealed was covered with haired skin and appeared to involve the dermis and subcutaneous tissues. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

2-8 L&B CVC: fine-needle aspirate of cutaneous mass Case: 028874
Dog, shar pei, male (neutered), 9-year-old

The dog was presented because of a mass in its skin. Physical examination revealed a dermal or subcutaneous mass of the right thorax. A fine-needle aspirate of the mass was collected and a smear was prepared for examination.

Additional slides will be reviewed if time permits

Virtual Microscopy of Lymph Nodes: Lymphoma or Just Reactive?

Steve Stockham, DVM, MS, DACVP
Kansas State University
Manhattan, KS

The major reason for a cytologic biopsy of lymph node aspirates is looking for the reason for an enlarged lymph node. Lymph nodes become enlarged from many diseases and typically are classified into one of the following groups.

Hyperplastic lymph node
Lymph node hyperplasia is characterized by increased numbers of lymphocytes: B-lymphocytes, T-lymphocytes, or both. The proportions of different types of lymphocytes may appear normal, in which case hyperplasia is suggested by normal cell populations in association with lymphadenomegaly. There may be increases in large lymphocytes and/or plasma cells, in which case the terms reactive or reactive hyperplasia are often used in place of hyperplasia, though the nodes are enlarged because of hyperplasia. A variety of infectious and noninfectious diseases, including bacterial, viral, fungal, and neoplastic disorders, can lead to the stimulation and proliferation of lymphocytes. If there is generalized lymph node hyperplasia, a systemic illness should be considered. If only one node is hyperplastic, a disease within the drainage field of that node should be considered.

Reactive lymph node
A node classified as reactive typically has increased numbers of plasma cells and/or large lymphocytes. The percentage of large lymphocytes is expected to be less than 50 % in a reactive node and is usually less than 10 %. An increase in plasma cells indicates B-lymphocyte stimulation.

The causes of a reactive lymph node are essentially the same as those for lymph node hyperplasia.

Lymphadenitis
Lymphadenitis is characterized by an increased number of nonlymphoid inflammatory cells in a lymph node. One inflammatory cell type might dominate (e.g., neutrophils), or there can be a mixture of inflammatory cells (e.g., neutrophils, macrophages, and eosinophils) The cause of the inflammatory state may be within the lymph node or, more commonly, in the node's drainage field. For example, an allergic dermatitis may result in an eosinophilic lymphadenitis, or a lymph node draining a necrotic hemorrhagic lesion may have many macrophages containing cell debris and Fe pigments. Lymphadenitis is often associated with reactive (proplastic) changes, and the term reactive lymphadenitis is sometimes used to reflect both changes

Lymphoma
Cytologically, lymphoma can be diagnosed when there is nearly a single population of atypical lymphocytes rather than the heterogeneous mixture of typical cell types present in normal, reactive, or inflamed lymph nodes. However, depending on the appearance of the cells, lymphoma can be an easy or difficult diagnosis cytologically.

When cytologic preparations consist of single populations of large lymphocytes with prominent nucleoli, the diagnosis of lymphoma is clear.

It is more difficult when the cells are of small to intermediate size or when substantial numbers of non-neoplastic cells are intermixed with neoplastic cells because of a nondiffuse form or a recent onset. In these cases, histologic examination may be necessary for a diagnosis.

Metastatic neoplasm
Lymph nodes can be enlarged because of the growth of non-lymphoid neoplastic cells in the node. Metastatic cells can also be found during biopsies of lymph nodes that do not appear enlarged. Many neoplasms have the potential to spread to regional lymph nodes. Those seen more frequently in the peripheral lymph nodes included squamous cell carcinoma, mammary carcinoma or adenocarcinoma, melanoma, mast cell neoplasia, and some hemic neoplasms.

Cell populations in lymphadenopathies other than lymphoma
Typical lymph nodes include popliteal, inguinal, and prescapular lymph nodes. Percentages are provided to illustrate the differences between the pathologic states. They are not firm decision limits; a true differential count is rarely completed.

	Normal*	Hyperplasia #1**	Hyperplasia #2	Hyperplasia (reactive)	Lymphadenitis***	Metastatic neoplasm
Lymphoid	> 95 %	> 95 %	> 95 %	> 95 %	???	Varies; depends on how much of the LN has been replaced by neoplastic cells
Small	> 80 %	> 80 %	***> 60 %***	***> 60 %***	? > 60 %	
Intermediate	< 10 %	< 10 %	***< 30 %***	***< 30 %***	? < 30 %	
Large	< 5 %	< 5 %	***< 10 %***	***< 10 %***	? < 10 %	
Plasma cell	< 2 %	< 2 %	< 2 %	***> 2 %***	? < 2 %	
Neutrophils	< 2 %	< 2 %	< 2 %	< 2 %	***? > 2 %***	
Macrophages	< 2 %	< 2 %	< 2 %	< 2 %	***? > 2 %***	
Mast cells	< 1 %	< 1 %	< 1 %	< 1 %	***? > 1 %***	
Organisms	---	---	---	---	*Maybe*	*Yes*

* Mandibular lymph nodes and mesenteric lymph nodes frequently have higher percentages of neutrophils, macrophages, or plasma cells

** The cell populations in this hyperplastic lymph node look like normal lymph node cells, but they came from an enlarged lymph node.

*** The distribution of the cell populations vary with the severity of the inflammatory process. The aspirate may look like a normal LN with only a minor increase in neutrophil percentage. Or, the aspirate may contain very few lymphoid cells as nearly all of the cells are inflammatory cells.

Cell populations in most lymphomas*

	Lymphoma (intermediate cell)	Lymphoma (large cell)	Lymphoma** (small cell)
Lymphoid	> 90 %	> 90 %	> 90 %
Small	**< 50 %**	**> 10 %**	> 80 %
Intermediate	**> 20 %**	**> 30 %**	< 10 %
Large	< 10 %	**> 30 %**	< 5 %
Plasma cell	< 2 %	< 2 %	< 2 %
Neutrophils	< 5 %	< 2 %	< 2 %
Macrophages	< 5 %	< 2 %	< 2 %
Mast cells	< 1 %	< 1 %	< 1 %

* Lymphoma classification based on the diameters of most of the neoplastic lymphoid cells in the sample: small cell = nuclei < 10 µm; intermediate (medium) cell = nuclei 10–15 µm; large cell = nuclei > 15 µm

** The small-cell lymphoma is difficult to recognize with certainty in an aspirate; the cell populations are similar to those of a normal lymph node or a hyperplastic lymph node. Histopathologic examination of an incised or excised lymph node is typically needed to establish the diagnosis.

1 LN CVC: Mandibular LN aspirate Case: 053394
Dog, Labrador retriever, 4-yr-old
Healthy dog

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

2 LN CVC: Mandibular LN aspirate Case: 021111
Dog, German shepherd, 3-yr-old, female (spayed)

The dog was presented because inappetence and lethargy. Physical examination revealed several mildly enlarged peripheral lymph nodes. An aspirate from the right mandibular lymph node was submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

3 LN CVC: Axillary LN aspirate Case: 079237
Dog, German shepherd, 3-yr-old, female (spayed)

The dog was presented because of right, foreleg lameness. Radiographs revealed a small lytic bone lesion in the humerus. An aspirate from an enlarged axillary lymph node was submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

4 LN CVC: Prescapular LN aspirate Case 053708
Dog, Golden retriever, 5-yr-old, female (spayed)

The dog was presented because of anorexia and lethargy. Several peripheral lymph nodes were enlarged. An aspirate from an enlarged prescapular lymph node as submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

5 LN CVC: Popliteal LN aspirate Case 032086
Dog, Basset hound, 6-yr-old, male (neutered)

The dog was presented because of polyuria and polydipsia. Initial laboratory data revealed a hypercalcemia. A slightly enlarged popliteal lymph node was aspirated and the sample was submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

6 LN CVC: Inquinal LN aspirate Case 028587
Cat, Tabbi, female (spayed), 8 years old

The cat was presented because of weight loss and poor appetite. Physical examination revealed enlarged peripheral lymph node. One lymph node was aspirated and cytologic preparations were submitted for examination.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

7 LN CVC: Popliteal LN aspirate Case 028260
Dog, Boxer, 7-yr-old, male (neutered)

A cutaneous mass on the left hind leg had been removed 10 days ago. The excised mass was not submitted for histopathologic examination. When the dog was returned for suture removal, an enlarged popliteal lymph node was found. An aspirate of the lymph node was submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

8 LN CVC: Prescapular LN aspirate Case 028445
Dog, Cairn terrier, 2-yr-old, female

The dog was presented because it was constantly scratching ears and neck. Physical examination revealed numerous fleas, red inflamed skin, and enlarged mandibular and prescapular lymph nodes. An aspirate of the lymph node was submitted for analysis.

Lymphoid	%		Neutrophils	%
Small lymphocytes	%		Macrophages	%
Intermediate lymphocytes	%		Mast cells	%
Large lymphocytes	%		Organisms	
Plasma cell	%			

Adverse Drug Reactions:
A General Introduction for Clinicians

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

A drug interaction is defined as any modification of the effect of a drug when administered with another drug (concurrently or in close sequence). This effect can be a decrease or an increase in the action (therapeutic or toxic) of either of the two drugs. It is important to remember that this interaction can be either beneficial or disadvantageous. It is also important to note that nutraceuticals and herbal supplements can also interact with drugs.

Different outcomes of a drug interaction

If Ea is the effect of drug A, Eb the effect of drug B, and Eab the effect observed when both drugs are given together, there are 4 possible outcomes:

Neutral effect

- Eab = Ea or Eb
- When 2 drugs have completely unrelated pharmacokinetic profiles, mechanisms of action, or tissue effects and therefore don't affect each other

Antagonistic effect

- Eab < Ea and Eb
- When 2 drugs compete for part of their pharmacokinetic profiles; when 2 drugs have action mechanisms that antagonize each other; or when 2 drugs compete for the same receptor

Additive effect

- Eab = Ea + EB
- When 2 drugs have complementary mechanisms or effects that simply add up

Synergistic effect (rare despite the term being commonly used instead of additive effect)

- Eab > Ea + Eb
- When 2 drugs have complementary mechanisms or effects that enhance each other

It is important to realize that antagonistic interactions can sometimes have a beneficial outcome for the patient (e.g. antidotal drug decreasing the absorption of a toxic drug) and additive/synergistic interactions can have a negative outcome for the patient (e.g. two nephrotoxic drugs together).

Drug interaction categories

Drug interactions themselves can be subdivided into categories:

Pharmacokinetic interactions

- Absorption interactions
  - Transporter & mucosal metabolism (e.g. competition for Pg-p or CYP3A4 in GI epithelium)
  - Physiology of absorbing tissue (e.g. prokinetic agent & GI flow & oral absorption; antibiotics & gi flora-dependent entero-hepatic cycle)
  - Availability of transportable form (e.g. activated charcoal & overdose; Al in sucralfate & tetracyclines or fluoroquinolones)
- Distribution interactions
  - Local tissue transporters & drug metabolism (e.g. competition for P-gp transport through blood-brain barrier)
  - Local tissue physiology (e.g. NSAIDs normalizing blood flow to target organ; diuretics & hydrosoluble drug)
  - Plasma protein binding competition; only significant with highly protein bound drugs (>90%) with a narrow therapeutic index and when administered by rapid IV; albumin & acidic drugs or αglycoproteins & alkaline drugs
- Metabolism interactions
  - Enzyme induction (e.g. rifampin; omeprazole; phenobarbital)
  - Enzyme inhibition/competition (e.g. cimetidine; most azoles; many fluoroquinolones; methyxanthines)
  - Liver physiology (e.g. decreased blood flow to liver during anesthesia; acetaminophen-induced GSH depletion & opioid conjugation)

- Elimination interactions
    - Tissue physiology of the eliminating organ (e.g. decreased renal blood flow during anesthesia; phenobarbital-associated decreased bile flow)
    - Local tissue transporters & drug metabolism (e.g. decreased statin elimination by cyclosporine OAT inhibition)
    - Urine pH (e.g. acidifying urines to increase the renal elimination of an alkaline drug)

Pharmacodynamic interactions

- At the molecular target level
    - Antagonistic interaction when both drugs target the same molecular target (competition): e.g. using 2 drugs from the same drug class!
    - Additive or synergistic effect when the two drugs have different binding site on their common molecular target: e.g. GABA receptor & benzodiazepine and barbiturates
- At the cellular level
    - Antagonistic interaction when a drug decreases the synthesis of another drug's target: e.g. azoles decreasing the synthesis of egesttrol (amphotericin target)
    - Additive or synergistic effect when two drugs target two different steps in a sequential cellular pathway (e.g. TMP and SMX sequential inhibition of folate pathway in certain bacteria)
    - Positive interaction when a drug promotes the synthesis of a molecule that decreases the toxicity of another drugs (e.g. GSH precursors & acetaminophen toxicity)
- At the clinical outcome level
    - Antagonistic interaction when the clinical effect of two drugs are antagonistic: e.g. immunosuppressive dose of corticosteroids & antibacterial agents; certain diuretics & K supplementation
    - Additive or synergistic effect when two drugs target two different steps in a sequential pathological pathway (e.g. multi-analgesia therapy)

Drug interaction risk factors

When considering unwanted drug-drug interactions, several risk factors need to be taken into account by the clinician very carefully:

- Drugs that interfere with PK
- Polypharmacy (e.g. hospitalization, especially in ICU; chronic diseases)
- Conditions that already affect important PK factors (e.g. decreased plasma protein levels in advanced liver disease)
- New drugs for which the profession has little toxicity background
- Compounding, which can modify the drug PK profile

Predicting, preventing, identifying drug interactions

Numerous softwares have been developed for human medicine that can help clinicians prevent and/or identify potential drug interactions. They are commonly used by human pharmacies, but they have not yet been evaluated and/or adjusted for veterinary species.

Therapeutic drug monitoring (TDM) can also be very helpful in cases of drug interactions, and should be considered as common practice in high-risk patients whenever possible.

References

Mills BM, et al: Current cytochrome P450 phenotyping methods applied to metabolic drug-drug interaction prediction in dogs. Drug Metab Dispos. 2010; 38(3): 396-404.

Goodman L et al: Potential Drug Interactions with Dietary Supplements. Compendium 2005. 27(10): 780-90

Reis AM et al: Evaluation of three brands of drug interaction software for use in intensive care units. Pharm World Sci. 2010; 32(6): 822-8

Environmental Toxicants and Immune Disorders

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

Over the past few decades, we have seen a significant increase in the incidence of allergic immune disorders, such as asthma, contact dermatitis or food allergy, in industrialized countries. This has happened too fast to be explained by genetic changes. At the same time, the amount of man-made chemicals with immunotoxic properties has drastically increased in these same countries. Researchers and clinicians are therefore hypothesizing that there could be a connection between the two phenomena.

What is immunotoxicology?

General immunotoxicology

Immunotoxicology is the field of toxicology that studies the effects of chemicals on the immune system. Environmental immunotoxicology focuses on xenobiotics present in our environment (e.g. diet).

Developmental immunotoxicology

This research field focuses more specifically on the effect of chemical exposure during key periods of the immune system development: *in utero*, neonatal, childhood, and adolescence. Immunotoxicants might have some effects on the developing immune system at lower doses than what would be toxic in the adult immune system. In addition, the nature of the effect might also be different. Some consequences of a disrupted immune development might not be noticeable until later in life, but others might happen early but only be transient.

Mechanisms of immunotoxicity

The immune system can be affected at any level: immune cell differentiation, proliferation, maturation, activation, and end function (e.g. antibody production by B lymphocytes; antigen presentation by macrophages). For any immune cell target, the cell can be affected at different locations as well: primary and secondary immune organs, circulatory system, or even in non-immune tissues where immune cells reside. Importantly, the immunotoxic effect of a chemical can vary with age, but also between species, gender. The molecular mechanisms behind such immunotoxic effects remain uncertain, but likely involve complex networks of cell signaling pathways.

Examples of environmental immunotoxicants

This proceeding will focus on a specific category of environmental toxicants called endocrine disruptor chemicals. The US Environmental Protection Agency (2012) defines them as “exogenous agents that interfere with the production, release, transport, metabolism, binding, action, or elimination of the natural hormones in the body responsible for the maintenance of homeostasis and the regulation of developmental processes”. However, there is increasing evidence that these chemicals are also significantly immunotoxic.

Bisphenols

Bisphenols, such as bisphenol A (BPA), are monomers found in epoxy resins used for lining to separate content from metal and in plastic objects to ensure shape and durability. They are found in food cans, plastic bottles, cosmetic containers, dental and medical material and in cashier receipts.

Phthalates

Phthalates, such as di-ethylhexyl-phthalate (DEHP), are polymers used to soften plastics in food or drink containers, medical tubing, medication coating, or toys; they have also been used in cosmetic care products and they are also found in various building and furniture materials.

PCBs

Polychlorinated biphenyls were widely used in dielectric or cooling fluids. Their production was banned in the US in 1979 and more broadly in 2001. However, they are very stable compounds and accumulated in the environment.

PBDEs

Polybrominated diphenyl ethers are flame-retardants that are widely used to decrease flammability (e.g. textiles, furniture, building materials, plastics.) The 2001 Stockholm Convention only restricted their production without fully banning it.

Exposure to immunotoxicants

Sources

Several millions of tons of endocrine disruptors are produced every year throughout the world. A central issue is that these chemicals are usually not covalently bound to the product matrix they were added to, and they can leach out. The second problem is that these chemicals are often very stable and can accumulate in the environment and in the body.

Routes

The most common route of exposure is usually thought to be the oral route. Food & drinks usually represent the most significant portion of the exposure. However, oral exposure also includes ingestion of house dust, chewing on plastic objects, or medications. In addition, inhalation (e.g. house dust; fragrances) and cutaneous exposure (e.g. cosmetics; house cleaning products) sometimes provide significant additional exposure.

In vivo levels

There is mounting evidence confirming the reality of human exposure to endocrine disruptors (CDC report 2009). All endocrine disruptors that have been investigated to date have been detected in one body fluid or another, sometimes with higher levels in children. For instance, over 95% of the US population, including newborns, shows detectable levels of phthalates in multiple body fluids (CDC report 2009).

Exposure of pets to endocrine disruptors has been investigated to a much lesser extent than for humans. However, BPA and PCBs have been detected in canned foods for dogs and cats. In addition, BPA and phthalates were found in dog toys and training devices. PCBs, PBDEs, BPA, and phthalates have been detected in the blood of the cats and dogs that have been tested so far.

Evidence of environmental immunotoxicity

Numerous studies (human epidemiology, laboratory animals, *in vitro* cell assays) have suggested or demonstrated the immunotoxic effects of various endocrine disruptors. For instance, higher levels of certain phthalates have been measured in the house dusts of adults and children with allergic disorders (e.g. asthma, contact dermatitis). BPA and certain phthalates have been shown to increase immune markers in animal models of these allergic disorders. Numerous endocrine disruptors have been found to affect various immune cells *in vitro*, by killing them or by activating them.

There is little literature available about pets and environmental toxicity. No study has been published so far about the immunotoxicity of endocrine disruptors in pets. However, a few recent investigations found some supporting evidence towards a relationship between PBDEs & hyperthyroidism, acromegaly, or diabetes in cats. A few relatively old studies looked at BPA and phthalate toxicity in laboratory dogs, which appeared more sensitive to phthalate toxicity than rats. BPA was also recently shown to kill certain canine cells *in vitro* (coronary smooth muscle and kidney cells).

References

Dietert 2009: Developmental immunotoxicology: focus on health risks.

Kabir et al. 2015: A review on endocrine disruptors and their possible impacts on human health.

Mensching et al. 2012: THE FELINE THYROID GLAND: A MODEL FOR ENDOCRINE DISRUPTION BY POLYBROMINATED DIPHENYL ETHERS (PBDEs)?

Dirtu et al: Organohalogenated contaminants in domestic cats' plasma in relation to spontaneous acromegaly and type 2 diabetes mellitus: A clue for endocrine disruption in humans?

Muller et al. 2006: Evaluation of the health risk to animals playing with phthalate containing toys.

Wooten et al. 2013: Canine toys and training devices as sources of exposure to phthalates and bisphenol A: quantitation of chemicals in leachate and in vitro screening for endocrine activity.

Immunomodulatory Therapy: Can Clinicians Play the Immune System to their Advantage?

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

What is "immunomodulation"?

Immunomodulation can be defined as the adjustment of the immune function, an increase in case of immunostimulation or a decrease for immunosuppression.

Immunotoxicology is a relatively new science. Some limited research was conducted between the end of the 19th century and the beginning of the 20th century, and immunossupressive agents only started being used for therapeutic purposes in the 1960s. Modern immunotoxicology as we know it, started in France in the 1970s, but the field itself was only officially created in 1983.

Immunosuppressants

Corticosteroids

- Mechanism of action: through intracellular glucocorticoid receptors (genomic effects; delayed) & membrane receptors (non genomic, rapid)
- Immunosuppressive effects: neutrophils (decrease adhesion and migration); antigen presenting cells (decrease cytokines; decrease antigen processing; decrease phagocytosis); lymphocytes (especially T; decrease activation, proliferation and cytokines)
- Side effects: multiple and potentially significant (PUPD; polyphagia; hypothalamic-pituitary-adrenal axis suppression; healing delay; infection & tumor risks…)

Antimetabolite agents

- Azathioprine
  - Mechanism of action: bioactivated to a toxic metabolite (6-TGN) responsible for both the wanted immunosuppressive effect but also the numerous and significant side effects; also inactivated to 6-MMP by thioprine methyltransferase (TPMT) and 6-TA by xanthine oxidase; delayed effect
  - Immunosuppressive effects: all immune cells
  - Side effects: potentially severe bone marrow toxicity and hepatoxicity (GI toxicity can usually be controlled); cats are especially sensitive
  - Variability in efficacy and side effects, probably due to drug metabolism polymorphism (e.g. TPMT)
- Methotrexate
  - Mechanism of action: folate analog that inhibits folic acid pathway
  - Immunosuppressive effects: all immune cells
  - Side effects: bone marrow and GI toxicity
- Mycophenolate
  - Prodrug: bioactivated to mycophenolic acid by hydrolysis
  - Mechanism of action: inhibition of Inosine Monophosphaste Dehydrogenase, key enzyme in the guanine synthesis
  - Immunosuppressive effects: mainly lymphocytes
  - Side effects: relatively mild compared to other agents (GI and bone marrow toxicity)
- Leflunomide
  - Mechanism of action: prodrug bioactivated in the GI tract or plasma; dihydrorotate dehydrogenase inhibitor therefore inhibiting pyrimidine synthesis; might also interfere with tyrosine kinases necessary for cytokine synthesis
  - Immunosuppressive effects: mainly lymphocytes
  - Side effects: mild GI toxicity; (some idiosyncratic immune-mediated hepatotoxicity reported in humans)

Alkalynating agents

Mechanism of action: covalent binding to DNA, stopping cell cycle

- Cyclophosphamide
  - Prodrug: biactivated to acrolein & phosphoramid acid
  - Immunosuppressive effects: mainly lymphocytes (especially B)
  - Side effects: bone marrow toxicity; GI toxicity; sterile hemorrhagic cystitis

- Chlorambucil
    - Immunosuppressive effects: mainly lymphocytes (B≈T); slow acting
    - Side effects: much less than cyclophosphamide ☺

Calcineurin inhibitors (cyclopsporine, tacrolimus)

- Mechanism of action: bind to an intracellular receptor that then bind to calcineurin, preventing it from stimulating IL-2 synthesis, further preventing lymphocyte proliferation and differentiation
- Immunosuppressive effects: lymphocytes (mainly T)
- Side effects: relatively mild compared to other agents (GI disturbances; nephrotoxicity; neurotoxicity; hypertension; metabolic abnormalities such as diabetes or dyslipidemia)
- Therapeutic Drug Monitoring available; be careful with PK drug interactions for cyclosporine

Others

Human IVIG (highly purified active immunoglobulins isolated from a large pool of healthy human plasma)

- Mechanism of action: unclear (Fc receptor binding? Cytokine profile modifications? Complement pathway inhibition? Fas apoptosis inhibition?)
- Immunosuppressive effects: all levels of immunity
- Side effects: appear limited; mainly acute hypersensitivity (even in humans); but also reports of thromboembolism, renal failure, hypotension, aseptic meningitis, and fluid overload
- Danazol
    - Mechanism of action: androgenic agent, but mechanism of its immunosuppressive activity unknown
    - Immunosuppressive effects: decrease B lymphocyte-mediated immunity (decreases antibody production; decreases complement & antibody interactions with platelets and red blood cells)
    - Side effects: related to its androgenic activity
- Pentoxifylline
    - Mechanism of action: immunosuppressive mechanism unknown
    - Immunosuppressive effects: decreases cytokines production, inhibits lymphocyte activation, decreases neutrophil and NK cell activity
    - Side effects: limited (no cardiac or respiratory effects)
- Anti-cytokine agents (mainly anti-TNFa agents)
    - Mechanism of action: inhibit a cytokine central to immune function (e.g. TFNa)
    - Immunosuppressive effects: non specific
    - Side effects: secondary infections and tumors
- Gold derivatives (aurothioglucose, auranofin)
    - Mechanism of action: unknown
    - Immunosuppressive effects: delayed; seem to affect T lymphocytes, macrophages and neutrophils
    - Side effects: nephrotoxicity, blood dyscrasia, skin reactions

Immunostimulants

We know much less agents that stimulate the immune system than immunosuppressive drugs. It is important for clinicians to realize that there is a striking lack of EBM information to support the therapeutic use of these agents, especially in veterinary medicine.

Cytokines & immune derived proteins

- **Lymphocyte T-Cell Immunomodulator** (LTCI, IMULAN from BioTherapeutics) is a protein isolated from the supernatant of bovine thymic epithelial cells. It is thought to stimulate immature T helper cells and has been approved as adjunctive therapy in FeLV and FIV cats.
- **IFNg**: To date, there is only EBM available to support its use in certain viral infections in several species.
- **GM-CSF** stimulates myeloid hematopoiesis of granulocytes/monocytes precursors and their differentiation into granulocytes and monocytes. It also stimulates the early differentiation of myeloid precursors into reticulocyte precursors.

Antimicrobials

- Levamisole
    - Mechanism of action: uncertain (phosphodiesterase inhibition)
    - Immunosuppressive effects: restores T lymphocyte and antigen presenting cell functions, and promotes differentiation of lymphocyte precursors into T lymphocytes
    - Side effects: GI and neurotoxicity
    - EBM: limited info in cats, dogs, pigs

Antioxidants

Antioxidants are often considered to be immune stimulants, however there is very little evidence (especially direct evidence) supporting this belief. Indeed, confounding factors and biases contaminate many of the few studies available. The other issue associated with antioxidant therapy is the fact that the content (of the active ingredient and of potential contaminants) is not guaranteed in nutraceuticals as it is with FDA-controlled drugs.

See the CVC San Diego 2015 Proceeding "Antioxidant therapy" for more information. -

"Biotics"

Prebiotics are indigestible food ingredients (including dietary fiber) that have a beneficial effect on commensal bacteria. The World Health Organization defines **probiotics** as "live microorganisms which when administered in adequate amounts confer a health benefit on the host". Finally, **synbiotics** are a mixture of pre- and pro-biotics with the underlining assumption that the combination will have a synergistic effect.

Like for antioxidants, there is no reliable evidence that "biotics" improve immunity itself. However, there is increasing evidence that local and overall immunity is affected by the microbiome (commensal microbes), and that "biotics" affect that microbiome. So future research on the interactions between immunity and "biotics" will hopefully support some interesting therapeutic applications.

Others

- Lactoferrin
- Herbs

References

de Vrese M et al 2008: Probiotics, prebiotics, and synbiotics. Adv Biochem Eng Biotechnol. 2008; 111:1-66

Puertollano MA et al 2011: Dietary antioxidants: immunity and host defense. Curr Top Med Chem. 2011; 11(14):1752-66

Thacker EL: Immunomodulators, immunostimulants, and immunotherapies in small animal veterinary medicine. Vet Clin North Am Small Anim Pract. 2010; 40(3): 473-83

Whitley NT et al: Immunomodulatory drugs and their application to the management of canine immune-mediated disease. J Small Anim Pract. 2011; 52(2):70-85

Drug Interactions in the Life of a Clinician

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

A drug interaction is defined as any modification of the effect of a drug when administered with another drug (concurrently or in close sequence). This effect can be a decrease or an increase in the action (therapeutic or toxic) of either of the two drugs. It is important to remember that this interaction can be either beneficial or disadvantageous. It is also important to note that nutraceuticals and herbal supplements can also interact with drugs.

Different outcomes of a drug interaction

If Ea is the effect of drug A, Eb the effect of drug B, and Eab the effect observed when both drugs are given together, there are 4 possible outcomes:

- Neutral effect
  - Eab = Ea or Eb
  - When 2 drugs have completely unrelated pharmacokinetic profiles, mechanisms of action, or tissue effects and therefore don't affect each other
- Antagonistic effect
  - Eab < Ea and Eb
  - When 2 drugs compete for part of their pharmacokinetic profiles; when 2 drugs have action mechanisms that antagonize each other; or when 2 drugs compete for the same receptor
- Additive effect
  - Eab = Ea + EB
  - When 2 drugs have complementary mechanisms or effects that simply add up
- Synergistic effect (rare despite the term being commonly used instead of additive effect)
  - Eab > Ea + Eb
  - When 2 drugs have complementary mechanisms or effects that enhance each other

It is important to realize that antagonistic interactions can sometimes have a beneficial outcome for the patient (e.g. antidotal drug decreasing the absorption of a toxic drug) and additive/synergistic interactions can have a negative outcome for the patient (e.g. two nephrotoxic drugs together).

Drug interaction categories

Drug interactions themselves can be subdivided into categories:

Pharmacokinetic interactions

- Absorption interactions
  - Transporter & mucosal metabolism (e.g. competition for Pg-p or CYP3A4 in GI epithelium)
  - Physiology of absorbing tissue (e.g. prokinetic agent & GI flow & oral absorption; antibiotics & gi flora-dependent entero-hepatic cycle)
  - Availability of transportable form (e.g. activated charcoal & overdose; Al in sucralfate & tetracyclines or fluoroquinolones)
- Distribution interactions
  - Local tissue transporters & drug metabolism (e.g. competition for P-gp transport through blood-brain barrier)
  - Local tissue physiology (e.g. NSAIDs normalizing blood flow to target organ; diuretics & hydrosoluble drug)
  - Plasma protein binding competition; only significant with highly protein bound drugs (>90%) with a narrow therapeutic index and when administered by rapid IV; albumin & acidic drugs or αglycoproteins & alkaline drugs
- Metabolism interactions
  - Enzyme induction (e.g. rifampin; omeprazole; phenobarbital)
  - Enzyme inhibition/competition (e.g. cimetidine; most azoles; many fluoroquinolones; methyxanthines)
  - Liver physiology (e.g. decreased blood flow to liver during anesthesia; acetaminophen-induced GSH depletion & opioid conjugation)
- Elimination interactions
  - Tissue physiology of the eliminating organ (e.g. decreased renal blood flow during anesthesia; phenobarbital-associated decreased bile flow)

- Local tissue transporters & drug metabolism (e.g. decreased statin elimination by cyclosporine OAT inhibition)
- Urine pH (e.g. acidifying urines to increase the renal elimination of an alkaline drug)

Pharmacodynamic interactions

- At the molecular target level
  - Antagonistic interaction when both drugs target the same molecular target (competition): e.g. using 2 drugs from the same drug class!
  - Additive or synergistic effect when the two drugs have different binding site on their common molecular target: e.g. GABA receptor & benzodiazepine and barbiturates
- At the cellular level
  - Antagonistic interaction when a drug decreases the synthesis of another drug's target: e.g. azoles decreasing the synthesis of egesttrol (amphotericin target)
  - Additive or synergistic effect when two drugs target two different steps in a sequential cellular pathway (e.g. TMP and SMX sequential inhibition of folate pathway in certain bacteria)
  - Positive interaction when a drug promotes the synthesis of a molecule that decreases the toxicity of another drugs (e.g. GSH precursors & acetaminophen toxicity)
- At the clinical outcome level
  - Antagonistic interaction when the clinical effect of two drugs are antagonistic: e.g. immunosuppressive dose of corticosteroids & antibacterial agents; certain diuretics & K supplementation
  - Additive or synergistic effect when two drugs target two different steps in a sequential pathological pathway (e.g. multi-analgesia therapy)

Drug interaction risk factors

When considering unwanted drug-drug interactions, several risk factors need to be taken into account by the clinician very carefully:

- Drugs that interfere with PK
- Polypharmacy (e.g. hospitalization, especially in ICU; chronic diseases)
- Conditions that already affect important PK factors (e.g. decreased plasma protein levels in advanced liver disease)
- New drugs for which the profession has little toxicity background
- Compounding, which can modify the drug PK profile

Predicting, preventing, identifying drug interactions

Numerous softwares have been developed for human medicine that can help clinicians prevent and/or identify potential drug interactions. They are commonly used by human pharmacies, but they have not yet been evaluated and/or adjusted for veterinary species.

Therapeutic drug monitoring (TDM) can also be very helpful in cases of drug interactions, and should be considered as common practice in high-risk patients whenever possible.

References

Mills BM, et al: Current cytochrome P450 phenotyping methods applied to metabolic drug-drug interaction prediction in dogs. Drug Metab Dispos. 2010; 38(3): 396-404.

Goodman L et al: Potential Drug Interactions with Dietary Supplements. Compendium 2005. 27(10): 780-90

Reis AM et al: Evaluation of three brands of drug interaction software for use in intensive care units. Pharm World Sci. 2010; 32(6): 822-8

Antioxidant Therapy

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

What is oxidative stress?

It is an imbalance between the effects of oxidants (such as reactive oxygen species, ROS) and the ability of antioxidant biological systems to detoxify the oxidant or to repair the damage it induced.

It is important to realize that an oxidant usually is an oxidizing agent as well. Indeed, it can oxidize another molecule by acquiring one or several of its electrons. An electron donor molecule (usually in the form of an hydrogen atom) would be a reducing agent that gets oxidized in the process.

Free radicals are molecules with an unpaired electron on their outer orbit. They therefore seek to acquire electrons from other molecules to stabilize their structure. Reactive oxygen species (ROS) are small molecules that contain oxygen atoms with missing electrons (e.g. superoxide radical $O_2^{\bullet -}$ or hydroxyl radical $HO^{\bullet}$). H_2O_2 (hydrogen peroxide) is not an ROS per se, but it can form ROS when reacting with transition metals such as iron. These molecules are very instable and highly reactive as they seek electrons from other molecules, oxidizing them in the process.

Where do ROS come from?

ROS can be endogenous or exogenous. Most cellular ROS are byproducts of the mitochondrial respiration. Their leakage into the cytosol increases when the integrity of the mitochondrial membrane is compromised. This is the case during hypoxia or ischemia for instance. Normal cellular enzymatic reactions, especially those involving oxidation, also generate some ROS.

Exogenous ROS can come from the ingestion of certain toxins (e.g. certain mycotoxins) or exposure to ionizing radiations (e.g. UV).

What are the beneficial aspects of oxidative stress?

ROS have beneficial effects that are part of normal body functions. For instance, they are a key component of innate immunity against microbes (e.g. neutrophil burst). In addition, ROS play an important role in regulating gene expression; more specifically, the expression of genes with an Antioxidant Response Element (ARE) in their promoter, is regulated by the intracellular redox status. ROS are also important in controlling apoptosis. Interestingly, ROS are part of the therapeutic function of radiotherapy.

What damages ROS and oxidants in general can do?

ROS are highly reactive molecules that can react with cellular macromolecules (proteins; lipid membranes; DNA). The oxidation process can either affect the macromolecule structure or its activity. This can eventually lead to cell death and if this becomes to extensive, serious tissue damage can occur. Thus oxidative stress has been shown to play an important role in the pathogenesis of numerous diseases: e.g. ischemia-reperfusion injury; degenerative diseases; immune disorders; burn; cardiovascular diseases…

What are the natural cellular defenses against oxidative stress?

Protein antioxidant systems

- Superoxide dismutase & Catalase: SOD reduces O2 -. to H_2O_2. CAT then reduces H_2O_2 to water.
- GSH pathway enzymes: γ-glutamyl cysteine synthase and GSH synthase form GSH from glutamate, cysteine and glycine. This reduced form of GSH can be oxidized while reducing H_2O_{22} to H_2O by GSH peroxidase. GSH reductase reduces GSH back to its reduced form using NADPH.
- Misc proteins: Certain proteins chelate transition metals that could entertain a ROS chain formation: e.g. transferrin; lactoferrin; albumin…

Non-protein antioxidants

- Vitamin E & Vitamin C: Tocopherols and ascorbic acid can both reduce oxidants. Vitamin C is present in the water compartments of the cell while vitamin E is present in the lipid membrane structures. Vitamin C can reduce back the oxidized form of vitamin E. The DHA reductase reduces back the oxidized form of ascorbic acid (DHA) using GSH.
- Glutathione (GSH) & cysteine: GSH is a tripeptide with one functional thiol group on its cysteine. GSH is the main intracellular small antioxidant while cysteine is very important is extracellular fluids. – See GSH pathway below. -

Evaluating oxidative stress *in vivo*

It is presently very difficult to accurately assess oxidative stress in patients. Indeed, of all the markers known to be associated with oxidative stress or antioxidant systems, we do not know which combination accurately reflects the redox status of an individual. In

addition, some of the assays presently available to measure some of these biomarkers are difficult to conduct routinely in clinics. Finally, collection and processing can affect redox markers in biological samples.

Examples of oxidative stress measurements:

- Levels or activity of antioxidant proteins
- Levels of ROS themselves: NMR; Electron Paramagnetic Resonance; Electron Spin Resonance and Radical Trapping
- Lipid peroxidation markers: Thiobarbituric Acid; Reacting Substances; malondialdehyde lipid hydroperoxides; conjugated dienes; F2-isoprostanes
- Protein oxidation markers: gluathionylation; carbonation; nitration; halogenation
- DNA oxidation markers: DNA adducts; DNA breaks

Pharmacological antioxidants

It is important to distinguish pharmaceuticals from nutraceuticals when it comes to antioxidants. In the first case, the agent has gone through a thorough regulatory process to prove its safety and efficacy for certain indications in certain patients. The production of these approved antioxidants is then controlled and inspected by the FDA. Nutraceuticals are not regulated by the FDA; there is therefore no guaranty that they are effective, safe, or that the formulation contains the claimed amount of active ingredient and no contaminants.

It is also important to realize that most antioxidants undergo oxidation when reducing their target oxidant. Although usually much less reactive than the oxidant it reduced, an oxidized antioxidant will have to be removed or reduced back by the cell. This means that in excess, such such antioxidants can also be toxic.

Vitamins

- Vit C (ascorbate)
- Vit E (tocopherol)
- B vitamins (thiamine; riboflavin; niacin…)
- Carotinoids (βcarotene; lycopene…)
- Flavonoids

Minerals

- Selenium
- Zinc

GSH precursors

- N-acetylcysteine (NAC)
- S-adenosylmethionine (SAMe)

Others

- Melatonin
- Lactoferrin

Nutritional antioxidants

A balanced diet normally contains numerous antioxidants. It is well known that anorexia, but also unbalanced diets, are associated with oxidative stress. Importantly, a well-balanced diet might not provide enough antioxidants if those are not properly absorbed. For instance, vitamin E absorption is chylomycron-dependent, and the absorption of selenium depends on the presence of methionine and cysteine.

References

Mandelker L.: Cellular effects of common antioxidants. Vet Clin North Am Small Anim Pract. 2008; 38(1): 199-211
Palmieri B et al: Oxidative stress tests: overview on reliability and use. Part I. Eur Rev Med Pharmacol Sci. 2007; 11(5):3 09-42
Palmieri B et al: Oxidative stress tests: overview on reliability and use. Part II. Eur Rev Med Pharmacol Sci. 2007; 11(6): 383-99.
Viviano KR et al: Glutathione, cysteine, and ascorbate concentrations in clinically ill dogs and cats. J Vet Intern Med. 2009; 23(2): 250-7
Brown SA.: Oxidative stress and chronic kidney disease. Vet Clin North Am Small Anim Pract. 2008; 38(1):157-66
Webb C et al: Oxidative stress and liver disease. Vet Clin North Am Small Anim Pract. 2008; 38(1):125-35
McMichael MA.: Oxidative stress, antioxidants, and assessment of oxidative stress in dogs and cats. J Am Vet Med Assoc. 2007; 231(5): 714-20.

Antibiotic Stewardship:
Antibiotic Resistance Crises and Veterinary Medicine

Sidonie Lavergne, DVM, PhD
University of Illinois
Urbana, IL

What is antibiotic stewardship?

Antimicrobial stewardship, in general, can be defined as an activity that promotes the appropriate selection of antimicrobials and the appropriate dosing regimen during antimicrobial therapy (IDSA guidelines, Infectious Diseases Society of America).

Why do we need antibiotic stewardship?

We have to use antibiotics judiciously: to eradicate (or prevent) the infection more effectively; to reduce toxic side effects; to prevent the emergence or selection of antibacterial resistance; and to save time and limit cost.

Antimicrobial resistance is a growing concern worldwide that is significantly associated with misuse of antimicrobial drugs. The incidence of antibacterial resistance is increasing, especially with antibiotics used very (too) commonly, such as cephalosporins and fluoroquinolones. Even relatively newer drugs, like carbapenems (imipenem), are now associated with alarming rates of resistance. The other side of this worrying situation is that the pharmaceutical industry is not developing new antibiotics. Governments have therefore started taking action, and veterinary medicine is one of their main targets.

Guidelines and recommendations on judicious antibiotic use have been published to address this issue in human medicine. In 2011, the American Veterinary Medical Association (AVMA) created a five-member steering committee to work with the FDA on a policy overseeing veterinary use of antimicrobials. The committee has been focusing on food animals so far to provide input to the FDA about policies and regulations that will dictate the use of antimicrobials in these animals. Unless the antibiotic resistance crisis gets under control, it is unlikely that restrictions will continue to only target food animals in the future. The World Organization for Animal Health has also included objectives for veterinary drugs, especially antimicrobials, in its Strategic Plan.

Factors entering the decisions around antibiotic therapies

Inadequate reasons to use an antibiotic when considered on their own

- Fever
- High white blood cell count
- Emergency status
- Clinical sign severity
- Patient already receiving an antibiotic, prescribed by ourselves, a colleague, or a referring veterinarian

Decision factors based on the bacteria

1. Is it really a microbial infection? Or is there a real risk for a microbial infection to develop?
2. If yes, is it a bacterial infection rather than another type of microbe?
3. If yes, which bacteria might be involved (based on empirical deduction or culture)?
4. What antibiotics is this bacteria sensitive to? (based on empirical choice or sensitivity test)

Decision factors based on the antibacterial agent

- Effective drugs available against the suspected bacteria
- Pharmacokinetic profile: absorption; tissue distribution; elimination mechanisms; half-life…
- Toxicity profile: side effects and potential drug interactions
- Resistance profile

Decision factors based on the patient

- Species; age; gender…
- Infection location
- Health status

Decision factors based on practicality

- Dosing regimen & duration
- Cost
- On- and off-label options
- Bans (in food and athlete animals)
- Withdrawal times for food animals or athlete animals.

Decision factors based on the environment & the community

- Likelihood for resistance emergence or selection (especially with cephalosporins and fluoroquinolones)
- Drug residues in the environment (not just for food animals!)

- Drug residues in the food supply (for food animals)

Judicious use of an antibiotic

Examples

- Restrict prophylactic antimicrobial therapy unless there is a very strong rationale for an infection risk (especially with surgery) (#)
- Favor narrow spectrum antibiotic therapy whenever possible (avoid "umbrella antimicrobial therapy" at all cost despite its reassuring appeal)
- Favor local administration when possible (BUT make sure EBM is available for efficacy, but also safety)
- Clearly communicate the importance of compliance with the owner to avoid relapse or resistance emergence/selection
- Do not use antibiotics for longer than necessary (*)
- Rotate antibiotics in long-term therapy

(#) When using antibiotic prophylaxis in surgical patients, protocols (timing, dose, route) should not be directly transferred from one species to another or from one drug to another without verifying that pharmacokinetic parameters are similar between situations.

(*) One of the main efforts in antibiotic stewardship started in human medicine is also to reduce the duration of antibiotic therapy as much as possible. For instance, antibiotic courses have been reduced to 3 days for uncomplicated UTIs in women or 7 days for pneumonia in otherwise healthy patients. A few studies in veterinary medicine have tried to investigate shorter antibiotic courses as well.

Infection prevention & alternatives to antibiotics

One of the key aspects of antibiotic stewardship is to not use antibiotics whenever possible. Several other strategies can be used to prevent an infection:

- Vaccination
- Disinfection of facility, cages, and material
- Hand washes before and after each patient
- Decrease surgery duration as much as possible
- Decrease hospitalization duration as much as possible
- Test employees for multi-resistant carriage when repeated multi-resistant bacteria are isolated
- Isolate the patient when a resistant strain is suspected or has been isolated

Other strategies can be considered instead of, or in addition to, antibiotics when a bacterial infection occurs:

- Remove infected sites and/or infected tissue debris whenever possible
- Alternative therapy: e.g. probiotics or immunostimulants

References

http://www.cdc.gov/getsmart/healthcare/learn-from-others/CME/antimicrobial-stewardship.html

Lloyd DH: Alternatives to conventional antimicrobial drugs: a review of future prospects. Vet Dermatol. 2012; 23(4): 299-304

Orand JP: Antimicrobial resistance and the standards of the World Organization for Animal Health. Rev Sci Tech. 2012; 31(1): 335-42, 325-34

Dryden M. et al: Antibiotic stewardship and early discharge from hospital: impact of a structured approach to antimicrobial management. J Antimicrob Chemother. 2012; 67(9): 2289-96

Rogers KS et al: Effects of single-dose and three-day trimethoprim-sulfadiazine and amikacin treatment of induced Escherichia coli urinary tract infections in dogs. Am J Vet Res. 1988; 49(3):345-9.

Grave K et al: Compliance with short-term oral antibacterial drug treatment in dogs. J Small Anim Pract. 1999; 40(4):158-62.

Where's there's Smoke, there's Fire: Emergency Treatment of House-Fire Victims

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

The emergency clinician is frequently called upon to treat burn wounds secondary to thermal, chemical, electrical, or radiation injury. Most burn wounds seen in veterinary medicine are relatively minor, possibly because animals with severe burns and smoke inhalation are less likely to be rescued from the scene of a house fire. However, life threatening burns and inhalation injury are being seen with increasing frequency and the emergency clinician should therefore be familiar with their pathophysiology and management.

Classification of burns

Burns are commonly classified according to the extent of body surface involved and the depth of injury to the skin. Extent of injury is initially estimated in human burn patients using "the rule of nines". This rule divides the adult human body into areas corresponding to 9% of the total body surface area, or multiples of 9%. For example, each forelimb comprises approximately 9% of total body surface area; each hind limb, 18%; head and neck, 9%; chest and abdomen, 18%; back, 18%; and perineum, 1%. Body surface area percentages vary in children, and as such, the rule of nines is not typically used in children less than 10 years of age. Although the rule of nines has been cited in veterinary texts, it seems similarly unlikely that these percentages accurately describe the majority of veterinary patients. Other methods of estimating extent of injury include serial halving (Do burns cover more than half the patient's surface area? If not, do burns cover ¼- ½ the surface area? and so forth), or measuring the burn area in centimeters and using a chart to calculate meters^2 from the patient's body weight in kilograms.

Depth of injury may be described as first-, second-, or third-degree, or using the more recent terms, partial- and full-thickness. First-degree burns involve only the epidermis (like a sunburn), and are bright red, non-blistered, and painful. First-degree burns typically heal within 5 days without scarring, and are therefore not included in the calculation of extent of burn injury unless they exceed 25% of body surface area. Second-degree, or partial-thickness, burns involve all epidermal layers and extend to various depths within the dermis. Superficial partial-thickness burns involve the epidermis and less than ½ of the dermis, and are characterized by blisters, pain, blanching in response to pressure, and intact hairs. The surface may appear moist, red, or mottled. Injuries of this depth typically heal without serious scarring within 2-3 weeks. Deep partial-thickness burns involve destruction of the deep dermal layers and may appear dry, or blistered and moist. As skin thickness is not uniform, partial-thickness burns may interdigitate with full thickness burns, appearing mottled-red intermixed with whitish areas. Deep partial-thickness burns do not blanch, lose hair easily, and heal more slowly, producing scarring and loss of function. They may easily progress to full-thickness injuries as a result of edema, infection, thrombosis, or mechanical injury. Third-degree, or full-thickness, burns involve destruction of the entire dermis, usually extending into the subcutaneous tissues. They are dry, leathery, lack sensation, and appear white or charred. Healing of these injuries can occur only by contracture and epithelial migration from the periphery, or through excision and grafting. Burn injuries that extend into the muscle, fascia, or bone can be seen as well, and are termed fourth-degree burns. These appear similar to third-degree burns, but may result in severe systemic illness if unrecognized due to severe underlying tissue necrosis. Depth of injury can be difficult to assess initially, and usually requires repeated evaluation over the first 24 hours for accurate determination. Once this information is collected, burned patients may be divided into minor, moderate, or severe categories for the purposes of treatment planning.

Pathophysiology of burn shock

Following severe burns (>20% TBSA), a severe systemic inflammatory response may develop within minutes, leading to cardiovascular collapse and multiorgan system failure if not quickly addressed. These systemic manifestations are driven by loss of the protective skin barrier, as well as release of inflammatory mediators from within the damaged tissues. Release of prostaglandins, leukotrienes, and other vasoactive substances leads to a diffuse "capillary leak" syndrome, increasing in proportion to size of burn injury, delay in initiation of resuscitation, age of the patient, and the presence of inhalation injury. This increased vascular permeability results in marked decreases in effective circulating volume as well of the development of edema in injured and non-injured tissues. Edema is further exacerbated by the development of hypoalbuminemia, resulting from loss of albumin through "leaky" vessels, compounded by decreased hepatic albumin production in favor of acute phase protein synthesis. Extensive tissue edema leads to tissue hypoxia at the junction between burned and non-burned tissues (the "zone of ischemia"), and may have adverse effects on depth of burn injury. Thromboxane A_2 and B_2, prostaglandins, cytokines, and reactive oxygen species are produced at the burn site and are associated with local ischemia and further tissue damage. Cardiac output decreases within the first eight hours of burn injury secondary to hypovolemia and myocardial depression associated with release of inflammatory mediators. Arterial blood pressure may be misleading however, as burn patients may have normal or increased blood pressure despite significant hypovolemia due to vasoconstrictive substances released from the burn wound.

Following successful resuscitation, microvascular leak typically “seals” after 18-24 hours. Hypermetabolic response develops during this time with near doubling of cardiac output and resting energy expenditure. Increased gluconeogenesis, protein catabolism, insulin resistance, and weight loss may also be seen. These changes are believed to result from increased cortisol, glucagon, catecholamine, and cytokine release, GI mucosal barrier dysfunction, bacterial translocation, burn wound sepsis, and heat loss. The hypermetabolic response typically persists until all wounds are closed, and continues for some time afterwards.

Sepsis is one of the major causes of death among burn patients. In addition to wound infections, respiratory infections, and catheter-related infections, decreased gastrointestinal perfusion in the first 24 hours following burn injury leads to compromised integrity of the mucosal barrier and allows passage of bacteria and endotoxin. Peak endotoxin levels have been reported to develop as early as 12 hours post-burn,[1] and may contribute to the development of multiorgan failure. It has been reported that patients with extensive burns also have altered humoral and cell mediated immunity attributed to increased levels of cortisol and inflammatory mediators such as TNF, IL-1, and IL-6. This immunosuppression may further contribute to the development of septic complications in these patients.

Inhalation injury contributes significantly to morbidity and mortality in the burned patient. Smoke inhalation triggers release of thromboxane, causing pulmonary vasoconstriction and pulmonary hypertension. Chemical and thermal injuries directly damage the respiratory epithelium, leading to sloughing of the tracheobronchial mucosa, impairment of the mucociliary escalator, and formation of cellular casts that may obstruct the airways and promote bacterial growth. Disruption of respiratory epithelium and vascular endothelium leads to exudation of proteinaceous fluid into the terminal airways and further contributes to respiratory compromise, impaired surfactant production, and bacterial proliferation. Acute lung injury or ARDS may also result *indirectly* from systemic inflammation related to the burn wound or from sepsis arising from various sources including the lungs, burn wounds, GI tract, or catheters.

Prehospital treatment of the burned patient

The first consideration in treatment of the burned patient is to stop the burning process. Flames should be extinguished and any collars or harnesses that may become constrictive should be removed. Because the skin is slow to cool, the burning process may continue for some time after the patient is removed from the heat source. For this reason burned areas should be cooled with running water for up to 10 minutes. Alternatively, cool wet towels can be placed over the burn areas. Ointments should not be applied at this time as these may hinder the subsequent assessment of extent of injury. Cold water or ice should also not be used as this can rapidly decrease the patient’s body temperature and may contribute to increased wound depth by inducing vasoconstriction. To avoid hypothermia during transport, the patient should be wrapped in several clean, dry sheets or blankets.

Primary and secondary surveys

A primary survey should be performed to determine the extent of injury and to institute treatment as needed. Ensuring a patent airway and supporting breathing should be the first priority, followed by shock resuscitation. 100% oxygen should be administered to any patient suspected to have smoke inhalation injury to hasten the elimination of carbon monoxide. Intubation or emergency tracheostomy may be required if airway edema is severe. In the event of orotracheal intubation, tubes should be carefully secured, as worsening edema may make re-intubation more difficult.

Vascular access may be difficult in hypovolemic, burned patients. Ideally, short peripheral catheters should be placed in non-burned areas, though burned areas may be used in the first 24 hours. If burned sites are used for catheterization, the catheters should be removed within 24-48 hours due to bacterial colonization of these areas. Intraosseous catheters are another good alternative for patients in whom vascular access is limited. Central lines may be required in patients with large burns, those needing parenteral nutrition, or those requiring central venous pressure monitoring, but their use should be avoided whenever possible due to the risks associated with hypercoagulability in burned patients.

Following initial stabilization, a secondary survey should be performed to identify concurrent injuries. Patients should be assessed for neurologic injuries secondary to trauma, hypoxemia, or carbon monoxide poisoning. The abdomen should be assessed for compartment syndrome, gastric distension, or other traumatic injuries. The airways and thorax should be carefully ausculted for stridor, crackles, or wheezes, and adequacy of ventilation should be assessed. The face, oral cavity, and pharynx should be examined for the presence of burns or particulate debris that may indicate inhalation injury. Baseline radiographs should be obtained to evaluate for changes related to smoke inhalation or traumatic injury. Chest radiographs may be normal initially, or bronchial markings may be present. The development of pulmonary infiltrates or lobar consolidation may suggest pneumonia. Arterial blood gas evaluation is useful for determination of parameters related to oxygenation and perfusion. However, because both partial pressure of oxygen (pO_2) and oxygen saturation can be misleading in the presence of carbon monoxide (pulse oximetry will misread carboxyhemoglobin as oxyhemoglobin), cooximetry should also be performed if available to determine carboxyhemoglobin levels. Baseline complete blood count, serum biochemistry panel, and urinalysis should be obtained upon admission. The presence of myoglobinuria may indicate a need for higher fluid rates to avoid renal tubular damage. Coagulation testing should be performed, as burned patients may suffer from

hyper- or hypocoagulable states. Blood typing may be indicated if surgery is anticipated for large burns, as these procedures frequently result in significant blood loss. The eyes should be evaluated for the presence of conjunctivitis, particulate material, or corneal ulceration. Corneal ulcers are common secondary to thermal injury or abrasion by particulate material, so fluorescein staining should always be performed. A topical anesthetic such as proparacaine may be used to facilitate examination behind the third eyelids for foreign material, and the eyes should be copiously flushed with sterile saline. Corneal ulcers may be treated with triple antibiotic ophthalmic ointment and atropine ophthalmic drops.

Fluid therapy

The goal of fluid therapy in the burn patient is to restore and maintain perfusion to the tissues while keeping edema fluid to a minimum. The greatest amount of fluid loss in burn patients occurs during the first 24 hours as a result of increased microvascular permeability. Fluids given during this time rapidly leave the vasculature, with colloids having no benefit over crystalloids due to the leakiness of the endothelium. Crystalloids, such as lactated Ringer's solution, are therefore usually the fluids of choice for the first 24 hours.[2] Hypertonic saline, used in some human institutions to decrease crystalloid requirements, is also of questionable benefit and has been associated with adverse outcomes in burn patients.[3] Fluid requirements can be estimated based on percentage of body surface area burned using the Parkland formula. LRS is given at 4 ml/kg x % TBSA, with one half of the calculated volume given within the first eight hours, and the second half given over the next 16 hours. The starting point is the time of injury, not the time of hospital admission. Urine output should reach 0.5-1 ml/kg/hr within the first three hours. If it falls below 0.5 ml/kg/hr, more fluid is needed. Lasix should not be used to increase urine output, as this will further deplete effective circulating volume as well as invalidate the use of urine output as an indicator of shock resuscitation. If total resuscitation needs are estimated to exceed 6 ml/kg/% TBSA, central venous pressure (CVP) measurement should be performed to assess intravascular volume. If blood volume is assessed as adequate, dopamine (5-15 ug/kg/min) or dobutamine (3-10 ug/kg/min) may be added to maintain cardiac output and arterial blood pressure.

Many resuscitation formulas recommend adding colloids at 0.5 ml/kg/day x % TBSA after 24 hours, as colloids are more likely to be retained within the vasculature at that time. (Note: some formulas advocate colloid supplementation as early as 8 hours post-burn). Hetastarch, fresh frozen plasma, or albumin may be used, though it is interesting to note that albumin supplementation in burn patients has not been associated with decreased mortality nor mobilization of tissue edema within the first week.[4] Crystalloids are continued only at doses needed to maintain urine output, approximately 1.5 ml/kg/day x %TBSA.

It is important to emphasize that these fluid formulas should be used only as guidelines, and should be frequently reevaluated and adjusted based on physiologic parameters. Additionally, because these formulas have been derived from experiences with human patients and experimental models in animals, they should be applied cautiously in clinical veterinary patients, and dose reduction may be appropriate in cats.

Wound care

Patients with small burns rarely develop overwhelming wound sepsis, and medical management for several days usually allows better determination of wound depth and extent. Wounds should be gently clipped of hair and then rinsed or soaked in dilute povidone-iodine solution. Animals with thick coats may hide more extensive wounds than initially suspected, so liberal clipping should be performed in these cases. After the wounds are cleaned, topical agents may be applied to decrease pain, prevent desiccation, and delay bacterial growth. Silver sulfadiazine is used most commonly as it has broad antibacterial activity, is soothing, and has no systemic effects. Eschar penetration is poor however. In contrast, mafenide acetate has excellent eschar penetration and similarly broad antibacterial effects, but can be painful when applied. Topical agents can be applied directly to wounds with a clean tongue depressor, or the burn can be covered with impregnated dressings. Gloves should be worn at all times during wound care to avoid spread of resistant organisms.

The choice of dressing is a much-debated topic. Of critical importance is the maintenance of a moist environment to promote rapid wound healing. This may be accomplished through the use of semi-occlusive dressings, or with various types of hydrogel shown to speed healing and to decrease scarring of partial thickness wounds. Wounds with heavy exudation may be managed with dry, absorbent bandaging material applied in layers. Following application of silver sulfadiazine, a non-adherent and porous inner layer is applied, allowing passage of fluid and exudates. Absorbent padding or gauze should then be applied, followed by an elastic outer layer. Bandages should be loose enough to avoid putting additional pressure on the wounds.

Patients with more extensive burns generally do better if full thickness wounds are excised within the first week, starting 24-48 hours following burn injury. Early wound excision has been shown to circumvent the development of wound sepsis and SIRS, attenuate the hypermetabolic response, and reduce morbidity and mortality, length of hospital stay, and pain in patients with large burn wounds.[5,6] Burns >20% total body surface area may require staged procedures, and burns > 50% TBSA make closure with autograft impossible. Once autograft closure is no longer feasible, temporary closure may be performed using cadaver allografts, porcine xenograft, or synthetic skin substitute, though these procedures are not routinely performed in veterinary medicine. Research is currently underway to evaluate the use of synthetic membranes such as Integra (Integra Life Sciences, Plainboro, NJ) that mimic

vapor transmission characteristics of normal skin and allow fibrovascular ingrowth from the host, ultimately undergoing biodegradation.[7]

Prophylactic antibiotic usage is controversial as penetration of the eschar is unlikely and the potential for development of antibiotic resistance exists.[8] As such, antibiotic therapy is generally reserved only for documented infections and should be based upon culture and sensitivity of full thickness eschar biopsies. Excision of eschar has been associated with bacteremia however, so intraoperative antibiotic administration has been recommended.

Inhalation injury

Management of smoke inhalation is typically supportive. The head should be elevated and excessive fluid therapy avoided to minimize development of edema. However, it should be noted that patients with inhalation injury typically have higher fluid requirements than those with burn injury alone due to increased severity of systemic inflammatory response. Bronchospasm may be treated with systemic β agonists such as terbutaline, or inhaled albuterol administered via spacer (Aerokat, Trudell Medical, London, Ontario). Prophylactic antibiotics have not been shown to reduce morbidity or mortality associated with smoke inhalation, and may contribute to resistant infections. Antibiotics should therefore be reserved for documented infections, and should be based on tracheal wash culture and sensitivity when possible.

Supplemental oxygen should be provided as needed, based on blood gas analysis. Carbon monoxide poisoning, if present, may be treated with hyperbaric oxygen therapy, but in most cases administration of 100% oxygen for 6 hours[9] constitutes appropriate therapy without the increased risks and cost involved in transporting a critically ill patient to a facility with a hyperbaric oxygen chamber. Administration of 100% oxygen has been shown to shorten the half life of carboxyhemoglobin from several hours to approximately 74 minutes (range 26 to 148 minutes).[10]

If ventilation is required, lung protective strategies should be use to minimize ventilator induced lung injury. Peak airway pressures greater than 40 cm H_2O and FiO_2 greater than 0.60 should be avoided, using PEEP, faster rate, and permissive hypercapnea to maintain an oxygen saturation greater than 90% with a PCO_2 less than 65 mmHg. Strict attention should be given to suctioning of airways, and asepsis should be maintained to minimize the likelihood of nosocomial infection.

Nutritional support and the hypermetabolic response

Nutritional support is an important component of burn care, and should ideally be provided as soon after resuscitation as possible. Enteral nutrition using a nasogastric or esophagostomy tube is ideal, as this is believed to decrease gut atrophy, possibly decreasing bacterial translocation and subsequent sepsis. Resting energy requirements may be calculated using the formula [RER= Weight (kg) x 30 + 70]. Although the use of an illness energy requirement calculation (IER) has largely fallen by the wayside in veterinary medicine, multiplying resting energy requirements by an IER of 1.3-1.7 may be appropriate in the burned patient to compensate for the anticipated hypermetabolic response. The use of such formulas has been shown to correlate poorly with actual energy requirements in both human and veterinary patients however, and as such, indirect calorimetry would be a more accurate method of determining resting energy requirements if available. Critically ill patients or those with very large burns may not tolerate their full nutritional requirements because of ileus or vomiting, and these patients may benefit from the supplementation of parenteral nutrition through a designated central line.

Pain management

Pain can be reduced initially using cool compresses and soothing ointments such as silver sulfadiazine. Once burn shock has been adequately controlled, narcotics may be administered. Pure agonists such as fentanyl (CRI: 3-5 ug/kg/hr), hydromorphone (CRI: 0.025 mg/kg/hr), or morphine (0.5-1 mg/kg SQ q4h) are recommended for patients with moderate to severe pain. Ketamine can be useful for the relief of somatic pain, and may be used in conjunction with narcotics at a constant rate infusion of 0.15-0.6 mg/kg/hr. Lidocaine may provide adjunctive analgesia in addition to free radical scavenging properties, and may also be added at a rate of 1.5-3 mg/kg/hr. If using constant rate infusions, a loading dose equal to the hourly rate should initially be administered.

References

Zhang C, Sheng ZY, Hu S, et al. Translocation of intestinal endotoxin and bacteria induced by the apoptosis of enterocytes in scald rats after delayed resuscitation. Zhongguo Wei Zhong Bing Ji Jiu Yi Xue 2003;15:150-3.

Hagstrom M, Wirth GA, Evans GR, et al. A review of emergency department fluid resuscitation of burn patients transferred to a regional verified burn center. Ann Plast Surg 2003;51:173-176.

Huang PP, Stucky FS, Dimick AR, et al. Hypertonic sodium resuscitation is associated with renal failure and death. Ann Surg 1995;221:543-557.

Zdolsek HJ, Lisander B, Jones AW, et al. Albumin supplementation during the first week after a burn does not mobilize tissue oedema in humans. Int Care Med 2001;27:844-852.

Tompkins RG, Remensnyder JP, Burke JF, et al. Significant reductions in mortality for children with burn injuries through the use of prompt eschar excision. Ann surg 1988;208:577-585.

Barret JP, Herndon DN. Effects of burn wound excision on bacterial colonization and invasion. Plast Reconstr Surg 2003;111:744-752.

Boyce ST, Kagan RJ, Meyer NA, et al. Cultured skin substitutes combined with Integra artificial skin to replace native skin autograft and allograft for the closure of excised full-thickness burns. J burn Care Rehabil 1999;20:453-461.
Wickman K. Burns, bacteria, and antibiotics. Swed J Defense Med 1970;6:202-206.
Piantadosi CA. Hyperbaric oxygen for acute carbon monoxide poisoning. N Engl J Med 2002;347:1053-1055.
Weaver LK, Howe S, Hopkins R, et al. Carboxyhemoglobin half-life in carbon monoxide-poisoned patients treated with 100% oxygen at atmospheric pressure. Chest 2000;117:801–808

Reproductive Emergencies

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Reproductive problems often arise after normal business hours, so it is not uncommon for them to fall into the domain of the emergency veterinarian. As most owners lack medical knowledge, they frequently look to the veterinarian to answer questions and to identify potential problems. The emergency clinician must therefore be familiar with normal reproductive behavior in addition to the common emergencies that may arise. With this goal, we will review the events surrounding normal parturition as well as the common complications that may develop during this period.

Normal reproductive physiology

Normal gestation length in the dog may range from 57-72 days from the time of first breeding, with an average length of 65 days.[1-2] Because cats are induced ovulators, there is generally less variability in gestation length, which ranges from 63-65 days. Ovulation may not take place after the first breeding however, so in the event of multiple breedings, uncertainties with regards to gestation length may still be present in the cat. As the whelping date approaches, a number of clues may point toward impending parturition. Mammary development, vulvar enlargement, mucous vaginal discharge, and relaxation of the pelvic ligaments are early signs of approaching parturition. Onset of lactation may be noted in primiparous bitches within 24 hours of parturition, but in multiparous bitches may occur several days before parturition. A sudden drop in body temperature (>2°F) is generally noted within 24 hours of parturition[3] in dogs and cats as a result of decreases in progesterone levels, but this finding is not always reliable. In one recent study, nadir temperature occurred >48 hours before parturition in 24% of dogs, and an appreciable drop in temperature (>1° F) was not seen in 35% of dogs.[4]

Normal parturition proceeds in three stages. The first stage is characterized by subclinical uterine contractions and progressive dilation of the cervix. During this stage, which typically lasts for 6-12 hours, bitches may show signs of restlessness, apprehension, panting, nesting behaviors, hiding, and anorexia. Queens may be tachypneic, restless, and vocal, or may lay in their nesting boxes, purring. Active expulsion of the fetuses occurs during the second stage of labor. The first fetus is usually delivered within 1 hour of onset of stage 2 labor in cats, and within 4 hours in dogs, with subsequent deliveries every 15 minutes to 3 hours.[5,6] Active straining generally results in expulsion of a fetus within 15 minutes. The entire process generally occurs over 2-12 hours, but may take as long as 24 hours with large litter sizes. The third stage of labor results in expulsion of the placenta. One placenta should be identified for each fetus delivered. Placentas are usually still attached to the fetus by the umbilical cord and emerge with the fetus, but may emerge within 15 minutes to several hours if they become detached. Lochia, a greenish vaginal discharge, indicates placental separation and may be seen during all stages of labor. Following parturition, the discharge gradually becomes red-brown, decreasing in volume over 4-6 weeks as uterine involution takes place.

Dystocia

Historical and physical exam findings that should prompt a clinician to suspect dystocia are as follows:[1]

- A definite cause is apparent (ie. fetus lodged in birth canal, pelvic fractures)
- Gestation is prolonged (>70 days) with no evidence of labor
- Temperature has dropped to <100° F and returned to normal with no evidence of labor within 24 hours
- Lochia is noted and 2 hours have elapsed without expulsion of a fetus
- Strong and persistent contractions fail to result in the delivery of a puppy within 30 minutes
- Weak and infrequent contractions fail to produce a fetus within 4 hours.
- More than 4 hours have elapsed since the birth of a puppy with no evidence of ongoing labor
- Signs of systemic illness or severe pain are present

Dystocia may result from either maternal or fetal factors that prevent delivery from taking place. Uterine inertia is the most common maternal cause of dystocia,[3,7-9] seen when the myometrium produces only weak and infrequent contractions that fail to expel a normal fetus through a normal birth canal. Primary uterine inertia is considered *complete* when gestation that has exceeded its expected length with no evidence of progression into active labor. Primary uterine inertia is termed *partial* if the bitch initiates parturition and expels one or more healthy fetuses, but then subsequently fails to deliver the remaining fetuses as a result of myometrial fatigue. Uterine inertia may also be considered *secondary* if myometrial failure results from prolonged attempts to expel an obstructed fetus, and persists following relief of obstruction. Morphologic causes of dystocia are those in which an anatomic abnormality of the bitch or queen results in obstruction of the birth canal (eg. small birth canal, pelvic fractures)

Fetal factors that may result in dystocia include malpresentations, oversize, fetal malformations, and fetal death. Some of the commonly described malpresentations include transverse presentation, lateral or ventral flexion of the neck, anterior presentation with flexion of one or both forelimbs, posterior presentation with retention of both hindlimbs, and simultaneous presentation of two fetuses.

It should be noted that posterior presentations are considered to be a normal variation in dogs and cats, occurring in approximately 40% of deliveries.[3] Fetal oversize is another potential cause of dystocia, most commonly seen with single pup pregnancies. Fetal death is an infrequent cause of dystocia, increasing the likelihood of malpresentation because of failure to rotate and extend the head and legs, which commonly occurs immediately prior to parturition. Fetal malformations are another potential cause of dystocia, with anasarca (generalized subcutaneous edema), hydrocephalus, cerebral and cerebrospinal hernias, abdominal hernias, duplications, and rib cage malformations among the more commonly noted.[7,8]

Diagnosis of dystocia

Workup of a patient that is presented for dystocia begins with a complete history and physical exam, including digital vaginal exam. If a fetus is lodged within the birth canal, digital manipulation should be attempted. The fetus may be grasped around the head and neck, around the pelvis, or around the proximal portions of the hind limbs, depending on fetal presentation. Excessive traction should never be applied to a single extremity because of the ease with which these may be avulsed. With the dam restrained in a standing position, traction is applied in a posterior-ventral direction. The fetus may be gently rocked back and forth, and twisted diagonally to free shoulders and hips "locked" in the pelvic canal. If flexion of head or extremities is preventing delivery, a finger may be used to extend them. One cannot overemphasize the importance of using copious amounts of sterile lubricant during obstetrical maneuvers, applied digitally or infused around the fetus using a red rubber catheter.

Radiographs should be obtained in any animal experiencing dystocia. Radiographs are accurate for assessing the number, size, location, and position of fetuses, as well as maternal pelvic morphology and general status of the abdomen. Fetal viability is more difficult to assess from radiographs, unless evidence of fetal decomposition is present. Signs of decomposition include intrafetal or intrauterine gas patterns, awkward fetal postures, collapse of the spinal column due to loss of muscular support, and overlapping of the bones of the skull. Ultrasound may be a more useful tool for assessment of fetal viability, fetal malformations, and fetal distress. Normal fetal heart rates have been reported at 180-245 beats per minute in dogs and up to approximately 265 bpm in cats.[10] Deceleration of fetal heart rates to less than 180 beats per minute and the presence of fetal bowel movements on ultrasound have been shown to correlate with severe fetal distress, and may indicate a need for rapid intervention.[11]

Medical management should be considered if there is no evidence of obstruction, and fetal and pelvic size appear normal. Oxytocin is a peptide hormone that increases the frequency and strength of uterine contractions by promoting influx of calcium into myometrial cells. Oxytocin also promotes post partum uterine involution, aids in control of uterine hemorrhage, and assists in expulsion of retained placentas. The dose for oxytocin has traditionally been reported at 5-20 units IM in the dog and 2-4 units IM in the cat. However, with an increase in the use of uterine contraction monitoring (Whelpwise, Veterinary Perinatal Specialties Inc, Wheat Ridge, CO) in veterinary patients, there is a growing body of evidence to suggest that traditional doses may be too high, potentially causing uterine tetany, ineffective contractions, and decreased fetal blood flow. Recent data suggests that doses of 0.5-2 units are effective in increasing the frequency and quality of contraction.[4,12] The oxytocin dose may be repeated in 30 minutes if expulsion of a fetus has not resulted. If labor proceeds and a fetus is delivered, oxytocin may be repeated every 30 minutes as needed to assist in expulsion of the remaining fetuses.

Calcium gluconate may be considered if weak, infrequent contractions are noted[4,12] or when labwork reveals hypocalcemia. Retrospective studies have indicated that many patients who fail to respond to oxytocin alone may respond to a combination of calcium and oxytocin.[3,8] The dose for calcium gluconate (10% solution) as a uterotonic agent is 11 mg/kg diluted in saline and given subcutaneously, or added to IV fluids and given slowly while monitoring an ECG for arrhythmias. If hypocalcemia is documented, a dose of 50-150 mg/kg intravenously should be used. Subcutaneous administration has been reported to result in irritation and potential granuloma formation, though this is an infrequent complication. Dextrose infusion should also be initiated if hypoglycemia is evident on labwork.

Surgical management should be considered for the following conditions:[1]

- Complete primary uterine inertia
- Partial primary uterine inertia or secondary uterine inertia where large numbers of fetuses remain and response to drugs is unsatisfactory,
- Fetal oversize
- Gross abnormalities of maternal pelvis (fractures, masses)
- Fetal malformations
- Malpresentation that is not amenable to manipulation
- Past history of dystocia or c-section
- Fetal putrefaction
- Maternal evidence of systemic illness
- Suspicion of uterine torsion, rupture, prolapse, or herniation
- Evidence of fetal distress with poor response to medical intervention

An anesthetic protocol for caesarian section should be selected with the goal of maximizing survival of neonates and dam. Attempts should be made to minimize exposure of the fetus to anesthetics by keeping the time from induction to delivery as short as possible. Ideally, the dam should be clipped and prepped prior to induction, equipment should be out, and the surgeon should be scrubbed and ready. Induction agents should be given *to effect*. Regional techniques such as line blocks and epidurals may help to minimize the need for other drugs. A line block can be performed using 2 mg/kg lidocaine infused along the ventral midline. Alternately, epidural lidocaine may be administered in dogs at a dose of 2-3 mg/kg, not to exceed a total volume of 6 ml. Propofol (4-6 mg/kg IV) or mask inductions are most commonly used for caesarian section at this time, and have been associated with reduced neonatal mortality in dogs. Anesthetic agents that have been associated with increased neonatal mortality include thiopental, ketamine, xylazine, medetomidine, and methoxyflurane.[13-15]

Neonatal resuscitation

A warm (90° F) incubator, hemostats, suture material, suction bulb syringes, emergency drugs, and an adequate supply of soft dry towels should be prepared beforehand. As each neonate is handed off, the umbilical cord should be clamped and ligated 1-2 cm from the umbilicus. Fetal fluids and amnion should be removed by rubbing briskly with a soft, clean towel. The oral cavity and nares may be suctioned with a bulb syringe. The old practice of "swinging" puppies to clear their airways is best avoided because of the potential for cerebral hemorrhage due to concussive injury. If vigorous rubbing is not successful at stimulating respiration, positive pressure ventilation may be initiated with a snug fitting mask, keeping the neonates head and neck extended to ensure adequate inflation of the lungs. Alternately, intubation may be accomplished using a catheter or small, uncuffed endotracheal tube. Because isoflurane is minimally metabolized, ventilation is the primary route of elimination. Thus, its depressant effects can not be reversed until the neonate breathes. Cardiac massage may be instituted if a heart beat is not detected once warming and ventilation measures have been instituted. Epinephrine (0.1 mg/kg) may be given intratracheally, intraosseously, or intravenously if cardiac massage is unsuccessful. Naloxone (0.1 mg/kg) should be considered if the dam received opioid analgesics as part of the anesthetic regimen. Although doxapram (dopram) is routinely administered in many practices as a respiratory stimulant, it is not used for this purpose in the resuscitation of human neonates and there is no evidence to support its use in veterinary patients.

The prognosis for medical management of dystocia is guarded, with success rates of 20-40% in the veterinary literature.[3,7-9] Additionally, stillbirth rates have been shown to rise when dystocia is allowed to continue for greater than 4.5-6 hours from the time of onset of second stage labor in the dog.[3,7] For these reasons, the decision to proceed to caesarian section should not be delayed if response to medical management is poor or unlikely to result in successful delivery. In recent studies, neonatal survival rates following surgical treatment of dystocia have been reported at 92% at birth, with 80% still alive at 7 days post c-section.[13,14]

Periparturient emergencies

Mastitis

Mastitis is a postpartum complication seen in both dogs and cats that results from bacterial infection of the mammary glands. Bacteria most commonly enter through the nipple as a result of nursing, trauma, or poor hygiene, but may also be spread hematogenously. In mild cases, discomfort, swelling, and inflammation may be seen, while in severe cases, signs of systemic illness such as fever, anorexia, and lethargy frequently develop. Dogs often refuse to allow their young to nurse and may be reluctant to lie down. Severe mastitis often progresses to abscessation and necrosis.

Diagnosis of mastitis is generally based on history and clinical signs (fever and swollen, painful glands in the postpartum animal), but baseline CBC and chemistry as well as milk cytology and culture are useful for assessing severity of illness and appropriateness of antibiotic selection. Milk expressed from the gland may be purulent and cytology typically shows large numbers of white blood cells and intracellular bacteria. The most common bacteria isolated on culture include *E. coli*, *Staphylococci*, and *Streptococci*.

Treatment is initiated immediately with broad spectrum antibiotics. Amoxicillin-clavulanic acid or cephalexin are good first choices and are safe for nursing neonates. Other measures that may be useful in the management of mastitis include warm compresses, hydrotherapy, and frequent milk stripping. If a fluctuant abscess pocket is identified on palpation, early lancing and flushing may limit the degree of skin necrosis that follows. Large, ruptured mammary abcesses may be successfully managed as open wounds with warm compresses, hydrotherapy, and systemic antibiotics, but in these cases mastectomy may provide a more rapid and cosmetic resolution of the problem.

Endometritis

Endometritis is a bacterial infection of the uterus that is generally seen within the first three days (up to one week) after whelping, though it may develop during pregnancy as well. Potential causes include retained fetuses or placentas, abortions, uterine trauma secondary to dystocia or obstetrical manipulation, and ascending infection from the vaginal canal. Typical signs include fever, lethargy, anorexia, vomiting, diarrhea, poor lactation, neglect of offspring, and foul-smelling vaginal discharge. Just as in the non-pregnant dog, any purulent vaginal discharge noted during or after pregnancy is abnormal and should prompt investigation.

Labwork abnormalities consistent with sepsis may be seen, including leukocytosis with a left shift or leukopenia, thrombocytopenia, elevated liver values, and hypoalbuminemia. Coagulation testing should be performed to rule out disseminated

intravascular coagulation. Radiographs or ultrasound are indicated to evaluate for fetal death, retained placentas, or evidence of uterine enlargement. Cytology of vaginal discharge typically shows degenerate neutrophils and macrophages with intracellular bacteria. The most common organisms associated with uterine infections include *Staphylococci*, *Streptococci*, *E. coli*, *Salmonella*, *Campylobacter*, and *Chlamydia*.

An animal suspected of having septic metritis should be treated aggressively with IV fluids. Broad spectrum antibiotic combinations such as ampicillin-enrofloxacin, ampicillin-aminoglycoside, or cefazolin-aminoglycoside-metronidazole, should be administered. Following stabilization, ovariohysterectomy is the treatment of choice for metritis. If the animal is not showing signs of sepsis and the owner wishes to use her for breeding purposes in the future, evacuation of the uterine contents using $PGF_{2\alpha}$ (Lutalyse) may also be attempted in conjunction with broad spectrum antibiotics. $PGF_{2\alpha}$ is typically administered at doses of 0.1-0.25 mg/kg SQ once daily for 5 days. If initial dosing does not result in adequate expulsion of uterine contents, the author generally increases treatment frequency to twice daily. Potential complications of $PGF_{2\alpha}$ include vomiting, abdominal discomfort, uterine rupture, and septic peritonitis. Because $PGF_{2\alpha}$ treatment may require several days to achieve a good effect, animals that are severely ill should always be treated with ovariohysterectomy. Ovariohysterectomy is also the best choice when the animal is not intended for future breeding or if the health of the dam is a higher priority than possible future breedings.

Eclampsia

Eclampsia or puerperal tetany is a life threatening condition that results from the development of hypocalcemia in the periparturient period. It is one of the more common complaints noted following parturition, accounting for roughly 1/4 of periparturient emergencies. Eclampsia is results from the loss of calcium through lactation and fetal skeletal mineralization, in excess of that entering the extracellular fluid through gastrointestinal absorption and bone resorption. Other factors such as inadequate diet or parathyroid atrophy resulting from oversupplementation of calcium may also contribute, though diet in affected animals has not been reported to be significantly different from non-affected animals. Increasing litter size to maternal body weight ratio has also been identified as a significant factor in the development of periparturient hypocalcemia.

Eclampsia is most commonly seen in small dogs, first-time whelpings, and dogs with large litter sizes. It typically develops 2-4 weeks after parturition but is occasionally seen in late gestation. Clinical signs in dogs most commonly include stiff gait, trembling, twitching, seizures, tachycardia, panting, and hyperthermia, but some dogs may present with atypical signs such as whining, vomiting, diarrhea, and behavior changes. If untreated, death may result from respiratory impairment, or from hyperthermia and cerebral edema. Cats may present with clinical signs similar to dogs, but unlike dogs, are more prone to hypothermia, and may present with hyperexcitability, hypersensitivity, or flaccid paralysis in place of clonic-tonic muscle spasms.

Diagnosis of eclampsia is made on the basis of history and physical exam findings in conjunction with low total or ionized calcium levels. Ionized calcium represents the physiologically active portion of calcium within the body, and is involved in muscular contraction, as well as neurologic and cardiovascular function. Ionized calcium levels are therefore believed to be a more sensitive indicator of extracellular calcium levels than total calcium, and typically fall below 0.8 mmol/L in dogs with eclampsia (reference range: 1.2-1.4 mmol/L). However, total calcium levels have been found to be decreased in all dogs with eclampsia, suggesting that total calcium levels may provide sufficient information in this disease if ionized calcium measurement is not available.

Animals presenting with eclampsia should have an IV catheter placed and intravenous fluids administered to address fever, dehydration, and tachycardia. Calcium gluconate (10%) should immediately be administered intravenously *slowly* to effect. Most animals will have tremors controlled at doses ranging from 0.5 to 1.5 ml/kg. An ECG should be monitored during calcium administration and the infusion stopped if bradycardia or arrhythmias develop. Ionized calcium levels should be rechecked post administration to make sure that ionized calcium levels remain within the normal range. Temperature should be carefully monitored in animals presenting with tremors, and active cooling measures (cool fluids, alcohol applied to footpads) should be instituted for patients with severe hyperthermia. Body temperature generally falls quickly once tremors are controlled, so active cooling measures should be discontinued once the temperatures falls below 103° F. Oral calcium carbonate (Tums) supplementation should be continued at a dose of 100 mg/kg/day throughout lactation. Up to 20% of dogs may have recurrence of eclampsia despite supplementation if puppies are allowed to nurse, so bottle feeding and early weaning of the puppies is recommended.

Supplementation of calcium prior to whelping is not recommended, as this may downregulate parathyroid hormone secretion, decreasing intestinal calcium absorption and increasing the risk of eclampsia during lactation. Instead, calcium administration (100 mg/kg/day divided) should be instituted following whelping in dogs at risk and dogs with a previous history of eclampsia.

References

Jutkowitz LA. Reproductive Emergencies. Vet Clin North Am Sm An Prac 2005;35:397-420.

Concannon P, Whaley S, Lein D, et al. Canine gestation length: variation related to time of mating and fertile life of sperm. Am J Vet Res 1983;44:1819-1821.

Gaudet DA. Retrospective study of 128 cases of canine dystocia. J Am Anim Hosp Assoc 1985;21:813-818.

Copley K. Comparison of traditional methods for evaluating parturition in the bitch versus using external fetal and uterine monitoring. In: Proceedings for the Society of Theriogeneology Annual Conference. Colorado Springs: 2002, p. 375-382.

Concannon PW, McCann JP, Temple M. Biology and endocrinology of ovulation, pregnancy, and parturition in the dog. J Reprod Fertil Suppl 1989;39:3-25.
Linde-Forsberg C, Eneroth A. Parturition. In: Simpson GM, editor. Manual of Small Animal Reproduction and Neonatology. Cheltenham: British Small Animal Veterinary Association; 1998, p. 127-142.
Darvelid AW, Linde-Forsberg C. Dystocia in the bitch: A retrospective study of 182 cases. J Small Anim Pract 1994;35:402-407.
Eckstrand C, Linde-Forsberg C. Dystocia in the cat: A retrospective study of 155 cases. J Small Anim Pract 1994;35:459-464.
Gunn-Moore DA, Thrusfield MV. Feline dystocia: prevalence, and association with cranial conformation and breed. Vet Record 1995;136:350-353.
Verstegen JP, Silva LDM, Onclin K, et al. Echocardiographic study of heart rate in dog and cat fetuses in utero. J Reprod. Fertil Suppl 1993;47:175-180.
Zone MA, Wanke MM. Diagnosis of canine fetal health by ultrasonography. J Reprod. Fertil Suppl 2001;57:215-219.
Davidson AP. Uterine and fetal monitoring in the bitch. Vet Clin North Am 2001;31:305-313.
Moon PF, Erb HN, Ludders JW, et al. Perioperative management and mortality rates of dogs undergoing cesarian section in the United States and Canada. J Am Vet Med Assoc 1998;213:365-369.
Moon-Massat PF, Erb HN. Perioperative factors associated with puppy vigor after delivery by cesarian section. J Am Anim Hosp Assoc 2002;38:90-96.
Funkquist PME, Nyman GC, Lofgren AMJ, et al. Use of propofol-isoflurane as an anesthetic regimen for cesarian section in dogs. J Am Vet Med Assoc 1997;211:313-317.

Managing Difficult Urethral Obstructions

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Overview and pathophysiology

Feline urethral obstruction is one of the most common emergency presentations in the cat, accounting for approximately 9% of feline emergency admissions.[1] While there are many factors that may play into the development of lower urinary tract diseases in the cat, matrix-crystalline plugs and urolithiasis are the most common causes of obstruction.[2] Cats with urethral obstruction may have signs localized to the lower urinary tract including dysuria, stranguria, pollakiuria, hematuria, vocalizing, and pain, or they may show signs of systemic illness such as vomiting, lethargy, or collapse. Cats with obstructive urinary tract diseases may or may not have demonstrated preceding signs of lower urinary tract disease.

Following the development of urethral obstruction, clinical signs of uremia typically develop within 24 hours.[3] Dehydration occurs due to decreased water intake and ongoing fluid losses secondary to vomiting. Acid-base (metabolic acidosis) and electrolyte disturbances (hyperkalemia and hyperphosphatemia) develop due to impaired excretion. Accumulation of metabolic wastes leads to post renal azotemia. Bladder capacity is reached, leading to rising intravesicular pressure and subsequently falling glomerular filtration rate (GFR). Prolonged obstruction may result in intrinsic renal failure. Damage to the urothelium and detrusor muscle may also develop during this time. If left untreated, death secondary to cardiopulmonary failure or hyperkalemia may occur within 3-6 days. Damage to bladder mucosa or urethra may shorten survival times.[3]

Diagnosis of urethral obstruction

Diagnosis of urethral obstruction is generally made on the basis of history and physical exam findings. Abdominal palpation typically reveals a turgid, painful bladder, though in rare cases, the bladder may be moderate in size if the cat is presented to the veterinarian shortly after clinical signs develop. Blood and/or crystalline debris may be visualized at the urethral orifice. The presence of bradycardia frequently indicates hyperkalemia, and severe systemic signs in conjunction with free abdominal fluid should prompt consideration of bladder leakage or rupture. In contrast, cats that present with stranguria but appear systemically healthy and have palpably small bladders typically have non-obstructive lower urinary tract disease.

At the time of presentation, a peripheral IV catheter is placed and blood is collected for complete blood count, serum biochemistry panel, and venous blood gas/electrolyte panel. The blood gas/electrolyte panel is particularly helpful as it provides rapid information on parameters such as potassium concentration (as well as acid-base status and renal values) that may affect initial interventions. Electrocardiography can also be helpful in the initial evaluation of the patient with urethral obstruction. Early ECG changes suggestive of hyperkalemia include bradycardia, dampened P-waves, tented T-waves, and prolongation of the P-R interval. As hyperkalemia worsens, loss of P-waves (atrial standstill) and widening of the QRS complex may develop. Electrocardiographic changes typically do not develop until potassium levels are greater than 7 mEq/L, but there is a great deal of individual variation in terms of patient response to hyperkalemia. Metabolic acidosis, hyponatremia, and hypocalcemia may contribute to the likelihood of hyperkalemic cardiotoxicity.

Once the animal has been medically stabilized and deobstructed, urine is submitted for urinalysis and culture. Because crystalline and cellular composition of the urine may change over time, evaluation of a fresh, undiluted sample is preferred. Diagnostic imaging should be performed to rule out cystic or urethral calculi. If a urolith or crystalline-matrix plug is retrieved at the time of deobstruction, composition should be determined as this may impact future therapies.

If free abdominal fluid is identified, fluid chemistry may be helpful in determining whether urinary tract rupture has occurred. An abdominal fluid:serum creatinine ratio of 2:1, or abdominal fluid:serum potassium ratio of 1.9:1 (cat) or 1.4:1 (dog) is predictive of uroperitoneum.[4] Cytology of the fluid sample should also be performed to rule out urosepsis. Contrast cystourethrography is used to determine location and severity of the rupture.

Treatment of urethral obstruction

Fluid therapy

Initial management of urethral obstruction in the cat should focus on correction of hypovolemia, hyperkalemia, and other acid-base and electrolyte disturbances. In most cases, appropriate fluid therapy followed by restoration of urine flow will effectively correct these abnormalities. A peripheral IV catheter should be placed and fluid therapy instituted immediately using 0.9% sodium chloride or balanced electrolyte solution such as lactated Ringer's solution (LRS). A shock rate of fluids (66 ml/kg/hour in the cat) is calculated and then administered *to effect* in increments of approximately ¼ of the calculated dose, reassessing major body systems after each bolus. For example, the calculated shock rate in a 5 kg cat is approximately 330 ml, and should be administered in individual boluses of 50-100 ml every 10-15 minutes until cardiovascular status is restored. The goal of fluid therapy should be normalization of vital signs such as heart rate, level of consciousness, pulse quality, blood pressure, and capillary refill time. The specific type of intravenous

fluid selected is of lesser importance than the administration of appropriate volume. Although 0.9% sodium chloride has traditionally been selected due to its lack of potassium, studies in both experimental and clinical cases have shown that potassium containing solutions (LRS, Normosol-R) do not adversely affect the rate of resolution of hyperkalemia in cats with urethral obstruction when compared with 0.9% saline.[5,6] Additionally, the buffered solutions are more efficient at restoring electrolyte and acid-base balance in severely affected animals.

Hyperkalemia

Relative or absolute bradycardia should be immediately investigated by monitoring electrocardiography and serum electrolyte concentrations. Severe electrocardiographic changes such as atrial standstill, widened QRS complexes, or sine wave formation provide strong indication for the administration of calcium gluconate. Calcium gluconate (10%) is given *slowly* at a dose of 0.5-1.5 ml/kg IV while carefully watching the patient's ECG for arrhythmias. Although calcium gluconate does not lower the serum potassium level, it has the immediate effect of buffering the myocardium from the toxic effects of hyperkalemia by restoring the normal difference between resting and threshold membrane potentials. Other intermediate to long-term interventions for hyperkalemia include the administration of regular insulin/dextrose and sodium bicarbonate, though these therapies are rarely warranted in animals with urethral obstruction as fluid therapy followed by timely restoration of urine flow are generally effective at reversing the hyperkalemia. However, if needed, 50% dextrose may be diluted 1:1 with saline and given at a dose of 1 gm/kg body weight to promote endogenous insulin release with subsequent potassium uptake by the cells through stimulation of sodium-potassium pumps. If regular insulin is used, it should be given at a rate of 1 unit insulin per 3 gm dextrose, though this is generally unnecessary and creates the need for careful blood glucose monitoring thereafter to avoid hypoglycemia. Sodium bicarbonate may also be given at a dose of 1 mEq/kg intravenously to facilitate intracellular potassium shifting in exchange for hydrogen ions.

Techniques for urethral deobstruction

During the initial exam, the urethra may be gently massaged, followed by careful palpation of the bladder to potentially dislodge superficial plugs. Extreme care should be taken to avoid accidental bladder rupture. While this technique is rarely effective, it is a simple extension of the initial physical exam and therefore may be worth trying in less severely affected cats prior to catheter deobstruction.

Although severely depressed patients may be deobstructed without the need for chemical restraint, sedation/analgesia is employed in the majority of "blocked" cats to improve patient comfort, facilitate deobstruction, and avoid urethral or bladder trauma secondary to patient struggling. Ketamine (100 mg/ml) may be combined with diazepam (5 mg/ml) in equal parts by volume and given at a dose of 1 ml/10 kg of the 50:50 mix. However, this combination should be avoided in cats with known or suspected hypertrophic cardiomyopathy, or when an undiagnosed murmur or gallop rhythm is present. In these cases, hydromorphone (0.05 mg/kg) in combination with diazepam (0.2 mg/kg) may provide a safer option.

Following sedation, the cat is positioned in dorsal recumbency with the legs pulled forward over the head. In this position, the prepuce may be retracted and the penis extruded by simply pushing the prepuce downward towards the anus. A further advantage to this technique is that it allows the urethra to be maximally straightened to facilitate deobstruction. The author's preferred technique for deobstruction uses an olive tip catheter (FUS needle 21 g x 1", Jorgensen Laboratories, Loveland, CO). This is a metal, bulb-tipped catheter that can be used to flush the urethra and either break down matrix-crystalline plugs or hydropulse them atraumatically into the bladder. Initially, the olive tip catheter is lubricated and inserted gently into the urethra to the site of the obstruction, approximately 1-2 cm. A 3 cc syringe is then used to lavage and break down the plug. Bits of the plug will often be seen emerging from the urethral orifice during the lavage. When the catheter is withdrawn, a strong stream of urine will frequently force the remainder of the plug from the urethra. Gentle bladder palpation may be used at this point to assist in the expulsion of the plug. To avoid urethral trauma, the catheter should not be forced past the obstruction. Instead, the lavage solution should be allowed to do the work. Additionally, acidic solutions should not be used for lavage as these have not been shown to be effective at plug dissolution and may further traumatize the urethral mucosa. If lavage alone is not successful at dislodging the urethral plug, the tip of the urethra can be pinched around the bulb tip of the catheter and hydropulsion used to push the plug back into the bladder.

Many clinicians use polypropylene "tomcat" catheters for the purposes of unblocking cats. These have the potential to cause additional trauma to the urethra when the rigid catheter is forced past the site of obstruction. If used, a number of steps may help to minimize iatrogenic urethral damage and maximize chances of success. (1) Completely straighten the urethra by pushing the prepuce dorsally towards to anus until the penis is parallel to the spine. (2) Use copious amounts of lubrication. (3) Hydropulse with sterile saline prior to advancing the catheter to assist in dislodging the plug. (4) Use a very light touch when advancing the catheter. Hold the catheter between index finger and thumb and twirl gently while advancing. Think about "picking a lock" when attempting to advance the catheter. Use finesse instead of force. (5) Once the catheter is well seated in the urethra, the penis may be allowed to retract into the prepuce. The prepuce may then be pulled caudally (toward tail tip) to further straighten the urethra while the catheter is advanced.

Some experienced clinicians advocate the use of cystocentesis prior to deobstruction to decompress the bladder and to potentially facilitate hydropulsion of urethral plugs. The author prefers to reserve this technique for use only as a last resort due to the number of

cats presenting to the emergency service with uroperitoneum and apical bladder tears following cystocentesis of overdistended bladders. However, it should be noted that our institution may see a biased population of more severely affected animals.

Cats that are critically ill, and those demonstrating large amounts of “sandy” crystalline debris in the urine, blood clots, uroliths, plugs hydropulsed into the bladder, bladder atony, or urethral narrowing are particularly at risk for reobstruction post-unblocking. For this reason, a soft, indwelling, 3.5-5 French red rubber catheter is placed following deobstruction to facilitate urine drainage overnight and to assist in quantitation of urine output. Indwelling catheters should be placed using liberal clipping and scrubbing of the perineum and aseptic technique to minimize risk of catheter-induced urinary tract infection. The tip of the catheter should sit just past the bladder neck to reduce risk of kinking or knotting. The catheter should then be connected to a sterile, closed collection system. To decrease the likelihood of premature catheter removal, careful attention should be given to suture placement. A piece of butterfly tape is placed around the catheter and appositional sutures are placed *at the margin* of the butterfly tape to prevent kinking of the catheter. The catheter body is then taped to the tail. An Elizabethan collar should be placed prior to anesthetic recovery.

Hospital management

Fluid therapy

Following initial stabilization and correction of hypovolemia, fluid rates should be adjusted to account for remaining fluid deficits, daily maintenance requirements, and ongoing losses. Deficits can be estimated as follows based upon clinical signs of dehydration: mild (5-6%), moderate (7-8%), and severe (8-10%). Multiplying the estimated percent dehydration by body weight gives the fluid deficit, which may then be replaced over the next 24 hours. For example, a 5 kg cat estimated to be 8% dehydrated would have an estimated deficit of 400 ml. To this value must be added maintenance needs (approximately 60 ml/kg/day) and ongoing losses. Ongoing losses following “unblocking” result from post-obstructive diuresis and can be estimated most easily by quantitating urine output. Normal urine output is approximately 1-2 ml/kg/hour (5-10 ml/hour in the average 5 kg cat). Urine output in excess of this amount typically results from post-obstructive diuresis. During the first 24 hours of therapy, a fluid rate should be selected that accounts for these ongoing losses. In other words, the intravenous fluids administered should slightly exceed measured urinary losses.

Urine output is quantified every four hours. Inadequate urine production (<1 ml/kg/hr) indicates inadequate fluid administration or urinary catheter occlusion with debris. After troubleshooting the catheter, a fluid bolus followed by an increase in fluid rate is indicated if urine output remains low.

Fluid therapy is typically tapered over the next 24-36 hours. Daily monitoring of electrolytes and renal values should be performed to ensure that azotemia resolves and electrolytes normalize. Potassium supplementation may be required during post-obstructive diuresis should hypokalemia develop.

Urinary catheter care

Indwelling urinary catheters and tubing should be cleaned externally once daily with a dilute chlorhexidine solution. Gloves should be worn and aseptic technique used when handling the catheters to avoid nosocomial infection. Bladder palpation should be performed every 4-6 hours to ensure that the bladder remains decompressed. When moving the patient, the urine collection system tubing should be clamped and the bag held below the level of the patient to prevent retrograde flow of urine into the bladder.

To minimize likelihood of catheter-induced urethral irritation or urinary tract infection, catheters should be removed as soon as possible. For most cats, the catheter is removed within 48 hours, but the presence of excessive crystalline debris or blood clots in the urine may necessitate longer indwelling catheter duration to avoid reobstruction. Use of antibiotics during hospitalization is not recommended as this is unlikely to prevent catheter-related infection, but may contribute to antibiotic resistance of organisms protected by the catheter biofilm. Culture should be performed prior to catheter removal, with antibiotic therapy initiated as indicated based upon results of culture and sensitivity.

Following catheter removal, patients should be monitored for an additional 12-24 hours to ensure that the urethra remains patent. Cats will typically urinate small volumes frequently following catheter removal due to irritation resulting from obstruction and catheterization. Although they may appear to strain in the litterbox, the bladder should remain small on palpation. A progressively distending bladder post-catheter removal typically indicates reobstruction (firm bladder, difficult to express) or bladder atony (large, flaccid, expressible). Cats with suspected urethrospasm post catheter removal may benefit from a smooth muscle relaxant following catheter removal (prazocin 0.5 mg/cat q24h).

Pain management

Urinary obstruction and initial management are frequently associated with significant discomfort. In our practice, buprenorphine (0.01 mg/kg IV q6h) is commonly used to provide analgesia for the first 24-48 hours.

Long term management

Strategies for long-term prevention of recurrence focus primarily on environmental modification and dietary changes. Occasionally, pharmacologic intervention may be warranted. An ample number of litterboxes should be provided, particularly in multi-cat households, and litterboxes should be cleaned regularly to encourage more frequent use. Canned or moistened food may decrease frequency of lower urinary tract episodes by promoting a more dilute urine and increasing frequency of urination. Fresh water should

be available at all times. In cases where obstruction was caused by struvite-matrix plugs, an acidifying diet may be of benefit. Antibiotics, anti-inflammatories, and antispasmotics have not been associated with reduction in frequency of episodes and their routine use is not recommended.

Perineal urethrostomy

Perineal urethrostomy may be considered in cases where frequency of urethral obstruction is unacceptable despite appropriate medical management or when irreversible changes in the urethra (stricture, scarring, urolithiasis) cause recurrent or persistent obstruction. Perineal urethrostomy has been associated with significant short and long term complications including recurrent urinary tract infection and stricture, and as such should not be considered a first line recommendation for cats with urethral obstruction.

References

Lee JA, Drobatz KJ. Characterization of the clinical characteristics, electrolytes, acid-base, and renal parameters in male cats with urethral obstruction. J Vet Emerg Crit Care 2003;13:227-233.

Osborne CA, Kruger JP, Lulich JP, et al. Feline matrix-crystalline urethral plugs: A unifying hypothesis of causes. J Small Anim Prac 1992;33:172-177.

Bartges JW, Finco DR, Polzin DJ, et al.. Pathophysiology of Urethral Obstruction. Vet Clin North Am Sm Anim Prac 1996;26:255-264.

Aumann M, Worth LT, Drobatz, KJ. Uroperitoneum in cats: 26 cases (1986-1995). J Am Anim Hosp Assoc 1998;34:315-324.

Cunha MG, Freitas CG, Carregaro AB, et al. Renal and cardiorespiratory effects of treatment with lactated Ringer's solution or physiologic saline (0.9% NaCl) solution in cats with experimentally induced urethral obstruction. Am J Vet Res 2010;71:840-846.

Drobatz KJ, Cole SG. The influence of crystalloid type on acid-base and electrolyte status of cats with urethral obstruction. J Vet Emerg Crit Care 2008;18:355-361.

Diagnosing and Treating Pericardial Effusion

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Pericardial effusion is defined as the accumulation of fluid within the pericardial space. As the pressure within the pericardial space increases, right sided cardiac filling is impaired, resulting in decreased stroke volume with subsequent decreases in cardiac output and ultimately decreased oxygen delivery to the tissues (shock). These manifestations of pericardial effusion are referred to as cardiac tamponade. Successful emergency management of dogs with life threatening pericardial effusion depends on early triage, a thorough physical examination, point of care diagnostic imaging techniques, and subsequent pericardiocentesis or placement of an indwelling pericardial drain.

Key etiologic and pathophysiologic points

Pericardial fluid accumulation and cardiac tamponade in the dog most often occurs secondary to a neoplastic process. Hemangiosarcoma (HSA) is most commonly identified in the region of the right atrium or right atrial appendage while chemodectoma (common in brachycephalic breeds) is most often identified at the heart base. Mesothelioma and any metastatic tumor are additional neoplastic causes. Although location and breed are frequently suggestive of tumor type, definitive diagnosis is dependent on a biopsy specimen.

Idiopathic pericardial effusion tends to be an inflammatory process and is frequently recognized in similar breeds to those that frequently develop HSA. Significant efforts in recent years have been directed towards developing diagnostic tests to help differentiate malignant from benign pericardial effusion (idiopathic). Pericardial fluid pH was initially thought to aid in making this differentiation, however, pericardial fluid pH has now been clearly shown to be of little diagnostic value.[5-6] Recent evidence suggests that blood concentrations of cardiac troponin I (cTnI) are significantly higher in dogs with masses consistent with HSA than in dogs without evidence of an underlying cause (idiopathic).[7]

Vitamin K_1 antagonists (anticoagulant rodenticides and coumadin) can also result in pericardial effusion.[8] Therefore; it is the authors' practice to always perform an ACT or other point-of-care coagulation assessment at the cage side prior to pericardiocentesis. If significant coagulopathy is present and patient condition permits, correction of coagulopathy with blood products (fresh frozen plasma or fresh whole blood) is indicated prior to pericardiocentesis. Subsequent institution of Vitamin K_1 therapy for 4weeks is indicated.

Left atrial tear is an uncommon consequence of chronic mitral regurgitation and left atrial dilatation, however, it has been recognized as a cause of acute pericardial effusion in the dog. An infectious cause of pericardial effusion is fungal disease (coccidiomycosis). Bacterial pericarditis and pericardial effusion secondary to trauma also occur, but are uncommon.

Numerous additional conditions such as congestive heart failure, uremia, decreased oncotic pressure, and a host of systemic inflammatory processes frequently result in small volume pericardial effusion accumulations without evidence of cardiac tamponade.

Key clinical diagnostic points

Triage and physical examination in pericardial effusion

The most common presenting complaints from the owners of dogs with pericardial effusion and cardiac tamponade are lethargy, anorexia, collapse or syncope, abdominal distention, and dyspnea.[1] Major body systems assessment of the dog with pericardial effusion will likely reveal compromise to one or all of the major body systems. Assessment of the cardiovascular system may frequently reveal the following:

- Pale mucous membranes: due to vasoconstriction and poor peripheral perfusion
- Slow CRT: due to decreases in cardiac output
- Increased heart rate: due to compensatory activation of the sympathetic nervous system
- Poor pulse quality: due to decreased stroke volumes and low blood pressure

Assessment of the respiratory system will frequently reveal increased respiratory rate and effort.

Assessment of the central nervous system will frequently reveal a decreased level of consciousness secondary to decreased oxygen delivery to the brain. Any one or combination of these findings should necessitate movement to the treatment area for further assessment including full physical examination, measurement of blood pressure, oxygen saturation, cardiac rhythm (ECG), and placement of an intravenous catheter from which a small blood sample for PCV / TS / Blood Glucose +/- Venous Blood Gas and Electrolytes can be rapidly acquired. If possible, blood for CBC, serum biochemical profile, and coagulation profile or ACT should also be collected. Concurrently, a second team member will be able to collect a full medical history.

Physical examination should still be centered on the major body systems, but subtle findings supportive of pericardial effusion may be noted including:

- Jugular venous distention: due to right sided congestive heart failure.

- Muffled heart sounds normal lung sounds: unlike pleural effusion which will frequently cause decreased heart and lung sounds, pericardial effusion will frequently only cause decreased heart sounds.
- Abdominal distention: ascites and hepatic engorgement may result from longstanding (days) pericardial effusion due to right sided congestive heart failure. Abdominocentesis will frequently reveal a relatively clear fluid will low cellularity and a protein concentration greater than 2.5g/dL but less than 3.5g/dL most consistent with a modified transudate.
- Pulsus paradoxus: An inspiratory fall of arterial systolic blood pressure of more than 10mmHg resulting in variation in pulse intensity with respiratory cycle due to increased venous return during inspiration, increased right sided filling, shifting of the interventricular septum to the left with decreased left sided diastolic filling and subsequent decreased left sided stroke volume.[2]
- Other physical examination findings specific to the underlying cause of the effusion such as fever in septic or fungal pericarditis.

Pericardial effusion causing cardiac tamponade should be HIGHLY suspected based on signalment, history, and physical examination findings, supported by diagnostic testing such as abdominocentesis and electrocardiography (+/- radiography) and confirmed through point of care diagnostic imaging techniques.

Diagnostic techniques

Abdominocentesis

See above.

Electrocardiography

Assessment of ECG in patients with pericardial effusion may reveal sinus tachycardia +/- ventricular arrhythmias. Ventricular arrhythmias may result from decreased myocardial oxygen delivery or aberrant conduction associated with the underlying cause of the effusion. QRS complexes <1mV in amplitude and the presence of electrical alternans (regular or irregular variation in QRS complex amplitude associated with the heart moving within the pericardium to and from the positive pole of lead II) are supportive of pericardial effusion.[4]

Echocardiogram

Echocardiogram is the diagnostic test of choice for confirmation of the presence of pericardial effusion in the dog. Many dogs with pericardial effusion have SEVERE cardiovascular compromise and can be on the verge of death. The stresses associated with radiographic imaging may put cause these patients to decompensate. Consequently, in the ideal world, radiographic imaging should be avoided initially. The authors have found that the presence of a small, portable ultrasound machine with a mid-range frequency transducer placed at the primary treatment station in the emergency room / treatment area to be of great utility for identifying conditions like pericardial effusion, pleural effusion, and to assess patients with acute abdomen for the presence of abdominal fluid. Echocardiographically, pericardial effusion appears as a hypoechoic space located between the hyperechoic pericardium and the right ventricular wall when viewed through the right cardiac notch. The presence of pericardial effusion provides excellent contrast to aid in the diagnosis of cardiac masses, however, pericardiocentesis should NOT be delayed in a patient with signs of shock simply to aid the diagnosis.

Thoracic radiography

As previously mentioned, thoracic radiography can be an extremely stressful procedure for dogs with cardiac tamponade. However, not all practices are equipped with ultrasound capabilities. If thoracic radiography is performed in dogs with suspected pericardial effusion, ventrodorsal positioning should be avoided. A dorsoventral projection can be acquired with minimal stress. Lateral thoracic radiographs may also be performed. Supportive radiographic findings include an enlarged, globoid cardiac silhouette. Acute effusions may not cause severe enlargement of the cardiac silhouette because the pericardium has not had time to stretch. Concurrent pleural effusion may be present. The other primary differential for a globoid heart is dilated cardiomyopathy (DCM) or other underlying cardiac disease. Key findings to try to differentiate DCM from pericardial effusion include:

- Heart sounds: Heart sounds in dogs with DCM are frequently normal in contrast to the decreased heart sounds seen in pericardial effusion. A systolic murmur may be noted in dogs with DCM and is uncommon in dogs with pericardial effusion.
- ECG: Atrial fibrillation is common in dogs with DCM. Atrial fibrillation is uncommon in dogs with pericardial effusion. Electrical alternans may be seen in dogs with pericardial effusion.[4]
- Cardiac Silhouette: The silhouette of the heart on thoracic radiographs of dogs with pericardial effusion tends to be extremely round with sharp borders. The silhouette of the heart in dogs with cardiomyopathy can be round, but often, there are still some dimples or “waist” associated with the divisions between the chambers and the borders of the cardiac silhouette tend not to be as sharp because of motion artifact.
- Pulmonary infiltrate: Pulmonary edema is common in DCM and uncommon in pericardial effusion.
- Pulsus paradoxus: Common in pericardial effusion, uncommon in DCM.

Key therapeutic points

Pericardiocentesis

Pericardiocentesis can be a stressful procedure. Use of cardiovascularly sparing sedatives (narcotics and benzodiazepines) may alleviate patient stress and facilitate safe pericardiocentesis. Numerous techniques have been described for pericardiocentesis in the dog including, but not limited to the use of a large-gauge over-the-needle catheter, through the needle catheter, and catheters placed using the Seldinger technique. Numerous commercial pericardiocentesis trays / kits are also available. The authors prefer to use a 14-16g, 5.5" over-the-needle catheter (Abbocath T, Hospira Inc. Lake Forest, IL) with two additional small side-holes or a commercial multi-lumen intravenous catheter placed using the Seldinger technique (Arrow Triple Lumen Central Venous Catheter, Arrow International, Reading, PA). The former is much less expensive while the latter may be left in place for ongoing drainage.

ECG should be monitored during and after pericardiocentesis for the presence of arrhythmias induced by catheter-associated irritation of the epicardium and decreased myocardial oxygen delivery experienced during cardiac tamponade. Lidocaine should be readily available, as should a defibrillator.

Pericardiocentesis is most often performed from the right hemithorax because injury to the left coronary artery is unlikely, and the cardiac notch is slightly larger. The patient can be positioned in sternal recumbency (preferred by most) or laterally. Full surgical preparation should be performed between the 2nd to the 8th ribs and from the mid-thorax to the level of the sternum. A fenestrated drape should be placed. Aseptic technique should be practiced at all times. The apex beat of the heart should be palpated (most often between the 4th and 5th ribs just above the costochondral junction) and lidocaine should be infiltrated locally off of the cranial edge of the rib (to avoid the intercostal neurovascular bundle). Ultrasound guidance can also be used to identify the optimal location for pericardiocentesis. A small skin incision (<5mm) should be made in the proposed insertion site and the catheter advanced through this incision (off the cranial edge of the rib). Upon the appearance of fluid in the flash chamber, the catheter and stylet should be advanced together for 2-3mm and the catheter fed over the stylet into the pericardium. Initially, a small fluid sample should be placed in an ACT or clot tube. A sample retrieved from the ventricle should clot (unless the underlying condition is anticoagulant rodenticide intoxication) while one that has been in the pericardial space for any appreciable period of time should not. A fluid sample should be saved for cytologic analysis and culture and the pericardium should be evacuated.

Monitoring

Patient response to decompression of significant pericardial effusion is often very rapid and very gratifying as vital signs and physical examination findings improve dramatically. Monitoring for recurrence of fluid accumulation by frequent reassessment of major body systems, physical examination and echocardiography is useful. Placement of a central venous catheter and monitoring of central venous pressure can also be a useful technique in that re-accumulation of pericardial fluid will result in a rise in central venous pressure.

Key prognostic points

Prognosis for dogs with pericardial effusion will depend on the underlying cause of the disease. Surgical removal of a mass on the right atrial appendage will at least temporarily alleviate signs of recurrent pericardial effusion. Surgical removal of right atrial / appendage HSA followed by chemotherapy will prolong life in dogs with pericardial effusion.[9] Pericardectomy will temporarily palliate clinical signs of pericardial effusion for most neoplastic processes, and will most often be curative for idiopathic pericardial effusion. Thoracoscopic pericardectomy or creation of a pericardial window may have similar effects.[10-12] Treatment with fresh frozen plasma, vitamin K1, and pericardiocentesis will be curative for dogs with anticoagulant rodenticide intoxication. Culture and sensitivity based antimicrobial therapy +/- surgical debridement is indicated for the management of infectious pericarditis. Dogs with left atrial tear secondary to chronic mitral valve regurgitation and left atrial dilation carry a guarded prognosis. Surgical repair of such a lesion has been described.[13]

Summary

Triage and careful attention to physical examination findings supported by ancillary diagnostic tests and point-of-care diagnostic imaging are the keys to the rapid identification of pericardial effusion in the dog. Rapid identification of problems and institution of treatment will maximize the likelihood of a positive outcome.

References/suggested reading

Berg RJ, Wingfield W. Pericardial effusion in the dog: a review of 42 cases. J Am Anim Hosp Assoc 1984;20: 721-730

Bouvy BM, Bjorling DE. Pericardial effusion in dogs and cats. Part I. Normal pericardium and causes and pathophysiology of pericardial effusion. *Compendium* 1991; 13: 417-424.

Bouvy BM, Bjorling DE. Pericardial effusion in dogs and cats. Part II. Diagnostic approach and treatment. *Compendium* 1991; 13: 633-341.

Bonagura JD. Electrical alternans associated with pericardial effusion in the dog. J Am Vet Med Assoc 1981;178: 574-579.

Fine DM, Tobias AH, Jacob KA. Use of pericardial fluid pH to distinguish between idiopathic and neoplastic effusions. J Vet Intern Med 2003;17: 525-529.

Edwards NJ. The diagnostic value of pericardial fluid pH determination. J Am Anim Hosp Assoc 1996;32: 63-67.

Shaw SP, Rozanski EA, Rush JE. Cardiac troponins I and T in dogs with pericardial effusion. J Vet Intern Med 2004;18: 322-324.
Petrus DJ, Henik RA. Pericardial effusion and cardiac tamponade secondary to brodifacoum toxicosis in a dog. J AM Vet Med Assoc 1999;215: 647-648.
Weisse C, Soares N, Beal MW et al. Survival times for dogs with right atrial hemangiosarcoma following surgical resection with and without adjuvant chemotherapy. In press.
Jackson J, Richter KP, Launer DP. Thoracoscopic partial pericardiectomy in 13 dogs. J Vet Intern Med 1999;215: 529-533.
Dupre GP, Corlouer JP, Bouby B. Thoracoscopic pericardectomy performed without pulmonary exclusion in 9 dogs. Vet Surg 2001; 30:21-27.
Sidley JA, Atkins CE, Keene BW et al. Percutaneous balloon pericardiotomy as a treatment for recurrent pericardial effusion in 6 dogs. *J Vet Intern Med* 2002;16: 541-546.
Sadanaga KK, MacDonald MJ, Buchanan JW. Echocardiography and surgery in a dog with left atrial rupture and hemopericardium. *J Vet Intern Med* 1990; 4: 216-21.

The Addisonian Crisis

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Hypoadrenocorticism is an uncommon disease in small animals, with relatively non-specific clinical signs and laboratory changes that may mimic other disease processes. Characteristic alterations in sodium and potassium are often present, but electrolyte concentrations may be normal in dogs with secondary or atypical primary hypoadrenocorticism. Early diagnosis may therefore pose a challenge, particularly when atypical signs are present.

Etiology and pathophysiology

The adrenal gland is made up of an outer cortex subdivided into three layers, and an inner medulla. The outer layer of the adrenal cortex (*zona glomerulosa*) is involved with synthesis & secretion of the mineralocorticoid hormone, aldosterone. The middle layer (*zona fasciculata*) synthesizes glucocorticoids, and the inner layer of the cortex (*zona reticularis*) secretes adrenal sex steroids. The adrenal medulla, not affected in hypoadrenocorticism, secretes catecholamines such as epinephrine and norepinephrine.

Adrenocortical insufficiency results from atrophy or destruction of the adrenal cortex and may be classified as either primary or secondary. *Primary hypoadrenocorticism* results from bilateral destruction of the adrenal cortices. Most cases are presumed to have an immune-mediated basis, though other causes include infections (fungal or mycobacterial), infarctions, neoplasia, surgical trauma, and amyloidosis. Iatrogenic destruction may also result from lysodren, ketoconazole, or megestrol acetate therapy. *Secondary hypoadrenocorticism* results from lack of adrenal stimulation via CRH or ACTH. Most cases of secondary hypoadrenocorticism are caused by inflammation, tumors, trauma, or congenital abnormalities of the hypothalamus or pituitary gland. Exogenous steroid administration may also suppress ACTH release, resulting in adrenal atrophy. Most dogs and cats have normal ACTH stimulation tests within 2 weeks of steroid withdrawal, but this is dependent on chronicity of treatment.

Most reports of dogs with hypoadrenocorticism have noted an increased prevalence in young to middle aged female dogs.[1-3] Some of the breeds reported to be at greater risk include Standard Poodles, Leonbergers, Portugese Water Dogs, Labrador Retrievers, Bearded Collies, Old English Sheepdogs, Standard Schnauzers, Soft Coated Wheaten Terriers, Basset Hounds, English Springer Spaniels, German Shorthaired Pointers, Nova Scotia Duck Tolling Retrievers, Great Danes, German Shepherds, West Highland White Terriers, and Rottweilers. Primary hypoadrenocorticism is considered rare in cats.[4]

The pathophysiologic changes seen with hypoadrenocorticism are a direct result of glucocorticoid and mineralocorticoid deficiency. Glucocorticoids have effects on nearly every tissue in the body. Some of these effects include the provision of a sense of well-being, stimulation of appetite, modulation of white blood cell function, and maintenance of blood pressure. Glucocorticoids also maintain fasting blood sugar levels by promoting gluconeogenesis, impairing uptake by peripheral tissues, and augmenting lipolysis. They are involved in maintaining calcium balance by augmenting renal excretion, reducing GI absorption, and decreasing resorption of calcium from bone. Decreased cortisol levels consequently lead to signs of lethargy, inappetance, vomiting, diarrhea, depression, and weight loss. Decreased sensitivity of the vasculature to catecholamines may contribute to hypotension. Hypoglycemia and hypercalcemia may develop. Failure to mount a stress leukogram or the presence of a “reverse stress leukogram” characterized by neutropenia, lymphocytosis, and/or eosinophilia may also result from cortisol deficiency.

Aldosterone is critically involved in the maintenance of sodium and water balance, acting primarily upon the distal nephron to promote reabsorption of sodium and chloride and excretion of potassium and hydrogen ions. Inability to release aldosterone therefore results in a number of adverse effects. Loss of sodium and chloride results in severe water losses, leading to polydipsia, polyuria, isosthenuria, and decreased effective circulating volume. Antidiuretic hormone (ADH) release is initially enhanced in response to hypovolemia, exacerbating hyponatremia by promoting free water retention. Ultimately, further ADH secretion may become impaired as the osmotic stimulus for ADH release is removed by the severity of hyponatremia. As salt and water losses continue, dehydration, hypovolemia, and azotemia become progressively more severe.

Failure to secrete potassium in exchange for sodium results in hyperkalemia. This is worsened by decreased renal perfusion (further impairing potassium excretion) and accompanying metabolic acidosis (promotes extracellular potassium shifts). Hyperkalemia causes signs of muscle weakness, bradycardia, hypotension, and ultimately death. A profound metabolic acidosis is also frequently seen, and results from loss of aldosterone stimulation of H+ secretion by the intercalated cells of the distal nephron, as well as by decreased perfusion & azotemia.

Diagnosis of hypoadrenocorticism

A tentative diagnosis of hypoadrenocorticism can frequently be made on the basis of history and physical examination findings. Common presenting complaints may include vomiting, diarrhea, abdominal pain, lethargy, weakness, and weight loss. Polyuria, polydipsia, and shaking or shivering are also frequently reported. Gastrointestinal ulceration is sometimes seen, and is believed to result from insufficient cortisol for normal maintenance of the gastric mucosa, coupled with poor gastrointestinal perfusion secondary

to hypovolemia. Severe gastrointestinal ulceration may result in signs of hematemesis, melena, and profound anemia. In some animals, symptoms of hypoadrenocorticism may develop acutely without prior signs of illness, or following a period of stress such as boarding at a kennel. In others, symptoms may have been present chronically, waxing and waning in intensity.

Patients presenting in Addisonian crisis typically manifest signs of shock. They frequently appear markedly dehydrated, hypothermic, depressed, and weak. Prolonged capillary refill time and weak pulses may be noted. Rapid respiratory rate may be seen in compensation for severe metabolic acidosis. One of the most striking findings, however, is the presence of a relative bradycardia, rather than tachycardia, in the face of signs of circulatory shock.

Electrocardiography can be helpful in the initial evaluation of the Addisonian patient. Early ECG changes suggestive of hyperkalemia include bradycardia, dampened P-waves, tented T-waves, and prolongation of the P-R interval. As hyperkalemia worsens, loss of P-waves (atrial standstill) and widening of the QRS complex may develop. Electrocardiographic changes typically do not develop until potassium levels are greater than 7 mEq/L, but there is a great deal of individual variation in terms of patient response to hyperkalemia.

Results of complete blood counts, serum biochemical profiles, and urinalysis may further support a diagnosis of hypoadrenocorticism. The typical Addisonian has hyperkalemia and hyponatremia, with a Na:K ratio that is <27:1. It should be remembered that a number of other diseases may result in altered sodium:potassium ratios including oliguric or anuric renal failure, urinary obstruction, uroabdomen, pregnancy, chylothorax, and primary gastrointestinal diseases such as trichuriasis, duodenal ulceration, and salmonellosis.[5-12]

Other common laboratory abnormalities include azotemia (present in over 80%), hypochloremia, hyperphosphatemia, and metabolic acidosis. Even in the face of significant prerenal azotemia, isosthenuria is a frequent finding and results from osmotic diuresis secondary to sodium losses.[1] Hypoglycemia has been reported in 16-33% of dogs with hypoadrenocorticism, and may be the only clinical finding in dogs with atypical Addison's disease.[1-3] Hypercalcemia occurs in approximately 30% of dogs.[1] Hypoalbuminemia is also common, though the mechanism by which this occurs is unclear. Gastrointestinal protein losses, anorexia, and loss of glucocorticoid stimulation of hepatic synthesis are speculated to play a role.[1-3] Hypocholesterolemia may also develop secondary to decreased fat metabolism as a result of hypocortisolemia. Elevations in ALT, AST, and alkaline phosphatase are reported in 20-30% of cases and may result from hypoperfusion or cholestasis. [1-3]

Hematologic changes reported in Addisonian dogs include hemoconcentration, normocytic-normochromic non-regenerative anemia, failure to mount a stress leukogram, and the presence of a reverse stress leukogram (characterized by an absolute lymphocytosis or eosinophilia). The anemia in animals with hypoadrenocorticism is multifactorial, resulting from a combination of chronic disease and the development of gastrointestinal ulceration. Glucocorticoids are also believed to have a facilitatory role in the responsiveness of the bone marrow to erythropoietin.[13] The anemia is frequently more severe than initially suspected based on packed cell volume (PCV) due to concurrent hemoconcentration. Reverse stress leukogram has been reported in 10-20% of dogs with hypoadrenocorticism and results from withdrawal of the effects of cortisol on maturation (glucocorticoids are known to stimulate neutrophil progenitors and inhibit eosinophil progenitors) and sequestration of leukocytes.[14]

Thoracic radiographs, if taken, may reveal changes consistent with hypovolemia such as microcardia and attenuation of the pulmonary vasculature and caudal vena cava. A small percentage of patients with hypoadrenocorticism may also have megaesophagus, and aspiration pneumonia may be present in these dogs due to regurgitation.[1,3]

Definitive diagnosis of hypoadrenocorticism is made on the basis of ACTH stimulation test. Venous blood is collected in either a heparinized or serum separator tube (depending on the laboratory) for baseline cortisol determination. Cortrosyn (synthetic cosyntropin) 5 μg/kg is given intravenously and a second blood sample is collected 60 minutes later. Minimal or absent cortisol secretion in response to ACTH is consistent with hypoadrenocorticism.

Other diagnostics that may be warranted in the atypical Addisonian include aldosterone levels and endogenous ACTH levels. Aldosterone levels may be useful in differentiating primary from secondary hypoadrenococorticism as dogs with secondary disease generally have normal aldosterone levels. Dogs with primary hypoadrenocorticism can also initially have glucocorticoid deficiency without mineralocorticoid deficiency. In these dogs, it is assumed that mineralocorticoid deficiency may develop in the future as adrenal atrophy progresses. Aldosterone levels may therefore be helpful in these cases to detect occult mineralocorticoid deficiency. However, whether aldosterone levels may be used to predict the development of mineralocorticoid deficiency in atypical Addison's disease is not known at this time. Endogenous ACTH levels are the most reliable means of differentiating primary from secondary disease. Animals with primary hypoadrenocorticism will have endogenous ACTH concentrations that are very high, while animals with secondary (ie hypothalamic or pituitary) forms of hypoadrenocorticism will have low ACTH levels.

Treatment of the Addisonian crisis

Treatment of patients suspected to be experiencing an Addisonian crisis should be instituted immediately with intravenous fluid therapy. 0.9% sodium chloride is the fluid of choice and should be administered *to effect* through a large bore intravenous catheter. A shock rate of fluids in the dog may be calculated at 90 ml/kg over the first hour. This is typically given in increments of one-quarter to

one-third of the calculated dose, reassessing every 10-15 minutes. The goal of fluid therapy should be normalization of vital signs such as heart rate, level of consciousness, pulse quality, blood pressure, capillary refill time, body temperature, and urine output, rather than the administration of an arbitrary fluid volume. Care should be taken in patients with severe hyponatremia not to correct sodium levels too quickly as neurological deficits may result.[15] An increase in sodium concentration of 12-14 mEq/L per 24 hours is generally accepted to be a safe rate of correction.

Relative or absolute bradycardia should be immediately investigated by monitoring electrocardiography and serum electrolyte concentrations. The presence of severe echocardiographic changes such as atrial standstill, widened QRS complexes, or sine wave formation provide strong indication for the administration of calcium gluconate. Calcium gluconate (10%) is given *slowly* at a dose of 0.5-1.5 ml/kg IV while carefully watching the patient's ECG for arrhythmias. Although calcium gluconate does not lower the serum potassium level, it has the immediate effect of buffering the myocardium from the toxic effects of hyperkalemia by restoring the normal difference between resting and threshold membrane potentials. Other intermediate to long-term interventions for hyperkalemia include the administration of regular insulin/dextrose and sodium bicarbonate. Regular insulin is given intravenously at a dose of 0.1 unit/kg to promote potassium uptake by the cells through stimulation of sodium-potassium pumps. It is typically followed by a 50% dextrose "chaser" of 2 gm per unit of insulin to avoid hypoglycemia related to insulin administration. Blood glucose should then be monitored carefully for several hours afterward. Sodium bicarbonate is given at a dose of 1 mEq/kg intravenously to effect intracellular potassium shifting in exchange for hydrogen ions.

Glucocorticoid therapy should be rapidly initiated in the Addisonian crisis patient. Dexamethasone sodium phosphate is preferred in the emergency setting, because unlike prednisone, it will not interfere with cortisol assays. Dexamethasone may be administered before or during the ACTH stimulation testing at a dose of 0.2-0.5 mg/kg. Remember that dexamethasone is 6-7 times as potent as prednisone, so this dose is substantially above the physiologic range. Subsequent glucocorticoid requirements may be fulfilled using prednisone at a dose of 0.2-0.5 mg/kg twice daily for the remainder of the hospital stay.

Although electrolyte abnormalities can generally be corrected with fluid therapy alone, mineralocorticoid supplementation should be initiated once stable to maintain sodium reabsorption and potassium excretion. Fludrocortisone acetate (Florinef) is most commonly used pending results of the ACTH stimulation test, and can be given orally at a starting dose of 0.01-0.02 mg/kg every 12 hours. Because of the inconvenience of multiple daily pill administrations, many patients are switched to desoxycorticosterone pivalate (DOCP) at the time of discharge. DOCP is labeled for use at a dose of 2.2 mg/kg subcutaneously every 25 days though clinical experience suggests that much lower doses are actually needed, particularly in larger dogs. Most dogs are successfully treated with a monthly dose of no greater than 1 ml of DOCP (25 mg/ml) with giant breed dogs receiving 1.5 ml. Electrolytes are typically measured at 12 and 25 days after each of first 2-3 treatments and the dosage adjusted downward in 10% increments or the interval between doses extended by 48 hr increments.

Outcome

The prognosis for dogs and cats with primary hypoadrenocorticism is generally good, and a normal quality of life can be expected as long as hormone replacement therapy is provided. This can generally be accomplished with either daily florinef or monthly DOCP as described above. Physiologic doses of prednisone are often required, though many dogs will tolerate dose reduction, requiring approximately 0.2 mg/kg every 24-48 hours. Prednisone supplementation may not be required in dogs receiving florinef as this drug possesses some glucocorticoid effects. Owners should be advised to increase the prednisone dose during boarding, hospitalization for non-adrenal illness, travel, other stressful situations, or if symptoms consistent with hypoadrenocorticism are noted.

References

Peterson ME, Kintzer PP, Kass PH. Pretreatment clinical and laboratory findings in dogs with hypoadrenocorticism: 225 cases (1979-1993). J Am Vet Med Assoc 1996;208:85-91.

Shaer M, Chen CL. A clinical survey of 48 dogs with adrenocortical hypofunction. J Am An Hosp Assoc 1983;19:443-452.

Lifton SJ, King LG, Zerbe CA. Glucocorticoid deficient hypoadrenocorticism in dogs: 18 cases (1986-1995). J Am Vet Med Assoc 1996;209:2076-2081.

Peterson ME, Greco DS, Orth DN. Primary hypoadrenocorticism in ten cats. J Vet Intern Med 1989;3:55-58.

Roth L, Tyler RD. Evaluation of low sodium:potassium ratios in dogs. J Vet Diagn Invest 1999;11:60-64.

Pak SI. The clinical implication of sodium:potassium ratios in dogs. J Vet Sci 2000;1:61-65.

Lee JA, Drobatz KJ. Characterization of the clinical characteristics, electrolytes, acid-base, and renal parameters in male cats with urethral obstruction. J Vet Emerg Crit Care 2003;13(4)227-233.

Schaer M, Halling KB, Collins KE, et al. Combined hyponatremia and hyperkalemia mimicking acute hypoadrenocorticism in three pregnant dogs. J Am Vet Med Assoc 2001;218:897-899.

Willard MD, Fossum TW, Torrance A, et al. Hyponatremia and hyperkalemia associated with idiopathic or experimentally induced chylothorax in four dogs. J Am Vet Med Assoc 1991;199:353-358.

Graves TK, Schall WD, Refsal K, et al. Basal and ACTH-stimulated plasma aldosterone concentration are normal or increased in dogs with trichuriasis-associated pseudohypoadrenocorticism. J Vet Internal Med 1994;8:287-289.

Ruckstuhl N, Hoerauf A, Tomsa K, et al. Pseudohypoadrenocorticism in two Siberian huskies with gastrointestinal parasitoses. Schweiz Arch Tierheilkd 2002;144:75-81.
DiBartola SP, Johnson SE, Davenport DJ, et al. Clinicopathologic findings resembling hypoadrenocorticism in dogs with primary gastrointestinal disease. J Am Vet Med Assoc 1985;187:60-63.
King DJ, Koekebakker M, Barr RD. Modulation of human erythropoiesis by hydrocortisone in vitro. Eur J Haematol 1987;38:137-40.
Bjornson BH, Harvey JM, Rose L. Differential effect of hydrocortisone on eosinophil and neutrophil proliferation. J Clin Invest 1985;76:924-929.
Brady CA, Vite CH, Drobatz KJ. Severe neurologic sequellae in a dog after treatment of hypoadrenal crisis. J Am Vet Med Assoc 1999;215:222-225.
Kintzer PP, Peterson ME. Treatment and long term follow-up of 205 dogs with hypoadrenocorticism. J Vet Intern Med 1997;11:43-49.

Cardiopulmonary Resuscitation: Current Guidelines

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Cardiopulmonary cerebral resuscitation (CPCR) refers to the re-establishment of circulation and preservation of neurologic function following an arrest.[1] Since its inception in the late 1800's, CPCR has saved the lives of countless human and veterinary patients. However, low overall survival rates following CPCR indicate that there is still much room for improvement in these practices. This session reviews current practices and updates on CPCR in the veterinary patient with an emphasis on evidence-based guidelines derived from the RECOVER initiative.

Basic life support

Basic life support refers to the process of establishing an airway, initiating positive pressure ventilation, and performing chest compressions. Because cardiopulmonary arrest (CPA) in veterinary patients is frequently initiated by respiratory arrest, an ABC approach is generally taken as described below. In recent years, there has been a paradigm shift prioritizing chest compressions above all other measures (CAB approach).

Circulation

Chest compressions are initiated at a rate of 100-120 per minute, compressing the circumference of the chest by approximately 30-50%. The patient should be in lateral recumbency during compressions. In smaller dogs, where the cardiac pump theory is believed to predominate, hands should be placed over the ventral third of the chest just behind the point of the elbow, corresponding to a position directly over the heart. In larger dogs, the thoracic pump theory is believed to be most important in generating blood flow, and hands should therefore be placed over the widest part of the thorax to create a maximal rise in intrathoracic pressure.

Airway

Orotracheal intubation is easily achieved in dogs, as the larynx can be directly visualized by retractig the tongue. The head and neck should be gently extended and a laryngoscope may be used to improve visualization of the larynx. In cases where hemorrhage, saliva, or gastric contents interfere with visualization, suction may be helpful. Alternately, the glottis may be palpated with one finger used to guide tube placement. Once tube placement is verified, the tube should be secured by tying to the nose or around the back of the head. The cuff should be inflated, and assisted ventilation provided. If chest wall excursion is not seen, lung sounds are absent, or abdominal distension is noted, tube placement should be reconfirmed by direct visualization and the cuff should be reinflated. Improper tube placement and tube dislodgement are common causes of CPCR failure.

Breathing

Once an endotracheal tube is in place, breathing is initiated at a rate of 10 breaths per minute with 100% oxygen to a tidal volume of approximately 10 ml/kg. An ambu bag with attached oxygen line is ideal for this purpose. If only one person is available to perform CPR, 2 breaths should be given for each 30 chest compressions. If several trained personnel are available, then breaths may be delivered independent of compressions. Chest wall excursion should be seen with each delivered breath. Airway pressures ideally should not exceed 20-30 cm H_2O. High airway pressures or inadequate chest wall excursion should prompt a search for pleural space disease, tube malposition, or tube occlusion.

A number of alternative techniques have been investigated that may help to augment blood flow during CPCR. Those that are directly applicable in veterinary patients include circumferential chest compression and interposed abdominal compressions. Circumferential chest compression is most commonly performed in cats and small dogs by encircling the chest with both hands to maximize the rise in intrathoracic pressure during chest compression. In larger animals, interposed abdominal compression may be implemented by having an additional person perform abdominal compressions during the relaxation phase between chest compressions. Interposed abdominal compressions increase venous return to the heart, leading to greater stroke volumes and cardiac output, and have been associated with increased survival to discharge in human patients.

Advanced life support

Advanced life support consists of drug administration, determination of cardiac electrical activity, and application of electrical defibrillation if indicated. These techniques build upon basic life support to increase the likelihood of successful resuscitation.

Drugs

Establishing vascular access is one of the first priorities during advanced life support. While central lines are preferable for rapid distribution of drugs, peripheral catheters are acceptable, and drug delivery may be facilitated by following drug administration with a 10-20 ml IV fluid "chaser". If vascular access is not immediately obtained, surgical cutdown or intraosseous techniques should be considered. The intratracheal route may also be used initially to deliver drugs. Epinephrine, atropine, vasopressin, lidocaine, and

naloxone may all be given in this way by administering twice the normal dose of the drug (or using the “high” dose for epinephrine) and administering several large breaths to disperse the drug.

Drugs administered during CPCR include intravenous fluids, narcotic reversal agents, vasopressors, vagolytics, antiarrhythmics, and potentially sodium bicarbonate. Shock doses of intravenous fluids should be provided in cases where hypovolemia is believed to have played a role in the arrest. Moderate fluid rates should be used in euvolemic patients or patients with underlying heart disease, as rapid administration in these cases may excessively elevate right atrial pressure and consequently decrease myocardial and cerebral perfusion pressure.

Patients who have received narcotic pain relievers or other sedative/anesthetic drugs prior to arrest should immediately be given the reversal agent for that drug. Naloxone may be used to reverse most narcotics at a dose that is isovolumetric to the dose of the original narcotic, or at 0.02-0.04 mg/kg IV if the original dose is unknown. Flumazenil (0.02 mg/kg IV) may be used to reverse benzodiazepines, and yohimbine (0.1 mg/kg) or atipamazole (0.2 mg/kg or isovolumetric) may be used to reverse xylazine and medetomidine respectively. Any anesthetic gases, if still in use, should be discontinued and the anesthetic circuit flushed with fresh oxygen.

Vasopressors are commonly used during CPCR to increase blood pressure and redistribute blood flow to vital organs like the brain and heart. Epinephrine continues to be the vasopressor of choice during CPCR in veterinary patients, though its use is largely extrapolated from clinical studies in human patients. Both low dose and high dose epinephrine protocols are described in human medicine. While high dose epinephrine has been associated with increases in early return of spontaneous circulation, no long-term benefits have been identified. High dose epinephrine has additionally been associated with increased myocardial oxygen demand and worse neurologic outcomes.[2] For these reasons, it is recommended that low dose epinephrine initially be administered every 3-5 minutes during CPCR, switching to the high dose only if there is a lack of response to the lower doses. Epinephrine dosing may be rapidly calculated according to the following rule of thumb: 0.1 ml per 20 lb of the 1:1,000 formulation for low dose, or 1 ml per 20 lb for high dose.

Vasopressin is another potent vasoconstrictor that is increasingly used in resuscitation of human patients. Unlike epinephrine, it does not increase myocardial workload, and its effect is not blunted by acidosis. Although clinical data in veterinary patients is currently lacking, animal models and human clinical trials suggest that vasopressin may be as effective as epinephrine.[3] Vasopressin (0.8 units/kg IV) may therefore be considered as an alternative to epinephrine in dogs.[4]

Atropine is another drug frequently administered during CPCR to reverse parasympathetic contribution to the arrest or to treat sinus bradycardia. Atropine is administered at a dose of approximately 1 ml per 20 lb (0.04 mg/kg) for asystole or pulseless electrical activity. When treating sinus bradycardia, only half this dose is needed.

Sodium bicarbonate use in CPCR is controversial, as it has been associated with numerous adverse effects including hypernatremia, paradoxical CNS acidosis, and decreased resuscitation rates in people. However, its use should still be considered during long duration (>10 minutes) arrests, as control of acidosis may improve response to catecholamines as well as post-arrest neurologic outcomes. Bicarbonate is typically given only after 10 minutes of CPCR at a dose of 1 mEq/kg and is repeated every 5 minutes thereafter.

Electrical activity

ECG leads should be attached as soon as feasible to assess electrical activity. Connecting the leads to the skin of the lower forelimbs and hindlimbs will help to minimize motion artifact associated with resuscitation efforts. Four rhythms are commonly seen during cardiopulmonary arrest in dogs. Asystole and pulseless electrical activity are the initial arrest rhythms most commonly seen in dogs, followed by ventricular fibrillation and sinus bradycardia.[5,6] Accurate ECG diagnosis is vital to a successful code. The presence of sinus bradycardia or suspicion of a vagal arrest should prompt administration of atropine. Asystole should be confirmed in more than one lead, to rule out the possibility of artifact related to poor contact. While some dogs in asystole will convert directly to sinus rhythm following resuscitation, many develop ventricular fibrillation and require electrical shock for conversion. Once ventricular fibrillation is identified, electrical defibrillation should immediately be administered, temporarily bypassing all other resuscitation measures. The greater the time that a dog spends in fibrillation, the lower the likelihood of successful conversion.

Defibrillation

Early application of electrical shock is the only effective method for converting VF to sinus rhythm. VF is a form of disorganized electrical activity with various portions of the heart muscle firing at different times. Electrical shock essentially "resets" the cardiac cells so that organized activity can resume. Practically speaking, applied current must pass through at least 30% of cardiac myocytes to effectively convert VF.

To accomplish defibrillation, the dog is flipped into dorsal recumbency immediately preceding defibrillation and handheld paddles are placed on either side of the chest directly over the heart. Ample conducting gel should be applied to the paddles to ensure good contact and prevent dispersion of current. The chest should be compressed between the paddles, minimizing impedance by narrowing the distance between paddles. If using a monophasic defibrillator, the energy for the first shock should be set at 3-5 J/kg. If defibrillation is not successful, CPCR is resumed for 60-90 seconds and a subsequent shock should then be given at the same energy

setting. Electrical shock is discontinued once the rhythm converts from VF. Lower energy biphasic shock waveforms have been shown to be as effective as higher energy monophasic waveforms and exclusively used at this time in human patients. If using a biphasic defibrillator, the pediatric settings should be used (2-4 J/kg). [7]

For shock-refractory VF, a search should be undertaken to identify problems such as improper paddle position, inadequate contact, insufficient conduction gel, or the presence of pleural space disease that may increase impedance. Drug-shock techniques may then be considered, administering epinephrine or amiodarone (5 mg/kg IV) prior to shock to lower defibrillation threshold. Lidocaine was previously used for this purpose as well, but has been reclassified as a therapy of indeterminate benefit in the most recent ACLS guidelines.[7]

Open chest CPCR

There are a number of absolute indications for open chest CPCR. These include cardiac arrest caused by or associated with pleural space disease (pneumothorax, pleural effusion, diaphragmatic hernia), pericardial effusion, or penetrating injury resulted in cardiac arrest. However, debate exists in veterinary medicine as to other indications for performing open chest CPCR. Some advocate open chest CPCR immediately in large breed dogs because of the limited success of restoring adequate circulation with external compressions while others prefer to perform external CPCR for 5 minutes and then open the chest if there is little or no evidence of effective circulation. Open chest CPCR has the advantage of allowing the clinician to directly compress the heart and improve stroke volume. In addition, opening the chest makes assessment of ventricular filling feasible aiding in the decision of volume delivery.

When opening the chest, it is critical to auscult the chest just prior to the incision to rule out ECG dysfunction as the cause of asystole. The left chest should be crudely clipped of hair at the left 5^{th}-6^{th} intercostals space and a chlorhexidine based antiseptic solution should be briskly applied. An incision should be made through the skin and subcutaneous tissues from just below the spinal musculature to the level of the costochondral junction. Between positive pressure breaths, mayo scissors should be used to poke through the intercostal musculature and the pleura and the chest is opened by sliding the mayo scissors dorsally and ventrally along the cranial border of the rib (to avoid the neurovascular bundle). The pericardium is opened at the pericardio-diaphragmatic ligament and the heart is compressed from the apex to the base. In large dogs, the heart can be compressed against the opposite chest wall.

In the event of return of spontaneous circulation, antibiotics should be instituted immediately, the chest should be lavaged with copious amounts of warm saline, and should be closed using sterile technique over a chest tube.

ICU care

Following a successful code, a search for underlying causes or complications should be performed and any problems corrected. Blood gases, hematocrit and total solids, blood pressure, and oxygen saturation are carefully monitored and optimized during this time. This tends to be the most challenging phase of arrest management, as complications and recurrence of CPA are common. Neurologic recovery is promoted by maintaining arterial blood pressure and oxygen saturation. Because elevation in carbon dioxide levels leads to cerebral vasodilation and consequently increased intracranial pressure, hypercarbia should be prevented by employing mechanical ventilation if needed. Once cardiovascularly stable, mannitol (0.25-0.5 g/kg IV over 20 minutes) may also be indicated to treat cerebral edema and resultant elevations in intracranial pressure. Corticosteroids are associated with potentially deleterious hyperglycemia in post-arrest patients, and current protocols do not support their use.[7]

Prognosis

Recurrence of CPA in the post-arrest period is common, occurring in up to 70% of successfully resuscitated dogs. Intensive care and monitoring during this time is therefore essential. Survival to discharge following cardiopulmonary arrest has been reported in 4-11% of cases.[5,6,8] Transient blindness, seizures, circling, ataxia, and decreased level of consciousness are common for some period of time following CPA, but the majority of survivors have a good prognosis for functional recovery.[6]

References

Otto CM. Cardiopulmonary cerebral resuscitation and ACLS guidelines. In Proceedings of the 8th International Veterinary Emergency and Critical Care Symposium. San Antonio, TX. September 2002. p. 478-481.

Gueugniaud PY, Mols P, Goldstein P. et al. A comparison of repeated high doses and repeated standard doses of epinephrine for cardiac arrest outside the hospital. N Engl J Med 1998;339:1595-1601.

Wenzel V, Krismer AC, Lindner KH, et al. Comparison of vasopressin and epinephrine for out-of-hospital cardiopulmonary resuscitation. N Engl J Med 2004;350:105-113.

Schmittinger CA, Astner S, Astner L, et al. Cardiopulmonary resuscitation with vasopressin in a dog. Vet Anaest Analg 2005;32:112-114.

Wingfield WA, Van Pelt DR. Respiratory and cardiopulmonary arrest in dogs and cats:265 cases (1986-1991). J Am Vet Med Assoc 1992;200:1993-1996

Waldrop JE, Rozanski EA, Swanke ED, et al. Causes of cardiopulmonary arrest, resuscitation management, and functional outcome in dogs and cats surviving cardiopulmonary arrest. J Vet Emerg Crit Care 2004;14:22-29.

2005 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2005;112(suppl.)

Kass PH, Haskins SC. Survival following cardiopulmonary resuscitation in dogs and cats. J Vet Emerg Crit Care 1992;2:57-65.

Clinical Approach to Anemia

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Anemia is commonly seen in veterinary emergency and critical care medicine. Patients may be brought in with the presenting complaint of anemia or may develop anemia during hospitalization as a result of their underlying disease or treatment. Anemia may contribute to patient morbidity, cost of treatment, and length of stay, frequently necessitating expensive interventions such as blood transfusion while the underlying disease is being treated.

Classification of anemia

Anemia seen in veterinary patients may be classified into three broad categories that relate to cause; blood loss, hemolysis, and decreased production. Classification of anemia in this way is not merely academic but is crucial to the workup of anemic patients. Because regenerative and non-regenerative anemia have different sets of differentials and diagnostics, this classification will guide further testing and provide useful prognostic information.

Three simple, in-house diagnostic tests can be performed in all anemic patients to help classify their anemia. These tests are inexpensive, easy to perform, and will frequently provide a great deal of information about the cause of the anemia. They can all be performed in approximately 5 minutes, allowing the clinician to classify the anemia and provide an appropriate diagnostic plan while the owner is still present at the hospital during the initial exam.

The first test is the packed cell volume (PCV) and total solids (TS). The importance of interpreting the PCV in conjunction with the total solids cannot be overemphasized. If the PCV and TS are both low, acute blood loss should be suspected. In contrast, a low PCV with normal total solids would be consistent with hemolysis or decreased red blood cell production. To differentiate these two clinical entities, the plasma of the spun sample should be carefully evaluated for the presence of hemoglobin or bilirubin that may suggest intravascular or extravascular hemolysis respectively.

The second test that should be performed is the blood smear. Blood smears are useful for differentiating hemolysis from decreased production anemia as the presence of significant polychromasia and anisocytosis may indicate the presence of a regenerative response. Blood smears should also be evaluated for blood parasites and telltale alterations in red blood cell morphology. Heinz bodies are characterized by bulging of the red blood cell membranes and indicate oxidative red blood cell damage secondary to toxins such as onions, garlic, or propylene glycol. Spherocytes are small, round erythrocytes with loss of central pallor that result when antibodies bound to red blood cell membranes lead to a portion of the membrane being phagocytized or “pinched off” by macrophages. Large numbers of these cells are typically seen in dogs with immune-mediated hemolysis. Schistocytes are erythrocytes that have become fragmented as a result of passage through narrowed microvasculature. Schistocytes typically reflect microangiopathic causes of hemolysis such as caval syndrome, disseminated intravascular coagulation, hemangiosarcoma, or splenic torsion. Acanthocytes are red blood cells with long spiny projections that are frequently seen in patients with hepatic or splenic neoplasia, though they may also be seen in animals with disorders of lipid metabolism as well.

Finally, a slide agglutination test should be performed when hemolysis is suspected. In this test, a drop of anticoagulated blood from a purple top tube or capillary tube is mixed with several drops of saline. Autoagglutination may be evidenced by the observation of obvious flecks within the drop of blood. The saline is used to disperse rouleaux that may mimic agglutination. Autoagglutination is caused by cross-linking of antibodies bound to the erythrocyte membranes, and as such is diagnostic for an immune-mediated component to the hemolysis.

Formulating a list of differential diagnoses

Once the anemia has been classified as blood loss, hemolysis, or decreased production, a list of differentials may be formulated. (see table 1)

Table 1. Some common differentials for anemia

Acute Blood Loss	Hemolysis	Decreased Production
Trauma	Immunologic	Selective Red Cell Hypoplasia
Hemoabdomen	Autoimmune (AIHA)	Chronic disease
Hemothorax	Secondary IMHA	Renal disease
Hemoretroperitoneum	Drugs	Red Cell Aplasia/PIMA
Fracture sites	Neoplasia	FeLV
Neoplasia	Blood Parasites	Immune
Splenic/liver	Vaccination	Endocrine
Pericardial	Infectious disease	Hypothyroid
Retroperitoneal	FELV	Addison’s

Other	Neonatal Isoerythrolysis	Generalized Hypoplasia
Primary hemostatic defect	Incompatible Transfusion	Toxic
Thrombocytopenia		Chloramphenicol
Thrombocytopathia	Non-Immunologic	Estrogen
Von Willebrands	Parasitic	Antifungals
Secondary hemostatic defect	Oxidative toxins (onions)	Chemotherapy
Rodenticide intoxication	Zinc toxicity	Infectious
Hemophilia	PK/PFK deficiency	Ehrlichia
DIC	Microangiopathic	FeLV/viral
Gastrointestinal losses	DIC	Myelopthesis
Ulcerative diseases	Caval syndrome	Myelofibrosis
Neoplasia	Hemangiosarcoma	Hypercellular bone marrow
Hemostatic defects	Organ torsion	Iron deficiency
Surgical/Iatrogenic losses	Hypophosphatemia	B12/folate deficiency
	Thermal damage	Lead toxicity
		Myelodysplasia
		Myeloproliferative neoplasia

Acute blood loss

Diagnosing acute blood loss is simple when an external source of bleeding is present. Howeve, cavity bleeding, gastrointestinal losses, coagulopathies, and chronic blood loss may be more challenging clinical entities. History and physical exam are usually the key elements in identifying a source of acute blood loss. Additional diagnostic testing generally includes minimum database (complete blood count, serum biochemistry panel, and urinalysis) and imaging studies such as radiographs and/or ultrasound to identify the source of bleeding. Platelet counts and coagulation testing should be performed any time hemostatic defects are suspected. Gastrointestinal blood loss should be suspected when external or cavitary bleeding is not identified. Significant gastrointestinal blood loss may occur before signs of melena, hematemesis, or hematochezia are noted.

Treatment of acute blood loss consists of providing hemostasis, administering fluids for volume replacement, and considering blood transfusion if volume support alone is insufficient to provide for tissue oxygen delivery and clinical signs of anemia are present.

Hemolysis

In patients presenting with hemolysis, CBC, chemistry, and urinalysis should be run as part of a minimum database. The presence of hemoglobinemia/hemoglobinuria or bilirubinemia/bilirubinuria may suggest intravascular or extravascular hemolysis, respectively. Leukocytosis is frequently noted on the CBC from patients with IMHA and may result from non-specific “gearing up” of the bone marrow, or more likely, from tissue damage secondary to hypoxia and thrombosis. White blood cell counts in excess of 40,000/µl have been associated with a poorer prognosis in dogs with IMHA.[1] Platelet counts should also be evaluated. Moderate thrombocytopenias may suggest consumptive coagulopathy or tick-borne illness, while severe thrombocytopenias (<50,000/µl) should prompt consideration of a concurrent immune-mediated thrombocytopenia. A Coombs test is indicated if hemolysis is suspected but autoagglutination is not present. The Coombs test, or direct antiglobulin test, is essentially a test for the presence of antibodies or complement bound to erythrocyte membranes. It is performed by adding anti-dog antibodies (immunoglobulins directed against canine IgG, IgM, or complement) to a sample of the patient’s red blood cells. If autoantibodies are present on the patient’s blood cells, the antiserum binds to them and cross-linking occurs. Because the end (positive) result of this test is agglutination, the Coombs test need not be run if the patient is already autoagglutinating. Note also that the Coombs test is not highly sensitive. Review of cases seen at our hospital (unpublished data) identified a sensitivity of only 66%, comparable to other reports in the veterinary literature.

A search should also be conducted for possible trigger factors. History taking should include questioning about recent vaccinations or medications. Recent vaccination (ie. within 4 weeks) has been associated with the development of IMHA in retrospective studies.[2] Sulfa drugs, penicillins, and cephalosporins have also been associated with IMHA by acting as haptens, substances that become adsorbed to erythrocyte membranes and subsequently are able to stimulate an immune response. Neoplastic processes such as hemangiosarcoma, lymphoma, leukemia, and histiocytic sarcoma are another common trigger factor, and chest radiographs and abdominal ultrasound are frequently performed to rule out these entities. Testing should also be performed for vector-borne illnesses such as Ehrlichiosis, Babesiosis, Bartonellosis, and Hemoplasmosis.[3-5] FeLV and FIV testing should not be overlooked in the cat.

Non-immunologic causes for hemolysis should also be considered. In addition to the oxidative toxins such as onions, ingestion of zinc may result in fulminant intravascular hemolysis, hemoglobinuria, multi-organ dysfunction, and DIC. Hereditary diseases such as phosphofrucktokinase deficiency seen in English Springer Spaniels may result in episodic hemolytic anemia, easily confused with IMHA because of its “apparent” response to steroids.

Reticulocyte count should always be performed to assess regenerative response. Hemolytic anemias are typically strongly regenerative, though it may take three days for regenerative response to be noted. The presence of a non-regenerative anemia (absolute reticulocyte count < 60,000/µl) should prompt suspicion of non-regenerative immune-mediated anemia (NRIMA), bone marrow disease, or other forms of decreased production anemia described below.[6-8]

Immunosuppressive therapies like prednisone ideally should not be initiated until neoplastic and non-immunologic causes of hemolysis have been ruled out, as the use of these drugs may interfere with accurate diagnosis and subsequent therapies. However, in cases where IMHA is strongly suspected and clinical signs are severe, prednisone is typically started pending labwork to avoid excessive delays in therapy.

Decreased production

An anemia should be considered non-regenerative when the reticulocyte count is less than 60,000/μL (corresponding to a *corrected* reticulocyte count of less than 1%). However, it should be noted that a regenerative response usually becomes apparent after a minimum of 2-3 days, so acute blood loss or hemolysis may initially appear to be non-regenerative. Once a non-regenerative anemia is identified, bone marrow aspiration is generally indicated. Differentials for decreased production anemia may be grouped according to bone marrow histopathology. Some diseases cause a selective hypoplasia of red cell lines, while others affect all cell lines within the bone marrow (see table 1 above).

Selective erythroid hypoplasia

Anemia of chronic disease, also termed anemia of inflammation, is immune driven. Cytokines and cells of the reticuloendothelial system (RES) induce changes in iron homeostasis, erythrocyte lifespan, production of erythropoietin, and proliferation of erythroid lines. Iron is diverted from circulation to storage sites within the RES, limiting availability for erythroid progenitors. Inflammatory mediators (TNF, IL-1, IFN) suppress activity of erythroid precursors and decrease their responsiveness to erythropoietin. Release of erythropoietin is also inhibited. Finally, erythrophagocytosis and free radical mediated erythrocyte damage shorten RBC survival. In contrast to iron deficiency anemia, anemia of chronic disease tends to be normocytic, normochromic, rather than microcytic, hypochromic. Serum iron tends to be low, but bone marrow iron stores are adequate. Anemia of chronic disease is generally mild to moderate unless complicated by other factors such as blood loss or hemolysis. Treatment is therefore directed at correcting the underlying disease. Transfusion may be considered if anemia is associated with clinical signs. Iron supplementation for anemia of chronic disease is controversial, and indications for its use in veterinary patients with chronic disease is unclear.

Chronic renal failure is typically associated with mild to moderate anemia. Because of the gradual and chronic nature of this type of anemia, it tends to be well compensated until very advanced stages. Anemia in renal failure is multifactorial and results from decreased erythropoietin production by the kidney, impaired responsiveness of bone marrow precursors, shortened RBC lifespan due to uremia, and GI blood loss resulting from uremic ulcers. Anemia of renal failure is typically well compensated, though transfusions may be indicated in the event of concurrent losses or surgery. Human recombinant erythropoietin has been used to stimulate RBC production in veterinary patients with renal failure, but is increasingly being used only as a “last ditch effort” as antibody production against epogen may lead to antibodies being directed against the patient’s own erythropoietin as well. Canine recombinant erythropoietin has not been associated with antibody production in dogs with renal failure, but is unfortunately not commercially available. Anabolic steroids (Winstrol-V) have been used in patients with renal failure based on the observations that they increase RBC mass in healthy animals. A benefit in these cases has not been clearly identified.

Pure red cell aplasia (PRCA) and precursor-targeted immune mediated anemia (PIMA) are immune mediated diseases directed against erythrocyte precursors. The anemia is non-regenerative, normocytic-normochromic, with normal leukocyte and platelet counts. Animals tend to present with marked anemia, as the progression of the disease is typically slow and there is adequate time to mount a compensatory response. Diagnosis is made on the basis of bone marrow aspiration or biopsy, with few to no erythroid precursors seen in PRCA. In cases of PIMA, left shifted erythroid hyperplasia is frequently seen, with maturation arrest at the level of the metarubricytes or rubricytes. Some animals with PIMA will also have immune mediated destruction of mature erythrocytes, resulting in concurrent hemolysis. Cats with PRCA should always have PCR or IFA performed on the bone marrow to rule out feline leukemia C associated attack on erythroid progenitors, as this form of PRCA is typically fatal. Treatment for immune-mediated PRCA and PIMA relies on immunosuppressive therapies similarly to IMHA. Periodic transfusions may be needed until regeneration occurs. This may take weeks to several months. Clinical signs and progression tend to be less severe than IMHA, as the anemia results from decreased production, rather than hemolysis.

Endocrine diseases such as hypothyroidism and hypoadrenocorticism may also result in a decreased production anemia. Both cortisol and thyroid hormone have a permissive role in the response of red blood cell precursors to erythropoietin. These forms of anemia are generally mild unless complicated by concurrent blood loss and resolve with hormone replacement therapy.

Generalized bone marrow hypoplasia

Generalized bone marrow hypoplasia may result from radiation, toxic, or infectious insults to the bone marrow. Common toxins include estrogen, chloramphenicol, phenylbutazone, antifungals, and chemotherapeutic drugs. Infectious diseases resulting in bone marrow hypoplasia include feline leukemia and chronic Ehrlichiosis. Generalized bone marrow hypoplasia may also result from the crowding out of normal bone marrow precursors by neoplastic cells, a process termed myelopthisis. The most common neoplastic causes are the hematopoietic and lymphoid neoplasms including lymphosarcoma, granulocytic leukemia, and lymphoid leukemias. Myelofibrosis, the replacement of marrow spaces by connective/scar tissue, usually represents the endpoint of previous severe marrow

injury (as in the case of estrogen toxicity and ionizing radiation) or it may occur spontaneously. Peripheral blood features of myelofibrosis usually include severe nonregenerative anemia, severe leukopenia, and a variable platelet response. Confirmation of the diagnosis depends on marrow core biopsy with a demonstration of connective tissue filling the marrow space.

Normal tohypercellular bone marrow

Iron deficiency anemia results from chronic blood loss. In young animals, parasitic infection is the primary ruleout for iron deficiency anemia, while in older animals, gastrointestinal masses or ulcers are generally implicated. Chronic blood loss leads to depletion of bone marrow iron stores over time, resulting in inability to form hemoglobin. Nuclear maturation of RBC precursors is normal however. Precursors continue to divide, getting smaller in size because they never acquire a complete amount of hemoglobin. This results in a hypercellular bone marrow with a build up of metarubricytes. Diagnosis is based on the presence of microcytic, hypochromic anemia, thrombocytosis, source of blood loss, and a bone marrow smear containing no stainable iron. Low serum iron is not diagnostic as it may rapidly decrease with inflammatory disease as a result of tissue sequestration. Treatment is aimed at removal of the source of blood loss. Ferrous sulfate may be administered at a dose of 100-300 mg per day in dogs and 50-100 mg per day in cats if needed. Note that this dose refers to ferrous sulfate, not elemental iron. Reticulocytosis should develop within 3-4 days of supplementation.

Myelodysplasia refers to a poorly understood group of diseases characterized by non-regenerative anemia or pancytopenia and prominent dysplastic changes in the bone marrow. Abnormal erythrocytes are generally unable to completely differentiate and early cell death results. Myelodysplasia may result from idiopathic (primary), neoplastic, toxic, immune-mediated, or infectious (FeLV) causes. The myelodysplasias tend to carry a very guarded prognosis, with treatment aimed at immunosuppression, chemotherapy, and/or erythropoietin depending on the suspected cause.

General comments on the treatment of non-regenerative anemias

Treatment of decreased production anemia is best aimed at identifying and eliminating any underlying disease processes or myelosuppressive drugs. Once this is done, clinical experience suggests that the most important thing we can do for patient is to buy time for the bone marrow to repopulate with normal precursor cells. Blood transfusions should be provided as needed until the patient is able to mount a regenerative response of their own. Most patients with non-regenerative anemia require transfusions every 4-6 weeks until their disease is well controlled. Broad-spectrum antibiotics are indicated in the event of severe neutropenia to prevent secondary infections. Immunosuppressive agents may be indicated if an immune-mediated disease (eg. red cell aplasia) is identified or strongly suspected. Myeloproliferative diseases and myelodysplasia tend to carry a poor prognosis, but other forms of decreased production anemia may respond well if the underlying disease or insult is eliminated and adequate time is provided for recovery.

Conclusion

A variety of diseases, both immunologic and non-immunologic in nature, may result in anemia and/or hemolysis in veterinary patients. Successful management relies upon accurate diagnosis and treatment of the underlying disease process. Simple test to help classify a patient’s anemia as blood loss, hemolysis, or decreased production may facilitate correct diagnosis. Initiation of immunosuppressive therapy prior to performing a methodical search for infectious, neoplastic, or other causes of anemia may result in therapeutic “missteps” and treatment failure.

References

McManus PM, Craig LE. Correlation between leukocytosis and necropsy findings in dogs with immune-mediated hemolytic anemia: 34 cases (1994-1999). J Am Vet Med Assoc 2001;218:1308-1313.

Duval D, Giger U. Vaccine-associated immune-mediated hemolytic anemia in the dog. J Vet Intern Med 1996;10:290-295.

Stegman JR, Birkenheuer AJ, Kruger JM, et al. Transfusion-associated Babesia gibsoni infection in a dog. J Am Vet Med Assoc 2003;222:959-963.

Birkenheuer AJ, Levy MG, Breitschwerdt EB. Efficacy of combined atovaquone and azithromycin for therapy of chronic Babesia gibsoni infections in dogs. J Vet Intern Med 2004;18:494-498.

Van Audenhove A, Verhoef G, Peetermans WE, et al. Autoimmune haemolytic anaemia triggered by Bartonella henselae infection: a case report. Br J Haematology 2001;115:924-925.

Stokol T, Blue JT. Pure red cell aplasia in cats: 9 cases (1989-1997). J Am Vet Med Assoc 1999;214:75-79.

Stokol T, Blue JT, French TW. Idiopathic pure red cell aplasia and nonregenerative immune-mediated anemia in dogs: 43 cases (1988-1999). J Am Vet Med Assoc 2000;216:1429-1436.

Weiss DJ. Primary pure red cell aplasia in dogs: 13 cases (1996-2000). J Am Vet Med Assoc 2002;221:93-95.

Immune-Mediated Hemolytic Anemia: Current Perspectives

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Immune-mediated hemolytic anemia (IMHA) is one of the most common hematologic diseases seen in dogs with a reported mortality rate that ranges between 29% and 77% in the veterinary literature.[1-9] Hemolysis results from the binding of immunoglobulins to red blood cell surface antigens, causing those cells to be lysed by complement intravascularly or removed from circulation by mononuclear phagocytes. IMHA may be a particularly frustrating disease for both owners and clinicians because of its waxing and waning clinical course, the potential for sudden complications, and the expense associated with treatment.

Immune-mediated red blood cell destruction may be classified in a number of ways. Primary or idiopathic autoimmune hemolytic anemia (AIHA) refers to immune-mediated hemolysis in the absence of an identifiable trigger factor, whereas secondary IMHA results from an underlying process such as neoplasia, infectious disease, or drug reaction. IMHA may also be categorized based on whether it results in intravascular or extravascular hemolysis. Intravascular hemolysis results from the lysis of red blood cells by complement within the vasculature, and may be identified by the presence of free hemoglobin within the plasma and urine. Extravascular hemolysis results when there are insufficient antibodies present to cause complement fixation, and antibody-labeled red blood cells are removed by the reticuloendothelial system within the spleen and liver. Extravascular hemolysis tends to be a more gradual process and may be identified by the presence of bilirubin, rather than hemoglobin within the plasma and urine. IMHA may also be classified based on the presence or absence of autoagglutination. Autoagglutination is the spontaneous clumping of red blood cells and results from the cross-linking of erythrocytes by large numbers of antibodies. We have noted autoagglutination in approximately 70% of dogs treated for IMHA.

IMHA is typically a disease of middle-aged to older pets. As with other types of immune mediated disease, a female gender predisposition has been reported. At Michigan State University in the past eight years, approximately 2/3 of IMHA cases were seen in female dogs. Although any breed may develop IMHA, a number of breed predispositions have also been reported and include Cocker Spaniels, Poodles, Shih Tzus, Lhasas, Old English Sheepdogs, Border Collies, and Springer Spaniels. A seasonal predilection has also been suspected, as some studies have observed a larger number of cases presenting in spring and summer months. This may be a result of increased exposure to outdoor allergens or antigenic stimulation, or may simply reflect the overall increase in patient admissions seen during these months.

Clinical signs of IMHA may be acute or chronic, depending upon the rate of hemolysis. With chronic disease, symptoms such as lethargy, weakness, inappetance, vomiting, diarrhea, and pigmenturia are most commonly reported, whereas with more rapid hemolysis, acute collapse may be the first symptom noted. It is not uncommon for dogs to be brought in for “possible urinary tract infection” because the owners have noted discoloration of the urine with hemoglobin or bilirubin. Symptoms related to anemia, including tachycardia, tachypnea, and systolic ejection murmurs may also be noted on physical exam. Hepatosplenomegaly is not unusual as these organs are common sites for extramedullary hematopoiesis as well as clearance of antibody-labeled erythrocytes. Fevers are frequently seen as a result of release of endogenous pyrogens like IL-1 and IL-8. Reactive lymphadenopathies may also be seen.

Initial in-house diagnostics should include PCV/TS, blood smear, and slide agglutination test, as these are inexpensive, easy to perform, and will frequently provide a great deal of information about the cause of the anemia. The importance of interpreting the PCV in conjunction with the total solids (TS) cannot be overemphasized. If the PCV and TS are both low, blood loss (rather than hemolysis) should be suspected. In contrast, a low PCV with a normal TS would be consistent with hemolysis or decreased red blood cell production. To differentiate these two clinical entities, the plasma of the spun sample should be carefully evaluated for the presence of hemoglobin or bilirubin that may suggest hemolysis. Blood smears may also be useful in differentiating hemolysis from decreased production anemia, as the presence of significant polychromasia and anisocytosis indicates the presence of a regenerative response. Blood smears should also be evaluated for blood parasites and telltale alterations in red blood cell morphology. Spherocytes are small, round erythrocytes with loss of central pallor, that result when antibodies bound to red blood cell membranes lead to a portion of the membrane being phagocytized or “pinched off” by macrophages. Large numbers of these cells are typically seen in dogs with immune-mediated hemolysis. Ghost cells, which appear as “empty” cell membranes may be seen with intravascular hemolysis. Finally, a slide agglutination test should be performed when hemolysis is suspected. In this test, a drop of anticoagulated blood from a purple top tube or capillary tube is mixed with several drops of saline. Autoagglutination may be evidenced by the development of obvious flecks within the drop of blood. Autoagglutination is caused by cross-linking of antibodies bound to the erythrocyte membranes, and as such is diagnostic for an immune-mediated component to the hemolysis.

A number of other diagnostics should be considered in the evaluation of animals suspected to have IMHA. CBC, chemistry, and urinalysis should be run as part of a minimum database. The presence of hemoglobinemia/hemoglobinuria or

bilirubinemia/bilirubinuria may suggest intravascular or extravascular hemolysis, respectively. Leukocytosis is frequently noted on the CBC from patients with IMHA and may result from non-specific "gearing up" of the bone marrow, or from tissue damage secondary to hypoxia and thrombosis. White blood cell counts in excess of 45,000/µl have been associated with a more guarded prognosis.[10] Platelet counts should also be evaluated. Moderate thrombocytopenias may suggest consumptive coagulopathy or tick-borne illness, while severe thrombocytopenias (<50,000/µl) should prompt consideration of a concurrent immune-mediated thrombocytopenia. Reticulocyte count should always be performed to assess regenerative response. Immune-mediated hemolytic anemias are typically strongly regenerative, though it may take three days for regenerative response to be noted. Non-regenerative anemias should prompt suspicion of red cell aplasia, precursor-directed immune-mediated anemia (PIMA), or other form of decreased production anemia. A Coombs test is indicated if hemolysis is suspected but autoagglutination is not present. The Coombs test, or direct antiglobulin test, is essentially a test for the presence of antibodies or complement bound to erythrocyte membranes. It is performed by adding anti-dog antibodies (immunoglobulins directed against canine IgG, IgM, or complement) to a sample of the patient's red blood cells. If autoantibodies are present on the patient's blood cells, the antiserum binds to them and cross-linking occurs. Because the end (positive) result of this test is agglutination, the Coombs test need not be run if the patient is already autoagglutinating.

A search should also be conducted for possible trigger factors. History taking should include questioning about recent vaccinations or medications. Recent vaccination (ie. within 4 weeks) has been associated with the development of IMHA.[3] Sulfa drugs, penicillins, and cephalosporins may also cause IMHA by acting as haptens, substances that become adsorbed to erythrocyte membranes. If these haptens are targeted by the immune system, the entire red blood cell may be destroyed. Neoplasias such as hemangiosarcoma, lymphoma, myeloproliferative diseases, and hemophagic histiocytosis are another common trigger factor, and chest radiographs and abdominal ultrasound are frequently performed to rule out these entities. Testing should also be performed for tick-borne illnesses such as *Ehrlichiosis* and *Babesiosis*.

Treatment of IMHA consists of improving tissue oxygen delivery, suppressing the immune response, preventing some of the major complications of IMHA (such as thromboembolic disease), and hopefully preventing future recurrence. In the emergent patient, tissue oxygenation may be improved greatly by the administration of intravenous fluids. Although some clinicians worry about "diluting" an already anemic patient with IV fluids, in actuality, fluids will improve tissue oxygen delivery in the hypovolemic patient by maximizing cardiac output. However, the majority of dogs with IMHA will also require blood transfusion or oxyglobin during the course of their hospitalization, as immunosuppressive therapies are not rapidly effective in stopping the hemolytic process. The decision to transfuse is based on a number of factors, including hematocrit values, clinical signs, and the chronicity of the anemia. Clinical signs of anemia such as reluctance to eat, tachycardia unresponsive to fluids, tachypnea, dyspnea, lethargy, and altered mentation should prompt consideration for transfusion.

A number of drugs may be considered for the purpose of immunosuppression. Prednisone is the mainstay of therapy in dogs with IMHA, and at this time no other drug has been *proven* to work better than prednisone alone. Clinical experience suggests that 2 mg/kg/day in dogs provides adequate immunosuppression in the dog. Higher doses are not necessarily more immunosuppressive but may be associated with an increased risk of gastrointestinal complications. Prednisolone, rather than prednisone, should be used in cats as the bioavailability of prednisone is limited in this species.[11] Additionally, cats may require higher doses than dogs, and the author typically uses 4 mg/kg/day in cats. A growing number of retrospective studies have suggested that azathioprine may improve long-term survival, and that cyclophosphamide may be associated with a poorer outcome.[2,4,9,12,13] Caution should be used in interpreting these studies as inherent bias may be present due to their retrospective or small scale nature. In our clinic, we frequently use azathioprine (2 mg/kg q24h for 7 days then q48h), cyclosporine (Atopica 5-10 mg/kg/day divided), or mycophenolate (10 mg/kg PO q12h) as adjunct therapies and to facilitate prednisone weaning later in the course of treatment. Intravenous immunoglobulin (IVIG) is also occasionally used in patients who are slow to respond to conventional therapy. IVIG is essentially purified IgG antibodies collected from the pooled plasma of over 2000 human donors. It is believed to act primarily by blocking macrophage Fc-receptors, thereby decreasing phagocytosis of red blood cells. Downregulation of antibody production, enhanced catabolism of antibodies, and suppression of cytokine release are other possible mechanisms of action. Although one small prospective study did not demonstrate more rapid response times in IMHA patients receiving IVIG at presentation, clinical experience and a number of retrospective studies have demonstrated its utility as a rescue therapy in individual patients.[14-17] IVIG is typically dosed at 0.5-1 mg/kg given over 6 hours. Side effects include vomiting, fever, potential for anaphylaxis, and possible increased risk of thrombosis.

Thromboembolic disease (TE) is a frequent complication of IMHA. In studies of dogs with IMHA that underwent necropsy, TE was identified in 60-80% of cases.[8-10, 18-20] Sites most commonly affected were the pulmonary and splenic vasculature. Although exact mechanisms for the prothrombotic state have not been elucidated, increased concentrations of procoagulant factors, decreased concentrations of anticoagulant and fibrinolytic factors, vasculitis, enhanced platelet reactivity, the presence of antiphospholipid antibodies, liberation of RBC stroma, blood transfusion, and administration of steroids have all been hypothesized to play a role in the development of TE. Changes in primary hemostasis are also thought to play a role in the development of a pro-thrombotic state. Weiss & Brazzell demonstrated increased platelet P-selectin expression in dogs with IMHA, supporting the hypothesis that platelets circulate in an activated state.[21] Documentation of the pro-thrombotic state remains challenging in clinical cases and has traditionally

been based upon detection of increased fibrinolysis (increased fibrin degradation products (FDPs) and D-dimers) and decreased endogenous anticoagulants (antithrombin) rather than rate of clot formation. Recently, our group has documented hypercoagulability as assessed by thromboelastography in this patient population. 26/26 dogs with idiopathic IMHA enrolled in this study all had an MA (maximal amplitude; a reflection of clot strength) that was significantly greater than normal.

Though antemortem identification of thromboembolic events can be challenging, data from 110 dogs treated for IMHA at the Michigan State University Veterinary Teaching Hospital between 2004 and 2007 showed that 34% were suspected to have developed TE during their hospital stay. Of the dogs with suspected TE, 51% had pulmonary thromboembolism (PTE) alone, 8% had portal venous thrombosis (PVT) alone, and 41% had both PTE and PVT. The development of TE appears to significantly contribute to the morbidity and mortality of IMHA. In our data, survival to discharge in dogs with TE was significantly lower than in dogs without TE (49% vs 81%) and median duration of hospitalization was longer (7 days vs 4 days). Of note however, 7 of 7 dogs with PVT identified on ultrasound whose owners opted for aggressive therapy all survived, suggesting that early identification and management of this problem may improve outcome. We are currently evaluating CT angiography as a technique for definitive identification and monitoring of pulmonary and portal clots.

Because hemostatic abnormalities are common in dogs with IMHA, obtaining baseline coagulation testing at the time of admission is strongly recommended. In our critical care unit, dogs with IMHA are then treated with heparin sodium at a loading dose of 150 units/kg IV followed by a continuous infusion of 30-60 units/kg/hour. The heparin dose is adjusted daily to prolong the activated partial thromboplastin time (aPTT) to 1.5-2 times the baseline value. Twenty-six dogs prospectively enrolled in a coagulation study and heparinized based upon this protocol all survived to discharge and serial evaluation of thromboelastography showed normalization of parameters related to clot formation by 30 days, once hemolysis was no longer taking place. Low dose aspirin (0.5 mg/kg PO BID)[22] may also be started during hospitalization, particularly in cases where there is failure to achieve a target aPTT. Plavix (2 mg/kg q24h) or aspirin (0.5 mg/kg q12h) are frequently started at the time of discharge to prevent rebound hypercoagulation associated with heparin withdrawal.

Gastrointestinal protectants, such as pepcid (0.5 mg/kg q24h) or sucralfate, are used by many clinicians in hopes of preventing GI ulceration. At this time there is no evidence to suggest that these medications are effective in preventing ulcers, and in our hospital, they are typically administered only once ulceration is suspected to have occurred. Gastric ulceration should be suspected if melena, vomiting, or reluctance to eat develop, or if serum total protein begins to fall in conjunction with the hematocrit. It is important to recognize the development of GI blood loss, because the resulting drop in hematocrit can otherwise be easily confused with treatment failure.

Dogs with idiopathic IMHA are at risk for recurrence of disease, and care should be taken not to wean the immunosuppressive drugs too quickly. Prednisone is typically maintained within the immunosuppressive range for at least one month following hospital discharge, and then may be decreased by approximately 20-25% each month, provided that the hematocrit remains stable. If azathioprine or other adjunctive agent is being administered in conjunction with the prednisone, it may be discontinued one month after discontinuing prednisone. In total, the weaning process should span at least 4-6 months. Labwork should be rechecked one week after each decrease in drug dosage to make sure that the change is tolerated. If relapse occurs during the weaning process, immunosuppressive dose prednisone should be reinstituted, then gradually weaned back to the lowest effective dose. Following weaning, it is frequently recommended that vaccines be avoided, though the association between vaccines and IMHA development is still unproven. Splenectomy may be considered for dogs with recurrent or refractory disease.

References

Allyn ME, Troy GC. Immune mediated hemolytic anemia. A retrospective study: Focus on treatment and mortality (1988-1996). *J Vet Intern Med* 1997;11:131.

Burgess K, Moore A, Rand W, Cotter SM. Treatment of immune-mediated hemolytic anemia in dogs with cyclophosphamide. *J Vet Intern Med* 2000;14:456-462.

Duval D, Giger U. Vaccine-associated immune-mediated hemolytic anemia in the dog. *J Vet Intern Med* 1996;10(5):290-295.

Grundy SA, Barton C. Influence of drug treatment on survival of dogs with immune-mediated hemolytic anemia: 88 cases (1989-1999). *J Am Vet Med Assoc* 2001;218:543-546.

Jackson ML, Kruth SA. Immune mediated hemolytic anemia and thrombocytopenia in the dog: A retrospective study of 55 cases diagnosed from 1969 through 1983 at the Western College of Veterinary Medicine. *Can Vet J* 1985;26:245-250.

Klag AR, Giger U, Shofer FS. Idiopathic immune-mediated hemolytic anemia in dogs: 42 cases (1986-1990). *J Am Vet Med Assoc* 1993;202:783-788.

Reimer ME, Troy GC, Warnick LD. Immune-mediated hemolytic anemia: 70 Cases (1988-1996). *J Am Anim Hosp Assoc* 1999;35(5):384-91.

Thompson MF, Scott-Moncrief MA, Brooks MB. Effect of a single plasma transfusion on thromboembolism in 13 dogs with primary immune-mediated hemolytic anemia. *J Am Anim Hosp Assoc* 2004;40:446-454.

Weinkle TK, Center SA, Randolph JF, et al. Evaluation of prognostic factors, survival rates, and treatment protocols for immune-mediated hemolytic anemia in dogs: 151 cases (1993-2002). J Am Vet Med Assoc 2005;226:1869-1880.

McManus PM, Craig LE. Correlation between leukocytosis and necropsy findings in dogs with immune-mediated hemolytic anemia: 34 cases (1994-1999). J Am Vet Med Assoc 2001;218:1308-13.

Graham-Mize CA, Rosser EJ. 2004. Bioavailability and activity of prednisone and prednisolone in the feline patient. Veterinary Dermatology 15(suppl 1):7-10.
Goggs R, Boag AK, Chan DL. 2008. Concurrent immune-mediated hemolytic anemia and severe thrombocytopenia in 21 dogs. The Veterinary Record 163:323-327.
Mason NJ, Duval D, Shofer FS, Giger U. Cyclophosphamide exerts no beneficial effect over prednisone alone in the initial treatment of acute immune-mediated hemolytic anemia in dogs: A randomized controlled clinical trial. J Vet Int Med 2003;17:206-212.
Whelan MF, O'Toole TE, Chan DL, et al. Use of human immunoglobulin in addition to glucocorticoids for the initial treatment of dogs with immune-mediated hemolytic anemia. J Vet Emerg Crit Care 2009;19:158-164.
Scott-Moncrieff JC, Reagan WJ, Snyder PW, et al. Intravenous administration of human immune globulin in dogs with immune mediated hemolytic anemia. J Am Vet Med Assoc 1997;210:1623-1627.
Scott-Moncrieff JC, Reagan WJ. Human intravenous immunoglobulin therapy. Sems Vet Med Surg 1997;12:178-185.
White HL, O'Toole TE, Rozanski EA, et al. Early treatment of canine immune-mediated hemolytic anemia with intravenous immunoglobulin: 11 cases. Proceedings of the 20th Annual ACVIM Symposium. Dallas, TX 2002:785.
Klein MK, Dow SW, Rosychuk RAW. Pulmonary thromboembolism associated with immune-mediated hemolytic anemia in dogs: Ten cases (1982-1987). J Am Vet Med Assoc 1989;195:246-250.
Scott-Moncrieff JC, Treadwell NG, McCullough SM, Brooks MR. Hemostatic abnormalities in dogs with primary immune-mediated hemolytic anemia. J Am Anim Hosp Assoc 2001;37(3):220-227.
Carr AP, Panciera DL, Kidd L. Prognostic factors for mortality and thromboembolism in canine immune-mediated hemolytic anemia: a retrospective study of 72 dogs. J Vet Intern Med 2002;16(5):504-9.
Weiss DJ, Brazzell JL. Detection of activated platelets in dogs with primary immune-mediated hemolytic anemia. *J Vet Intern Med* 2006;20:682-686.
Rackear D, Feldman B, Farver T, et al. The effect of three different doses of acetylsalicylic acid on canine platelet aggregation. *J Am Anim Hosp Assoc* 1988;24:23-26.

Hypercoagulation in Canine IMHA

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Immune-mediated hemolytic anemia (IMHA) is one of the most common hematologic disorders seen in dogs. Hemolysis results from the binding of immunoglobulins to red blood cell surface antigens, causing cell lysis by complement intravascularly or phagocytosis within the liver or spleen. IMHA carries a guarded prognosis with mortality rates that have ranged between 29% and 77%.[1-8]

Thromboembolic disease (TE) is a frequent complication of IMHA and appears to be a major contributor to morbidity and mortality.[9,10] In studies of dogs with IMHA that underwent necropsy, TE was identified in 60-80% of cases.[8-11] Sites most commonly affected were the pulmonary, portal, and splenic vasculature, with many dogs having thrombi in multiple organs.[9-12] Although exact mechanisms for the prothrombotic state have not been elucidated, increased concentrations of procoagulant factors such as tissue factor and fibrinogen, decreased concentrations of antithrombin and fibrinolytic factors, vasculitis, enhanced platelet reactivity, the presence of antiphospholipid antibodies, liberation of RBC stroma, circulating microparticles, blood transfusion, and administration of steroids have all been hypothesized to play a role in the development of TE.[9-15]

The antemortem prevalence of thromboembolic disease in dogs with IMHA has not been well described due to difficulties involved in making an accurate diagnosis. However, preliminary data from 110 dogs treated for IMHA at the Michigan State University Veterinary Teaching Hospital between 2004 and 2007 suggested that 34% had a clinical diagnosis of TE during their hospital stay.[16] Clinical diagnosis of pulmonary thromboembolism (PTE) was made on the basis of hypoxemia, thoracic radiographs excluding other respiratory diseases, and laboratory evidence of a prothrombotic state. Clinical diagnosis of portal vein thrombosis (PVT) was based upon the presence of ascites, vomiting or diarrhea, ultrasonographic findings consistent with altered portal blood flow or visualized thrombus, and laboratory evidence of a prothrombotic state. Of these dogs with a clinical diagnosis of TE, 51% had pulmonary thromboembolism (PTE) alone, 8% had portal venous thrombosis (PVT) alone, and 41% had both PTE and PVT.

The development of TE appears to significantly contribute to the morbidity and mortality of IMHA.[5,9,10,12] In our data, survival to discharge in dogs with TE was significantly lower than in dogs without TE (49% vs 81%) and median duration of hospitalization was longer (7 days vs 4 days).[16] However, 5 of 5 dogs with suspected PTE and confirmed PVT (by ultrasound or CT angiography) that were treated with thrombolytic therapy and thromboprophylaxis with warfarin survived > 1 year from the time of diagnosis. This suggests that accurate and prompt identification and treatment of TE may result in improved survival in this compromised patient population.

Definitive diagnosis of PTE remains challenging. Radiographic changes suggestive of PTE may include interstitial or alveolar infiltrates, small volume pleural effusion, regional oligemia resulting from reduced pulmonary blood flow distal to the thrombus, wedge-shaped pulmonary opacities, and enlarged or truncated pulmonary arteries. Unfortunately, radiographic changes associated with PTE in dogs are neither sensitive nor specific and may be absent in some cases.[12,17] Ventilation-perfusion (V-Q) scintigraphy has been evaluated in experimental PTE in dogs and was reported to be helpful in supporting a diagnosis of PTE in one dog with IMHA.[10] However, V-Q scanning is not widely available and the need for a 24 hour isolation period at a nuclear medicine holding facility makes this technique unfeasible in animals requiring oxygen therapy and critical care monitoring. In human medicine, CT angiography (CTA) is considered the test of choice for diagnosing pulmonary embolism. Recently, we developed pulmonary and portal angiographic techniques using a 16 slice multidector CT unit that have been successfully used to detect PTE and/or PVT in dogs with IMHA.

Documentation of the pro-thrombotic state that is responsible for the TE disease is also challenging, and has traditionally been based upon detection of increased fibrinolysis (increased FDPs and D-dimers) and decreased endogenous anticoagulants (antithrombin) rather than rate of clot formation. Thromboelastography (TEG) has shown promise in demonstrating hypercoagulability in dogs with IMHA.[18,19] Recently, our group has documented hypercoagulability as assessed by TEG in this population and demonstrated resolution of the prothrombotic state once hemolysis has ceased. (unpublished data)

Because of the close association between TE and mortality in dogs with IMHA, thromboprophylaxis is commonly instituted. Low-dose aspirin, clopidogrel (Plavix), and parenteral unfractionated heparin are the drugs most frequently used in veterinary patients at this time. Despite the frequent use of these drugs in dogs with IMHA, no large scale prospective randomized clinical studies exist and the use of various drug and dosing regimens remains controversial.

Aspirin irreversibly inhibits the formation of thromboxane A2 thus inhibiting platelet aggregation. It has traditionally been used in disease states associated with arterial thromboembolic disease such as heart disease, as the composition of arterial thrombi tend to be more “platelet-rich” than venous thrombi. However, several human studies have reported a decrease in the occurrence of TE in patients at high risk for venous TE when they have been prescribed low dose aspirin in addition to other antithrombotic drugs. Additionally, inhibition of platelet aggregation with aspirin appeared to be beneficial in one retrospective study evaluating treatment protocols in 151 dogs with IMHA.[7] The optimal aspirin dose in dogs with IMHA has not been determined. However, a comparison of

aspirin doses in normal dogs showed that 0.5 mg/kg q12 hours was more effective than 0.5 mg/kq q24 hours or 10 mg/kg q24 hours at inhibiting platelet aggregation.[20]

Clopidogrel inhibits ADP receptors P2Y12 on the platelet membrane, offering a different mechanism for platelet inhibition than does aspirin. A daily dose of 1 mg/kg was shown to effectively inhibit platelet aggregation in normal dogs.[21] Clopidogrel was also evaluated in a small prospective study and resulted in similar short-term survival rates when compared to low dose aspirin.[22] Whether clopidogrel offers additional benefits over aspirin in dogs with IMHA remains to be determined.

Heparin inhibits secondary hemostasis through activation of antithrombin (AT) and subsequent inhibition of the proteases (factors II, IX, X, XI, XII) necessary for the formation of a clot. Because fibrin-rich pulmonary and venous thrombi are most common in IMHA, drugs like heparin that target coagulation would appear to be the most logical choice for clot prevention. However, unfractionated heparin was not shown to be beneficial in retrospective studies[2,7] although the dose administered (75-125 U/kg subcutaneously every six to eight hours) in these studies was lower than that shown to prolong activated partial thromboplastin time (aPTT) in healthy dogs.[23] In dogs with IMHA, heparin doses of 300 u/kg every 6 hours were insufficient to achieve therapeutic anti-Xa activity (>0.35 u/ml) in a majority of clinical cases, suggesting that significantly higher doses may be required in this patient population.[24] It is also clear that titration of heparin to a therapeutic endpoint is most appropriate due to variations in individual response to heparinization. Dogs with IMHA that had their heparin doses individually adjusted based upon anti-Xa activity demonstrated significantly longer survival times when compared with dogs on fixed dose heparin.[25] However, the optimal test for monitoring heparinization and the appropriate therapeutic endpoints that should be employed are not well established in dogs. Anti-Xa activity appears to be a likely candidate, but is not widely available at most institutions and therapeutic endpoints are currently extrapolated from human patients. Activated partial thromboplastin time (aPTT) is readily available, but has shown questionable correlation with anti-Xa activity in dogs. Further studies comparing therapeutic endpoints and outcome in clinical patients are necessary.

The current protocol at our institution is a 150 U/kg intravenous bolus of unfractionated heparin followed by 30-60 U/kg/hr constant rate intravenous infusion. The heparin dose is then adjusted daily in 10 U/kg/hr increments, to achieve target prolongation of aPTT (1.5-2.5x upper limit of reference interval). Aspirin (0.5 mg/kg q12h) is added in the event of failure to achieve a target aPTT by day 2. In a pilot study, 26 consecutive dogs with IMHA were admitted to the hospital and treated with this heparin protocol before being transitioned to oral low-dose aspirin before discharge. In this population, no significant TE or bleeding complications were reported and 60 day survival was 100%. (unpublished data)

Conclusion

Despite the frequency with which TE is suspected in dogs with IMHA, definitive diagnosis is rare. Consequently, effective preventative and therapeutic options may be withheld due to concerns about side effects such as bleeding. However, current evidence suggests that thromboprophylaxis is an important consideration in the management of dogs with IMHA. Further studies are required to better define the optimal drugs, dosages, and monitoring strategies in this patient population.

References

Allyn ME, Troy GC. Immune mediated hemolytic anemia. A retrospective study: Focus on treatment and mortality (1988-1996). J Vet Intern Med 1997;11:131.

Burgess K, Moore A, Rand W, Cotter SM. Treatment of immune-mediated hemolytic anemia in dogs with cyclophosphamide. J Vet Intern Med 2000;14:456-462.

Grundy SA, Barton C. Influence of drug treatment on survival of dogs with immune-mediated hemolytic anemia: 88 cases (1989-1999). J Am Vet Med Assoc 2001;218:543-546.

Jackson ML, Kruth SA. Immune mediated hemolytic anemia and thrombocytopenia in the dog: A retrospective study of 55 cases diagnosed from 1969 through 1983 at the Western College of Veterinary Medicine. Can Vet J 1985;26:245-250.

Klag AR, Giger U, Shofer FS. Idiopathic immune-mediated hemolytic anemia in dogs: 42 cases (1986-1990). J Am Vet Med Assoc 1993;202:783-788.

Reimer ME, Troy GC, Warnick LD. Immune-mediated hemolytic anemia: 70 Cases (1988-1996). J Am Anim Hosp Assoc 1999;35(5):384-91.

Weinkle TK, et al. Evaluation of prognostic factors, survival rates, and treatment protocols for immune-mediated hemolytic anemia in dogs: 151 cases (1993-2002). J Am Vet Med Assoc 2005;226:1869-1880.

Thompson MF, Scott-Moncrieff JC, Brooks MJ. Effect of a single plasma transfusion on thromboembolism in 13 dogs with primary immune-mediated hemolytic anemia. J Am Anim Hosp Assoc 2004;40:446-454.

Carr AP, Panciera DL, Kidd L. Prognostic factors for mortality and thromboembolism in canine immune-mediated hemolytic anemia: a retrospective study of 72 dogs. J Vet Intern Med 2002;16(5):504-9.

Scott-Moncrieff JC, Treadwell NG, McCullough SM, Brooks MR. Hemostatic abnormalities in dogs with primary immune-mediated hemolytic anemia. J Am Anim Hosp Assoc 2001;37(3):220-227.

McManus PM, Craig LE. Correlation between leukocytosis and necropsy findings in dogs with immune-mediated hemolytic anemia: 34 cases (1994-1999). J Am Vet Med Assoc 2001;218:1308-1313.

Klein MK, Dow SW, Rosychuk RAW. Pulmonary thromboembolism associated with immune-mediated hemolytic anemia in dogs: Ten cases (1982-1987). J Am Vet Med Assoc 1989;195:246-250.

Weiss DJ, Brazzell JL. Detection of activated platelets in dogs with primary immune-mediated hemolytic anemia. J Vet Intern Med 2006;20:682-686.
Stone MS, Johnstone IB, Brooks M, et al. Lupus-type anticoagulant in a dog with hemolysis and thrombosis. J Vet Intern Med 1994;8:57-61.
Piek CJ, Brinkhof B, Teske E, et al. High intravascular tissue factor expression in dogs with idiopathic immune-mediated haemolytic anaemia. Vet Immunol and Immunopathol 2011;144:346–354.
Garcia-Pereira BL, Jutkowitz LA, McBride BL, Brown AJ. Prevalence of portal vein thrombosis and pulmonary thromboembolism in dogs with immune-mediated hemolytic anemia. J Vet Emerg Crit Care 2009;19:A8.(abstract)
Fluckiger MA, Gomez JA. Radiographic findings in dogs with spontaneous pulmonary thrombosis or embolism. Vet Radiol Ultrasound 1984;25:124-131.
Fenty RK, deLaforcade A, Shaw SP, O'Toole TE. Identification of hypercoagulability in dogs with primary immune-mediated hemolytic anemia by means of thromboelastography. J Am Vet Med Assoc 2011;238(4):463-467.
Sinnott VB, Otto CM. Use of thromboelastography in dogs with immune-mediated hemolytic anemia: 39 cases (2000-2008). J Vet Emerg Crit Care 2009;19(5):484-488.
Rackear D, Feldman B, Farver T, et al. The effect of three different dosages of acetylsalicylic acid on canine platelet aggregation. J Am Anim Hosp Assoc 1986;24:23-26.
Brainard BM, Kleine SA, Papich MG, Budsberg SC. Pharmacodynamic and pharmacokinetic evaluation of clopidogrel and the carboxylic acid metabolite SR 26334 in healthy dogs. Am J Vet Res 2010 Jul;71:822-30.
Mellett AM. Nakamura RK, Bianco D. A prospective study of clopidogrel therapy in dogs with primary immune-mediated hemolytic anemia. J Vet Intern Med 2011;25:71–75.
Diquelou, A. Pharmacokinetics and pharmacodynamics of a therapeutic dose of unfractionated heparin (200 U/kg) administered subcutaneously or intravenously to healthy dogs. Vet Clin Pathol 2005;34(3):237-242.
Breuhl EL, Moore G, Brooks MJ, et al. A prospective study of unfractionated heparin therapy in dogs with primary immune-mediated hemolytic anemia. J Am Anim Hosp Assoc 2009;45:125-133.
Helmond SE, Polzin DJ, Armstrong PJ, et al. Treatment of immune-mediated hemolytic anemia with individually adjusted heparin dosing in dogs. J Vet Intern Med 2010;24:597–605.

Respiratory Complications of Trauma

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Trauma is one of the most common emergencies seen in the busy emergency room. Examples of common veterinary trauma presentations include motor vehicle accidents (i.e. hit by car) interaction with other animals, interaction with humans, fall from heights, and penetrating trauma such as gunshot wounds, knife wounds, and impalement by sticks.

Trauma may affect only one body system or it may affect multiple organ systems. For this reason, the initial approach to the trauma patient must be rapid, thorough, and detailed to decrease further morbidity and mortality.

The initial triage evaluation should be rapid, developing a problem list outlining life-threatening conditions. The goals of the initial triage examination are to:

1. Assess / evaluate the ABCD's of triage medicine:

a. **A**irway: Does the patient have a patent airway? Upper airway or lower airway abnormalities?
b. **B**reathing: Does the patient have an abnormal breathing pattern? Is the patient dyspneic? Is there a rapid, shallow breathing pattern? Is there a slow, labored breathing pattern? Is there increased stertor or stridor?
c. **C**irculation: Is there an abnormal heart rate? Are the mucous membranes an abnormal color with evidence of internal or external hemorrhage? Are the pulses weak? Are the extremities cold?
d. **D**isability: Is there evidence of head trauma or other neurological injury?

2. Specifically regarding thoracic trauma, the goal is to rapidly determine if there are respiratory abnormalities. If present, the goal is to localize the cause for respiratory distress to best provide treatment:

a. Inspiratory wheezes: associated with narrowing of the upper airways by inflammation, hemorrhage, mucosal edema, or mucus.
b. Expiratory wheezes: associated with narrowing of the lower airways by inflammation, hemorrhage, mucosal edema, or mucus.
c. Crackles: fluid present within the lower airways / alveoli (e.g. edema, hemorrhage)
d. Stridor or stertor: indicates an upper airway respiratory abnormality
e. Short / shallow pattern: may indicate pleural space disease such as pneumothorax, pleural effusion, or diaphragmatic hernia
f. Paradoxical breathing: recognized by a lack of synchronous movement of the chest and abdominal walls.

Initial therapy chosen will be based on the degree and location of injury. Common therapies include oxygen supplementation, intravenous fluid therapy, and analgesia. Procedures such as a thoracocentesis may also be required, which can be both diagnostic and therapeutic.

Oxygen supplementation is one of the mainstays of therapy for a patient with respiratory difficulty. Initially, oxygen is often provided by facemask or flow-by to permit the clinician to perform the initial assessment. While oxygen cages may allow a higher percentage of oxygen to be delivered, it is difficult to assess the patient once in the closed oxygen cage, and therefore placement into the oxygen cage is often delayed until after initial assessment has been performed.

Oxygen supplementation techniques.

Supplementation technique	Required flow rate	Maximum inspired oxygen concentration achieved
Flow-by	3-15 l/min	40%
Oxygen cage	15 l/min	45-60%
Oxygen hood (unsealed bag)	5-15 l/min	85-95%
Oxygen collar	1 l/10 kg bodyweight/min	<80%
Nasal cannula	50-100 ml/kg/min	40%
Nasal catheters	50-100 ml/kg/min	40-50%

Nasopharyngeal catheter	50-100 ml/kg/min	60-70%
Nasotracheal catheter	25-50 ml/kg/min	80-90%

Intravenous access for fluid therapy and drug administration is also important. Initially, intravenous access is preferred via the use of by peripheral veins, notably the cephalic or saphenous veins. Other sites such as the jugular vein, while available, are not preferred as placement is not only more technically challenging but requires increased restraint which can be distressing to the dyspneic patient. Moreover, the use of the jugular vein should be avoided if there is a concern for head trauma and increased intracranial pressure. If patient stability allows, when placing the catheter it is advised to pull blood for anticipated testing including a minimum database (packed cell volume (PCV), total protein (TP), Azostick / dipstick BUN, and blood glucose concentration). A complete blood count, chemistry panel, and coagulation panel can also be drawn at that time if patient stability allows.

Once intravenous access is obtained, fluid therapy for resuscitation can be initiated. The goal of fluid resuscitation is to restore tissue perfusion and oxygenation. The type, volume, and rate of fluid administration are determined based on the patient assessment and underlying injuries. The two most common fluid choices for the resuscitation phase are isotonic crystalloids and synthetic colloids. Examples of isotonic crystalloid replacement fluids are 0.9% saline, lactated Ringer's solution, Normosol-R or Plasmalyte-A. Typically smaller doses of fluids are administered (10-30ml/kg in the dog, 5-10ml/kg in the cat) with frequent re-assessment rather than large volumes at once with the risk of worsening respiratory distress. Colloids are larger molecular weight fluids considered intravascular volume expanders. Examples of synthetic colloids include Hetastarch and Vetstarch. Typically smaller doses of fluids are administered (2-5ml/kg in the dog, 1-3ml/kg in the cat) with frequent re-assessment rather than large volumes at once with the risk of worsening respiratory distress. Once initial evaluation, treatment, and stabilization have started, the clinician can further evaluate the patient with a more thorough general examination to assess other complications of thoracic trauma.

Airway trauma

Trauma to the major airways may be seen with penetrating wounds or blunt trauma to the neck and chest. Clinical signs of upper airway trauma include abnormal upper airway noise on inspiration and expiration. Respiratory changes may result from traumatic inflammation, edema, hemorrhage, or even tracheal rupture or avulsion.

Subcutaneous emphysema may also be noted on examination, prompting a thorough airway integrity assessment. Pneumomediastinum and pneumothorax are more severe complications of airway trauma. While subcutaneous emphysema and pneumothorax may be easily found on examination alone, the diagnosis of pneumomediastinum is made radiographically by increased contrast with the mediastinal structures resulting in a clear visualization of the thoracic vena cava, aorta and esophagus.

Pneumothorax

Pneumothorax is defined as the abnormal accumulation of air in the pleural space. Air accumulation is most commonly bilateral but unilateral pneumothorax can occur. It is the most common complication of blunt trauma to the chest. Studies have shown that animals hit by car with fractures had evidence of pneumothorax 47.1% of the time. Furthermore, 36% of dogs and 63% of cats that fell from high rises that had evidence of pneumothorax on examination. Pneumothorax can be further classified as closed, open, and tension pneumothorax.

- Closed pneumothorax is seen following trauma due increased intra-thoracic pressure against a closed glottis causing rupture of alveoli or small airways, laceration of lung by fractured rib, iatrogenic, and airway or esophageal rupture causing pneumomediastinum which has progressed to pneumothorax.
- Open pneumothorax may result from gunshots, dog bites, knife wounds, and stick impalement.
- Tension pneumothorax is the third type, resulting when an air leak acts as one-way valve increasing intrathoracic pressure, compressing the lungs and decreasing venous return to the heart.

The astute clinician often makes the diagnosis of a pneumothorax based on history and examination alone. Common examination abnormalities include an increased respiratory rate and effort characterized by a short and shallow breathing pattern, dull lung sounds dorsally, and muffled heart sounds. Less specific examination abnormalities may include pale or cyanotic mucous membranes, poor pulses, and an abnormal posture with the head and neck extended and elbows abducted. While useful in the diagnosis of a pneumothorax, thoracic radiographs risk increased stress on the compromised patient. Radiographic signs of pneumothorax include elevation of the cardiac silhouette from the sternum, collapse of the lung lobes, and absence of vascular markings out to the periphery of the thorax.

Recently, the use of ultrasound has been documented for rapid detection of pleural space disease, specifically the "TFAST" (thoracic focused assessment with sonography for trauma) procedure. It does, however require practice to be competent in its use.

When radiographs are not suitable, the unstable patient may benefit from thoracocentesis, which can be both diagnostic and therapeutic. The equipment needed for this procedure includes clippers, scrub, sterile gloves, a 10-60ml syringe, 3-way stop-cock, butterfly catheter or needle and extension tubing. The site preparation and eventual needle placement for a patient suspected of a pneumothorax is on the dorsal 1/3 of the thorax between the 7th-10th intercostal spaces. The needle is inserted cranial to the rib to avoid the intercostal artery, vein, and nerve located caudal to each rib. Air is aspirated until negative pressure is obtained.

A chest tube is indicated when thoracocentesis needs to be repeated multiple times over a short period of time or when the clinician cannot achieve negative pressure on simple thoracocentesis. Large bore chest tubes require sedation or general anesthesia. Smaller bore chest tubes are also available, placed via the modified seldinger technique with the patient awake or receiving local analgesia. Equipment required for chest tube placement includes clippers, surgical scrub, surgical blade, local analgesia, suture material, the thoracostomy tube, 3-way stop-cock and syringes for initial aspiration. The chest tube can be used intermittently or attached to a suction device for continuous suction. The technique for chest tube placement will depend on the type of tube used, including surgical and trocar methods for the larger bore tubes or the modified seldinger technique for the smaller bore tubes. Similar to the thoracocentesis, surgical preparation of the site between the 7th-10th intercostal spaces is recommended.

Pulmonary contusions

Pulmonary contusions result from blunt or crushing trauma and are one of the most common problems associated with thoracic trauma, seen in approximately 50% of all thoracic injuries. Thoracic trauma leads to blood within the alveoli, ventilation/perfusion mismatch, increased pulmonary shunt fraction, and loss of lung compliance. Hypoxemia, increased work of breathing, and hypercarbia, are the physiologic results.

Physical examination findings may include tachypnea, hemoptysis, increased respiratory effort, and harsh lung sounds or crackles on auscultation. Radiographically, there may not be evidence of pulmonary contusions on presentation, delayed anywhere from 12 to 48 hours following trauma. When present, contusions appear radiographically as dense patchy, interstitial to alveolar disease.

As discussed above, initial fluid resuscitation must be started with caution as large volumes of rapidly administered fluid can exacerbate the fluid within the alveolar space with increased vascular permeability, worsening the hypoxemia. If radiographs have evidence of pulmonary contusions, the astute clinician should carefully look for concurrent abnormalities including pneumothorax and/or rib fractures. Additional diagnostic findings may include hypoxemia on pulse oximetry or arterial blood and an increased A-a gradient.

There is no specific medication or reversal therapy for pulmonary contusions. Common supportive care measures include oxygen supplementation, judicious IV fluid therapy, and analgesics. Although evidence is lacking, low dose diuretic therapy has been described anecdotally (furosemide, 0.5 to 1 mg/kg IV intermittently or CRI) in the treatment of pulmonary contusions.

Fractured ribs

Rib fractures result in discomfort and reduced diaphragmatic and chest wall motion. More specifically, the reduced chest wall motion and pulmonary expansion results in decreased oxygenation, ventilation, and atelectasis of the lungs. Rib fractures should be a clue to the astute clinician that severe thoracic trauma occurred prompting careful evaluation for additional injuries such as pulmonary contusions or a pneumothorax. Physical examination findings may include an increased respiratory rate with shallow respirations, subcutaneous emphysema, palpation of crepitus over the fracture site, and/or conformational changes of the chest wall.

Treatment of rib fractures consists of treating concurrent injuries such as pulmonary contusions, oxygen therapy if hypoxemia exists, and pain management with local or systemic analgesia.

Flail chest

A flail chest is a more severe manifestation of the simple rib fracture. A flail segment occurs when 2 or more ribs are fractured at the junction of ribs and the sternum producing a paradoxical movement of the flail segment. On inspiration, the chest wall normally expands. With a flail segment, the negative intrapleural pressure causes the flail segment to collapse inward during inspiration. On expiration, the chest wall normally collapses. With a flail segment, the intrapleural pressure becomes less negative and the flail segment moves outward on expiration. Abnormal chest movement and the accompanying pain from the fractures themselves result in decreased oxygenation, ventilation, and pulmonary atelectasis.

Treatment consists of placing the patient in lateral recumbency with the flail side down, minimizing movement of the flail segment and reducing the associated fracture discomfort. Pain management includes local nerve blocks and systemic opioid analgesia. Surgical stabilization of the flail segment may also be indicated.

Hemothorax

A hemothorax is defined as an accumulation of blood in the pleural space. This is uncommon following trauma. If present, the amount of blood loss into the pleural space is usually minimal and does not contribute significantly to respiratory compromise. If a large amount of hemorrhage into the pleural space is documented, there should be an increased suspicion for rupture of a large vessel.

More common causes for a hemodynamically insignificant hemothorax include laceration of pulmonary or intercostal vessels and/or lung laceration by a fractured rib.

The diagnosis of hemothorax is often be made on physical examination with signs including dyspnea, tachypnea, dull lung sounds ventrally, muffled heart sounds, and signs of hypovolemic or hemorrhagic shock. Thoracocentesis confirms the diagnosis when hemorrhagic fluid is obtained during aspiration with a PCV and TP of the effusion similar to that of the PCV and TP of the peripheral blood.

Treatment of a traumatic hemothorax may include diagnostic and therapeutic thoracocentesis, intravenous crystalloid or synthetic colloid therapy and blood products, notably whole blood or packed red blood cell transfusions. Autotransfusion can be considered if blood products are not available.

Diaphragmatic hernia

Diaphragmatic hernia is defined as disruption of the diaphragm, allowing displacement of abdominal organs into the thoracic cavity. Diaphragmatic hernia occurs most often as a result of blunt trauma where intra-abdominal pressure is suddenly increased causing rupture of the diaphragm. The resulting herniation of abdominal contents can range from a single organ or component of an organ (such as a single liver lobe) to almost all the abdominal contents moving cranially through the diaphragmatic rent into the chest cavity. The result is restriction of lung expansion and respiratory distress.

The diagnosis of diaphragmatic hernia can be made with physical examination findings and radiographic abnormalities. Clinical signs of diaphragmatic hernia depend upon the type and number of organs within the chest cavity as well as associated abnormalities such as fluid in the pleural space or pulmonary contusions. Examination findings may be mild and include a slight tachypnea or may result in severe dyspnea, dull lung sounds, muffled heart sounds, borborygmi from the stomach or intestines ausculted in the thorax, abnormal percussion, and a tucked/empty abdomen on palpation. Thoracic radiographs are often diagnostic with the presence of abdominal organs in the thorax.

Treatment for diaphragmatic herniation will depend on the clinical signs of the patient with surgical repair being the definitive therapy. Although there are no recent studies which outline the recommended time from stabilization to surgical correction, worsening respiratory distress or compromised blood supply to the displaced organs and ischemia would warrant a more rapid surgical correction.

Summary

Thoracic trauma is common in small animal medicine. Most patients respond well to rapid and aggressive support therapy. Concurrent injuries are common and the clinician should carefully evaluate their patients to address each specific medical condition to reduce patient morbidity and mortality.

References

Boysen SR, Rozanski EA, Tidwell AS, et al. Evaluation of a focused assessment with sonography for trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. J Am Vet Med Assoc. 2004;225(8):1198–1204.

Campbell V, et al. Pulmonary function, ventilator management, and outcome of dogs with thoracic trauma and pulmonary contusions: 10 cases (1994-1998).J Am Vet Med Assoc. 2000 Nov 15;217(10):1505-9.

Cockshutt JR. Management of fracture-associated thoracic trauma. Vet Clin North Am, Small Anim Pract. 1995; 25: 5, 1031-1046.

Gibson TW, et al. Perioperative survival rates after surgery for diaphragmatic hernia in dogs and cats: 92 cases (1990-2002).J Am Vet Med Assoc. 2005 Jul 1;227(1):105-9.

Gordon PN, Dunphy E, Mann F. A traumatic emergency: handling patients with head injuries. Vet Med. 2003;98(9):788–798.

Gordon LE, Thacher C, Kapatkin A. High-rise syndrome in dogs: 81 cases (1985-1991). J Am Vet Med Assoc. 1993; 202: 1, 118-122.

Lisciandro GR. Abdominal and thoracic focused assessment with sonography for trauma, triage, and monitoring in small animals. J Vet Emerg Crit Care (San Antonio). 2011 Apr;21(2):104-22.

Powell, LL Rozanski EA, Tidwell AS, Rush, JE. A retrospective analysis of pulmonary contusion secondary to motor vehicular accidents in 143 dogs: 1994-1997. J Vet Emerg Crit Care. 1999; 9(3), 127-136.

Serrano S, Boag A. Pulmonary contusions and hemorrhage. In: Silverstein DC and Hopper K, eds. Small Animal Critical Care Medicine. St. Louis, MO: Elsevier; 2009:105–110.

Spackman CJA, Caywood DD, Feeney DA, Johnston GR. Thoracic wall and pulmonary trauma in dogs sustaining fractures as a result of motor vehicle accidents. J Am Vet Med Assoc. 1984; 185: 9, 975-977.

Whitney WO, Mehlhaff CJ. High-rise syndrome in cats. J Am Vet Med Assoc. 1987; 191: 11, 1399-1403.

Emergency Management of DKA

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Pathophysiology

Diabetes mellitus (DM) is a common endocrine disease in dogs and cats characterized by an absolute or relative deficiency of insulin. The classic signs of DM are polyuria, polydypsia, polyphagia, and weight loss. Ultimately, hyperglycemia results from a combination of factors including decreased insulin production, insulin resistance, lack of glucose transport, and decreased availability of glucose by cells for energy.

Aside from glucose transport, insulin also has other important roles in the body including inhibition of lipolysis. Absence of insulin results in increased activity of the hormone sensitive lipase system resulting in increased free fatty acids (FFAs) in circulation as they are released from adipocytes. FFAs are taken up by the liver where they are primarily made into triglycerides, metabolized via the tricarboxylic (TCA) cycle to CO2 and water, or formed into the ketone bodies acetoacetate, β-hydroxybutyrate, and acetone.

An uncomplicated diabetic patient produces mostly triglycerides, with a small portion being shifted to ketone production. The question then remains, what causes the transformation of a stable diabetic patient to a diabetic ketoacidotic patient? Development of diabetic ketoacidosis (DKA) requires more than just an increased FFA production. Along with an increased FFA production, there are increased concentrations of circulating levels of diabetogenic hormones such as glucagon, epinephrine, cortisol, and growth hormone. These are increased as a result of additional stressors or illnesses. Although not always identified, these stressors or illnesses include any inflammatory, infectious, or even neoplastic process.

Epinephrine and glucagon inhibit insulin-mediated glucose uptake in muscle and stimulate hepatic glycogenolysis and gluconeogenesis which results in persistent hyperglycemia. Cortisol and growth hormone inhibit insulin activity and potentiate the effects of glucagon and epinephrine on hepatic glycogenolysis and gluconeogenesis. Additionally, epinephrine, glucagon and growth hormone stimulate lipolysis which increases the amount of circulating FFAs available for ketone formation. Persistent hyperglycemia, increases in ketone formation combined with academia results in diabetic ketoacidosis. Along with glucosuria (from marked hyperglycemia), ketoacids exacerbate the osmotic dieresis and combined with the associated illness often seen with DKA patients (vomiting, diarrhea, decreased intake) contribute to development of severe dehydration.

Historical findings

Most dogs and cats with DM present with a history of polyuria, polydipsia, polyphagia, and weight loss. The polyuria and polydipsia results from hyperglycemia that exceeds the renal threshold (average ~ 200 mg/dl in the dog, 250 mg/dl in the cat) leading to glucosuria and an osmotic dieresis, medullary washout, and electrolyte loss. A patient that presents with DKA not only often has a chronic history similar to DM, but they often have an acute history of lethargy, mental depression, anorexia, vomiting, diarrhea, weakness, and other signs consistent with concurrent disease (i.e. abdominal pain with pancreatitis or urinary tract signs with a pyelonephritis.)

Physical examination findings

Persistent hyperglycemia and ketonemia will result in clinical signs including lethargy, dehydration, hypovolemia, muscle wasting, vomiting, diarrhea, and an acetone odor on the breath. On physical examination, hepatomegaly is often manifested as cranial organomegaly. Other abnormalities include diabetic cataracts (dogs) and signs consistent with a peripheral neuropathy. Icterus can develop as a result of the complicating factors of hemolysis, hepatic lipidosis or acute pancreatitis.

Epidemiology

DKA is commonly associated with a new diagnosis of DM. The signalment for dogs and cats with DKA is similar to that for other presentations of DM. In one study 40% of newly diagnosed diabetic cats had evidence of ketoacidosis. In another study, 15% of newly diagnosed diabetic dogs were also diagnosed with diabetic ketoacidosis. Breed characteristics may also play a role in development of DKA. Certain breeds, notably the Keeshond, Miniature Schnauzer, Poodle, and Dachshund seem overrepresented. DKA patients are more likely to be obese and either a female dog or male cats.

Common concurrent disorders in dogs with diabetes mellitus include urinary tract infections, hyperadrenocorticism, acute pancreatitis, neoplasia, and hypothyroidism. In cats, concurrent diseases common in DKA include pancreatitis, hepatic lipidosis, cholangiohepatitis, chronic renal failure, infection, and neoplasia.

Clinical pathology

The diagnosis of DKA is made in the presence of hyperglycemia, glucosuria, acidemia, and ketonuria or ketonemia. Blood pH can be determined with a blood gas machine in patients with suspected DKA. Point-of-care analyzers have made this readily accessible (e.g., i-STAT®).

Additional clinical pathology findings include an elevated anion gap and hyperosmolality.

An elevated anion gap indicates an accumulation of unmeasured anions in the form of ketones. The anion gap can be calculated by the equation:

Anion gap = [sodium (mEq/L) + potassium (mEq/L)] - [chloride (mEq/L) + bicarbonate (mEq/L)]. Normal is approximately 17–24 mEq/L.

Hyperosmolality is also common in the DKA patient, estimated by the equation:

Osmolality = 2[sodium (mEq/L) + potassium (mEq/L)] + BUN (mg/dl)/2.8 + glucose (mg/dl)/18. Normal osmolality is approximately 290–310 mOsm/kg.

Additional diagnostics performed in DKA patients to help formulate the most appropriate treatment plan include:

- Complete blood count
- Chemistry profile
- Serum electrolyte profile
- Urinalysis
- Urine Culture and Sensitivity
- Thoracic radiographs
- Abdominal radiographs
- Abdominal ultrasound
- Coagulation profile

These diagnostics are used to rule out complicating and causative diseases including pancreatitis, renal disease, neoplasia, pulmonary parenchymal disease and other associated illnesses that transition a stable DM patient to an unstable DKA patient.

Clinicopathologic findings

DKA patients have a relative or absolute deficiency of insulin and excessive hepatic production of glucose resulting in hyperglycemia. As blood glucose concentration increases, renal threshold is exceeded (average ~ 200 mg/dl in the dog, 250 mg/dl in the cat) and glucosuria ensues.

On a complete blood count (CBC), approximately 50% of dogs with DKA will have a non-regenerative anemia. Causes for the anemia may include hypophosphatemia, anemia of chronic disease, GI blood loss, hemolysis, or neoplasia. Other CBC findings include a leukocystosis with left shift with infectious or inflammatory processes.

Electrolyte abnormalities are common, notably abnormalities of potassium, phosphorus, and magnesium. DKA patients often have a total body depletion of potassium as a result of decreased intake (anorexia) and increased losses through the gastrointestinal tract (vomiting and diarrhea), and osmotic diuresis. Although a total body potassium depletion is present, initial bloodwork often shows a normal or low-normal potassium level due to shifting of potassium. To maintain electroneutrality to balance the concurrent acidosis, potassium is shifted from the intracellular space to the extracellular space and hydrogen ions are shifted from the extracellular space into the intracellular space, giving a false sense of a normal potassium level although a total body depletion exists. With treatment, notably fluid and insulin therapy, potassium and glucose are shifted back intracellularly resulting in hypokalemia. The hypokalemia, which can be significant, can result in muscle weakness, cervical ventroflexion, cardiac arrhythmias, and respiratory muscle failure.

Similarly, hypophosphatemia develops when phosphate is shifted from the intracellular space to the extracellular space. Like potassium, fluid and insulin therapy results in electrolyte shifting, and phosphorous is shifted back intracellularly in exchange for hydrogen ions to maintain electroneutrality. Hypophosphatemia can result in weakness, hemolysis, arrhythmias, myocardial depression, and even seizures.

Magnesium is also an important electrolyte to monitor. Hypomagnesemia results from electrolyte shifting seen with decreased intake, acid-base changes and an osmotic dieresis resulting in refractory hypokalemia despite supplementation, weakness, and arrhythmias.

Serum chemistry abnormalities found in DKA patients are often related to co morbidities. One example is increased liver enzymes seen with inflammatory conditions such as pancreatitis, hepatic lipidosis (cats), cholangiohepatitis, or bile duct obstruction. Azotemia is commonly found and may be due to pre-renal hypovolemia or underlying primary renal disease.

Urinalysis abnormalities include glucosuria, ketonuria, and decreased urine specific gravity as a result of the osmotic dieresis and medullary washout. The urine should also be evaluated for the presence of an inflammatory sediment and a sample should be submitted for bacterial culture regardless as an osmotic diuresis may result in an artificially dilute urine specific gravity. Although

ketonuria is expected, this may not be initially seen on the urine strip because the nitroprusside reagent in the urine dipstick reacts with acetoacetate and not with beta-hydroxybutyrate, which is the primary ketone body in DKA.

Diagnostic imaging

Radiography is valuable in the diagnostic evaluation of the DKA patient. Thoracic radiographs are used to assess pulmonary parenchymal disease or cardiac disease including pulmonary pneumonia, neoplasia, cardiomegaly, and / or congestive heart failure.

Abdominal radiographs and/or ultrasound can be used to identify abdominal disease associated with DKA including pancreatitis, pyelonephritis, hepatitis, intestinal diseases, and/or neoplasia.

Treatment

Treatment of the DKA patient is multifactorial, with the combined therapy of:

1. Fluid therapy
2. Insulin therapy
3. Correction of electrolyte imbalances
4. Nutrition

When designing a hospitalization and treatment plan it is important to be proactive. DKA patients often spend several days in the hospital with the need for frequent reassessment of blood glucose and electrolytes. For this reason, the author recommends placing a sampling catheter or central venous catheter on admission. These catheters will allow repeated, painless, venous sampling, central venous pressure monitoring (CVP) in those patients with a possible fluid intolerance (i.e. underlying heart disease), the use of multiple fluid types which may be incompatible when administered through one catheter, and parenteral nutrition if enteral feeding is contraindicated such as with protracted vomiting or prolonged anorexia.

Fluid therapy

Fluid therapy should be started immediately. Most DKA patients are markedly dehydrated due to the osmotic diuresis (caused by the hyperglycemia, ketonemia, and medullary washout) and concurrent fluid loss from illness (vomiting, diarrhea, decreased intake). Fluid therapy is generally instituted for several hours (4-6) before starting insulin therapy. Rehydration alone will aid in decreasing the blood glucose concentration by dilution and increased glomerular filtration through the kidneys. Fluid therapy should be calculated based on an estimate of dehydration, presence of ongoing losses and maintenance requirements. Fluid therapy with a replacement crystalloid such as Normosol-R®, Plasmalyte 148®, 0.9% NaCl, or lactated Ringers is appropriate in most cases. Although potassium is often normal on bloodwork, due to a total body depletion (see electrolyte section above), potassium should be added to these replacement solutions.

Table Formulas that relate to fluid balance and response to fluid therapy

Daily maintenance volume	Volume ml = (30 x kgBW) + 70
Resuscitation (shock) volume	Crystalloid (dog) = 80–90 ml/kgBW delivered as 30 ml/kg boluses Crystalloid (cat) = 50–60 ml/kgBW delivered as 20 ml/kg boluses Colloid (dog) = 10–20 ml/kgBW delivered as 5 ml/kg boluses Colloid (cat) = 5–10 ml/kgBW delivered as 2.5 ml/kg boluses 7.5% saline (dog) = 10 ml/kgBW bolus, single dose (slowly) 7.5% saline (cat) = 5 ml/kgBW bolus, single dose (slowly)
Replacement (dehydration) vol	Volume ml = % dehydration (estimate) x Body weight (kg)

While an isotonic crystalloid fluid is appropriate in most cases, the fluid choice should be isotonic to the patient's sodium level to prevent rapid sodium shifts. Regardless of the fluid type chosen, the fluid rate is not a set-it and forget-it treatment. Constant re-assessment is needed to ensure the patient is not at risk for fluid overload or continued dehydration with ongoing losses. Re-assessment patient parameters include serial physical examinations, PCV/TS, body weight, urine output and other losses such as continued vomiting, diarrhea, or excessive panting. It is important to remember that hyponatremia may appear severe in cases of severe hyperglycemia, but this is often an artifact. Pseudohyponatremia may be seen as a result of marked hyperglycemia resulting in water retained within the vascular space, diluting the plasma sodium. The corrected sodium can be calculated by adding the measured sodium with 1.6 (glucose mg/dl–100)/100. The pseudohyponatremia corrects once normoglycemia is established.

Insulin therapy

Insulin therapy is essential to provide glucose to the starving cells, decrease lipolysis, reverse ketosis and correct the acidemia. While nobody will argue the importance of insulin in treatment of the DKA patient, insulin is not the most important (*or even preferred treatment)* on presentation. It is typically recommended that insulin therapy be delayed for at least 4-6 hours while fluids are started. Delayed insulin therapy is recommended to prevent rapid glucose and electrolyte shifts without adequate fluid replacement as well as prevent a rapid decease in blood glucose and shift in osmolality causing CNS fluid shifts.

When insulin therapy is started, regular, short acting insulin (Humulin R®) therapy is recommended. Regular insulin is administered either intravenously (IV) as a CRI or intramuscular (IM). Subcutaneous insulin therapy is not recommended as dehydration may delay absorption from the subcutaneous space.

When administered as an intravenous CRI, it is recommended to have at least two catheters. As discussed above, a sampling catheter or central venous catheter is preferred to aid in frequent venous sampling. The CRI solution is formulated using 2.2 U/kg of regular insulin for dogs or 1.1 U/kg of regular insulin for cats diluted in 250 ml of saline. Approximately 50 ml of the combined solution is allowed to run through the fluid line and discarded as insulin binds to the plastic tubing. The rate of CRI insulin administration is based on a CRI chart (example below) and adjusted based on serial blood glucose readings, often every 2-4 hours.

Insulin CRI(Regular Insulin) Cat- 1.1u/kg in 240ml 0.9% NaCl Dog- 2.2 u/kg in 240ml 0.9% NaCl	
Blood Glucose (mg/dl)	Insulin CRI
> 350	10ml/hr
250-349	7mlhr
150-249	5ml/hr + 2.5% dextrose
100-149	3ml/hr + 5% dextrose
<10	0ml/hr

If the CRI protocol is not used, an alternative is an intramuscular regular insulin protocol. The intramuscular protocol is less labor intensive and often considered in patients that are more stable and less dehydrated. A common starting dose is 0.25 U/kg of regular insulin administered every 4 hours. The author in practice uses the chart below. Similar to the CRI protocol, the insulin dose is adjusted based on serial blood glucose monitoring.

IM Insulin Protocol - Regular Insulin		
Blood Glucose	Insulin Dose	IV Fluids – Dextrose
>300	0.4u/kg	No dextrose
200-299	0.3u/kg	+ 2.5% dextrose
100-199	0.1u/kg	+ 5% dextrose
<100	None	+ 5% dextrose

Once the blood glucose is controlled, ketosis is resolved, and clinical signs improve, notably vomiting, dehydration, and anorexia, subcutaneous insulin can be started. Common insulin types including Glargine and NPH, q12 hours. Following discharge, a blood glucose curve is recommended 7-10 days to ensure appropriate insulin therapy.

Electrolyte supplementation

Electrolyte monitoring should be performed once to twice daily, depending on the severity of the electrolyte abnormalities. The main electrolytes to monitor are potassium, phosphorus, and magnesium. Although pseudohyponatremia is often found on presentation, careful sodium monitoring can help the clinician assess the fluid therapy plan.

Hypokalemia is primarily due to anorexia (lack of intake), correction of the metabolic acidosis with fluid therapy, and osmotic diuresis. Clinical signs of hypokalemia include muscle weakness, cervical ventroflexion, cardiac arrhythmias, or respiratory muscle failure. In addition to fluid therapy, insulin therapy further worsens hypokalemia as it drives potassium intracellularly.

Potassium Replacement Chart	
Serum potassium concentration (mEq/L)	***Potassium added to fluids (mEq/L)***
3.5–5	20
3.0–3.4	30

2.5–2.9	40
2.0–2.4	60
<2.0	80

Hypophosphatemia occurs due to acidosis, insulin therapy (which like potassium, drives it intracellularly), and urinary losses due to osmotic diuresis. If hypophosphatemia is present, phosphorous should be supplemented (0.01-0.12 mmol/kg/hr CRI) as potassium phosphate. Phosphorous levels below 3.5 mmol/L may cause illness weakness, lethargy, and ataxia. More severe signs of illness including seizures and hemolytic anemia may be seen with phosphorous levels below < 1.5 mmol/L.

Hypomagnesemia, like potassium and phosphorus, is seen with anorexia, decreased intake, gastrointestinal loss, and osmotic diuresis. Hypomagnesemia can result in arrhythmias, weakness, hypotension, and exacerbate other electrolyte abnormalities. If hypokalemia persists despite adequate potassium supplementation, it is important to check the magnesium level. Hypomagnesemia is treated with magnesium sulfate supplementation at 0.75 mEq/kg/day with appropriate electrolyte monitoring once to twice daily.

Treatment for metabolic acidosis

In most cases, specific therapy for metabolic acidosis is not required. Metabolic acidosis is often present from a combination of ketone formation, lactic acid from decreased perfusion, and uremic acids. Fluid therapy restores perfusion and insulin therapy decreases formation of ketones, thus often resolving the metabolic acidosis. When the metabolic acidosis is severe and persists despite appropriate therapy (pH < 7, bicarbonate < 8-11 mEq/L, and BE < -15 mm Hg) treatment with bicarbonate can be considered. The amount of bicarbonate to administer is calculated with the following question:

Base deficit X body weight (kg) X 0.3 (ECF volume).

One quarter to one third of this calculated deficit is administered as a CRI diluted in IV fluids over 4-6 hours. Following this treatment, bloodwork is rechecked to assess response to therapy.

Nutrition

While patients with DM are historically polyphagic, patients with DKA are often anorexic with complicating clinical signs including vomiting and diarrhea. Ultimately, we must have improved nutrition to reverse and resolve the state of DKA. At the most basic level, the transition from short acting regular insulin to the insulin required for successful discharge from the hospital (i.e. NPH, glargine, etc.) requires that the patient is eating well. This is often improved with resolution of the underlying cause (i.e. pancreatitis, enteritis, pyelonephritis, etc). Although enteral nutrition is ideal, depending on the severity of DKA and concurrent disease, further enteral and even parenteral nutritional support may be needed. Nasoesophageal feeding tubes can be placed with local anesthetic in critical patients. If ongoing nutritional support is needed an esophagostomy tube can be placed. When prolonged anorexia is suspected and enteral nutrition is not possible, placement of a central venous catheter and the use of TPN is recommended.

Patient monitoring and supportive care

Treatment and monitoring of the DKA patient depends on the severity of the clinical condition, concurrent underlying diseases, and response to therapy. Frequent reassessment of vital signs (temperature, heart rate, pulse quality, respiratory rate, respiratory effort, body weight) is imperative. Electrolytes, notably potassium, phosphorus, and magnesium should be monitored at least once to twice daily. Venous blood gas analysis and urine or serum ketones should also be checked once to twice daily to assess response to therapy.

Conclusion

Successful treatment of the DKA patient requires a multipronged approach addressing fluid therapy, insulin therapy, electrolyte imbalances, and nutrition. Fortunately, approximately 70% of patients treated for DKA survive to discharge from the hospital. Owner education is important in both short and long term treatment plans. The owner should be educated on not only the average hospitalization time (6 days) but the long term commitment if insulin administration and the commitment to long-term veterinary care.

References

Bruskiewicz KA, Nelson RW, et al. Diabetic ketosis and ketoacidosis in cats: 42 cases (1980–1995). J Am Vet Med Assoc 1997;211:188–192.

Durocher LL, et al. Acid base and hormonal abnormalities in dogs with naturally occurring diabetes mellitus. J Am Vet Med Assoc 2008;232(9):1310–1320.

Goossens MC, Nelson RW, et al. Response to insulin treatment and survival in 104 cats with diabetes mellitus (1985–1995). J Vet Intern Med 1998;12:1–6.

Greco DS. Pancreatic Disorders: Diabetic Ketoacidosis and Insulinoma. In: The Veterinary ICU Book. Eds: Wingfield WE, Raffe MR. Teton NewMedia, Jackson Hole, WY. 2002.

Hess RK, Saunders MH, et al. Concurrent disorders in dogs with diabetes mellitus (1993–1998). J Am Vet Med Assoc 2000;217:1166–117.
Hume DZ, Drobatz KJ, Hess RS. Outcome of dogs with diabetic ketoacidosis: 127 dogs (1993–2003). J Vet Intern Med 2006;20:547–555.
Koenig A, Drobatz KJ, Beale A, King LG. Hyperglycemia, hyperosmolar syndrome in feline diabetes: 17 cases (1995-2001). J Vet Emerg Crit Care Soc 2004; 14(1): 30-40.
Kraus MS, Calvert CA, et al. Feline diabetes mellitus: a retrospective mortality study of 55 cats (1982–1994). J Am Anim Hosp Assoc 1997;33:107–11.
Macintire DK. Treatment of diabetic ketoacidosis in dogs by continuous low-dose intravenous infusion of insulin. J Am Vet Med Assoc 1993;202:1266–1272.
Nichols R, Crenshaw K. Complications and concurrent disease associated with diabetic ketoacidosis and other severe forms of diabetes mellitus. Vet Clin North Am Small Anim Pract 1995; 25: 617.
Plotnick AN, Greco DS. Diagnosis of diabetes mellitus in dogs and cats. Contrasts and comparisons. Vet Clin North Am Small Anim Pract 1995; 25: 563.

Emergency Management of Hepatic Lipidosis

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Feline hepatic lipidosis is a potentially fatal intrahepatic cholestatic process that develops in cats in association with prolonged anorexia and catabolism. It is the most common form of liver disease in cats in North America[7], although seen worldwide. Most affected cats are middle-aged adults (median age 7 years), domestic shorthaired cats, and obese or overweight[1, 3]. There is no gender or breed bias. The period of anorexia documented prior to evaluation may be as short as 2–7 days[3, 4].

Feline Hepatic Lipidosis can occur as either a primary idiopathic disease syndrome or secondary to another disease process, such as pancreatitis, small intestinal diseases, renal disease, and neoplasia.

Although prolonged anorexia and decreased nutritional intake is the primary concern, decreased cellular nutrition can also lead to the development of hepatic lipidosis. Processes such as uncontrolled diabetes can lead to decreased cellular nutrition where intake is adequate, or even increased, followed by fat deposition in the liver.

Pathogenesis

The pathogenesis of hepatic lipidosis is likely multifactorial and many theories have been discussed.

One such theory is that there is a defect in hepatic lipid mobilization, decreased ability for hepatic fat oxidation, and decreased lipoprotein removal from the liver. Evidence for this theory includes ultrastructural changes of the liver, notably decreased number hepatic peroxisomes, altered mitochondria and altered endoplasmic reticulum.

Cats are also predisposed to accumulating triglycerides in their hepatocytes. With prolonged anorexia and decreased cellular nutrition there is hepatocellular fatty vacuolation despite an increased rate of Very-low-density lipoprotein *(*VLDL*)* secretion. In a normal feline liver, fat comprises < 5% of the total organ weight. In contrast, the liver of a cat with hepatic lipidosis may triple in weight due to lipid accumulation. This is more pronounced in overweight cats as prolonged anorexia results in a release of fatty acids from their abundant peripheral adipose stores, overwhelming the liver's ability to use or transport the excess fatty acids and lipid.

When fatty acids are released from the peripheral stores, there are several pathways they can follow. They may undergo beta-oxidation, be used for triglyceride synthesis, be converted to phospholipids, be used in the formation of cholesterol esters, or be packaged with apoproteins for dispersal as lipoproteins.

The most important pathway for triglyceride distribution is the formation of Very-low-density lipoprotein *(*VLDL*)*. In order for this to take place, there must be an intact lipid transport system, adequate combination with apoproteins, formation of a secretory particle, and transportation out of the hepatocyte and into the perisinusoidal space. If any of these pathways are disrupted, this will result in abnormal fat mobilization.

Presenting complaint

Most patients presenting with feline hepatic lipidosis are bright and alert. The most common presenting complaints from the owners during questioning include inappetence, weight loss, vomiting, diarrhea and lethargy[3,4].

Less commonly they present with more serious illness as a result of hepatic encephalopathy or weakness as a result of hypokalemia.

Clinical signs- examination

Common physical examination findings include dehydration, icterus, an unkempt appearance, a pendulous abdomen with cranial organomegaly (hepatomegaly), and weight loss seen as dorsal muscle wasting.

Bloodwork

Complete blood count

Complete blood count (CBC) findings often include a nonregenerative anemia and a stress leukogram. The nonregenerative anemia may result from chronic disease, phlebotomy, or hypophosphatemia. Stress leukograms have a characteristic white blood cell count differential including a mature neutrophilia, lymphopenia, and eosinopenia. A monocytosis is variable in cats. Neutrophilia is due to decreased adherence to the vascular endothelium, which prolongs circulating time and increased bone marrow release of neutrophils. Lymphopenia is due to redistribution or lysis of lymphocytes. Poikilocytosis is common and may reflect altered red blood cell membrane lipids or oxidative stress to the red blood cells affecting cell membrane stability and flexibility. Heinz bodies are also common, and may reflect oxidation as a result of medications, inflammation, or the underlying disease[5].

Serum biochemistry

Serum biochemical changes primarily reflect cholestasis. Cholestasis, is a term used to describe any condition in which there is impaired flow of bile from the bile duct preventing bile from entering into the intestines. Cholestasis may result from a variety of diseases related to the gallbladder, liver, and pancreas.

Most cats have a markedly increased Alkaline phosphatase (ALP/ALKP) as well as an increased serum bilirubin concentration. Transaminases such as Alanine transaminase (ALT) may be slightly elevated, but it would be uncommon for a cat to present with primary hepatic lipidosis and have a markedly elevated Alanine transaminase and only a mild elevation in Alkaline phosphatase. Gamma-glutamyl transferase (GGT) is often within the normal range in patients with hepatic lipidosis. This is in contrast to other diseases where the gamma-glutamyl transferase (GGT) elevations are normally in parallel Alkaline phosphatase (ALP). An elevated gamma-glutamyl transferase (GGT) in a cat with hepatic lipidosis would increase the suspicion of a secondary process, such as pancreatitis, cholangitis, an extrahepatic bile duct obstruction, or neoplasia of the pancreas, liver, or biliary tree.

Other biochemical abnormalities include a low Blood Urea Nitrogen (BUN) and low Albumin. The BUN is often low due to an abnormal urea cycle (also known as the ornithine cycle, this is a cycle occurring in many animals that produces urea ((NH2)2CO) from ammonia (NH3) and takes place primarily in the liver and to a lesser extent in the kidney. The albumin is low as a result of decreased synthesis and loss.

Hypoglycemia is uncommon, as more than 70% of the functional liver mass must be lost before hypoglycemia ensues. In contrast, hyperglycemia is present in about 50% of cases due to either a stress hyperglycemia or the underlying disease process, a primary example being diabetes mellitus.

Electrolyte panel

Important electrolytes to assess include potassium, phosphorus and magnesium. Prolonged anorexia results in total body depletion and untreated and persistent hypokalemia, hypophosphatemia, and less commonly hypomagnesemia increase the risk of morbidity and mortality. Signs of hypokalemia and hypophosphatemia include pallor due to red blood cell hemolysis, weakness, vomiting, and vetroflexion of the head and neck.

Coagulation profile

Evaluation of Prothrombin time (PT) and Partial Thromboplastin Time (PTT) is an essential part of the diagnostic evaluation in feline hepatic lipidosis. In less than 7 days cats can become vitamin K deficient and over 50% of cats with hepatic lipidosis have coagulation test abnormalities. Coagulation profile abnormalities are not uncommon as the liver plays a primary role in clotting factor synthesis, notably the Vitamin K dependent clotting factors II, VII, IX and X, Protein C and Protein S10. The importance of checking clotting factors and treating coagulopathies cannot be over emphasized in patients that may require the placement of large bore feeding tubes, liver aspirates or biopsies8, or jugular venipuncture.

Blood gas evaluation

Common venous blood gas abnormalities include a metabolic acidosis, consistent with elevated ketones and lactate. The lactate elevation is suspected as a result of impaired hepatic lactate metabolism, dehydration, hypovolemia, and poor perfusion. The elevated ketone level suspected as a result of poor cellular nutrition and accumulation of plasma ketones.

Urinalysis

Lipid accumulation may be present in the urine sample from renal tubule lipid vacuolation. Bilirubin pigmenturia and bile crystalluria may also be seen. Due to prolonged anorexia and fluid loss as a result of vomiting and diarrhea, dehydration is supported by an increased urine specific gravity.

Abdominal ultrasound

Following a thorough physical examination and biochemical analysis (complete blood count, serum biochemistry, urinalysis, and coagulation panel), further diagnostics are often considered in an attempt to rule out a primarily disease which resulted in the initial anorexia and subsequent development of secondary hepatic lipidosis.

An abdominal ultrasound allows a non-invasive evaluation of the abdominal organs, notably the liver, pancreas, stomach, small intestine, large intestine, spleen, and kidneys.

In health, the liver is isoechoic to the falciform fat and to the cortex of the right kidney, and hypoechoic to the spleen. With hepatic lipidosis, the liver is characteristically large (hepatomegaly) with diffuse hyperechoic parenchyma, hyperechoic to the falciform fat and renal cortex, and isoechoic to the spleen6.

Additional concerning findings on ultrasound include pancreatitis, triaditis, biliary disease, and inflammatory bowel disease. Triaditis is a term referring to inflammatory diseases involving three specific organs, namely the liver, pancreas and small intestine.

Combined with the history, examination findings, bloodwork results, and ultrasound findings, liver aspirates are often adequate for a presumptive diagnosis of hepatic lipidosis. The expected cytological finding is hepatocellular lipid vacuolation. Aspirates not only support the diagnosis with the presence of lipid, but also rule out other primary liver diseases that may appear similar ultrasonographically, (hyperechoic hepatomegaly) including hepatic lymphoma and hepatitis.

A true tissue biopsy (ultrasound guided, surgical, or laparoscopic) has an increased risk of complications, notably hemorrhage, and may be academic if all other information points towards a diagnosis of hepatic lipidosis8. On gross evaluation (surgical or laparoscopic), the liver is tan-yellow in color, friable, and biopsy specimens float in formalin. Histopathology reveals marked hepatocellular vacuolation. If true tissue biopsies are needed, it is imperative to stabilize the patient, including hydration, electrolyte abnormalities, coagulation abnormalities, and the overall cardiovascular status.

Therapy

Successful recovery of cats with hepatic lipidosis requires nutritional support, correction of fluid loss, correction of electrolyte abnormalities, and appropriate detection and treatment of an underlying disease process (if present).

Enteral feeding

The cornerstone of therapy in reversing hepatic lipidosis is appropriate nutritional support. For this reason, enteral feeding is initiated as soon as possible in the treatment process. Food requirements are calculated based on energy typically referred to as the resting energy requirement (RER). Common formulas used to calculate the RER for a feline patient:

1. RER = 70 x (current bodyweight in kilograms)0.75 (for > 5 kg)
2. RER = 30 x BWkg +70 (for < 5 kg)
3. RER = 60kcal x BWkg

Once enteral feeding is initiated, the complete daily caloric intake *(*100% RER) is not offered on day one. Once the RER is calculated, a fraction (25-33%) is divided over the first 24 hours. If this is tolerated, the caloric intake is increased on day two (50-67%). Finally, on day three and thereafter, the caloric intake is increase to 100% RER. Over a 24 hour period, the feeding schedule will be adjusted based on the individual patient's characteristics, often dividing the total caloric intake into 4-6 feedings rather than large infrequent boluses. Smaller volumes are preferred as prolonged anorexia in patients with hepatic lipidosis may reduce the gastric volume to as little as 10% of the original gastric volume[1,9].

For example: a cat that has a 5kg ideal body weight:

- 5kg x 60kcal/kg = 300kcal over a 24 hour period.
- Day 1 RER = 300kcal * 25% = 75kcal total, or approximately 19kcal every 6 hours.
- Day 2 RER = 300kcal * 50% = 150kcal total, or approximately 38kcal every 6 hours.
- Day 1 RER = 300kcal * 100% = 300kcal total, or approximately 75kcal every 6 hours.

The importance of nutritional support cannot be overemphasized. Continued lack of nutrition will lead to further lipolysis and storage of lipid within the hepatocytes.

By the time these patients are presented to the hospital and diagnosed with hepatic lipidosis, they have often been anorexic for at least 3-5 days. As a result, force-feeding is not considered an effective or well-tolerated form of enteral nutrition. It is not only difficult to ensure adequate caloric intake, but continued nausea and systemic illness may develop into a food aversion. Appetite stimulants (i.e. Mirtazapine, Cyproheptadine) are also clinically ineffective and not recommended.

For this reason, adequate nutritional support often involves the use of a large bore feeding tube, nasoesophageal (NE) tube, esophageal tube (E-Tube) or Gastrostomy tube (G-Tube).

Esophagostomy tubes (E-tubes) are the most common feeding tube used in feline hepatic lipidosis. Placement requires a stable patient including coagulation factors, correction of electrolyte abnormalities, the cardiovascular system, and the ability to tolerate a short general anesthesia. As compared to a NE-feeding tube, an E-Tube allows the clinician to start a more suitable diet, and the E-tube has fewer complications than G-tubes.

However, when the patient is not stable enough for the placement of an E-tube, initial feeding via a NE- tube is an accepted alternative. A NE-tube is inexpensive and does not require anesthesia in most cases.

Following the placement of any feeding tube (NE tube, E-Tube, or G-Tube) a radiograph is recommended to confirm placement. An E-collar is also recommended to avoid accidental trauma to the tube or premature removal of the tube.

Securing the E-Tube is imperative. While traditionally, gauze and Vet WrapTM has been used, the Kitty Kollar (http://www.kittykollar.com) has been used by the author with success. This is a washable, fabric collar designed to wear in conjunction with an esophageal feeding tube. The collar replaces the gauze and bandaging normally used to hold the tube in place, keeping it more sanitary, more stable and comfortable, and more protected against scratching and damage.

When using an E-Tube in practice, while there are several diets to consider (see chart below), the author commonly uses Hill's A/D. Undiluted Hill's A/D contains 1.2 Kcal per ml. If the contents of 1 can are diluted with 50ml of water, the mixture will contain1.0 KCal per ml and is a better consistency for placement through the E-tube with less risk of clogging of the tube.

Fluid and electrolyte therapy is essential for rehydration, maintenance, as well as correction of electrolyte abnormalities primarily resulting from a lack of nutritional intake. A balanced electrolyte solution is recommended. Due to decreased hepatic lactate metabolism, hyperlactatemia may already be present. For this reason, some clinicians avoid lactate-containing solutions such as

Lactated Ringer's solution (LRS). With that said, more often we are concerned about improving overall hydration and intravascular volume replacement, and the use of one specific crystalloid as compared to another is more academic than clinical. Dextrose supplementation is also avoided unless hypoglycemia is documented, as many patients are already showing some degree of hyperglycemia as a result of glucose intolerance.

Electrolyte monitoring is also valuable, notably to assess and correct hypokalemia and hypophosphatemia. If supplementing potassium yet the patient is not responding, refractory hypokalemia can be seen with concurrent hypomagnesaemia. Refractory hypokalemia is a negative prognostic indicator, thus hypokalemia must be addressed aggressively. Magnesium is found in enteral diets and once enteral feeding resumes this often corrects. When critical and not yet on an enteral diet, intravenous CRI supplementation is needed.

Although total body electrolyte depletion is expected, initial evaluation may show normal or low-normal electrolyte values. Prolonged anorexia and electrolyte depletion initially results in shifting of electrolytes out of the cells into the periphery. This is why the values, although expected to be low, can be normal or low-normal. Once enteral or parenteral nutritional therapy is started, a refeeding phenomenon is seen within 12-24 hours of therapy. Refeeding causes a shift in the body from a catabolic state to an anabolic state. Administration of enteral (or parenteral) nutrition stimulates the release of insulin, resulting in a dramatic shift of electrolytes from the extracellular space to the intracellular space, primarily phosphorus, potassium and to a lesser degree magnesium. Thus, the phosphorus (and other electrolytes) that were shifted extraceullarly, are pushed back into the cell, resulting in dramatic and often sudden decreases in serum electrolytes.

Repeated blood sampling and electrolyte monitoring will depend on the patient's clinical signs and disease severity; electrolytes are often checked every 6-12 hours initially, then 12-24 hours for continued monitoring.

While the focus thus far has been on stabilization, diagnosis, and nutritional support, many of these patients present with anorexia, nausea, and gastrointestinal signs such as vomiting and diarrhea. In order for enteral feeding to be effective, nausea and vomiting must be addressed. The vomiting is addressed in several ways; pharmacologic therapy, reducing meal volume with an increasing meal frequency, and treatment of any existing underlying illness. Although enteral feeding via an E-Tube is typically performed every 4-6 hours, for patients that cannot handle these volumes, trickle feeding is an alternative feeding method. Trickle feeding is performed with slow, constant feeding over a longer period of time, often for convenience employing a syringe pump or fluid pump to deliver a constant infusion of enteral nutrition through the attached feeding tube.

Vitamin and anti-oxidant therapy should be considered as well. Cobalamin (Vitamin B12) deficiency is common in cats with intestinal or pancreatic disease. Thiamine (vitamin B1) deficiency is also common and can result in weakness, lethargy, ventroflexion, and poor pupillary light responses, vestibular signs10.

Cats with hepatic lipidosis also are suspected to have a vitamin K deficiency. Vitamin K treatment is imperative when a coagulopathy is diagnosed prior to insertion of feeding tubes, jugular venipuncture, or hepatic aspiration / biopsy. Vitamin K therapy is also empirically used in patients when a large bore feeding tube placement is scheduled.

Supplementation with L-carnitine has demonstrated improved fat metabolism and clinical survival. L-carnitine transports long chain fatty acids across the mitochondrial membrane for Beta oxidation, and is an essential cofactor for fatty acid oxidation.

S-adenosyl-L-methionine (SAMe), an essential methyl donor and important for glutathione (GSH) synthesis may also aid in hepatic recovery.

Prognosis

The presence of a concurrent medical condition and the ability to treat this condition with directly affect the outcome. Overall, greater than 80% of patients can have a full recovery. With treatment, serum bilirubin concentration should decrease by 50% in approximately 7-10 days. The liver values may remain elevated at that time, but improve slowly with therapy. Feeding via the E-Tube may be needed for 3-6 weeks, and should be reduced and stopped only when there is consistent documentation of adequate oral caloric intake.

Summary

For successful treatment of feline hepatic lipidosis, client education and active owner involvement is essential. Treatment may require weeks to months of assisted feedings, electrolyte support, and treatment of concurrent medical conditions. A recovery rate greater than 80% is reported if the primary disease can be identified and treated.

Caloric densities, for feeding volume calculations.

Hill's A/D ™	1.2kcal/ml
Rebound ™	1kcal/ml
Clinicare ™	1 kcal/ml
Royal Canin/MediCal Recovery ™	1.23kcal/ml
Eukanuba Maximum Calorie ™	2.1 kcal/ml

Drugs used for vomiting

Drug	Dose Range	Frequency	Route	Indications
Chlorpromazine	0.5mg/kg	TID	IM	Vomiting
Prochlorpromazine	0.1mg/kg	QID	IM	Vomiting
Metoclopramide	1-2mg/kg	Over 24 hours	IV CRI	Vomiting
Ondasetron	0.1-0.2mg/kg	BID-QID	IV / PO	Vomiting
Dolasetron	0.6mg/kg	SID-BID	PO, SC, IV	Vomiting
Maropitant	1mg/kg	SID < 5 days	SQ / PO	Vomiting

Drugs used for appetite stimulation

Drug	Dose Range	Frequency	Route	Indications
Mirtazepine	1.875-3.75mg	q72h	PO	Appetite stimulant
Cyproheptadine	2 mg	BID-TID	PO	Appetite stimulant

Drugs used for hepatic support

Drug	Dose Range	Frequency	Route	Indications
Vitamin K1	0.5-1.5mg/kg	SID-BID	SC/PO	Coagulopathy
L-Carnitine	250-500mg	SID	PO/Tube	Fat metabolism
Taurine	250-500mg	SID	PO/Tube	Lipidosis
Ursodeoxycholic acid	15mg/kg	SID-BID	PO/Tube	Cholestasis
S-adenosyl- L-methionine	20–40 mg/kg	SID	PO/Tube	Glutathione donor
Milk thistle (silymarin)	5-15mg/kg	SID	PO/Tube	Hepatoprotective antioxidant
Lactulose	0.25-2ml/kg	BID-QID	PO/Tube	Hepatic Encephalopathy
Metronidazole	7.5mg/kg	BID	PO/Tube/IV	Hepatic Encephalopathy
Cobalamin	1 to 2 mL Vitamin B complex in 1 L of fluids	IV CRI in crystalloid fluids	IV	Cobalamin deficiency, pancreatic or GI disease
Thiamine	50 to 100mg	Total dose per day	PO	Low thiamine levels

Drugs used for electrolyte support

Drug	Dose Range	Frequency	Route	Indications
Potassium	**Potassium Replacement Chart** K+ Add to 500mls 3.1-3.5 14mEq 2.6-3.0 20mEq 2.1-2.5 28mEq 1.6-2.0 40mEq For critical hypokalemia, you can infuse KCL at higher than recommended doses (e.g. KMax - 0.5 mEq/kg/h)		IV CRI	Hypokalemia
Magnesium	0.75-1mEq/kg/day	24 hour CRI	IV Cri	Hypomagnesemia
Phosphorus	0.01–0.03 mmol/kg/hr	IV CRI	IV CRI	Hypophosphatemia

References

1) Blanchard G, Armstrong PJ. Feline hepatic lipidosis. Vet Clin N Am Small Anim Pract 2009;39:599–616.
2) Center SA. A retrospective study of 77 cats with severe hepatic lipidosis: 1975-1990. J Vet Intern Med 1993; 7: 349
3) Center SA. Feline hepatic lipidosis. Vet Clin N Am Small Anim Pract 2005;35:225–269.
4) Center SA. Feline hepatic lipidosis syndrome - current knowledge. Proc 29th ACVIM Forum, Denver, CO. 2005
5) Christopher MM. Relation of endogenous Heinz bodies to disease and anemia in cats: 120 cases (1978-1987). J Am Vet Med Assoc 1989; 194: 1089
6) Feeney DA et al. Statistical relevance of ultrasonographic criteria in the assessment of diffuse liver disease in dogs and cats. Am J Vet Res 69, 212-21; 2008
7) Gagne JM, et al. Clinical features of inflammatory liver disease in cats: 41 cases (1983–1993). J Am Vet Med Assoc 1999;214:513–516.
8) Leveille R et al. Complications after ultrasound guided biopsy of abdominal structures in dogs and cats; 246 cases (1984-1991). J Am Vet Med Assos. 203, 413-415; 1993
9) Simpson KW, Michel KE. Medial and Nutritional management of feline pancreatitis (abstract) Proc 18th ACVIM Forum, Seattle, WA, 428; 2000
10) Simpson KW et al Subnormal concentrations of serum cobalamin (vitamin B12) in cats with gastrointestinal disease. J Vet Intern Med 15, 26-32
11) Lisciandro SC et al, Coagulation abnormalities in 22 cats with naturally occurring liver disease. J Vet Intern Med 12, 71-75, 1998

Emergency Approach to the Hemoabdomen

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Hemoabdomen is defined as free blood in the peritoneal or retroperitoneal space. It is most commonly categorized into nontraumatic and traumatic causes with non-traumatic causes being further categorized into coagulopathic and non coagulopathic (spontaneous). Patients can present with internal hemorrhage that is mild and self-limiting. Patients can also present with rapid and severe hemorrhage, which is ultimately fatal without rapid intervention. It is up to the clinician to perform a rapid assessment and provide emergency treatment to reduce further morbidity and mortality.

Signalment & history

Breed, age, and history can be extremely helpful when evaluating a patient with hemoabdomen. Trauma is often a presenting complaint, offered as information by the owner and part of the immediate triage history directing further patient assessment and treatment. If the history is unknown, clinical examination findings (see below) can provide some important clues regarding the possibility of trauma. If there is no history or evidence of trauma, signalment can help form a differential diagnosis and treatment plan. For example a spontaneous hemoabdomen in a 2 year old dog is more likely from rodenticide exposure whereas a 14 year old large breed dog with a spontaneous hemoabdomen is more likely to have a neoplastic cause.

Physical examination

Most animals presenting with a hemoabdomen will have historical clues lethargy, collapse, exercise intolerance, and weakness. Physical examination abnormalities include pale mucous membranes, prolonged capillary refill time, snappy (short and narrow) femoral pulses, tachycardia, and tachypnea. Evidence of traumatic causes of hemoabdomen may include bruising, abrasions, lacerations, fractures, and/or road rash. Whether the bleeding is traumatic or non traumatic, the abdominal cavity is the most common place for clinically significant internal hemorrhage. Dependent on the amount and the speed of blood loss signs may range from mild anemia to hemorrhagic shock. Surface bleeding of the skin and mucosa such as petechia, ecchymoses, epistaxis, gingival bleeding, melena, hematochezia, and/or hematuria are more likely to be seen with a primary hemostatic disorder (thrombocytopenia or thrombocytopathia) and are less common with coagulation defects that cause cavity bleeding.

Diagnostic testing

A minimum database of a bleeding patient includes a packed cell volume (PCV), total protein (TP), blood urea nitrogen (BUN) and blood glucose (BG). Further emergency database information includes blood gas analysis, lactate, and electrolytes. Blood pressure and ECG should also be obtained. Common Findings consistent with hemoabdomen include decreased PCV, decreased TP, and increased lactate. Additionally, hypotension (low blood pressure) and a sinus tachycardia (on ECG) are common. A blood smear is useful to provide a platelet estimate, to evaluate RBC morphology, and to perform a differential blood count. Each platelet per high power oil emersion field represents approximately 15–20,000 platelets/µl blood. The feathered edge of the slide should be carefully evaluated as white blood cells and platelet clumping may be found there, notably platelet clumping which can explain a lower than expected platelet count in the monolayer when attempting to calculate an estimated platelet count.

Imaging studies can also be a valuable diagnostic tool for patients presented with hemoabdomen. Radiographs may show decreased serosal detail, organ enlargement, abdominal masses, diaphragmatic and/or body wall hernia. Decreased serosal detail may indicate free peritoneal fluid. Alternatively, many are now using ultrasound as a more detailed diagnostic tool. Specifically, ultrasound is used in combination with the FAST (focused assessment sonography trauma) protocol. The FAST protocol is the quickest and most sensitive way to detect a hemoabdomen. If ultrasound is not readily available, a four quadrant abdominocentesis can be performed to obtain free abdominal fluid. Obtaining non-clotting hemorrhagic fluid via this technique supports a diagnosis of free abdominal fluid unless a coagulopathy is present. If grossly hemorrhagic, then PCV and TP of the fluid should be evaluated. Acute hemorrhage tends to have PCV and TP that is similar to peripheral blood. A cytological evaluation should be performed on the fluid to assess for inflammation, bacteria or neoplastic cells.

Finding hemorrhagic fluid in the abdominal cavity confirms the diagnosis of hemoabdomen. Other diagnostics on the effusion that can be considered depending on the clinical presentation includes:

- Measurement of potassium and creatinine if urinary bladder rupture is suspected.
- Measurement of bilirubin if gall bladder rupture is suspected.
- Let’s discuss more the general categories of hemoabdomen:

Coagulopathic hemoabdomen

Hemorrhage as a result of coagulopathy is most commonly caused by disorders of the secondary hemostatic system. Disorders of the primary hemostatic system (platelets) less commonly cause cavity bleeding.

One of the most common coagulopathic causes of hemoabdomen is toxicity, specifically vitamin K deficiency due to anticoagulant rodenticide poisoning. While this can happen at any age, it is the most common cause for spontaneous (non traumatic) hemoabdomen in young patients. If anticoagulant rodenticide toxicosis is suspected, the goals are to prevent further hemorrhage and reverse coagulopathy by administration of vitamin K1. Treatment for the coagulopathic patient may also include transfusion medicine including whole blood, packed red blood cells, and/or fresh (frozen) plasma.

Traumatic hemoabdomen

Treatment of the patient that presents with a hemoabdomen as a result of trauma will depend on the severity of bleeding, resulting anemia, and concurrent injuries. Regarding traumatic causes of hemoabdomen, ultimately, there is a lack of evidence to support immediate surgery versus medical therapy. In the author's opinion, most traumatic hemoabdomen cases can be managed with non-surgical measures. If stabilization fails, the clinician should be prepared to perform surgery. While surgical intervention can often be avoided, these patients may require immediate and intensive care including intravenous fluid therapy and blood transfusions.

If hypovolemia is present, intravenous fluid resuscitation is warranted. Choices for fluid therapy include isotonic crystalloid therapy, hypertonic crystalloid therapy, or synthetic colloid therapy.

- Isotonic crystalloid 10-30 ml/kg IV bolus
- Synthetic colloid 2-5 ml/kg IV bolus
- Hypertonic saline (7.5%) 2-4 ml/kg IV

Regardless of the fluid choice, careful monitoring is warranted due to the risk of abrupt increases in systemic blood pressure and the concern for increased hemorrhage. With severe acute blood loss, blood transfusions or blood substitutes are indicated. The blood product used (packed RBCs, whole blood) depends on the availability and on the type of the hemostatic disorder.

Specific variables to monitor to help direct further therapy and case management include:

- Blood pressure
- Heart rate
- PCV and TP
- Lactate

A specific resuscitation therapy reported for traumatic conditions such as this is hypotensive resuscitation. This technique employs small volumes of fluid rather than large rapid volumes with the goal of increasing perfusion but tolerating slight hypotension with a Doppler blood pressure of 80-100mmHg. This method has been shown to reduce mortality in human patients with abdominal bleeds after trauma. The theory is that there is less likelihood of disrupting blood clots that are forming, and that bleeding will stop. Additional supportive measures include external abdominal counterpressure, strict cage rest, analgesia, and careful handling.

Measuring intra-abdominal pressure can be done if you have a urinary catheter in place. It is just like measuring central venous pressure and can be done easily with a stopcock and water manometer. Pressures above 25cm H_2O are associated with decreased organ perfusion.

Spontaneous hemoabdomen

This category is distinct from other common causes of a hemoabdomen. Obtaining a thorough history and point-of-care diagnostics can quickly decrease the suspicion of a traumatic hemoabdomen or coagulopathy. Often with a traumatic hemoabdomen, the patient presents with a recent history of trauma, such as vehicular trauma. Physical examination findings can also increase the suspicion for an unwitnessed trauma, such as bruising, fractured ribs, or skin abrasions or lacerations. Point of care diagnostics such as a PT clotting test (prothrombin time), can also be very helpful. A PT test that is normal or slightly elevated in the presence of a hemoabdomen would decrease the suspicion of the primary cause being a coagulopathy, as clinical experience would require a PT test to be out of range (or close to out of range) to increase the suspicion of the primary cause being a coagulopathy to result in a hemoabdomen. A slight elevation often can be considered a consumptive coagulopathy.

Once trauma and coagulopathic causes have been ruled out, especially in an older, and often large breed dog (although there are no studies to say smaller breed dogs are any different), the term spontaneous (or non-traumatic, non-coagulopathic) hemoabdomen can be used.

There are several studies that have evaluated the spontaneous (non-traumatic, non-coagulopathic) hemoabdomen. These studies indicate an overwhelming likelihood neoplasia as an underlying cause, most commonly a ruptured splenic hemangiosarcoma (65-85%). Other causes do exist, both benign (ruptured hematoma) and malignant (e.g. mesothelioma, carcinoma, pheochromocytoma, lymphoma), but unfortunately the overwhelming likelihood is that a spontaneous hemoabdomen in an older dog will result from a splenic hemangiosarcoma.

Often these patients present in shock, specifically hypovolemic shock. Physical examination findings may include tachycardia, poor pulses, pale mucous membranes, increased respiratory rate and effort, and a distended abdomen with a palpable fluid wave. As in other causes of hemoabdomen, the first priority should be stabilization (e.g. intravenous catheter placement, fluid therapy, oxygen therapy, etc). Based on the patient's state of illness, fluid therapy options to debate would include isotonic crystalloids, hypertonic saline, colloids, and even blood products.

Following diagnosis and stabilization, as these are often older dogs with a primary concern for a neoplastic process, diagnostics that to considered should include:

- Bloodwork (CBC and Chemistry Screen) – to check for cell counts, organ values, electrolytes, and overall assess for metabolic or electrolyte derangements which would need correction
- Coagulation testing (specifically a prothrombin time – PT) – this should have been performed in the initial diagnostics on presentation to place the patient in this specific category (non-traumatic, non coagulopathic) – but if not, should be performed pre-operatively.
- Thoracic X-Rays – While helpful to assess cardiac size and shape, often the primary reason to recommend thoracic x-rays is to identify pulmonary metastasis. The presence of pulmonary metastasis would worsen the prognosis substantially and likely make this patient a poor candidate for surgery and anesthesia.
- Abdominal Ultrasound - My personal experience with an abdominal ultrasound and interpretation for clients falls in 1 of 3 scenarios:
    1. There is a solitary mass (spleen, liver, etc) that can be identified. Often radiologists are reluctant (and refuse) to note their impression of malignancy and while not helpful in differentiating between a benign or malignant tumor for the owners in their decision, a solitary mass present would hopefully lead one to assume this patient is a better surgical candidate in the absence of diffuse disease. The owner must also understand that there is a possibility that microscopic disease exists (not able to be seen on ultrasound) which may be identified during the exploratory procedure.
    2. There are multiple masses present (not just on one organ). While malignancy cannot be confirmed, the presence of multiple masses throughout the abdomen would give the impression that malignancy is more likely and this patient is likely a worse surgical candidate than the previous patient with one solitary mass.
    3. No masses/lesions have been identified. At that time further investigation is warranted (unwitnessed trauma?) and further stabilization may be needed to note progression.

Does every patient need an ultrasound? I have clients that would like to save their pet regardless of the ultrasound findings. Are the ultrasound findings then academic in nature? If the client understands the risk that diffuse disease may be present and identified during surgery, resulting in a phone call to discuss humane euthanasia on the table, wouldn't it then be reasonable to save the $400-$600 on the ultrasound and proceed directly to surgery following stabilization and additional diagnostics? Ultimately, once stabilized to the best of the clinician's ability, an exploratory laparotomy is needed.

Hemoabdomen in cats

Hemoabdomen in cats is relatively rare compared to dogs. In a study that evaluated hemoabdomen in cats, 46% had abdominal neoplasia and 56% had non-neoplastic causes. Hemangiosarcoma was diagnosed in 60% of the cats with neoplasia with the spleen being the most common site. Unfortunately, only 12% of the 65 cats survived to discharge suggesting that the overall prognosis of hemoabdomen in cats is poor.

Summary

In theory, surgery is a consideration for every non-coagulopathic hemoabdomen patient, especially in patients that do not stabilize medically. Specifically regarding the traumatic hemoabdomen, the author believes that most patients can be stabilized with medical therapy within two hours of presentation. If appropriate resuscitation efforts are not successful and do not achieve cardiovascular stabilization within 2 hours, it is unlikely further medical therapy will be successful. Traumatic hemoabdomen patients that do not stabilize with aggressive and appropriate medical therapy should be considered surgical candidates. Surgery will not only achieve hemostasis but also provide an underlying diagnosis.

References

Aronsohn MG, Dubiel B, Roberts B, Powers BE. Prognosis for Acute Nontraumatic Hemoperitoneum in the Dog: A Retrospective Analysis of 60 Cases (2003–2006). J. Am. Anim. Hosp. Assoc. 2009 March/April; 45:72-77.

Brockman DJ, Mongil CM, Aronson LR, Brown DC. A practical approach to hemoperitoneum in the dog and cat. Vet Clin North Am Small Anim Pract. 2000 May; 30(3):657-68. Review.

Clifford CA, Pretorius S, Weisse C, et al. Magnetic resonance imaging of focal splenic and hepatic lesions in the dog. J Vet Intern Med 2004;18:330–338

Croce MA, Fabian TC, et al. Presley Regional Trauma Center, Department of Surgery, University of Tennessee-Memphis, USA. Nonoperative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients. Results of a prospective trial. Ann Surg. 1995 Jun; 221(6):744-53; discussion 753-5.
Delgado Millán MA, Deballon PO. Department of Surgery, Hospital Universitario de Getafe, Spain. Computed tomography, angiography, and endoscopic retrograde cholangiopancreatography in the nonoperative management of hepatic and splenic trauma. World J Surg. 2001 Nov; 25(11):1397-402.
Hammond TN, Pesillo-Crosby SA. Prevalence of hemangiosarcoma in anemic dogs with a splenic mass and hemoperitoneum requiring a transfusion: 71 cases (2003-2005). J Am Vet Med Assoc. 2008 Feb 15; 232(4):553-8. Erratum in: J Am Vet Med.
Herold LV, Devey JJ, Kirby R, Rudloff E. Clinical management of hemoperitoneum in dogs. J Vet Emerg Crit Care 2008;18(1):40–53.
Levinson JG, Bouma JL, Althouse GC, Rieser TM. Prevalence of malignancy when solitary versus multiple lesions are detected during abdominal ultrasonographic examination of dogs with spontaneous hemoperitoneum: 31 cases (2003-2008). J Vet Emerg Crit Care (San Antonio). 2009 Oct; 19(5):496-500.
Mongil CM, Drobatz KJ, Hendricks JC. University of Pennsylvania, Philadelphia. Traumatic hemoperitoneum in 28 cases: a retrospective review. J Am Anim Hosp Assoc. 1995 May-Jun; 31(3):217-22.
Nakamura K, Sasaki K, Murakami M, et al. Contrast-enhanced ultrasonography for characterization of focal splenic lesions in dogs. J Vet Intern Med 2010;24:1290–1297.
Pintar J, Breitschwerdt EB, Hardie EM, Spaulding KA. Acute Nontraumatic Hemoabdomen in the Dog: A Retrospective Analysis of 39 Cases (1987–2001). J. Am. Anim. Hosp. Assoc. 2003 November/December; 39:518-522.
Sorenson SR, Rozanski EA, Tidwell AS, et al. Evaluation of a focused assessment with sonography for trauma protocol to detect free abdominal fluid in dogs involved in motor vehicle accidents. J Am Vet Med Assoc 2004;225:1198–1204.
Streeter EM, Rozanski EA, de Laforcade-Buress A, Freeman LM, Rush JE. Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA. Evaluation of vehicular trauma in dogs: 239 cases (January-December 2001). J Am Vet Med Assoc. August 2009; 235(4):405-8.

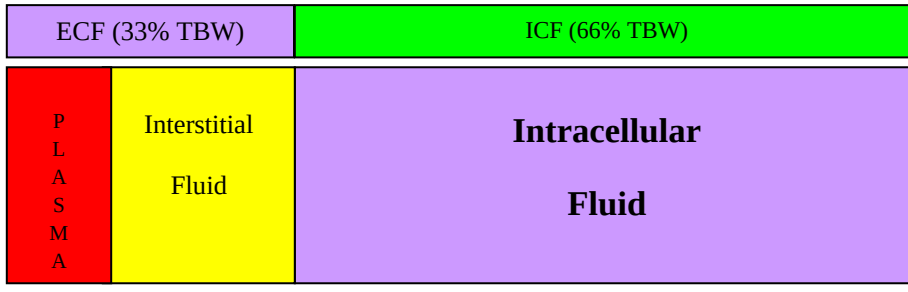
Practical Fluid Therapy:
It's More Than Just Water and Salt

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Fluid therapy is one of the most commonly used therapies for the small animal practitioner. Despite a large amount of research the general consensus is that there is not one fluid type that is better than another for resuscitation. This is often why there is debate as to what fluids a practice should purchase to have on the shelf. Moreover, the type of fluid desired may vary based on the underlying disease process.

The reason that fluid therapy is so important in medicine is that living organisms are comprised predominantly of…fluid!. Total body water content is approximately 60% of body weight in a non-obese, adult dog or cat. Total body water is further distributed between two major compartments: the intracellular (ICF) and extracellular (ECF) fluid.

Total body water (TBW) fluid compartments



The ICF compartment is the larger of the two compartments and comprises 66% of the total body water and 40% of body weight. It is separated from the ECF compartment by a cell membrane that is permeable to water but impermeable to most solutes. The ECF comprises the remaining 33% of the TBW and 20% of body weight. The ECF is subdivided into the plasma (25% of ECF) and interstitial (75% of ECF) fluid compartments.

The need for fluid therapy is often divided into 2 main categories:

1. Restoring the patient's intravascular volume (hypovolemia)
2. Replacement of extravascular fluid (dehydration)

There are 4 types of hypoperfusion commonly recognized in veterinary practice:

1. Hypovolemia (i.e., loss of intravascular volume)
2. Maldistributive / Septic (i.e., loss of vascular tone, fluid shifting, third spacing)
3. Cardiogenic (i.e., myocardial dysfunction leading to lack of cardiac output and perfusion)
4. Obstructive (i.e., decreased venous return to the right side of the heart as a result of obstruction, e.g., due to gastric dilatation and volvulus or pericardial effusion)

It is important to distinguish which type of hypoperfusion is present as their initial treatment as well as long term therapy will differ based on the underlying disease process. As compared to cardiogenic causes, when clinical signs of hypovolemia are present (pale mucous membranes, prolonged capillary refill time, dull mentation, poor pulse quality, cold extremities, and tachycardia (or bradycardia in cats) intravascular fluids must be replaced for emergency resuscitation. The estimated shock volumes of fluids are 90 ml/kg in dogs, and 60ml/kg for cats. The author initially replaces 1/4 to 1/3 of the calculated volume as rapidly as possible, the reassess perfusion parameters, notably heart rate, mucous membrane color, CRT, pulse quality, blood pressure, and eventually urine output. The reason the volumes calculated seem high is that approximately 75% of the crystalloid fluid administered with redistribute out of the intravascular space within 30-60 minutes of administration.

The administration of synthetic colloids is another option considered in hypovolemic patients, notably if there is a concern for hypoproteinemia (TP < 4.5) or in combination with crystalloid therapy. Common colloid bolus doses are 10–20 ml/kg in dogs and 5–10 ml/kg in cats followed by rapid and frequent reassessment. Synthetic colloids such as Hetastarch and Vetstarch cause expansion of the intravascular volume by pulling fluid from the interstitial and intracellular spaces into the intravascular compartment and keeping the fluid within the intravascular space longer due to the colloidal properties.

Besides isotonic crystalloids and synthetic colloids, another alternative fluid therapy is hypertonic crystalloids, specifically hypertonic saline. Hypertonic saline is considered for rapid expansion of the intravascular compartment and used in patients that have a normal hydration status. Hypertonic saline is contraindicated for a patient that is dehydrated or hypernatremic. Hypertonic saline has a potent effect, drawing fluids from other compartments into the intravascular space due to its potent osmotic forces. The typical dose

recommended for rapid resuscitation is 4-7 ml/kg of 7.5% HS over 20 minutes. Additionally, hypertonic saline is theorized to have other beneficial properties including improved myocardial contractility, activation of a neurogenic reflex leading to peripheral vasodilation, improving microcirculatory flow by preventing capillary collapse, a reduction of endothelium cell swelling and alterations in function of polymorphonuclear cells (PMN) and endothelial cells. Complications include bradycardia, bronchoconstriction, sodium fluctuations, fluid overload and pulmonary edema, phlebitis and ventricular arrhythmias.

To prolong the effect of fluid resuscitation, the author also considers the combined use of a hypertonic saline/synthetic colloid. To achieve this fluid mixture, 1:2.5 ratio of 23.4% hypertonic saline (sodium chloride) and hetastarch or Vetstarch are used. To easily make this solution, 17ml of 23.4% hypertonic saline and 43ml of the colloid are mixed in a 60ml syringe. 3-5ml are then used as a bolus in the canine patient and 2-3ml are used as a bolus in the feline patient, followed by re-assessment.

Once immediate life-threatening fluid deficits are replaced, the focus then shifts to the patient's dehydration level, maintenance level, and provisions for suspected ongoing losses.

The following chart is commonly used to asses patient dehydration characteristics:

Physical examination findings in dehydrated patients

Percent dehydration	Clinical signs
<5	No detectable abnormalities
5-8	Decreased skin turgor, dry mucous membranes
8-10	Decreased skin turgor, dry mucous membranes, eyes may be sunken in orbits, slight prolongation of CRT
10-12	Severe skin tenting, prolonged CRT, dry mucous membranes, eyes sunken in orbits, possibly signs of shock
>12	All of the above plus signs of shock, often life threatening

Measurement of dehydration is subjective and is not expected to be detected clinically below 5%.

For patients with evidence of chronic dehydration on examination but stable cardiovascular parameters (i.e. no evidence of hypovolemia), fluid deficits are corrected over a 6-24 hour period

Following treatment of hypovolemia, the following formulas are used to create a fluid therapy plan

1. Dehydration fluid replacement = Body weight (kg) x %dehydration x 1000
2. Maintenance daily requirements = Body weight (kg) x 2–4 ml/kg/h.
3. On-going losses = 3-4 ml/kg/vomit or diarrhea

Complications of fluid therapy

While fluid therapy is often considered a benign treatment, it is not without risk. Complications to consider based on the individual patient characteristics include:

- Pulmonary edema
    - Volume overload
    - Increased vascular permeability
- Rapid sodium shifts
    - Neurologic signs
    - Obtundation
    - Cerebral edema
    - Seizures
- Phelbitis
    - Use of hyperosmotic agents

Conclusions

Intravenous fluid therapy can be performed rapidly and can be life saving for the emergency patient. A thorough history, physical examination, and preliminary diagnostics can be used to help differentiate disease processes which may be worsened by fluid therapy (i.e. cardiogenic shock), as well as help the clinician choice the best fluid type to improve the clinical condition.

Table: Colloids and their chemical properties.

Colloid	Mean MW (KDa)	Molar substitution	COP (mmHg)
5% Human albumin	69	N/A	23.2± 0.1
25% Human albumin	69	N/A	> 200
Canine fresh frozen plasma	69	N/A	17.1± 0.6
6% Hetastarch in 0.9% NaCl	600	0.7	32.7± 0.2
6% Hetastarch in balance electrolyte solution--Hextend™	670	0.75	37.9± 0.1
6% Voluven™	130	0.4	37.1± 0.8
6% Vetstarch™	130	0.4	40*

In vitro

Table: Common crystalloids and their chemical properties.

Solution	LRS	Plasmalyte A; Norm R	0.9% NaCl
Na	130	140	154
K	4	5	0
Ca	3	0	0
Mg	0	3	0
Cl	109	98	154
Gluconate	0	23	0
Lactate	28	0	0
Acetate	0	27	0
Osmolarity	270	294	310

References

Barron ME, Wilkes MM, Navickis RJ. A systematic review of the comparative safety of colloids. Arch Surg 2004;139(5):552-63.

Chan DL. Colloids: Current recommendations. Vet Clin No Amer Small Anim Pract 2008;38(3):587-93.

Choi PT, Yip G, Quinonez LG, et al. Crystalloids vs colloids in fluid resuscitation: a systematic review. Crit Care Med 1999;27(1):200-10.

Cohn LA, Kerl ME, Lenox CE, et al. Response of healthy dogs to infusions of human serum albumin. Am J Vet Res 2007;68:657-663

Cornelius LM. Fluid therapy in small animal practice. *J Am Vet Med Assoc*. 1980;176:110.

Cornelius LM, Finco DR, Culver DH. Physiologic effects of rapid infusion of Ringer's lactate solution into dogs. *Am J Vet Res*. 1978;39:1185.

Cunha MG, Freitas GC, Carregaro AB, *et al*. Renal and cardiorespiratory effects of treatment with lactated Ringer's solution or physiologic saline (0.9% NaCl) solution in cats with experimentally-induced urethral obstruction. *Am J Vet Res*. 2010;71:840–846.

DiBartola SP, Bateman S. Introduction to fluid therapy. In: DiBartola SP. *Fluid, Electrolyte, and Acid Base Disorders in Small Animal Practice*. 4th ed. St. Louis, MO: Elsevier; 2012:331–350.

Hansen B, DeFrancesco T. Relationship between hydration estimate and body weight change after fluid therapy in critically ill dogs and cats. *J Vet Emerg Crit Care*. 2002;12:235.

Moore LE, Garvey MS. The effect of hetastarch on serum colloid osmotic pressure in hypoalbuminemic dogs. J Vet Intern Med 1996;10(5):300-3

Rose RJ. Some physiological and biochemical effects of the intravenous administration of five different electrolyte solutions in the dog. *J Vet Pharmacol Ther*. 1979;2:279.

Silverstein DC, Aldrich J, et al. Assessment of changes in blood volume in response to resuscitative fluid administration in dogs. Journal of Veterinary Emergency and Critical Care 2005;16(3):185–192.

Trow AV, Rozanski EA, Delaforcade AM, et al. Evaluation of use of human albumin in critically ill dogs:73 cases (2003-2006). J Am Vet Med Assoc 2008;233(4):607-12.

ER Life-Saving Procedures

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Abdominocentesis

Abdominocentesis is a minimally invasive, inexpensive, diagnostic and potentially therapeutic procedure for patients with ascites. Evaluation of the fluid aids in diagnosis and helps guide treatment. Abdominal effusion is classified as a transudate, modified transudate, or exudate based on the cellularity and protein content of the fluid. Transudates **(**protein concentration < 25 g/l, nucleated cell count < 1000/l (1 x 10^9/l)), are commonly due to causes including hypoalbuminemia and early congestive heart failure. Modified transudates (protein concentration < 35 g/l, cell count < 5000/l (5 x 10^9/l)) result from increased hydrostatic pressure (right-sided congestive heart failure, left-sided congestive heart failure in cats), decreased oncotic pressure (hypoalbuminaemia) or lymphatic obstruction (neoplasia). Exudates (protein concentration > 30–35 g/l, cell count > 5000/l (5 x 10^9/l), are found with causes including sepsis, feline infectious peritonitis (FIP), neoplasia, lung-lobe torsion, and pancreatitis. Along with cellularity and protein content, biochemical evaluation of the fluid for creatinine, potassium, bilirubin, lactate and glucose can aid in the diagnosis of various conditions, including uroabdomen, bile peritonitis, and septic peritonitis.

The equipment needed to perform an abdominocentesis includes clippers, antimicrobial scrub, 70% ethyl alcohol, sterile gloves, 18 – 22 gauge, 1 - 1 ½ inch needles, extension tubing, 20 – 60 ml syringes (depending on size of the patient), and sterile EDTA and red top tubes for sample collection.

To perform an abdominocentesis, the patient is placed in left lateral (to allow the spleen to fall away from midline) or sternal recumbency. Using the prepared abdominocentesis site, the needle is inserted through skin and abdominal musculature into the abdominal cavity. This can be performed with or without ultrasound guidance. If ultrasound is not available, a four-quadrant technique can be used. This procedure is accomplished by preparing 4 aseptic sites, cranial and left, cranial and right, caudal and left, and caudal and right in respect to the position of the umbilicus.

Endotracheal and transtracheal washes

Procedures including endotracheal, transtracheal, or bronchoalveolar lavage are indicated in the diagnostic evaluation of lower airway disease. The sample obtained by the procedure can be used for cytological and microbiological evaluation (bacterial, fungal, protozoal, parasitic) and non-infectious disease such as allergic airway disease, inflammatory airway disease, and neoplasia.

Equipment needed for the endotracheal wash includes general anesthesia, sterile endotracheal tube, large bore suction catheter or Salem-sump suction catheter, sterile saline, 2-3 sterile syringes, mucus-specimen trap, oxygen tubing, suction, and sterile gloves.

Equipment needed for the transtracheal wash includes sedation and/or local analgesia with 2% lidocaine, clippers, scrub, 18 gauge sampling catheter, sterile saline, 2-3 sterile 10 cc syringes, and sterile gloves.

Approximate injection volumes of sterile saline include:

Cat:	2-3 ml per attempt, start with lowest amount, up to 5 ml
Small Dog:	2-4 ml per attempt, up to 5-20 ml based on size of dog
Large Dog:	3-5 ml per attempt, up to 20-50 ml based on size of dog

To perform either an endotracheal wash or transtracheal wash, the clinician prepares the equipment prior to the procedure. This ensures that before sedation or anesthesia the clinician is able to perform the procedure quickly and efficiently to reduce patient morbidity. For example, prior to the endotracheal wash procedure, the sterile syringes are pre-loaded with sterile 0.9% NaCl, the oxygen tubing is connected to the suction device, and the mucus specimen trap and suction catheter are connected. Once the procedure set-up is complete and the veterinary team is ready, the assistant intubates the patient with a sterile endotracheal tube. Prior to contaminating the endotracheal tube by connecting the tube to the anesthesia machine, the endotracheal wash procedure is performed. The procedure itself is performed by inserting the catheter down the endotracheal tube until it cannot pass any further. The preloaded saline syringes are used to flush the saline down the tube. Once the saline is inserted, the assistant gently coupages the chest while the veterinarian is applying suction to the catheter. The procedure continues until an adequate sample is obtained provided the patient is not decompensating. Immediately after obtaining a sufficient sample the patient is connected to the anesthesia machine to provide 100% oxygen. The sample obtained is then submitted for cytology and aerobic culture, +/-mycoplasma and fungal.

To perform a transtracheal wash, the ventral neck is clipped and scrubbed, notably between two rings of cartilage 3-4 rings below the larynx. Along with manual restraint, chemical restraint can reduce stress and anxiety during the procedure. A local block combined with an opioid or benzodiazepaine is considered for mild sedation. When inserting the sampling catheter, the bevel of the needle should be faced downward. The needle is advanced through the skin on the midline of the neck through two cartilage rings, perpendicular to the trachea into the tracheal lumen. As you enter the trachea, you will feel a pop. Once seated within the tracheal lumen, the needle is advanced 2-3 mm further to ensure appropriate positioning. The sampling catheter is advanced through the needle completely into the tracheal lumen. Once the catheter is completely advanced, the needle is pulled back until it is no longer in

the trachea. Once it is completely exteriorized, the needle guard is attached to reduce the risk of tracheal laceration. The next step is to inject sterile saline, coupage the patient, and aspirate with the attached syringe to obtain your diagnostic sample. The procedure is repeated often 1-3 times to achieve an adequate sample. The sample obtained is then submitted for cytology and aerobic culture, +/- mycoplasma and fungal.

Thoracocentesis

Thoracocentesis is a common emergency procedure to remove fluid or air from the thoracic cavity. Patients that present in respiratory distress should be evaluated for their breathing pattern. Clinical signs may include a short and shallow restrictive breathing pattern, paradoxical breathing pattern, increased respiratory rate, orthopnea, and an abdominal component to respiration. Thoracic auscultation that may warrant thoracocentesis includes decreased or dull lung sounds ventrally (pleural effusion) or dorsally (pneumothorax). If the patient presents in respiratory distress with a short and shallow, restrictive breathing pattern, dull and muffled lung and heart sounds, and suspicion of pleural space disease, a thoracocentesis should be considered.

The equipment needed to perform a thoracocentesis includes clippers, antimicrobial scrub, 70% ethyl alcohol, sterile gloves, 18 – 22 gauge, 1 - 1 ½ inch needles, extension tubing, 20 – 60 ml syringes (depending on size of the patient), and sterile EDTA and red top tubes for sample collection.

To perform a thoracocentesis, the patient should be restrained in sternal recumbency. The procedure will vary slightly depending on the cause for pleural space disease. If air is present, a pnuemothorax, the dorsal 1/3 of the chest will be prepared. If fluid is suspected, the ventral 1/3 of the chest will be prepared. The appropriate area of the chest wall is prepared by making a large (approximately 10 cm x 10 cm) window, clipped and aseptically scrubbed. Unless directed by ultrasound guidance to a more specific area, blind thoracocentesis is performed between rib spaces 7-11. The needle should be inserted in the intercostal space cranial to the rib, avoiding the blood supply and nerves found caudal to the rib.

Thoracostomy tube placement

A thoracostomy tube is most commonly considered on the emergency basis when ongoing accumulation of air or fluid requires frequent re-aspiraton.

For large bore thoracostomy tube placement, the equipment required includes: clippers, antimicrobial scrub, 70% ethyl alcohol, 2% lidocaine, 3 ml syringe, 22 gauge needle, sterile surgical pack, sterile drapes/towels, trocar-type chest tube (Argyle), 2-0 nylon suture, bandage material, sterile gloves, 3-way stopcock, Christmas tree adapter, wire, wire cutters, and antimicrobial ointment.

To place a large bore thoracostomy tube, the patient is placed in lateral recumbency under general anesthesia. The entire lateral thorax is clipped, aseptically prepared, and draped to deliver a sterile field.

For local analgesia, 2% lidocaine is used to infiltrate the dermis and intercostal muscle at the intercostal space where you will be entering the chest, often the 8^{th}-10^{th} intercostal space. Following lidocaine infiltration, a small incision is made through the skin over the 10^{th} intercostal space in the dorsal third of the chest. Through this incision, the chest tube is inserted into the subcutaneous space. Using a curved tip Carmalt forcep or Kelly hemostats, a tunnel is made through the subcutaneous space to the level of the 8^{th} intercostal space. Using the instrument, force is placed on the tips to bluntly enter the pleural space. Once the tip of the instrument enters the pleural space, it is not removed, rather used to guide the chest tube into the pleural space. The trocar of the chest tube is removed once the tube is guided into the thoracic cavity. The chest tube is clamped prior to the complete removal of the trocar to prevent air entering the thoracic cavity. Adapters are then attached to the chest tube and secured to the chest tube with a suture or wire. The tube is secured with a purse-string suture and Chinese finger trap suture. The procedure is completed with the use of antibiotic ointment at the skin incision site, a non-adherent pad covering the incision and ultimately a gentle chest wrap for compression and securing of the tube to the patient.

While large bore chest tubes can be considered, the author has transitioned almost completely to the use of a smaller bore chest tube, specifically the Mila International ® chest tube device, 14g x 20cm fenestrated chest tube catheter. This catheter can be placed easily without the use of general anesthesia via the modified seldinger technique. With the combination of an introducer/catheter, guide wire, catheter, and securing instrumentation, this chest tube has been used successfully for a variety of conditions including pneumothorax, chylothorax, pyothorax, and hemothorax.

Pericardiocentesis

Pericardiocentesis is a life saving procedure to remove effusion from the pericardial space. Pericardial effusion is abnormal fluid in the pericardial space resulting in inadequate cardiac filling, decreased cardiac output, and right heart tamponade.

Equipment needed for pericardiocentesis include clippers, antimicrobial scrub, 70% ethyl alcohol, sterile drapes, sterile gloves, electrocardiogram (ECG), ultrasound (if available), large intravenous catheter or pericardiocentesis catheter, extension set, three-way stopcock, syringe, sampling tubes (red top and EDTA) and 2% lidocaine (both for local analgesia and preparedness if ventricular tachycardia develops.)

To perform a pericardiocentesis, the patient is placed in sternal recumbency or lateral recumbency. Anesthesia is not necessary although sedation with an opioid/diazepam combination can be helpful for mild chemical restraint. A local block with 2% lidocaine can be used to reduce discomfort as well. Cardiovascularly compromising medications such as propofol, acepromazine, and inhalant anesthesia should be avoided. Unless ultrasound guidance dictates a more appropriate location, the patient is prepared by clipping and scrubbing between the 4th and 6th intercostal space. While there is controversy as to the best side to use, the author prefers to enter the right side of the thorax. Similar to the thoracocentesis discussed above, the needle should enter cranial to the rib as the intercostal vessels and nerve runs caudal to the rib.

At the preference of the clinician, to prevent drag of the catheter through the skin a small skin stab incision can be made with a No. 11 scalpel blade. Also at the preference of the clinician, side holes can be placed in the distal portion of the pericardiocentesis catheter. If side holes are made, avoid a hole greater than 40% of the circumference of the catheter and holes directly opposite each other on the catheter, both which increase the risk of catheter weakness.

With appropriate patient monitoring including ECG, the catheter is inserted through the skin and into the pleural space. Once within the pleural space, the catheter is advanced slowly (1-2mm at a time) towards the heart while continuously monitoring the patient for discomfort and the ECG for arrhythmias. As the catheter is advanced, the clinician is watching carefully for fluid accumulation into the hub of the catheter. Typical fluid from the pericardial space will range from red to a port wine color. Once the fluid is seen within the hub of the catheter, the catheter is advanced another 1-2mm to make certain it is best seated within the pericardial space. The stylet is then removed and the catheter is connected to the extension tubing along with a three-way stopcock. Using a 10-20ml syringe, the fluid is aspirated. A sample of the aspirated fluid is to placed into a red top tube and a lavender top tube for further analysis. Specifically, the red top tube is monitored for clotting. A clot within the red top tube is a concern for trauma to the heart via the catheter and the catheter should be removed from the pericardial space. The amount of fluid obtained will vary but may be as much as 1/2 to 1 liter in a large breed dog. As they are often tachycardic on presentation, the clinician should notice a fairly dramatic decrease in heart rate within a few minutes of successful pericardiocentesis.

Central venous catheter placement

A central venous catheter is a catheter where the tip of the catheter sits in the thoracic part of the cranial or caudal vena cava and commonly placed in dogs and cats via the external jugular vein. A peripherally inserted central line (PICC) is also available, placed via the medial (cat) or lateral (dog) saphenous vein. Advantages of a central venous catheter include serial blood collection, hypertonic fluid administration (fluid osmolality > 600 mOsm/l), administration of total parenteral nutrition, and measurement of central venous pressure. Potential risks of central venous catheter placement include hemorrhage, thrombus formation, emboli, and infection.

Equipment needed to place a central venous catheter include clippers, antimicrobial scrub, 70% ethyl alcohol, sterile gloves, bandage material, antimicrobial ointment, 14, 16, or 18 gauge Venocath catheter, 3 ml syringe(s) with heparinized saline to use as flush, suture, and gauze 4 x 4s, and the central venous catheter kit.

A central venous catheter is most often placed via the Seldinger, or "over-the-wire" technique. Multi-lumen systems are frequently used to allow for infusion of multiple fluids, medications, CVP measurement, and parenteral nutrition. Surgivet, Abbott, and Arrow make over-the-wire catheter kits which have components that include the introduction catheter, vascular dilator, wire, wire introducer, and central catheter.

The central venous catheter is placed with the patient in lateral recumbency with the assistance of chemical restraint. Similar to other critically ill patients, this can often be easily accomplished with the use of a local block combined with an opioid or benzodiazepaine. The lateral cervical area is clipped and aseptically prepared from the ventral ramus of the mandible caudally to the thoracic inlet and dorsally and ventrally to the respective midlines. Sterile drapes are then placed over the aseptically prepared area. The assistant extends the head and neck with the front legs pulled caudally. If available, a second assistant or the clinician occludes the jugular vein for visualization. Once the site is prepped, the provided 18 - 20 gauge over-the-needle catheter is inserted into the jugular vein. Once seated within the jugular vein, the stylet is removed. While monitoring the ECG for arrhythmias, the provided guide wire is inserted through the catheter into the jugular vein. Never let go of the wire. Repeat it with me, never let go of the wire. Once a majority of the wire is inserted via the catheter into the jugular vein, the over-the-needle catheter is removed, leaving the wire seated within the jugular vein exiting through the skin. The vascular dilator is fed over the wire into the vessel using a twisting motion, creating a larger hole in the vessel to prepare for placement of the multi-lumen catheter. Once the vascular dilator is bluntly used to create the larger diameter hole in the jugular vein, it is removed, again leaving the wire within the jugular vein, exiting through the skin. The large hold created is more likely to bleed and sterile gauze can be used to apply gentle pressure to the site. Once the vascular dilator is removed, the large multi-lumen catheter is fed over the wire into the jugular vein. Again, never lose the wire – keep this in your hand at all times. Once the multi-lumen catheter is fed into the jugular vein, the wire often has to be fed backwards through the most distal port of the catheter before the catheter can be completely seated within the jugular vein. The catheter is then secured with suture and wrapped with a gentle bandage.

Intraosseous catheter placement

Intraosseous catheters are considered when intravenous access is difficult or impossible due to hypovolemia, hypotension, or (small) patient size. Intraosseous catheters can be used for crystalloids, colloids, blood products, and medications. Placement of an intraosseous catheter is simple in pediatrics and slightly more complicated in larger and older patients.

The equipment needed for placement of an intraosseous catheter include clippers, antimicrobial scrub, 16 - 18 gauge bone marrow needle (or spinal needle, or 16 - 20 gauge needle), 2% lidocaine, heparinized saline flush, antimicrobial ointment, T-set connector, white tape, and nylon suture.

While there are several possible locations for IO catheter placement, the author prefers placement in the femur. The greater trochanter and the trochanteric fossa are palpated with the leg held in adduction to avoid the sciatic nerve. The desired needle is inserted through the skin to the level of the trochanteric fossa. The needle should be placed parallel to the length of the femur. The needle is rotated in a back and forth in a twisting motion, applying constant pressure to drive the needle into the cortex of the bone. Once the needle is seated within the cortex of the femur, movement of the leg should move the needle in the appropriate direction. A second test for appropriate placement is to flush the needle with sterile heparinized saline. If there is resistance, it may be necessary to rotate the needle 90–180 degrees to make certain the bevel of the needle is not lodged against the wall of the cortex. If the flush results in a swelling along the shaft of the femur, the catheter has penetrated the femoral cortex and should be replaced. Following successful placement, the needle is secured with suture and bandaged.

Potential complications of intraosseous catheter placement include osteomyelitis, bone trauma, and leakage of injected material into subcutaneous tissues.

Nasal and nasopharyngeal oxygen catheter placement

Placement of a nasal oxygen catheter is a quick and easy way to provide supplemental oxygen to the hypoxic patient. Nasal oxygen catheters are easy to maintain and often well tolerated.

The equipment required for nasal oxygen catheter placement includes a red rubber catheter (or similar tubing), 3-0 nylon suture, 2% lidocaine, sterile lubricant, 1 ml syringe case, flexible extension tubing, oxygen source, bubbler for humidification, and an Elizabethan collar.

In preparation for placement, the catheter is measured from the end of the nostril to the medial canthus of the eye. The tube that is then at the level of the tip of the nose is marked with a permanent marker to indicate how far the catheter is advanced during placement. For nasopharyngeal oxygen catheter placement, the tip of the tube is measured from the ramus of the mandible to the tip of the nose. Once measured, 0.5 - 1 ml of dilute 2% lidocaine can be instilled in the patients nostril. The tip of the tube is lubricated with sterile lubricant and directed ventrally and medially, advanced to the level of the tube marked. Once the tube is in place, it is secured with suture (or staples). Oxygen flow rates of 50 - 100 ml/kg/minute are usually well tolerated making sure to humidify the oxygen source.

Temporary tracheostomy tube placement

A temporary tracheostomy tube is considered for severe upper airway obstruction, upper airway trauma, laryngeal or pharyngeal collapse, or when long-term positive pressure ventilation is planned.

Equipment required for tracheostomy tube placement includes: sterile surgical pack, sterile towels/drapes, small gelpi retractors, nylon suture, Shiley tracheostomy tubes, umbilical tape, hydrogen peroxide, sterile bowls, sterile pipe cleaners, sterile bottle brush, and sterile long cotton swabs.

To place a tracheostomy tube, the patient is placed under general anesthesia. The patient is placed in dorsal recumbency to expose the ventral neck. The ventral neck is clipped from the ramus of the mandible caudally to the thoracic inlet and laterally extending greater than 50% of the diameter of the neck. The ventral neck is aseptically clipped, scrubbed, then draped. The larynx is palpated and a skin incision is made on ventral midline, caudally for several centimeters. The subcutaneous tissues are dissected and sternohyoideus muscles are visualized. These layers are bluntly dissected using curved hemostats and Metzenbaum scissors. Gelpi retractors are used retract the skin and underlying tissues for adequate tracheal visualization. Once the trachea is visualized, a horizontal incision between tracheal rings is made with a Number 11 scalpel, between the 4^{th} and 5^{th} or 5^{th} and 6^{th} tracheal rings. The horizontal incision should not extend more than 50% of the circumference of the trachea. A stay suture should is placed around the tracheal ring at the cranial and caudal edges of the incision to allow retraction of the incision for placement (and re-placement) of the tracheostomy tube. The tracheostomy tube can be secured with umbilical tape and a light wrap. While opinions may differ, the author does not recommend suturing the tracheostomy tube directly to the neck. The tracheal ring stay sutures are left in place until the tracheostomy tube is no longer required.

References

Anderson, MA, Payne JT, Mann FA, Constantinescu GM. Flail Chest: pathophysiology, treatment, and prognosis. *Comp Cont Ed Pract Vet* 1993;15:65-74.

Boudrieau RJ, Muir WW. Pathophysiology of traumatic diaphragmatic hernia in dogs. *Comp Cont Ed Pract Vet* 1987;9:379-384

Conzemius MG, Brockman DJ, King LG, Perkowski SZ. Analgesia in dogs after intercostal thoracotomy: a clinical trial comparing intravenous buprenorphine and interpleural bupivacaine.*Vet Surg* 1994;23:291-298.

Kramek BA, Caywood DD. Pneumothorax. *Vet Clin North Am Small Anim Pract* 1987;17:285-300.

Lisciandro GR, Lagutchik MS, Mann KA, *et al*. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. *J Vet Emerg Crit Care* 2008;18(3):258–269.

Orton EC. Pleura and pleural space. In: Slatter DH, ed. *Textbook of Small Animal Surgery*. Philadelphia: WB Saunders Co, 1985;547-565.

Suter PF. Trauma to the thorax and cervical airways. Thoracic Radiology of the Dog and Cat. Switzerland: PF Suter, 1984;130-151.

Williams J, Leveille R, Myer CW. Imaging modalities used to confirm diaphragmatic hernia in small animals. *Comp Cont Ed Pract Vet* 1998;20:1199-1209.

Wilson GP, Newton CD, Burt JK. A review of 116 diaphragmatic hernias in dogs and cats. *J Am Vet med Assoc* 1971;159:1142-1145.

Yoshioka MM. Management of spontaneous pneumothorax in twelve dogs. *J Am Anim Hosp Assoc* 1982;18:57-62.

Emergency Management of Cardiac Disease

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Cardiac diseases commonly seen in the small animal emergency room include congestive heart failure (mitral or tricuspid regurgitation, hypertrophic cardiomyopathy, dilated cardiomyopathy), myocardial failure (dilated cardiomyopathy, end-stage heart disease), pericardial effusion, arrhythmias, and aortic thromboembolism in cats secondary to HCM.

Regardless of the presenting complaint, an important concept to remember when approaching any emergency patient is a rapid primary survey, keeping in mind the ABCDs of evaluation and resuscitation. Briefly, "**A**" refers to **A**irway or **A**rterial Bleeding. "**B**", **B**reathing is equally important assessing the character of the patient's respirations. "**C**" refers to **C**irculation and the overall perfusion status of the patient. Finally, "**D**" refers to **D**isability notably the patients mental status.

Emergency therapy

Emergency management of the patient presenting with respiratory distress includes systemic oxygen delivery and minimizing patient stress. While flow-by and oxygen mask oxygen delivery will allow concurrent patient assessment, there are times when other methods of oxygen delivery are needed.

Oxygen supplementation techniques

Supplementation technique	Required flow rate	Maximum inspired oxygen concentration achieved
Flow-by	3-15 l/min	40%
Oxygen cage	15 l/min	45-60%
Oxygen hood (unsealed bag)	5-15 l/min	85-95%
Oxygen collar	1 l/10 kg bodyweight/min	<80%
Nasal cannula	50-100 ml/kg/min	40%
Nasal catheters	50-100 ml/kg/min	40-50%
Nasopharyngeal catheter	50-100 ml/kg/min	60-70%
Nasotracheal catheter	25-50 ml/kg/min	80-90%

Once initial patient assessment is made, a more thorough physical examination is essential in the diagnosis and management of emergency cardiac patient.

Congestive heart failure

Patients with congestive heart failure often present in respiratory distress. Common examination findings include an increased respiratory rate and effort. If pulmonary edema is present, auscultation commonly is reported to have pulmonary crackles. More common in feline patients, dull lung sounds may be present ventrally with pleural effusion. Ascites may also be present with right sided heart failure as a result of tricuspid regurgitation, DCM, or heartworm disease. Other common physical examination findings include auscultation of a heart murmur, hypothermia in cats, pale mucous membranes, and other signs of respiratory distress (i.e. extension of the head/neck abduction of the elbows, and reluctance to lay down). Although uncommon in dogs, absent femoral pulses, cold rear extremities, and hindlimb paresis are seen with aortic thromboembolism (ATE), seen most commonly as a consequence of hypertrophic cardiomyopathy (HCM) in cats.

Along with the history and physical examination, diagnostics to consider include blood pressure, pulse oximetry, thoracic radiographs, or thoracic ultrasound. Before performing diagnostics, it is important to make sure the patient is stable and can tolerate the diagnostics without a risk of decompensation.

Thoracic radiographs are often considered the mainstay diagnostics in evaluating the heart and lungs. In fulminant congestive heart failure, radiographs commonly show congestion / distension of the pulmonary vessels and interstitial to alveolar pulmonary infiltrates.

In dogs, the pulmonary interstitial to alveolar disease is often seen in the perihilar area while cats may have a more generalized pulmonary patent of edema. Specific cardiac disease may also become more apparent with the use of radiographs, notably a large, globoid heart with dilated cardiomyopathy (DCM) or pericardial effusion. When performing thoracic radiographs, at least two views should always be taken with many cardiologists preferring a lateral view and dorsoventral (DV) view.

While thoracic radiographs often confirm the diagnosis of CHF, thoracic ultrasound is an upcoming diagnostic in the ER. Along with the TFAST and AFAST , a new term, “Vet Blue” has recently been discussed. Using these ultrasound techniques, lung pathology is assessed based on the distinction between wet (ultrasound lung rockets (ULRs) vs. dry lung (A-lines with a glide sign). The goal of using this technique is to provide rapid, point-of-care global evaluation of the emergent patient with minimal restraint and risk of decompensation. For the TFAST (Vet Blue) procedure, the patient is placed in either right lateral recumbency and/or sternal recumbency. Dorsal recumbency is not recommended as it has not been validated for VetBlue and it also may increase patient stress. The Vet Blue "L"ung Scan (VBLS, and "blue" for cyanosis, "L" for the scan pattern) is a rapid respiratory evaluation primarily based on the concept of wet vs. dry lung. In human patients lung ultrasound has been shown to be superior to chest auscultation for the detection pulmonary pathology. The goal of the VBLS scan is to identify pulmonary patterns that improve the speed of diagnosis for the respiratory distressed patient preempting the stress of thoracic radiography.

The initial treatment of congestive heart failure will vary slightly depending on the specific patient as well as specific diagnosis but involves oxygen, furosemide (1-4 mg/kg IV as often as every 1-2 hours initially for fulminant edema), and monitoring including blood pressure, pulse oximetry, hydration status, electrolyte status, and renal status. In severe case, sodium nitroprusside may be considered. Sodium nitroprusside is a balanced vasodilator effective in reducing pulmonary edema by increasing venous capacitance and reducing ventricular afterload. The dose is 0.5-10µg/kg/min IV as a CRI. The author starts at a dose of 1-2µg/kg/min and increases based on the response to therapy by 1µg/kg every 20-30 minutes until there is an improvement in respiratory rate, effort and thoracic auscultation. When using sodium nitroprusside, blood pressure must be monitored as it may cause moderate to severe hypotension.

In cases of low output failure (weak pulses, pale membranes, slow CRT, weakness, hypothermia, azotemia), dobutamine is a synthetic beta-adrenergic agonist is considered. This is commonly used in patients with DCM. Dobutamine has a dose range of 2–20 mcg/kg/minute At lower doses, dobutamine improves cardiac contractility with minimal effects on chronotropy or heart rate. At higher doses, however, dobutamine can be pro-arrhythmogenic.

Pimobendan (0.25 mg/kg PO BID) has been used with success in dogs with CHF secondary to DCM and mitral valve insufficiency. Pimobendan is a phosphodiesterase-III inhibitor that sensitizes the myocardium to calcium, and improves inotropic activity in addition to causing arteriolar and venous dilation. In addition to its use as a long-term inodilator in the treatment of dogs with CHF, Pimobendan is also recommended for use in emergency therapy of CHF, as it can have an onset of effects within one hour.

Cardiac tamponade

Cardiac tamponade results from the pressure of pericardial effusion on the heart leading to decreased filling, decreased cardiac output, and ultimately left and right heart failure. The degree of pressure exerted by the pericardial effusion depends on several factors. These include the volume of pericardial effusion, the rate of pericardial fluid accumulation, and the distensibility of the fibrous pericardium. In the author’s opinion, there are two common presentations of pericardial effusion. Patients presenting with acute cardiac tamponade often have a small volume of pericardial effusion (50–100 ml) which causes marked intrapericardial pressure and cardiac tamponade. However, we do also see patients with a more chronic, slower accumulation where there is increased compliance, allowing the pericardial sac to accommodate a significantly larger amount of fluid before intrapericardial pressure increases enough to result in cardiac tamponade.

Clinical signs of patients suffering from pericardial effusion may include tachycardia, tachypnea, poor or absent femoral pulses, pulsus paradoxus, jugular venous distension, dull heart sounds, exercise intolerance, weakness, and syncope. If more chronic in nature, patients may display signs of right-sided congestive heart failure including hepatomegaly, ascites, and jugular venous distension.

Aside from the traditional diagnostics listed above, echocardiography is recommended for the diagnosis of pericardial effusion. Pericardial effusion is diagnosed by the presence of hypoechoic fluid between the epicardium and the pericardium.

Diagnostic and therapeutic pericardiocentesis is indicated in patients with pericardial effusion.

Equipment needed for pericardiocentesis include clippers, antimicrobial scrub, 70% ethyl alcohol, sterile drapes, sterile gloves, electrocardiogram (ECG), ultrasound (if available), large intravenous catheter or pericardiocentesis catheter, extension set, three-way stopcock, syringe, sampling tubes (red top and EDTA) and 2% lidocaine (both for local analgesia and preparedness if ventricular tachycardia develops.)

To perform a pericardiocentesis, the patient is placed in sternal recumbency or lateral recumbency. Anesthesia is not necessary although sedation with an opioid/diazepam combination can be helpful for mild chemical restraint. A local block with 2% lidocaine can be used to reduce discomfort as well. Cardiovascularly compromising medications such as propofol, acepromazine, and inhalant anesthesia should be avoided. Unless ultrasound guidance dictates a more appropriate location, the patient is prepared by clipping and

scrubbing between the 4th and 6th intercostal space. While there is controversy as to the best side to use, the author prefers to enter the right side of the thorax. Similar to the thoracocentesis discussed above, the needle should enter cranial to the rib as the intercostal vessels and nerve runs caudal to the rib.

At the preference of the clinician, to prevent drag of the catheter through the skin a small skin stab incision can be made with a No. 11 scalpel blade. Also at the preference of the clinician, side holes can be placed in the distal portion of the pericardiocentesis catheter. If side holes are made, avoid a hole greater than 40% of the circumference of the catheter and holes directly opposite each other on the catheter, both which increase the risk of catheter weakness.

With appropriate patient monitoring including ECG, the catheter is inserted through the skin and into the pleural space. Once within the pleural space, the catheter is advanced slowly (1-2mm at a time) towards the heart while continuously monitoring the patient for discomfort and the ECG for arrhythmias. As the catheter is advanced, the clinician is watching carefully for fluid accumulation into the hub of the catheter. Typical fluid from the pericardial space will range from red to a port wine color. Once the fluid is seen within the hub of the catheter, the catheter is advanced another 1-2mm to make certain it is best seated within the pericardial space. The stylet is then removed and the catheter is connected to the extension tubing along with a three-way stopcock. Using a 10-20ml syringe, the fluid is aspirated. A sample of the aspirated fluid is to placed into a red top tube and a lavender top tube for further analysis. Specifically, the red top tube is monitored for clotting. A clot within the red top tube is a concern for trauma to the heart via the catheter and the catheter should be removed from the pericardial space. The amount of fluid obtained will vary but may be as much as 1/2 to 1 liter in a large breed dog. As they are often tachycardic on presentation, the clinician should notice a fairly dramatic decrease in heart rate within a few minutes of successful pericardiocentesis.

Life-threatening arrhythmias

The most common arrhythmia the small animal veterinarian will see is a tachyarrhythmia. These are also considered to be the most concerning as tachyarrhythmia's require increased oxygen consumption and lead to reduced diastolic filling and coronary artery perfusion. Underlying causes of tachyarrhythmia's include shock, anemia, hypoxia, hyperthyroidism, infection, inflammation, and pain. Supraventricular tachycardias should improve with treatment and resolution of the underlying cause (i.e. fluid therapy for hypovolemic shock or oxygen therapy for hypoxemia). If the heart rate does not decrease with appropriate therapy, a vagal maneuver can be attempted by applying pressure to the eyes or carotid sinus pressure. If there is no improvement despite appropriate therapy and despite a vagal maneuver, drug therapy is considered, notably digoxin. Other antiarrhythmics which may be effective include propranolol (20-60 mcg/kg IV slowly over 5-10 min.) or verapamil (.05 mg/kg IV q 10-30 min, up to 3 times). Both of these are negative inotropes and should be used with caution if there is concurrent evidence of congestive heart failure. Intravenous diltiazem (0.25 mg/kg administered slowly over 3 minutes) can be used instead of verapamil to control supraventricular tachycardias.

Ventricular tachycardia is another common arrhythmia seen, associated with primary cardiac disease or secondary to systemic disease. The arrhythmia is treated pharmacologically if signs of hemodynamic instability are present, notably with EKG findings including tachycardia (>160bmp), multiform QRS configurations, R on T phenomenon, and or hypotension. Lidocaine is the drug of choice for ventricular arrhythmias, dosed initially with a bolus of 2-4mg/kg IV given slowly to effect while monitoring the electrocardiogram. This bolus is followed by a CRI (25-80 μg/kg/min). Refractory ventricular arrhythmias can be treated with procainamide (2-15 mg/kg IV over 20-30 minutes).

Bradyarrhythmias are not as commonly seen in clinical practice, although bradycardia as a result of hyperkalemia seen with (feline) urethral obstruction is often seen. Aside from hyperkalemia as a result of urethral obstruction in male cats, other common causes include hypoadrenocorticism and renal failure. Treatment will depend on the underlying cause, but for hyperkalemia may include fluid therapy, Calcium gluconate (0.2-0.5 ml/kg IV), regular insulin (0.25 U/kg IV), dextrose (0.5g/kg), or sodium bicarbonate (1-2 mEq/kg IV slowly).

Summary

Patients presenting with evidence of emergent cardiac disease should be triaged quickly and treated immediately to reduce morbidity and mortality. Oxygen is a mainstay therapy for cardiac patients and should be administered on presentation and during the initial assessment phase. Prognosis will vary on the underlying cause of disease although patients may live for several years with careful monitoring.

Common medications, dosages and indications

Key Drug	*Drug Class*	*Dose Range*	*Frequency*	*Route*	*Indications*
Furosemide	Diuretic	2-4 mg/kg	Every 2-4 hours as needed, then every 8 hours	IV best in patients with CHF; IM	Pulmonary edema due to CHF
Nitroglycerin	Vasodilator	1/8" strip on ear pinnae	Every 6 hours	Topical	Vasodilation to decrease afterload on the heart
Dobutamine	β-1 agonist	2-10 µg/kg/min	CRI	IV	Positive inotrope to increase cardiac output in patients with primary myocardial failure
Lidocaine	Class I antiarrhythmic	40–80 mcg/kg/min	CRI	IV	Ventricular tachycardia
Procainamide	Class I antiarrhythmic	25–40 mcg/kg/min	CRI	IV	Ventricular tachycardia
Diltiazem	Calcium channel blocker	0.25 mg/kg slow bolus	Q 20 min	IV	SVT +/- atrial fibrillation
Esmolol	Beta-blocker	0.01 mg/kg slow bolus	Q 5 min	IV	SVT
Nitroprusside	Nitrate	2 to 10 mcg/kg/min	CRI	IV	Refractory CHF

References

Smith, F.W.K., Keene, B.W.: Left Sided Congestive Heart Failure. In The Five Minute Veterinary Consult, 3rd Edition. (eds. L. Tilley and F.W.K. Smith) Baltimore, Lippincott, Williams & Wilkins, 2004.

Tilley, L.P., and Goodwin, J.: Manual of Canine & Feline Cardiology, 3rd Edition. Philadelphia, W.B. Saunders, 2000.

Norsworthy, G., Crystal, M., Fooshee, S., Tilley, L.P.: The Feline Patient. Baltimore, Lippincott, Williams & Wilkins, 1998.

ER Tools:
Techy and Non-Techy Ways to Assess Your Patient

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

I recently asked a veterinary student what a minimum database (MDB) for a patient should be…They responded, "Complete Blood Count, Serum Chemistry Panel, Chest X-rays, and Abdominal Ultrasound." I don't know about you, but in *my* day, this "MDB" was not *my* "MDB!" What ever happened to the PCV (packed cell volume), TP (total protein), Azo (Azo stick®), and BG (blood glucose)? These rapid, cheap, and readily available tests provide clinically useful information in a short period of time. For only a few dollars you even have a chance to make the diagnosis! If not a diagnosis, they help with patient assessment and can guide not only therapy, but determine the best way to proceed with more advanced diagnostics. Especially as the cost of veterinary care increases, using the financial resources of the owner to the best of our ability will ultimately allow for better patient care.

Let's dive a little deeper into the specific components of the MDB:

PCV/TP

There is a current Ford car company commercial that has the punch line, AND is better. Who wants a PCV or TP? Having a PCV without the TP is like having to choose a Bed or Breakfast rather than a Bed and breakfast. Evaluation of the PCV and TP together can help diagnose or fine-tune your differential diagnoses.

You now are asking…"why are you talking about TP (total protein) and not TS (total solids)?" Modern refractometers measure total protein (TP) by the refraction produced by the total dissolved solids in plasma and have been calibrated to subtract 2.0 g/dL, the value expected of non-protein solids in plasma. These non-protein solids include urea, triglycerides, cholesterol, and glucose. So, TS and TP *are* different and should not be used interchangeably.

Here is a chart with a few examples of how PCV and TP together can help direct your diagnosis and treatment plan:

Packed cell volume and total protein			
↑ PCV/ ↑TP	↓ PCV/ Normal TP	↓ PCV/ ↓TP	Normal PCV/ ↓ TP
Hemoconcentration	- Hemolytic anemia - Anemia of chronic disease - Pure red blood cell aplasia	- Blood loss - GI - Body cavity (abdominal, thoracic, etc)	- Protein Losing Enteropathy (PLE) - Protein losing nephropathy (PLN) - Acute blood loss - Liver disease / failure

Before breaking the hematocrit tube for evaluation on the refractometer, make sure to use all of the tools available to you! Evaluation of the color of the serum in the hematocrit tube can also help. A yellow discoloration of the serum within the hematocrit tube can indicate icterus or hemolysis. If the patient has a low packed cell volume with yellow serum, for example your 5-year-old Cocker Spaniel, immune mediated hemolytic anemia would be a concern. If the patient is not anemic, but is a 5 year old obese domestic shorthair cat that has been anorexic for 5 days, hepatic lipidosis would be a concern when there is icteric serum. Other abnormalities when evaluating the hematocrit tube include a buffy coat for a gross assessment of a white blood cell count elevation and lipemia, which can be seen in sick patients with severe hypothyroidism or pancreatitis.

Blood glucose concentration

Prompt recognition and treatment of both hyperglycemia and hypoglycemia is essential to reduce morbidity and mortality in our patients. There are many cage-side portable blood glucose meters and point-of-care analyzers that provide reliable real time assessment for our patients. Patients that present hypoglycemic may have clinical signs including weakness, lethargy, tremors or seizures. Patients that present hyperglycemic have less reliable clinical signs, often suffering from the underlying cause for the hyperglycemia itself. Hyperglycemia may be found and historical information (polyuria, polydypsia, polyphagia, and weight loss) may help confirm a diagnosis of diabetes mellitus. On the other hand, hyperglycemia found in specific diseases such as head trauma and critical illness has been more recently found to be a negative prognostic indicator with a worse morbidity and mortality. In both human and veterinary medicine, studies have been performed ultimately concluding that tight glycemic control in critical illness reduces morbidity and mortality and prolonged hyperglycemia should be addressed in these patients. Thus, blood glucose monitoring and management in emergent patients can be quite helpful.

Blood Glucose		
Hypoglycemia	Euglycemia	Hyperglycemia
- Insulin overdose - Hepatic failure - Sepsis - Insulinoma - Paraneoplastic - Pediatric hypoglycemia - Portosystemic shunt - Adrenal insufficiency - Toxicity (xylitol)	- Normal - Regulated diabetic	- Stress (cat > dog) - Diabetes Mellitus - "Death Glucose"

AZO / BUN

Reagent test strips (Azo stick®) are used to estimate BUN and provide a semi-quantitative estimation of the blood urea nitrogen concentration. The normal Azo is considered less than 26mg/dl with test strip ranges of 5-15 mg/dl, 15-26 mg/dl, 30-40 mg/dl, and 50-80 mg/dl. Along with PCV/TP, history, and physical examination, the presence of azotemia will need further assessment to determine if the cause is pre-renal, renal, or post-renal in nature. Provided the patient does not suffer from a urinary obstruction, indicating a post renal cause for azotemia, ideally, a urine specific gravity should be obtained prior to starting IV fluids to help differentiate renal from pre-renal azotemia. Other causes for AZO/BUN elevation include gastrointestinal hemorrhage and following a high protein meal.

Ancillary testing

Depending on your background, the MDB (minimum database) can quickly turn into the EDB (extended database). I know what you are saying…let's not get crazy! But it really is not much more work. An extended database is a minimum database plus minor additional testing. The minimum database discussed includes a packed cell volume (PCV), total protein (TP), blood glucose, and dipstick BUN/Azo. Additional testing that converts the MDB to the EDB includes a blood smear, venous blood gas, lactate and electrolytes including sodium, potassium, chloride, and ionized calcium. These additional tests in the EDB help provide a more rounded metabolic assessment of the patient and can better assist the clinician rapidly determine the underlying cause.

Learning on the run

In the ever-growing number of hours we work and the ever-growing number of resources that we are supposed to study, memorize, and put to use in practice, having information at your fingertips may be life saving for patients. There are now numerous options we have to carry medical references digitally. These include Amazon Kindle, Google Play, and Apple resources to download textbooks and Apps to your mobile devices.

We all know what books are, but what are "apps"? "Apps" are applications, otherwise known as computer programs built to run on a mobile devices, such as your iOs or Android based device. Many apps are now available to the veterinary professional to enhance your education, patient assessment and patient treatment. While there are numerous apps out there, just to exemplify how these apps can be useful in practice, here are 2 examples:

A common app for the small animal practitioner is the Target app. This is veterinary specific antibiotic reference published by the North American Compendiums and developed by veterinary clinical pathologist Dr. David Aucoin. This allows the practitioner to evaluate specific, common antibiotics and their likelihood of efficacy based on the species and body system affected.

Another app many find useful in practice is a fluid therapy app from Abbott Animal Health. This is an app for veterinarians and technicians to assist with small animal crystalloid fluid therapy. Abbott's app allows the practitioner to develop a fluid therapy following assessment including patient weight, percent dehydration and any ongoing losses.

Get your head out of the clouds…or should you?

Finally, don't forget to use the "cloud" to your advantage as a busy clinician. What is the "cloud"? The cloud is a term used to indicate that data is stored on another hard drive, on another server, not your own hard drive.

Especially as laptop hard drives get smaller and smaller, it is becoming impossible to store all the data on your computer. But even better, cloud storage allows the user to access files on multiple devices (e.g. home computer, work computer, Smartphone, tablet, etc), knowing that they are available and backed up.

There are numerous options for cloud storage, many of which have free options, allowing the user to see if they like the service, with the ability to upgrade to larger data plans. Examples include Google Drive, Dropbox, Copy, and many more.

More specifically, how do I use cloud storage in practice?

1. I have created my own digital medical library

In my searchable Google Drive account, I have a personal library that includes:

- Journal articles
- Lecture notes from veterinary school

- Quick references
    - Hospital phone list
    - Favorite treatment and protocols
    - Reference lab information
    - Personal notes of drugs, devices, therapies, patient treatment options.
    - Consensus Statements and Guidelines

In my Dropbox account I have:

- Conference proceedings and notes
- Pictures of cases, normals, abnormals
- Client Handouts

Using cloud storage I am also able to easily share documents, upload and download documents, and even collaborate on documents, at home, at work, or even at a local coffee shop.

Summary

Ultimately, the condition of your emergency patient can be rapidly assessed with rapid and cost effective bedside diagnostics included in the MDB. Along with the history and physical examination this more objective information can help you maximize additional testing and treatment and make a large difference in your quality of care.

References

Acierno MJ, Mitchell MA. Evaluation of four point-of-care meters for rapid determination of blood lactate concentrations in dogs. J Am Vet Med Assoc 2007;230:1315–1318.

Acierno MJ, Johnson ME, Eddleman LA, Mitchell MA. Measuring statistical agreement between four point of care (POC) lactate meters and a laboratory blood analyzer in cats. J Feline Med Surg 2008;10:110–114.

Bosiack AP, et al. Comparison of ultrasonic Doppler flow monitor, oscillometric, and direct arterial blood pressure measurements in ill dogs. J Vet Emerg Crit Care2010;20(2):207–215.

Cohen TA, Nelson RW, Kass PH, et al. Evaluation of six portable glucose meters for measuring blood glucose concentration in dogs. J Am Vet Med Assoc 2009;235:276–280.

Di Tommaso M, Aste G, Rocconi F, et al. Evaluation of a portable meter to measure ketonemia and comparison with ketonuria for the diagnosis of canine diabetic ketoacidosis. J Vet Intern Med 2009;23:466–471.

Hill D, Correa MT, Stevens JB. Sensitivity, specificity, and predictive values of reagent test strip estimations of blood urea nitrogen. Vet Clin Pathol 1994;23(3):73–75.

Stevenson CK, Kidney BA, Duke T, et al. Serial blood lactate concentrations in systemically ill dogs. Vet Clin Pathol 2007;36:234–239.

Torre DM, deLaforcade AM, Chan DL. Incidence and clinical relevance of hyperglycemia in critically ill dogs. J Vet Intern Med 2007;21:971–975.

van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in critically ill patients. N Engl J Med 2001;345:1359–1367.

Wiedmeyer CE, DeClue AE. Continuous glucose monitoring in dogs and cats. J Vet Intern Med 2008;22:2–8.

Periodontal Basics: What Not to Forget

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

With the high prevalence of periodontal disease in pets, and the potential for impacting systemic health, most of us are aware that providing periodontal care is good medicine. It is also good business, as a complete dental care program encompasses the entire life of the pet, particularly in the 'micro-dog' breeds (under 20-25 pounds as adults), as the prevalence of disease in these patients is higher than in larger breeds. An emphasis on senior care entails sound dental care also. Dental care is one facet of our practice that is preventable in most cases, so wellness programs that encourage regular visits should always include evaluation of oral and dental health.

In the exam room

Though some patients are presented for specific dental problems, it is more common that the veterinary team will examine, discover and point out areas of concern to the owner. The extent of plaque and calculus can be ascertained in most patients, and providing a photo to the client (on their own cellphone?) can help point out the problems seen. While some might not be impressed with the presence of plaque, calculus or even oral malodor, education as to the importance of managing the extent of infection in the oral cavity can help them decide to get professional care. At times, pointing out additional lesions – or red flags – such as tooth resorptions, broken teeth or areas of advanced infections, may be necessary to encourage care.

Complete dental examination

Having the patient under general anesthesia is the only way a complete evaluation – with intraoral radiographs – and thorough treatment can be provided. The tissue of the periodontium surrounding the tooth are the structures that are evaluated, and their loss can lead to tooth loss.

- Attached gingiva – the first line of defense, the attached gingival is secured to underlying alveolar bone by connective tissue rete pegs. A minimum of 2-3 mm of attached gingival is preferred for optimal periodontal health
    - Free gingival margin – borders the gingival sulcus
        - Normal sulcus: 2-3 mm for dogs; 0.5mm for cats
    - At the mucogingival border /junction– transitions to looser alveolar mucosa
- Cementum – the outer layer of the tooth root, is partially cellular, allowing for the attachment of the periodontal ligament that suspends the tooth in the alveolar socket
- Alveolus – indentation in the jaw as the tooth socket – provides support for the tooth as it is suspended in the alveolus by the periodontal ligament
- Periodontal ligament – a connective tissue shock absorber that keeps the tooth root in the alveolus; evaluation of the periodontal ligament space is key in periodontal assessment.

Progression of periodontal disease

The term periodontitis refers to inflammation of these tissues, and is initiated by bacteria, collecting with a matrix of salivary glycoproteins and extracellular polysaccharides deposit on the tooth surfaces. This plaque then becomes mineralized to form calculus, upon which additional plaque accumulated. While the calculus can be quite extensive, it is not as active as the plaque in the actual progression of oral disease. The bacteria in supragingival plaque on the crown tend to be Gram-positive, non-motile, aerobic cocci, but as the debris accumulates and the infection progresses deeper into the sulcus, the population evolves into Gram-negative, motile, anaerobic rods and flagellates that are more virulent. The direct effect of the bacteria and toxins cause significant periodontal inflammation and destruction, but it is also the hosts' response to the bacteria that can cause additional loss of attachment.

The different levels of periodontal inflammation can be determined by complete evaluation of the tissues, including a thorough oral examination, probing of periodontal pockets and oral radiography. The levels of plaque, calculus and gingival inflammation are all important markers on the extent of debris accumulation and inflammation, but it is attachment level that determines the actual stage of disease. One of the most important ways to assess periodontal disease is to determine the depth of the periodontal sulcus or pocket.

When the bacterial plaque and host response cause inflammation of the periodontal tissues, their destruction can lead to formation of periodontal pockets. The periodontal probe should be used around the tooth to determine the depth of any pockets, and these are then accurately recorded. At times, there will be sufficient gingival and bone loss that the levels recede down the root, causing root exposure and even furcation (the space between two roots of the same tooth) exposure. The true level of attachment loss is a summation of root exposure and periodontal pocket – measuring the loss of attachment from where it once was.

With all cases, it is vital to take intraoral radiographs to see the extent of bone loss, as well as the type of bone loss. A level amount of bone loss across the roots of several adjacent teeth is termed horizontal bone loss. If the gingival is not loss, this will cause the formation of periodontal pockets. If the gingival recedes as well, then root surfaces will be exposed, and sometimes no pocket will be formed. If the attachment loss extends down a specific root or area, a deep infrabony pocket is formed between the tooth root and the wall of the pocket. With enough tissue loss, a tooth may become mobile and even be lost eventually.

Stages of periodontal disease

Stage I Periodontal disease refers to those cases with inflammation primarily in the gingiva itself, with no actual loss of attachment in the sulcus - soft or osseous. At times the sulcus depth will be greater than normal, but this is an increased height of the gingival margin due to inflammation and edema. Once the area is thoroughly cleaned, the inflammation should resolve, returning pocket depth to normal values. As such, this is the one stage of periodontal disease that is considered reversible. Therapy consists of professional cleaning as needed, with regular home care to minimize further damage. The term “prophylaxis” to describe dental cleaning is probably accurate only at this stage, since it is true prevention; once periodontal attachment loss is realized, prevention is no longer possible, so “periodontal therapy” is a more accurate term.

Stage II Periodontal disease, or early periodontitis, is the first stage with measurable amounts of attachment loss. Amounts of loss up to 25% in this stage necessitates a thorough cleaning and evaluation, in order to adequately treat the areas and arrest any further loss. More frequent cleanings and more advanced periodontal therapy (root planing, perioceutics) can minimize any further damage, and home care to keep plaque and calculus from extensive accumulation can be vital in preserving the teeth.

Stage III Periodontal disease includes cases with up to 50% attachment loss, as determined by periodontal probing and radiographs. Some teeth in this category will start to become mobile, and if continued care cannot be given, occasionally extractions may be necessary. This can be appropriate with particular teeth (non-strategic) such as lower corner incisors or fourth premolars or upper third premolars that are adjacent to larger, more strategic teeth. If the smaller teeth continue to contribute to bone loss that could also affect their neighbors, sometimes the smaller teeth should be extracted to be able to maintain the larger teeth’s health. More extensive periodontal therapy, including perioceutic therapy and even regenerative therapy may be selected to improve the prognosis on important teeth such as the canines or carnassial teeth.

Stage IV Periodontitis involves teeth that have greater than 50% attachment loss, and as such are often candidates for extraction. With such extensive loss, particularly if osseous, heroic attempts at salvaging will require more advanced periodontal therapy and owners committed to regular care, both professional and at home. Without such care, retention of such teeth will often result in the persistent presence of plaque, calculus and bacteria in the deeper pockets, putting the patient’s overall health at risk. While saving teeth is a noble cause, if extraction will improve the general health, it is sometimes the best choice.

Periodontal therapy

When looking at periodontal disease, therapy is determined by a number of factors, such as the stage of the disease, and the desired outcome. There are several goals to set, including removal of all debris or biofilm (plaque, calculus), keeping the maximum amount of attached gingiva, minimizing attachment loss and minimizing the pocket depth. Certainly, all foreign material, from bacteria to desquamated cells must be removed from the tooth surfaces and pockets in order to attain healing. Since the attached gingiva is the first line of defense against bacteria, a minimum of 2-3 mm is necessary to protect underlying tissues, as the looser alveolar mucosa doesn’t afford that protection. The inability to halt attachment loss will eventually lead to tooth loss, and with smaller cat teeth, tooth loss can occur quickly, due to small alveolar bone mass. Minimizing pocket depth is related to attachment loss, but is a more specific parameter, because pocket depth in itself directly affects the ability for effective home care and maintenance. There are even times where excessive gingiva will be removed to decrease pocket depth (hyperplastic gingiva) or the gingiva will be sutured further down the root (apically repositioned flap) for the same effect.

These goals are best realized with a comprehensive program of dental care for the patient. At every patient visit, the oral exam should be evaluated. When appropriate, professional care under general anesthesia should be administered, and effective home care can help keep the tissues as healthy as possible. Periodontal disease is ultimately a preventable disease, with a lifetime of dental care.

Professional dental care

The most common dental procedure performed in practice is usually called a prophylaxis. Since this term means “prevention”, about the only time it is truly applicable is in Stage I Periodontal disease cases with just gingivitis present. All other procedures would more correctly termed “periodontal therapy”, because you truly are treating the periodontium. By staying with a methodical process following the correct steps, you can offer the best treatment possible for your patients. Since the aerosolization of bacteria occurs during dental cleaning, both operators and patients should be protected. Flush the oral cavity at the beginning of the procedure with chlorhexidine solutions can help decrease the bacterial assault.

Certainly, the gross removal of calculus and plaque is the most obvious step of cleaning, but this is literally only scraping the surface! Most practices have some form of dental scaler, often an ultrasonic type. There are many units available, and you should be familiar with your particular unit. Most units can generate some heat, and so should be used with adequate water flow. Some newer units have tips with water flow that can be introduced under the gumline in shallow pockets, but for the most part this should be avoided with other models, as damage can be caused to the root surface. Sonic units (on a high-speed handpiece, air-driven unit) don't generate as much heat, but require adequate air pressure for maximum effectiveness. Rotary burs on a highspeed handpiece can be quite damaging, especially to feline teeth, and should be avoided.

A periodontal probe is one of the most vital tools in dealing with periodontal disease. The probe is marked in millimeters, so the depths of pockets can be accurately measured. Especially with inflamed pockets, it is important to use the probe gently, as force can push the probe tip through the fragile junctional epithelium at the bottom of a pocket. Measuring pocket depth at six points around the tooth will give a fairly accurate picture of the extent of the pocket. The explorer tip of the instrument is a thin, sharp-tipped hook that can be used as a tactile instrument in pockets (gently) to detect remaining calculus or debris. The tip can also be used to determine if the pulp canal is exposed in broken teeth, if a carious lesion is present (soft enamel), or if a resorptive lesion is present on the tooth surface.

For most areas of subgingival scaling, periodontal curettes are the instrument of choice. They differ from hand periodontal scalers in that the curettes have a rounded back and toe as compared to the scalers' sharp tip and back (triangular in cross-section). While pocket formation is not as common in cats as in dogs, it is important to clean these areas. You should choose a curette with a small, delicate working head that can be inserted gently into the pocket without causing more damage or stretching of the gingiva. The curette is introduced gently into the depth of the pocket and pulled against the tooth with its cutting edge (regular sharpening is essential) to scrape biofilm off the tooth and root surfaces. Overlapping strokes help clean the root surface thoroughly (root planing), avoiding excessive force. Curettes can be used in closed root planing (pockets up to 5 mm – a pretty deep pocket for most cat teeth), and the upper edge of the curette can also gently scrape the inner lining of the gingival sulcus or pocket, termed subgingival curettage. Both root planing and subgingival curettage should not be done too aggressively. Placing a doxycycline hyclate gel in moderate pockets that have been scaled has been shown to help decrease pocket depth.

With pockets deeper than 5-6 mm, often a gingival flap must be elevated to allow further exposure of the lesion. Hand curettes can't reach further than that effectively, and visualization is nearly impossible. Teeth with this much attachment loss should be thoroughly assessed, because few teeth with pockets of this depth are salvageable.

Polishing should always follow a scaling procedure, to smooth the roughened tooth/root surface, but damage can be caused if it is done improperly. The rotational speed of the prophy cup should not exceed 3000 RPM (watch the speed on variable slowspeed units), and the foot of the cup should be gently splayed, with adequate amounts of prophy paste used. Complete irrigation of the teeth, including reaching into the sulci or pockets (use a blunt-tipped needle), with anything from water to saline to dilute chlorhexidine or fluoride will wash away any remnants of biofilm and even prophy paste. If any material is left in the sulcus, a periodontal abscess may result. Complete charting of any lesions is essential, not only for good medical records, but also to be able to follow out the progression of the disease n the future.

Home care

The level of home care attainable will depend on both the pet and the owner, and their ability to "cooperate". Cats in particular can pose a variety of problems with attempts at brushing, but if the owner starts out slowly, gently rubbing the side of the face with a small cat toothbrush and using solutions with good flavors initially (save the water from a can of tuna), many pets can tolerate at least some brushing. There are many products available for use, so become familiar with a few that you can keep in stock. Soft-bristled toothbrushes or finger cots are useful, and specific toothpastes formulated for pets come in many flavors. Clients should be instructed never to use human toothpastes on their pets, as they contain detergents for foaming and fluorides, which can upset the stomach and cause renal toxicity, if ingested on a regular basis. Oral antimicrobials, such as chlorhexidine in paste or solution, and oral cleaning solutions with zinc ascorbate can be used in patients that resist brushing efforts. However, chlorhexidine products can sometimes be bitter, and gels that are more viscous are more effective than solutions. Newer gel products have removed the ascorbic acid that can sometimes have a negative taste effect. Fluoride gels can be used in select cases with sensitive or worn teeth, but sparingly with monitoring for renal function.

Whether an uncomplicated case of periodontal disease or a patient with advanced disease, regular and systematic examination and therapy can help provide optimal oral and dental health for these patients. Education of the clients is critical is getting them involved in the total process. Treating the oral cavity can also have a positive effect on the rest of the patient. Providing a broader range of dental care to more patients can help make your practice healthier as well!

Advanced Periodontal Management for Every Clinic

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

The extent of periodontal disease you might encounter in patients can vary from patient to patient and even from tooth to tooth in the same patient. From minimal inflammation and no attachment loss in Stage 1 Periodontal Disease to the beginnings of attachment loss (up to 25%) in Stage 2, then deeper pockets (up to 50% attachment loss in Stage 3) and even compromised teeth (greater than 50% loss) in Stage 4, you must be able to tailor the treatment to the problem. Beyond the dental cleaning, being able to provide advanced peridontal management for your patients is not only good medicine, but good business. By adding simple instruments, materials and skills to your dental armamentarium, you can identify and treat those teeth that may have been extracted in the past.

Therapy goals

When looking at periodontal disease, therapy is determined by a number of factors, such as the stage of the disease, the involved tooth, the client's commitment and the desired outcome. There are several goals to set, including removal of all debris or biofilm (plaque, calculus), keeping the maximum amount of attached gingiva, minimizing attachment loss and minimizing the pocket depth. [1] Certainly, all foreign material, from bacteria to desquamated cells must be removed from the tooth surfaces and pockets in order to attain healing. Since the attached gingiva is the first line of defense against bacteria, a minimum of 2-3 mm is necessary to protect underlying tissues, as the looser alveolar mucosa doesn't afford that protection. The inability to halt attachment loss will eventually lead to tooth loss. Minimizing pocket depth is related to attachment loss, but is a more specific parameter, because pocket depth in itself directly affects the ability for effective home care and maintenance, and deeper pockets can harbor more virulent strains of bacteria. There are even times where excessive gingiva will be removed to decrease pocket depth (hyperplastic gingiva) or the gingiva will be sutured further down the root (apically repositioned flap) for the same effect. Attachment loss without pocket formation occurs when gingival tissue and bone is lost at the same time, exposing the roots and even furcation areas.

The ability to take intraoral radiographs is essential, in order to determine the extent and characteristics of bone loss. With recession of gingiva and bone across several roots and/or teeth, a horizontal bone loss pattern will often result in exposed roots. With a deeper osseous loss down one root surface, an infrabony pocket may result from the vertical bone loss, and specific therapy may be needed to address that specific defect. These deeper pockets are more difficult to treat and maintain, and anaerobic infections may persist.

Attachment loss – treatment decisions

In evaluating teeth at either end of the spectrum – minimal disease with stage 1 or 2 teeth, or extensive stage 4 disease – the decision process is pretty straight forward. With stage 3 periodontal disease affected teeth – there is more of a challenge to decide whether to extract or try to save. The extent and type of attachment loss is a part of the decision process, as is the consideration of the relative importance of the tooth itself. Major teeth (canines, carnassials) will often be considered for advanced procedures, and adjacent, smaller teeth that are contributing to the infection should be considered for extraction, as their removal will allow better access to the strategic tooth. By extracting the middle tooth in the middle of three rotated, crowded premolars can often enhance the health of the remaining two teeth.

If the attachment loss results in root exposure with minimal pocket formation, professional cleaning and home care may be easier. Any involvement of the furcation puts the tooth at higher risk, due to challenges of continued care. If a pocket is present, it should be thoroughly evaluated: how deep is it? is it suprabony or infrabony?

Patient health status is also evaluated: patients with systemic disease would like benefit more from extraction with the immediate removal of the infection, and a decreased anesthetic time. Clients also are involved in the decision: advanced periodontal therapy requires excellent home care and more frequent professional visits.

Advanced periodontal therapy

Periodontal therapy initially concerns itself with removing all plaque, calculus and debris possible. This is of particular importance if there is any attachment loss or pocket formation, because the surfaces must be thoroughly cleaned to help remove the destructive action of the bacteria and moderate the host response as well. With addition of a few instruments and materials, most procedures can be done in most practices.

Supportive care

Additional care beyond the periodontal work is often necessary to maximize the outcome. Assistance with various antimicrobial agents can help the patient fight off the bacterial onslaught, by using everything from oral rinses and gels to medically appropriate prescriptions of systemic oral antibiotics. Even pain management must be considered, because the conditions alone can be painful, and any surgical procedures must be covered as well.

Non-surgical periodontal therapy

With suprabony pockets (soft tissue only) of up to 5 mm in depth, closed root planing and placement of a perioceutic can provide excellent care for the defect.

Root planing/ subgingival curettage

This is by far the most important aspect of periodontal therapy. [3] If the debris is not thoroughly removed from the pocket depths, the disease will remain and intensify. The rounded tip of the curette, and it's rounded back, makes it ideal for subgingival therapy, as opposed to the sharp tip and back of a hand scaler. Certain ultrasonic scalers are modified for subgingival treatments, but most are not. If root surfaces are exposed, or if the pocket depth is less than five mm, closed root planing and subgingival curettage may be performed. Using a curette subgingivally with overlapping strokes in horizontal, vertical and oblique directions, root planing removes calculus, debris and necrotic cementum to provide a clean, smooth surface. The curette can also be angled slightly to engage the gingival surface for removal of diseased or microorganism-infiltrated tissues. When pocket depth exceeds 5 mm, or other pathology exists, more invasive procedures are warranted.

Perioceutic therapy

In moderate pockets of up to 5 mm in depth (and generally deeper than 2 mm), once the area is debrided, placement of a local perioceutic gel containing doxycycline hyclate can not only provide a direct antibacterial affect against any remaining bacteria, but the anticollagenase activity can help "rejuvenate" the soft tissue of the pocket. The combination of the cleaning and therapy can often help reduce the pocket depth in moderate situations.

Once mixed, the tip of the cannula is gently placed to the depth of the treated pocket, and the material is slowly inserted into the pocket, until a small amount extrudes from underneath the gingival edge. By using light digital pressure on top of the gum, and by gently scraping the cannula tip on the tooth surface, the cannula can be removed without taking the gel with it.

The gel firms up on its own within a minute or two, or a drop of water can be placed on the material to speed up the process. Once firm, the visible material should be gently packed into the pocket, using an instrument such as a W-3, or beaver tail instrument. The owner should be instructed not to brush for about a week in the region (gels and solutions are recommended), nor to pick at the ridge of material that may become visible (light yellow-brown). The material is biodegradable and does not need removal. Sometimes periodontal sealants can be placed after a procedure.

Surgical periodontal therapy

Many standard pieces of equipment and supplies can be used, including scalpel blades (15C works well), scissors (sharp/sharp for gingival remodeling), and sutures (usually absorbable, from 3-0 to 5-0). It is important to other equipment as well for unique oral situations, including periodontal curettes for scaling root surfaces and periosteal elevators (Molt No. 2 or No.4) for elevating gingival.

When pocket depths exceed 5 mm but with minimal bone loss or diseased soft tissue that needs removal, a simple envelope flap allows access and improved visibility for open curettage and root planing. Insert the scalpel blade into the sulcus and follow the scalloped contour to sever the epithelial attachment and use the periosteal elevator to expose the area to be treated. For large areas requiring treatment, vertical-releasing incisions can be made at the mesial and distal ends of the initial incision (at line angles of adjacent teeth). Using a periosteal elevator, the gingiva is reflected to expose the root surfaces. A polishing of the root surfaces and irrigation with dilute chlorhexidine follows thorough root planing and subgingival curettage. After repositioning the flap, sometimes further apically down the roots, it is sutured interdentally with absorbable, interrupted sutures. While this procedure is most commonly performed on facial and lingual surfaces, deep pockets on the palatal aspect of the maxillary canines can be exposed using a similar technique for treatment.

If an adjacent, smaller tooth is involved in the area of attachment loss, its extraction is sometimes the best way to get access to the larger, more strategic tooth's surfaces. The releasing incision is made away from the tooth being treated, allowing a complete attached gingival coverage of the treated site. Extraction of the middle of three crowded teeth also allows better exposure and treatment of the remaining teeth.

Guided tissue regeneration

In an infrabony defect, where the attachment loss has occurred down the surface of a tooth, forming a deep pocket in between the root and alveolar bone, inadequate therapy can lead to even further attachment loss and even tooth loss. While attachment loss is generally considered irreversible, materials can be place that can help encourage regrowth of bone at the site. Typically the soft tissues (gingival epithelium, gingival connective tissue) will grow back into a defect faster than the more important supportive tissues of the periodontium (alveolar bone, periodontal ligament).

By placing a barrier between the instrumented root surface and the gingival flap, it can act as a deterrent to exclude the gingival epithelium or gingival connective tissue from populating the root structure. This barrier then provides an area for the progenitor cells of the periodontal ligament and/or alveolar bone to have free access for migration. Bone development being slower than the soft

tissues of the periodontal ligament, it is hoped that it should develop prior to bony incursion. It is generally believed that periodontal cells have the greatest potential to promote new attachment, but that bone also plays a significant role.

While some barriers are actual membranes, bulk material can also be placed to keep the soft tissue out. When a substance that promotes osseous growth is placed, alveolar bone stands a better chance of filling the defect. There are even products that stimulate periodontal ligament re-growth. An essential key to such a procedure is adequate exposure and debridement of the area. A gingival flap is necessary to allow for thorough curettage of all material in the infrabony pocket in between the tooth and root, including the removal of any granulation tissue. Once healthy bone and tooth surfaces are clean, the bone graft material is packed into the defect, and the gingival closed over it.

Post operatively vigorous home care and plaque control is essential. Antibiotics for up to three weeks post surgically are generally recommended. Non-absorbable membranes are normally removed one to nine months following surgery. Some materials do not need removal.

Two sites that are most commonly selected for GTR involve the distal root of the mandibular first molar (often with extraction of the second molar for exposure) and the palatal aspect of the maxillary canine, before the defect results in an oronasal fistula. Mesial and distal releasing incisions can be made extending out from the maxillary canine towards the adjacent teeth, on the gingival papillae. Exposure with this method can be somewhat limited, like an envelope flap, and closure involves using a sling suture technique, running the suture in a semi-circle pattern within the palatal mucosa from a mesial to distal direction, exiting distal to the canine and re-entering near the same site, reversing the semi-circle pattern to exit mesial to the tooth, and tying off the two ends, tightening the flap against the tooth. Incisions made directly into the palatal mucosa not only can cut the palatine artery, but make a flap that is more difficult to hold against the canine.

One alternate method is making a crescent-shaped flap in the palatal mucosa, extending from a point just mesial to the canine in the incisor-canine interdental space, and running medial to the canine to a point just distal to it. When the flap is elevated, there will be hemorrhage from the rostral severing of the palatine artery, but it can be tied off at that extent and preserved within the flap itself. Once elevated, good exposure allows for thorough cleaning of the infrabony pocket, though care must be taken to avoid puncturing the remaining alveolar bone separating the pocket from the nasal cavity (oronasal fistulation), else the tooth would have to be extracted. Once the pocket is cleaned and filled, simple interrupted sutures can hold the crescent flap in place. If some gaps appear, a small amount of the mesial extent of the flap can be trimmed, to bring the gingival margin closer to the tooth. Sutures can be placed to join the cut edge of the flap back to the palatal mucosa, as long as no tension is placed on the flap that would cause it to pull away from the tooth. A small gap between the cut edge of the flap and the remaining palatal mucosa will typically heal without complication.

In some areas there will be horizontal bone loss and suprabony pockets (bone loss occurs at same level of attachment loss but no defect in between the tooth and alveolar pocket). Once the area is exposed, all root surfaces areas should be thoroughly cleaned using curettes. In some cases, if the bone loss includes interdental spaces, the flap can be sutured in place so the gingival margin is actually placed further down the root than originally positioned (apically repositioned flap). This can help minimize the pocket depth, though the actual level of attachment is still the same, just more root structure is left exposed. These sites are not amenable to osseopromotive products.

Special conditions

Gingival hyperplasia (gingival enlargement)

Gingivectomy/gingivoplasty

Occasionally, significant local or generalized increases in pocket depths without attachment loss will occur with conditions such as gingival hyperplasia or associated with an epulis. In these cases, gingivectomy removes redundant gingiva to reduce the suprabony pseudopocket depths to facilitate the cleaning of tooth surfaces while maintaining at least 2 mm of attached gingiva. Pocket depth is measured and a corresponding bleeding point is made with the probe at several junctures around the affected teeth. A beveled incision is made with a scalpel blade, connecting the bleeding points, maintaining a scalloped edge gingival appearance and preserving adequate tissue. A 12-fluted bur can be used to contour the gingival margins, and Tincture of Myrrh and Benzoin placed (several layers) as a gingival dressing.

Dental Emergencies: A Misnomer?

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

Most dental conditions found in practice are often chronic in nature – from progressive periodontal disease or tooth resorption to the tooth that has been broken for years. Occasionally a patient is presented with a true dental emergency – often due to some type of trauma – or due to the fact that the owner finally noticed something that had been happening for some time. If trauma has occurred, it is important to quickly assess the extent of injury and the stability of the entire patient. A life-threatening condition should be addressed first. Injuries should be "staged" as to their relative importance, and handled accordingly, until the patient is stabilized. Pain management before, after, and during surgery is an integral part of the treatment plan.

There are occasions where trauma in the oral region can endanger the pet, such as when the airway becomes obstructed, or when hemorrhage cannot be controlled. Once stable, it is then important to regain normal function of the oral cavity as quickly as possible. Getting a patient to eat, drink, and even groom normally is an important part of the healing process.

Oral trauma

An event of oral trauma requires complete evaluation, from soft tissue that might require hemorrhage control or reconstruction to osseous damage such as fractures and luxations. Dental trauma may involve individual teeth, or teeth involved in more extensive damage, making decisions for combined care necessary. No matter how the mouth is fixed, it is important to be able to maintain a functional occlusion.

Soft tissue trauma

A degloving trauma to the mandible can often be managed with conservative means, gently cleaning and debriding the area before replacing the soft tissue. Areas of necrotic tissue should be debrided, but remain on the conservative side, as blood supply to the oral tissues is usually extensive. The tissue can either be sutured to remaining soft tissue, or stay sutures can be placed around the lower canines to hold the lower lip in place until it is healed.

Tears in the gingiva sometimes require repair as well. The entire site should be thoroughly evaluated, to determine if any underlying pathology exists (fractures, pockets, etc). Often a simple interrupted suture pattern of a small, absorbable material is sufficient. Attempts should be made to preserve as much viable attached gingiva as possible, because this is an important tissue in periodontal defenses.

Damage to the tongue, such as is seen in electric cord trauma from chewing on it, should include conservative debridement of noticeably necrotic regions, and suturing cut areas. Salvage as much of the tongue as possible in the cat, as it plays important roles both in eating and grooming.

Osseous

The first step with osseous tissues is to completely determine the extent of damage, as multiple injuries may be present. In cats, the most common osseous oral fracture is that of the mandibular symphysis. Always evaluate the temporomandibular joints (TMJ), because luxation in the presence of another fracture is not uncommon. It is essential to have proper occlusion throughout, as even a small discrepancy in the distal oral cavity can translate into a large variation in the front of the mouth. Any occlusal interference will then disrupt the stability of the fracture repair, further complicating matters. If necessary, a pharyngostomy tube should be placed, so occlusion can be assessed at regular intervals perioperatively.

With mandibular body fractures, the direction of the fracture (especially mid-body) will determine the form of stabilization. A fracture from the ventral surface running caudally to the dorsal surface benefits from muscle placement that helps to keep the fracture reduced (Favorable). Often a single interosseous wire is sufficient here. On the other hand, a fracture line from dorsum to ventrum (caudally) will have muscular forces working to separate the two pieces, so a triangulation of two interosseous wires will be necessary.

Every tooth at a fracture site should be closely examined for viability. If severe periodontal bone loss around a tooth had contributed to the fracture, the tooth might have to be extracted anyway, but most in a fracture line should be preserved to help with stabilization, at least temporarily. With non-invasive methods, the presence of teeth is essential, especially with wire or splint placement. If the injury involved the apical region of a tooth, future endodontics may be necessary if the blood supply was compromised.

One of the most common, and most challenging, areas of mandibular fracture can be the region around the lower first molars. Not only can extensive periodontal bone loss around these teeth significantly compromise the strength of the jaw, but any extraction attempts can potentially result in jaw fracture. With any injury in the area, stablization with interosseous wiring or suturing (use osseopromotive substance to help strengthen bone) can often be supplemented with a splint if surrounding teeth remain.

Wiring

The steps of osseous wiring are not too complicated, but basic rules are essential – such as avoiding tooth roots, apical structures and other vital landmarks such as the mandibular canal. In cats, it is more challenging to place wires, so sometimes large gauge suture material (non-absorbable or long-lasting) may be used. Obviously, intraoral radiographs are necessary during these procedures. Either with gingival flaps, or external to the gingiva, holes can be drilled used round burs on a highspeed handpiece, IM pins, or even larger 16 to 18 gauge needles. These methods can provide sufficient stability without having to go to more invasive methods with external fixators, plates or screws in most cases.

Interdental wiring methods are even less invasive, even when placed through the gingiva in between teeth (soft tissue healing occurs after removal). Learning the technique of wiring is the difficult part, but the benefits are great. Splints (acrylic or composite) may also be used as a non-invasive technique, either alone, or in combination with wiring.

- Stout's Multiple Loop – 2-3 teeth on either side of a fracture
    - Static wire – long lead – facial aspect
    - Working wire – lingual/palatal – passed in interdental spaces – loops (IV tubing)
    - Two ends tightened, then tighten loops
    - Acrylic or composite splint to reinforce and cover loops
- Circumferential wiring – mandibular symphysis
    - Midline ventral incision – use large gauge needle to guide wire distal to canines
    - Tighten ends, cover tip with composite

Splints

Splints for fixation of fractures in the oral cavity can be a good conservative way to provide stability, with minimal invasiveness or complications. With adequate ventilation, nearly any practice can use the dental acrylics for splints. Once the teeth are flour pumiced and acid-etched, and the surrounding soft tissue protected with petroleum jelly, the jaw fracture should be reduced, and the pieces held into place (with proper occlusion). The "salt and pepper" technique of adding small sequential amounts of acrylic powder and liquid allow for a directed placement of the material, as well to help to minimize the hyperthermic reaction that takes place during the polymerization of acrylics. This type of splint material can be "molded" into desired shapes before the full set-up, and acrylic burs can be used later to trim down excess amounts or to smooth rough edges.

Composite materials, especially temporary ones, are also suited for splint placement. Again, the teeth should be cleaned, flour pumiced and acid etched (rinse well) before the placement of the product and/or a bonding agent below it. Most products require a special dispenser or mixer and are self-cure, allowing sufficient time for shaping of the material. Even without the bonding agent, some of these material will cause staining of the teeth once removed. (Acid-etch and bond lingual/palatal surfaces only; this minimizes staining labially)

Complicated fractures

Comminuted or non-union fractures pose special problems, particularly if there is extensive bone loss, either prior to injury (periodontal disease) or after (gunshot, necrosis). With a gap in the bone, it is difficult to place interosseous wiring, and there may be too many missing teeth to provide a framework for a splint. IM pins placed at several sites, distal and mesial, to a fracture site may be joined with tubing filled with acrylic or composite, to form a type of external fixation, but care must be taken to avoid further injury to tooth roots.

With some of the newer osseous implant materials, if some level of stability can be attained, osseous bridging may occur in some cases. Working with a modified splint, tape muzzles, or even bonding opposing canines in a locked position (mouth slightly open to allow the lapping of water or liquid diets), enough stability may be possible in order for these materials to be effective.

With more severe unstable fractures, especially those with poor bone quality and missing teeth, wiring is usually impossible, and the possibility of a partial mandibulectomy may arise. Most animals tolerate such a procedure fairly well, and a commisureplasty may be performed to close the mouth a little further to help keep the jaw from hanging down. Some patients may even tolerate the long term use of a tape muzzle device, with owners that can periodically remove and change the muzzle.

TMJ injuries

A good percentage of patients with injuries to the temporomandibular joint (TMJ) come in after trauma such as being hit-by-car, and will present with an open mouth, unable to close it. The condyle can be luxated, either caudally or rostrally (most common), and can often be reduced by using a dowel placed between the upper and lower carnassial teeth with gentle force to press the jaws back together (distal pressure if luxated rostrally, and vice-versa).

Fractures of the condyle will often be painful, and lead to chronic arthritic changes and pain, even if "repaired". Mandibular condylectomy will help to remove the source of pain, and most animals recover well

Tooth injuries

While most dental or oral injuries may enjoy the luxury of not requiring immediate attention, a few situations occur where the prognosis of the treatment is enhanced with timely intervention. Other than cases such as osseous fractures that need stabilization as soon as the patient can undergo treatment, cases of tooth avulsion or fractures of immature teeth also benefit from prompt response.

Tooth avulsion/luxation

Complete avulsion

If the tooth is completely avulsed from the mouth, it is essential to handle it properly to have any chance of it being saved. As soon as the owner reports the incidence, they should be instructed to place the tooth in a container of fresh milk, to keep it moist and to help preserve any periodontal ligament (PDL) cells that may be present on the root. Sterile saline is the preferred storage medium, if it is available. Once the patient and tooth are presented, the tooth should be gently flushed with sterile saline, and the alveolus flushed (dexamethasone) and gently debrided. Care should be taken with these tissues, as you want to keep as many PDL cells viable as possible. With radiographs, evaluate the area for signs of advanced periodontal disease (including chronic osteitis/alveolitis with extrusion of maxillary canines) or osseous changes associated with neoplasia, that may have predisposed the patient to tooth loss. Such teeth are not viable candidates for reimplantation.

With a completely avulsed tooth, it is often easier to do a retrograde endodontic procedure since it is already out, if you have the capability. The tooth is then replanted into the alveolus, any fractures reduced, and the site stabilized. Stabilization of the fracture alveolus or jaw is best done with non-invasive techniques, with interdental wiring and acrylic or composite splints. Soft tissue defects should also be closed at this time. The interdental wiring will actually allow some of the normal minute movements of the tooth within the alveolus – so rigidity is not necessarily the best option.

If an endodontic procedure was not performed initially, standard root canal technique may be performed 2 to 3 weeks after this time. This gives the patient time to recover from the first anesthetic event, and to give supportive tissues time to start to heal, but removes the chance of a periapical abscess from interfering with continued healing. The wire and splint can usually be removed in 4 to 6 weeks, once radiographic and physical signs of healing are present.

Partial avulsion

Teeth that retain a portion of their attachment are treated similarly, especially if the apex is completely separated from its bed. If just the coronal portion is avulsed, there may be a chance that the apical blood supply was not disrupted, so replantation and stabilization may be the only treatments necessary. Such teeth must be monitored on a regular basis, to determine if apical blood supply remains viable. If any signs indicate that the pulp was injured or has become non-vital, endodontics must be performed. If any tooth avulsion or even invulsion are due primarily to severe periodontal disease that compromised the periodontal tissues, often extraction is the best treatment option.

Tooth fracture

In most cases a fractured tooth has been present for some length of time in a pet, and unless it abscesses, will seldom seem to cause discomfort (though it needs treatment). Occasionally, a tooth with periapical abscess will have an active episode, or suddenly flare up, and these “phoenix abscesses” can be quite painful. At other times, the infection turns into an area of swelling or a draining fistula (suborbital for upper fourth premolars), which may be the first time an owner even realizes there is a problem.

Acute tooth fracture – mature teeth

With very astute owners, sometimes the actual fracture event is noticed immediately, and in these cases, there is a window of opportunity to treat the fracture and exposed pulp. With mature teeth, if the pulp is treated within 5 days (see below), with immediate administration of antibiotics and anti-inflammatories (to reduce infection and inflammation potential), sometimes the remaining pulp can be kept alive, and the tooth can remain vital. Because of the narrow canal and subsequently a smaller population of odontoblasts, sometimes even timely therapy is not sufficient to keep the remainder of the pulp viable in a mature tooth. If this is the case, and even as a primary decision in a number of cases, immediately therapy with a standard root canal procedure or even extraction is always an option with mature teeth.

Acute tooth fracture – immature teeth

With teeth in patients under 18 months of age, lack of apical closure, thin dentinal walls, and a richer blood/odontoblast supply make options other than standard root canal more likely. In fact, if the fracture happened up to 2 weeks prior to presentation (or if the pulp is exposed iatrogenically during a crown reduction), the chance to treat the tooth with hopes of keeping the pulp alive should be taken. Administration of oral antibiotics and anti-inflammatories is an important step to start until the patient can be seen, though medications that interfere with normal platelet function should be avoided (hemorrhage control is an important step in the therapy).

In these patients, therapy is aimed at removing the coronal portion of the pulp that has been exposed to the environment and bacteria, and placing medicaments so the remaining healthy pulp can form dentin at the exposure site, and continue to help in the tooth’s maturation process, including apical closure (apexigenesis) and continued dentinal wall deposition (odontoblasts).

- Partial pulpectomy – sterile round bur to remove exposed pulp to a depth of at least 3-5 mm
- Hemorrhage control – sterile saline flush, then apply blunt end of a paper point
    - Hemostatic agents – local anesthetic with epinephrine, oxymetazoline

    - Persistent hemorrhage – remove additional pulp
- Place MTA to stimulate the pulp to form a dentinal layer
- Intermediate layer – glass ionomer or flowable composite
- Restorative closure of opening

It is essential to follow these patients closely, in order to assess the continued vitality of the pulp. Intraoral radiographs taken every six months for the first year or two will allow the practitioner to monitor continued maturation of the tooth. Comparison with both the opposite tooth and previous radiographs will show if the canal continues to narrow, and if the apex continues to mature and close, signs that the pulp and odontoblasts are still alive and healthy. A more subjective evaluation would include the appearance of a dentinal bridge, though this may be less distinct. Certainly, there should be no periapical bone loss, which might indicate pulpal death and infection.

Summary

It is important to be able to thoroughly assess traumatic injuries to the oral cavity and decide when and how to treat. Often, more conservative methods work well, so be sure not to cause more damage with invasive techniques, preserving teeth and occlusion at all times.

Oral Tumors- the Hidden Challenge

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

As we continue to provide optimal care for our patients, including dental care, we are seeing an increase in the senior population of pets. With advancing years comes the increased incidence of oral tumors, though some masses can occur in younger individuals as well. Early detection of oral tumors can be challenging, because they are often not as obvious as more visible tumors. Regular dental care, including home care and professional care, can help increase the potential for detecting any abnormality early in its development, thus improving the chances for treatment.

Detection and identification

Recognition of a lesion prior to any clinical symptoms or signs become apparent is unusual. Typically a patient may present with problems that range from discomfort with eating, swelling, bleeding, changes in the color of the gingival or mucosa, displacement of teeth, or a decrease in grooming (cats). Gross appearance of a mass may offer some clues, but additional diagnostics are needed for accurate identification. Most oral lesions don't exfoliate well, and surface impressions may just contain contaminants. Fine needle aspiration or core needle biopsy may be employed on soft tissue lesions, as long as a representative sample is taken. Often some degree of surgical biopsy must be used, such as an incisional biopsy if the mass is large, or if initial identification is needed prior to staging the disease. An Excisional biopsy may be performed if the practitioner feels the lesion is well enough defined by visual assessment and imaging to be able to remove it all at once.

Juvenile tumors – dog

While many masses are seen in mature or senior patients, there are a few tumors that are known to be found primarily in younger animals

Papillomatosis

This virally induced disease typically consists of multiple, peduncalated, tan to pink wart-like masses of the cutaneous and mucous membranes. Its appearance in younger dogs is somewhat diagnostic, though biopsy of a lesion will show fronds of epithelium. Most cases regress spontaneously, but if they are excessive in number and interfere with eating or cause extensive bleeding, some de-bulking may be necessary. It is thought that the self-limitation occurs due to the animal 'self-innoculating' itself by consuming some of the tissue. Heat-activated autogenous vaccines have been considered, but their use is controversial.

Oral papillary squamous cell carcinoma (OPSCC)

Once thought to be found in dogs less than 9 months of age, additional studies have found this invasive tumor in adults as well. A subtype of squamous cell carcinoma, this tumor can have a variety of appearances, with either a cavitating or non-cavitating appearance. It is found in the maxilla 80% of the time, and frequently in the rostral portion. Treatment is excision with wide surgical margins of 1-2 cm, though in humans, 1 cm has been documented. For those with unresectable tumors, piroxicam has been used palliately, with 46% of patients showing some degree of remission or stabilization of disease.

Odontoma

This group of tumors arise from odontogenic cell lines, either epithelium or mesenchyme. The more classical forms include the complex and compound odontoma, with each containing fully differentiated dental components. The complex odontoma will have tissues found in teeth, but no tooth-like structures, while the compound variety has everything from denticles present to fully formed teeth (sometimes multiples).

The ameloblastic fibro-odontoma (AFO) also arises from odontogenic cell lines, but presents more as osteolysis with mineralization. It requires more aggressive surgical removal, while the complex or compound masses can often be managed with enucleation and intracapsular excision with aggressive debridement of the cyst walls.

Common masses in dogs

"Epulis" – current terminology changes

The term 'epulis' refers to a gingival mass of any type, and previous classifications included fibrous (FE), ossifying (OE) and acanthomatous (AE) epulides, all though to arise from the periodontal ligament tissues. The fibrous and ossifying types have now been grouped in a fibromatous group (some with mineralization) that contain PDL-like stroma and are considered benign. Recent conjecture theorizes that these possibly develop in response to chronic stimuli or inflammation.

Within the fibrous group, focal fibrous hyperplasia (FFH) is an inflammatory, non-neoplastic hyperplastic change without the presence of odontogenic epithelium. When the mass contains rests of odontogenic epithelium, is highly cellular with fibroblastic connective tissue and variable amount of bone and collagen, it is now identified as a peripheral odontogenic fibroma (POF). Similar in components to POFs found in humans, these are most likely to be found in the rostral maxilla, with a higher prevalence in males. They

may not have well-defined borders radiographically, and teeth may be displaced. With surgical excision of 1 cm margins and clean borders, this carries a good prognosis. Recurrence is likely, however if not completely excised.

The canine acanthomatous ameloblastoma (CAA) is also considered 'benign' with cords of squamous epithelium in connective tissue and minimal cell atypia with few mitotic figures. However, it demonstrates aggressive infiltrative growth and can be locally very aggressive, most frequently found in the rostral mandible. Radiographs can show significant osseous changes and expansion into adjacent spaces, and advanced imaging (CT) would be preferred to detail the extent of the invasiveness of the tumor. With the goal of at least 2cm margins for resection, partial mandibulectomy or maxillectomy should be performed. With non-resectable tumors, options for radiation therapy or intralesional bleomycin injections may provide some management.

Melanocytic tumors

Considered the most common malignancy in the dog, these very aggressive tumors are considered to already have micro-metastases by the time the tumor is detected. Up to 1/3 of these are poorly pigmented, so the presence or absence of black tissues is not diagnostic in itself. Early detection is critical to have any chance at tumor management with aggressive surgery with complete clinical staging, lymph node removal and other options of radiation therapy, chemotherapy and even consideration of the vaccine in Stage II and III tumors.

Fibrosarcoma (FSA)

As the third most common tumor in dogs and the second most common in cats, these tumors contain mesenchymal cells, malignant spindle cells and collagen, and are typically gingival in origin. In dogs, these are typically found in large male dogs (sometimes younger) as aggressive local disease with about 20-30% metastasizing. Particularly in golden retrievers, these tumors can appears low grade histologically, yet act high grade biologically with very aggressive local behavior, invasion into bone and metastasis to lymph nodes.

Survey skull radiographs can be helpful to show larger areas of local invasion while advanced imaging such as CT should be recommended for maxillary masses, larger mandibular ones, or ones in the caudal mandible. Margins of 2-3 cm are recommended, with adjuvant radiation therapy, or radiation therapy alone if the mass is inoperable.

Squamous cell carcinoma (SCC)

The second most common tumors in dogs, and the first most common tumors in cats (with three variants), the malignant tumor of the squamous epithelium tends to have more impact locally, with only 10-20% metastasizing in dogs (less if rostral SCC). In cats, the three types are gingival, lingual and tonsillar.

Gingival SCC in cats can be very locally invasive, and while metastasis is less likely, full stagin of the thorax with radiographs and lymph node assessment is recommended. With recommended margins of at least 2 cm, in cats with mandibular masses, mandibulectomy is recommended. Prognosis is better with rostrally occurring tumors. Combinations with radiotherapy, chemotherapy (dogs have more options) and even photodynamic therapy have all been reported.

Lingual SCC is the most common lingual tumor in cats and is often hidden in the sublingual tissues. Cats that have dysphagia, anorexia and are not grooming should always have the tongue examined, particularly the ventral portions. Most are inoperable, as they would require aggressive excision, and most cats would not do well with loss of a substantial portion of their tongue, whether it is rostral or longitudinal. Dogs respond better to near total glossectomy, learning how to eat and drink in a new manner. There are no effective agents for lingual SCC, though piroxicam can provide some palliation.

Tonsillar SCC is more common in dogs than cats, with rapid invasion from the tonsillar fossa into regional lymphoid tissue. This is typically unilateral, but with early metastasis. It is thought that toxins from urban environments may increase the incidence. Full staging is necessary with this tumor and while likely unresectable (with clean margins), excision may alleviate airway obstruction. Chemotherapeutic drugs used in dogs include cisplatin, carboplatin and piroxicam with regional radiotherapy for partial response or palliative management. A recent study in cats with radiation and carboplatin provided more favorable prognosis than previously thought.

Treatment planning

The possibility for early detection provides the best chance for a reasonable success with oral tumors. Intraoral radiographs and skull radiographs can outline where osseous changes have begun, while advanced imaging provides much better analysis of all tissues involved. Biopsy can be used as part of the diagnostic process, whether incisional for initial identification or excisional for a combination treatment and diagnosis.

Incisional biopsy of a small portion of a larger mass, or one that aggressive surgical decisions are needed, can provide valuable information as to the tumor type in order to determine margin placement. In lesions that are possibly FFH (hyperplasia) or POF, excision of the present mass without attempts at wider margins may be all that is needed, or for regular management. With proliferation in the oral cavity, an incisional biopsy may not be representative of deeper tissues, so non-diagnostic histolopathology reports are possible: always consider what the mass looks and acts like, and consider additional attempts.

Excisional biopsy may be performed, with anticipated margins based on physical and radiographic signs. This will not be as accurate as in cases with previous histopathology or advanced imaging, but in many cases, pet owners prefer one surgical procedure. Choosing 1, 2, or 3 cm margins is based on the anticipated tumor type, and is often dictated by the relative size of the patient as well.

Ectomies

When the decision for excisional biopsy has been made, there are a number of considerations to consider when planning the surgical approach. If advanced imaging is not available, over-estimate the extent of the lesion seen radiographically. Since margins are planned on distance away from the tumor edge, larger dog have the advantage of being able to lose more structures before critical areas are reached. Once the extent of excision has been determined, evaluating the area closely for closure options is also important. Adequate release of surrounding soft tissue must be afforded, and at times, (rostral mandibulectomy), sections of soft tissue (lips, skin) might need to be resected to provide a cosmetic closure.

If the tumor is located in them mandibular body, full thickness segmental removal can contribute to instability and drift, and this should be considered in long term management, both for self-induced trauma from the opposite side drifting, as well as TMJ stress. If the mass is on the dorsal portion of the mandible, and the bone is large enough, a rim excision could be considered, removing that portion of mandible dorsal to the mandibular canal. With any cut, the edges should be rounded – for better stability in the rim excision and closure for full segmental removal. Rostral mandibulectomies should always address the extent of the symphysis that may need removal. The structures in the mandibular canal, including the large mandibular artery, should be addressed whether encountered distally or rostrally at the mental foramina.

Hemimandibulectomy may be used for masses that encompass most of the mandible, or the caudal portion, particularly in cats and small dogs. While fairly uncomplicated in cats, TMJ resection in dogs is more challenging. Again, considerations of mandibular drift and contralateral TMJ degeneration should be evaluated.

Maxillectomies can provide a number of challenges, based on the depth of excision required. The palatal artery should be taken into account, from its distal aspect to the rostral branches at the level of the palatine foramina. Any excision that exposes the nasal cavity may have challenges in closure, and with significant rostral maxillectomies, soft tissue reconstruction around the nares can be very difficult. Mid- or caudal en-bloc resections also need to manage the infraorbital canal and structures, as well as the palatal artery and nasal or sinus cavity exposure. Margin delineations need to consider the structures of the zygomatic region, ptyergoid fossa (caudal aspect of the infraorbital canal) and the orbital region.

Summary

Like with other regions of the body, monitoring for any unusually masses is recommended; however, many oral tumors remain hidden until they are quite advanced. Being able to identify the mass accurately to make appropriate treatment plans can have a substantial impact on the prognosis for the patient. Most oral surgeries are possible in most practices, though some might be challenging.

Is Seven the New Senior?
Realities of Senior Care

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

As the pet population continues to get more 'gray', with care that can extend the lifespan of our patients, we have to pay closer attention to issue that can arrive with these mature, senior and geriatric pets. Certainly, monitoring these individuals for medical parameters that can indicate a disease state is crucial, as early detection of any problem, from cancer to diabetes, can be helpful to the outcome of treatment.

What is aging?

In articles, aging is described as "the progressive changes that occur after maturity in various organs, leading to a decrease in their functional ability", and "the sum of deleterious effects of time on the cellular function, microanatomy, and physiology of each body system… not a specific disease, but rather a complex process of genetic, biological, nutritional and environmental factors all contributing to the progressive regression." There is high degree of variability of aging amongst species, breeds, individuals, and even organ systems within an individual. As an individual ages, the physiological reserves of an organ system, or multiple organ systems, are depleted.

While most of these specific alterations and mechanisms are not well defined, on a cellular level, cumulative DNA damage leading to genomic instability, oxidative damage and telomere shortening have all been discussed.[1] Specific organ systems are often evaluated extensively, both on an individual basis (tracking renal function), and on a population basis (looking at the prevalence and risk of chronic renal disease within an age group).

Since the process of aging ultimately results in the demise of the patient, much attention has been given to the trends of aging and relative life expectancy for particular breeds, and in relation to dog size, or healthy weight range for a breed or individual. Since excess weight, taken to the extreme in obese pets, is known to have direct impact on the health of an individual, this should also be taken into account when evaluating a pet.

Relative age

For an owner, and the veterinary staff, the first step is to determine the relative age of the pet, as compared to human years. The old adage of one dog year equaling 7 human years can provide an estimate, but dogs and cats age at different rates, primarily based on their size. Smaller pets have longer expected life spans and giant breeds are often considered senior at 5-6 years of age. Several resources have tables that allow you to determine your pets' relative age – but each animal is an individual, so these are starting guidelines to assess their senior status. Keep in mind, if the pet was adopted as an adult, there is a chance that the age on record might be an estimate, sometimes on the low side, when trying to determine their relative age.

Starting the care early – wellness from maturity

And just because a pet is growing older doesn't mean those twilight years can't be healthy ones. Think of the concept of "healthspan" when dealing with mature pets, not just "lifespan": recognizing changes that are within normal limits for the pet and dealing with those changes that are not healthy. Within that "healthspan", it is important to determine when the level of care for the different life stages needs to be adjusted. According to the AAHA Senior Care Guidelines for Dogs and Cats[1], the comparable start to the senior years in humans is around 56 – 60 years of age, or approximately the last 25% of the expected lifespan of the pet. The clinical screening of healthy pets prior to this stage can set baselines for comparison when the pet's systems being to experience changes. From a chart estimating the relative age of a dog or a cat in human years, this senior stage is reached at around 10 years of age for pets up to 20 pounds, 9 years of age for those between 21 and 50 pounds, 8 years for those between 51 and 90 pounds, and 7 years for dogs over 90 pounds.

Body condition and senior nutrition

Many practices now enjoy assessment of the Body Condition Score (BCS) to determine if a patient is in its correct weight range. Certainly, excess body weight can be accompanied by higher risks of osteoarthritis, diabetes and other metabolic diseases. On the other hand, with aging pets, weight loss can be a significant issue as well. While the basal metabolism rate of dogs continues to slowly decline with age, at around 11 years of age in cats, that decline changes to an increase in BMR, and an increased need for high quality nutrients. This is another reason, besides chronic disease, to also monitor a patient's lean body mass or LBM. By tracking both BCS

[1] J Am Anim Hospt Assoc 2005; 41: 81-91.

and LBM, nutritional adjustments can be made for that particular patient's needs. In some older cats, increased protein of a high quality might be recommended in the absence of renal failure. In fact, even in renal cases, dietary protein levels do not cause or alter the course of kidney disease. Low dietary protein only decreases the symptoms associated with kidney failure, not slow it or cure it. Geriatric pets require the same or more protein than younger animals, especially active seniors. Old pets may be special, but not with regards to protein.

Other conditions may require nutritional adjustments as well, from sodium restriction in cardiac disease to special gastrointestinal needs or an increase in antioxidants. Unfortunately, there are no specific guidelines from AAFCo for senior nutritional needs (as there are for growth vs maintenance), so the wide variation in nutrients can be quite confusing.

Mobility/exercise/enrichment

If a patient has a high BCS, managing the diet might be accompanies by increased exercise, but it is important to do a full evaluation on the musculoskeletal health of the individual. If they are already overweight, osteoarthritis may limit their mobility, and this has been identified in many dogs and even cats. Starting an exercise program gradually, with supplements or medications to ameliorate any discomfort can help that patient reach an ideal weight much more quickly. Exercise and environment enrichment (that can also adjust food intake appropriately) is also thought to help with the patient's overall health and attitude.

Cognitive dysfunction

As many pets age, there can be a noticeable change in activity and attitude and in some pets, certain signs may not be attributable to a medical cause, and "he's just getting old" isn't enough of an explanation. Just as in humans, dogs and cats can experience diminished cognitive function, beyond what can be expected in the normal aging process. The **DISHA** acronym found in many publications can help alert you and the client to potential issues:

- **D** – Disorientation – may appear lost. confused
- **I** – Interaction – may not respond to familiar faces, or be clingy
- **S** – Sleep-wake cycles – sleep more during day, less during night
- **H** – Housetraining – eliminates inappropriately
- **A** – Activity levels – aimlessly wanders or decreased focus

Cognitive Dysfunction Syndrome (CDS) can be devastating to a family, when their life-long friend is disoriented, gets 'lost', forgets housetraining, doesn't interact with others, or has a disrupted sleep cycle that can impact everyone. Most of the previous studies and data have been focused on canine patients, and while many of the signs are similar, excessive vocalization, irritability and decreased self-hygiene seem to be more prevalent signs in felines. This new emphasis on feline patients is supported by is a recent study that investigated cognitive decline in cats. Behavior modification, environment enrichment, various supplements and even prescriptions can help decrease some of these signs, but the best results are found with earlier intervention

Dental health

Dental care and senior care often go hand-in-hand, as dental disease can affect appetite, comfort levels and associations with organ disease. Using the need for dental care is a reason to complete diagnostic recommendations, and when a thorough senior health care check has been done, that can be a good time to catch up on dental care.

Senior care programs

There are many recommendation for starting and implementing senior care programs, but one important aspect that is often overlooked is the ability to measure how well your program is performing, or if you have met the goals you set at the beginning. Here is an example of one approach:

- Bi-annual exam
- Annual CBC, U/A, chemistries
    - Mini-chem at 6-7 years of age (or at 'mature' status)
    - Full chem at 8-10 years of age (or at 'senior' status)
    - Add in Thyroid profile for cats at 8, dogs at 10
- Add in disease related
- Chest radiographs, ECG
- Behavior and Nutrition counseling

If you are just starting a senior wellness program, trying to do too much at once can be challenging and some client might be resistant.

- Sudden introduction with additional costs may be challenging to implement
    - Phased-in program with Mature Wellness first
        - "Silver Elite" status

- Step-up to Senior Wellness with more comprehensive evaluation and testing
  - "Gold Elite"
- Promotion to Geriatric Care – likely with disease related therapy
  - "Platinum Elite"

Diary – daily functions

- Body condition, skin condition, masses - photos
- Appetite – increased, decreased, change in food type preference, difficulty prehending, chewing, swallowing?
- Water consumption/elimination – increase, decrease, change in habits?
- Activity –amount, frequency, type
  - Encourage interaction
- Alertness – Cognition or sensory (sight, hearing?)
- Sleep patterns – increased, decreased, change patterns, vocalization
  - Resting parameters – respiratory rate, cardiac rate
- Senses – sight, hearing
- Comfort level – watch gradual changes, response to medication
- Regular pictures for comparisons

Client education and involvement

The key for having a successful senior care program – and healthier senior patients – is getting the clients involved with every stage of patient care; and that takes education. Discussing wellness and preventive care throughout the pet's life stages will help prepare the owner for the increased needs as their pets' age. Using the tools such as the Daily Diary will keep the owner aware of gradual, subtle changes, and can help prepare them when those changes add up to conditions that need management. Working as a team, with the owners' input and clinical diagnostics and therapies, will help provide optimal care for your senior patients.

Senior Dental Care:
Never too Old for Good Dental Health

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

It has been shown that periodontal disease increases in prevalence as age increases, and as body weight decreases (small dogs vs large dogs). With any chronic process, particularly one with loss of tissues (gingival and bone), the disease is likely to get worse without intervention until the final phase of periodontal disease, which is actually tooth loss. The co-influence relationship of dental disease with diabetes and even renal disease underscores the importance of addressing issues in senior pets before they cause more problems.

Senior dental issues

Periodontal disease has in increased incidence in older pets, as does any of the conditions that can increase over time, such as tooth resorption or stomatitis in cats. Extensive periodontal disease that has destroyed mandibular bone at the level of the first molar can lead to pathological fractures, sometimes bilaterally, that have insufficient osseous structure for stabilization. Older cats may exhibit a thickening of the alveolar bone surrounding the canine teeth, especially the maxillary ones, with a concurrent super-eruption of the teeth, making them look longer than normal. This chronic osteitis/alveolitis may be minor, with periodontal management sufficient for treatment. If the tooth is mobile or the surrounding tissues inflamed, extraction may be the best route.

Oral tumors are also seen more frequently in mature/older patients, and early detection and identification of any mass can provide the only possibility for adequate management. In dogs, melanocytic tumors, fibrosarcoma and squamous cell carcinomas (SCC) are some of the most frequent types found, while the three forms of SCC (gingival, lingual, tonsillar) are the most common types found in cats.

Treatment concerns

Yet, as the increase in periodontal disease would warrant professional care, it is the presence of the co-morbidities that can make the necessary anesthetic procedure potentially riskier. In very few instances is the level of disease so severe, or unresponsive to management, that the dental care should be avoided completely. Most cases can be evaluated pre-operatively to identify underlying issues, and those identified disease processes can be treated to return the patient to a more stable level, to decrease the risk an anesthetic procedure would entail. In each patient, the risk of retaining the dental disease its potential effects on the rest of the body typically is outweighed by the benefits of treatment.

Individualized treatment plans are essential for senior and geriatric patients: from the pre-operative evaluation and stabilization therapy (if needed) to the immediately pre-operative period and peri-operative time frames. Many comparisons can be made to guidelines for human patients for dental procedures, including the benefit of pre-operative laboratory screening, but we have to realize that our patients can give us details on how they are feeling. In fact, dentistry and blood work can help support each other's efforts: if a recent senior screening has been done, that might be a good time to get dental work accomplished, and if dental care is needed, it is a good time to update that patient's lab work profile (especially if it has been declined in the past). While not always common, it is possible to pick up on underlying, inapparent disease of a patient when doing the pre-op screening.

For those patients in the mature-senior-geriatric categories, utilizing the patient anesthetic risk classification is a good starting point for evaluation and for determination of what level of assessment should be done. ASA levels of I and II might require basic blood work, UA and ECG, while adding additional chemistries to the levels III-V. Monitoring urine output (1-2 mg/kg/hr) is seldom done, but can provide beneficial information.

Pre-operative medications often play a role in these patients, including evaluating what medications could have an impact on anesthetic and analgesic drugs utilized. Decisions may have to made about what medications need to be given on the day of the procedure, and how fasting may influence diabetic patients. For most patients, while food should be taken up the evening before, small amounts of water can be given until they are admitted to the hospital.

Antibiotic use and selection will always generate plenty of discussion, and again, while human dental recommendations are to be considered, adding in the complications of anesthesia, with possible hypovolemia, hypotension and hypothermia, should be considered in each patient. If it is determined that the individual has some systemic risk (cardiac disease, borderline renal disease, etc), it may be appropriate to use a broad spectrum antibiotic (such as amoxicillin-clavulanic acid) just prior to the procedure, or to consider interoperative administration of an IV ampicillin/amoxicillin. In some patients with extreme dental infection, prior use of an antibiotic such as clindamycin has greatly improved the health of the dental tissues, and also the patient, in this author's opinion.

Pain management

Another very important aspect of dental care is pain management. By customizing the analgesia and anesthesia protocols for each patient, appropriate use of pre-operative agents can reduce the anxiety and stress on the patient in the pre-operative stage, which could

have a positive effect on stress-induced immunosuppression. With good pre-operative, multi-modal analgesia, combined with local and regional blocks, the level of general anesthetic needed for the patient can be reduced significantly. If NSAIDs are chosen (renal-healthy), perfusion with fluids is important.

For local and regional blocks, the total dose should be calculated, particularly in small dogs and cats. Bupivacaine (0.5%) premixed with epinephrine (1:200,000) provides a longer time for analgesia, with some hemorrhage control, but should not be used in cases with contraindications (cardiac arrhythmias, hyperthyroidism). It also needs to be placed 10-20 minutes before the extraction or periodontal procedure for maximum effectiveness. Lidocaine doesn't last as long, but does provide quicker analgesic effects.

Patient care

Perfusion before and throughout the procedure is critical in dental anesthetic cases, to maintain adequate blood volume, particularly for renal function. An initial bolus (5-10mg/kg) may be provided preoperatively, with 5-10mg/kg/hr for a maintenance dose. Cardiac patients might have a decreased fluid capacity, so monitor patients closely for any signs of overhydration, including increased pulmonary sounds or even monitoring HCT. This interoperative replacement of fluids will offset loss of water by evaporation, third space losses into traumatized tissues, and even volume replacement for hemorrhage loss in some cases.

Maintain body temperature in dental cases can be quite challenging at times: most are older, smaller, and the oral cavity is constantly wet, or being rinsed. Geriatric patients in particular can have exaggerated hypothermia with a decreased basic metabolism rate. Body temperatures less than 98 degrees can alter mentation, the immune competency of the patient, and can affect wound healing. Decreased body temperature can also impact recovery time. Keep the patient as dry as possible and provide patient warming devices where appropriate. Passive and active surface rewarming with warm water blankets, air warming devices or conductive fabric blankets can be helpful, as can active core rewarming with warmed isotonic fluids.

Patient monitoring

The reason we have more confidence in safer anesthesia events is the combination of individualized analgesia/anesthesia protocols and the level of patient monitoring that can be provided. General anesthesia depresses many systems of the patient that may already be compromised: respiratory, cardiovascular, CNS, thermoregulatory, hepatic and renal, to name a few. Monitoring should be constant throughout the procedure, and into the post-operative period as well, where most unexpected deaths occur.

With all the advances in monitoring equipment available, the best monitor is still a good technician. Observation of general parameters, in addition to readings from monitoring equipment can provide the best assessment of the depth of anesthesia, or when changes indicate a need for intervention. Heart rate and respiration recorded every 5 minutes can be combined with pulse oximetry, blood pressured, CO2 levels, body temperature and continuous ECG readout. CNS evaluation of the muscle tone of the jaw and eye position/palpebral reflex are more subtle indicators of anesthetic depth.

A dental procedure can sometimes be lengthy, and in particular with older patients, this can lead to concerns about decreasing body functions as the time goes on. Maintaining perfusion and blood pressure with fluids can decrease body temperature, as can moisture associated with the procedure. Anesthetic levels should be kept to as low of a level as possible to help maintain blood pressure, without waking the patient. There are situations, either due to the patient's body systems, the length of time needed, or the extent of treatment needed that could necessitate 'staging' the procedure and completing a portion of the surgery at a later date.

Emergency situations should be anticipated ahead of time with printed protocols for the common drugs that may be needed in such events. Regular monitoring should consider any trends in parameter changes that could precede an emergent event, and if patient response is inadequate, immediate recovery should be instigated.

Recovery

Patient management and monitoring should not end when the anesthesia is turned off, or when the endotracheal tube is removed. In fact, since the patient is not observed as closely as during the peri-operative period, the recovery time is when many adverse events happen, sometimes leading to patient death. Brachycephalic patients in particular should be closely monitored, as the challenges to their air passages return once the tube is removed, so the tube should remain in place for as long as possible. Any swelling, hemorrhage or pain flare-up can add to the morbidity of the case. In patients with emergent delirium, a very low dose of dexmedetomidine may be administered (if not contraindicated) to help relieve the anxiety, stress and pain for a smoother, slower recovery. If a patient show significant pain beyond that, additional opioids may be required.

If a patient had issues with hypotension, fluid administration and even inotropes may be considered in the post-operative period, with close monitoring. Bracycardia may be present due to the effects of anesthesia, as well as any prolongation of hypothermia. If any medication (alpha 2) was used, a reversal agent would be recommended, and an anticholinergic may be used, with caution. Providing a safe means of keeping the patient warm – and dry - is also recommended.

Monitoring urine output, either a specific measurement, or encouraging conscious voiding, can assess if addition fluids are needed. With smaller patients, and certainly those with diabetes mellitus, monitoring blood glucose during and after anesthesia can point out those that might need supplementation.

Post-operative

Returning the patient to normal function as quickly as possible helps in the recovery process. Post-operative medications from analgesics to antibiotics should be discussed with the owner for proper administration. Eating and drinking small amounts should be encouraged that evening, though the food may need to be softened for a period of time after the procedure. Supplemental feeding may be necessary, to include anything from syringe feeding to a peg tube, depending on the case. Phone recheck the next day and a physical exam in two weeks allows for continued monitoring of the patient with plans for ongoing management.

Summary

While senior pets may present with particular circumstances that make anesthesia planning more complicated, in most instances appropriate patient evaluation and care will provide the opportunity for good dental care. If dental health can be improved in a senior patient, their overall health is likely to improve as well.

Interactive Oral Radiograph Reading Session

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

The use of intraoral radiography is critical in being able to accurately diagnose oral and dental disease, to assess the results of treatment, and to monitor therapy success in the long run. While films don't have to be perfect to be diagnostic, adequate technique is necessary to be able to determine if changes are present. Practice in taking radiographs can increase the quality of the images provided, and practice in reading the radiographs taken will improve diagnostic skills.

Identification of teeth or region

Most digital intraoral radiography software systems have precise ways of taking images to correspond with the appropriate teeth. While this is very helpful in record keeping, if anesthetic time needs to minimized, or if images are unlabeled or mislabeled, it is important to be able to identify a tooth or structure in any image taken.

With actual digital films, part of this identification process deals with how the film is placed in the mouth. A dot is embossed on the film (through the packet), so the raised dot faces the xray beam source. In reviewing hard films, placing the film so the raised dot is facing you orients the image in the same way as digital films are viewed, as if you are looking onto the outward surfaces of the patient. Having models or skulls are helpful guides when starting out, until you become familiar with structures, including the differences between maxillary and mandibular images.

With either digital or actual films, there are a few quick steps to take to be able to identify what teeth are being viewed:

- First, orient or rotate the film/image until the roots are pointing in the appropriate direction
  - Maxillary roots pointing up
  - Mandibular roots pointing down
- If the teeth imaged are incisors or canines – "Shake hands"
  - The patient's right is on your left, and vice-versa
- If the teeth images are premolars and molars -
  - Ask – "which way is the nose?"
  - If the nose is to the right – it is the right side, and vice-versa
- It is VERY important to only rotate the image digitally – NEVER "FLIP"
  - Flipping the image – horizontally or vertically – reverses right and left
- However, for images taken with the sensor or film placed extraorally:
  - Then right and left are reversed
  - This should be noted on the film/image that it was taken extraorally

Know normal

By reading lots of films/images, you will become more familiar with normal structures of the oral cavity. Superimposition of the nasal cavity, the mandibular canal, foramina and osseous structures such as the zygomatic arch can complicate evaluation of the films. An apex of a tooth superimposed over a less dense structure, such as the nasal cavity or mandibular canal, may give the impression of a wider periodontal ligament space, or even bone loss. This chevron effect should be verified by imaging the tooth on the opposite side, or taking multiple views at different angles. Further evaluation for tooth vitality, such as transillumination, can provide additional input. Imaging both sides can also help identify lucencies that may appear as lesions that are actually mental foramina. Adjusting technique and angles to 'move' the zygomatic arch away from maxillary premolars can allow you to visualize certain tooth portions better.

Evaluation of periodontal bone

In the evaluation of periodontal disease, it is important to be able to assess the extent of periodontal bone loss, as well as the type of bone loss. This information, along with probing depth and visual assessment, will give a complete picture of the staging of the disease for that tooth or region, and will guide treatment decisions. Each tooth in a patient's oral cavity can have a different bone loss pattern, and the pattern can differ from root to root of the same tooth.

- Stage of disease – with each subsequent stage of disease, there is an increase in the percentage of attachment loss, which included bone
  - Stage 1 – no attachment loss
  - Stage 2 – up to 25% attachment loss
  - Stage 3 – 26 to 50% attachment loss
  - Stage 4 – greater than 50% attachment loss

- Type of bone loss
  - Crestal bone loss – initial loss of the rounded alveolar crest in between teeth
    - There is typically little periodontal pocket formation
  - Horizontal bone loss – bone loss proceeds in a linear fashion across a tooth or several teeth
    - If accompanied by gingival recession, roots can be exposed, and even the furcations of multi-rooted teeth, with variable extents of soft tissue pockets that will be suprabony
    - If there is no gingival recession, the horizontal bone loss will result in the formation of soft tissue or suprabony pockets
  - Vertical bone loss – bone loss extends down the length of a root or roots
    - This will form an infrabony pocket that can be challenging to access without gingival flaps or surgery
    - If the vertical bone loss extends to the apex of a root, the infection will enter the root canal system at that point and infect the pulp, eventually killing the pulp
      - This may lead to endodontic or apical bone loss of additional roots of a multirooted tooth

Endodontic disease evaluation

There are several ways to assess the health of the endodontic system: if the pulp is exposed by fracture, resorption or caries, treatment (extraction or root canal) must be performed, even in the absence of radiographs signs or lack of transillumination. Discolored teeth should likely be considered to be non-vital, though transillumination may help in the evaluation. The absence of radiographic signs does not mean the tooth is vital, as osseous changes may be very subtle, may take extended periods of time to occur, or may be missed. When present, however, radiographic signs are confirmation of pulpal compromise and can also be used to determine the best course of therapy.

- Apical bone changes – apical periodontitis
  - If the periodontal ligament at the apex is wide, this may be an early indication that infection or compromise is present
  - The typical 'mushroom' area of bone loss – often termed an apical abscess – won't be found in every case, and in theory, cannot be termed an abscess unless histopathology or culture is done. Some lesions could be sterile granulomas
  - Chronic lesions may also show resorption of the root itself
    - Significant changes would decrease the likelihood that an endodontic treatment would be successful, so extraction may be needed.
- Canal width – normal aging changes includes a narrowing of the pulp canal as the dentinal walls increase in width with a healthy pulp and odontoblasts
  - A wide canal, in comparison to a relatively more narrow canal of a similar tooth, may indicate the pulp became non-vital at some time in the past (the tooth stopped growing)
    - This comparison is used to assess teeth that have sustained injury (pulpitis) or have been treated (vital pulpotomty) to make sure they continue to mature
  - Internal resorption – irregular areas of wider canal
    - Indicative of an inflammatory process occurring in the pulp – likely non-vital or compromised
- Combination periodontal and endodontic diseases
  - Type 1 Perio-endo lesion – an initial endodontic lesion at the apex extends up the root length coronally until it reaches the base of the sulcus (J-shaped)
  - Type 2 Perio-endo lesion – an initial periodontal lesion (deep infrabony pocket) extends down the root to the extent that the infection reaches the apex of the tooth and the infection compromises the pulp; a periapical bone loss pattern may occur on other roots of multirooted teeth
  - Type 3 Perio-endo lesion – concurrent periodontal lesion and endodontic lesion – either separate or eventually coalescing

Tooth resorption

While classically thought of as feline odontoclastic lesions (FORL), the term tooth resorption (TR) refers to any resorptive or erosive lesion of the hard tissues of the teeth (enamel, dentin, cementum), internal or external, dog or cat. Both the type and extent of resorption should be determined radiographically. (AVDC Website)

- Severity of resorption
  - Stage 1 – mild dental hard tissue loss (cementum or enamel)

    - Stage 2 – moderate dental hard tissue loss (cementum or cementum and enamel with loss of dentin) that does not extend to the pulp cavity
    - Stage 3 - deep dental hard tissue loss (cementum/enamel/dentin) – extends to pulp cavity but most of the tooth retains its integrity
    - Stage 4 – extensive dental hard tissue loss, extends to the pulp cavity, most of the tooth has lost its integrity
    - Stage 5 – Remnants of dental hard tissue are visible only as irregular radiopacities and gingival covering is complete (usually odontoclastic)
- Types of resorption
    - Type 1 – focal or multifocal radiolucency is present in the tooth with otherwise normal radiopacity and normal periodontal ligament space
    - Type 2 – there is narrowing or disappearance of the periodontal ligament space in at least some areas and decreased opacity of part of the tooth
    - Type 3 – features of both 1 and 2

Oral masses

Radiographic evaluation of the osseous tissues surrounding any oral mass can be important in trying to determine the extent of involvement of the mass beyond visual review. Full skull radiographs can be helpful to look at broader involvement or extensive into parts of the calvarium. Advanced imaging is preferred for complete evaluation, as radiographic changes may be subtle or less apparent in some aggressive tumors. Tooth position should be compared to other teeth, or to a model, skull or other radiographs if an entire region is involved. Any tooth displacement may indicate a more aggressive lesion. The extent of osseous destruction or proliferation should be noted, including the pattern of excessive bone production.

TMJ

While the temporomandibular joints of smaller patients may be imaged on dental radiographs, even the smaller sensor, standard survey films of the entire skull would be an simpler method of evaluating the TMJs bilaterally for comparison. Open mouth technique, dorsal-ventral or ventral dorsal views, and oblique films can be taken for full evaluation.

Extractions:
Headache or Triumph?

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

Extraction decisions

Sometimes it is easy to decide when to keep a tooth and when to extract, but at others time, the choice is not as obvious. Of the three criteria to evaluate, examining the tooth in question is the first step. If periodontal attachment loss is greater than 50% or the pulp is compromised or there is extensive tooth resorption, then it is typically best to remove. If periodontal disease is moderate, then you consider the relative importance of the tooth and if the disease around it can impact a more strategic tooth. For instance, if either the fourth premolar or second molar adjacent to the large mandibular first molar can compromise the health of that important tooth, it may benefit the patient to extract the smaller tooth, thus giving better access to treat the adjacent surface of the first molar. The same would apply to the mandibular third incisor or even the maxillary third premolar. If the decision is still up in the air, the health of the patient is to be considered: any patient with an ongoing systemic issue (heart murmur, diabetes, renal disease) would likely benefit more from an extraction that will remove the source of infection in one visit, as compared to extended anesthetic times and more frequent procedures. And third, consider the owner: if an advanced periodontal procedure or root canal is to be done, are they willing to consider the additional expense, and be committed to thorough home care and regular re-treatments? If not, then again, extraction may be optimal

Requirements

Equipment

- Periosteal elevator – Molt #2 and Molt #4 – for elevating flaps
- Means of sectioning –
    - High speed handpiece/unit is preferable, but sectioning teeth can be done with a lowspeed unit, just have someone dripping water on the site for cooling
        - Set up regular maintenance schedule, including daily oiling
    - Sectioning burs – replace regularly, they get dull quickly
        - 700L – dog teeth
        - 699 – cat teeth
        - #2 or #4 – round burs for alveoloplasty
- Dental elevators
    - Winged, not too thick – to fit in the PDL space
    - SHARPEN on a regular basis, even during the procedure
        - If used and sharpened regularly, they will wear down and will need to be replaced
- Dental luxators – thinner, more delicate – be careful not to bend
- Extraction forceps – small breed
- Blade – 15C
- Suture – 4-0 to 5-0 poliglecaprone
    - Reverse cutting for dogs
    - Tapered for cats
- Magnification – better posture

Pain management

Apply general principles of surgical pain management to every dental patient, even if not performing extractions. Pre-operative analgesia with opioids, alpha 2 agents,and NSAIDs when appropriate, with post-operative dispensing of NSAIDS, opioids. Peri-operative regional, local and splash blocks can minimize the amount of general anesthesia used, help keep the patient more stable, and provide better post-operative analgesia for a smoother recovery. While lidocaine and bupivacaine can be mixed, if surgery sites are identified early in the procedure, use bupivacaine alone if it can be administered 20 minutes prior to extraction. Bupivacaine with 1:200,000 epinephrine premixed will provide longer analgesic effect and reduce bleeding. Watch total dose, not to exceed 1 mg/kg for cats and 2mg/kg for dogs.

Regional blocks can be very effective when placed accurately and not causing damage. Adequate training should proceed any attempts on patients, as nerve damage can result. If a regional block cannot be placed (infraorbital on brachycephalic, inflamed purulent tissue, etc), then at least place a linear local block in the alveolar mucosa above/below the tooth, and you can place additional material directly at the site when open (splash block).

Radiographs

Extractions are one of the major reasons to use intraoral radiographs, particularly when challenging procedures are encountered. Pre-operative radiographs should be closely evaluated to determine the presence and condition of the periodontal ligament (PDL), as this is the structure that elevation attempts to impact. If there is no periodontal ligament space, indication of ankylosis or even tooth/root resorption, then elevation will not go as planned. Radiographs will also alert you to abnormal root structure (or number), and if there is any compromise to the jaw strength. Radiographs will not always be decisive in evaluation teeth with compromised pulps, so use transillumination and examination to assess those teeth. Post operative radiographs are a good medical and legal record, to show the correct tooth was extracted completely, without any complications (root tip, fractured jaw).

Steps of extractions

Flaps

With few exceptions (very loose incisors, premolars where envelope flaps are sufficient), most extraction sites benefit from full thickness mucoperiosteal flaps with releasing incison(s).

- Flap design – broad base, not directly over bone defect if possible
    - Extend releasing incision just past mucogingival junction, into alveolar mucosa
    - Maxillary canine – two releasing incision
    - Maxillary fourth premolar – one releasing incision mesially (rostral)
    - Mandibular canine – T- or Y- shaped distal incision, mesial incision
        - Follow the 'path' of the root – angled lingually
        - Elevate buccal flap completely
        - Elevate lingually to expose distal aspect of root
    - Maxillary first molar – if extracted on its own, a flap will not be reasonable
- Flap elevation and release
    - Debride gingival margin before elevating – cut 1-2mm away
    - Periosteal elevation to lift full thickness flap off of bone – past MGJ
        - Only elevate as far as you need for adequate access
    - Use blade or iris scissors to snip the fibers of the periosteum on the under side of the flap

Alveoloplasty/sectioning

- Maxillary Canine
    - Make a groove at mesial and distal aspects of the root – place for elevator – to the widest part of the root, then connect across
- Mand Canine
    - Remove bone from buccal, distal and lingual surfaces, as well as a groove at the buccal-mesial aspect
- Multi-rooted teeth
    - Shave away buccal bone until furcation is visualized
    - Using crosscut fissure bur – section from furcation through the crown
        - Max fourth premolar – one cut from furcation into developmental groove; second cut from furcation mesially to remove 'diamond' shaped piece of crown
            - Access to furcation between two mesial roots now visible, section those two apart
        - Mand first molar – section from furcation to just past mesial crown, but not at too much of an angle
        - Max molars – section palatal root away from two buccal roots, then separate the two buccal roots

Elevation – the goal is to fatigue the periodontal ligament to the extent that the tooth can be elevated from the socket

- Advancing the sharpened tip of the dental elevator down the root, in the periodontal ligament space, with rotational hold, is the best force to use
- Elevating in between crown portions with the fulcrum of force below the alveolar ridge – teeth may break
- Elevate tooth/section against adjacent tooth – make sure that tooth is very stable
- Gently grasping the tooth/segment with the extraction forceps and putting rotational force can help fatigue the ligament and/or tell you where you need further elevation
- If there is no movement and Radiographically the PDL was healthy, remove more buccal or interseptal bone.
    - In the maxilla, additional buccal bone removal is reasonable (window washer movement of the bur on the bone surface)
    - In the mandible, particularly of small dogs, preserve as much buccal bone as possible (cortical bone)
        - To access adjacent roots, remove one first, then remove the cancellous bone that was in between the roots to get better access for elevation without having to remove buccal bone
- Once fully elevated, radiograph to confirm

Finishing

- Elevate the lingual/palatal mucosa once the tooth is gone for better exposure for alveoloplasty and to facilitate suturing
- Smooth any rough edges of the alveolar bone (alveoloplasty)
- Curette any debris or infected tissue from the alveoli
- Determine if any bone graft material is needed
- Small breed dog – mandibular canines and first molars, incisor?
- Osseconductive or promotive?
- Scarify any epithelial edges
- Simple interrupted, bite through palatal, lingual mucosa first, then buccal flap

Complications

One of the most important resources in performing extractions is a load of patience. As soon as you lose focus or are distracted, that's when you hear the 'crack'. If that sound is a root tip breaking off, go through these steps to manage the situation:

- On radiographs – was the PDL intact and healthy
    - Elevation should continue – more bone may have to been removed
        - Buccal bone removal at maxillary teeth – 'shave' the cortical bone away to expose the root further
        - Mandibular teeth – try to preserve buccal bone, but remove the cancellous bone that was in between the teeth for better access
        - Palatal root – dig a trench around the root and make sure there are no overhangs
    - If there is any periapical bone loss (and the pulp is dead or infected), the root HAS to come out
        - Avoid aggressive elevation toward the apex – the root could punch through into the nasal cavity or mandibular canal
        - Work the root tip from side to side – use a root tip pick
- If the root tip goes into the nasal cavity or mandibular canal, every effort should be made to remove it THEN! – this is your best chance to remove it while it is still loose and not encased in scar or fibrous tissue
    - Take radiographs at several angles to localize where the tip is
    - Open the hole it pushed through even more (watch for important vessels)
    - If you can gently grasp it without damaging other structures, attempt to do so – but it will usually move further away
    - Once the hole is wider than the root tip without overhangs, uses copious water to flush the area, and adjust the head to allow ventral drainage
    - Many times you won't even see the tip flush out – so re-radiograph often.

If you hear the big 'crack' – the jaw breaking – hopefully you had pre-operative radiographs and have told the owner that the jaw could be fragile. If this is a pathological fracture due to extensive periodontal disease, it will be a difficult area to stabilize, as the affected teeth usually have to be extracted anyway. Sometimes a partial rostral mandibulectomy is the best option for the patient.

Tooth resorptions

The term Tooth Resorption (TR) is now used to describe any level of root and/or crown erosion or loss due to a variety of processes. While this is most commonly seen in cats, dogs can also exhibit signs of TR. The 'typical' tooth resorptive lesions that are diagnosed are those in cats, frequently in the premolars (mandibular third premolar) where radiographically it appears as if the root is being turned into bone. This odontoclastic lesion is a Type 2 TR, and should be distinguished from the less common Type 1 inflammatory lesion. The inflammatory lesions may appear similar to odontoclastic lesions in the physical appearance of the crowns (some crown loss with gingival tissue growing into the defect), but radiographs will show roots with intact periodontal ligament space(s) and intact roots, other than where the resorption is taking place. If this type is diagnosed, careful extraction of the entire root(s) is necessary.

If the radiograph shows root structure that is not distinct, with no clear periodontal ligament (PDL) space (as the root is being converted into bone, the PDL space is obliterated), and if there is no indication of apical bone loss or infection, then a modified extraction technique may be appropriate. While some of these roots can still be gently elevated, if the PDL is damaged, elevation will not be able to fatigue the ligament for extraction. If this is the case, after radiographic evaluation and initial attempts at elevation result in the crown breaking off, the modified technique may be done: remove the remainder of the crown and coronal aspects of the root (if possible), and smooth the alveolar bone before suturing the gingival closed. These areas should be radiographed post-operatively, the client should be informed that there was intentional root retention of the resorbing roots, and that the patient should be monitored for any persistent inflammation in the area.

Post-operative

Most patients benefit from appropriate pain medications, and some may require antibiotics after the oral surgery. Depending on the extent of surgery, a softened diet may be needed, and in rare instances, supplemental feeding may be needed. Active tooth brushing may be delayed for two weeks, until the oral recheck, but oral rinses and gels may be used immediately post-operatively to help with tissue healing and antimicrobial needs.

Summary

With the right equipment, training and patience, extractions in practices can be successful surgical procedures with minimal complications. Often these patients will clinically be much healthier once the infection in their oral cavities have been managed with extractions.

Intraoral Radiography: Not Just a Fancy Coat Rack

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

Karen Felsted, CPA, MS, DVM, CVPM
PantheraT Veterinary Management Consulting
Dallas, TX

Radiology is a vital tool in veterinary dentistry assisting in diagnosis, treatment planning, and monitoring of oral disease. Diagnostically, being able to assess normal anatomy helps to determine if abnormalities exist, including variations in development (missing or aberrant teeth) or acquired diseases that may affect the bone and tooth structure (CMO, hyperparathyroidism, neoplasia). When determining the possible treatment for problems such as feline cervical line lesions, endodontically compromised teeth and periodontal disease, radiology can help the practitioner make a more accurate assessment. Preoperative radiographs can help monitor extractions by revealing abnormal root structures, impacted teeth, tooth resorptionand ankylosed roots. Post-operative films check treatment success. Endodontics requires several films during the procedure to evaluate routine treatment and reveal complications.

Basics of equipment

Radiographic unit

The most commonly used x-ray generator is a standard dental model, which is either wall-mounted or supported by a mobile stand. There are also hand-held units available for greater ease in transportation or use in multiple sites. Staff should minimize their exposure by standing at least 6 feet from the tube head and always at an angle of 90 to 135 degrees from the path of the primary beam.

Films

Intraoral films provide isolation of a specific tooth with excellent detail, with a non-screen, double-coated emulsion film. The No.2 periapical film is the most commonly used, and is similar in size to most digital sensors. Occlusal films (No.4,) are 2 1/4 X 3 inches in size and often used for imaging the incisal areas, to include the canines of larger dogs, and can be useful for nasal imaging. A raised dot imprinted on the film and packet indicates the side that should face the X-ray tube, placing the concave "dimple" away from the tube. Once developed, this dot helps determine the orientation and identification of the teeth. The film is encased in an inner black paper sheet with a layer of lead foil on the backside that reduces backscatter from deeper oral tissues, all in a plastic or paper cover. These films can be hand developed in small containers in a dark room, using a chairside developer, or an automatic developer.

Direct digital

For convenience, increased use and decreased patient anesthetic time, investing in a digital dental system often pays for itself in a matter of months, and greatly increases the learning curve for new users. While the sensors are not inexpensive, being able to immediately see the image on the computer screen is of great benefit for both diagnostic purposes and to be able to adjust the angulation or technique to get a reasonable image. A downside to direct digital is the single size (No.2) of the sensor.

Indirect digital

As a compromise between standard films and direct digital, indirect digital radiography may be accomplished using phosphor plates that are photostimulatable. The phosphorus sensor uses an image plate that can be reused (the outer sleeve is replaced), then the plate is placed in a scanner, so the image can be transferred to a computer. There are more steps with the indirect method and it takes longer than the direct method, but varying sizes of plates can be utilized.

Technique

There are many ways to teach and take dental radiographs; the author's preference is to have the patient in lateral recumbency and slightly adjust the head position using towels, depending on the image needed. Others prefer dorsal and ventral recumbency for taking radiographs - determine what works best for you and your staff

Parallel

While a parallel technique (film and object parallel with x-ray beam perpendicular) would be ideal to minimize distortion, most areas of the oral cavity do not lend themselves easily to this positioning. The only region where the film can be placed parallel to the teeth is that of the mandibular premolars and molars, with a corner of the film pressing into the intermandibular space. The most mesial (rostral) roots and teeth may not be visible on this view, as the film may be limited by the mandibular symphysis, but aiming the radiographic beam from a slightly rostral oblique position may allow these roots to be imaged.

Bisecting angle technique

For the rest of the teeth in the oral cavity, a parallel positioning is not possible, so, a film is placed as close to a parallel plane to the object (root or tooth) as possible. Remember to place the film so the roots will be imaged, not necessarily the crown. One option is to use a bisecting angle technique for these films by aiming the beam at a line that bisects the angle formed by the long axis of the object (tooth) and the film.

Modified technique

Another way of determining beam position is to first line up the beam (or similar object such as a 2-inch roll of tape) perpendicular to the film. This would result in an image that is too short (shadow of a tree at noon). Next, line up the beam perpendicular to the root (tooth); this image would be too long (shadow of a tree at daybreak). Then, split the difference between these two positions, and the resulting image will be approximately the same size as the object, thus minimizing the distortion (and the beam will be perpendicular to that bisecting line mentioned earlier). Helpful devices, such as connecting two tongue depressors with a pushpin, and using a roll of tape to invisualize where the beam will travel , can help you determine the two positions (perpendicular to film; perpendicular to tooth), so you can aim the beam halfway between the two. This perspective will also help you make appropriate adjustments to an image; if you want to make the image shorter, move the beam to a position more perpendicular to the film.

Challenging radiographs – the cat quick 6

- With the cat in lateral recumbency (e.g. – left side down), take the first image of the mandibular premolars and molar with a parallel technique.
    - If the mesial (rostral) root of the mandibular third premolar does not show, adjust the xray head further ventral and forward
- Take an image of the lower canines and incisors: roll the tongue back into the pharyngeal area to keep the sensor in place better; use the modified technique
- Take an image of the upper canine and incisors with the sensor 'wide' across the palate
    - If you need to isolate the right canine tooth apex better, come slightly off midline
    - Take an image of the maxillary premolars
    - Place the sensor up against the palate
    - Using a tape roll, visualize where the beam would be, if aimed directly perpendicular to the teeth: you will not be coming directly laterally to the maxilla, but slightly from in front
    - Then visualize where the beam would be perpendicular to the film
    - Split the difference
    - The zygomatic arch will always be in the way – if you elongate the image by moving the xray beam more perpendicular to the teeth, the arch 'moves' a little more out of the way.
- Using a clear feline mouth gag (cut part of a tuberculin syringe); place the sensor under the head on the left side (extraoral); the left maxillary premolars will be placed nearly flat on the sensor in this position.
    - Using the tape roll, and angled from the back of the head, look across the arch at an oblique/angle, until you see the palatal surfaces of the left maxillary premolars without the right premolars superimposed over them
        - Make sure the sensor is placed far enough forward and dorsal that the angled beam will go through the teeth and hit the plate.
- 5 of the 6 films are done!
    - Adjust the cat to left lateral recumbency and take the left mandibular premolars

Challenging dog radiographs

- Maxillary incisors – in most dogs with a normal head shape, then ventral portion of the nares will be lined up with the base of the xray cone when positioned
- Maxillary canine apex – palpate where the apex is positioned by running your finger up the buccal jugae to the tip (it is usually somewhere over the second premolar
    - Place the sensor centered at the maxillary second premolar
    - Adjust the xray beam from midline to a slight oblique so the canine is not superimposed over the premolars in the image; make sure it is centered on the spot where you palpated the canine apex
- Maxillary molars – with a skull or model, observe how the molars are in a different 'line' than the premolars
    - Place the sensor in the mouth lined up with the two molars (usually angled in a palatal direction)
    - Aim the beam almost directly onto the sensor (just a slight adjustment)
- Mandibular canines
    - If you place the sensor across both lower second premolars and aim the beam perpendicular to the sensor, you will have both canine apices for good comparison
- Mandibular premolars
    - Since the symphysis restricts the sensor from going far enough forward to get a true parallel image of the first and second premolars, adjust the beam to come from in front of and below the teeth to 'push' them onto the image (or take it extraorally)
- Brachcephalic dogs

- Use extraoral shots as is done for cats

Troubleshooting radiographs

- Teeth are too long, or the apex is not on the film
  - Place the sensor deeper into the palate – you want to see the roots, not the crown
  - Adjust the beam to be more perpendicular to the film – 'shortens' the teeth
- Teeth are too short
  - Adjust the beam to be more perpendicular to the tooth – 'enlongates' the teeth
- Image shows unexpected bone loss (and crowns are burnt out)
  - Decrease time of exposure; if at lowest time, move xray cone an inch or two away from object

Diagnosing and Managing Cutaneous Adverse Food Reactions

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

The ACVD task force on canine atopic dermatitis (cAD) defined cAD as a genetically-predisposed inflammatory and pruritic skin disease, most commonly associated with IgE antibodies to environmental allergens. This author believes that the definition should be expanded to include food allergens with or without IgE involvement. Regardless of the trigger symptoms of cAD may wax and wane leading to confusion as to whether the pruritus improved because of a therapy or in spite of a therapy. It is important to remember that there are many other causes for pruritus in the dog. In veterinary medicine the criteria for diagnosing cAD has evolved over time. Historically 1 of 2 sets of criteria have been used for making the diagnosis of cAD The problem with these previous criteria is the former was never validated while the later had a limited sample size. The most current guideline was proposed by Favrot. Please note that before applying these criteria to a pruritic dog, other causes of pruritus, such as ectoparasites or infectious causes, need to be ruled out. This is the reason you shouldn't use the criteria alone to make a diagnosis of cAD. History, physical examination, diagnostic testing and response to treatment should also be evaluated.

The criteria used to establish a diagnosis of cAD include

1. Onset of signs under 3 years of age
2. Dog living mostly indoors
3. Glucocorticoid-responsive pruritus
4. Pruritus sine materia at onset (i.e. alesional pruritus)
5. Affected front feet
6. Affected ear pinnae
7. Nonaffected ear margins
8. Nonaffected dorso-lumbar

Using these criteria, if 5 criteria are matched, and ectoparasites and infectious causes have been ruled out, the sensitivity and specificity are about 85% and 79% respectively. This means that using only this criteria, a wrong diagnosis will be made about 20% of the time.

Once you have established a diagnosis of cAD it is important to identify triggers that may cause the cAD to flare up. Triggers include

1. Environmental allergens
2. Food allergens
3. Ectoparasites
4. Infectious (bacterial, *Malassezia*)

This lecture is going to focus on food allergens as the trigger.

Food allergy (FA) is recognized as a potential cause of various dermatological and gastrointestinal (GI) signs in the dog and cat. The exact incidence of FA is unknown. However, the term "allergy" is often used indiscriminately. Acquaintance with exact terminology is important when dealing with FA.

The current terminology of adverse food reactions is advised by the "American Academy of Allergy and Immunology" and the "National Institute of Allergy and Infectious Disease." Adverse food reactions (food sensitivity) are divided into two categories: immunological and non-immunological reactions. Food allergy (food hypersensitivity) implies an immunological reaction following food intake. Non-immune mediated reactions are indicated as food intolerance (FI). Food idiosyncrasy, food toxicity, food poisoning, anaphylactic food reaction, pharmacological and metabolic food reactions are all forms of FI.

Clinical signs of cutaneous manifestation of an adverse food reaction (CAFR) are identical to that of environmental triggered cAD. The only clue that the dog may have a CAFR is that there MAY be GI signs present. In regards to an environmental trigger, the only definitive clue is if the dog has a history of seasonal symptoms.

An elimination diet trial (EDT) is the ONLY diagnostic tool that is useful in dogs with suspected adverse reactions to food. *In vitro* testing, biopsies, intradermal skin testing and gastroscopic food sensitivity testing are not reliable for diagnosing FA. Be aware that an EDT doesn't give any information about the underlying immunologic mechanism. Although FI can also be identified with an elimination diet it is generally accepted that most of the animals with adverse reactions to food do suffer from FA if cutaneous signs are present.

The first step in performing an EDT is to identify 1 protein and 1 carbohydrate that the dog has not previously eaten and feed that to the dog for 60 days. No other food, treats, flavored medications, etc should be fed during the EDT. The dog is then re-examined 30 and 60 days after beginning the EDT. If symptoms resolve, the dog is then "challenged" with his original diet, expecting exacerbation of the pruritus within 14 days. Within 14 days of going back on the EDT, symptoms should once again resolve.

What diet should be used to diagnosis CAFR? The choices are a commercial novel protein, a limited antigen or a home cooked diet. A diet can only be "hypoallergenic" if the animal was never exposed to the food components before. The identification of what is truly a novel protein for any given individual is determined by a very detailed dietary history. Because of the enhanced complexity of pet foods, it has become more difficult to compose a suitable elimination diet.

Regardless of what type of diet is used to diagnose CAFR there are a number of potential pitfalls to avoid. A common mistake made during food trials regardless of the diet used is using flavored heartworm preventative. This was reported in an abstract in which there were 12 dogs with natural occurring CAFR to either soy or corn. The author fed a flavored heartworm preventative fed to each dog. This preventative contained pork liver and soy (Interceptor). A clinical score (CS) was assigned based on the severity of skin and otic disease. After 1 pill 10/12 dogs had an increase in CS. In 5/12 dogs the values peaked on day 2 post challenge while in 5/12 dogs it occurred on day 5.

Another potential problem is the use of supplements or medications during the food trial. In a study by Parr et al, the authors tested 7 supplements for the presence of soy, pork, or beef antigens. Three were flavored OTC products and 4 were veterinary therapeutics. All OTC test products produced ELISA results in agreement with their ingredient lists. ELISA testing of veterinary therapeutic products did not agree with either their ingredient lists or product inserts because of other ingredients not listed. In 1 product the "artificial beef flavor" was made using pork liver and 1 arthritis product listed "natural flavors" which was determined to be a spray-dried digest derived from pork liver. Another potential problem identified was administering supplements/medications that were in a gelatin capsules. This is because the gelatin is derived from beef or pork. This lead the authors to recommend that veterinarians contact manufacturers of oral therapeutics prior to prescribing them during a dietary elimination trial to determine the other ingredients in those products that may not be listed on the ingredient list or product insert.

Mislabeling is not limited to supplements. A study was done using 12 dog foods (eleven novel protein diets and one hydrolyzed diet) from five different manufacturers, both international and Italian, for potential contamination by animal origin ingredients that were not mentioned on the label. The food was analyzed using both the official method (microscopy to identify bone fragments of different zoological classes (mammalian, avian and fish) and by polymerase chain reaction (PCR) for the identification of DNA of animal origin. In 2/12 samples the results of both analyses match the ingredients listed on the label. In the remaining 10 samples, microscopy detected bone fragments from 1 or 2 unlabeled zoological classes. In 6/10 samples there were undeclared avian fragments, 5/10 had fish and 4/10 had mammalian fragments. In two samples, microscopy analysis identified a contamination that would have otherwise passed unobserved if only PCR had been used. However, PCR identified the DNA of undeclared zoological class in 2 samples. The conclusion by the authors was that dogs might fail to respond to commercial limited antigen diets because such diets are contaminated with potential allergens. Both PCR and microscopy analysis are required to guarantee the absence of undeclared animal sources in pet foods. Lastly a study by Okuma et al collected 52 commercial dog and cat food products from southern California and on line. They tested the foods for the presence of eight meat species (bovine, caprine, ovine, chicken, goose, turkey, porcine, and equine) using real-time polymerase chain reaction (PCR). Of the 52 products, 31 were labeled correctly, 20 were potentially mislabeled because they either (1) contained meat species that were not included on the product label (16) and/or (2) did not contain meat species that were included on the product label (7) - note some food had both problems. One food contained a non-specific meat ingredient that could not be verified. Pork was the most common undeclared meat species detected. There was also a trend to substitute lower cost ingredients, such as poultry meats, for higher cost ingredients, such as beef and lamb. These studies support the position that before ruling out AFR, a novel protein home-made diet trial should be performed.

An appropriate elimination diet should contain 1 new, highly digestible protein or a diet that contains hydrolyzed proteins. Ideally a homemade diet (HMD) should be fed. This is the type of diet the author uses. A HMD consists of one protein and one carbohydrate. The protein usually is rabbit, venison, goat, ostrich, emu or alligator. White or sweet potatoes, oats, quinoa or rutabaga are appropriate carbohydrate sources. It is mixed 1 part meat and 3 parts carbohydrate and the dog is given 1-2 cups of the mixture/10#. HMDs should not include ANY other ingredients. The dog must not ingest any other food, treats, tidbits, etc including items used to hide medication in. Avoiding gelatin capsules should be attempted. This may be difficult because some medications only come in a capsular form (e.g. modified cyclosporine). The problem with HMDs is that they are nutritionally inadequate for growth and maintenance therefore they are not using in growing dogs or for long term maintenance. Because they are not very calorically dense most animals will lose weight on these diets. If a dog has a body score of 4/9 or less, this author does not use a HMD. Although a HMD is not nutritionally balanced nor complete, supplements are not necessary, nor used, during the short test period. When a HMD is given during a prolonged time, it is recommended to consult a veterinary nutritionist to formulate a balance diet.

Although the gold standard for diagnosing CAFR is a HMD there are circumstances where the author will use a commercial diet instead. Examples include owners who will not cook for the dog, if the dog doesn't tolerate HMDs (typically because of weight loss but some dogs will become lethargic on them or have GI disturbances). They are not fed to growing dogs.

Commercial novel protein diets (NPDs) can be used to diagnosis CAFR and also can be used long term to maintain a dog with CAFR. A variety of NPDs are available for dogs. These diets are readily available but do not have a 100% negative predictive value (false negatives occur 25-50% of the time). A number of studies have demonstrated the problems associated with NPD. In the first study

they fed dogs with proven CAFR either venison/rice, chicken/rice or catfish/rice commercial dog food. When fed the venison dog food 85% of the dogs with CAFR reacted while 52% and 47.5% reacted to chicken and catfish dog food respectively. More recently 3 of 4 over the counter (OTC) dog foods that didn't list soy on their ingredients list had soy identified via ELISA testing. More disturbing was the study that reported 3 out of 4 OTC dog foods that specifically stated "NO SOY" had soy found when ELISA testing was performed. Note that in the same study 2 of 3 hydrolyzed soy diets had intact soy identified.

Commercial hydrolyzed protein diets (HPDs) contain proteins that been enzymatically hydrolyzed to smaller molecules. This reduces the MW of the original protein which leads to a decrease in the antigenicity and allergenicity of the protein. This means that the molecules are too small to evoke a cross binding between IgE on the surface of the mast cell. This prevents degranulation of the mast cell and IgE-mediated (Type I) hypersensitivity. This is a key point, if the CAFR in that dog is not caused by IgE but by some other mechanism (e.g. type IV which is a T cell driven disease) the size of the molecule doesn't not matter and the diet will be ineffective. The optimal MW of a protein hydrolysate in dogs has not been agreed upon. Note that these diets are only partially hydrolyzed. This means that only a percentage of the protein is hydrolyzed- there is still some intact protein remaining. In the humans, peptides with a MW as low as 3000 Da are still capable of an allergic reaction. Free AA are not allergenic, but are not suitable in foods because of their bitter taste, high osmolarity (leading to diarrhea) and very high costs. As with the NPD, HPD are not able to diagnose CAFR in all dogs- they probably miss about the same percentage as the NPD.

Regardless of which diet is used there are a few points to discuss. Many owners believe that food additives (dyes and preservatives) are common food allergens in dogs, yet there has not been even 1 published case report documenting this. The length of time for the diet depends on the dog's response or failure to respond. It should be continued until clinical signs resolve OR 60 days, whichever is shorter.

Which ingredients cause the most reactions? In 265 dogs reported collectively by 12 different studies, beef, dairy products, and wheat accounted for two thirds of reactions. Reactions to corn, pork, rice, and fish were rarely reported in dogs. In the April 2013 issue Veterinary Dermatology a letter to the editor reported the most common ingredients causing CAFR in 330 dogs- beef, dairy, chicken and wheat accounted for 78% of the reactions. Of 56 cats reported collectively by 10 studies, beef, dairy products, and fish accounted for 80% of reactions.

Maillard reactant products are formed when proteins are cooked with carbohydrate. They can increase or decrease the allergenicity of proteins, depending on the food component. This phenomenon may explain the apparent increase in allergenicity of proteins in commercial pet foods compared to fresh proteins. Because of this, the author suggests that when preparing the HMD the protein and carbohydrate should be cooked in separate pots.

Autoimmune Skin Diseases

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

Pemphigus

Pemphigus foliaceus (PF) is the most common form of pemphigus and is probably the most frequently diagnosed autoimmune skin disease (AISD) affecting cats and dogs. In general, PF is a disease of young to middle aged animals. Any dog may develop PF but Chow Chows and Akitas have a higher incidence in the author's practice.

Historically, the owner may report that the lesions wax and wane or are progressive. The progression of the disease may be slow, especially cases with only facial involvement, or the dog may develop acute eruptions (most commonly associated with generalized disease). With the generalized form the dogs frequently will be febrile, may have limb edema and have constitutional signs. Pruritus with any form varies from non-existent to moderately intense.

There are 3 primary distribution patterns of PF -facial (most common) form which involves the bridge of the nose, nasal planum, periorbitally, pinnae (especially in cats); a footpad form (cats may present only with paronychia) and a generalized form where lesions usually begin on the face and then spread.

Because there is involvement of the hair follicles, multi-focal to diffuse alopecia is frequently present. The primary lesions of PF are large nonfollicular pustules (there are also follicular pustules present). The pustules that are present in a bacterial pyoderma usually involve the ventral abdomen and/or trunk and are much smaller than those seen with PF. Other lesions include epidermal collarettes, yellow brown crusts and erosions.

Differential diagnosis would include any pustular, crusting and scaling disease such as: pemphigus erythematosus; zinc responsive dermatosis (especially with foot pad involvement); metabolic epidermal necrosis (especially with foot pad involvement); bacterial and fungal (dermatophytosis) infections; demodicosis, DLE (facial/nasal form); erythema multiformae; mycosis fungoides; Leishmaniasis; and sebaceous adenitis.

Diagnosis

A cytologic prep of a pustule or crust should be performed. Microscopic findings would include acantholytic keratinocytes, either individually or in clusters, surrounded by NON-degenerative neutrophils and/or eosinophils- bacteria should not be seen. Histopathology is the only definitive means to diagnose pemphigus. An intact pustule (or if none are present, a crusted lesion) should be biopsied. Infectious diseases that produce proteases, such as a bacterial pyoderma or a dermatophyte infection (Trichophyton mentagrophytes), can breakdown the intracellular glycoproteins (desmoglein) leading to acantholysis. Because these infectious diseases mimic PF histologically, you should request special stains for both bacteria (gram stain) and fungi (GMS, PAS) anytime a there is a histopathologic diagnosis of PF.

Prognosis

PF may be drug related, either drug-induced or drug-triggered. The drug-induced form PF is caused by a drug and upon removal of the drug, sometimes with a short course of immunosuppressive treatment, the disease resolves. Drug-triggered PF occurs when a drug stimulates a genetically predisposed individual to develop PF. Typically, this form of PF must be managed long term, similar to idiopathic PF. Currently there is no way to identify which cases of drug related PF are drug induced and which ones are drug triggered. In fact there is no test that can be used to predict how well a case of PF will respond to treatment.

A study at NCSU revealed that 6 of 51 dogs (11.7%) with PF were weaned off all medication and stayed in remission for >1 year. Recognizing that PF is a sunlight aggravated disease, it was interestingly the dogs in this study were from areas (NC or Sweden) with high UV light exposure. In this report the dogs took 1.5–5 months of therapy before the disease was in remission. The drug(s) were then slowly tapered and then all therapy was stopped. The total duration of immunosuppressive therapy varied between 3 and 22 months. These dogs stayed in remission for the entire follow up period (1.5–6 years after treatment). Supporting this finding is a study from the University of Pennsylvania that reported that 10% of their cases went into long-term remission after weaning off medication.

This study performed at the University of Pennsylvania suggests that dogs with PF survived longer when given antibiotics (usually cephalexin) in addition to their immunosuppressive regimen. This is in contrast to the author's clinical observation that if dogs with PF do develop a concurrent pyoderma it only occurs AFTER being placed on immunosuppressive therapy. Supporting the author's observations is a study from CSU that reported that there was no difference in survival when antibiotics were part of the initial treatment. In the study from University of Pennsylvania the survival rate was approximately 40% with 92% of the deaths occurring by 1 year. Other researchers have reported having a long-term survival rate of approximately 70%.

Cats may have a better prognosis than dogs with this disease. In the same report from the University of Pennsylvania, only 4/44 cats treated died (from their disease or therapy) during the study period. In the author's practice, survival at 1 year also exceeds 90%. In addition, a significant number of the cats are eventually able to have all medications discontinued without suffering a subsequent relapse.

Treatment

Managing any AISD takes frequent rechecks and alertness to complications associated with immunosuppressive therapy such as demodicosis, dermatophytosis and bacterial pyoderma. Interestingly the author has rarely seen a dog with PF that had a secondary pyoderma at initial presentation. It is more common to develop after beginning immunosuppressive therapy. If a patient was controlled and then has a relapse or if the patient has been improving and suddenly worsens, there are 2 possibilities. The PF (which does wax/wane) is flaring up OR that the dog developed a secondary infection due to immunosuppression. If the new lesions are folliculocentric you must also rule the big 3 folliculocentric infections – bacteria, demodex and dermatophyte. Skin scrapings, Wood's light examination (screening test) and impression smears are the minimum data based that should be performed when a dog is presented with these lesions. Whether or not you need to do a fungal culture at this time depends on the how frequently you see dermatophytosis in your practice and what is seen on cytology (acantholytic keratinocytes, cocci, demodex mites). If dermatophytosis is commonly seen in your practice then a fungal culture should be performed. Otherwise a fungal culture and a repeat skin biopsy can be considered second tier tests to be performed if the case doesn't respond to appropriate therapy (eg antibiotics)

In addition to the treatment options listed below, shampoo therapy should be included for symptomatic treatment of the crusting dermatitis. Pending biopsy results, if intracellular cocci are seen on cytology the author will dispense cephalexin (10-15 mg/# bid-tid), unless there is a suspicion that it is a case of cephalexin induced PF. If only extra cellular cocci are seen, then topical shampoo therapy with a antiseptic (eg chlorhexidene, benzoyl peroxide, etc)

Treatment must be individualized for each patient since there is no "best" treatment that works in all PF patients. This is why monitoring the progress of the disease closely by PHYSICALLY examine the dog or cat is critical for successful management of PF. It is especially important to recheck the patient prior to any adjustment in medication. When devising a treatment plan, be sure to consider the severity of the disease so that the treatment side effects are not worse than the disease itself.

There may be regional differences in how aggressively PF needs to be treated. Some of this may be due to the differences in the gene pools of the patients. But since PF is a sunlight aggravated disease, it also may be related to the differences in sun exposure. Regardless of the locale, sun avoidance should be part of the treatment for PF.

Because diet has been implicated as a cause of PF (endemic) in humans, the author will review the dietary history and consider dietary modification if the initial response to therapy is poor

Vitamin E (400-800 IU bid) and essential fatty acids may be used as part of the treatment since these nutrients have anti-inflammatory properties and anti-oxidant activities.

Glucocorticoids (GC) are the main stay of therapy for AISD. They may be applied topically or administered systemically depending on the severity of the disease and the amount of the body involved. Since some cats can't metabolize inactive prednisone to the active form, prednisolone, ONLY PREDNISOLONE should be used in cats. In dogs either prednisone or prednisolone may be used. The author has seen cases of feline PF, which were well controlled on prednisolone, but when prednisone was dispensed relapsed, only to go back into remission once the cat was placed back on prednisolone- all at the exact SAME dosage and frequency.

For localized disease the author will apply a potent topical steroid product bid until clinical remission (not to exceed 21 days) and then tapered slowly over the next few months. Be sure to have the owners wear gloves when applying this product. If this treatment is unsuccessful the one of the following systemic therapies will be instituted.

In dogs with more extensive disease or those that fail topical therapy, prednisone or prednisolone is administered at 1 mg/# bid for 4 days then ½ mg/# bid for another 10 days. The dog is rechecked every 14 days. If the disease is in remission, the dose is decreased 25% at each recheck examination. The author defines "remission" as the absence of any active lesions (no pustules and any crusts that are present are easily removed with the underlying epidermis appearing pink rather than erosive). DON'T TAPER THE DOSE TOO QUICKLY. The goal is to maintain the dog on 0.25 mg/# or less every other day of prednisone/prednisolone. If this is not achievable, then azathioprine is added to the therapy (see below). Some dermatologist will use the combination therapy from the onset, but because at least 75% of the dogs in the author's practice can be maintained on just GC and there are additional risks and costs associated with this drug the author considers this a second tier therapy. Only if the dog fails to respond to GC, or can't be managed with every other day administration, will the author add azathioprine to the therapy.

For cats, ONLY prednisolone is used and in fact only prednisolone is stocked in the author's pharmacy- this is to avoid the inadvertent administration of prednisone to a cat. The dose for cats is 1 mg/# bid for 14 days. From that point forward the management of the cat with prednisolone is the same as the dog. If the disease is not controlled with prednisolone then CHLORAMBUCIL (see below) is added to the therapy NOT AZATHIOPRINE!!!

If an animal fails to respond to prednisolone other immunosuppressive agents (see below) will be added to the therapy

Animals on chronic GC, regardless of dose should have a CBC, serum chemistry profile, urinalysis and urine CULTURE (monitoring for asymptomatic bacteriuria) every 6 months. The recommendation for performing a urine culture, even with a normal urinalysis, is best exemplified in 2 reports. In these reports, dogs had been receiving steroids for a minimum of 6 months. The incidence of UTI ranged from 21%-39%. In addition, pyuria was not identified in 48% of the samples that yielded growth. There was

not a correlation between the incidence of UTI and the frequency of drug administration (eg alternate-day versus daily), the type of GC or dosage administered or the duration of therapy (minimum 6 months). Lastly, clinical signs of UTI ranged from 0-32% of the cases. These 2 studies support the recommendations of performing urine cultures on dogs who receive steroids for at least 6 months whether or not they are symptomatic of a UTI. Also it stresses the need for a urine culture whether the urinalysis is normal or not since urine sediment analysis alone was not an adequate means of detecting urinary tract infections in these dogs

Azathioprine (AZA) is an antimetabolite that is a competitive inhibitor of purine. Purine is necessary for DNA formation, so in the presence of AZA, defective DNA is formed preventing cell replication. It has a lag phase of four to six weeks before it reaches its full effectiveness. The drug is administered concurrently with GC. The initial dose of azathioprine is 1.0 mg/# sid. Once remission is achieved, and the dog is either off of GC, or the lowest dose of GC has been obtained, AZA is then tapered every 60-90 days. Usually the author will decrease the frequency, not the dose of azathioprine, first decreasing it to every other day and then if the disease is still in remission, to every 72 hours. A CBC, platelet count, serum chemistry profile are performed every 14 days for 2 months, then q 30 days for 2 months then q 3 months for as long as the dog is on azathioprine. Potential adverse effects include anemia, leukopenia, thrombocytopenia, hypersensitivity reactions (especially of the liver) and/or pancreatitis. AZA should not be used in cats- it may cause irreversible bone marrow suppression.

Chlorambucil (CAL) is used in cats and in dogs who failure to respond to azathioprine or can't tolerate it. The protocol/precautions/monitoring for CAL is the same as w/AZA. The induction dose is 0.1-0.2 mg/KG/day.

Because tetracycline and niacinamide (T/N) have a variety of anti-inflammatory & immunomodulating properties the combination has been used in treating a variety of immune mediated skin diseases, such as discoid lupus erythematosus, vesicular cutaneous lupus erythematosus (idiopathic ulcerative dermatosis of collies and Shelties), lupoid onychodystrophy, pemphigus erythematosus, German Shepard Dog metatarsal fistulae, sterile panniculitis, sterile periadnexal granulomatous dermatitis (idiopathic sterile granuloma-pyogranuloma syndrome), vasculitis, dermatomyositis and cutaneous histiocytosis. The author used to use this combination for any of the previous mentioned diseases if the disease is relatively mild. If any of these diseases fail to respond well to immunosuppressive therapy, T/N may also have been added to the therapy in dogs. Since the unavailability of tetracycline, the author has replaced it with either doxycycycline or minocycline. Currently the author uses subantimicrobial doses of doxycycline. This has 2 advantages- 1 has minimum impact on oral and intestinal bacterial resistance and secondly makes the product cost effective. The dose is 2 mg/kg sid. At this dose the author has not seen the side effects that have occurred with tetracycline (anorexia, vomiting and diarrhea). The dosage for niacinamide in dogs <10 kg is 250 mg, q 8 hours and for dogs >10kg - 500 mg q 8 hours. If there is clinical response, which may take a few months, the niacinamide is slowly decreased from tid, to bid to sid while maintaining sid doxycycline. Side effects are rare but when they occur as usually due to niacinamide. These side effects include vomiting, anorexia, lethargy, diarrhea and elevated liver enzymes. The author has not tried the low dose doxycycline in cats yet but will try 10 mg sid (1/2 of a 20 mg tablet crushed in the food). When administering doxycylcline be sure to use a liquid form or administer a pill in a meat bolus followed immediately with food. ESOPHAGEAL STRICTURES have occurred as a sequele to doxycycline use in cats!!!

Cyclosporine A (CSA), a calcineurin inhibitor, has been used orally at a dose of 5 mg/kg sid in cases of PF with poor results in dogs. Recently the author has used CSA at 5 mg/kg sid- bid with success either as monotherapy or as steroid sparing agent. Others report that using at 5–10 mg kg every 24 hours along with ketoconazole 5 mg kg every 24 hours has increased the treatment success rate. In a retrospective study of cases in which either CSA or chlorambucil was used concurrently with steroids (steroids alone were ineffective) the author concluded that CSA appeared to be as effective as chlorambucil for controlling feline PF when used in combination with steroids.

Recently topical tacrolimus has been reported to be effective in the treatment of facial PF and PE. The author has limited experience with this product.

Sulfasalazine (SSZ) is a sulfa that has both anti-inflammatory and/or immunomodulatory properties due to its prostaglandin synthetase and leukotriene inhibition. In the past it has been used for the treatment of colitis but more recently it has been used for neutrophilic vasculitis. SSZ is metabolized by colonic bacteria to 5-aminosalicylic acid (5ASA) and sulfapyridine (SP). SP is well absorbed, metabolized in the liver, and excreted by the kidney while 5-ASA is much less well absorbed. Because SSZ is metabolized to aminosalicylic ("aspirin") this drug should be used cautiously in cats. The biggest concern with this medication is the possibility of developing irreversible keratoconjunctivitis sicca. This appears to be an idiosyncratic reaction that occurs more in smaller dogs but may occur in any dog. It is essential that you warn the owner that if the eyes become red or they notice an ocular discharge or squinting to contact you immediately so that you can do tear testing. Other side-effects associated with this drug include anemia, KCS and hepatotoxicity so a CBC, serum chemistry profile and Schrimer tear test are performed every 14 days for 2 months, then q 30 days for 2 months then q 3 months for as long as the dog is on SZA. In cases of neutrophilic vasculitis that fail SZA treatment w/dapsone may be effective, however, dapsone appears to be more toxic than SZA. The dose is 20-50 mg/kg tid (maximum 1 gm/dose), usually beginning with 20-30 mg/kg tid. Once the disease is in remission, the dose is slowly tapered

Specific treatment approach- for mild cases of facial PF (or cases of pemphigus erythematosus), a topical glucocorticoid is used. For generalized forms, or in cases with severe facial and/or footpad involvement, prednis(ol)one should be used as described above.

As long as the disease is in remission at each recheck, the steroids are tapered as previously described. If the disease is not in remission at the first 14 day recheck or it can't be kept in remission with steroids at a dose of <0.25 mg/# q 48 hrs, then either azathioprine (dogs) or chlorambucil (cats) is added to the treatment.

If the disease is not responding to the above treatment, CONFIRM that the diagnosis is correct (be sure to have ruled out dermatophytosis, demodicosis and bacterial pyoderma) then , changing to either dexamethasone or triamcinolone may be helpful. Use 0.05-0.1 mg/# bid of either drug, as the starting dose, and then taper as previously discussed.

As a "rescue" treatment for refractory cases of PF, high dose GC pulse therapy has been reported to be successful. Pulse therapy is followed by ½ mg/# bid of prednisolone and then taper as described previously. There are 2 protocols for pulse therapy:

1. 11 mg/kg of methylprednisolone sodium succinate (mixed w/250 ml of D5W) IV sid x 3-5 days
2. 10 mg/kg once daily for 3 days of prednisone ORALLY

Lymphoplasmacytic lichenoid dermatitis

Historically discoid lupus erythematosus (DLE) was considered an auto-immune disease whose symptoms were localized to the skin. Diagnosis was made using the same approach as in cases of PF- signalment, detailed history, physical findings, histopathology changes and response to therapy. In the dog, DLE is the 2nd most common autoimmune skin disease**Error! Bookmark not defined.**. The author has never recognized it in a cat. It has been suggested that there is no age predilection, but in the author's experience it seems to be more common in young to middle aged-dog. Collies, Shelties, German shepherd dogs, Siberian huskies and Brittany spaniels are at risk breeds**Error! Bookmark not defined.**.

Clinical findings include depigmentation, erythema, erosions, crusts and alopecia. When the nasal planum is first affected there is loss of its normal cobblestone appearance and it develops a slate gray appearance. Depigmentation, erythema, erosions and crusts may occur over time. DLE usually begins on the nasal planum and may process to involve the bridge of the nose. It may also involve the lips, periocular region, pinnae, and genitalia. Dogs affected with DLE are not clinically ill.

Differential diagnoses may include mucocutaneous pyoderma, pemphigus complex, cutaneous drug reaction, erythema multiformae, cutaneous lymphoma, uveodermatologic syndrome, SSC, solar dermatitis/collie nose and systemic fungal infections

Mucocutaneous pyoderma (MCP) (the author feels a better name is "antibiotic responsive dermatitis" since bacteria are not seen histologically) is a crusting disease that may affect the lips, nasal planum (exclusively), the bridge of the nose, periocular region, genitals or anus. Clinically it is indistinguishable from DLE. There is no identifiable cause for this disease and the diagnosis is based on the signalment (adult dog, most commonly in German Shepard Dogs (or mixes)), clinical appearance and distribution of the lesions and most importantly response to antibiotic therapy.

In the past MCP was differentiated from DLE based on histopathologic findings. DLE was diagnosed when a lichenoid lymphocytic to lymphoplasmacytic interface dermatitis with hydropic degeneration and/or individual necrotic keratinocyte involving the basal cell layer, pigmentary incontinence and a thickened basement membrane was present. Mucocutaneous pyoderma would be diagnosed histologically when a lichenoid plasmacytic to lympho-plasmacytic infiltration was present without an interface change and without basal cell damage. HOWEVER, this criterion has been called into question with a study that reported that histologically mucocutaneous pyoderma and DLE are indistinguishable! In that study, dogs were separated, based on histologic findings, into 3 groups, ones with lymphocytic lichenoid interface dermatitis with hydropic degeneration; ones with plasmacytic lichenoid dermatitis, and lastly ones with a mixture of the first 2 patterns- lymphoplasmacytic lichenoid, interface dermatitis with hydropic degeneration. The authors then evaluated whether the group responded to antibiotics or immunomodulating therapy. There was no statistical difference when histopathologic features were compared between the 2nd and 3rd groups! The author now believes that all cases of canine nasal dermatitis should have a 30 day course of cephalexin prior to immunomodulating therapy- in fact prior to biopsy a 3-4 week course of a cephalosporin is appropriate and may establish a diagnosis without needing to biopsy the lesion!

A better way to approach cases of nasal dermatitis that presents clinically as the "typical" DLE is to recognize that this is a reaction pattern rather than a disease. This reaction pattern (lymphoplasmacytic lichenoid dermatitis) may be antibiotic responsive or may require immunomodulating therapy. Since the biopsy findings will be identical in both cases, a 30 day trial of a cephalosporin prior to biopsy should be administered. This is the same approach I would apply to those cases of "DLE" that involve other areas, such the perivulvar region or in cases of chelitis.

Diagnosis

Dogs with DLE are clinically healthy and are normal hematologically and serologically (including a negative ANA). Historically the histopathologic changes consistent w/DLE included a lymphocytic to lymphoplasmacytic lichenoid interface dermatitis w/hydropic degeneration of basal keratinocytes. Scattered apoptotic keratinocytes may also be present. Failure to respond to a 30 day course of a cephalosporin is also required for the diagnosis.

Treatment

When treating dogs with DLE it is important to avoid aggressive therapy since it is primarily a cosmetic disease. Occasionally the lesions seem to bother the dog because of pruritus. It is therefore important to treat cases in proportion to the severity of the

symptoms. Be sure that the therapy is not worse than the disease. The author treats this disease in a stepwise progression with each step added to the previous therapy except where noted. The steps are as follows: Cephalexin 10-15 mg/# bid- tid for 30 days (since DLE and MCP are indistinguishable); if the dog does not respond to the cephalexin, then the cephalexin is discontinued and the following treatment is begun, sun avoidance, sun screens and vitamin E and omega 3 fatty acids. Niacinamide and doxycycline are as begun as previously described. If after 60 days the dog doesn't respond to this treatment the next step is topical GC (beginning with a moderately potent GC). If after 60 days there is no response then stop the doxycycline and niacinamide and begin systemic prednisone (anti-inflammatory doses) that is slowly weaned over a period of months to achieve the lowest possible dose.

Update on Diagnosing and Treating Malassezia Dermatitis and Demodicosis in Dogs

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

Demodex canis is the dog follicular mite, while Demodex injai is found within sebaceous glands and ducts. D. cornei lives in the stratum corneum.

Neonates are thought to acquire mites from their dam during nursing. Direct transmission, other than from dam to the pup rarely occurs.

Dogs may have either localized or generalized disease. There is no universally accepted definition of localized vs generalized disease but recently it has been suggested that with localized disease there are no more than four lesions with a maximum diameter of to 2.5 cm. Demodicosis is also categorized based on age of onset- those less than 12 months of age (18 months in large or giant breeds) are considered juvenile onset while older dogs are considered adult onset . The prognosis is excellent for the localized form either in puppies or adult dogs while the generalized form carries a more guarded prognosis.

Demodex causes disease when there is an overgrowth of the commensal mites either associated with a genetic defect (juvenile onset) or immune suppression (adult onset). In the adult dog, hyperadrenocorticism (iatrogenic or spontaneous), hypothyroidism, leishmaniasis, or chemotherapy are the most identifiable causes of adult onset generalized demodicosis.

The lesions include non pruritic alopecia, scaling, follicular casts, follicular papules/pustules (if a secondary bacterial infection is present), comedones, crusts, erythema, hyperpigmentation, and lichenification. Pruritus is variable but is mild except in cases with a secondary bacterial folliculitis.

Lesions frequently involve the face and/or forelegs and may progress to affect other body sites. Since the lining of the external ear canal is epidermis, demodicosis may cause a bilateral ceruminous otitis externa. As the disease progress dogs may develop a deep bacterial folliculitis and furunculosis and draining tracts. In those cases peripheral lymphadenopathy, lethargy and fever are commonly present. In some patients their presentation is exclusively pododemodicosis. In these cases a deep bacterial folliculitis and furunculosis is frequently present and the feet are swollen and painful leading to lameness.

In contrast to D.canis and cornea, D. injai tends to be associated with a greasy hair coat on the dorsum of the trunk. Many times alopecia is not present and only a low number of mites may be found on skin scrapings. It has been reported that terriers, especially wire haired fox terrier and West Highland white terrier, are at risk of developing this form of demodicosis.

Since demodicosis is a folliculocentric disease it will look identical to follicular lesions caused by a bacterial pyoderma and dermatophytosis. Superficial (for D.cornea) and deep skin scrapings (for the other species of demodex) are the most reliable method to diagnose demodicosis

To perform a deep skin scraping it is best to squeeze the skin prior to and during the scraping to push the mites out of the hair follicles. Scrape the skin in the direction of hair growth until capillary bleeding occurs. When lesions are present on the face or paws the animal should either be sedated before scraping or a hair pluck/trichogram may be performed in an awake animal. Hair plucks are performed with mosquito hemostat forceps that grasp and pull out hairs. It is best to collect hairs from the leading edge of the lesion. To increase your yield, squeeze the skin as you are plucking the hairs and be sure to collect a large number of hairs (50–100). Take the collected hairs and lay them on a slide containing a drop of mineral oil and add a cover slip. Sample multiple sites in each patient. Trichograms, or in cases of pustular demodicosis examination of the exudate, will detect Demodex mites in about 85% and 100% of dogs respectively with demodicosis. If the trichogram is negative but other sites are positive, sedation and skin scrapings of the feet should be performed since the mites may be present even if the feet appear alesional. It has been the author's experience that pododemodicosis, if present, is usually the hardest component of generalized demodicosis to resolve and so should be used as one of the monitoring sites.

Recently it has been reported that applying tape to a skin lesion and then squeezing the skin is as an effective way to identify demodex mites in dogs. A study was performed to confirm this observation. Specifically the study was to evaluate and compare the sensitivities of acetate tape impression deep skin scraping for the diagnosis of canine demodicosis. They concluded that squeezing the skin followed by acetate tape prep was found to be as sensitive as deep skin scraping for the diagnosis of canine demodicosis. Unfortunately the author has not had the same experience.

Be sure to collect samples from multiple sites and note the site that the sample is collected from since localized disease is treated differently than generalized disease. When examining the slides you need to evaluate for the approximate number of each stage that is present (eggs, larva, nymph and adults). Also note how many of the mites alive vs are dead. These results will be important to compare to future skin scrapings as you are monitoring the dog's response to therapy. With effective treatment a decreasing number of immature mites and the disappearance of eggs should occur. The number of live mites should also decrease. In all cases of demodicosis be sure to perform an examination of an otic swab. Otodemodicosis is identified by collecting roll swabs from each ear

using a cotton swab that has been dipped in mineral oil. The sample collected is place onto a glass slide that also has a drop of mineral oil on its surface. A cover slip is applied and then the sample is examined. .

If samples are collected as described it would be extremely uncommon to miss the presence of demodex mites. Occasionally this may occur, even with properly performed skin scrapings and hair plucks, if the dog has scarring due to chronic disease or because of the thickness of their dermis (therefore the deeper depth of their hair follicle making expulsion of the mite more difficult) (i.e. Shar-Peis)**Error! Bookmark not defined.**. If demodicosis is strongly suspected, but no mites are found on skin scrapings and hair plucks, skin biopsy is recommended to rule in or rule out their presence.

How to treat a dog with demodicosis depends on whether it is localized or generalized. In cases of localized demodicosis, less is best. In many cases, especially juvenile onset, the disease will spontaneously resolve within a couple months. Miticidal therapy is not required unless the disease becomes generalized. Since the progression of localized disease to more generalized form is not influenced by whether the localized form is treated or not, treatment of localized disease is not necessary. However, in the author's practice "benign" topical treatment is prescribed. This is done so that if the disease does progress, the owner feels that something had been done to try to prevent for occurring. Topical therapy with benzoyl peroxide shampoo and/or gel can theoretically be helpful due to its antibacterial properties and follicular flushing activity. Due to its suppressive effect on the immune system you should avoid using any steroid containing product (topically or systemically) in patients with demodicosis (localized or generalized). Ensuring a proper diet and intestinal deworming program should also be part of the treatment of dogs with demodicosis. To evaluate the effectiveness of treatment, a follow up examination, including repeating skin scrapings, should be performed in 30 days.

Treating a dog with generalized demodicosis requires much more aggressive therapy than localized. Multimodal therapy, a common approach that is used to treat other diseases (eg arthritis, atopic dermatitis or congestive heart failure) will be necessary when treating generalized demodicosis. Acaricidal therapy and treating secondary bacterial infections if present is required for both adult and juvenile onset disease. In adult onset cases attempts should be made to identify and treat the underlying systemic disease.

Dogs with juvenile onset generalized demodicosis, in addition to the above mentioned treatment should be neutered. This is important not only to prevent the propagation of this genetic defect but also estrus may trigger recurrence of clinical disease .

As mentioned previously, in cases of adult onset generalized demodicosis attempts should be made to identify and treat the underlying disease. Evidence shows that successful treatment of an underlying cause increases the likelihood that adult onset demodicosis can be cured. . In the author's practice, diagnostics performed in cases of adult onset generalized demodicosis include a CBC, serum chemistry profile and a urinalysis. Depending on the age of onset, abdominal ultrasound and thoracic radiographs may be included in the minimum data base. Because of the influence that bacterial pyoderma or generalized demodicosis has on evaluating thyroid or adrenal gland disease, evaluation of these organs is delayed until any secondary bacterial infection has been resolved and the demodicosis has improved or is in remission.

Specific treatment of generalized demodicosis is outline in table 1. This table is the result of the most recent consensus guidelines written by an international group of dermatologists. The author has indicated in bold the approach used in his practice.

Since dogs may look normal clinically but still have active disease (as determined by the presence of mites on skin scrapings) treatment must be continued beyond clinical resolution. Parasitic cure is defined as multiple negative skin scrapings, including lack of dead or fragmented mites, on 3 consecutive monthly visits. Skin scrapings should be used to determine the therapeutic end-point. This end point is reached when the dog looks normal clinically and skin scrapings have been performed monthly on the 4-6 most severely affected areas and have been negative for 3 consecutive visits. If during a visit the skin scraping is positive, it is important to compare the number of live and dead mites and the number of each stage of the mite life cycle to the previous visit. An indication of effective treatment is that during therapy the number of live mites found on skin scrapings and the number of immature mites should be reduced from the previous visit. If this doesn't occur, therapy should be re-examined and possibly changed.

Table 1- Summarized treatment of canine demodicosis *

Treatment of a dog with severe generalized disease

1. Perform cytology and if there is evidence of a deep bacterial skin infection or the dog has been treated previously with antibiotics a bacterial culture and sensitivity. With inflammatory cells and bacteria present, appropriate oral antibiotic therapy is required.
2. Use topical therapy with chlorhexidene or benzoyl peroxide shampoo weekly to possibly twice weekly. (Unless amitraz is being applied)
3. There are several treatment options for the treatment of canine demodicosis. The best option will depend on the legalities pertaining to the use of veterinary pharmaceutical products in the country of residence, the finances of the owner and the clinical situation. However, independent of the treatment specifics the dog should be neutered because dogs in need of mite treatment should not be allowed to breed, and the disease may relapse in cycling bitches.
    a. Amitraz weekly or every 2 weeks in a concentration of (0.025–0.06% can be used. Dogs with a medium to long hair coat need to be clipped, and skin should stay dry between rinses to avoid washing off the drug.

Rinsing should be performed in well-ventilated areas. The author only uses this therapy if the dog has failed to respond to ivermectin or is a herding breed. Please note that amitraz is EPA registered and doesn't EVER allow any off label use (label states 1 bottle/2 gallons every 14 days)

b. Milbemycin oxime may be administered orally at a dose of 1–2 mg⁄kg⁄day. Moxidectin orally (see below) is in the milbemycin family, is much less expensive than milbemycin, and is used if the dog fails to respond to ivermectin (again a non herding breed)
c. Moxidectin as a spot-on in combination with imidacloprid may be used weekly. This spot-on formulation has a markedly higher success rate in dogs with milder disease.
d. Ivermectin at an oral dose of 0.3–0.6 mg⁄kg (0.4 mg/kg) or moxidectin at 0.2–0.5 mg⁄kg p.o. daily are further options. With both drugs, a gradual increase from an initial dose of 0.05 mg⁄kg to the final dose (of 0.4 mg/kg) within a few days is recommended to identify dogs that cannot tolerate those drugs. Monitoring for neurological adverse effects should occur throughout the course of therapy. Ivermectin is the treatment of choice in the author's practice.
e. Doramectin weekly at 0.6 mg⁄kg p.o. or SQ is a possible treatment. A gradual increase from an initial dose of 0.1 mg⁄kg to the final dose seems prudent to identify dogs that cannot tolerate the drug and will show neurological adverse effects.

So to summarize- this report states that "There is good evidence for the efficacy of weekly amitraz rinses and daily oral macrocyclic lactones such as milbemycin oxime, ivermectin and moxidectin for the treatment of canine demodicosis."

Other recommendations are

Dogs should be evaluated monthly, and treatment should be continued until 3 consecutive visits with multiple negative skin scrapings have been achieved.

Treat secondary bacterial infections

Factors predisposing to demodicosis, such as malnutrition, endoparasites, endocrine disease, neoplasia and chemotherapy, should be identified and corrected to maximize response to therapy.

* Modified from - Mueller, R. S., Bensignor, E., Ferrer, L. et al Treatment of demodicosis in dogs: 2011 clinical practice guidelines. Veterinary Dermatology, 2012; 23: 86

Diagnosis and management of malassezia dermatitis

Overview

Malassezia is a genus of lipophilic yeast found as a commensal of the skin and mucosal surfaces that may cause skin disease in a variety of mammalian species. In normal dogs these organisms are present in very small numbers on the skin (fold areas-lip, vulvar, axillae, interdigital), oral and anal mucosal surfaces, in the ear canals and in the anal sacs. In contrast to *Candida*, MD is not associated w/recent antibiotic administration, in fact, there appears to be a symbiotic relationship between the surface staphylococcal organisms and the yeast. It is theorized that the organisms produce growth factors and micro-environmental changes (eg inflammation) that are beneficial to each so it is not uncommon to see concurrent infections w/*Malassezia* and staphylococcus. Why do animals develop *Malassezia* dermatitis (MD)? There have been numerous studies comparing the strain of *Malassezia* organisms found on skin of affected dogs vs. the skin of unaffected dogs. To date there has not been an identifiable difference in virulence and/or adhesion in *Malassezia* organisms found on skin of affected dogs vs. the skin of unaffected dogs. Since the organism virulence doesn't explain MD, the explanation seems to be the host response to *Malassezia* organism. Both type I and type IV hypersensitivity reactions to *Malassezia* have been identified in dogs w/MD. Disorders that affect the barrier function of the skin (eg pruritic skin disease) or the cutaneous lipid content (eg hypothyroidism) are risk factors for developing MD

Signalment

There is no age or sex predilection

History

MD is always secondary to another skin disease. A clue that MD may be present is that the clinical features and/or the previously effective therapy of the underlying disease become ineffective. For example, pruritus that was seasonal becomes nonseasonal; the distribution of the pruritus changes, responsiveness to previously effective antibiotic and/or glucocorticoid therapy is decreased. Any allergic animal whose pruritus (intensity or distribution) or the therapeutic responsiveness of the pruritus changes suddenly should be evaluated for MD, pyoderma and ectoparasites.

Clinical findings

On physical examination lichenification, erythema, greasy exudate, dry scale, papules, plaques, alopecia or hyperpigmentation may be present. A moist dermatitis with a musty odor is not an uncommon clinical finding. Pruritus may vary from mild to intense and erythema may be present with minimal pruritus especially interdigitally.

The lesions may be focal or generalized and the distribution of the lesions overlaps with other pruritic diseases. Affected areas include interdigitally, intertriginous areas, face, nail folds, perioral (lateral muzzle), pinna and flexor surface of the elbow

Diagnosis

MD may cause a folliculitis that is clinically identical to staph pyoderma. Therefore if there are follicular papules, epidermal collarettes or lichenification you can't assume that there is a bacterial component to the skin disease without performing skin cytologies. Remember to include skin scrapings for ectoparasites as part of your minimum data base.

Identifying *Malassezia* organisms budding yeast from the affected area is necessary to establish a diagnosis of MD. Tape impression or direct impression smear are the most common method used for sampling affected areas.

The question is "how many is too many organisms?" A previous report found that normal dogs had 1 yeast per 2700 oil field. MD is confirmed when, on cytology, you find ANY field that **has more 1** organism OR if there is 1 organism every 1-3 fields (1000X).

The ACVD task force on atopic dermatitis discussed MD as a complication of atopic dermatitis. The task force states that "Surface cytology of the skin and ear is useful to determine whether or not *Malassezia* or *Staphylococci* are present at lesional sites. Making antimicrobial treatment decisions based solely on microbe numbers is incorrect and inappropriate." The article goes on to discuss that the host response to these normal organisms determines the severity of clinical signs. Their recommendation was "the result of cytology might better be limited to the sole report of 'presence' or 'absence' of detectable bacteria or yeast".

Treatment

In order to prevent recurrence of MD the underlying cause must be identified and treated. As previously mentioned any disease that disrupts the barrier function, the lipid content of the skin surface, the cutaneous microclimate or host defense mechanisms may predispose the animal to MD. These include hypersensitivities (atopy, cutaneous adverse food reactions), ectoparasites (demodex, sarcoptes, and fleas), endocrinopathies (hypothyroidism, hyperadrenocorticism), metabolic diseases (metabolic epidermal necrosis), neoplasia (cutaneous T-cell lymphoma) and excessive skin folds. Genetic factors, as seen in Bassett hounds, predispose a dog to maintaining higher number of *Malassezia* organisms on their skin, putting them at greater risk for developing MD.

Unless the MD is very focal, the author prefers both topical and systemic therapy. This combination will be the most successful treatment of MD. Eliminating MD as the cause of pruritus is important so that when the dog is rechecked any remaining pruritus is a result of the underlying hypersensitivity reaction, not the MD.

There are a variety of effective topical agents including selenium sulfide, miconazole, ketoconazole, clotrimazole and chlorhexidene. In the authors experience any shampoo that contains at least 3% chlorhexidene or contains 2% chlorhexidene combined w/an azole is effective. Shampooing should be followed by a leave on conditioner containing an antifungal ingredient such as 2% miconazole. Depending on the severity and extensiveness of the lesions the frequency of application varies from daily to 3x/week.

Ketoconazole (KCZ) 5-10 mg/kg sid was the systemic drug of choice. Since the drug is now unavailable fluconazole (5-10 mg/kg/day). Another choice, especially for hard to medicate dogs is itraconazole 5 mg/kg given 2 consecutive days/week. A less costly therapy is terbinafine (30-40 mg/kg sid w/food). Regardless of which treatment is chosen the treatment should be continued for 14 days beyond clinical resolution BASED ON YOUR examination (not a phone call) with a minimum treatment time of 21 days. Please note that griseofulvin is ineffective against *Malassezia.*

Be sure to evaluate the dog for concurrent superficial bacterial pyoderma since MD and pyoderma occur simultaneously in dogs. In cases of concurrent superficial bacterial pyoderma, antibiotic therapy should be used simultaneously.

New Drugs in Veterinary Dermatology

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

Antibiotics

A consensus statement has been released with the purpose of guiding practitioners in the diagnosis, treatment and prevention of superficial bacterial folliculitis(SPF). These guidelines, like the previous guidelines published concerning antibiotic use for treating urinary tract infections, are the result of a committee consisting of veterinary internists, pharmacologists, microbiologists and dermatologists. In this article it is stated that "there is concern among some members of this panel about the potential selective effects of third generation cephalosporins (cefpodoxime and cefovecin) on the Gram-negative microbiota, due to their broader spectrum of activity compared with first generation cephalosporins". The following is the author's position on the use of these broad spectrum antibiotics in the treatment of SPF.

Cefpodoxime is a 3rd generation cephalosporin (broad spectrum) effective for most Staphylococcus infections that occur in dogs. The company believes that this drug should be a first line antibiotic instead of using the narrower spectrum antibiotic, cephalexin, in the treatment of SPF. The concern about using a broad-spectrum antimicrobial is that they affect a wider variety of microorganisms and their use may select relatively resistant strains of non targeted microorganisms. Even if these microorganisms are non pathogenic, they can be a source of resistance genes for pathogens. A cited advantage of cefpodoxime over cephalexin is that it is a once a day antibiotic leading to better owner compliance. This belief of higher compliance rate with once daily medication vs. twice daily has been dispelled in a study that revealed there is no difference in compliance with once daily versus twice daily dosing. Also be aware that there are numerous studies showing that once daily cephalexin at 30-40 mg /kg is as effective as splitting this dose and administering q 12 hours. However these were not peer reviewed studies so this is NOT my recommendation. But these studies do suggest that missing 1 dose of cephalexin is not catastrophic. Recognizing that missing one dose of a once daily pill would be the same as missing TWO doses of a twice daily pill the author believes that there is no advantage of medications that are given once daily vs. twice daily. Note if once daily dosing is important there are other antibiotics that would be more appropriate to dispense when treating SPF such as clindamycin (5-10 mg/#) or one of the potentiated sulfas. Another advantage mentioned is that the cefpodoxime pill is easier to administer than cephalexin capsules. Cephalexin is now available as a chewable tablet (Rilexine® Virbac) that helps make administration of cephalexin much easier. Other concerns about cefpodoxime as a 3rd generation cephalosporin will be discussed below.

Cefovecin is a parenterally administered 3rd generation cephalosporin that has tremendous value when used properly (selectively). It too is a broad spectrum antibiotic when compared to cephalexin. In New Zealand it is approved for infections due to Staphylococcus intermedius, ß-haemolytic Streptococci, Escherichia coli and/or Pasteurella multocida and Proteus spp. In Canada it is approved for skin infections in dogs due to Staphylococcus (pseudo)intermedius, Streptococcus canis and Escherichia coli. It is also approved for canine urinary tract infections caused by Escherichia coli and Proteus mirabilis. In cats it is for skin infections caused by Pasteurella multocida, Prevotella bivia, Bacteroides fragilis, and Staphylococcus (pseudo)intermedius. This wide sprectrum is in contrast to is compared to chewable cephalexin (Rilexine® Virbac) which is only approved for the treatment of superficial bacterial pyoderma caused by Staphylococcus (pseudo)intermedius . Because of the previously mentioned issues, the author believes that this drug should be reserved for cases where the owner is unable to orally medicate the dog or cat or the animal can't tolerate oral antibiotics. The concern about using this medication is that therapeutic drug concentrations (above MIC) are only maintained for 7-14 days post injection, depending on the infectious agent, while sub-MIC tissue levels persist for up to 65 days. The question is whether this prolonged subtherapeutic blood (tissue?) level will enrich the environment for the proliferation of resistant bacteria. Will adverse reactions require prolonged treatment due to the prolonged systemic drug clearance? What are the long-term effects on injection sites, especially in cats? Most of these questions have not been answered, even by the company. The following is from the Convenia drug insert (New Zealand)

"Cefovecin is a long acting broad spectrum fourth group cephalosporin. Cefovecin may persist in the body for approximately 4 to 5 weeks; therefore, adverse event monitoring should be carried out for a similar amount of time". (note USA insert states that reactions may require prolonged treatment due to the prolonged systemic drug clearance (65 days) "Prudent Use: It is prudent to reserve third generation cephalosporins for the treatment of clinical conditions which have responded poorly, or are expected to respond poorly, to other classes of antimicrobials including first generation cephalosporins. Use of the product should be based on susceptibility testing and take into account official, and local, antimicrobial policies. Indiscriminate use of Convenia could contribute to the development of antibiotic resistance."

An additional concern about 3rd and 4th generation cephalosporins is that they are a risk factor for developing extended spectrum beta- lactamase (ESBL) producing bacterial infections. Extended-spectrum beta-lactamases (ESBLs) are mutant beta lactamases found in Enterobacteriaceae (E. coli, K. pneumoniae, etc) and are a concern in human medicine because they cause serious, potentially

life threatening infections. These bacteria are not only resistant to beta lactam antibiotics but are frequently multi- drug resistant being resistant to non beta lactam antibiotics such as aminoglycosides, fluoroquinolones, tetracyclines, chloramphenicol, and sulfamethoxazole-trimethoprim. This wide ranging resistance greatly limits effective treatment options. The genes encoding this resistance are mediated by plasmids and/or mobile elements which allows horizontal transfer between the same and different species of Enterobacteriaceae. Horizontal transmission allows wide spread dissemination between human bacteria or between human and animal bacteria. In contrast to FQ and 3rd generation cephalosporins, first generation cephalosporins have not been reported to be a risk factor for such resistance.

Bottom line – we should be very selective when dispensing any antibiotic but especially third- and fourth-generation cephalosporins in the treatment of SPF. The most convincing argument against using these newer drugs as a first line antibiotic is since there are disagreements about the long term impact of these drugs on bacteria, and since cephalexin works well in most cases, why would you change?

Antiprupritic

Oclacitinib is a JAK inhibitor approved for the treatment of canine pruritus. Cytokines bind to unique cell membrane receptors and activates specific intracellular pathways. JAK is one such intracellular pathway. Once triggered, the JAK pathway activates, via phosphorylation, intracellular proteins call Signal Transducer and Activator of Transcription (STAT). These proteins bind to specific DNA regulatory sequences in the nucleus to activate or repress cytokine production. JAK 1 is involved in the production of cytokines (IL-2, IL-4, IL-6, IL-13 and IL-31) that trigger and perpetuate the clinical signs of pruritus and cutaneous inflammation. Oclacitinib inhibits the activation of JAK 1 thereby decreasing the amount of pro-inflammatory and pruritogenic cytokines produced. It is approved for use in dogs as an antipruritic agent. This oral medication is dosed at 0.4-0.6 mg/kg bid for 14 days then sid. It appears that this drug, when effective, works very quickly, sometimes within hours. However a noticeable number of dogs will become pruritic when switching from bid to sid. In those cases, make sure you are using the 0.6 mg/kg dose- if not, then increase to that dose. If that dose is not effective when given sid, then try splitting the daily dose into bid. Please be aware that this drug will mask pruritic diseases such as sarcoptes, flea allergy dermatitis, pyoderma and *Malassezia* dermatitis. These are diseases that should be treated with ectoparasiticides for the former 2 or antimicrobials for the latter 2 rather than masking the pruritus with medication. As is true with any drug used in the treatment of atopic dermatitis, it should be used as a temporary therapy as you are trying to identify and manage the underlying cause (eg adverse food reaction (food trial), ASIT for environmental atopic dermatitis). The author monitors cbc, serum chemistry profile, urinalysis and urine culture q 6 months for dogs on prolonged treatment. To date only a few dogs have had adverse events (neutropenia/leucopenia) that resolved with discontinuation of the drug.

Sublingual immunotherapy

Recently sublingual immunotherapy (SLIT) has become available to veterinarians for the treatment of canine atopic dermatitis (cAD). The author has some reservations about the use of this therapy for cAD. Recognizing that SLIT has been used for many years in Europe for the treatment of human asthma we can review the information that is available in that species. The vast majority of studies and protocols in humans are for rhinitis/asthma and NOT atopic dermatitis. A review in human medicine (2006) found the following

1. Dosing summary
    a. The studies included doses that varied by 30,000-fold
    b. Frequency of dosing varying from daily to weekly
    c. Duration of treatment varying from 2 months to 5 years

Their conclusion was that SLIT is an effective treatment (for rhinitis or asthma) but it was unclear what the proper dose, treatment schedule and overall duration of treatment was to be effective.

Other review articles found that the cumulative monthly dose varied between 0.017 and >500 times the customary subcutaneous maintenance dose. In addition that each manufacturer uses its own standardization, formulation, and administration schedules. In a review of SLIT for human atopic dermatitis the authors could only find 1 DBPCR. That study evaluated the efficacy and safety of SLIT using housedust mite containing drops. They concluded that for mild–moderate disease there was significant improvement but there was no improvement in cases of severe disease. But it went on to say that standardized treatment was essential to ensure therapeutic efficacy. They used 80 umg protein concentration/day once daily with instructions to Patients were instructed to keep the drops under the tongue for 1–3 minutes and then swallow. Note in this study the treatment group had a total efficacy rate of 77.78% (cured + marked improvement) vs. 53.85% in the control group. These were statistically significant but look at the placebo effect! The other important finding was that during the first year of immunotherapy there was no difference between placebo and SLIT response and the difference was only noticeable at 2 years. In 2015 there was a systematic review to evaluate the evidence supporting the use of SLIT for hAD? They could only find 5 studies to fit their criteria. They found that in 4/5 studies there was an improvement in AD but in 2/4 there was a substantial placebo effect making the true effect of SLIT difficult to determine. They found serious

shortcomings such as lack of control group, lack of randomization, data analysis was not by intention to treat. The group graded 1 of the studies to have moderate quality, 2 to have low quality and 2 to have very low quality.

As you review the studies in veterinary medicine concerning SLIT and eAD you will note that all studies except for 1 have the same very serious limitations- they are open studies, there are no placebo groups and only the study only applies to mite sensitive dogs. Also the studies state that there are statistically significant changes in CADESI and PVAS but don't state if this translated into CLINICAL improvement- for example pruritus may go from +10/10 to a +7/10- statistically different but not clinically different. In the 1 DBPCR study that has been done to date in veterinary medicine, they found that overall the percentage of dogs that improved >40% were 50% in the control and 66% in the active group. Once again look at that placebo response! Two problems with this study- 1 they don't state if the response rate is statistically different and also the criteria that has been establish states there must be at least a 50% improvement to be considered clinically significant- so why did that study use a 40% cutoff?

Lastly, things that give the author great pause about this whole subject is that there are some companies that refuse to tell the veterinarian what is in the SLIT formula that they expect us to give to our patients. In addition the different antigen companies are using different strengths in their SLIT (one company offers a dilution of 20,000 pnu or 40,000 pnu whichever you want – but doesn't give guidelines how to chose), different volumes and different frequency (sid vs bid). So how can they all be effective? The author uses SLIT in very limited, specific situations such as when owners are absolutely adamant that they won't give SCIT and won't bring the pet in for you to give the injection, an animal that has had a severe reaction to SCIT or if the animal fails to respond to SCIT after 1- 1 ½ years. I tell the owner that we really don't know how successful this method is but that it is very safe to try.

Antifungal

Itraconazole (Sporonax ®-Janssen Pharmaceuticals- 100 capsules and 10 mg/ml oral solution)) is a member of the azole family of antifungal agents. Imidazoles (Imidazole family (thiabendazole, clotrimazole, ketaconazole, miconazole and enilconazole) and triazoles (itraconazole and fluconazole) make up this family of drugs. All azoles are potent inhibitors of ergosterol synthesis (a main membrane lipid of fungi) via inhibition of a microsomal cytochrome P450 enzyme (14 □ sterol demethylase) (see table 1). Since mammalian cytochrome P450 is involved in glucocorticoid and sex hormone synthesis (androgens), depending on which azole, the dog's cortisol and androgen levels may decrease during therapy. This is more of a potential problem w/ketaconazole then w/itraconazole (ITZ) because ITZ is more selective for the fungal enzyme than the mammalian form. Itraconazole has been used in veterinary dermatology for many years to treat subcutaneous (eg Sporotrichosis) or systemic (eg cryptococcus, histoplasmosis) mycotic infections. More recently it has been used for treating cats (and occasionally dogs) for dermatophyte infections. It has also been found to be very effective for the management of Malassezia dermatitis. For cats w/dermatophytosis the author uses "pulse" therapies (i.e., daily therapy for 1 week, then one week off, then one week on, etc) at a dosage of 5-10 mg/kg/day. It is better absorbed if given with food. Side effects of itraconazole in dogs or cats include anorexia, GI disturbances, hepatopathies and in dogs (when using higher doses (10 mg/kg)) vasculitis. It is teratogenic so it is not to be used in pregnant animals. For dog's w/Malassezia dermatitis, 5 mg/kg, 2 consecutive days/week is as effective as daily administration.

Fluconazole (Diflucan®, Pfizer Pharmaceuticals) is another alternative for the systemic treatment of Malassezia but until recently has been more expensive than either ketoconazole or itraconazole. The dosage is similar to ketoconazole 5-10/kg once daily- GI absorption is unaffected by food intake. The residual effect of fluconazole is similar to itraconazole. Fluconazole is eliminated primarily via the kidneys so administering this drug to a dog w/hepatic disease could be advantageous over the other azoles. Dosage adjustments for dog's w/renal compromise are necessary.

Terbinafine is an allylamine antifungal agent used in human medicine for the treatment of dermatophyte infections. An advantage of terbinafine over the azoles is that terbinafine has minimal effect on the cytochrome P450 enzyme system as opposed to the azoles. Clinically this translates into fewer drug interactions especially compared to ketoconazole. This drug is effective for dermatophytes (when used w/lime sulfur) and Malassezia and can be used in both cats and dogs. The dose is cats and dogs is 30-40 mg/kg sid however there is a study that used the following dose for dermatophytosis (used w/lime sulfur dips)= cats < 2.8 kg – 62.5 mg, 2.8-5.5 kg- 125 mg and in cats > 5.5 kg 1 tablet.

Diagnosing and Managing Non-Pruritic Alopecia in Dogs

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

Alopecia in the dog is a common clinical finding. It is most commonly associated with pruritus due to allergic skin disease. There are also many nonpruritic causes of alopecia. Since the skin and hair can only "react" in a limited manner regardless of the triggering event, signalment, history (hx), physical exam (PE) and laboratory testing (eg skin scrapings, skin biopsies, fungal cultures, endocrine testing, intradermal testing, etc) will be needed to help determine the underlying cause.

Once congenital, pruritic or infectious causes of focal to multifocal alopecia have been eliminated as a cause, the remaining alopecic diseases are associated with inflammation or interface dermatitis. Note that the inflammation may only be histologically apparent, not clinically observable. These can only be differentiated based on microscopic examination of skin biopsies. Vaccine induced alopecia is an example of an inflammatory alopecic disease. When performing a skin biopsy in an alopecic disease it is best to submit an elliptical shaped sample that has the tip of one end in the alopecic region and the other tip in the normally haired area. Be sure to request that the sample is sectioned from tip to tip (longitudinally) rather than transversely. This will allow the pathologist to see the progression of the lesion from early to late stages all on one sample.

Vaccine induced alopecia is most commonly associated with rabies vaccination and occurs due to ischemic changes in the skin. The alopecia occurs 2-12 months after administering a rabies vaccine. Small white breeds of dogs seem to be at risk for developing these lesions. SQ or IM injections have no impact on the occurrence of this reaction. Lesions consist of scaling, focal (occasionally multifocal) areas of alopecia, plaques, hyperpigmentation, nodules, erosions, crusts and cutaneous atrophy (scarring). The lesions may also develop at sites distant from the vaccination site. Histologically in addition to typical vasculitis changes, septal panniculitis and focal lymphoid nodules will be seen. Rule-outs are fairly limited but should include demodicosis, dermatophytosis, allergic skin disease and bacterial skin disease.

Dermatomyositis is an ischemic genodermatosis in collies and shelties involving both the skin and muscles. When it occurs spontaneously in adult dogs of other breeds there is only skin involvement. The onset of clinical disease in the inherited form is between 6 weeks and 1 year of age- usually occurring before 6 months of age. The lesions may be fairly limited and heal as the puppy matures or they may progress. Usually the lesions stop progressing by the time the dog is a year old. The cutaneous lesions, which are usually the predominant clinical sign, include focal to multifocal areas of alopecia, scaling, crusts, erosions, ulcers, depigmentation, hyperpigmentation and scarring. These lesions occur on the face, mucocutaneous junctions, carpal and tarsal regions and the tip of the tail and ears. Onychodystrophy may also be present. Secondary bacterial pyodermas may occur. Muscle involvement, which only occurs in the inherited form, tends to be proportional to the severity of the skin lesions and is usually identified subsequent to the cutaneous lesions developing. These dogs may develop megaesophagus or muscle atrophy involving the muscles of mastication and ambulation. Differential diagnoses for the skin disease include demodicosis, dermatophytosis, superficial bacterial folliculitis, DLE, cutaneous drug reaction, erythema multiformae, vasculitis and epidermolysis bullosa simplex. In the author's experience, puppies are mostly commonly presented with limited facial lesions that the breeder claims are wounds/scars from the other puppies or from a cat in the household. Diagnosis is based on signalment, physical examination and histopathologic changes consistent with a vasculopathy.

Treatment for ischemic skin diseases would include avoiding the trigger and various immunomodulating drugs. For vaccine-induced alopecia the treatment options include pentoxifylline or surgical excision of the affected area. Pentoxifylline is a methylxanthine derivative that increases RBC deformability and lowers blood viscosity thereby allowing for better blood flow through narrowed/edematous vessels. It also suppresses synthesis of proinflammatory cytokines such as IL-1, IL-4, IL-12 and TNF-α. Pentoxifylline is administered at 15 mg/kg tid. There may be a 30-90 day lag before full clinical response is seen.

Other treatment options for ischemic dermatopathy include tetracycline (or doxycycline) and niacinamide. These drugs are used with, not replacing pentoxifylline. Doxycycline and niacinamide (D/N) have various anti-inflammatory & immunomodulating properties. The dosage for niacinamide in dogs or cats <10 kg is 250 mg q 8 hours. For dogs >10kg - 500 mg of niacinamide q 8 hours are administered. Doxycycline is dosed at 2 mg/kg q 24 hrs. If there is a clinical response (may take 2-3 months) the treatment is decreased from tid, to bid to sid. Side effects are rare but include vomiting, anorexia, lethargy, diarrhea and elevated liver enzymes from niacinamide and hepatotoxicity from doxycycline.

If there are focal lesions that fail to respond to the previous treatment, topical glucocorticoids (GC) may be added. The topical products are applied bid until clinical remission (not to exceed 21 days) and then tapered slowly over the next few months. Be sure to have the owners wear gloves when applying these products. Please note that topical steroids may cause pu/pd/polyphagia. This sensitivity to steroids is quite variable and may occur in unexpected situations. Topical tacrolimus (0.1%) may be used in cases that fail to respond to topical steroids, the pet has side effects to the topical steroid or for the dog that needs long term topical treatment to control the disease.

If the disease is more widespread or fails to respond to the previous treatments, prednisone may be used. It is administered at 1 mg/kg bid for 14 days. The dog is rechecked every 14 days. If the disease is in remission, the dose is decreased 25% every 14 days. The author defines "remission" as the absence of any active lesions. DON'T TAPER THE DOSE TOO QUICKLY. The goal is to maintain the dog on 0.25 mg/# or less every other day. Another option for SEVERE cases would include azathioprine along with the oral GC. The initial dose of azathioprine is 2.2 mg/kg sid. Once remission is achieved, and the dog is either off of GC or the lowest dose of GC has been obtained, AZA is then tapered usually every 30-60 days. When tapering AZA, the author will decrease the frequency, not the dose of azathioprine, first decreasing it to every other day and then if the disease is still in remission, to every 72 hours. When using AZA, a CBC, platelet count and serum chemistry profile are performed every 14 days for 2 months, then q 30 days for 2 months then q 3 months for as long as the dog is on AZA. Potential adverse effects include anemia, leukopenia, thrombocytopenia, hypersensitivity reactions (especially of the liver) and/or pancreatitis.

Cyclosporine (Atopica®) may be effective in some cases of ischemic dermatopathy. Be sure to use modified cyclosporine (Atopica®) since unmodified CSA is not absorbed as well. The dosage is 5 mg/kg sid.

Sulfasalazine (SSZ) is a sulfa that has both anti-inflammatory and/or immunomodulatory properties due to its prostaglandin synthetase and leukotriene inhibition. In the past it has been used for the treatment of colitis but more recently it has been used for vasculitis. Side effects associated with this drug include anemia, KCS and hepatotoxicity so a CBC, serum chemistry profile and Schrimer tear test are performed every 14 days for 2 months, then q 30 days for 2 months then q 3 months for as long as the dog is on SSZ. The dose for SSZ is 20-50 mg/kg tid (maximum 1 gm/dose), usually beginning with 20-30 mg/kg tid. Once the disease is in remission, the dose is slowly tapered

Sebaceous adenitis (SA) is an inflammatory disease of the sebaceous glands. Some people will separate this disease into the granulomatous form (Standard Poodle form= SPf) that is seen in Standard Poodles, Akitas, Samoyeds, Old English and Belgian sheepdogs and the short coated breed form seen in the Viszla, Weimeraners and Dachshunds. The author believes this later form is not sebaceous adenitis but rather part of the syndrome known as sterile granuloma/pyogranuloma syndrome (sterile periadnexal granulomatous dermatitis) and will not be discussed in this lecture.

A genetic basis has been identified in Standard Poodles and is believed to be an autosomal recessive trait. Both the spontaneous and genetic forms of the disease occur in young adult to middle aged dogs.

Clinically the dog with the SPf will have adherent white scaling, follicular waxy "casts", and matted hair from the waxy scale, varying degrees of hypotrichosis (including alopecia) and a dull appearance to the hair coat. In Standard Poodles many of the remaining hairs lose their curls. Secondary bacterial folliculitis may be present and result in pruritus. SPf tends to begin on the dorsum, especially the head and then progress caudally and distally onto the extremities.

Early histopathologic changes that are found with the granulomatous form include a nodular granulomatous to pyogranulomatous reaction in the ischemic region of the hair follicle that is unilateral (sebaceous glands are unilateral), follicular and surface hyperkeratosis (clinically will appear as scaling). In the end stage of the disease, the inflammation has resolved and you will be left with perifollicular fibrosis, follicular atrophy and absence of sebaceous glands. Treatment for the SPf includes treating secondary bacterial or *Malassezia* infections. Pre-bath spraying with baby oil, bathing with a keratolytic shampoo (eg sulfur/salicylic acid containing product) and follow with a humectant. Keratolytic agents will cause desquamation of the cornified epithelium, basically loosening the outer layer of the skin (SC). Oral omega 3/6 combination products at double the bottle dose and evening primrose oil (500 mg bid). The author has discontinued using oral Vitamin A for this disease. This is based on a study that revealed there was no correlation between vitamin A dosage and response to treatment nor any difference between dogs responding and those not responding to adding vitamin A to topical therapy. In addition, there is evidence that retinoids are the most potent pharmacological inhibitor of sebum secretion. Histological changes in sebaceous gland size can be seen after 8 weeks of treatment. The sebaceous glands have a reduced size and the sebocytes appear undifferentiated with decreased lipid accumulation. These are undesirable effects in treating sebaceous adenitis.

In a study oral cyclosporine was used to treat 12 dogs with SA (not just SPf). Ten of twelve dogs improved within 4 months however most needed topical therapy once the mCSA was discontinued. In summary, treatment with mCSA resulted in clinical improvement in dogs with SA, with the greatest improvement evident within 4 months after the initiation of treatment. The authors concluded that long-term treatment appears to be necessary to control the disease. The authors reported that there was some evidence that mCSA was of limited benefit in dogs with chronic disease in which the perifollicular inflammatory reaction had already resolved. Therefore, treatment with mCSA should be initiated as early as possible during the course of the disease.

A subsequent study is only available in abstract form so details are lacking. This study involved 20 dogs with SA. Initial therapy included essential fatty acid supplementation with a total gamma linolenic acid dose of 10–20 mg/kg once daily and an antiseborrhoeic shampoo twice weekly. All animals were assessed at 3 weeks. An improvement in coat condition was noted at this time, but there was no evidence of hair regrowth. Treatment was started with topical cyclosporine. Twenty-five millilitres of cyclosporine (Neoral oral solution, 100 mg/mL) made up to a total volume of 250 mL of liquid with sterile water (making it a 1% solution) was applied to the coat once daily followed by an emollient spray. At a 6-week recheck, further improvement was noted. In

some cases, new hair regrowth was apparent. In six dogs, blood samples were taken at 9 weeks to measure blood levels of cyclosporine. In no case could cyclosporine be detected. Therapy was successful in every case, but was deemed too labor intensive by the owners of some dogs. Despite good initial improvement in their dog's skin condition, they were lost to follow-up. In all other cases, once hair had regrown after 8–12 weeks, the frequency of application could be reduced to once or twice weekly.

In a study using 9 dogs Lucas et al used a 0.4% CSA solution. He made the solution by mixing four 100 mg capsules in 100 mL vegetable oil. The solution was applied twice per week. Clinical improvement was noticed in all dogs, and total hair regrowth occurred in 4 months. Topical (0.4%) cyclosporine A applied twice a week was well tolerated and efficacious in the symptomatic treatment of sebaceous adenitis in dogs.

Lastly there was a study that revealed that the combination of topical treatment and oral CSA gave the best results. Differences between the treatment protocols are marginal. Topical treatment, both alone and in combination with CsA, appeared to reduce scaling more effectively than CsA alone. Both therapies reduced alopecia. In the study there was some evidence suggesting a synergistic benefit on both scaling and alopecia if both treatment options were combined. Inflammation of the sebaceous glands was reduced the most by a combination of both CsA and topical therapy. There was evidence that regeneration of sebaceous glands is best achieved by CsA, either given alone or in combination with topical treatment.

The next group of alopecic diseases that will be discussed are the ones that are diffuse or symmetrical on examination. The first group we will discuss are the endocrinopathies. Hypothyroidism is one of the most over-diagnosed endocrine disease in the author's referral practice. Hypothyroidism is most commonly caused by an immune mediated destruction of the thyroid gland. Middle-aged medium sized to large breed dogs are the most commonly affected dogs. Clinical findings that have been associated with hypothyroidism are quite extensive and will not be reviewed here. A few dermatologic clues would include seborrhea sicca or oleosa, poor hair regrowth (seems to be a more common complaint than spontaneous alopecia), recurrent bacterial pyoderma and a dry, dull hair coat. Alopecia (triangular in shape) just caudal to the nasal planum is another finding that suggests hypothyroidism. The "frizzies" may be seen in Golden retrievers and Irish setters. CBC, serum chemistry profile and urinalysis may reveal mild nonregenerative anemia, hypercholesterolemia and hypertriglyceridemia. Thyroid testing is needed for a definitive diagnosis of hypothyroidism. Thyroid tests that are of value include Total T4 (TT4), free T4 by equilibrium dialysis (fT4ed), thyroid stimulating hormone concentrations (cTSH), thyroglobulin autoantibody (TgAA), T4 autoantibodies (T4ab) and T3 autoantibodies (T3ab). Details of these tests sensitivity and specificity are beyond the scope of this lecture.

The thyroid profile requested by the author includes TT4, cTSH, TgAA, T4ab, T3ab. The author will have a fT4ed added to the profile if there are T4ab present, if non-thyroidal illness is present or the dog has received drugs known to affect the thyroid. In general DOGS MUST NOT HAVE RECEIVED TOPICAL OR ORAL STEROIDS FOR 30 DAYS OR REPOSITOL STEROIDS FOR 3 MONTHS BEFORE TESTING THE THYROID. Also, they must not have received sulfa drugs for at least 30 days. For dogs with hypothyroidism, after 1 month of therapy (L-thyroxine 0.02 mg/kg bid-use BRAND NAME ONLY), a blood sample is submitted 4-6 hours post pill for a TT4. The levels should be in the upper range of normal or even a little higher than normal.

A far more common endocrinopathy seen by the author is hyperadrenocorticism (HAC). It is not the purpose of this lecture to discuss all the symptoms of HAC but a few points must be made. In dermatology it is NOT uncommon to have a dog with HAC present without pu/pd or a potbelly appearance and may ONLY have a recurrent pyoderma, poor hair regrowth or non-inflammatory truncal alopecia. If there is a suspicion that the dog may have an endocrinopathy (based on PE, cbc, serum chemistry and urinalysis results) then it is important to first rule out HAC since a dog with HAC may have a low thyroid profile due to the influence that steroids have on the thyroid gland. The 2 screening tests that are used by the author are the ACTH stimulation and the LDDS. If the dog has a history of steroid exposure, then an ACTH stimulation test is performed. If the dog has no recent steroid exposure, then the author prefers to begin with a LDDS test. Note that 1 normal screening test doesn't rule out HAC. The author believes that the sensitivity of the LDDS is much better than the ACTH stimulation. Treatment for HAC is based on the severity of the clinical signs. Either trilostane or mitotane may be used.for treatment.

Dyscyclic follicular diseases of unknown etiology (post clipping alopecia, alopecia X, seasonal flank alopecia.) are diseases in which the hair follicle is structurally normal but it is not cycling properly. Rule outs for these dyscyclic diseases include the endocrinopathies already discussed and also hyperestrogenism (sertoli cell tumor associated).

Alopecia X is a syndrome of unknown etiology. Theories abound as to the cause including an adrenal sex hormone imbalance, an abnormal metabolism of hormones by the hair follicle or a hormone receptor problem at the follicular level. The later theory is supported by the observation that hair regrows at the site of skin biopsies. This ability to induce hair regrowth by localized trauma would suggest a local inhibition of hair cycling rather than systemic. Alopecia X occurs in plush coated breeds and in poodles. It occurs in young adults of either sex or reproductive status. Clinically these dogs lose their guard hairs, beginning on the neck and progressing to the shoulders, trunk and thighs. Eventually the dog may have a woolly, cream color coat. In some dogs this may progress to alopecia with hyperpigmentation. Diagnosis is based on signalment, hx, PE and ruling out (r/o) other alopecic diseases. Histopathology can support but not diagnosis Alopecia X. That is because the findings with Alopecia X resembles other dyscyclic alopecic diseases such as hypothyroidism, hyperadrenocorticism, gonadal sex hormone abnormalities, recurrent flank alopecia and

post clipping alopecia. Histologically, these diseases are characterized by many specific (follicular atrophy, telogenization of follicles with excessive trichilemmal keratinization (flame follicles), orthokeratotic hyperkeratosis, follicular keratosis, sebaceous gland atrophy), but nondiagnostic (nondifferentiating) findings. An adrenal sex hormone panel stimulation test can be performed but it is of questionable value in the author's opinion. Treatments that have been used with variable success include neutering, sex hormone replacement (estrogen OR testosterone), low dose lysodren, melatonin, trilostane, growth hormone and thyroid supplementation. All of these treatments may cause a temporary improvement in the alopecia (nonspecific anagen induction?) but rarely is the hair coat returned to normal. Also these medications (other than melatonin) are associated with potentially significant side effects. In the author's practice, if a diagnosis of Alopecia X is made then the client is counseled about the choice in treating a cosmetic disease with potent drugs. Neutering is recommended if it is an intact animal. If the alopecia fails to respond to the neutering, a therapeutic trial with melatonin 3-6 mg tid for 90 days is performed.

Seasonal flank alopecia (SFA) is a nonscarring alopecia that has been reported in a variety of breeds, but it has been reported to be more common in Boxers, Airedales and Bulldogs. The etiology is unknown. Some people think that it is caused by a "melatonin deficiency" since many of the dogs develop the lesions in the fall, when melatonin levels should be increasing and some dogs respond to melatonin administration. But there are some cases that the hair is lost in the spring and regrows in the fall so it makes this etiology impossible. The disease occurs in young adult dogs and will begin most commonly in the fall with spontaneous resolution in the spring. This disease may occur once and never recur, it may recur each year with each episode involving larger areas of the body, or it can occur once and never completely resolve. The lesions involve the flanks and sometimes the caudal lateral thorax. The alopecia is usually bilateral with annular lesions that may coalesce into polycyclic lesions with hyperpigmented and smooth glistening skin. Papules and pustules consistent with a bacterial pyoderma may develop in these areas. Diagnosis is based on r/o other nonscarring alopecias – hx alone may be diagnostic if it is a recurrent problem. Biopsy can support but not diagnose SFA. Treatment is again either a tincture of time or melatonin. Since the disease usually goes into spontaneous resolution it may be difficult to determine if the melatonin had any impact, especially the first time the disease occurs. In the author's practice melatonin is more commonly used to prevent symptoms by beginning therapy just prior to the onset of the symptoms (if there is a seasonal pattern). Dose is as discussed previously.

Post clipping alopecia occurs primarily in the Arctic breeds. It has been theorized that these breeds have a very long telogen (resting) phase to their hair cycle in order to preserve a high protein substance (hair!). If the hair is clipped during the telogen stage, it will not regrow until it cycles back to the anagen stage. Others have suggested that when the hair is clipped there is decreased blood flow to the area (to minimize heat loss) leading to a decrease in growth factors. Diagnosis is based on hx and r/o endocrinopathies. Histopathology will reveal follicles of normal size but in most are in telogen. Treatment is tincture of time or sometimes a 7-10 days course of thyroid supplementation (will stimulate anagen formation) or a 90 day trial of melatonin

The structural follicular dysplasias -color linked, non-colored linked and pattern baldness all have an abnormality not just of the hair follicle but also the hair shaft. Be aware that finding dysplastic hair follicles on histopathologic is not adequate evidence to diagnosis a structural follicular disease; there should also be dysplastic hair shafts. A study in 1998 reported that 46% of the dogs with an endocrine alopecia had dysplastic hair follicles but less than 1% had concurrent dysplastic hair shafts.

Colored linked alopecias include color dilution (mutant) alopecia (CDA) and black hair follicular dysplasia (BHFD). CDA occurs in dogs with a blue or fawn hair coat. These hair coat colors occur as a result of the effect of the "dilute" gene on black or brown hairs respectively. Any dog with a blue or fawn coat may be affected by CDA but not always. Dobermans and Great Danes are the most common breeds seen in the author's practice affected by CDA. A dog with this autosomal recessive genodermatosis is born with a normal coat but as the dog matures, usually beginning at between 4 months of age and 3 years, it will develop varying degrees of hypotrichosis (including frank alopecia) affecting the "dilute color" areas only. The hair coat will become dull and there will be scaling and comedone formation. Secondary bacterial pyodermas are frequently present. The exact cause of the hair shaft abnormality is not known but is believed to be related to a dysfunctional melanin transfer from the melanosomes to the hair matrix or a defect in the storage of the melanin once it is in the hair shaft. The result is melanin clumping. This clumping leads to weakening and eventual fracturing of the hair shaft. Diagnosis is based on hx, PE, appearance of hairs on a trichogram, r/o other alopecic diseases (especially demodex, dermatophytosis, bacterial pyoderma and endocrinopathies) and is supported by histopathology. Microscopic examination of plucked hairs will reveal melanin clumping in the hair shafts and disruption of the normal hair shaft architecture. Treatment (other than elimination from the breeding stock) is directed toward managing the secondary pyodermas and seborrhea. Bathing, humectants, fatty acids +/- antibiotics are the mainstay of therapy. Melatonin, which can stimulate hair cycling, has also been reported to improve hair coats in some dogs. The author uses melatonin, 6 mg tid, as a 90 day therapeutic trial.

BHFD is an alopecic disease of dogs with bicolored or tricolored hair coats such as Boston Terriers, Basset hounds and Cocker spaniels. It has been reported to be inherited as an autosomal recessive trait. This tardive disease is also believed to be due to a defective transfer of melanin leading to melanin clumping that weakens the hairs and eventual fracture. Usually abnormalities of the hair coat are noted by the time the dogs are weaned. Initially changes consist of a dull hair coat affecting only black hairs. Eventually these areas become alopecic. As with CDA secondary pyodermas may occur. It may be easiest to think of BHFD as a localized form

of CDA. Histopathology is similar to CDA and diagnosis is based on signalment, hx, PE, appearance of hairs on a trichogram and can be supported by histopathology. Treatment is the same as CDA.

Non-colored link follicular dysplasias have been reported in a number of breeds including Portuguese Water dogs, Irish Water Spaniels and Curly Coated Retrievers. Between 6 months and 6 yrs of age (depending on the breed) these dogs develop symmetrical hypotrichosis to alopecia usually beginning on the neck and progressing to the shoulders, trunk, tail and thighs. Any remaining truncal hairs may have a color change (lightening). In dogs, estrogen receptors are present in telogen hair follicles and are important in keeping hairs in this phase. In Irish Water Spaniels dietary change (avoiding soy which may contain phytoestrogens) has been reported to be effective. Melatonin and trilostane both block estrogen receptors and may account for the effectiveness of these drugs in a variety of canine alopecic diseases.

Pattern baldness alopecia (PBA) is also a tardive genodermatosis. The dogs are born with a normal coat but develop PBA at 6 months-1 yr of age. There are 4 different forms of this non-inflammatory, non-pruritic alopecia. One form occurs in male Dachshunds. These dogs develop a slowly progressive alopecia and hyperpigmentation of the pinnae. A second form occurs in primarily in female Dachshunds, Chihuahuas, Whippets, Manchester Terriers, Greyhounds, and Italian Greyhounds. This form is identical to the first form except for the distribution of the alopecia. In this form there is progressive alopecia caudal to and involving the pinnae, ventral neck, ventrum and caudomedial thighs. The 3rd form affects American Water Spaniels and Portuguese Water Dogs (see above). The last form is seen affecting the caudolateral thighs of Greyhounds. Regardless of the form of the PBA, diagnosis is made on signalment, hx, PE, ruling out other alopecic diseases and supported by histopathology in which there is miniaturization of hair follicles and shafts with normal adnexa. There have been reports of some dogs improving with melatonin.

What Would You Do?

Paul Bloom, DVM, DACVD, DABVP
Allergy, Skin and Ear Clinic for Pets
Livonia, MI

What would you do? An interactive session where a real case is presented for the audience to diagnose and manage

This case presentation will focus on a typical allergic dog that is not responding to therapy as he has in the past. During this discussion we will focus on the step by step approach that should be taken to help address this dog's problems in the most cost effective manner. Also we will discuss common pitfalls that occur in managing these cases and how to avoid them. We will discuss both the short term and long term therapy of an allergic dog. During the session we will learn which questions to ask, which tests to perform and which therapies should you use and which you should avoid. We will delve into how to interpret bacterial cultures using the MIC data and how it applies clinically to dosing and frequency of antibiotics. We will discuss which antibiotics are considered first tier and which are considered second tier when dealing with bacterial pyodermas in the dog.

How Taking a Great History Can Make You a Great Dermatologist

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

The importance of the dermatological history can't be overstated. Having a standardized dermatological history form for clients to fill out can be extremely useful and improve efficiency. Regardless of if it is obtained via paperwork or on direct questioning, there is basic information that should be known prior to the dermatological examination. It is remarkable how much of a differential diagnosis list or working diagnosis can be generated with history alone.

What is the chief complaint?
You immediately need to know why the pet is presenting to you, as it will help guide your historical questions and allow you to instantly identify to the client that you are addressing why they brought the animal in. If you don't do this, they can become frustrated as you proceed to questions that in their mind could be irrelevant.

What is the signalment of the pet, when was it acquired and from where?
Many skin conditions have a strong predilection for certain breeds, ages and genders of the pet. For example, if a 4-month-old puppy presents with acute facial swelling, huge submandibular lymph nodes and a papular/pustular rash on the muzzle, juvenile cellulitis would be the top differential. If a young Persian cat obtained from a cattery presented with non-pruritic alopecia, dermatophytosis would be the top working diagnosis until proven otherwise.

What is the age of onset of the dermatological condition?
The age of onset when dealing with pruritic disease is extremely useful information. Pruritus beginning before 6 months of age is most often seen in parasitic diseases, allergies (most often flea allergy or food allergy) and dermatophytosis. Middle-aged pets would include the above but also would tend to emphasis allergies (food and atopic dermatitis). When older pets present with new pruritic skin disease food allergies are a top differential, as are more unusual causes of pruritus in older animals, such as mycosis fungoides (cutaneous T cell lymphoma). Furthermore, certain hormonal and autoimmune diseases are more likely to occur at certain times in a pet's life than others.

What is the seasonality of the dermatological condition?
The presence of seasonal pruritus makes atopic dermatitis and/or flea allergic dermatitis more likely. If seasonality is present during which time the patient's symptoms fully resolve and then return after a substantial period of time, certain conditions, such as food allergies and endocrinopathies are unlikely and can usually be ruled out.

Questions about the pet's immediate environment: is the patient indoor/outdoor; if outdoor what percentage of the time; what kind of exposure to the non-home environment do they have: i.e. how frequently do they board, go to dog parks, doggy day care, etc. Are there other pets in the household? If so, what species and are they affected with dermatological disease as well. Are any humans in the house affected with dermatological disease?
Determining the nature of the pet's environment is very important. Animals that have a history of leaving the home environment can be more at risk to be exposed to parasites (fleas, sarcoptes) and infectious agents (dermatophytosis, viral infections). Symptoms triggered by environmental changes such as a recent move or addition of a new pet can all help give clues to if the condition could be allergic or parasitic. Knowing if any animals or people in the household have skin disease can be very important, as it would make contagious or zoonotic conditions a consideration.

Is the patient pruritic? If so, what is owner's numerical assessment using the pruritus score (0-10)?
In a pruritic patient, it is helpful to have the client assess the pruritus scale for you at each appointment. This helps gauge progress and provides documentation that allows you to track seasonality/waxing and waning in your records.

Different conditions have typical levels of pruritus that are expected. Canine sarcoptic mange and feline notoedric mange are some of the itchiest skin diseases that occur, with most owners observing 10/10 on the pruritic scale. Hormonal and autoimmune diseases are typically minimally pruritic, although the presence of a secondary infection can create a level of pruritus that can mimic allergies. Similarly, canine demodectic mange is classically considered a non-pruritic disease, which is why many demodectic dogs that are pruritic from secondary bacterial infection are commonly misdiagnosed as allergic and erroneously treated with glucocorticoids.

What types of symptoms is the patient displaying?
It is important to clarify the dermatological symptoms that the owner is observing including, but not limited to: pruritus, alopecia, rashes, pustules, blackheads, erythema, hives, crusting or the presence of growths or nodules.

What are the locations of the symptoms?
Many conditions have predilections to manifest at certain locations. A dog that has front paw licking and recurrent ear infections is typically food allergic and/or atopic. Pemphigus foliaceus would be the top concern in a cat with crusting on the nail beds, pinna, and around the mammae. Because lesions can come and go and because the dermatological examination may not indicate the location of a pet's problems (especially in allergies), having the owner tell you where they perceive symptoms is extremely important. A pruritic dog that comes in looking 100% normal but whose owner reports non-stop chewing at the base of the tail needs to be treated for flea allergies before proceeding to other differentials, regardless of if fleas or flea dirt are present.

Does the patient have any other previous problems?
Knowing about other concurrent or previous diseases can be very important. Dogs with a history of inflammatory bowel disease (IBD) that develop pruritus may be more likely to have a dietary allergy. Herpes virus and calicivirus would be concerns in a cat with a history of upper airway viral disease that has developed facial lesions and pruritus.

Does the patient have any concurrent gastrointestinal symptoms? How many bowel movements does the patient have daily? Are they prone to vomiting/diarrhea/loose stool/gas/perianal pruritus?
All these questions are asked to obtain if the patient is possibly displaying other symptoms of food allergies. Whenever I have a pruritic puppy with five-six bowel movements daily I have a serious discussion about diligent evaluation for underlying food allergies. If a patient like this persists with symptoms after one food trial I'm more likely to try a second food trial with a different diet before moving on to other causes of differentials.

What current medications is the pet on? What is the pet's vaccination history? Has the pet received any medications/treatment for this condition and if so what was the efficacy of these treatments?
Certain drugs and vaccines can create drug reactions, and having a detailed history of all previously used drugs is very important. If the current pruritic condition is drug responsive, to what drugs is helpful information. Is the condition antibiotic or glucocorticoid responsive? Many allergy cases are glucocorticoid responsive, however some cases are not or may require higher than typical dosages. Knowing that the condition gets worse with glucocorticoid therapy would make you think of infectious conditions, such as dermatophytosis, demodicosis or possibly autoimmune diseases such as pemphigus foliaceus (PF). PF can be very pruritic and non-glucocorticoid responsive especially if the dosage of the glucocorticoids was not initially high enough. Knowing current medications before prescribing new therapy is critical as there are many drug interactions to be aware of. Do not use oral monthly spinosad flea treatments in patients receiving high dose ivermectin for parasitic conditions, as this can potentiate neurological side effects. Never prescribe glucocorticoid therapy to a patient receiving non-steroidal therapy, as this can cause stomach ulceration.

Cutaneous Manifestations of Internal Diseases

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

This will be a case based lecture, which each case being representative of a cutaneous manifestation of a systemic disease. This is meant to be a more interactive hour to help practitioners think about how to appropriately work up these more unusual cases. Conditions that will be covered include superficial necrolytic dermatitis (also known as shepatocutaneous disease), feline paraneoplastic alopecia, cutaneous xanthomas and nodular dermatofibrosis.

Dermatophytosis: Dealing with Typhoid Mary

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

Dermatophytosis implies cutaneous infection with one of several species of keratinophyllic fungi. Three species are responsible for the vast majority of clinical cases: Microsporum canis, Microsporum gypsum and Trichophyton mentagrophytes. Microsporum gypsum is a soil inhabitant, Microsporum canis is a zoophilic organism that has adapted to animals and is a normal inhabitant of the hair coat of some cats. Trichophyton mentagrophytes infections are usually associated with exposure to rodents or their environment. Dermatophytosis is a disease, which is both over diagnosed, as well as often overlooked. If clinicians rely on clinical signs alone the disease is over diagnosed. Since the organism usually causes a folliculitis, a common clinical sign is circular areas of alopecia with scale. These signs cannot be clinically distinguished from a staphylococcal folliculitis or demodicosis. However, due to the variety of other clinical presentations, dermatophytosis is often overlooked. Many patients will show papular eruptions with variable scale and crusting and cats often times can display military dermatitis. Pruritus is also extremely variable; some cases are non-pruritic while others can be very pruritic. This may lead to an erroneous diagnosis of an allergic condition or other pruritic disease, with the subsequent inappropriate use of glucocorticoids. Without appropriate diagnostics, dermatophytosis can go undiagnosed for long periods of time.

Definitive diagnosis of dermatophytosis is made by positive fungal culture or identifying the organism by histopathology, although diagnosis is best made with positive fungal cultures. Dermatophyte test media (DTM) is a convenient fungal culture media commonly used by practitioners. Dermatophytes utilize protein and produce an alkaline by product that produces a red color change. However, after all the carbohydrates are utilized, the saprophytes can utilize the protein and turn the media red. The DTM cultures should be inspected daily. Suspected fungal growth can be lifted with clear plastic tape and stained with lactophenol cotton blue for characteristic macroconidia and fungal identification. Identifying the dermatophyte causing the infection is extremely important, as it will tell you where the pet contracted the fungal organism and how to best control it. If the source of the fungus isn't addressed, reinfection after treatment is possible.

Other less accurate diagnostics include Wood's light fluorescence and direct microscopic examination of the hair. The Wood's light fluorescence is positive in only a small percentage of M. canis cases. Positive fluorescing hairs should be plucked for DTM culture or for direct microscopic examination. The direct microscopic examination requires a trained individual, and hyphae or arthrospores can be seen in 40-70% of cases. Diagnosis of dermatophytosis by Wood's lamp examination is wrought with hazards. The Wood's light is an ultraviolet light with a light wave of 253.7 nanometers filtered through a cobalt or nickel filter. When exposed to this UV light, hairs infected by M. canis may give a yellow/green fluorescence. The fluorescence is caused by the tryptophan metabolite produced by the organism. This test however is subject to numerous errors. False negative results may be obtained by inadequate examination. The lamp should be allowed to warm up for 5 minutes since the light wavelength is more stable at certain temperatures. Some hairs also need prolonged exposure to show fluorescence. Certain medications like iodine will also destroy florescence. False positive results are also common. It is essential to remember that only the hairs should florescence. Color changes to scale, crust or other material is not significant. Certain bacteria, specifically Pseudomonas or Corynebacteria may also cause fluorescence. It is imperative to remember that of the commonly encountered veterinary dermatophytes, only Microsporum canis will fluoresce and, then, only approximately 40% of the time. So while a positive Wood's lamp test is meaningful, a negative test means nothing and further diagnostics should be undertaken.

Treatment

There are three keys to the appropriate treatment of dermatophytosis: environmental decontamination, topical treatment, and systemic treatment.

The environment should be addressed in every case of dermatophytosis you diagnose. This is the most important in cases of *M. canis*, as the spores can live in the environment for up to 18 months. Vacuuming, disinfection, steam cleaning, and discarding infected bedding are all important.

Topical therapy is palliative at best and in a number of cases is ineffective on its own. This is not surprising if you remember that this disease is causing a folliculitis and topical medications are just unable to penetrate the skin as much as needed. Many miconazole, ketoconazole and chlorhexidine based shampoos and rinses are available and can be applied 2 to 3 times a week. An older, reportedly effective topical is 2% lime sulfur, it can be tried at 5-7 day intervals. Shaving affected longhaired cats with generalized lesions may facilitate topical therapy. Shaving dermatophyte patients needs to be done with care. Not adequately cleaning/containing the shaved hair can cause release of infected hairs into the environment. If the pet is shaved too closely, microtrauma to the skin can occur which can facilitate infection of the fungus into the hair follicle.

There are numerous drugs that can be used when treating dermatophytes. Regardless of the drug chosen, the author prefers to treat through two-three consecutive negative fungal cultures at 2-4 week intervals. The first culture is usually taken 4-6 weeks into treatment, depending on the drug used and the clinical presentation, and only after clinical signs have resolved and a previously positive Wood's lamp is now negative.

Systemic oral medications used for treating dermatophytosis:

Drug	Dosage	Comments
Griseofulvin (microsized)	50-100mg/kg divided BID	Monitor CBC Give with a fatty meal Teratogenic Do not use in FIV cats
Griseofulvin (ultramicro)	10-15mg/kg divided or as a single daily dose	Same as above
Itraconazole daily	5mg/kg once daily	Monitor liver values
Itraconazole pulse	5mg/kg once daily for 1 week, off one week, repeat	Monitor liver values
Ketoconazole	10mg/kg/day (dog)	Monitor liver values Not as effective Higher incidence of GI side effects in cats-so not recommended
Terbinafine	30mg/kg/day	Monitor liver values Anecdotal efficacy May be safer in animals with liver issues
Fluconazole	5-10mg/kg/day	Monitor liver and kidney values Not always as effective Typically safe and well tolerated

Other

Lufenuron (Program®, Novartis) has been used for dermatophytosis treatment due to its anti-chitin properties. It is used at 100mg/kg every 14 days. There is a tremendous amount of controversy associated with its success. Controlled prospective studies have cast doubt on its efficacy. Some dermatologists use Program in conjunction with other systemic treatment, but it is not recommended to use as the main systemic treatment. Dermatophyte vaccines have been used in Europe to treat cattle and foxes, and have been available in the United States. However, for small animals they show little benefit and are not recommended by the author.

What to do with those Challenging Dermatology Cases

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

This two hour lecture will be purely cased based, going through several complicated dermatology cases. A variety of patients will be presented, and the discussion will help establish the thought processes used to manage cases that present as a diagnostic or therapeutic challenge.

Toes and Nose:
Approach to Diseases of the Footpads and Nasal Planum

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

Diseases of the nasal planum and footpads in cats and dogs range from life threatening diseases to benign conditions that require long-term therapy to maintain control. It is of the utmost importance to properly diagnose the diseases that affect these locations, as the treatment and prognosis varies greatly depending on the disease entity. It cannot be underestimated how valuable histopathology is in elucidating the majority of these diseases.

History

Taking a thorough history is the first step in determining the underlying cause of diseases of the nasal planum or footpads. Age of onset, breed, gender, location of lesions, systemic illness, spread to other animals/humans, husbandry conditions and chronicity/progression of disease all give clues to narrow down the differential list. For example, if a cat with a history of chronic upper respiratory tract infections starts developing ulceration of the nasal planum, feline herpesvirus dermatitis would be a top differential.

Physical examination

A complete physical examination is key. It is especially important when evaluating diseases of the paws to differentiate between diseases of the footpads versus interdigital pathology, as both can cause lameness and pain. Furthermore, the presence of lesions on locations other than the nasal planum and footpads needs to be noted, as this will affect the differential list. In addition, the lesion type should be determined to help assist with the differential diagnoses list.

Differential diagnoses

Tables 1 and 2 present the most significant diseases affecting the nasal planum and footpads of cats and dogs, as well as other key points about the diseases.

Diagnostic tests

Cytology/skin scraping

Cytology can be very helpful in cases involving the nasal planum and footpad to evaluate for things such as bacteria, acantholytic keratinocytes associated with pemphigus, and inflammatory cells that can give clues to the underlying etiology. Skin scraping can also be useful in certain cases to evaluate for parasitic causes of disease.

Fungal culture

Fungal culture should be performed to rule out dermatophytosis. In cases where acantholytic cells are seen on cytology and pemphigus is suspected, a fungal culture should definitely be performed as inflammatory, pustular dermatophytosis can cause acantholysis.

Skin biopsy

Definitive diagnosis of the majority of the diseases of the nasal planum and footpads are confirmed by histopathology. It is imperative that the clinician be comfortable choosing lesional skin, as this is the most likely to provide a definitive diagnosis. In general, ulcerated skin should be avoided, as the epidermis is no longer intact. As bacteria and/or yeast often colonize compromised skin, treatment with antimicrobials is usually indicated prior to taking biopsies. Furthermore, as diseases of these anatomical locations are often unusual, it is also recommended that biopsy samples be sent to a dermatopathologist or a pathologist with a special interest in skin disease, as the changes in some of these conditions can be subtle and require an experienced eye to diagnose.

Table 1: Differential diagnoses for diseases affecting the nasal planum and footpads in cats

Feline Diseases and incidence	Anatomical Sites		Other key points	Predispositions
	Nasal Planum	Footpads		
Pemphigus foliaceus (Uncommon)	Pustular dermatitis leading to crusting/alopecia, erythema/erosions	Pustules, hyperkeratosis, crusting and pitting	Lesions can occur anywhere, but are especially common on the pinna, nail beds and nipples	None
Drug eruption (Rare)	Ulcerative dermatitis or pemphigus-like lesions	Ulcerative dermatitis or pemphigus-like lesions	Highly variable in presentation and body parts affected.	None
Erythema multiforme (Rare)	Ulcerative or vesiculobullous dermatitis	Ulcerative or vesiculobullous dermatitis	Most common on the trunk and mucocutaneous junctions.	None
Herpesvirus dermatitis (Uncommon)	Ulcerative, crusting dermatitis	Uncommonly causes an ulcerative/crusting dermatitis	Skin lesions commonly follow the path of the trigeminal nerve	History of upper respiratory tract viral infections
Plasma cell pododermatitis (Uncommon)	---	Swelling w a layer of white, scaly striae	+/- enlarged lymph nodes, muzzle swelling	FeLV/FIV cats at higher risk
Systemic lupus erythematosus (Very rare)	Erythematous, scaling, crusting dermatitis	Erythematous, scaling, crusting dermatitis	Symmetric face, ear and paw lesions	Siamese, Persians and Himalayans
Squamous cell carcinoma (Uncommon)	Ulcerative/erosive/swollen, erythematous, painful, necrotic dermatitis	Under cutaneous horns or, rarely, an ulcerative dermatitis	Pinna, eyelids and lips commonly affected	White cats
Epitheliotropic lymphoma (Rare)	Erythema, depigmentation or ulceration	Depigmentation, hyperkeratosis or ulceration	Variable	None
Vasculitides (Rare)	Ulcerative dermatitis	Ulcerative dermatitis	Pinna, lips and oral mucosa	FeLV positive cats, secondary to drug or vaccine reactions
Mosquito bite hypersensitivity (Common)	Papulocrusting, ulcerative dermatitis	Footpads can become painful, swollen, and hyperkeratotic,	Crusting, papular, erosive dermatitis, on the pinna and bridge of the nose	White cats and black and white cats anecdotally predisposed
Eosinophilic granuloma (Common)	---	Firm, erythematous or ulcerated footpad swellings	Often present in the oral cavity, on the chin and limbs	Allergic cats

Table 2: Differential diagnoses for diseases affecting the nasal planum and footpads in dogs

Canine diseases	Anatomical Sites		Other key points	Breed Predispositions
	Nasal Planum	Footpad		
Pemphigus foliaceus (Common)	Pustular dermatitis that leads to crusting, alopecia, depigmentation, erythema and erosions	Hyperkeratosis and crusting	Pinna, muzzle and periocular skin commonly affected	Chow Chows and Akitas
Pemphigus vulgaris (Very rare)	Vesiculobullous progressing to an erosive/ ulcerative dermatitis	---	Oral cavity is often involved. Patients systemically ill.	None
Discoid lupus erythematosus (Common)	Erythema/crusting/depigmentation /scaling that leading to loss of cobblestone/ ulceration/erosion/ fissuring	Hyperkeratosis of the footpads is uncommon	Periocular area, bridge of the nose, lips, pinna and genitalia	German shepherds, Labrador retrievers, Collies
Drug eruption (Rare)	Ulcerative dermatitis or pemphigus-like lesions	Ulcerative dermatitis or pemphigus-like lesions	Highly variable in presentation and body parts affected.	None
Erythema multiforme (Rare)	Ulcerative or vesiculobullous dermatitis	Ulcerative or vesiculobullous dermatitis	Variable	None
Uveodermatological Syndrome (Rare)	Depigmentation, rarely crust and erosion	Depigmentation	Uveitis; Mucocutaneous jxn depigmentation	Akitas, Siberian huskies, Chows
Vitiligo (Uncommon)	Depigmentation	Depigmentation	Mucocutaneous junctions, face, muzzle	Rottweilers, German shepherds, Dobermans
Nasal hyperkeratosis (parakeratosis) of Labrador retrievers (Uncommon)	Hyperkeratosis, crusting, depigmentation that can lead to ulceration and erosion	Hyperkeratosis of the footpads can be seen	Scale and crust on the bridge of the nose	Labrador retrievers and their crosses
Epitheliotropic lymphoma (Rare)	Depigmentation, scale, crusting, or ulcerative dermatitis Early lesions often develop around nasal planum	Depigmentation, hyperkeratosis or crusting.	Can be localized-generalized depigmentation, erythroderma scale and crust or can present as plaques or nodules.	Golden retrievers
Squamous cell carcinoma (Common)	Ulcerative-erosive, swollen, erythematous, painful, necrotic dermatitis	Ulcerative dermatitis	Solar induced lesions common on the trunk and ventrum	Beagle, Dalmatian, Bull terrier
Zinc responsive dermatoses (Uncommon)	Erythema, crusting dermatitis	Hyperkeratosis and crust	Erythema, alopecia, crusting often involves the muzzle, pinna and genitals Can be associated with poor diet	Siberian husky, Alaskan malamute, American Eskimo, Samoyed
Mucocutaneous pyoderma (Common in general, rare on the nasal planum	Crusting and erythema that can lead to fissuring	---	Swelling and erythema leading to crust and fissuring of the lips and other mucocutaneous junctions	German shepherds and their crosses

Superficial necrolytic dermatitis (Rare)	Crusting and erythema	Moderate-severe hyperkeratosis and crusting which can lead to ulceration and fissuring	Erythema, hyperkeratosis and crusting of the mucocutaneous junctions	Cocker spaniels and terriers
Distemper (Not uncommon)	Crusting and hyperkeratosis	Crusting and hyperkeratosis	Generalized impetigo Unvaccinated dogs	None
Systemic lupus erythematosus (Rare)	Erythematous, scaling, crusting, ulcerative and erosive dermatitis. Depigmentation and scarring can occur	Erythematous, scaling, crusting, ulcerative and erosive dermatitis. Depigmentation and scarring can occur	Ulcerative, erosive, erythematous, crusting, or alopecic dermatitis. Lesions most common on face, ears and paws, lesions very variable, typically bilaterally symmetric	German shepherds- medium to large breed dogs
Familial footpad hyperkeratosis (Rare)	---	Severe hyperkeratosis of the footpads, as well fissuring and the formation of cutaneous horns	Abnormal nail growth has been reported	Dogue de Bordeaux, Irish and Kerry blue terriers
Vasculitidies (Uncommon)	Crusting, ulcerative dermatitis. Depigmentation can occur	Ulcerative dermatitis, typically in the center of the pads. Depigmentation can occur	Ulcerative, necrotic dermatitis common on the pinna, lips, tail tip, periocular skin, and in the oral cavity	None
Dermatomyositis (Uncommon)	Depigmentation and scale. Ulceration if a vasculitic component is present	Depigmentation and scale. Ulceration if a vasculitic component is present	Muzzle, periocular, ear and tail tips commonly affected. Symptoms associated with myositis can also be seen	Collies, Shetland Sheepdogs, Beauceron shepherds
Hookworm dermatitis (Uncommon)	---	Hyperkeratosis and erythema leading to painful, pruritic paws	Affects areas that typically contact the infected ground, such as the interdigital spaces, sternum and groin.	Dogs housed in unsanitary environments

Approach to the Pruritic Cat

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

Cats are not small dogs when it comes to pruritus. Diagnosing the underlying cause of itching in the cat can be difficult due to variations in clinical presentation and numerous possible etiologies. Many cats are secretive about licking and overgrooming, making it difficult to assess their true itch level. It is critical to be able to interpret historical information, identify and understand the meaning of clinical lesions, and know the appropriate usage of diagnostic tests when diagnosing and managing the pruritic cat.

Historical information

Signalment

Age of onset and breed can provide clues to underlying etiologies. Pruritus beginning prior to six months of age is more commonly associated with parasitic diseases (*Notoedres*, cheyletiellosis, *Otodectes*), allergies (especially food and flea) and dermatophytosis. When pruritus begins in middle age, the differentials include those mentioned for younger animals, but allergic disease becomes more probable (food allergy and atopy). When pruritus begins in older animals with no history of prior skin disease, conditions such as epitheliotropic lymphoma, pemphigus foliaceus, Bowen's disease and paraneoplastic syndromes should also be considered, although food allergy can present at any age. Finally, breed predilections exist for certain diseases, such as Persians for dermatophytosis and Siamese for food allergies.

Environment

Outdoor cats have greater exposure to mosquitoes, parasites (ex. fleas and *Notoedres)* and infectious agents (ex. dermatophytes and viruses). Knowing if other people or pets are affected can indicate if a contagious or zoonotic disease is present, such as dermatophytosis, cheyletiellosis, *Notoedres* or *Otodectes*. Psychogenic pruritus can be triggered by environmental changes, such as construction/remodeling/moving, or introduction of a new pet or person into the household. Siamese and their crosses seem to be at risk for psychogenic disorders, although it should not be assumed based on breed, and is diagnosed only after all other causes of pruritus have been excluded. If an animal's symptoms are fully medically responsive to non-behavior medications, psychogenic disease can be ruled out.

Previous drug and disease history

In cats with concurrent histories of pruritus and gastrointestinal disease (ex. inflammatory bowel disease), food allergy should be seriously considered. Atopic dermatitis needs to be strongly considered in pruritic animals with concurrent airway disease/asthma. Viral dermatoses should be suspected in cats with a history of upper airway viral disease that develop erosive facial lesions. Vaccines and drugs, even those perceived as safe, can trigger erythema multiforme and pemphigus foliaceus.

Physical examination

Lesion distribution and type

Distribution of lesions, especially at the initial stages of the disease, can be extremely useful in narrowing a differential diagnosis list. Flea allergy cases are typically more severe over the lumbosacral, groin and dorso-cervical areas, whereas food allergies often focuses on the head. Atopy symptoms can be variable, and can easily mimic food and flea allergy presentations. Cheyletiellosis tends to have a dorsal distribution, presenting with scale, papules and crusts. Dermatophytosis can be localized to a specific site or can present more generalized. Asymptomatic carriers can be seen with both cheyletiellosis and dermatophytosis. Pemphigus foliaceus usually targets the pinnae, bridge of the nose, claw folds and peri-mammary areas, but can also be generalized. These lesions tend to be thick crust, often honey-colored. The pustule stage can be super difficult to observe in pemphigus cats. Remember to submit crust when biopsying, as the is is where the diagnostic acantholytic cells are present in the highest numbers.

Being able to recognize and identify lesion types can provide valuable information in the evaluation of a pruritic cat. The following are the most typical lesion types seen in our pruritic cat patients.

Excoriations, which are a nonspecific symptom, typically of scratching, are characterized by their linear shape and are most prevalent on the head and neck.

Erosions are superficial lesions that are similar to excoriations but often wider. When due to scratching, erosions tend to be linear, while those associated with licking tend to be circular. They can often be associated with eosinophilic plaques.

Ulcers can occur as focal non-pruritic lesions on the upper lip area, known as rodent or indolent ulcers. These lesions are one of the components in the triad of the eosinophilic granuloma complex (EGC). EGC lesions are reaction patterns typically indicative of an underlying allergy or hypersensitivity reaction, they are not their own disease. I.E. EGC lesions, including indolent ulcers, are symptoms of an underlying condition, typically allergies. Other conditions that can create ulcers on the body with variable degrees of pruritus include vasculitis, autoimmune diseases, drug reactions, and neoplasia.

Papules are small raised 1-5mm lesions that are often associated with **crusts** and are the most common lesions seen in miliary dermatitis. Like the EGC lesions, miliary dermatitis is the symptom of an underlying disease, not a disease itself, and can be associated with flea allergy dermatitis (most commonly), atopic dermatitis, food allergies, bacterial folliculitis, cheyletiellosis, dermatophytosis, pemphigus foliaceus and drug reactions.

Plaques appear as moderate to well-defined elevations of the skin with erythema. Eosinophilic plaques, one of the EGC variants, are most commonly associated with underlying allergic disease. These plaques can be highly prone to secondary bacterial infection.

Eosinophilic granulomas are the third component of the EGC complex, and are characterized as firm, sometimes ulcerated, raised areas that are often found in the mouth or in a linear pattern on the body. It's important to check the hard palate of allergic cats for this, I've seen cats come in on emergency with granulomas having worn through the palate and causing oral bleeding.

Alopecia that is associated with pruritus usually presents as broken-off, barbered hairs from over grooming, scratching or rubbing. Other lesions of pruritus are often present with alopecia; however, in some cases, broken/barbered hair is the only clue that the cat is pruritic. Thin flakes of shed epidermis characterize **Scale**, a nonspecific symptom that is commonly seen in cheyletiellosis.

Diagnostic tests

Dermatological diagnostic tests are powerful tools, that can often provide quick information as to how to manage a case. **Cutaneous cytology** is a rapid test that is easy and inexpensive to perform that can assess the presence of bacteria, inflammatory cells, fungal spores/hyphae, acantholytic cells and neoplastic cells. I perform cytology in almost every pruritic cat with dermatological lesions, aside from non-inflammatory alopecia, that I see. True bacterial pyoderma cases should demonstrate intracellular bacteria, usually within neutrophils, and, sometimes, within eosinophils. Eosinophils are a very common inflammatory cell seen in a variety of disorders, but are most commonly associated with ectoparasites, allergies and some forms of EGC lesions. Fungal spores or hyphae can be visualized in many dermatophyte cases, although a fungal culture should ALWAYS be performed for speciation, to verify the causative species to guild environmental treatment recommendations. Cytology can also be of value in some forms of cutaneous neoplasia, and, on rare occasion, can identify ectoparasites such as *Cheyletiella*, especially when adhesive tape is used. Acantholytic cells are suggestive of pemphigus foliaceus, although they can also be seen in dermatophyte cases and biopsy should always be performed to confirm the diagnosis. **Skin scrapings** are one of the most important diagnostic tests, and should be utilized on all pruritic cats, aside from those with seasonal symptoms, which automatically indicated atopic disease or flea allergies. Some of the more common parasites that can be identified include *Cheyletiella blakei, Otodectes cynotis, Lynxacarus radovsky, Trombicula autumnalis, Felicola subrostratus, Notoedres cati, Demodex cati* and *gatoi*. One of the most reliable ways to find *Cheyletiella* mites in both symptomatic and asymptomatic animals is to use a fine tooth comb on the entire hair coat for several minutes to collect dander and scale, and then examine under a cover slip with mineral oil.

The **Dermatophyte test media (DTM)**, or fungal culture, is considered the gold standard to identify dermatophytes. Dermatophyte infections can present as pruritic infections with any lesion type. Dermatophytes utilize protein, thereby producing an alkaline by-product that produces a red color change. However, after all carbohydrates are utilized, any saprophyte contaminant can utilize the protein and turn the media red, and for this reason, DTMs should be inspected daily for color change, and growth needs to be examined microscopically for evidence of macroconidia. Suspected fungal growth can be lifted with clear adhesive tape, stained with lactophenol cotton blue, and then examined microscopically. Speciation of the dermatophytes should always be performed to determine the source of infection to help prevent future re-infection. For example, if the dermatophyte is *Trichophyton mentagrophytes* caused by exposure to a rodent and the rodent is still around, the cat will continue to get re-infected. **Woods light examination** can be utilized in suspect dermatophyte cases, but only fluoresce in a small percentage of *Microsporum canis* cases, and positive fluorescing hairs should be plucked for culture for definitive diagnosis, as other things can cause false positive glows. **Direct hair exams** can also be a method of identifying dermatophytosis, as hyphae and spores can often be seen when the condenser is turned down, although cultures should always be performed to confirm the diagnosis. In cases of alopecia where pruritus levels are unknown, **trichograms,** to examine the tapered tip of plucked hairs, can help determine if the hairs were removed by self-trauma, in which case they appear fractured and jagged. This can especially be seen in hair from the caudoventral abdomen. **Skin biopsies** can be a powerful tool, when used in the correct case. Many specific infectious, parasitic, autoimmune and neoplastic diseases will be diagnosed via biopsy. Biopsies are indicated in unusual lesions or clinical presentations, or if a case is not responding to standard treatment. The various allergies look the same on histopathology, so biopsy is usually not used to diagnose them, and NEVER to differentiate between them.

If all non-allergic differentials have been ruled out, a systematic approach to allergies must be pursued, as three three common allergic disease,atopy, flea and food allergy, can look identical. The majority of allergic cats are flea allergic, and **flea control trials** should be performed to eliminate this differential. Several approaches can be taken to flea control trials. Because none of the products that can be used are repellants, it is virtually impossible to rule out flea allergy in an outdoor cat, but keeping cats indoors is not always feasible. One of the ideal methods of performing a flea trial, especially in outdoor animals, is to use the oral medication Nitenpyram (Capstar, Novartis) every other day, for a 4-6 week period. This product lasts for 24 to 36 hours, and must be re-

administered to provide continued elimination of newly acquired fleas. Another option is to use one of the topical formulations, such imidacloprid (Advantage®, Bayer), fipronil (Frontline Plus®, Merial), dinotefuran/pyriproxifen (Vectra®, CEVA) or selamectin (Revolution®, Pfizer), off label every 2-3 weeks for a 4-6 week period. Diligent spinosad (Comfortis, Elanco) every 3-4 weeks can be an effective flea trial as well. Please note that Vectra 3D® for canines contains permethrin at a level that can be highly toxic to cats, and care must always be taken to not use the canine product on felines.

When proceeding with the evaluation of food allergic dermatitis, a **food elimination trial** must be performed to rule out the disease, as serological testing is unreliable and inaccurate. Food allergic cats can have the same symptoms as atopic or flea allergic animals, but commonly display severe head and neck pruritus. The only way to diagnose food allergy is with an elimination diet that is fed for an 8-12 week period. The author prefers a diet trial consisting of home-cooked or limited protein based commercial diets, such as Royal Canin® (Innovative Veterinary Diets, IVD) duck, rabbit, or venison and green pea, and typically only utilizes hydrolyzed diets if the other diets are not eaten. When the owner is willing to home cook, they can be directed to www.balanceit.com, where they can purchase recipes and supplements. Because of the unique nutritional needs of felines, it is imperative that only balanced home cooked diets be fed, as feeding an unsupplemented diet for more than four weeks can create nutritional deficiencies. At the end of the 8-12 week period, the cat is re-challenged with the original diet and observed for exacerbation of clinical signs. Many food allergic cats are so severely pruritic that they need short courses of oral steroids or cyclosporine to control their itch, with the goal of being able to taper them off these medications as they proceed on the diet trial. Apoquel® (oclacitinib, Zoetis) is off label for cats, and is not recommended for use to control pruritus in the feline at this time.

The diagnosis of atopic dermatitis is made primarily on history, physical findings and ruling out all other pruritic diseases. **Allergy testing** is used to determine what specific allergens the patient is allergic to after the diagnosis has been made, typically to start immunotherapy. Intradermal skin testing, although considered the gold standard of allergy testing, is more difficult to perform in the feline due to the difficulty of performing and interpreting intradermal injections in the cat. Feline skin is thinner and more difficult to inject allergens into, and the degree of reactivity at the allergen injection sites is often flatter, producing false negatives. In-vitro allergy tests are also available which provide a reasonable alternative to skin testing, with some specialists preferring this method in the feline.

Approach to the Pruritic Dog

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

Pruritus is the most common symptom of skin disease in the dog. Proper management includes a methodical work up to determine the underlying disease, and treatment to alleviate symptoms with the fewest number of side effects.

Pruritus affects a large percentage of the pet population, and is one of the top causes of presentation of dogs to general practitioners, especially depending on the time of year. Because there are a varied number of conditions that can cause itching, it is important to approach this symptom methodically, and having a general algorithm in your head can be very useful. As soon as your history starts you are gathering critical information that is allowing you to formulate your diagnostic list and therapeutic plan. Key features of the dermatological examination then help formulate the differential diagnosis list (DDX) further, as well as notify where to take optimal samples for diagnostics. If you approach every itchy dog with a solid basic diagnostic and therapeutic plan you'll be much more successful then if you just administer steroids and hope the problem goes away.

The most common causes of pruritus in the canine are the allergic diseases (atopic dermatitis, food allergic dermatitis, flea allergic dermatitis), parasitic diseases (sarcoptic mange, cheyletiella, flea exposure, demodectic mange with secondary infection), and infections (yeast, bacterial, dermatophytic). Uncommon causes of pruritus that the practitioner needs to be aware of include autoimmune diseases (such as pemphigus foliaceus), neoplastic diseases (such as mycosis fungoides), drug eruptions/erythema multiforme, contact allergic dermatitis and psychogenic.

History

The importance of historical information can not be understated. Although you can not always expect the history alone to give you a specific diagnosis, it actually can in many cases and is critical information in all cases. It can be helpful to create a dermatology history questionnaire-if there is down time the client can fill it out before the appointment, and if not then you can use it to help trigger the most important questions to remember to ask. We have our form available online for clients to fill out and bring to the initial pruritus appointment.

I find the most important question to be where is the dog pruritic. Ask specifically about the face, feet and perineum, as people will often not associate the rubbing, licking and scooting seen in these locations as a sign of itchiness. Verify where the dog was initially pruritic and where they feel the most pruritic areas are currently. There are many recognized patterns of pruritus for specific diseases: flea allergic dermatitis tends to affect the caudal 1/3 of the body, especially on the dorsal lumbar region, tail, groin and thighs. Atopic dermatitis and food allergic can look identical on the face, ears, ventrum and feet, although food allergic dogs will sometimes have a history of perineal pruritus. Sarcoptic mange dogs tend to be itchy along the ear pinnal margins, elbows and hocks, although it can easily progress to generalized. Cheyletiella tends to favor the dorsal trunk.

Seasonality of symptoms is probably the second most important question that I ask. When symptoms are strictly seasonal the DDX instantly becomes atopic dermatitis, flea allergic dermatitis or insect bite hypersensitivity. When dogs have nonseasonal symptoms with seasonal exacerbations I always think about atopic dermatitis plus or minus a concurrent food allergy. Verifying if the symptoms started seasonally and then became nonseasonal is also useful.

I follow this with grading the pruritus level. I ask all owners to score the pruritus on a scale of 0-10 where 0 is asymptomatic and 10 is so itchy they have to pull the dog off themselves in the middle of the night due to pruritus. This acts as a reference point to monitor response to treatments and therapeutic trials. Clients will often overscore the itch level to increase your thinking the pet's issue is significant, but that's why it's useful to remind them at follow ups what they previously said for comparison. The conditions which tend to cause the most severe pruritus are sarcoptic mange (almost always a 10, but sometimes they are more mild to start, which can make them occasionally get misdiagnosed as allergies), flea allergic dermatitis, food allergic dermatitis and atopic dermatitis, although atopic dogs are more likely to wax and wane a bit depending on time of year and presence of infection.

I find some clients will freeze when asked to grade the pruritus on the 0-10 scale, so another thing I like to ask is percentage of improvement from last appointment. This is a super important question when making decisions about ongoing therapeutic management.

Age at onset of pruritus is a vital question in formulating a differential list. When significant pruritus affects very young dogs, especially less than 6 months of age, sarcoptic mange, demodectic mange with secondary infection, food allergic dermatitis and flea allergic dermatitis are the top differentials. Young food allergic patients can be very challenging to diagnose, as they don't always respond to the first diet tried, we are limited with the diets we can use for dogs on food trials under one year of age (royal canin venison and potato and royal canine HP) and they can be EXTREMELY itchy and not very responsive to anti-pruritics. Remember that apoquel is not recommended and is off label for dogs under one year of age. When pruritus affects dogs over 1 year of age (although it can be as early as 6 months) the main differentials are sarcoptic mange, demodectic mange with secondary infection, flea

allergic dermatitis, food allergic dermatitis and atopic dermatitis. Atopic dogs classically first show signs between 6 months and 3 years of age, but I've seen dogs younger and older that were confirmed to be atopic. It is quite unusual for dogs over 7 years of age to develop atopic dermatitis unless there has been a major change in the environment (such as a move, increased allergens, exposure to parasites that pushes any subclinical symptoms over the threshold to cause itch). If a dog has never had any history of pruritic skin disease and then develops it later in life out of the blue, I check for infections (sarcoptes, demodex, dermatophyte, yeast, bacterial) and am more concerned about an unusual condition such as mycosis fungoides or pemphigus foliaceus. I have seen many older dogs present with pruritus secondary to skin infections caused by an endocrinopathy such as hypothyroidism or hyperadrenocorticism that aren't classically considered, but with marked, untreated secondary infections they most certainly can present for severe itching. It can be useful to ask these clients of the itch came first or if the rash came first, as an allergic dog/parasitic dog will typically start with itch first, but a dog that has itch secondary to a yeast or bacterial infection [triggered by something else, possible a "non pruritic" disease] will often get a rash first and then become itchy.

Verify if the dog has received any prior therapies and if so how useful they were and for what period of time. I specifically want to know the usage and usefulness of glucocorticoids, cyclosporine, apoquel, antibiotics, topical therapy and parasite control (ideally drug, dose, route of administration and duration). The literature tends to generalize that flea allergic and atopic dogs are steroid responsive and that sarcoptic mange and food allergies are steroid resistant. Many food allergic dogs are VERY steroid responsive (39-63% of cases in reported in studies) and many atopic dogs will not respond to steroids at all. Atopic dogs tend to respond to cyclosporine better than food allergic dogs. It is still early for me to make a definitive statement about apoquel other than it doesn't work to control pruritus in all atopic dogs, and I've seen it control the pruritus in dogs that didn't have atopic dermatitis (flea allergic dermatitis, food allergic dermatitis).

Lastly, ask if any other pets or contact animals are affected, and if the humans have any skin lesions or pruritus themselves. Infectious diseases such as sarcoptic mange, cheyletiellosis, dermatophytosis will affect other animals and humans. If other animals are not affected you can typically eliminate sarcoptic mange and cheyletiellosis from the differential list, but since pets can be inapparent carriers of dermatophytes, especially cats, I don't rule this out base on this information.

Physical examination

It's important to be able to perform a thorough dermatological (and otoscopic) exam on every pruritic patient, paying attention to note primary lesions (such as papules, pustule and crust), secondary lesions (excoriations, alopecia, erythema, lichenification, hyperpigmentation and scale) and lesions consistent with self trauma. The distribution of lesions can correlate directly with the site of pruritus DDX list above. Dogs with sarcoptic mange will often have crusting on the margins of the pinna as well as on the elbows and hocks, and many will have a positive pinnal-pedal reflex. If a dog has been chewing its paws excessively (salivary staining can be a big clue to this), atopic dermatitis and food allergic are considered. Pay attention to erythema, hyperpigmentation and lichenification around the perineum, as many food allergic dogs will show this and the owner will not have reported perianal symptoms. Dogs with symptoms confined to sparsely haired "contact regions" especially with a compatible history, should have contact allergy considered. Dogs with large areas of acute moist dermatitis over the dorsal lumbar region and tail are considered flea allergic until failing the strictest of flea control regimes.

Initial diagnostics

I perform skin scrapings, to evaluate for sarcoptic mange, demodectic mange and cheyletiella, on every pruritic dog I see. If they don't have obvious lesions I'll be sure to focus on the hocks/elbows/pinna where sarcoptic mange tends to be the easiest to find (remember it's only found a small percentage of the time). The presence of a single sarcoptic mange mite or egg is diagnostic. Negative skin scrapings do not rule out sarcoptic mange, as even in dogs with the disease it's only found roughly 30-40% of the time. Demodectic mange isn't classically considered to be pruritic, so if found verify if there is secondary infection present, the most common cause of pruritus in these cases, OR if there an additional pruritic disease present.

Also extremely important is to perform skin surface cytology to verify the presence of bacterial or Malassezia infections. Cytology can be taken in a variety of ways, including surface swabs, impression smear and scotch tape prep. It is so important to be comfortable being able to diagnose these infections as they are a huge reason for failure to respond to treatment. If a dog has a significant bacterial skin infection that hasn't responded to previous appropriate antimicrobial therapy a bacterial culture and sensitivity is performed.

Other initial diagnostic tests include flea combing/evaluation of flea dirt, dermatophyte culture or wood's lamp in suspect cases, tape prep for Cheyletiella in dogs with suspicious scale.

Initial therapeutic plan

My first step is to make sure I've ruled out sarcoptic mange in animals that have that on their differential list, and my treatment of choice for this is Revolution® (selamectin, Pfizer) every two weeks for three doses to cover the lifecycle of the sarcoptic mite. This will also act as strict flea control in MOST pets, and addressing flea control is my next concern. If the dog is in a super high exposure area I'll consider adding in an oral flea pill monthly, or Capstar® (nitenpyram, Novartis). It can't be understated how important it is

that the environment and contact pets also be treated, otherwise failure is certain. It can take up to 6-8 weeks to see the results of implementation of strict flea control, and if the owner is slacking about letting new fleas come into the environment it is impossible to gauge the dog's response to this trial. My next step in the initial therapeutic plan is to always address skin infections appropriately based on the results of my initial diagnostic plan. If a dog is clearly food allergic or atopic this will be the day that I'll start my elimination food trial, unless the owner has a conflict that delays this (ex. the dog is going on antibiotics and they don't think they can administer antibiotics and change the diet simultaneously). Topical therapy is implemented to help assist in infection control/itch control. Whether to use and what form of anti-pruritic medication is based on the health of the patient, the severity of the disease, and my suspicion of what is causing the problem. If I have a young healthy 1 year old dog with sarcoptic mange that is a 10/10 itchy I'll give it oral steroids (I always avoid injectable steroids because of side effects and the fact that they're just not necessary in the practice of canine dermatology) to cut its itch/scratch cycle on day 1, knowing if I don't there will be a significant delay in achieving comfort, even if the mites and secondary infections are addressed. Conversely, if I have a newly moderately allergic dog with a severe Malassezia dermatitis secondary to suspect allergies I'll start with infection control and topicals and see how much of the pruritus can be controlled with infection control/addressing the underlying issue. There is no magic answer for when to use and not use anti-pruritics, but remember to consider the patient's health, don't use them as a crutch to not evaluate the underlying disease, and monitor them properly if used for extended periods of time.

Next steps

If the pet continues to be itchy after ruling out parasites/dermatophytes/infection and flea allergy several things most be considered. Firstly, if the case is unusual or not responding to therapy as it should pursuing a skin biopsy and submitting it to a pathologist with special interest in dermatology may be indicated. Second, you need to always truly verify that all infections have been fully resolved and that the the flea regime is strict and adequate. If all of these issues are addressed then the vast majority of the time you're left with food allergic dermatitis or atopic dermatitis. It can take more than one strict diet trial to find the perfect diet that works for a dog, and care must be taken that dogs are switched from flavored to non flavored supplements, flea control products and heartworm preventatives. This includes medications used to treat other conditions, such as if a dog is on carprofen for arthritis or phenylpropanolamine for urinary incontinence. If left with a diagnosis of atopic dermatitis then treatment should be aimed at minimizing symptoms with the fewest number of side effects. These treatments include allergen specific immunotherapy, topical therapy, fatty acids/antihistamines, or chronic anti inflammatory with medications like oral glucocorticoids, apoquel and cyclosporine, all of which require stringent routine bloodwork monitoring every 6 months (ideal).

Otitis:
The Complete Diagnosis

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Otitis cases are often complex and involve more than one etiologic component. This means the diagnosis and management of otitis externa is often much more complex than just recognizing what " caused" the ear disease. A successful approach to ear disease requires the understanding of what really is contributing to the pathology of any given ear, which requires that each component of the problem ear be recognized. The PSPP classification considers the etiologies as causes, which are diseases, or agents that directly produce inflammation in the ear and are Primary and Secondary. Factors are agents or elements of the disease or pet that contribute to ear disease and are divided into Perpetuating and Predisposing. For each cause or factor there is a prognosis, methods for assessing or monitoring as well as treatment options. The classification has been combined with prognostic labels, some educational diagrams, a table (Table 1) into a handout the PSPP System© which may be used to help organize a diagnostic plan, complete diagnosis, prognosis, treatment plan and educate the client. See attached PDF and it is also available to download at www.animaldermatology.com.

Table 1 from PSPP system©

Name Date	Determine and Assess	Treatment T / S AB/AF/GC/EC/AllRx/D/Ot		
Causes and Factors Identified	Cyt/Oto/CR/Ot	C	LTM	LLRx
Primary				
Secondary				
Perpetuating Factors				
Predisposing Factors				

It is important to establish if a dog with chronic otitis hears. First this often changes my approach to a case. If hearing loss seems permanent and non reversible then total ear canal ablations and bulla osteotomy become better treatment options. Hearing loss is the main side effect of the procedure and if this were not an issue I would spend less time and expense trying medical therapy. In addition hearing needs to be determined prior to ear flushing and medicating with topical medications when otitis media is likely. It always surprises me how often dogs have fairly apparent hearing loss or deafness and owners are not aware of it. This is especially common when there are multiple pets in the household. It is important to ask questions about response to doors, cars pulling up, being called when outside and localizing the sound, sound sleeping and anything else that will help determine if there is significant hearing loss. Sounds should be made in the exam room when the dog is not paying attention to the veterinarian. It is important to not just see the dog responded to the sound but did it localize where the sound was coming from almost immediately. A problem may occur if a near deaf or deaf dog is not recognized in the examination and then the owner is warned about deafness as a side effect to the deep ear flush and treatment being sent home. After the procedure the client pays attention and recognizes there dog does not hear well then blames the treatment when in fact the dog had been deaf prior to the treatment. Brainstem auditory evoked response (BAER) testing is a more accurate way of assessing the dogs hearing. This allows one to assess hearing threshold, the level of sound that each ear detects and stimulates a brain response. It is being used to assess hearing loss and ototoxicity. Unfortunately it is not readily available.

Primary causes

Primary causes are usually the actual inciting agent or etiology that directly causes damage or inflammation to the ear canal skin. These can occur alone and induce otitis externa without any other cause or factor. The primary cause may be very subtle and often go unrecognized by the owner or even veterinarian until a secondary cause occurs. Once a primary etiology alters the aural environment secondary infections often develop. In the authors opinion the vast majority of cases will have a primary cause though they may not always be readily apparent. Idiopathic or not diagnosed was reported in 32 of 100 cases.[1] In general practice foreign bodies and ear mites make up a significant number of cases and once they occur they may result in perpetuating factors that result in chronic ear

disease. If not seen early in the process they may then present without the primary cause being readily diagnosed. That and atopic otitis without obvious skin disease likely are responsible for many of these cases called idiopathic or not diagnosed. Some of these may also occur when predisposing factors combine with secondary causes, but it is likely most of these cases have a primary cause that was unrecognized. The most common causes seen in a dermatology referral practice are atopic disease, food allergy, epithelialization or metabolic disorders. In general practice foreign bodies and ear mites are relatively more prevalent. It is critical too successful long-term management that a primary cause be found and either eliminated or control be secured. The diagnosis of the primary cause often is determined from the otoscopic exam, cytology, complete dermatologic history and examination as well as diet or therapeutic trials, and possible organ testing or biopsy of the skin in other areas or the external ear.

Secondary causes

The secondary causes do not create disease in a normal ear; they contribute to or cause pathology only in the abnormal ear. As such they occur in combination with primary causes or predisposing factors. Generally secondary causes of otitis externa are easy to eliminate once identified and when they are chronic or recurrent it is usually because primary causes or perpetuating factors have not been adequately addressed. Secondary causes in the past were often considered as primary causes or the "main" diagnosis of an ear case. (ie. *Pseudomonas* or *Malassezia* otitis) Even today many clinicians direct all their efforts at diagnosing and treatment of secondary causes. Although their treatment may be important, other causes and factors must be looked for. In some cases such as *Malassezia*, eliminating the concurrent predisposing factor or primary disease may result in the resolution of the secondary problem. Secondary causes are most often diagnosed with cytologic examination and culture and sensitivity testing when indicated.

A more recently recognized concern in otitis cases is the presence of biofilms. Biofilms are a community of bacteria that live in an extracellular polymeric matrix that increases resistance to antibiotics and host defense mechanisms. Biofilms are different than the planktonic or individual cells of bacteria that are what is most commonly studied when evaluating infectious diseases that fulfill Koch's postulates. The extracellular matrix is composed of polysaccharides, DNA and proteins and is often referred to as SLIME, a physical characteristic that is associated with some biofilms seen in nature. These communities, originally associated with adhesion to solid surfaces, are known to occur in aggregates in some tissues.[2] The tissue aggregate form may further enhance mechanisms of survival in the affected tissue.[3, 4] The slime may also contribute to damage of the tissue and pathologic responses that occur. The biofilm increases resistance to antimicrobial agents by more than producing SLIME. In addition metabolic adaptations occur at a higher frequency in biofilms and the communities stimulate the development of persister cells. Persister cells are slow growing and do not grow in the presence of an antibiotic. They persist and are able to grow again once the antibiotic is gone. These biofilm infections are most often associated with chronic diseases and in humans middle ear and possible the external ear are sites of predilection.[5, 6] Forty percent of canine otitis strains of Staph. intermedius and Pseudomonas are capable of producing the extracellular polymeric substance of biofilms.[7, 8] Malassezia may also form biofilms.[9] So far biofilms have not been documented in canine otitis cases by two of the best methods for detecting biofilm infections, peptide nucleic acid-fluorescent in situ hybridization (PNA-FISH) and confocal laser scanning microscopy (CLSM). However I have seen cases that have aggregates present on cytologic examination of ear exudate. Seeing these three dimensional aggregates is suggestive and in humans the otitis media aggregates vary from 4-80 uM.[4]

Culture and sensitivity is not routinely recommended and should never be done without cytology. A culture is typically only done if systemic therapy is being prescribed. It has been shown that response to topical therapy does not correlated with culture results.[10] If the cytology reveals suppurative inflammation with relatively pure populations of rods or cocci and the animal has not responded to appropriate topical and systemic antibiotic then a culture and sensitivity may be indicated. The lab should also be sent a cytology slide and any information regarding the organisms seen at time of collection so they know if multiple organisms should be identified.

Perpetuating factors

Perpetuating factors are changes in the anatomy and physiology of the ear that occur in response to otitis externa, they occur after ear disease. These factors may be subtle at first but over time can develop into the most severe component of chronic ear disease. These factors are not disease specific and are most commonly seen in chronic cases. Once present, they accentuate or permit the development of secondary causes by providing environments and microscopic niches that favor their persistence. In many cases perpetuating factors prevent the resolution of otitis externa when treatments are only directed at primary and secondary causes. They cause much frustration to clinicians for several reasons. They often result in animals presenting repetitively with different causes present at each subsequent visit. These factors can become self-perpetuating and lead to progressive worsening of disease. They can become severe and end up causing the majority of symptoms exhibited by a pet or be so mild appearing that to many veterinarians as well as owners a pet and its ear canal appear normal. Yet left untreated perpetuating factors, even though primary and secondary causes are controlled or eliminated, result in recrudescence of clinical disease.

In chronic cases often more than one of these factors will be present. Standard treatments of the primary and secondary diseases present often times will not immediately eliminate the perpetuating factors. In early cases, treating the primary cause may be

sufficient in controlling a case, but after the establishment of perpetuating factors treatment may need to be directed at them. The treatment for perpetuating factors is often different that what is required to control primary and secondary causes of otitis externa. Their treatment should be continued until they have resolved which may take months of continuous therapy and in some cases they are permanent and will require life long therapy or a surgical solution.

Perpetuating factors are the most common reasons otitis externa cases require surgery. Perpetuating factors are diagnosed otoscopic examination; repetitive otoscopic examination timed appropriately, tube palpation and other imaging techniques (radiology, CT scans, MRI).

Diagnosis of otitis media can be made when a ruptured tympanic membrane is seen. A technique of tube palpation and flushing can aid in the diagnosis of otitis media. This technique also may reveal false middle ear cavities. The method is greatly enhanced with FOVEO and the ear canal filled with water, which increases magnification by 4/3 thus appearing 25% larger. Also air bubble may be seen coming through some small tears. The soft tube can be used to palpate any material located at the approximate level of the tympanic membrane. Both depth of the canal and location of the tip of the tube are utilized to determine if a false middle ear or otitis media is present. The feeding tube is passed under visualization with a surgical otoscope head down the ear canal to the level where the tympanic membrane is expected to be located.

Predisposing factors

Predisposing factors are present prior to the development of ear disease but alone do not cause otitis externa. They increase the risk of development. These factors work in conjunction with either primary causes or secondary causes to become a significant problem. In rare cases a predisposing factor may combine with a secondary cause to create disease even when no primary cause is present. The best example of this is a dog that gets water in its ear that leads to epidermal maceration or damage and then a secondary bacterial or yeast infection occurs. It is possible this is how environment, increased heat and humidity, also contribute to otitis. However in the authors experience these animals often do have a subtle but mild primary disease still present but controlling that disease does not appear to be necessary. Some predisposing factors relate to the normal anatomy of the dog and as such are not something that is cureable unless surgery may alleviate it, such as a stenotic external orifice in a Chinese shar pei. Pendulous pinnae have been shown to be a statistically significant predisposing factor for otitis externa though no studies have adjusted for this finding based on the presence of breed predisposition to other primary causes of otitis[11].

References

Saridomichelakis, M.N., et al., Aetiology of canine otitis externa: a retrospective study of 100 cases. Vet Dermatol, 2007. 18(5): p. 341-7.

Alhede, M., et al., Phenotypes of non-attached Pseudomonas aeruginosa aggregates resemble surface attached biofilm. PLoS One, 2011. 6(11): p. e27943.

Haaber, J., et al., Planktonic aggregates of Staphylococcus aureus protect against common antibiotics. PLoS One, 2012. 7(7): p. e41075.

Bjarnsholt, T., The role of bacterial biofilms in chronic infections. APMIS Suppl, 2013(136): p. 1-51.

Wessman, M., et al., Mucosal biofilm detection in chronic otitis media: a study of middle ear biopsies from Greenlandic patients. Eur Arch Otorhinolaryngol, 2014.

Fusconi, M., et al., Is biofilm the cause of chronic otitis externa? Laryngoscope, 2011. 121(12): p. 2626-33.

Pye, C.C., A.A. Yu, and J.S. Weese, Evaluation of biofilm production by Pseudomonas aeruginosa from canine ears and the impact of biofilm on antimicrobial susceptibility in vitro. Vet Dermatol, 2013. 24(4): p. 446-9, e98-9.

Moreira, C.A., et al., Biofilm production by clinical staphylococci strains from canine otitis. Braz J Microbiol, 2012. 43(1): p. 371-4.

Cannizzo, F.T., et al., Biofilm development by clinical isolates of Malassezia pachydermatis. Med Mycol, 2007. 45(4): p. 357-61.

Robson, D., G. Burton, and R. Bassett. Correlation between topical antibiotic selection, in vitro bacterial antibiotic sensitivity and clinical response in 16 cases of canine otitis externa complicated by Pseudomonas aeruginosa. in Nt Am Vet Derm Forum. 2010. Portland, Oregon.

Lehner, G., C.S. Louis, and R.S. Mueller, Reproducibility of ear cytology in dogs with otitis externa. Vet Rec, 2010. 167(1): p. 23-6.

Otitis:
The First Step in Treatment

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

It is important to be aware of all the different treatment options that are available and their indications table 1.

Table 1

Treatment Class	Route Administered	Indication
Analgesics/anesthetics	Systemic	Some cases for examination Chronic proliferative otitis externa /media Deep cleaning Intralesional therapy
	Topical	Ear examine and some cleaning procedures
Antibiotic (AB)	Topical	Bacterial infection ear canal
	Systemic	Bacterial otitis media or proliferative changes over 50% lumen, topical reactions
Antifungal (AF)	Topical	Yeast overgrowth or when present with inflammatory cells and no bacteria
	Systemic	Otitis media with yeast present from middle ear
Antiseptic (AS)	Topical	With or following cleaning For resistant bacterial infections Control of microbial overgrowth
Cerumenolytics	Topical	Waxy greasy ceruminous exudates in ear canal
Cleansers	Topical	Control of mild dirty, waxy ears odor microbial overgrowth
Glucocorticoids	Topical	Allergy not controlled by cleaning alone Otitis externa Pinnal erythema/pruritus
	Systemic	Proliferative otitis greater than 50% of lumen, when exudatation not stopped with topical therapy
	Intralesional	When cleaning, topical and oral systemic therapy does not improve proliferative otitis enough
Hypoallergenic diets	Oral	Control of adverse food reactions
Parasiticides	Systemic	Otodectes in adult animals
	Topical	Otodectes in puppies and kittens

Successful treatment outcomes will require that a complete treatment plans is developed the client adheres to the treatment plan. Therefore one of the most important jobs of the veterinarian treating a case of otitis externa is getting good client compliance. This is achieved with client education about the treatment plan and gaining the clients confidence it is a good plan that they can accomplish. The client needs to agree with both what the problem is and the appropriate solutions. It is important that the plan includes the appropriate follow up and that this is explained.

The first step in this process is developing the recheck plans and getting the client to understand their importance and follow through. The client needs to understand clinically the odor, head shaking and discomfort may be gone, but the ear may still be building up debris and not staying cleaned, have proliferative changes, or the tympanum may not have returned. These changes may

eventually lead to another infection or acute flare up of otitis. The return to a healthy ear canal can only be determined with otoscopic and cytologic examination of the ear canal. Follow up examinations are also important to determine if cleaning is being done effectively and when normal self-cleaning returns. Scheduling the follow up examination is critical and has to be done differently to answer the preceding questions. To determine if home cleaning is effective then the examination should be done within 24 hours of the cleaning procedure. To determine if the interval is to long between cleanings or that self cleaning may have returned the examination needs to occur when the ear has not been cleaned for at least the interval between current cleanings or longer. Clients need to understand there are different types of follow up for chronic ear cases and that multiple visits will be required.

The number one rule of topical therapy is the active ingredient(s) must reach the site to be treated. This means if only one treatment was allowed to manage ear cases then it would definitely be cleaning, as no single topical product is as effective. Cleaning techniques that are most effective occur in the sedated or anesthesized dog and generally that is the preferred initial therapy when there is a a lot of proliferation, exudate or otitis media. There are cases where initial therapy will make this more effective or unnecessary but in some cases there will be a poor response without the in clinic cleaning. Deep ear cleaning in clinic also allows for the false middle ear pockets or middle ear to be cleaned. *Tube flushing* may be an effective non-surgical method for cleaning these deeper sites. It is also the least expensive method. A variety of tubes such as polypropylene tomcat catheters have been recommended for use but my preference is a soft rubber feeding tube (Sovereign® feeding tube and urethral catheter) of several sizes (3.5, 5.0, 8.0 and 10.0 French) though the 5 and 8 are my most commonly used sizes. These may be prepared for use then kept in cold sterilization solutions. They are cut short (5-7 inches in length and the ends are trimmed so that the tube will fit over a syringe hub. A 6-12cc syringe is attached. Some clinicians prefer to use a three-way valve so that fluids can be run through one port and suction from a separate port. Which action (flush or suction) is being done is determined by the position of the three-way valve. Water or saline may be utilized as the flushing solution. It should be at roughly body temperature. Saline has the advantage of causing less swelling if repetitive flushing is performed. Usually multiple flushes are required and a bowl of flushing solution should be available. Cleansers and antiseptics may be used in the flushing solution though the author rarely does this and utilizes these products only as the final rinse.

The feeding tube is passed down through a surgical otoscope head and attached cone or through a video otoscope. Under visualization the tube is passed down to the level of the middle ear. If possible the tip is then passed ventrally towards the bottom of the tympanic bulla. The objective is to place the tip of the tube at the most ventral aspect so that the exudate and organisms are flushed directly out towards the external ear canal. In other cases the tube may be placed within the exudate, which may be inspissated, and aids in dislodging and removing it. The passing of the tube into the dorsal or middle aspect of the middle ear has a greater risk of damaging the vestibular (oval) or cochlear (round window) that lies within the promontorium. Actual placement in the ventral bulla is difficult due to the boney ridge that separated the ventral from middle parts of the middle ear cavity. Soft tubes are more likely to reach this location due the ability for the tip to bend. Therefore attempts to get the tube below the ridge should be made and is easier when using 5 French or smaller tubes. Trying to bounce the tube off the dorsal aspect of the external acoustic meatus just prior to entering the area of the dilated or ruptured tympanum may help in achieving this. Once the tip is placed in an appropriate location the flushing solution is gently infused into the ear and this will fill the otoscopic cone and any debris is seen floating in the solution. The flush solution is then aspirated out and it along with the aspirated debris is discarded. Flushing by infusing fluid and aspirating is repetitively done until no debris is seen floating up in the solution. Ear cleaning units that combine flushing and suction are very helpful thought not required for tube flushing.

Vestibular syndrome or deafness may occur after ear flushing, even when no ototoxic drugs are utilized. These side effects are uncommon. In one study of 44 cases that had the middle ear flushed no side effects were reported[31]. Another study of 105 otitis ears flushed none had hearing loss and some even improved following cleaning[32].

Home ear cleaning may also be essential, particularly in cases where epithelial migration is not occurring. Generally I do not have clients begin to clean until the dogs ears are not painful and then usually only once weekly. Most often I have clients do an ear wash by filling the ear canal to the opening of the external orifice with a mild antiseptic cleanser. The clients massage the ear both vertical and horizontal ear canal for a few minutes if possible. To effectively massage the annular cartilage the client must be educated about the location and need for deep digital palpation. Following several minutes of massage the material is allowed to be shaken out and then the external orifice and concave pinna is wiped clean with tissue or cotton balls. If they get more than a little debris they should fill and rinse the ear again and repeat until only a small amount of debris is obtained. Do not allow excessive use of cotton tipped applicators down the ear canal as these commonly push debris deeper into the ear canal. Antiseptics are sometimes utilized as an ear rinse daily for some infected ears or following the home cleaning. My favorites contain acetic or other acids or tris edta with 0.15% chlorhexidine which in the US is usually labeled as a flush not ear product.

References

Abelardo, E., et al., A double-blind randomised clinical trial of the treatment of otitis externa using topical steroid alone versus topical steroid-antibiotic therapy. Eur Arch Otorhinolaryngol, 2009. **266**(1): p. 41-5.

Bensignor, E. and E. Grandemange, Comparison of an antifungal agent with a mixture of antifungal, antibiotic and corticosteroid agents for the treatment of Malassezia species otitis in dogs. Vet Rec, 2006. **158**(6): p. 193-5.

Ghubash, R., R. Marsella, and G. Kunkle, Evaluation of Adrenal Function in Small-Breed Dogs Receiving Otic Glucocorticoids. Vet Dermatol, 2004. **15**(6): p. 363-368.

Reeder, C., et al., Comparative adrenocortical suppression in dogs with otitis externa following topical otic administration of four different glucocorticoid-containing medications. Vet Ther, 2008. **9**(2): p. 111-121.

Moriello, K.A., et al., Adrenocortical suppression associated with topical otic administration of glucocorticoids in dogs. J Am Vet Med Assoc, 1988. **193**(3): p. 329-31.

Aniya, J.S. and C.E. Griffin, The effect of otic vehicle and concentration of dexamethasone on liver enzyme activities and adrenal function in small breed healthy dogs. Vet Dermatol, 2008. **19**(4): p. 226-31.

Robson, D., G. Burton, and R. Bassett. Correlation between topical antibiotic selection, in vitro bacterial antibiotic sensitivity and clinical response in 16 cases of canine otitis externa complicated by Pseudomonas aeruginosa. in Nt Am Vet Derm Forum. 2010. Portland, Oregon.

Pietschmann, S., et al., Synergistic effects of Miconazole and Polymyxin B on microbial pathogens. Vet Res Commun, 2009. **33**: p. 489-505.

Otitis:
Tips You Can Use

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Do a hearing evaluation

It is important to establish if a dog with chronic otitis hears. First this often changes my approach to a case. If hearing loss seems permanent and non reversible then total ear canal ablations and bulla osteotomy become better treatment options. Hearing loss is the main side effect of the procedure and if this were not an issue I would spend less time and expense trying medical therapy. In addition hearing needs to be determined prior to ear flushing and medicating with topical medications when otitis media is likely. It always surprises me how often dogs have fairly apparent hearing loss or deafness and owners are not aware of it. This is especially common when there are multiple pets in the household. It is important to ask questions about response to doors, cars pulling up, being called when outside and localizing the sound, sound sleeping and anything else that will help determine if there is significant hearing loss. Sounds should be made in the exam room when the dog is not paying attention to the veterinarian. It is important to not just see the dog responded to the sound but did it localize where the sound was coming from almost immediately. A problem may occur if a near deaf or deaf dog is not recognized in the examination and then the owner is warned about deafness as a side effect to the deep ear flush and treatment being sent home. After the procedure the client pays attention and recognizes there dog does not hear well then blames the treatment when in fact the dog had been deaf prior to the treatment. Brainstem auditory evoked response (BAER) testing is a more accurate way of assessing the dogs hearing. This allows one to assess hearing threshold, the level of sound that each ear detects and stimulates a brain response. It is being used to assess hearing loss and ototoxicity. Unfortunately it is not readily available.

Dilating the ear for cleaning

With proliferative end stage ears it is difficult to impossible to really get cleansers down the ear. To achieve this when the dog is anesthetized use the 3mm otoscope cone to dilate the ear and force the cone down as far as possible. An ear loop can be passed down the canal just past the tip of the cone and then the cone is filled with the cleanser and slowly pulled out. This will allow a layer of cleanser to be deposited on many of the folds as they fall back in place as the cone is removed.

Glucocorticoids

Topical glucocorticoids are the most common prescription item used in treating ear disease. This makes sense when one considers the most common causes of chronic otitis are allergic diseases such as atopic disease or adverse food reaction, which is likely an allergic reaction. Even ear mites are known to stimulate an allergic reaction. In addition many cases of otitis become secondarily infected with bacteria or Malassezia and glucocorticoids at least topically are believed to improve the response to topical antimicrobial therapy. This has been shown in dogs with Malassezia otitis and is supported by the fact that most topical antibiotic ear products labeled for the treatment of otitis do contain a glucocorticoid.[1] Eliminating or decreasing inflammation in the ear canal is an essential component of treating secondary infections and often is also indicated as it helps control the primary allergic disease as well. What this means is most cases should be treated with some glucocorticoid and so the real question is when to you avoid using them. I really have come to where the only time I do not use glucocorticoids in otitis cases is when 1. Cleaning ears alone is effective, 2. Infections are not responding or 3. Ulcers are not healing even though the infections appear to be controlled.

Glucocorticoids available for topical use in veterinary products are, from generally the weakest to more potent, 1% hydrocortisone, 0.1% or 0.015% triamcinolone, 0.1% betamethasone, 0.1% dexamethasone, 0.1% fluocinolone acetonide and 0.1% mometasone furoate. The initial therapy or during acute exacerbations a potent topical glucocorticoid v may be required, but once the inflammation or allergic reaction is controlled prophylactic or long term therapy should utilize the least potent topical glucocorticoid possible. Long-term therapy is safer with products containing 1.0% or .5% hydrocortisone. A topical triamcinolone product (0.015% triamcinolone spray (Genesis®, Virbac) that has reduced systemic absorption has been useful, particularly for pinnal inflammation associated with allergic otitis. In cases of atopy or food allergy induced otitis externa, the pinna is frequently affected and should also be treated. Low dose dexamethasone 0.01 to 0.05% has also been formulated in hospital and used effectively for long-term control of allergic otitis or *Malassezia* otitis.

Combination therapy the key to killing organisms

Combinations are the key to eliminating resistant bacteria. Three different topical agents, antiseptics, synergistic agents and topical antibiotics, may be used for the purpose of killing the resistant bacteria. When 16 Pseudomonas cases were treated empirically, 90% reported resistant responded to an topical containing the antibiotic the organism was supposedly resistant to and 83% responded when the empiric treatment was reported used for a sensitive strain.[2] The favorable response regardless of what the sensitivity says may have been due to the combination approach and use of the synergist Tris EDTA as well as the high concentration we achieve when

using topical antibiotics. Topical antiseptics include such ingredients as certain acids (acetic, boric, citric, lactic), alcohols, aluminum hydroxide, chlorhexidine (0.25% or lower concentration), povidone iodine, silver sulfadiazine and sodium chlorite. Micronized silver is the newest addition to our topical antibacterial solutions. Antiseptics kill organisms by methods other than antibiotics, generally are inexpensive ingredients and can work in conjunction with antibiotics. Resistance is generally not a problem though this may be changing which is another reason to employ combination therapy. Some ingredients that look promising for destroying biofilms are chlorhexidine, acetic acid, and tris EDTA, N-acetyl-L-cysteine and sulfhydryl compounds. In cases resistant to all antibiotics antiseptics may end up being the treatment of choice. The drawback to using antiseptics is they often need to have contact time in clean ears and be used multiple times a day for a good effect. Some are also irritating which limits their use. The antiseptic should be left in the ear canal for 5 minutes. In difficult cases that are being cleaned under sedation/anesthesia then I may leave acetic/boric acid in the ear canal for five minutes then follow with a five-minute soak with Tris edta/chlorhexidine. When antiseptics are the only topical antibacterial used then they often should be applied 4-6 times a day.

Synergistic agents improve the killing effect of what they are mixed with in a way that is more than the additive effect of the two ingredients. Tromethamine-ethylenediaminetetra acetic acid (Tris edta) is the synergist used the most in veterinary otitis cases. It has been shown to enhance the effects of antibiotics as well as the low safe concentration antiseptic chlorhexidine (0.15%).[3, 4] Has been shown to be synergistic with tris EDTA.[3, 4] A very interesting agent is polymyxin as it is not only and antibiotic but also a synergistic agent. Polymyxin has a cationic detergent effect and similar to tris EDTA disrupts the outer membrane of bacteria, particularly gram-negative bacteria. It is synergistic with some other antibiotics but also has a synergistic effect with miconazole. When polymyxin is mixed with miconazole it is synergistic for killing Malassezia but also highly synergistic for the killing of Pseudomonas.[5] By combining synergistic agents with antibiotics even resistant strains of Pseudomonas are killed.

Repetitive ear flushes in clinic

Since many chronic end stage ear cases will require multiple ear flushes in clinic it is common to encounter clients reluctant to do general anesthesia. Instead it is common to use sedatives and pain medication to allow some of the follow up ear flushes. In these cases even though the laryngeal reflex may be present it can be suppressed enough that care must be taken to prevent inhalation pneumonia. Those resistant *Pseudomonas* and MR *Staphylococcus* do not do well in the lungs. Remember any time an ear, with access to the middle ear, is being flushed in a sedated dog and an endotracheal tube is not in place the head should be angled down. We have the racks on the wet table raised at one end with the dog lying in lateral recumbency and the nose at the low end of the rack.

Malassezia in ears

When dealing with possible resistant Malassezia then Posaconazole is reported to be more effective though it was not as potent as some papers described in one recent study. Miconazole is most often found at 1% but when dealing with difficult cases should higher concentrations such as the 2.3 percent or 1.7% would be more effective. Also polymyxin is synergistic with miconazole for killing Malassezia.

Follow up cytology

Antiseptics, antibiotics or anti yeast topical therapy is not discontinued until reasonably normal self cleaning has returned and cytology shows no inflammatory cells or DNA strands. It is common for practitioners to discontinue therapy to early, especially if the ear looks reasonably good and there is no obvious odor or discharge. I see many cases when I think it is time to quit but based on cytology I do not. This is something else it is wise to warn owners to expect and if it does not happen they will be pleased and think you or they did a better job than usual.

References

Bensignor, E., *Treatment of Malassezia otitis in dogs: a comparative field trial.* Vet Dermatol, 2004. **15**(s): p. 45.

Robson, D., G. Burton, and R. Bassett. *Correlation between topical antibiotic selection, in vitro bacterial antibiotic sensitivity and clinical response in 16 cases of canine otitis externa complicated by Pseudomonas aeruginosa*. in *Nt Am Vet Derm Forum*. 2010. Portland, Oregon.

Ghibaudo, G., L. Cornegliani, and P. Martino, *Evaluation of the in vivo effects of Tris-EDTA and chlorhexidine digluconate 0.15% solution in chronic bacterial otitis externa: 11 cases.* Vet Dermatol, 2004. **15**(s): p. 65.

Farca, A.M., et al., *Potentiating effect of EDTA-Tris on the activity of antibiotics against resistant bacteria associated with otitis, dermatitis and cystitis.* J Small Anim Pract, 1997. **38**(6): p. 243-5.

Pietschmann, S., et al., *Synergistic effects of Miconazole and Polymyxin B on microbial pathogens.* Vet Res Commun, 2009. **33**: p. 489-505.

Ears:
What You Need to Know

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Recognizing the components of otitis requires an understanding of the normal anatomy and physiology of the external and middle ear, which has been reviewed. Otoscopic examination and cytology are critical in recognizing pathologic findings and for these to be performed well the veterinarian needs to have adequate equipment and training.

The external ear is formed from two pieces of cartilage and a boney canal that are covered by skin, which ends at a specialized epithelial structure the tympanic membrane. The external ear canal is variable in length (5-10cm) and classically divided into the vertical and horizontal portions. As one proceeds down the vertical canal there is another ridge or fold in the cartilage that is called the auricular projection. It creates the "corner" around which one must proceed to allow access down the canal and when otitis is present the lumen ridge is often inflamed and when pushed against by otoscope cones, especially the edge of the cone, may result in pain and the dog resisting examination. The smaller second cartilage is the annular cartilage. It overlaps with the external acoustic meatus. The external acoustic meatus varies but in mid size dogs is about 1 cm long. The skin lining the acoustic meatus lies on bone and therefore is not subject to movement and massage as the skin lining the cartilaginous canal. The medial ring of the acoustic meatus is the location of the tympanic membrane. Often there are larger primary hairs located in the skin adjacent to the tympanum and this is more often seen on the ventral wall of the lumen, a helpful landmark for locating the ventral tympanum with diseased ears.

The skin and adnexa are constantly producing exfoliating corneocytes, intercellular material and glandular secretions. This material forms the earwax and cerumen that is believed to play some protective role. This cerumen is constantly being produced throughout the ear canal. If this material were to build up blockage could result. However there is a normal clearing mechanism. The material produced in the ear canal is cleaned or cleared out by the movement of the epidermis, epithelial migration. The surface of the skin of the tympanum and ear canal is constantly moving from the tympanic membrane laterally to the external orifice of the ear canal. This process starts on the tympanum and this was shown to occur in dogs.[1] The tympanic membrane is an epithelial structure that separates the external ear laterally from the middle ear cavity located medially. The tympanic membrane of the dog is made up of the pars flaccida and pars tensa. The pars flaccida is a small area of the dorsal to anterior-dorsal aspect of the tympanum, which is relatively flaccid and quite vascular. The majority of what is seen of the tympanum when it is examined through the otoscope is the large pars tensa. A normal pars tensa is translucent, with striations seen extending from the manubrium of the malleus outward to the periphery. A whitish appearing discoloration can sometimes be seen through the lower to mid section of the tympanum. This whitish structure is the bony ridge that separates the tympanic cavity from the tympanic bulla. The manubrium of the malleus is "C" shaped with the open end of the "C" pointing toward the nose. It is located over the anterior- medial aspect of the tympanum.

The middle ear consists of the tympanic cavity and the medial wall of the tympanic membrane, the auditory ossicles and associated ligaments, muscles and nerves (chorda tympani and other smaller nerves), and the auditory tube. The tympanic cavity is divided into three parts: dorsal, middle, and ventral. The dorso-medial surface of this is primarily made up of the barrel shaped, cochlear promontory. The promontory is situated opposite to about the mid dorsal aspect of the tympanum. At the caudal end of the promontory is the cochlear window, which communicates with the bony labyrinth of the cochlea. This is the structure one must avoid when doing a myringotomy and flushing the middle ear. The ventral portion is the tympanic bulla and is the largest portion. The tympanic bulla is somewhat egg-shaped, with the dorsal aspect open to communicate with the middle part. It is separated dorsally from the tympanic cavity by the septum bulla, which is most prominent over the medial and anterior aspects of the bulla and responsible for making passing tubes into the ventral bullae very difficult. It may have many bony ossicles or projections along it lateral free edge in the lumen of the bulla.

Microscopic anatomy of ear canal cerumen

Ear samples are routinely collected from abnormal ears for cytologic examination and sometimes for culture and sensitivity testing. The samples should reflect the material exudate from the skin of the ear canal or the middle ear cavity. A technique, which will get a deep sample, is to pass a soft rubber tube down the canal and aspirate once the tip is deep into the canal. Cytologic examination of discharge usually does not establish a definitive diagnosis, but it is valuable in determining what infectious agents, if any, are present. With waxy discharges heat the author has preferred fixation though two studies suggest it may not be necessary. Modified wrights stain (Wright's Dip Stat) is a rapid method that adequately stains specimens and has two colors to help differentiate stained items. Cytologic evaluation is the preferred method to ascertain the role of Malassezia and probably bacteria. Two published studies specifically evaluated cytology in normal dog and cat ears and one study in comparison to otitis externa cases but at 400x.[2, 3] Though they did not have that similar results one important observation they made is normal ears never had inflammatory cells. The Tater study did not find rods and Ginel was not able to separate rods and cocci as 400x. An unpublished study at 1000x is the basis of

what I use. Normal dogs and cats then greater than 3 yeast per oil immersion field is considered highly suspect and for bacteria greater than 5 cocci or 1 rod per oil immersion field would be very suspect. But as or more important is the presence of inflammatory cells which is highly suggestive that secondary infection is present.

Cytology allows evaluation of the cellular make-up of the discharge as well as microbial agents present. The degree of wax, lipids, keratin (nucleated corneocytes) can also be determined. Ceruminous otitis externa is seen with endocrinopathies and seborrhea; the discharge in this condition is keratin and glandular secretions. Eosinophils may be seen with parasitic disease, topical drug reactions and some food allergic animals. Cytology determines what secondary infections or microbial overgrowth is present. In addition the presence of mixed bacterial aggregates that are three dimensional may be a way to evaluate for biofilm infections. Biofilm formation has been identified as a common problem in human otitis media and may play a role in some otitis externa cases. Canine ear isolates have been shown capable of forming biofilms.[4-6] Toxic neutrophils indicate that the ear canal must be flushed to remove the toxins. The presence of white blood cells as well as phagocytosis of bacteria indicates that the body is responding to the infection and treatment for the bacteria is warranted. The presence of blue staining nuclear strands indicates that some inflammatory cells are present even though intact cells may not be identified. If any neutrophils or nuclear strands are found then it is likely there is still a bacterial component to the disease even if bacteria are not found.

Cytologic evaluation is the preferred method to ascertain the role of *Malassezia* in a particular case for two reasons. In one study by the author 18% of the cases that had *Malassezia* detected by cytology were sterile on culture by a commercial laboratory culturing specifically for *Malassezia* at 37 degree C.

Magnifying the ear canal

Otoscopes must have a strong light and power source combined with at least 10x magnification that allows focusing within the normal length of the ear canal. If any of these components is not present otoscopic examinations may not be totally effective. We have borrowed this equipment from human medicine where there are two main types of otoscope heads the diagnostic or medical and the surgical. They differ in the size of the magnifying lens that one looks through as well as the shape of the cone holders. Many practitioners purchase the diagnostic otoscope head. In general we prefer the surgical otoscope head, which allows more manipulation and angulations as well as easier use with cleaning and therapeutic procedures that require passing instruments or tubes into the ear canal with concurrent visualization. One of the most common mistakes made in practice is the use of hand help battery operated otoscopes that no longer have enough power to adequately light the deep ear canal. In general every clinic should have at least one plug in otoscope, which is not dependent of having fresh fully charged batteries. The battery operated is valuable for being readily moveable to different locations in the practice but for abnormal ears that require work a strong well-lighted otoscope is preferred.

Various sizes of otoscope cones are needed to be able to examine the different size and breeds of dogs and cats seen in practice. This equipment is essential to practice and even if the newer fiberoptic video enhanced otoscopes are available the traditional otoscopes are still necessary. These allow larger instruments and tubes to be passed into the ear canal and allow much faster deep ear cleaning. Smaller 3mm cones are fine for routine examinations but when working on ears it is important to use the largest diameter cone that you can get down the ear canal. This will improve visualization and allow more room for manipulating instruments and tubes. A clean cone, which is at least 10minute soaking in cold sterilization fluids, should be used in each ear for examination and performing procedures. At least 10minute soaking in cold sterilization fluids

The advent of fiber optics, improved lighting and miniaturization of video cameras combined with a rigid endoscope has led to the development of Fiberoptic Video Enhanced Otoscopy(FOVOE). This equipment can be connected to a video monitor and printer, digital recorder or video camera. The fiber optic tip with camera also magnifies and with a focal length of several centimeters can improve the visualization of the ear canal. Besides improving visualization it allows permanent recordings of what is present as well as allowing clients or other veterinarians to see the pathology of the ear canal. In some cases small tears of the tympanic membrane not readily seen with the normal 10x magnified otoscope will be apparent with FOVEO. In addition filling the ear canal with water or saline is sometimes used with FOVEO as it further enhances magnification and keeps the tip of the camera lens from fogging. This cannot be done with normal otoscopes. With water or saline in the ear canal, perforations not even visible with FOVEO will sometimes be found and are recognized by the air bubbles coming from the middle ear cavity. This equipment is relatively expensive but considering the improved diagnostics and more importantly the client education and benefits on gaining client support for recommended procedures makes this a worthwhile investment in a busy practice. The fiberoptic scopes also have made assessment of the abnormal tympanic membrane more effective.

The technique for doing proper otoscopic examination is one that allows complete as visualization as possible with minimal pair or trauma. Many dogs or cats will allow a carefully done otoscopic exam but resist or make it impossible to complete an examination if the technique is not optimum. Examinations are best done on a table to allow for appropriate orientation of the scope. Though large breed dogs may be able to be done on the floor is the head is held high enough and the operator is kneeling on the floor. The head should be high enough to allow the observed to move the otoscope into a more horizontal position. Occasionally it is easier to examine an ear of a dog lying in lateral recumbence on a table. The muzzle should be directed slightly towards the thoracic inlet. It may also

be necessary to have someone else hold the dog or cats muzzle as the natural tendency is for the head to be tilted as the examination starts. This will redirect the cone tip resulting in more pain. The pinna should be pulled up and out from the base of the skull, which helps to straighten the ear canal and minimize the blocking of the lumen by the cartilage fold that occurs near the junction of the vertical and horizontal canal. In addition the cone is passed down the lumen of the ear canal while the operator is visualizing the canal through the otoscope cone. Attempting to insert the cone without visualization is a sure way to "hit" the canal epithelium, which can be painful even in a normal ear. The cone is then moved slowly into the vertical canal, visualizing as you go, then the otoscope handle is rotated downward so the cone approaches a horizontal position. The movement is best accomplished when the ear is also pulled up and out over the tip of the cone so that the two processes happen simultaneously. Proper placement at the junction often allows visualization into the horizontal canal and if necessary advancement into the horizontal canal. Deep penetration into the horizontal canal is only done if necessary to visualize the tympanum. One problem often encountered in practice is the extremely painful ulcerated swollen ear that one cannot adequately exam. Even with anesthesia these cases may not be adequately examined. It may be necessary to treat the animal and reduce the swelling and inflammation and have the patient return in 4 - 7 days so that an otoscopic exam can be properly performed.

References

Tabacca, N.E., et al., *Epithelial migration on the canine tympanic membrane.* Vet Dermatol, 2011. **22**(6): p. 502-10.

Ginel, P.J., et al., *A semiquantitative cytological evaluation of normal and pathological samples from the external ear canal of dogs and cats.* Vet Derm, 2002. **13**(3): p. 151-156.

Tater, K., et al., *The cytology of the external ear canal in the normal dog and cat.* J Vet Med, 2003. **50**: p. 370-374.

Moreira, C.A., et al., *Biofilm production by clinical staphylococci strains from canine otitis.* Braz J Microbiol, 2012. **43**(1): p. 371-4.

Cannizzo, F.T., et al., *Biofilm development by clinical isolates of Malassezia pachydermatis.* Med Mycol, 2007. **45**(4): p. 357-61.

Pye, C.C., A.A. Yu, and J.S. Weese, *Evaluation of biofilm production by Pseudomonas aeruginosa from canine ears and the impact of biofilm on antimicrobial susceptibility in vitro.* Vet Dermatol, 2013. **24**(4): p. 446-9, e98-9.

Diet Trials: Getting Success

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Food allergy important clinical findings

Canine atopic dermatitis is a clinical diagnosis and it can be caused by foods or environmental allergens or a combination.[1] Generally the cases with food allergy have perennial signs. It has also been shown that AFR cases are more glucocorticoid-resistant[2, 3]. Some cases with food allergy are responsive to glucocorticoids, cyclosporine or oclacitinib but when CAD cases are not responsive food allergy is more likely than environmental allergy. That has been shown is studies for glucocorticoids and cyclosporine though the studies were not really designed to answer this question specifically.[4, 5]. Other cutaneous signs may be seen and if present in a dog with CAD are strong indicators food may be a problem. These cutaneous manifestations include lesions associated with urticaria, vasculitis (more often eosinophilic), erythema multiforme, otitis, onychodystrophy, and perianal fistula.[6-9].

AFR may cause a wide variety of non-cutaneous signs that most commonly involve the gastrointestinal and cutaneous organs. In addition: behavioral change, neurologic, urologic, respiratory, hematologic disorders, pseudo lymphoma, malaise, and fever have been reported [8, 10-12]. Despite our focus on the skin, another area that must be seriously considered is the gastrointestinal system. A significant percentage and up to half of the CAD cases from food have gastrointestinal disorders [12-14], although they are often mild and not severe enough for the owners to even note them as abnormal. Vomiting and diarrhea are seen in less than 15% of the cases. The most common sign is an increased number of bowel movements. Based on unpublished surveys, three a day is suspect but still can be normal, whereas four or more per day should be considered abnormal. Two studies that specifically questioned owners regarding gastrointestinal signs, including number of bowel movements, reported abnormal responses in 60% and 65% of the cases with confirmed AFR [14, 15]. One study that confirmed my impression reported that AFR dogs had 3.1 bowel movements per day and dogs with nonseasonal pruritus that did not have AFR had 2.1 bowel movements per day. When all the dogs were on the ZD Ultra diet (Hill's), the average number decreased overall to 1.6 but was lower in dogs that had AFR [15]. More important, the number of bowel movements in AFR dogs not only decreased on the elimination diet but also increased on provocation. The cause of the increased bowel movements may relate to alterations in colonic transport function. Dogs with nonspecific dietary sensitivity are particularly susceptible to diet-induced changes in absorptive function that are associated with damage to colonic microstructure and disrupted electrolyte transport [16]. It is also very important to get a good gastrointestinal (gi) history, as many food induced atopic dogs will have abnormal gi signs. Stetina et al in an article accepted by Vet Derm studied the normal incidences of some gi signs. Table 1

Table 1. Frequency of gi signs that should raise suspicion about food induced disease.

GI Sign	Frequency	N= 314	%
Number of BM/day (1-≥ 5)	1	27	8.6
	2	205	65.3
	3*	70	22.3
	4	11	3.5
	≥ 5	1	0.3
FCS (1-7)	1	3	1.0
	2**	227	72.3
	3**	71	22.6
	4	5	1.6
	5	8	2.6
	6	0	0
	7	0	0
Belching* (0-5)	Never	108	34.4
	Only after eating/drinking**	45	14.3
	A few times/year	73	23.3
	A few times/month	43	13.7
	A few times/week**	32	10.2
	Daily	11	3.5
	Multiple times/day	2	0.6
Flatulence (0-5)	Never	72	22.9
	A few times/year	91	29.0
	A few times/month	74	23.6

	A few times/week*	48	15.3
	Daily	23	7.3
	Multiple times/day	6	1.9
Borborygmi (0-5)	Never	155	49.4
	A few times/year	87	27.7
	A few times/month*	52	16.6
	A few times/week	13	4.1
	Daily	7	2.2
	Multiple times/day	0	0
Fecal mucus (0-5)	Never	227	72.3
	A few times/year*	74	23.6
	A few times/month	12	3.8
	A few times/week	1	0.3
	Daily	0	0
	Multiple times/day	0	0
Vomiting** (0-5)	Rarely, ≤ once/year	197	62.7
	A few times/year*	105	33.4
	A few times/month	8	2.6
	A few times/week	3	1.0
	Daily	1	0.3
	Multiple times/day	0	0

Recognizing all the signs is critical for doing diet trials effectively, particularly when cases have both environmental and food induced CAD. Clinicians and owners often only grade pruritus and skin disease and as a result may miss the improvement from an effective diet trial. Also since GI signs typically improve faster (2-4 weeks) than skin lesions observing these other signs allows one to assess the effectiveness of the diet sooner than in dogs with just skin disease as those signs may take longer (4-8 weeks) to improve. In some cases improvement of the skin will not be recognized until both the environmental and food allergens are both being treated at the same time.

Diagnosis of AFR

Diagnosis of AFR is often based on history. It may then be further suggested by doing an elimination diet trial (EDT) and showing lack of signs when foods are avoided. It can be even more strongly confirmed through provocation tests with suspect foods.

Performing diet trials correctly is not easy. In one study, owners who intended to complete a home cooked diet trial had a 36% withdrawal rate [17]. In another study of 63 dogs with suspected AFR pruritic dogs, 27% failed to correctly complete a commercial diet trial with 13% having known exposure to other food [13]. Some have suggested that the dropout rate is higher with home-prepared diets; however, one study comparing home-prepared with commercial diets did not find a significant difference in completion rate [18]. We do not know how many cases fail to complete a diet trial or how many other times cases ate non diet items that the owners did not report or were not aware of. One study showed that improved client education and the use of diagrams and emphasis on the role of diet in allergic dogs is valuable in improving client compliance [19]. These facts mean we often cannot be 100% sure that an AFR has been ruled out and educating the client about the many potential pitfalls is important.

Failure to recognize that an AFR is a significant contributor to signs means that the pet is destined to long-term drug therapy that is often associated with poorer responses and frequent flares with secondary infections [5].

Phases of a diet trial

A diet trial performed correctly has several phases. Putting the pet on a new diet—referred to as the elimination diet—is the first step. During this phase, clients observe the pet for changes, generally the resolution or reduction in signs. (see Client education below) Once changes are noted or the specified end point of the trial is reached, then the pet is reevaluated. After all signs and symptoms are assessed is again fed the diet it was on before the elimination diet. This is the initial challenge phase. Some clients want to avoid this phase and go immediately to the ingredient challenges. Any recurrence of signs with any challenge is a positive provocation and the first step toward a tentative diagnosis. In my opinion, the most important confirmation of the diagnosis is when signs remain resolved in the second challenge. Absolute confirmation requires ingredient-provocation testing, which involves multiple episodes of positive provocation evidenced by exacerbation of signs when the offending ingredient is added and resolution of signs when it is withdrawn. Ingredient-provocation testing is how to determine which diets, commercial or home-cooked, are options for long-term management. The diet trial does require a committed owner and family. When one completes all three phases the dog and client will have invested at least 3 and often 4-6 months. This is not something to take lightly.

The elimination diet

The elimination diet should ideally comprise no ingredients that the pet has been exposed to. However, this is usually impossible and the concern of cross reactivity also impacts how diet decisions should be made. Cross-reacting allergens do occur, although the true extent is unknown. A study suggested that the high incidence of reactions to a venison diet in a country where venison is rarely fed may be due to cross-reactivity [20]. Cross-reactivity can occur to more than other foods. A dog with atopic dermatitis (AD) that developed oral allergy syndrome to tomato was shown to cross-react with the Japanese cedar pollen [21].

Since proteins are the most common offending allergen, the primary goal is to feed a protein and carbohydrate source that the pet has not been routinely exposed to. Pure carbohydrates are not of primary concern, except that most carbohydrate sources do have low levels of protein in them that may be allergenic. Even cornstarch, which is commonly found in medication and other tablets, has a low level of protein. Fat supplements may also be contaminated with protein. This may be one reason that three studies that have looked at diet contamination have shown this is a serious problem and the hydrolyzed diets appear to be better choices to avoid contamination.[22-24] What is not known is how often a low level of contamination will cause a failure in a diet trial.

There are three main sources for the hydrolyzed diets: Hills, Purina, and Royal Canin. These diets have lower average molecular weights than nonhydrolyzed diets and these smaller proteins do decrease but not eliminate reactions to those proteins. The theory behind these diets is that food allergy is generally due to large complex proteins or glycoproteins. Hydrolyzing reduces the molecular weight so they are no longer allergenic. Human evidence has yielded some evidence to support this theory. The use of these diets has been reviewed in veterinary medicine and the diets are not totally effective in eliminating reactions.[25] However the diets did work for some dogs sensitive to the parent ingredient.

Because of the difficulty doing diets, long time needed to complete multiple trials, potential for cross-reactions, problems with contamination and difficulty in balancing home made diets it is better to do diet trials with the high quality commercial hydrolyzed diets. They are also expensive which is an advantage when if comes time get clients to do ingredient challenges, as that is the way they can find a less expensive high quality diet they can feed for the rest of the pets life. The presence of gi signs is valuable because they can be assessed at four weeks and if not improving an alternative diet be selected. If all the hydrolyzed diets are ineffective in resolving the gi signs the a home make diet such as pumpkin and pinto beans may be utilized but is not a balanced diet and this needs to be discussed with the owner. Home cooking is not be done in growing dogs and should be only done for the 8 weeks then supplements added to balance the diet.

Client education

Key points need to be emphasized to owners before starting a diet trial. Establish baseline symptom scores before the trial is started because this provides the comparison for future responses and exacerbations. It is preferable to establish these scores without concurrent microbial disease. Therefore, baseline signs are often determined at a recheck when the pet is on other medications, such as antibiotics and ant yeast medicine. Symptom scores should record the extent and the pattern of pruritus as well as what gastrointestinal and other signs are present. The Hill visual analog score is helpful, but it is important to pay attention to the extent of pruritus in all affected areas. Some areas may change when the overall pruritus score does not in cases of canine AD with both food and environmental components. Grade at least lesions and pruritus of the paws, perineum, dorsal trunk, and ears. For example, the dog may still have grade-10 disease at the end of the trial even though the pruritus of the ear or dorsal lumbar have totally resolved; such cases often indicate that the dog has a combination of allergies. Clients must be educated on how to recognize a response in their pet, and this can only be done if they pay close attention during the challenge phase. Owners of nonresponsive cases must always be counseled that though they do not think the diet has helped they need to see whether any changes occur after reintroduction of the old diet.

An important but often difficult aspect to control is other sources of foods the animal may ingest. Preventing consumption of other foods often means keeping animals confined indoors with outside exposure controlled, such as on a leash. I have also had cases that require a muzzle to prevent inappropriate food consumption. The owners must be aware that the dog should consume *nothing* but what is in the diet on a regular basis, so that precludes other pets' food, treats, medication wrapped in food and even alone, chewable forms of dog vitamins, and supplements. It takes very little for signs to flare, as was shown in a study where 12 dogs that were allergic to soy were challenged with one tablet of Interceptor Flavor Tabs, which contain pork liver, soy, and 2.3 mg milbemycin. Clinical scores increased significantly in 10 of 12 dogs, with peak scores seen 2 days after challenge in five dogs and 5 days after challenge in five dogs [26]. So dogs eating inappropriate foods weekly may not respond to the diet trial. This does mean a monthly flavored heartworm or flea control product is okay, but the owner needs to pay close attention at the monthly application times, as this is essentially a challenge with that ingredient. The fluralaner flea product is only given every three months and contains hydrolyzed pork protein allowing a diet trial to be completed without the challenge. The whole family must be aware of the dietary requirements. Dogs need to be prevented from cleaning floors of crumbs. The presence of young children in a household often precludes any chance of controlling a diet in an indoor pet. Coprophagia must also be prevented. There is a report that a food-allergic dog that ate cat feces did not respond until the housecat was also put on a similar hypoallergenic diet.

Challenge and specific provocation testing

True confirmation of AFR occurs when feeding the offending diet induces signs (challenge phase), which resolve on the elimination diet with no other changes in concurrent therapies. Many clients are resistant to this proposal until I explain its value. The first is the best, money. The limited ingredient hydrolyzed diets are generally expensive so most owner will be motivated to find a new food, especially once it is explained the cost is not for a extra high quality diet but just a highly processed diet. This is a big reason I use hydrolyzed diets and describe their expense as the cost of a test. Some pets will develop new allergies and by doing multiple challenges the client will not have to start from scratch to determine what else the pet can eat. In addition, knowing what foods the pet is not sensitive increases feeding options. This is particularly helpful for the long-term management, especially in multiple-pet households.

How the challenge is done can vary depending on the client. Some like to try and prove exactly what the dog is allergic to. For these we do ingredient challenges. One ingredient at a time is added to the elimination diet for up to a week. The other is new commercial food challenges with different ingredients. Here I generally pick a less expensive limited ingredient diet and switch to that. If the dog does not react then we have either found another diet it can eat or it was not food allergic. So I also then try a treat that contains lots of ingredients so we hopefully can confirm the food allergy is present but maybe not the exact ingredients. With either approach there are some rules to follow. The client keeps a diary on which ingredients cause reactions. They should watch for how long and what signs are seen with each ingredient. After signs have improved significantly or have resolved completely, the pet should be challenged with the diet being fed before the diet trial. If there is no increase in signs, then all other treats, etc. should be fed. Each challenge should be given only until a recurrence is obvious to the client or for 7 days. If there is no recurrence after 7 days, that food is not likely to be the problem. When signs recur, it is usually just an increase in pruritus. This will usually occur rapidly if the exacerbation is noted in the first 2 or 3 days on the challenge. With true allergy, signs recur rapidly and in my experience, most well-confirmed food allergies are worse in 1 to 2 days. If this occurs, then the elimination diet is again fed until the signs resolve. The sooner a client observes a sign of disease occurring and goes back on the elimination diet, the sooner the pet will respond. Fortunately, when they only get one to several meals of the offending diet the response is usually rapid again and often does not need a treatment to resolve it.

References

1. Olivry, T., et al., Food for thought: Pondering the relationship between canine atopic dermatitis and cutaneous adverse food reactions. . Vet Derm, 2007. **18**(6): p. 390-391.
2. Picco, F., et al., A prospective study on canine atopic dermatitis and food-induced allergic dermatitis in Switzerland. Vet Dermatol, 2008. **19**(3): p. 150-155.
3. Favrot, C., et al., A prospective study on the clinical features of chronic canine atopic dermatitis and its diagnosis. Vet Dermatol, 2010. **21**(1): p. 23-31.
4. Rosser, E., Diagnosis of food allergy in dogs. J Am Vet Med Assoc, 1993. **203**: p. 259-262.
5. Jackson, H., et al. The effect of oral cyclosporine on acute reactions following oral allergen challenge in a spontaneous canine model of food allergy. in ESVD-ECVD. 2006. Lisbon, Portugal.
6. Nichols, P.R., D.O. Morris, and K.M. Beale, A retrospective study of canine and feline cutaneous vasculitis. Vet Dermatol, 2001. **12**(5): p. 255-64.
7. Mueller, R.S., et al., Diagnosis of canine claw disease a prospective study of 24 dogs. Vet Dermatol, 2000. **11**(2): p. 133-141.
8. Kennis, R., Use of Atopic Dogs to Investigate Adverse Reactions to Food. J Am Vet Med Assoc, 2002. **221**(5): p. 638-640.
9. Itoh, T., et al., Erythema multiforme possibly triggered by food substances in a dog. J Vet Med Sci, 2006. **68**(8): p. 869-871.
10. Vaden, S.L., et al., Food hypersensitivity reactions in Soft Coated Wheaten Terriers with protein-losing enteropathy or protein-losing nephropathy or both: gastroscopic food sensitivity testing, dietary provocation, and fecal immunoglobulin E. J Vet Intern Med, 2000. **14**(1): p. 60-7.
11. Wills, J. and R. Harvey, Diagnosis and management of food allergy and intolerance in dogs and cats. Aust Vet J, 1994. **71**(10): p. 322-6.
12. Scott, D.W., W.H. Miller, Jr,, and C.E. Griffin, Muller and Kirk's Small Animal Dermatology. 6 ed. 2001, Philadelphia: W,B. Saunders.
13. Loeffler, A., et al., Dietary trials with a commercial chicken hydrolysate diet in 63 pruritic dogs. Vet Rec, 2004. **154**(17): p. 519-22.
14. Patterson, S., Food hypersensitivity in 20 dogs with skin and gastrointestinal signs. J Small Anim Pract, 1995. **36**: p. 529-534.
15. Loeffler, A., et al., Dietary trials iwth a commercial chicken hydrolysate diet in 63 pruritic dogs. Vet Rec, 2004. **154**: p. 519-522.
16. Rolfe, V.E., et al., Relationships between fecal consistency and colonic microstructure and absorptive function in dogs with and without nonspecific dietary sensitivity. Am J Vet Res, 2002. **63**(4): p. 617-22.
17. Tapp, T., et al., Comparison of a commercial limited antigen diet vs a home prepared diet in the diagnosis of canine food adverse reaction. Veterinary Therapeutics, 2002. **3**(3): p. 244-251.
18. Loeffler, A., et al., A retrospective analysis of case series using home-prepared and chicken hydrolysate diets in the diagnosis of adverse food reactions in 181 pruritic dogs. Vet Dermatol, 2006. **17**(4): p. 273-9.
19. Chesney, C., Food sensitivity in the dog: a quantitative study. J Small Anim Pract, 2002. **43**(5): p. 203-207.
20. Leistra, M.H.G., P.J. Markwell, and T. Willemse, Evaluation of selected-protein-source diets for management of dogs with adverse reactions to foods. J Am Vet Med Assoc, 2001. **219**(10): p. 1411-1414.
21. Fujimura, M., et al., Oral allergy syndrome induced by tomato in a dog with Japanese cedar (Cryptomeria japonica) pollinosis. J Vet Med Sci, 2002. **64**(11): p. 1069-1070.

22. Raditic, D.M., R.L. Remillard, and K.C. Tater, ELISA testing for common food antigens in four dry dog foods used in dietary elimination trials. J Anim Physiol Anim Nutr (Berl), 2011. **95**(1): p. 90-7.
23. Ricci, R., et al., Identification of undeclared sources of animal origin in canine dry foods used in dietary elimination trials. J Anim Physiol Anim Nutr (Berl), 2013. **97 Suppl 1**: p. 32-8.
24. Widman, K., S. Handl, and C. Horvath-Ungerboeck. Detection of food antigens in commercial elimination diets for dogs using PCR. in ESVD-ECVD. 2014. Salzburg, Austria.
25. Olivry, T. and P. Bizikova, A systematic review of the evidence of reduced allergenicity and clinical benefit of food hydrolysates in dogs with cutaneous adverse food reactions. Vet Dermatol, 2010. **21**(1): p. 32-41.
26. Jackson, H.A. and B. Hammerberg. The clinical and immunological reaction to a flavoured monthly oral heartworm prophylactic in 12 dogs with spontaneous food allergy. in AAVD and ACVD. 2002. New Orleans.

Pruritus: What's New?

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Pruritus is an uncomfortable sensation of the skin that provokes the desire to rub or scratch, the popular term for this action is itching. Pruritus is a primary neurologic sensation that is a symptom associated with many diseases. The diseases result in the production of pruritic mediators that stimulate itch specific C fiber nerve receptors that are found in the epidermis and dermis. The classic pruritus mediator that has been studied the most is histamine. The discovery of a fourth histamine receptor(H4) has stimulated a new evaluation. There is evidence the H4 receptor is important in both T helper cell type 2 (TH2) inflammation and pruritus. H4 has been shown to occur in dogs but its role is just being investigated. However there are many other mediators believed more important in the dog. There is a long list of pruritic mediators that come from a variety of classes such as neuropeptides, peptides, proteases, cytokines and leukotrienes. We have known for a long time that mast cells contain many pruritic mediators but sensory nerves, lymphocytes and endothelial cells are also sources as is the keratinocyte. Keratinocytes can produce proteases, cytokines and neuropeptides, especially acetylcholine now considered an important mediator of itch. Work in dogs has shown that serum IL-31 is elevated in over half of atopic dermatitis dogs but not in normal, flea allergic or experimentally induced house dust mite allergic beagles.[1] IL-31 is produced by canine TH2 lymphocytes and this production is increased when house dust sensitized T cells are co-stimulated with Staphylococcus enterotoxin B.[2] It is also important to note that two different groups have found IL-31 receptors in the dorsal root ganglia of dogs.[2-4] Pruritus is induced in dogs with exposure to IL-31 and with this model pruritus can be reduced with treatment with prednisolone or the Janus kinase inhibitor, oclacitinib.[1, 5]

Oclacitinib maleate is a new synthetic drug that that has been developed for the treatment of allergic diseases in dogs. It is a member of a relatively new class of drugs called Janus kinase (JAK) inhibitors. Janus kinases are a group of 4 enzymes (Janus kinase 1-3 and tyrosine kinase) that function by facilitating transmission of signals form cell membrane receptors intracellular. They function in pairs with certain cytokine receptors being acted on by various combinations of paired enzymes. Oclacitinib mainly acts on JAK 1 and at higher serum levels on JAK 2. The Cmax does relate to the dose and at 0.6mg/kg daily for 168 days is 273-406 ng/ml. Cmax at 0.4mg/kg was around 200ng/ml for beagle and mongrel dogs after a single dose.[6] Oclacitinib is considered an immune modulating drug because it suppresses cytokine function, particularly IL 31 and to some extent IL 2.

Efficacy of oclacitinib has been shown for pruritus associated with allergic disease.[7] A blinded placebo controlled study- evaluated oclacitinib in 436 dogs with a variety of allergic diseases. Pruritus scores decreased from 7.39 to 2.59 and 7.58 to 5.54 in the oclacitinib and placebo treated groups respectively. The response in the treated group was significant and significantly better than the placebo group. Another blinded placebo study done by board certified veterinary dermatologists studied 299 AD dogs.[8] Pruritus scores decreased from 7.8 to 2.6 and from 7.7 to 7.4 in at the 14 days scoring in the oclacitinib and placebo treated groups respectively. This was very significant difference between groups. Following 14 to 28 days all dogs were allowed to go into an open label study and at the end of 112 days the pruritus score averaged 3.2. The skin lesions as graded by the canine atopic dermatitis extent and severity index (CADESI) had also dropped from a pre treatment score of 62 to 32 and 58 to 57 in the oclacitinib and placebo groups respectively. When all dogs finished the open label phase the CADESI was 26 at day 112. Another study showed efficacy in flea allergy dermatitis.[9] Apoquel was also shown to decrease pruritus as fast as glucocorticoid therapy and in IL 31 pruritus model even better than glucocorticoids.[10, 11]

There is one 84-day randomized controlled trial comparing Apoquel® (oclacitinib) to Atopica® (cyclosporine) in 226 dogs. Veterinary dermatology specialists performed this study with client owned dogs in Australia. Dogs were evaluated for PVAS and CADESI-02 scoring on days 1,2,7, 14, 28, 56 and 84 days. Differences were significant at all time points up to day 28 regarding PVAS scoring. By day 56, cyclosporine treated dogs had a similar PVAS scoring to Apoquel treated dogs. As expected the Apoquel treated dogs had much quicker onset of activity regarding the pruritus reduction (See Graph below). More adverse events were found in the cyclosporine treated group which was largely gastrointestinal (vomiting and diarrhea Atopica group (44 and 15%) vs. Apoquel group (14 and 4%)[12] (See table below comparing side effects). Atopica is FDA approved to be used with low dose prednisolone and a recent study showed no increase in adverse events when combined with low dose prednisolone therapy during the first 3 weeks of therapy. Combination therapy expedited the reduction of pruritus during the first 3 weeks during Atopica induction[13].

Initial results at the Animal Dermatology Clinic in San Diego were evaluated in August 2014.

Apoquel was prescribed for 107 dogs, 13 (12%) of 107 stopped the drug because of poor efficacy, 2 stop for the development of masses, one for UTI, 11 went off for alternative therapy and 9 was because ASIT was working. 3 cases were deceased. One at 9-year age with lymphoma, one at 14year age and was reported weak prior to expiring and one with a Histiocytic sarcoma. We had followed up on 47 dogs treated with16mg tabs and 30 (64%) were still on therapy, 43 dogs on 5.4mg and 26 (60%) still on therapy and 17 dogs on 3.6mg with 12 (71%) still on therapy.

In dogs pruritus is manifested by a variety of behaviors though most classic is scratching but also includes: biting, chewing, dragging body parts, licking, rolling, rubbing against objects, scooting, and shaking. Clients may indicate that a dog is not able to itch a part of its body but in reality any area can be itched. However the location partly determines which one of the described methods is utilized. Unfortunately these methods of itching are behaviors that may be seen to some degree in normal animals or animals experiencing another sensation such as pain. Determining that pruritus is abnormal is typically based on a number of criteria such as severity, intensity, duration, induction of skin lesions, or not being able to be distracted from the behavior. Pruritus may occur without visible cutaneous changes, may be associated with a rash that caused the pruritus, or have skin changes present that have resulted from the pruritus. So complete recognition of pruritus and where a dog is pruritic can only be determined by a good history from an observant dog owner. This leads to a problem when trying to assess all pruritic locations as some may not be as affected and therefore the behavior considered normal. For example when surveyed in groups I find there are some veterinarians who believe a dog observed to lick its paws once or twice daily is normal but all agree that 100 times a day is abnormal. Coming to a consensus between those two numbers is difficult. Based on an unpublished survey it is very infrequent for an owner of a dog that they consider normal and has never been treated for skin or ear disease to answer that question with daily or more! Recently Stetina et al completed a study in 314 apparently healthy dogs. The results have been presented at the 2015 NAVDF and the paper accepted by Veterinary Dermatology. This study has revealed that the following behaviors regarding pruritic behaviors. Table 1

Table 1 Frequency of behaviors that should make you suspicious the dog is abnormally pruritic

Pruritic Behavior	Frequency	N= 314	%
Paw licking/chewing	Never	106	33.8
	Daily*	24	7.6
	Multiple times/day	8	2.6
Facial/muzzle rubbing	Never	121	38.5
	Daily*	29	9.2
	Multiple times/day	6	1.9
Head shaking	Never	102	32.5
	Multiple times/day*	15	4.8
Sneezing	Never	73	23.3
	Daily*	17	5.4
	Multiple times/day	4	1.3

A visual analog scale utilizing those behaviors has been developed and validated for assessing pruritus by owners of dogs.[14] This scale was evaluated in 305 dogs that were either healthy or had non cutaneous disease and 408 dogs with skin disease.[15] In the non-skin disease dogs the median pruritus sore was zero, which was recorded by 214 (70.2%) owners with 228 (75%) of the dogs having a score ≤ 0.5. Ninety dogs (29.5%) had scores above 0. The median score in the skin disease group was 5.5 and only 26 (6.4%) of 408 with skin disease had a score of 0. Stetina study showed a lower level though similar results for 0 scores in normal dogs and there was a positive correlation between higher scores and increased frequency of many pruritic behaviors. Stetina et al found 60.2% scored 0 and 92.1% were 2 or less and only 9 dogs (2.8%) scored > than 3.

Fleas are also known to cause pruritus particularly in flea allergy dermatitis. A recently study has also shown fleas are very important in non-allergic dogs as well. When dogs were identified to have at least ten fleas on them 100% were given PVAS scores above 0 and most were above what is considered normal.[16] Effective flea control with fast killing Spinosad was able to decrease pruritus dramatically but improvement was taking up to 90 days to be seen.

References

1. Gonzales, A.J., et al., Interleukin-31: its role in canine pruritus and naturally occurring canine atopic dermatitis. Vet Dermatol, 2013. **24**(1): p. 48-e12.
2. McCandless, E.E., et al., Allergen-induced production of IL-31 by canine Th2 cells and identification of immune, skin, and neuronal target cells. Vet Immunol Immunopathol, 2014. **157**(1-2): p. 42-8.
3. Rossbach, K. and W. Baumer, Expression of different receptors possibly involved in pruritus in canine dorsal root ganglia. Vet Derm, 2012. **23** (suppl 1Abst WCVD 2012): p. 98-99.
4. McCandless, E.E., et al., Production of IL-31 by canine Th2 cells and identification of inflammatory and neuronal target cells. Vet Dermatol, 2012. **23**(suppl 1 WCVD abst): p. 52.
5. Humphry, W., et al., Development of a model of IL-31 induced pruritus in beagle dogs. Vet Dermatol, 2012. **23**(suppl 1 WCVD abst): p. 35.
6. Collard, W.T., et al., The pharmacokinetics of oclacitinib maleate, a Janus kinase inhibitor, in the dog. J Vet Pharmacol Ther, 2013.
7. Cosgrove, S.B., et al., Efficacy and safety of oclacitinib for the control of pruritus and associated skin lesions in dogs with canine allergic dermatitis. Vet Dermatol, 2013. **24**(5): p. 479-e114.

8. Cosgrove, S.B., et al., A blinded, randomized, placebo-controlled trial of the efficacy and safety of the Janus kinase inhibitor oclacitinib (Apoquel®) in client-owned dogs with atopic dermatitis. Veterinary Dermatology, 2013. **24**(6): p. 587-e142.
9. Wheeler, D.W., et al., Oclacitinib for the treatment of pruritus and lesions associated with canine flea-allergic dermatitis. Vet Dermatol, 2012. **23**(suppl 1 WCVD abst): p. 38,39.
10. Fleck, T.J., et al., Comparison of the janus kinase (JAK) inhibitor, oclacitinib, and prednisolone in canine models of pruritus. Vet Dermatol, 2012. **23**(suppl 1 WCVD abst): p. 38.
11. Fleck, T.J., et al. Comparison of the onset and anti-pruritic activity of the JAK inhibitor oclacitinib to prednisone and dexamethasone in an IL-31 canine model of pruritus. in NAVDF. 2013.
12. Little, P., et al. Efficacy and safety of oclacitinib compared to ciclosporin for the control of atopic dermatitis in client-owned dogs. NAVDF, Phoenix AZ 2014
13. Dip, R., et al., Concurrent short-term use of prednisolone with cyclosporine A accelerates pruritus reduction and improvement in clinical scoring in dogs with atopic dermatitis. BMC Vet Res, 2013. **9**: p. 173.
14. Hill, P.B., P. Lau, and J. Rybnicek, Development of an owner-assessed scale to measure the severity of pruritus in dogs. Vet Dermatol, 2007. **18**(5): p. 301-8.
15. Rybnícek, J., et al., Further validation of a pruritus severity scale for use in dogs. Vet Dermatol, 2009. **20**(2): p. 115-122.
16. Dryden, M.W., et al., Assessment of owner-administered monthly treatments with oral spinosad or topical spot-on fipronil/(S)-methoprene in controlling fleas and associated pruritus in dogs. Vet Parasitol, 2013. **191**: p. 340-346.

Pyodermatitis: Another Perspective

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Pododermatitis is often defined as inflammation of the skin of the foot. However several dictionaries actually use the term related to only inflammation of the dermal tissue underlying the horny layers of the hoof and generally are referring to diseases most often seen in cattle. If one uses the broader definition often applied to dogs then any foot (paw) epidermal or dermal tissue that is inflamed would be a form of pododermatitis. This would include interdigital spaces, footpads, nail folds (paronychia), and claws. The diseases that may affect any of these structures would include most of the diseases that affect dog skin, which results in an extremely long and not very helpful differential diagnosis. Therefore another approach is to separate the disorders based on more specific anatomic regions as well as to those diseases that may affect the paws along with other body areas from those diseases that are limited to the paws. Even in this context there are diseases that tend to affect only one paw or even one digit versus diseases that typically affect all or at least most paws and digits. When one narrows the presenting features based on this approach then the differential diagnosis is much more limited.

The author uses definitions based on these more specific anatomic sites and therefore different differentials. Paronychia is those diseases that are limited to the skin of the claw folds of the digits. Any involvements of the claw are superficial and from deposition of exudate or debris from the claw fold accumulating or contacting the adjacent claw. Pad diseases are those that affect the pads, which are located on the palmer/plantar surface of each digit, and under the metacarpal- and metatarsal-phalangeal joints, and the carpus of dogs and cats. The skin of the pad is non-haired, thickened, tough, and rough surfaced. It is most often hyperpigmented and the hypodermis contains large amounts of adipose tissue, as most pads are weight-bearing surfaces. Claw diseases are those that result in changes in the claws and can include the dermal or deep structures of P3. That leaves the rest of the digital and interdigital haired skin, as the last anatomic region of the paw which when inflamed is what this author defines as pododermatitis. We can then take this one more level and that is disorders that affect the hair follicles of the interdigital haired skin, podofolliculodermatitis.

Chronic interdigital pododermatitis has been described for years. Though it is often idiopathic it has been proposed that friction, scarring and trauma may predispose or cause follicular damage and lead to infection and inflammation. Podofolliculitis is one form of pododermattitis, which is defined as follicular disease (most often hyperkeratosis) with perifolliculitis and or folliculitis or furunculosis. These cases may involve one or multiple paws. Once there is follicular involvement in multi paw symmetrical disease then the most common differentials are secondary bacterial podofolliculitis, demodex and follicular hyerpkeratotosis and furuncular granulomatosis.

Pododemodicosis is most common in young dogs with generalized demodectic mange. Occasionally cases are seen that following resolution of generalized demodex will have persistent pododemodecosis or podofolliculitis and sterile furuncular granulomatosis. These cases are generally very apparent with the history of generalized demodex prior to the pododermatitis. Rarely a case of adult onset demodicosis or iatrogenic demodicosis from long term immune suppressive therapy will present with lesions confined to the paws. It is important to look close as perioral disease is often seen with the pododemodecosis in these cases. Pododemodicosis is tentatively ruled out with properly performed skin scrapings and hair plucks. In rare cases demodex pododermatitis will only be diagnosed with a skin biopsy. Treatment of pododemodicosis is systemic ivermectin 450-600ug/kg q 48-24 hours. Some difficult cases may respond better to ivermectin twice weekly combined with weekly or twice weekly amitraz paw soaks.

Bacterial podofolliculitis may be seen secondarily to most diseases that affect the paws, including demodex pododermatitis. It also has been described as occurring as an idiopathic disease. Many cases likely described as idiopathic likely occur secondary to conformational disease. Two syndromes have been described that likely reflect the same or similar syndrome. Canine interdigital palmar and plantar comedones and follicular cysts (IPPCFc) was described as generally localized form of chronic pododermatitis.[1] This syndrome most often affected the $4^{th}/5^{th}$ interdigital space (26/36 lesions) or the $3^{rd}/4^{th}$ space (7/36 lesions) and mostly on the front paws. The same or at least very similar lesions called interdigital cysts had been reported many years ago.[2] It has also been shown that the type of flooring the dog is maintained on and trauma does play a role in the formation of interdigital cysts.[3] Another syndrome called immunomodulatory-responsive lymphocytic-plasmacytic pododermatitis (ImR-LPP) shares similar features though often is not localized to one or two interdigital spaces.[4-6] This syndrome has been associated with purebred dogs and the presence of *Staph pseudintermedius*.[6] Multiple authors have theorized that the lesions may be induced, at least in some cases or partially, by trauma from friction or haired skin being becoming weight bearing.[1, 7] There are some similarities between these lesions and callus formation in other regions where haired skin is exposed to chronic weight bearing trauma. This theory is certainly supported for the interdigital palmer planter comedones, which occur in the spaces that are most weight bearing in dogs.[1, 8] Cases are also seen that the onset of disease is associated with increases in weight, which is also supported by the average age of onset being middle-aged dogs. In some cases conformational abnormalities are obvious and may also be associated with the development of joint laxity and

"flat footedness". In others it is possible to see the digital pads projecting anterior. What is also interesting some dogs and even affected dogs with some lesions may develop effective calluses or even modified pad tissue that does not result in perifolliculitis and granulomatous furunculosis. What determines the development of that response is unknown.

What complicates the diagnosis of these disorders is that they can occur secondary to other diseases that result in pododermatitis, pain and altered weight bearing. Even chronic infections lead to follicular hyperkeratosis therefore these syndromes can be associated with other diseases or occur with no predisposing condition other than conformational changes or apparently be truly idiopathic though this is very infrequent in the author experience. Another complicating factor is some dogs with deeply recessed folds in the palmar plantar skin will develop infections related to the fold dermatitis, often aggravated by concurrent allergic dermatitis. Diagnosis thus may be limited to the presence of interdigital palmar plantar comedone and follicular cysts and IrR-LPP or they may be associated with another disease in which case maybe the diagnosis of that name is not appropriate. However once present treating the primary disease will not resolve the pododermatitis. The primary causes that need to be ruled out are the potential causes for bacterial podofolliculitis, such as allergy, hormonal, parasitic, keratinization, metabolic and immune mediated disorders. Once all those are ruled out then it may be appropriate to diagnose IPPCFc or IrR-LPP if there is follicular disease and appropriate histopathology. Certainly a conformational component needs to be addressed as an underlying cause because when present medical therapy is rarely successful without long term anti-inflammatory therapy.[4, 9] Once conformational disease is diagnosed then the treatment of choice is surgical removal of the diseased tissue and creating non-haired weight bearing surfaces. Both syndromes may present with secondary infection but eliminating the infection does not result in complete resolution of the lesions. All drainage, fistulous tracts and pain may resolve with antibiotics leading some owners and even veterinarians to believe the lesions are healed, only to recur following the discontinuation of antibiotic therapy. Even successful removal of the diseased tissue has had recurrence if the dog ends up weight bearing on haired skin that is sutured into the defect. For localized lesions focal surgical excision or laser therapy may be successful. The key is to remove all foreign hair and epithelial debris and then allow the lesion to granulate in so there is no haired skin brought back into the weight bearing area. Cases with generalized pododermatitis may respond best to a complete podoplasty.[10, 11]

References

1. Duclos, D.D., A.M. Hargis, and P.W. Hanley, Pathogenesis of canine interdigital palmar and plantar comedones and follicular cysts, and their response to laser surgery. Veterinary Dermatology, 2008. **19**(3): p. 134-141.
2. Whitney, J.C., Some aspects of interdigital cysts in the dog. J Small Anim Pract, 1970. **11**(2): p. 83-92.
3. Kovacs, M.S., et al., An epidemiological study of interdigital cysts in a research Beagle colony. Contemp Top Lab Anim Sci, 2005. **44**(4): p. 17-21.
4. Breathnach, R.M., et al., Canine pododermatitis and idiopathic disease. Vet J, 2008. **176**(2): p. 146-57.
5. Breathnach, R.M., et al., Clinical, immunological and histopathological findings in a subpopulation of dogs with pododermatitis. Vet Dermatol, 2005. **16**(6): p. 364-72.
6. Breathnach, R.M., et al., Association between skin surface pH, temperature and Staphylococcus pseudintermedius in dogs with immunomodulatory-responsive lymphocytic-plasmacytic pododermatitis. Vet Dermatol, 2011. **22**(4): p. 312-8.
7. Gross, T., et al., Skin Diseases of the Dog and Cat, Clinical and Histopathologic Diagnosis. Second ed. 2005, Ames: Blackwell Science.
8. Besancon, M.F., et al., Distribution of vertical forces in the pads of Greyhounds and Labrador Retrievers during walking. Am J Vet Res, 2004. **65**(11): p. 1497-501.
9. Bloom, P., Idiopathic pododermatitis in the dog: an uncommon but frustrating disease. Vet J, 2008. **176**(2): p. 123-4.
10. Papazoglou, L.G., et al., Fusion podoplasty for the management of chronic pedal conditions in seven dogs and one cat. J Am Anim Hosp Assoc, 2011. **47**(6): p. e199-205.
11. Swaim SF, et al., Fusion podoplasty for the treatment of chronic fibrosing interdigital pyoderma in the dog. J Am Anim Hosp Assoc 1991;27:264–74. J Am Anim Hosp Assoc, 1991. **27**(3): p. 264-274.

Pyoderma:
How Complex is it?

Craig Griffin, DVM, DACVD
Animal Dermatology Clinic
San Diego, CA

Skin infections with bacteria are often found in dogs secondary to other diseases such as seborrhea, endocrine diseases and allergic diseases. Many of these cases have abnormalities in skin barrier function or desquamation. When the primary disease is controlled if this defect is not corrected the dog may still be prone to recurrent infections though episodes may be less severe or less frequent. In chronic or recurrent infections other factors may develop which are referred to as perpetuating factors. The most common bacteria to cause skin infections in dogs is *Staphylococcus pseudintermedius* though occasionally other bacteria such as *Staphylococcus aureus* or *schleiferi, Enterococcus, Corynebacteria, E. coli,* and *Pseudomonas* may be pathogenic. The emergence of methicillin resistant Staphylococcus including pseudintermedius in dogs is now recognized around the world. Prior antibiotic therapy generally has been shown to be a risk factor for its occurrence though this was not the case in a recent study in Germany.[1] The Staph pseudintermedius associated with infections has very similar virulence factors with the only difference shown was increased protein A in dogs with pyoderma.

The diagnosis of pyoderma requires a skin lesion that has neutrophils with bacteria present that is preferably found intracellular within inflammatory cells. The classic primary lesions of pyoderma are: Pustules, furuncles, and fistula. Other lesions suggestive or compatible with pyoderma include: Crusts, papules, nodules, and lichenification. The spreading ring of scale (epidermal collarette) associated with some erythema, exudate or crusting is also very typical of pyoderma. If cocci are seen then most commonly the pyoderma is due to *Staphylococcus* though definitive identification requires a culture. Based on the simplest definition of a pyoderma I prefer to diagnose bacterial overgrowth when no inflammatory cells are present but bacteria are present in abnormally high numbers. High is greater than one cocci or 0.5 rods per OIF (1,000X) based on unpublished work by Dr Colombo. It has also been proposed that 5 cocci may be an appropriate number to use. Further work evaluating this is indicated and should look at various sites commonly involved with pyoderma. Histopathology is also helpful in diagnosing pyoderma though bacteria are not often seen. Histopathology is also used to identify primary diseases as well as perpetuating factors. Most suppurative folliculitis and perifolliculitis occur because of pyoderma. The presence of bacteria in a crust or the stratum corneum is also significant. Determination of resistance does require sensitivity testing and should be performed whenever cases have not responded to empiric therapy.

Predisposing and perpetuating factors

Since pyoderma is most often secondary successful long-term management will require that underlying primary diseases are identified and managed, but it is also important to realize other aspects of the dog may predispose such as inappropriate friction or alteration in skin microenvironment from things such as skin folds. Both friction and skin folds may be associated with genetically selected traits or obesity. Chronic trauma to the skin results in changes of the affected hair follicles. This is best exemplified by the formation of a callus. In some cases this response can predispose to pyoderma.

The role of chronic skin disease and the development of recurrent and also resistant pyoderma are well accepted. What is not often discussed is what role does the pyoderma have on causing recurrent pyoderma. Does the presence of a pyoderma result in changes that may perpetuate the development of chronic inflammation and more pyoderma. There are some clinical observations that support this but studies are needed to answer this question. These perpetuating factors occur because the pyoderma has damaged cutaneous structures. The histopathology of chronic pyoderma cases will often have follicular hyperkeratosis. What has not been studied is what causes the follicular hyperkeratosis, is it always just the primary disease or is it the pyoderma? Many atopic dogs that have had chronic pyoderma will have follicular hyperkeratosis, but that is not a classic lesion of atopic dermatitis. It is common for a dog with deep pyoderma to have a history of chronic superficial pyoderma that eventually progresses to a case with both superficial and deep lesions. Why does this occur? Other aspects than just the primary disease may be involved. In some cases maybe drugs the dog is on contribute. How do corticosteroids impact chronic pyoderma cases? Folliculitis often results in foci of alopecia. The loss of hair now exposes the skin to ultraviolent radiation and in some dogs they do not have the ability to pigment the skin. What role does the ultraviolet radiation have on the local immune response or even the hair follicle structure or cutaneous inflammation? When an infected hair follicle does rupture it releases keratin and hair shafts into the dermis. That material also stimulates inflammation and in some cases fibrosis and scarring. Though normally this material is broken down and eventually eliminated some cases develop persistent hair shaft sequestrum that appears to be associated with chronic or recurrent cases. In others it may not be hair shafts but remnants of corneocytes are found in the center of microabcesses or scars and the possibility of cocci that may adhere to corneocytes being protected inside a folded or rolled up corneocyte is another possible site for sequestering bacteria and protecting them from tissue levels of antibiotics or the body's immune defenses. Abscess or granuloma formation may alter the ability of some antimicrobials to effectively reach or kill the microorganisms. Another pathologic change that may be less apparent is fibrosis unless

it occurs grossly. Fibrosis more often occurs at the microscopic and not the gross level. The fibrosis may be perifollicular or more diffuse throughout the dermis. Certain breeds (Doberman pinscher, bull and Staffordshire terriers, Rottweiler) seem more predisposed to excessive scarring that appears to make resolution of the pyoderma more difficult.

Clinically cases occur that the primary disease is well controlled or eliminated yet recurrent infections may continue for some time. One could argue in the atopic dog that this is because the barrier defect that was present even before the atopic disease is not really controlled. How does one explain it in the testicular tumor dog that still gets recurrent pyoderma after the testicular tumor is removed? Studies evaluating causes of chronic recurrent pyoderma other than primary diseases are needed. If perpetuating factors are important then how we manage these cases may need to change. If we can prevent infections from causing perpetuating factors or find ways to reverse perpetuating factors we may improve the chances of eliminating recurrent infections.

Treatment

Success treating skin infections requires appropriate antimicrobial therapy and systemic antibiotic therapy has been the main emphasis of veterinarians for many years. Topical therapy though considered helpful can actually be essential to successful therapy and in some cases with resistant bacteria such as methicillin resistant Staph (MRS) may become the main or sole method to eliminate the infection. Even following therapy is it common to find Staphylococcus either persisting on the skin or in carriage sites and often these will still be resistant strains though fluctuations in this pattern are seen.

Additionally any pathologic changes in the normal anatomy or physiology of the skin that occur because of the inflammation from the infection need to be reversed or controlled. If any part of these components is not addressed then more antimicrobial therapy will be required and success will be limited. Some treatments may need to be directed at reversing pathologic changes or long-term therapy may be required until the body naturally remodels or reverses those changes. In others surgical correction or removal of localized fibrotic or granulomatous lesions can be an effective and cost saving procedure. Long-term pentoxifylline may help to reverse scarring in some cases with widespread lesions not amenable to surgical therapy. Glucocorticoids have been used in some cases with residual granulomas but this should only be done after antibiotic therapy has eliminated the bacteria and the granulomas are sterile based on culture of ground up tissue samples.

Cleaning the skin promotes desquamation, which removes surface bacteria and yeast as well as irritants and allergens. In some cases ingredients may be used to normalize keratinization or improve barrier function. Inflammation may be decreased by addition of anti-inflammatory ingredients or just the use of cool water. This along with moisturizing and cooling the skin will also decrease pruritus. Cleansing the skin is most readily accomplished by bathing the pet and is also the most effective way to topically treat large body areas. Bathing also lends itself to the use of rinses after the bath that may contain topical antimicrobials. In general the more frequent the bathing the better and in some cases 2-3 times a week is very effective in preventing recurrent pyoderma and bacterial overgrowth. Daily is required in some cases to get complete resolution then less frequent may maintain remission.

Antiseptics are often incorporated into shampoos and other topical therapies (leave on conditioners and gels, lotions, spays and wipes) used to treat pyoderma. These are particularly useful for more localized areas such as the chin, paws and fold areas. Similar to antibiotics one might expect natural selection to eventually favor the development of resistant strains of bacteria. A group of gene mutations have been recognized that confer some resistance to a wide variety of lipophilic cationic compounds including quaternary ammonium compounds which is what the genes have been named after (QACs) though many other antiseptics are also seeing resistance due to these genes.[2] So the problem with resistance is not just to antibiotics but also antiseptics. These have not yet been found in canine S pseudintermedius.[3] Strategies for reducing resistance and mitigating the problems it can present have been described for parasites for a number of years. Integrated pest control is a process of using multiple different types of anti parasitic agents and rotating and or combining there use. Apparently this is a strategy that we should incorporate into out approach to canine recurrent pyoderma. This approach has been more used for years in dealing with chronic otitis cases and now that we see some similarities between chronic recurrent pyoderma chronic recurrent otitis we should be incorporating a similar approach.

The most common active antimicrobial ingredients used in veterinary medicine are: benzoyl peroxide, chlorhexidine, ethyl lactate, mupirocin, neomycin, polymyxin, phytosphingosine, salicylic acid, sulfur and triclosan. Multiple studies have shown chlorhexidine and benzoyl peroxide to be particularly effective though some have show benefit with other antiseptic ingredients. Based on how we approach ear cases it is preferable to use synergists or combinations of antiseptics as long as their effects are not antagonistic. In addition using systemic antimicrobials that target the bacteria by pathways that do not share the same gene mutations for resistance will be more similar to how integrated pest control is done, we should consider integrated antibacterial therapy as a way to try and minimize the risk of or slow down the development of even more resistant strains.

References

Lehner, G., et al., Case-control risk factor study of methicillin-resistant Staphylococcus pseudintermedius (MRSP) infection in dogs and cats in Germany. Vet Microbiol, 2014. **168**(1): p. 154-60.

Jaglic, Z. and D. Cervinkova, Genetic basis of resistance to quaternary ammonium compounds – the qac genes and their role: a review. Veterinarni Medicina, 2012. **57**(6): p. 275-281.

Murayama, N., et al., In vitro antiseptic susceptibilities for Staphylococcus pseudintermedius isolated from canine superficial pyoderma in Japan. Vet Dermatol, 2013. **24**(1): p. 126-9 e29.

The Evidence-Based Power of Mindfulness

Steve Noonan, DVM, CPCC
Effecti-Vet Corporation
Campbellville, ON

The purpose of this article and accompanying discussion is to share some of my own experiences with happiness and positivity, look at the evidence-based science that shows the benefits of positivity in the workplace and in our personal lives, and then offer some research based strategies that have worked for thousands, including me. While we enjoy this conference it is an opportune time for reflection. Modern life has created a hectic treadmill where the demands of commerce and technology have torn us mercilessly in many directions. Everyone wants to be happy yet excessive, destructive stress is prevalent for many members of our profession. I believe the pursuit of happiness and positivity is important for many reasons. In no particular order here are a few:

1. Clients gravitate to a pleasant environment – people want to do business with happy, positive people
2. A positive business environment is conducive to higher profitability, higher client satisfaction and greater team productivity and performance
3. Happiness and positivity are clearly linked to physical, mental and emotional health and any efforts to improve this for ourselves and our loved ones is an effort well-spent
4. The evidence –based strategies for developing positivity work not only to help someone who is languishing lift themselves from depression and negativity, but also to help someone who is already doing well do even better and flourish.
5. Happiness and positivity are contagious to the point that we can become an 'epi-center ' of positivity, radiating and infecting those around us, creating a ripple effect to help make the world a better place

My vet school visits to nursing homes with dogs back in 1980 were heartwarming and humbling. The most memorable thing for me was a woman who was bed-ridden and seemed catatonic to me. My dog started nuzzling her hand and she started moving and talking, even though incoherently. Her caregiver was brought to tears as she said the woman hadn't moved for weeks. Two things dawned on me later. First that it was better to give than to be selfish, but more importantly it was then I realized we weren't just in the business of animal health but we were in the business of happiness. If we could keep animals healthy so they could bring this much joy to people then what we did was exceedingly important.

I used this new found knowledge to support me in vet school. I knew I would graduate because I had a higher calling, to keep animals healthy so they could help make people happy. What could be more important than helping people be happy?

As a young veterinarian and business owner I became intrigued with happiness and positivity because I noted that business success seemed to be intricately linked with happiness. The positive owners I met were more likely to have successful businesses and they had cheerful team members. The ones who were negative or sour just didn't seem to be as successful, plus they seemed miserable. I took a Dale Carnegy course, then helped teach it, and read positive motivational literature by authors like Norman Vincent Peale, Napolean Hill, Dale Carnegie – How to Win Friends and Influence People, The Amazing Results of Positive Thinking, Think and Grow Rich. And the results were pretty good. Diane and I had 3 veterinary clinics by the time we were 27 and by most measures were pretty successful. In hindsight our clinics exuded positivity and attracted positive employees and clients.

Fast forward 25 years and I became so consumed by life, family, practice and veterinary association work that I forgot all the positivity I had learned and the success it had helped create. Eventually I became burned out and retired from active practice. It turns out I was not alone. Surveys in our profession report very high levels of stress. The suicide rate for veterinarians is 4-7 times that of the general population. In a large Harvard study people reported being unhappy 47% of the time.

For the past 6 years I have been a consultant relying on my business skills to help clients. Perhaps it was because of the experience I had been through, but I found I was spending more time helping the owners deal with their unhappiness than their business. During this time I have studied positive psychology, how to work on one's happiness and how to cope with stress. Seeking more tools, I became a certified life coach and attended a number of courses on stress reduction through mindfulness. In my studies I uncovered lots of work showing how deliberate efforts to improve positivity created happiness, but also improved business success.

Whereas the early positive thinking that I had read about in the 80's was anecdotal and opinion-based, the new positive psychology and business literature was rigorously evidence based. There are many people in veterinary medicine talking about how stressed we are, but very few talking about what we can do about it. There is plenty of work on positivity in the workplace but few are talking about how critical this is to the success of a veterinary team.

Harvard researcher Shawn Achor describes research about the relationship between positivity and success. A team of researchers studied 60 business teams for several years. Research assistants were trained to code every single statement made during business meetings as to whether they were positive or negative. Positive statements (P) tended to be more uplifting, other-focused and based on inquiry whereas negative statements (N) were deflating, self-focused and self-advocating. It was determined the high-performing successful teams had significantly higher P/N ratios vs those low performance teams.

In one specific example, a mining company was losing 10% per year and the ratio was 1.15:1 The researchers trained the executives to increase their praise and positive comments. The company profits improved by over 40% when the ratio increased to 3.56:1. It was shown there was a direct correlation between positivity and current and future business success in not only this company but many others. Companies with low ratios also had very few resources to cope with adversity. One major business hurdle like an economic turndown, a new competitor or loss of a key client may be all it would take to topple these companies with low positivity.

Studies show positive teams make higher sales, have better customer satisfaction and perform better on 360 degree reviews. Negotiators are more successful when trained to be positive. It's not all that surprising when you think of it. Subsequently it has been shown in studies at numerous business schools that positivity fuels creativity, energy, motivation, resiliency, engagement and productivity, all precursors to success. Efforts of management to foster positivity using techniques such as Appreciative Inquiry are successful not only in team-building but financially as well.

University of North Carolina positive psychologist Barb Fredrickson has studied positivity extensively for almost 20 years. She defined, quantified and has been able to create in the laboratory 10 positive states, namely: joy, gratitude, serenity, hope, interest, pride, amusement, inspiration, awe, and love. She is renowned for her 'broaden and build' theory which proves that positivity broadens ones mental, psychological, physical and social resources and that positivity enables one to create/build a better future life.

She sought to determine the relationship between positivity and negativity and whether a higher P/N would separate those who are truly flourishing from those who are merely existing (languishing)? First she conducted a survey with participants to determine their baseline psychological state. Next, over a period of several months she tallied the ratio between the number of positive and negative emotions participants experienced each day. She found a similar phenomenon to that of the successful companies. In order to flourish emotionally, one must experience at least 3 times as many positive emotions as negative. She then worked with those participants with scores lower than 3:1 to increase their positivity using a number of tools described below and was successful in doing so. Other researchers have duplicated these results and provided additional information regarding the relationship between positivity and mental well-being.

Positivity and happiness are terms that are often used interchangeably. What is happiness? Wikipedia calls it a state of positive well-being ranging from contentment to intense joy. According to University of California psychologist Sonja Lyubomirsky , author of "The How of Happiness", about 50% of our happiness is genetically predetermined , 10% is due to current circumstances and about 40% by intentional activities. Some of us are genetically pre-programmed to have higher dopamine and serotonin levels than others and therefore be more positive than others. There is nothing we can do about this 50% genetic set point.

The next portion of our happiness is the 10% of our happiness related to our current circumstances. I find this work fascinating. As one might imagine it's easier to be happy while on holiday than while un-plugging the toilet. But all the studies have shown that happiness OR unhappiness, related to circumstances, is temporary. The most telling study as described by Harvard psychologist Dan Gilbert compared mega-lottery winners with acute paraplegics. While understandably there was a large increase in the happiness of the lottery winners and a large decrease in the happiness of the paraplegics, within 6 months each group settled back to their original genetic set point of happiness. In other words, adversity or good fortune had no lasting effect! Other studies have shown that age, health, education, geography, sex and many other variables have no lasting effect on happiness. To say, I'll be happy when, I get that job, if I was more beautiful, younger, more intelligent or lived in a better climate, is only true temporarily – one will revert back to the basic level of happiness. That's why people fall madly in love only to separate a few months later. A change in circumstance will only buy a few months happiness at best. One study showed that the thrill obtained from buying something may only last for as little as 11 minutes. This can be seen perfectly at holiday resorts. In the beginning people are delighted to be there and to be waited on and have delicious food and beverages…….. but within a few days we see righteous indignation while waiting a few extra seconds for a beer, or IMAGINE forgetting our dessert fork, or the maid did not leave a mint on the pillow!

To recap 50 % of our happiness is predetermined genetically and 10% is circumstantial. This leaves 40% that we CAN do something about . We CAN intentionally increase our happiness, by using the large number of evidence-based tools that have been proven to improve happiness and positivity, help people to feel fulfilled and improve well-being . We can change how our brain works and new findings in neuroscience substantiate this.

NEUROSCIENCE: it is very well evidenced now that our nervous system is plastic and the term neuroplasticity is recognizable. It used to be thought that once we reached adolescence our intelligence and reasoning abilities were cast in stone; we could only look forward to diminishing capacity with aging. This is not true. This is the very reason why brain training companies like Luminosity exist. Extensive research has shown that we absolutely can modify our nervous system, our thought processes, and subsequently our feelings and emotions.

If one considers that when we multiply the number of neurons times the number of synapses and interneuronal microtubules there are 10 x 27th possible interneuronal connections. That's more than the 10 x 23rd stars that Google estimates are in the universe. There are so many possible firing sequences and each time we learn a new thing and habitualize it , be it piano or a surgery technique or learning to appreciate things more often, new neural pathways are being created that can be documented by fMRI. My analogy is this is like creating a new trail through deep snow. Each time we pass through this trail the path becomes easier to traverse.

It is now known we can and do grow new brain cells. Just as we replace skin and blood cells, there are neural stem cells in the hippocampus and lateral ventricles that differentiate into neurons as required. Essentially we replace all the cells in our body every 3 months so that we become a 'new person'! Some people have hypothesized as we retrain the brain we are essentially training new cells?

We can train new pathways for our emotions just as we can for motor skills. Functional magnetic resonance imaging/fMRI shows different areas of the brain lighting up after training . The best example of this is the Stanford Tibetan monk study where monks laid in MRI machines and meditated on loving kindness. They had 4 standard deviations greater left pre-frontal cortex activity than is normal or average, suggesting that thinking about love and compassion will forge a new neural pathway. It is said in neuroscience, 'neurons that fire together, wire together'.

It is now known that happiness activates the vagus nerve which controls and calms heart rate and respiration ie improves 'vagal tone'. Vagal activation triggers the secretion of oxytocin, the 'bonding hormone' which creates warm feelings of attachment and inclusiveness. Oxytocin dampens the amygdala, the trip switch that enables our brain to flip from cool logical thinking into panicked flight and fright and as a result cortisol production is reduced. A happy person, one with a strong positivity ratio, has better health, is calmer and is able to think more clearly.

Neuroscience says and researchers have proven that positivity and happiness can become a habit. Because we have developed and worked on them, we have created new neural pathways to support them, and the benefits to us are greater contentment, better health and greater success in our life and business.

Vaccines for Happiness:
10 Tips to Take Home Today for Practice Positivity

Steve Noonan, DVM, CPCC
Effecti-Vet Corporation
Campbellville, ON

In order to work on the 40% of our happiness we have under our control, there are tools. These tools can be used to increase the positivity ratio, to tip towards and over that 3:1 barrier and to lift us past our genetic set point and circumstances into that area where WE are controlling our own destinies, WE are controlling our mind and WE are choosing positivity, happiness and success. When we do this we improve our emotions, our health, our minds and our businesses. These tools work, as simple as they are, because our minds are plastic and we can change them.

Here is a little reminder of what we already know: "Feelings 101 – in order to have a feeling or emotion, it must be preceded by a thought – a good thought will create a good feeling, a bad thought will create a bad feeling – these thoughts can be real or imaginary, conscious of subconscious, but the feelings that result are very real. In order to change your feelings, you must change the thought".

1.Gratitude has been shown to increase positivity

I think that is one of the reasons why we felt so good visiting the seniors. Clearly they were grateful to us. There are 2 gratitude exercises that have been studied extensively and work well.

Martin Seligman, the founder of positive psychology describes the 'gratitude visit ': write a 300 word letter thanking someone who has been influential in your life, specifying what they did to influence you and why it was important. Meet with this person, and read the letter to them in person. There will probably be tears. Not only will you feel better but they will too and the effects of this single exercise can last months because gratitude expressed is a powerful catalyst to happiness. Take a moment to think about an influential person in your life that you may like to thank. Can you write down a name or 2? How did they affect you? What was the result? What would it take to conduct a gratitude visit to this person? How might you both benefit? What is stopping you?

Also in this category is the Gratitude Journal, also called Three Blessings. It is most beneficial to keep journals on our nightstand because what we write before we sleep will go into our subconscious mind more effectively. Write down 3 things for which you are grateful. It can be as simple as your comfortable bed, good health, the ice cream you ate or something deeper, like a nice thing someone said or did at work today or the safe return of a group of hostages. To maintain this journal for at least 30 days will cause positivity and happiness to increase significantly over that of control groups. Some people have found that maintaining this daily becomes boring for much longer than 30 days although this has not been the case for me. A suggestion for this is after a couple of weeks perhaps start entering their 'gratitudes' every other day or perhaps every third day. Regardless it is scientifically proven that honing our recollection of things to be grateful for will sharpen our mind to look for other things to be grateful for. Gratitude is a very powerful form of positivity and to seek it out is very effective. Here's why:

Tetris effect

Have you ever played a video game for so long that the pattern in the game was all you could see? Of course psychologists have studied this effect called 'cognitive afterimage'. They did this with the addictive video game Tetris where the goal is to fill all the gaps with tiles. Participants played as much as they could non-stop for 3 days; afterwards all they could see were patterns with gaps and would search for something to fill the gap, like looking at a city skyline, and moving a skyscraper to fill the gap between 2 buildings. Harvard psychologist Shawn Achor describes this as the 'Tetris Effect'. Now imagine you are in a profession that constantly scans for errors/mistakes/loopholes, like a tax accountant, a lawyer or a medical person scanning for abnormalities. This constant scanning for WHAT IS WRONG, makes it very hard to see WHAT IS RIGHT! In fact, this behaviour can spill into their everyday life so they are spending their time looking for what is wrong with their spouse, their kids, their life; it's no wonder these professions have high levels of depression, lawyers at 4 times the rate of the general population. They have high levels of pessimism where they are more apt to see things as permanent, pervasive and beyond their control. The very same traits that make them good lawyers or doctors can make them prone to depression. Achor calls this the negative Tetris effect. This is exactly WHY exercises like gratitude journals can be effective to retrain the brain to look for what is Right, what is Good, correcting the negative Tetris Effect and trying to create a positive Tetris effect.

2.Positive events journal/what went well and why (W4)

This is another strategy to retrain the brain to scan for the positive events that have happened. On those days when not writing about 3 things for which one could be grateful, try writing about something that went well today and ***why*** it went well. This takes a bit more work and can be quite fulfilling. The extra thought to determine ***why*** things went well bolsters positivity significantly. According to the research the positive effects of maintaining a Positive Events Journal for 30 days can last for months.

3. Kindness

Studies show that intentionally boosting our kindness will increase our positivity. Everyone has likely heard about random acts of kindness where gestures such as paying for another's highway toll, or cup of coffee makes both the giver and receiver feel good. Studies have shown exactly this. What is wonderful is that it has now been proven by research that kindness is a sure-fire positivity booster. Kindness is a self-fulfilling prophecy because as we think about what nice, kind thing we may do next for someone, we are actually performing a kindness on yourself, scanning for a good thing, a kind of Positive Tetris Effect, increasing your own positivity. When you perform a kindness, your levels of oxytocin and progesterone, the bonding hormones, increase, in the same way that makes you feel good to be hugged and the stress hormone cortisol lowers, in both giver and receiver. The latest findings in neuroscience show that when we connect with others in a positive fashion there is a neural synchrony where both the giver and receiver have similar brain wave patterns. In fact kindness and positivity feed on each other to create a positive upward spiral.

It's suggested and Seligman determined that boosts in your positivity are most profound when we create a "kindness day" each week where the plan is to perform a number of kindness acts, such as helping at a shelter, delivering meals and so on. Volunteerism is strongly linked to positivity. I would highly recommend regular volunteer work as an integral part of everyone's life. Seligman showed that participating in even one kindness day would have lasting positive effects for participants, up to months. Clearly a constant focus towards kindness is not only a pretty good strategy for the health of this planet but also is a wonderful self-help tool to grow positivity.

4. Positivity ratio.com

There is a 20 question brief positivity questionnaire created by Fredrickson on –line which will rapidly calculate our positivity ratio. Not only does it create awareness of our current status but we can also track our own progress as we work to improve our positivity ratio. Fredrickson also suggests a great way to boost your ratio is to "TRIPLE YOUR PLEASURE/SAVOUR THE GOODNESS". I like this idea. Remember that we want to improve our positivity so the ratio of positive emotions to negative emotions we experience is 3 to 1 or greater. With this strategy we anticipate a positive event with great enthusiasm, we experience it well, and then we savour it, remembering it fondly, sharing it with our friends, reminding ourselves with pictures or memorabilia. It is too easy to quickly forget a positive event, a vacation, a family outing. Squeeze all the positivity juice possible out of every good event and triple the pleasure; anticipate eagerly, enjoy enthusiastically and savour frequently. There are four kinds of savouring, **basking** in it if it was congratulatory**, thankfulness** if it was a blessing, **marvelling** if it was something to awe and **luxuriating** if it was a sensory experience.

5. Commune with nature

Studies out of the University of Michigan showed that spending time outside in good weather increased positivity – as little as 20 minutes per day increased positivity, increased the openness of their thinking and expanded working memory. Isn't it great that something physically healthy is also emotionally healthy. That's why looking at glaciers and hiking all feel so good. It feels good to get physically close to the earth by walking barefoot, getting our hands in the soil gardening, laying on a beach, floating in a lake or river or ocean, sleeping on the ground, anything that puts us in contact with Mother Earth. These feel good mentally, may also have physical benefits such as better oxygenation and may possibly be linked with a grounding effect and a flow of electrons into the earth. Regardless science shows it is good for us to get outside. What a great way to improve memory!

6. Connect with people

Be social! Psychologist George Vaillant study of Harvard Men was a longitudinal study of hundreds of Harvard men beginning in the 1930's. The study showed very clearly that social connections, good relationships and friendships were a key factor in health, longevity, marital success and business success. Subsequent studies have duplicated these results. While people can be also a source of stress, surrounding one with good, successful, loving people will contribute dramatically to positivity. Other studies have shown that social interactions increase one's resiliency and lateral thinking. Make the extra effort to connect and re-connect with loved ones, pick up old friendships and stretch out to make new friendships. Social connections can help keep us happy, healthy and alive for a long time. It may seem pretty obvious yet the science shows we are a social species who are at our best when we are with others.

7. Flow

The state of Flow is the "mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity". In essence, flow is characterized by complete absorption in what one does. Proposed by Mihály Csíkszentmihályi, this positive psychology concept has been widely referenced across a variety of fields. Everyone has at least one thing they do well that is difficult and requires concentration, be it surgery, fly-fishing, needlepoint, playing a musical instrument or bridge. It was said that Edison was in a state of flow when he developed the light bulb and Michaelangelo when he painted the Cistine Chapel. They went for days with very little sleep or food, completely absorbed in their

work. When truly in flow it is impossible to think of something else because the task at hand requires complete focus and time stands still.

There is great deal of literature showing a direct correlation between experiencing flow and having a positive effect. A very successful happiness strategy, is to be certain to incorporate into most days something that allows one to go into flow. If we can incorporate it into our job, even better!

Take a moment to write down one or several things that you do that put you into flow. Is it singing, surgery, a musical instrument, fishing, running, flying? What do you need to do to incorporate flow into your life regularly? Find a way to make it easy to access the opportunity, schedule it and have the equipment or whatever you need nearby and ready☺

8. Mindfulness

To quote the founder of MBSR Jon Kabat-Zinn, ' to be mindful is to be in the present moment, on purpose, by choice and without judgement'. That can be quite a tall order. In the early 80's at the University of Massachusetts Medical School, Kabat -Zinn volunteered to take on a group of patients that conventional medicine could not treat. There were chronic pain patients, psychiatric patients with depression and anxiety disorders and medicine patients including cardiac patients, hypertensives and so on. He taught them to meditate and to be mindful, developing an 8 week course that is taught to this day. It involves a weekly 2.5 hour class and daily homework. Involvement in this course was found to significantly improve pain scores, psychological scores and other medical parameters over the control group. In simple terms learning to be mindful and in the present moment was more beneficial controlling medical symptoms for these patients than pharmaceuticals. This same course has now been taught to tens of thousands over the past 30 years.

There are now over 1300 peer-reviewed papers which chronicle the medical, physical and psychological benefits of meditation. It has been shown that daily meditation is correlated with a better sense of well-being, less anxiety. Meditation increases compassion, forgiveness and self-forgiveness. It improves working memory, improves executive decision- making and task performance – pretty important stuff for a vet – and a myriad of other mental functions.

The thing about mindfulness, is simply this; when we are in the present moment it is not possible to think about other things. This by definition is a very sublime form of happiness (serenity); the concept is elegant in its simplicity. Just let the nervous system have a rest, just let it be, instead of functioning in overdrive all the time. Mindfulness may be more important now than ever before in a world of constant distraction where our phones have us on an endless treadmill of information and interruptions.

Those who meditate feel more positive and optimistic. In Fredrickson's study, **meditation alone** was able to shift the positivity ratio from less than 3:1 to greater than 3:1 in a few short months. The most powerful meditations are modifications of ancient Buddhist teachings of loving kindness and compassion. In my view this single tool, the loving kindness meditations that are freely available on-line, are the most effective positivity tools.

This is the same loving kindness meditations the Tibetan monks did in the Stanford study. With loving kindness meditation the purpose is to imagine the warm feelings you have towards a loved one and to send these same feelings towards everyone in your sphere starting with your immediate loved ones and extending into friends, community and even the entire world. A mantra such as 'may they be safe, may they be healthy, may they be happy, may they live with ease' is traditionally used.

There are countless websites, books and apps on learning how to meditate. It requires discipline and a small amount of time each day but the rewards are immeasurable.

Breathing, learning to breathe properly, fully and deeply will lower stress and increase positivity. This is a form of 'mini-meditation', as all meditations have a focus on the breath as a component. When you are feeling stressed, stop and take in 10 deep breaths, inhalations and exhalations. It will lower your heart rate and blood pressure, release oxytocin, improve your vagal tone, lower cortisol and you will feel better after.

9. Signature strengths

www.authentichappiness.org signature strength – Martin Seligman at the University of Pennsylvania, has made available a website with a large number of questionnaires and it includes one which can determine your strengths. This is a 240 question survey to determine which of the 24 strengths are more predominant for an individual and in what order. These 24 strengths include social intelligence, bravery, diligence, kindness and many others. The 5 for which one is rated highest are that person's signature strengths. Studies show that to incorporate our signature strengths into our job and into our daily life is very satisfying and fulfilling. In fact just completing a single task using our signature strengths fully will have a lasting positive effect for a couple of months. If we can incorporate these into our job, our marriage, our family, we can have a dramatic positive effect that can be very long lasting and even permanent.

10. Positivity portfolios

Fredrickson devised the strategy of creating a portfolio or memorabilia to demonstrate how any of the 10 aspects of positivity, such as joy, gratitude or love, play a role in one's life. It might be a series of photos, a screensaver, a collection of paraphernalia, a montage or

any of a number of possible ways to commemorate positivity that is meaningful to the person. These portfolios should be built with care and consideration. It is suggested to take up to a week to build one. After all it is designed to be a testimony to a particular element of positivity in your life. Fredrickson describes how to build positivity portfolios in more detail in her book, 'Positivity'.

Positivity has been documented to contribute to help build better physical and mental health as well as business success. Almost half of the positivity or happiness we experience is within our control. We can modify the way we think and create lasting patterns of happiness and positivity using a large number of well researched positivity tools. It is not for the faint-hearted; it takes work and dedication in the same way one would embark on a weight-loss or exercise program or learn to play a musical instrument, yet is well worth the effort. I challenge you to take on the task of improving your own personal positivity. Leadership starts at the top. What can you do to improve your own positivity? What effect could it have on your business, your happiness, your health? I encourage you to explore the work of the authors discussed above, look at their websites, do your own research and find the strategies that work best for you.

The Sometimes Tricky Art of Diagnosing Hyperadrenocorticism in Dogs

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

1. Introduction

A. Cushing's syndrome refers to all causes of hyperadrenocorticism with overproduction of cortisol.
   a. ACTH-dependent
      i. Cushing's disease: Pituitary hypersecretion of ACTH which results in bilateral adrenal hyperplasia (90% of cases)
      ii. Ectopic ACTH production: Non-pituitary tumors secreting ACTH resulting in bilateral adrenal hyperplasia. Has not been completely documented in dogs or cats.
   b. ACTH independent
      i. Adrenocortical adenoma or carcinoma: Hypersecretion of cortisol with atrophy of normal adrenal and suppressed ACTH concentrations (10% of cases).
   c. Iatrogenic
      i. Excessive or prolonged administration of glucocorticoids. Clinically indistinguishable from natural disease. Results in adrenal atrophy and suppressed ACTH levels.

2. Signalment

A. Poodles, Dachshunds, Schnauzers, Boston Terriers, Boxers.
B. Middle to old age. Average 12 years; range 6 months to 17 years.
C. No sex predilection.
D. Rare in cats. Usually seen with insulin resistant diabetes mellitus and/or cats with severe dermal atrophy/ulceration.

3. Clinical signs

A. PU / PD
B. Pendulous, "pot-bellied abdomen": Due to muscle catabolism by glucocorticoids and hepatomegaly.
C. Bilaterally symmetric alopecia: Head and extremities spared.
D. Thin skin
E. Muscle weakness and muscle atrophy; cruciate ruptures
F. Mineralization of skin (calcinosis cutis)
G. Hyperpigmentation: ACTH similar to MSH, co-existing hypothyroidism, chronic skin irritation.
H. Reproductive abnormalities
   a. Anestrus
   b. Clitoral hypertrophy
   c. Testicular atrophy
   d. Perianal adenomas in females and neutered males.
I. Respiratory signs
   a. Panting: Pulmonary hypertension and decreased compliance, primary CNS disturbance, pulmonary mineralization.
   b. Dyspnea: Rare; seen with pulmonary thromboembolism and concurrent congestive heart failure.
J. Central nervous system
   a. Seen with large pituitary tumors (macroadenomas). Present at time of diagnosis or following therapy for Cushing's disease as microscopic pituitary tumors enlarge into macroadenomas.
   b. Signs due to compression/invasion of pituitary and/or hypothalamus:
K. Seizures
   a. Pacing
   b. Lethargy
   c. Inappetence
   d. Behavior change
   e. Head pressing
   f. Circling

4. Diagnosis of Hyperadrenocorticism

A. History and clinical signs

B. R/O iatrogenic disease with questions concerning current or past medications. These medications can include oral, ophthalmic, otic, and topical medications. Make sure the owner tells you about everything and anything that went on or in their pet.

C. Laboratory data

- a. Hemogram
  - i. Polycythemia (PCV 45-55%)
  - ii. Stress leukogram
    1. Lymphopenia
    2. Eosinopenia
    3. Neutrophilia (mature)
- b. Biochemistry profile
  - i. Elevations in:
    1. Serum alkaline phosphatase (SAP)
    2. Cholesterol
    3. Serum alanine aminotransferase (ALT)
    4. Fasting blood glucose: Diabetes in 5-10%.
- c. Thyroid function tests
  - i. T3 and T4 basal levels are generally decreased.
  - ii. Response to TSH parallels normal.
  - iii. Secondary to negative feedback of cortisol on pituitary.
  - iv. 80% have a normal fT4ED
  - v. Does not require thyroid supplementation.
- d. Blood pressure: 50 – 80% are hypertensive, cause unknown.
  - i. Recent study demonstrated normal or decreased levels of atrial natriuretic factor (ANF) in dogs with hyperadrenocorticism. Argues against hypervolemia as the etiology of the hypertension.
- e. Urinalysis
  - i. Decreased urine specific gravity.
  - ii. Proteinuria

D. Radiographic abnormalities

- a. Thoracic films
  - i. Bronchial calcification
  - ii. Metastases from adrenal adenocarcinoma
- b. Abdominal films
  - i. Hepatomegaly
  - ii. Osteopenia
  - iii. 50% of adrenal tumors are visualized as soft tissue or calcified masses.
  - iv. Subcutaneous calcification

E. Adrenal function tests

- a. Three tests used to diagnose hyperadrenocorticism. They do not differentiate between PDH or AT.
  - i. ACTH stimulation test
    1. Look for exaggerated cortisol response in response to ACTH.
    2. See protocols at the end of this discussion.
    3. Diagnostic in 85% of pituitary-dependent cases (PDH)
    4. Diagnostic in 70% of adrenal tumors (AT)
    5. Overall accuracy 80-85 %
    6. A suppressed response to ACTH in animals with clinical signs of hyperadrenocorticism suggests iatrogenic disease.
- b. Low-dose dexamethasone suppression test
  - i. Low doses of dexamethasone inhibit ACTH release from the pituitary via negative feedback and decrease plasma cortisol concentrations in normal dogs.

ii. Dogs with Cushing's are more resistant to steroid suppression. Therefore, lack of suppression following dexamethasone = hyperadrenocorticism.
iii. Diagnostic in 95% of PDH
iv. Diagnostic in 100% of AT

c. Overall 90-95%
i. May also be used to distinguish PDH from AT (see below)
ii. See protocols

d. Urine cortisol/creatinine ratio
i. Assessment of cortisol production and excretion rate.
ii. Sensitivity of this test is greater than that of the LDDS (some animals with clinical signs of hyperadrenocorticism may have normal LDDS response tests but elevated urine cortisol to creatinine ratios). Used as a screening test.
iii. Test is easy to perform.
iv. As with all adrenal function tests, elevated results may occur in animals with non-adrenal disease.
v. Positive tests confirmed with a LDDS.
vi. Must be performed on urine obtained at home, preferably in the AM

e. Tests to differentiate PDH from AT (performed after confirming diagnosis of hyperadrenocorticism).
i. High-dose dexamethasone suppression test
1. With PDH, a high dose of dexamethasone results in a decrease in ACTH release from the pituitary and a decrease in plasma cortisol.
2. With AT, the tumor secretes cortisol autonomously thereby suppressing ACTH production. With low ACTH concentrations already present, dexamethasone has no effect on plasma cortisol.
3. 70% of patients with PDH suppress plasma cortisol to less than 50% of the pre-treatment value.
4. 100% of patients with AT do not suppress.
5. Therefore: Suppression = PDH; Lack of suppression = Inconclusive
6. See protocol

f. Endogenous ACTH concentration
i. PDH: Levels normal or high
ii. AT: Levels low to undetectable
iii. Contact lab regarding sample handling and collection. Use of the preservative (Aprotinin) allows for greater utilization of this test.
iv. Excellent method to differentiate PDH from AT.

Testing protocols

These are suggested protocols that are used in the evaluation of patients with hyperadrenocorticism. You must use the protocol and normal values from the laboratory to whom you are submitting samples to properly evaluate endocrine tests.

A. ACTH Stimulation Test
a. Synthetic ACTH (Cortrosyn) 5 ug/kg IV or IM; collect serum at 0 and 1 hour, or
b. ACTH gel (Acthar) 2.2 U/kg IM; collect serum at 0 and 2 hours.
c. Hyperadrenocorticism if post-cortisol > 20 ug/dl (530 nmol/L)

B. Low-Dose Dexamethasone Suppression Test
a. 8 A.m: Baseline serum cortisol. Administer 0.01 mg/kg dexamethasone sodium phosphate (0.015 mg/kg dexamethasone) IV.
b. 12 p.m: Collect 4 hour post-dexamethasone cortisol.
c. 4 p.m: Collect 8 hour post-dexamethasone cortisol.
d. In normal animals cortisol suppresses to less than 1.0 ug/dl (27.5 mmol/L) at 8 hours.
e. 50% or greater suppression at either 4 or 8 hours together with lack of suppresion at 8 hours is diagnostic for PDH and additional tests are not necessary.

C. Urine Cortisol/Creatinine Ratio
a. First morning urine sample is preferred. Sample should be obtained at home. Requires 1 – 2 mls.
b. Stable at room temperature or refrigerated for 3 days.

c. Normal range 2.8 - 4.8. A normal result effectively rules-out hyperadrenocorticism, an abnormal result should be confirmed with a LDDS or ACTH stimulation test.

Differentiating PDH From AT

A. Low-Dose Dexamethasone Suppression Test
   a. See above.
B. High-Dose Dexamethasone Suppression Test
   a. 8 a.m: Obtain serum cortisol. Administer 0.1 mg/kg dexamethasone sodium phosphate (0.15 mg/kg dexamethasone) IV.
   b. 4 p.m: Collect post-dexamethasone cortisol.
   c. Suppression defined as greater than a 50% reduction of cortisol.
   d. Suppression = PDH, non-suppression = Inconclusive
C. Endogenous ACTH Concentration
   a. Check with lab on sample collection and handling.
   b. Normal: 20-100 pg/ml (4.4-22.0 pmol/L)
   c. PDH: 40-500 pg /ml (8.8-110 pmol/L)
   d. AT: < 20 pg/ml (<4.4 pmol/L)

Exploring Treatment Options for Canine Hyperadrenocorticism

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Treatment options

A. Pituitary-dependent hyperadrenocorticism

1. Surgical management
    a. Bilateral adrenalectomy
        i. Technically difficult
        ii. Poor surgical/anesthetic risk
        iii. Permanently hypoadrenal and require lifelong replacement therapy
    b. Hypophysectomy
        i. See discussion at the end of this section
        ii. Lifelong therapy with thyroid hormone and prednisone necessary.
2. Medical therapy

Prognosis

Most dogs with PDH live normal lives (average 2.2 years, but remember most are geriatric to begin with.)

1. Complications
    a. Recurrence of disease.
    b. CNS signs.
    c. Pulmonary thromboembolism.
    d. Infections.
    e. Hypertension.
    f. Congestive heart failure.
2. Adrenal tumors:
    a. Adenomas: Good if no evidence of local invasion.
    b. Carcinomas: Guarded to grave with metastases.

Trilostane therapy of canine hyperadrenocorticism

The efficacy and safety of trilostane in the treatment of canine PDH were evaluated in a multicentre study at the Royal Veterinary College in London, the Veterinary Teaching Hospital in Dublin and Small Animal Hospital in Glasgow. Seventy-eight dogs with confirmed PDH were treated with trilostane for up to 3 years. The starting dose varied from 1.8 to 20 mg/kg (mean = 5.9 mg/kg).

Trilostane appeared to be well tolerated by almost all dogs with only 2 dogs developing signs and biochemical evidence of hypoadrenocorticism. One of these dogs recovered with appropriate therapy. The other died despite withdrawal of trilostane and administration of appropriate therapy. A further two dogs died within one week of starting trilostane but in neither case could a direct link with the trilostane therapy be established. The low prevalence of side effects compared favourably to those reported with mitotane.

Trilostane was found to be nearly as effective as mitotane in resolving the signs of hyperadrenocorticsm. Polyuria, polydipsia and polyphagia had dissipated in 40 dogs within 3 weeks after starting trilostane. Within 2 months, a further 20 dogs showed decreases in their water and food consumption. These improvements were maintained as long as the dogs remained on adequate doses of trilostane. Skin changes resolved in 24 out of 39 (62%) of dogs that initially presented with dermatological signs. All of these improvements were maintained as long as the dogs remained on adequate doses of trilostane. Only 8 dogs that were treated with trilostane for more than 2 months showed poor control of clinical signs. In contrast, mitotane is effective in about 80% of cases of pituitary dependent hyperadrenocorticism (PDH).

Trilostane caused a significant ($p<0.001$) reduction in both the mean basal and post-ACTH stimulation cortisol concentrations after 10 days of treatment. The post ACTH cortisol concentration decreased to less than 250 nmol/l (9 µg/dl) in 81% of dogs within one month and in another 15% at some time whilst on treatment. These improvements were also maintained in the study population for the duration of the trial.

Thirty-five dogs had at least one dose adjustment over the treatment period. The dose was increased in 23 dogs up to four times the starting dose. In one dog the dose was increased nine fold over a period of six months. The dose was decreased in nine dogs to as low as a quarter of the starting dose.

The mean survival of all trilostane treated dogs was 661 days. Direct comparison with mitotane was difficult as 65% of the dogs were still alive at the time of censor and therefore the mean survival may still increase.By comparison, the mean survival of mitotane treated dogs has been reported to be 810 to 900 days.

Dosage and administration

The current suggested initial starting dose range for dogs with PDH is 1-2 mg/kg once daily. This needs to be adjusted according to clinical signs and serum cortisol values (see below). Doses up to 40-50 mg/kg (divided twice daily) have been given with no unwanted side effects. In some dogs twice daily dosing may be necessary. The drug is given with food.

Transsphenoidal hypophysectomy

A variety of treatments are available for PDH. Medical treatment options include drugs that chemically destroy the adrenals (lysodren or op-DDD) inhibit enzymes in the adrenal leading to the synthesis of cortisol (ketoconazole, trilostane) or inhibit the release of ACTH from the pituitary gland (Anipryl or selegiline). While these treatments can improve the clinical signs in 40-80% of patients they need to be chronically administered, necessitate frequent monitoring and do not cure or address the primary cause of the disease (the pituitary tumor). In humans, surgery to remove the tumor is the most successful long-term therapy. The most common approach used is the transsphenoidal method, in which a passage way is made in the sphenoid sinus, an air space behind the back of the nose, which is just below the pituitary gland. Surgical cure rates for PDH are reported to be in the range of 65-85%, although more recent long-term follow up data suggest that the recurrence rate is as high as 25 % within 5 years. When no discrete adenoma can be identified, remission of hypercortisolism is observed in only about 40%. Surgery has also been used to treat PDH in dogs. Several groups, most notably in the Netherlands have performed these surgeries with success rates paralleling those reported for humans. However, these surgeries have generally not been performed in the US. Veterinarians at VCAWLAAH, in collaboration with human neurosurgeons that regularly perform transsphenoidal surgery in humans have developed the methods to perform these surgeries in the US and are conducting a research study to determine how effectively these surgeries can be performed.

How I Treat Diabetes in Cats

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Diabetes mellitus is a common endocrine disorder in dogs and cats. Recent data has shed light on the pathogenesis of the disorder in dogs and cats and has highlighted the role of diet, insulin and novel hypoglycemic therapies. In the majority of cases, the most appropriate therapy in both dog and cats includes the administration of insulin.

The key to successful management of the diabetic patient lies in close communication with the pet owner and prompt recognition and treatment of concurrent disorders.

Key facts

1. Insulin is still the mainstay of therapy in the majority of dogs and cats with diabetes mellitus.
2. Diet is an important part of diabetic management especially in obese patients and cats.
3. Auto-immune disease, pancreatitis and amyloidosis are the most common causes of diabetes in dogs and cats.

Successful management of the diabetic patient involves many factors. An understanding of dietary therapy, insulin preparations, oral and novel hypoglycemic agents and management of concurrent illness, are all required to optimize glycemic control. The goals of therapy are to control clinical signs, prevent or slow the progression of cataracts, avoid hypoglycemia and maintain ideal body weight. An additional goal in cats is to obtain remission. The challenge is to address these concerns while attempting to help the owners deal with what they may consider a time consuming, expensive and chronic medical condition.

Diabetes Mellitus in dogs and cats results from a decrease in insulin secretion from the beta cells of the pancreas and/or a decrease in insulin action. There are three classifications of diabetes:

Type I diabetes is comparable to insulin dependent diabetes mellitus (IDDM) in humans. It results in low basal insulin concentrations with impaired insulin secretion following a glucose load. Treatment requires insulin injections. It is the most common form of diabetes in dogs.

Type II diabetes is similar to non-insulin dependent diabetes (NIDDM) in humans and is managed with dietary therapy and oral hypoglycemics. It causes normal to increased basal insulin concentrations with decreased secretion following a glucose load. Insulin may or may not be required for animals with Type II diabetes.

Type III diabetes is seen most commonly in *hormonally-induced* diabetes in dogs and cats and is similar to impaired glucose tolerance (IGT) in humans. Diabetogenic hormones (epinephrine, cortisol, glucagon and growth hormone) or medications interfere with insulin action and cause glucose intolerance, which can lead to diabetes.

Etiology and signalment

Feline

The most common causes of diabetes in cats are obesity, pancreatitis and most commonly, amyloidosis of the pancreatic beta cells. There appears to be very little gender predisposition to this disease in cats, although it is slightly more common in males than females. As with dogs, the onset of diabetes in cats occurs most often in middle age.

Clinical signs

The clinical signs of diabetes include PU/PD (polyuria and polydipsia) from hyperglycemia, resulting in glycosuria and a resultant osmotic diuresis. Polyphagia and weight loss is common although many animals will still be obese upon presentation. In addition to the polyphagia, there may be variable degrees of dehydration especially in the cat. Cataract formation is very common in dogs with diabetes, but rare in cats. Cats often present with icterus as a result of concurrent hepatic lipidosis and/or pancreatitis. Icterus is not common in dogs unless they have pancreatitis. Cats may also exhibit a plantigrade stance (peripheral neuropathy) that is directly related to the severity and duration of hyperglycemia. Clinical neuropathies do occur in dogs, but are extremely rare.

Differential diagnoses include: hyperthyroidism (in cats), gastrointestinal lymphoma, hepatic disease, renal disease, pancreatitis, hyperadrenocorticism, and acromegaly.

Diagnosis

Diagnosis involves testing for persistent fasting hyperglycemia, with fasting blood glucoses greater than 200mg/dl. Clinicians also will need to rule out transient hyperglycemia that may be due to: post-prandial hyperglycemia; diabetogenic hormones (endogenous or exogenous); and stress hyperglycemia. Stress hyperglycemia can be a problem in cats due to the release of epinephrine when stressed or handled.

Laboratory abnormalities include:

- Hemogram
    - non-specific
    - signs of dehydration
- Biochemistry profile
    - hyperglycemia
    - increases in SAP and ALT
    - increases in bilirubin (usually in cats)
        - hepatic lipidosis
        - pancreatitis
- Urinalysis
    - glycosuria
        - renal threshold for glucose
            - canine 180-220mg/dl
            - feline 240-300 mg/dl
    - ketonuria
    - up to 40% of patients will have positive urine cultures in the absence of an active urine sediment.

Treatment

The number one cause of death in diabetic dogs and cats is not the disease itself, rather, it is the owner's frustration with the disease. This is an extremely important point to remember when treating diabetic animals. Good communication with the pet owner is perhaps the most important component of managing the disease.

It is recommended that clinicians schedule a 30-minute appointment with the client at the time of discharge before sending the diabetic patient home for the first time. During this appointment, clinicians should thoroughly discuss the care required for the patient. Include the following instructions in that discussion: how to give the animal injections; how to store insulin, what types of food to feed and how often; how to recognize the signs of hypoglycemia and how t react to this condition. Also include information on what clinical signs to look for in terms of monitoring water intake and urine production. The client should be give written instructions for use as a reference once they are caring for the patient at home. It is essential that the clinician and veterinary staff strive to educate the caregiver and motivate them to get involved in the care of their diabetic pet.

The goals of treatment include elimination of the clinical signs of diabetes, prevention or slowing of cataract formation and resulting blindness, prevention of potentially dangerous hypoglycemia, and prevention and/or treatment of concurrent illness.

Therapy for diabetes centers on three main areas: Treatment of concurrent illness (i.e., urinary tract infections, pydermas, etc.), insulin therapy, and dietary management.

Concurrent illness

Monitoring for concurrent illness is very important in effectively managing diabetic dogs and cats. Clinicians must effectively recognize and treat the other disorders because the concurrent illness will impact the diabetic regulation and many common diseases have similar clinical signs to diabetes mellitus. Even simple problems such as UTI's and pyodermas can result in activation of stress hormones and result in insulin resistance.

Insulin therapy

There has been a considerable amount of confusion over the various insulin preparations that are available. In general, animal origin insulins are being discontinued as the desire and ability to treat people with human derived insulin preparations has progressed.

There is concern that animals receiving human insulin will develop antibodies resulting in decreased insulin activity and/or effectiveness. Dogs receiving any insulin product that is not derived from pork may make antibodies. However, studies have shown that those antibodies do not interfere with the glucose control. In fact, dogs that made antibodies against insulin had a longer duration of insulin action, which actually enhanced the effect of the insulin rather than decreased its efficacy. A recent study in cats should that 13% developed anti-insulin antibodies. None of the cats should signs of insulin resistance.

The options with human insulin include ultra short acting, short acting, intermediate acting, and long-acting insulins. The short acting insulins are primarily used for ketoacidosis, and therefore, are not covered in this article. The intermediate acting insulins are classified as either NPH or Lente. It is important to note however, that even though they are classified as intermediate, they do not behave the same way in the dog or cat. Lente is actually a mixture of two different insulin preparations, which results in a bimodal onset of actions. This is helpful in some patients because is helps block post- prandial hyperglycemia. Conversely, a lente insulin is not recommended for use in an animal that does not develop post prandial hyperglycemia. It is recommended that NPH be used in the

majority of dogs and cats with diabetes and it is also understood that most patients will require two injections a day to achieve glycemic control.

Feline patients

Newly diagnosed patients

1. Insulin glargine (Lantus): Glargine is a modified, recombinant, long acting insulin analog. A study presented at ACVIM in 2005 showed a very high rate of remission (8/8 in remission within 4 months with 6/7 still in remission at 1 year) in feline diabetics with the use of glargine and a low carbohydrate-high protein diet. The recommended starting dose is 0.5 units/kg BID if the fasting blood sugar is greater than 360 mg/dl and 0.25 units/kg BID if the initial fasting blood glucose is less than 360 mg/dl. For additional product information see: www.lantus.com. Glargine highlights:
    a. Should not be diluted or mixed as this will affect pH
    b. Should be kept refrigerated. Once open the vial has a shelf life of 4 weeks at room temperature. I would discard any remaining insulin after 8 weeks of refrigeration pending further clinical data.
2. PZI: As with dogs we only recommend the use of PZIR from BI.
3. Humulin N and Novolin N: Similar to PZI with remission rates of 40-50 % when used with a low carbohydrate-high protein diet. Starting doses are generally 1-3 units/cat once a day.
4. Vetsulin: Again similar to PZI and Humulin N with remission rates of 40-50 % when used with a low carbohydrate-high protein diet. Starting doses are generally 1-3 units/cat once a day.

Transitioning feline patients

If you have patients currently taking either Humulin L or Humulin U, I would switch them to either Vetsulin or Humulin N. The initial starting dose will remain the same with re-assessment of clinical signs and a serial blood glucose curve performed 1 week after changing insulin preparations. If you wish to transition them to glargine, I would follow the dosage recommendations as outlined above under newly diagnosed patients. It is important to note that remission rates will be much lower with glargine and a low carbohydrate-high protein diet in long standing diabetic patients (cats with diabetes for more than 6 months) than in newly diagnosed patients.

With the recent introduction of the AlphaTrak Blood Glucose Monitoring System (Abbott) we have the ability to very accurately measure blood glucose concentrations in both dogs and cats using very small quantities of blood. This will allow both veterinarians and pet owners to obtain very reliable results in both the hospital and home setting. This information can then be used to make informed decisions regarding the management of diabetic patients. These decisions impact the type and dose of insulin selected, the frequency of insulin administration, aid in the assessment of glycemic control, help in preventing hypoglycemic episodes and monitor for remission of diabetes especially in feline patients.

Glycemic control can be evaluated in a numbers of ways. Owner assessment of clinical signs (polyuria, polydipsia, weight gain or loss), progression of diabetic cataracts (dogs), presence of peripheral neuropathy (cats), and episodes of hypoglycemia are often the best indicators of glycemic control. Changes in insulin dosage or documenting remission of diabetes, is best determined by blood glucose measurement. Recognizing that the measurement of blood glucose concentrations can be problematic in the hospital setting (especially in cats as a result of stress induced hyperglycemia) recent work has evaluated the practicality and value of at home blood glucose monitoring in dogs and cats. At home blood glucose monitoring is essential in the management of human patients with diabetes given that a number of the complications associated with long term diabetes are directly related to persistent hyperglycemia. While diabetic retinopathy, nephropathy, painful neuropathies and cardiovascular disease are rare in our veterinary patients, adequate glycemic control is required to eliminate clinical signs and decrease morbidity and mortality in dogs and cats. Control of clinical signs does not require the restoration of euglycemia but rather involves keeping the blood glucose levels below renal threshold for the majority of the day. Renal threshold for glucose is 180 mg/dl in the dog and approximately 280 mg/dl in the cat. It is very important that we remember the owners of diabetic dogs and cats are being asked to do a great deal to help in the management of their pet's chronic illness and we need to do whatever we can to make the clients job easier while at the same time taking steps to assure maximal diabetic control.

Using the information derived using at home or in hospital glucose monitoring

The data obtained with at home blood glucose monitoring in conjunction with clinical signs is used to adjust the dose of insulin and to monitor for remission of diabetes. We will look at scenarios for both cats and dogs. The recommendations for cats are based on our experience as well as the data generated by Dr Jacquie Rand at the University of Queensland.

Cats

1. Cats on Glargine and PZI Insulins
    a. If the preinsulin blood glucose concentration is > 360 mg/dl and/or the nadir blood glucose (PZI) or 4 hour (glargine) post blodd glucose concentration is > 180 mg/dl the dose of insulin is increased by 0.5 to 1 unit BID.

b. If the preinsulin blood glucose concentration is 270 to 360 mg/dl and/or the nadir glucose (PZI) or 4 hour (glargine) post blood glucose blood glucose concentration is 90 - 180 mg/dl the dose of insulin is maintained.
c. If the preinsulin blood glucose concentration is 190 - 270 mg/dl and/or the nadir glucose (PZI) or 4 hour (glargine) post blood glucose blood glucose concentration is 54 - 90 mg/dl use the nadir, clinical signs and the next preinsulin glucose concentration to determine if the dose is decreased or maintained.
d. If the preinsulin blood glucose concentration is < 180 mg/dl and/or the nadir blood glucose (PZI) or 4 hour (glargine) post blood glucose glucose concentration is < 54 mg/dl the dose of insulin is decreased by 0.5 to 1 unit BID. If the total insulin dose is already 0.5 – 1 unit BID, stop the insulin and check for diabetic remission.

2. Cats on NPH, Lente or Ultralente Insulins
   a. If preinsulin blood glucose is < 210 mg/dl withhold insulin and check for diabetic remission.
   b. If preinsulin blood glucose is 234 - 288 mg/dl total insulin dose should not be higher than 1 unit BID.
   c. If nadir blood glucose is < 54 mg/dl insulin dose should be reduced by 50%.
   d. If nadir blood glucose is 54 - 90 mg/dl dose should be reduced by 1 unit BID.
   e. If nadir blood glucose is 91 - 162 mg/dl insulin dose should remain the same.
   f. If nadir blood glucose is > 180 mg/dl insulin dose should be increased by 1 unit BID.

Diet

There is a considerable amount of reliable research data showing that diets high in carbohydrates, low in fat and high in fiber are helpful in regulating diabetic dogs. These types of diets lower the average insulin dose, the average blood sugar, the amount of urine being produced and glycosolated hemoglobins and fructosamine levels.

The carbohydrates in these diets are complex carbohydrates. It is important to avoid diets high in simple sugars, which includes any commercial semi-moist food, primarily those packaged in foil packets. Diets high in simple sugars are absorbed very rapidly before the insulin has time to work. The goal with diet is to balance the absorption of sugar with the onset of action of the insulin. A high carbohydrate/low fat diets also decreases plasma free fatty acid and cholesterol concentrations, and increases the number and activity of insulin receptors.

High fiber diets reduce insulin resistance. The fiber acts to decrease post prandial hyperglycemia, primarily because it delays gastric emptying. A high fiber diet also decreases absorption of glucose and increases insulin action at the receptor.

It has recently been suggested that diabetic cats be fed a high protein/low carbohydrate diet. This can be accomplished with several commercially available canned diets (Hill's M/D, IVD Development, Purina DM, many other canned kitten diets). These diets may result in remission of the diabetes and elimination of the need for exogenous insulin and/or oral hypoglycemic agents. High protein/low carbohydrate diets more closely resemble the diet of felines in the wild and may help reduce glucose intolerance, insulin resistance and obesity.

Feeding

Ideally, the feeding schedule should be coordinated with the onset of action of the insulin. With dogs, this is fairly easy to regulate, but with cats, it is nearly impossible due to their "grazing" style of eating. For cat owners who may not be able to follow a strict feeding schedule or those with multiple pet households, insulin therapy will have to be adjusted to meet the owner's needs. The most important component of the dietary plan is to stress consistency in the diet. The following feeding schedule can be used for dogs and some cats. With insulin given once a day, feed three meals a day (of equal calories) at six-hour internals. Give the first meal at the time of the insulin injection. For animals receiving insulin twice a day, feed four meals a day. Schedule them to coincide with the insulin injections and feed mid-afternoon and late evening.

If the owner is unable to follow this schedule, advise them to feed twice a day, at the time of injection and 8-10 hours later (for once a day insulin patients); or at the times of insulin injections (for twice a day insulin patients).

Home management

1. Instruct owner on proper injection techniques, injection locations, storage and handling of insulin.
2. Instruct owner on how to monitor clinical signs.
3. Continue feeding schedule and dietary therapy.
4. Instruct owners to initially monitor urine glucose/ketone levels daily, usually in the morning or evening prior to feeding. If persistent glycosuria or ketonuria is observed, ask owner to contact the veterinary hospital.
5. Advise owners of the signs of and treatment for hypoglycemia. Have owners keep a bottle of Karo syrup on hand if signs occur (i.e., weakness, ataxia, seizures) so they can rub syrup on the gums immediately. Instruct them to call the veterinary hospital.
6. Home monitoring of a diabetic cat is frequently based on observance of clinical signs only.
7. Serial sugars after the first week of home management.

Re-check evaluations

1. Obtain owner assessment of clinical signs.
2. Serial blood sugars are helpful due to:
    a. Variability of insulin action in a given patient.
    b. Inaccuracy of random blood or urine sugars in monitoring the degree of glycemic control.
    c. Not particularly helpful as a routine procedure in animals that are well controlled clinically.
3. Body weight
4. Physical examination/ophthalmic exam
5. Discuss urine log book with owner
6. Laboratory work as clinically indicated
7. Role of glycosylated hemoglobin and frustosamine:
8. Fructosamine may be helpful in distinguishing stress-induced hyperglycemia from diabetes in cats. These tests can be used every 3 – 4 months as an indicator of long term (2-3 weeks fructosamine; 4-6 weeks glycosylated hemoglobin) glucose control. Rising values indicate the need for further evaluation.

Problems with insulin therapy

1. Insulin induced hyperglycemia (Somogyi phenomenon)
    a. Hypoglycemia (<65mg/dl) followed by hyperglycemia (>300mg/dl) within 24 hours of insulin injection.
    b. Suspect when insulin requirements exceed 2 U/kg and clinical signs persist.
    c. Suspect when animal has signs of hypoglycemia in afternoon.
    d. Diagnosis with serial sugars.
    e. Treat by decreasing insulin dose 25-50% and review insulin administration with the owner to rule out management problems.
    f. Re-check serial sugars in one week.
2. Rapid insulin metabolism
    a. Duration of insulin less than 18 hours.
    b. Signs return in the evening.
    c. Diagnosis is with serial sugars. Hyperglycemia (>250) within 18 hours of insulin injection without previous hypoglycemia.
    d. Treatment:
    e. -Review management with owner
    f. -Switch to twice daily insulin administration. Most dogs and cats require insulin twice a day to achieve adequate glycemic control. Consider switching to PZI in cats.
3. Insulin Resistance
    a. Hyperglycemia (>300) throughout the day, despite insulin dosages > 2 U/kg.
    b. Diagnosis based on serial sugars.
    c. Potential causes of insulin resistance:
    d. Management problems
    e. Hyperadrenocoticism
    f. Steroid or Ovaban administration
    g. Diestrus or pregnancy
    h. Acromegaly
    i. Concurrent illness, infection
    j. Anti-insulin antibodies
    k. Hypothyroidism (dogs), hyperthyroidism (cats)
    l. If insulin dose exceeds 2U/kg, the animal should be evaluated for one of these causes of resistance.
4. Hypoglycemia
    a. Insulin overdosage
    b. Suspect if animal shows weakness, shaking, ataxia, seizures at time of insulin's peak effect.
    c. Therapy (instructions for owners)
    d. Mild signs - give food and call veterinarian
    e. Moderate signs - apply Karo syrup to the mouth, offer food when alert and then notify veterinarian.
    f. Comatose - apply Karo syrup to mouth and take animal to hospital.
    g. When hypoglycemia occurs, serial sugars should be performed to re-assess insulin dose

Insulin-Resistant Diabetes: What to do When Insulin Therapy Stops Working

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Insulin resistance is a condition in which a normal amount of insulin produces a suboptimal biologic response. Insulin resistance may result from problems occurring before the interaction of insulin with its receptor (e.g., insulin-binding antibodies), at the receptor (e.g., altered insulin receptor binding affinity or concentration), or at steps distal to the interaction of insulin and its receptor. Post-receptor problems are difficult to differentiate clinically from receptor problems, and both often coexist. In dogs and cats, receptor and post-receptor abnormalities are usually attributable to obesity, inflammation (such as occurs with pancreatitis or gingivitis), a disorder causing excessive secretion of a potentially insulin-antagonistic hormone (such as cortisol in dogs and cats or growth hormone and T4 in cats), or a disorder that causes a deficiency of hormone necessary for insulin action (such as thyroid hormone).

No insulin dose clearly defines insulin resistance. For most diabetic dogs and cats, control of glycemia can usually be attained using 1.0 U or less of NPH, lente insulin or glargine (cats) per kilogram of body weight given twice daily. Insulin resistance should be suspected if control of glycemia is poor despite an insulin dosage in excess of 1.5 U/kg, when excessive amounts of insulin (i.e., insulin dosage >1.5 U/kg) are necessary to maintain the blood glucose concentration below 300 mg/dL, or when control of glycemia is erratic and insulin requirements are constantly changing in an attempt to maintain control of glycemia. Failure of the blood glucose concentration to decrease below 300 mg/dL during a serial blood glucose curve is suggestive of but not definitive for the presence of insulin resistance. An insulin resistance-type blood glucose curve can also result from stress-induced hyperglycemia (cats), the Somogyi response, and other problems with insulin therapy, and a decrease in the blood glucose concentration below 300 mg/dL can occur with disorders causing relatively mild insulin resistance. Serum fructosamine concentrations are typically greater than 500 µmol/L in animals with insulin resistance and can exceed 700 µmol/L if resistance is severe.

Two diseases that have the potential to cause the most severe insulin resistance are hyperadrenocorticism and hypersomatotropism (acromegaly), although insulin resistance may also be mild or variable. Approximately 80% of cats with hyperadrenocorticism and nearly all cats with hypersomatotropism will develop diabetes mellitus. Hyperadrenocorticism is rare: 75% to 80% of cats have pituitary-dependent disease and 20% to 25% have cortisol secreting adrenocortical tumors. In rare circumstances, adrenocortical tumors secrete other steroid hormones (e.g.,progesterone). However, clinical signs are identical to those of hypercortisolism, and diabetes mellitus may develop as well.In addition to PU/PD and weight loss, which are usually due to concurrent diabetes mellitus, typical clinical signs are abdominal enlargement, an unkempt seborrheic hair coat, thinning of the hair coat, failure of hair to regrow, or alopecia and muscle weakness. Severe cases may have thin, fragile skin that tears easily. Cats with large pituitary masses may have CNS disturbances. However, clinical signs may also be mild and hyperadrenocorticism is often not suspected until it becomes evident that the diabetes is difficult to regulate. The dexamethasone suppression test is the preferred screening test. Whether poorly regulated diabetics do indeed have hyperactivity of the hypothalamus-pituitary-adrenal gland axis that leads to abnormal test results is controversial. Based on recent studies, the dexamethasone test (0.1 mg/kg dexamethasone IV with a pre, 4 and 8 hour post) appears to be a suitable part of the diagnostic workup in diabetic cats suspected of having hyperadrenocorticism and should be carried out only after insulin therapy has been instituted for 6-8 weeks to mitigate the effects of poor glycemic control on the HPA axis.

Hypersomatotropism in cats is caused by a growth hormone (GH)-producing tumor (usually an adenoma) in the pars distalis of the pituitary gland. GH has catabolic and anabolic effects; the latter are in part mediated by insulin-likemgrowth factor-1 (IGF-1). The catabolic effects are mainly due to insulin antagonism and are the reason for the diabetes mellitus. The anabolic effects include proliferation of bone, cartilage, soft tissue, and organs resulting in a large body size, broad head and large paws, weight gain, prognathia inferior, respiratory difficulties because of thickening of pharyngeal tissues, degenerative arthropathy, and organomegaly with potential organ dysfunction. Growth of the tumor may lead to signs of CNS disease. As previously mentioned for hyperadrenocorticism, clinical signs may also be very subtle or even absent. Acromegaly has long been considered a rare disorder. However, it was recently suggested that acromegaly occurs more frequently than previously thought and is most likely underdiagnosed. Because the availability of a validated GH assay for cats is inconsistent, diagnosis is usually based on the finding of high IGF-1 concentration. Two important points should be kept in mind. First, circulating IGF-1 is bound to proteins, which must be removed before measurement. Not all assay methods are equally effective, and intra assay inference of binding proteins may lead to false high IGF-1 levels. Therefore, only assays validated for the cat should be used. Second, IGF-1 concentrations are often low in newly diagnosed diabetic cats and increase markedly after initiating insulin therapy. Low IGF-1 levels have also been seen initially in untreated diabetic cats with acromegaly. This observation is explained by the fact that relatively high insulin concentrations are required in the portal vein for the expression and function of GH receptors on hepatocytes, and this mechanism is impaired in insulin-deficient states. IGF-1 is therefore measured 6 to 8 weeks after initiating insulin therapy.

Problems with insulin therapy

- Inactive insulin
- Improper insulin syringe
- Diluted insulin
- Improper administration technique
- Inadequate dose
- Somogyi response
- Inadequate frequency of insulin administration
- Impaired insulin absorption
- Anti-insulin antibody formation (rare)

Caused by concurrent disorder

- Diabetogenic drugs
- Hyperadrenocorticism
- Diestrus (intact female dogs)
- Infection, especially of skin, oral cavity and urinary tract
- Chronic inflammation, especially pancreatitis and oral cavity
- Severe obesity
- Hyperlipidemia
- Hypothyroidism
- Hyperthyroidism (cat)
- Acromegaly (cat)
- Renal insufficiency
- Liver insufficiency
- Cardiac insufficiency
- Pancreatic exocrine insufficiency
- Neoplasia
- Glucagonoma
- Pheochromocytoma

Many disorders can interfere with the effectiveness of insulin therapy. The most common disorders causing insulin resistance in dogs include severe obesity, use of diabetogenic drugs (glucocorticoids), hyperadrenocorticism, diestrus, chronic pancreatitis, renal insufficiency, oral and urinary tract infections, hyperlipidemia, and antiinsulin antibodies in dogs receiving beef source insulin. Obtaining a complete history and a thorough physical examination are the most important steps in identifying these concurrent disorders. Abnormalities identified on the physical examination may suggest a concurrent insulin-antagonistic disorder or infectious process, which will give the clinician direction in the diagnostic evaluation of the dog. If the history and physical examination are unremarkable, a CBC, serum biochemical analysis, serum progesterone concentration (intact female dog), abdominal ultrasound, and urinalysis with bacterial culture should be obtained to further screen for concurrent illness. Additional tests will be dependent on results of the initial screening tests.

Diagnostic tests to consider for the evaluation of insulin resistance in diabetic dogs and cats

- Complete blood count, serum chemistry profile, UA and UMIC
- cPLI (pancreatitis)
- TLI (if suspect EPI)
- Adrenal Function Testing
    - Dexamathsone suppression test (cats)
    - ACTH stimulation (likely less affected by concurrent diabetes in dogs)
- Thyroid Function Testing
    - TT4
    - fT4 (if TT4 is less than 1.5 ug/dl in a dog or between 2.5 – 4.0 ug/dl in a cat)
- Serum progesterone levels (diestrus in dogs)
- Serum IGF-1 concentrations (cats with suspected acromegaly)
- Fasting triglycerides and cholesterol
- Abdominal ultrasonography (pancreatitis, neoplasia, adrenal masses or enlargement)
- Thoracic radiographs (cardiopulmonary disease, neoplasia)
- MRI (if document PDH or acromegaly)

A Fool-Proof Method for Managing Hypothyroidism in Dogs

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Canine hypothyroidism, while a common endocrinopathy in the dog, may be over diagnosed due to confusion/inconsistencies in establishing a definitive diagnosis.

Etiology/pathophysiology

Hypothyroidism is due to decreased thyroidal production of the thyroid hormones thyroxine (T4) and triiodothyronine (T3). Greater than 90% of cases are primary and are due to acquired immune mediated destruction of the thyroid gland which is preceded by thyroiditis, idiopathic atrophy or less commonly neoplasia. Secondary forms of the disease include thyroid stimulating hormone (TSH) deficiency, pituitary neoplasia, and cystic Rathke's pouch, are uncommon clinical entities. Tertiary hypothyroidism with thyrotropin releasing hormone (TRH) deficiency has not been documented in dogs. Congenital cases have been reported in both dogs and cats.

Signalment/history

Hypothyroidism most commonly occurs in young to middle aged dogs with an average age of 7 years. Dogs with autoimmune disease tend to develop hypothyroidism at a younger age. While thyroid values decrease within the reference range in senior dogs, hypothyroidism is very uncommon and other factors (see below) are likely responsible for the observed decreased thyroid concentrations in euthyroid older patients. Spayed females and neutered males are at an increased risk when compared to sexually intact animals. Breed predispositions have been reported for golden retrievers and Doberman pinschers. Thyroiditis is heritable in the beagle, Borzoi, golden retriever, great Dane, Irish setter, Doberman pinscher, and old English sheepdogs.

Risk factors

No known environmental factors have been identified. Breed predispositions as outlined above.

Historical findings

As thyroid hormone regulates the metabolic rate and influences the functions of many organs, clinical signs are often non-specific and insidious in onset. Many other diseases can have similar clinical signs to hypothyroidism, which may lead to an incorrect diagnosis. As such laboratory testing of thyroid function is often performed as part of the diagnostic work in animals with non-thyroidal illness.

Clinical features

Common clinical signs include lethargy, mental dullness, weight gain, exercise intolerance, alopecia, and obesity.

Differential diagnosis

Many metabolic, infectious, neoplastic, congenital, degenerative, and inflammatory diseases can cause similar clinical signs and biochemical abnormalities seen with hypothyroidism.

Diagnostics

Laboratory diagnosis

Thyroxine is the major secretory product of the thyroid while the majority of T3 is derived from extra-thyroidal sources. Both T4 and T3 are highly protein bound to serum carrier proteins such as thyroid binding globulin, transthyretin and albumin. Only unbound (free) hormone is able to penetrate cell membranes, bind to receptors and result in biologic activity. Protein bound hormone acts as a reservoir to maintain steady concentrations of free hormone in the plasma despite rapid alterations in release and metabolism of T3 and T4 and changes in the plasma protein concentrations.

Serum total T4

Serum T4 is a sensitive (>90-95%), but not specific test (70-75%) for the diagnosis of canine hypothyroidism. The vast majority of dogs with hypothyroidism have a serum T4 below normal, but some normal dogs and those with a variety of other problems may have a low serum T4. A diagnosis of hypothyroidism can be ruled out if the T4 is in the upper 50% of the reference range. Autoantibodies to T4 occur in about 15% of hypothyroid dogs, and these antibodies may falsely increase the serum T4 concentration from below normal into or above the normal range. In house testing of TT4 is not recommended.

Serum total T3

Serum T3 concentration is an unreliable test for evaluation of thyroid function.

Serum free T4 (fT4)

Thyroxine is highly (99.9%) protein bound in the circulation. Protein binding can be altered by many nonthyroidal illnesses and by certain drugs. Measurement of the unbound or free hormone can provide a more accurate assessment of thyroid function in these cases (sensitivity > 95%, specificity > 97%). The sensitivity of fT4 is equivalent to or slightly better than total T4 in diagnosing hypothyroidism in routine cases. More importantly, fT4 is more specific, particularly when non-thyroidal factors that can influence

total T4 are present. Free T4 is less affected by most non-thyroidal illness and drugs, but still can be altered in cases of moderate to severe illness. In addition, fT4 by equilibrium dialysis is not affected by the presence of T4 autoantibodies that will falsely elevate total T4. Measurement of fT4 by equilibrium dialysis should be performed when uncommon clinical signs of hypothyroidism are present, the dog is being treated with a drug that may affect thyroid function, when non-thyroidal illness is present, and if autoantibodies to T4 are detected.

Serum TSH

Primary hypothyroidism results in a decrease in T4 and thus decreased negative feedback on the pituitary gland. In response, the pituitary secretes more TSH and plasma TSH levels increase. In man, TSH is elevated prior to any decrease of T4 or fT4 outside the normal range. In the dog, TSH concentration is elevated in only 65-75% of cases of hypothyroidism, as such it lacks sensitivity for use as a screening test. The combination of decreased total T4 or fT4 with an elevated serum TSH is diagnostic of hypothyroidism (specificity > 95%). Therefore, a normal TSH does not rule out hypothyroidism, but an elevated TSH combined with a low T4 or fT4 provides a definitive diagnosis.

Diagnosis of thyroiditis

Antibodies against either T4 or T3 or both are sometimes present in dogs with thyroiditis with or without hypothyroidism. The presence of these antibodies does not indicate that the dog is hypothyroid, but suggests that autoimmune thyroid disease is present. These antibodies frequently cause false elevation of T4 or T3 concentrations that can result in marked elevation of the hormones. Autoantibodies to T4 are present in about 10-15% of hypothyroid dogs.

Dogs with autoimmune thyroiditis may have circulating antibodies to thyroglobulin, the primary protein in the colloid of the thyroid gland. This is not a test of thyroid function, but rather a marker for the presence of autoimmune thyroiditis. In one long-term study at Michigan State University, 20% of asymptomatic, antithyroglobulin positive dogs with normal thyroid function progressed to hypothyroidism in 1 year. The presence of these antibodies in a dog with borderline laboratory evidence of hypothyroidism and clinical signs supports a diagnosis of hypothyroidism.

Additional considerations

Breeds

Certain breeds have normal ranges of thyroid hormones that are different from most other breeds. Few have been evaluated, but greyhounds have serum total T4 and fT4 concentrations that are considerably lower than most other breeds. Scottish deerhounds, Saluki's and whippets also have total T4 concentrations that are well below the mean concentration of dogs in general. Alaskan sled dogs have serum T4, T3, and fT4 concentrations that are below the reference range of most pet dogs, particularly during periods of intense training or racing.

Time of day

In one study 50% of normal dogs had a low serum T4 concentration at some time during the day.

Medications

The drugs that are known to commonly alter thyroid function tests are glucocorticoids, phenobarbital, sulfonamides, clomipramine, aspirin, and some other NSAIDs. Glucocorticoids suppress total T4 and sometimes fT4 as well. Phenobarbital causes decreased total T4 and mild increases in TSH. Sulfonamides can induce overt primary hypothyroidism with clinical signs and thyroid function tests that support the diagnosis. The changes may be reversible when the medication is discontinued. There are dozens of drugs that affect thyroid function and thyroid function tests in man, so many others likely affect the dog as well.

Nonthyroidal illness

Illness not involving the thyroid gland can alter thyroid function tests and has been labeled "non-thyroidal illness" or "euthyroid sick syndrome". Any illness can alter thyroid function tests, causing a fairly consistent decrease in total T4 and T3 concentrations in proportion to the severity of illness. Serum TSH concentration is increased in 8-10% of dogs with non-thyroidal illness. Serum fT4 measured by equilibrium dialysis is less likely to be affected, but can also be increased or decreased. However, in dogs with substantial non-thyroidal illness, the fT4 is likely to be decreased. It is recommended that testing of thyroid function be postponed until the non-thyroidal illness is resolved. If this is not possible, measurement of T4, TSH and fT4 are indicated.

Ancillary testing

Thyroid gland ultrasound

Although rarely necessary, ultrasound of the thyroid glands (by an experienced ultrasonographer) can be used to aid in differentiating dogs with primary hypothyroidism from those with non-thyroidal illness. Thyroid glands of hypothyroid dogs tend to be smaller, less homogeneous, and hypoechoic than those of euthyroid dogs. There is considerable overlap with the ultrasonographic appearance and size of the thyroid glands of euthyroid and hypothyroid dogs. Thyroid ultrasound can only be used to help support a diagnosis of hypothyroidism if the thyroid glands are quite small.

Therapeutics

Drugs

Levothyroxine is the only hormone that appears necessary for treatment of hypothyroidism. The frequency of levothyroxine dosing is controversial, and the only study to closely evaluate the response to treatment showed that once daily treatment is adequate. However, in clinical practice some dogs seem to respond better to twice-daily treatment.

The initial starting dose is 0.02 mg/kg PO q 24 h. In general you will never have to exceed exceed 0.8 mg as an initial daily dosage even in very large dogs. If the dog has significant cardiovascular disease, diabetes mellitus, or hypoadrenocorticism, treatment should be instituted at 25% of the standard dose, with the dosage increased by 25% every 2 weeks based on clinical response and post-pill testing. Most dogs show improvement within the first 1-2 weeks, with increased activity, improved attitude, and partial or complete resolution of neurologic signs. The cutaneous manifestations of hypothyroidism may take several weeks to months to resolve. Post treatment monitoring may be carried out but clinical response is the most important monitoring tool. Peak T4 concentrations generally occur 4-6 hours after administration of levothyroxine and should be in the high normal to slightly above normal range (40-70 nmol/L). However, the bioavailability of thyroxine ranges from 13 to 87% in the same dog from day to day bringing into the question the utility of random post pill monitoring of TT4. It is likely more meaningful (though more expensive) to measure TSH (especially if the TSH concentration was elevated pre-treatment) or fT4 concentrations after replacement therapy has been started, especially in animals that show a poor clinical response to therapy. Serum TSH concentrations should be in the normal range or undetectable and fT4 concentrations should be in the normal range. Serum concentrations of TSH and fT4 should not be performed until the patient has been on supplementation for at least 2 weeks. If the patient was initially started on twice daily therapy, treatment can be reduced to once daily treatment when a good clinical response has been obtained.

Hyperthyroidism is the most common complication of treatment with levothyroxine, but it is rare in dogs. Clinical signs are similar to those of hyperthyroidism in cats and the diagnosis is confirmed by documenting a substantial elevation of serum T4. Treatment consists of stopping levothyroxine treatment for 2-3 days, then instituting treatment at a lower dose.

Comments

Expected course and prognosis

Response to therapy should be observed in the first 4- 8 weeks post treatment. Improvements in mentation and physical activity may be noted within the first week though some abnormalities, especially dermatologic signs, may take several months to resolve. An absent or incomplete response to therapy may be due to an incorrect diagnosis, poor owner compliance, inadequate dosing, or poor absorption.

Feline Hyperthyroidism: Management and Options for Treatment

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Hyperthyroidism is recognized as the most common endocrinopathy of older cats. Despite worldwide occurrence, the pathogenesis of feline hyperthyroidism remains unclear. Traditional methods of managing feline hyperthyroidism include thyroidectomy, anti-thyroid medications, and radioactive iodine. Recent studies document that another option now exists for hyperthyroid cats; feeding a limited-iodine food normalizes thyroid hormone concentrations and alleviates clinical signs of hyperthyroidism. Surgery and radioactive iodine are designed to provide permanent solutions, whereas, oral anti-thyroid drugs and nutritional management control hyperthyroidism and are needed daily to achieve/maintain their effect. All management options are effective and each has its pros and cons. It's important to discuss all options with pet owners so the appropriate management can be selected for each hyperthyroid cat.

Diagnosis

Diagnosis most often is based on the presence of one or more typical clinical signs and increased serum total thyroxine (T_4) concentration. However, up to 10% of all hyperthyroid cats and 40% of those with mild disease have serum T_4 values within reference range [1,2] The diagnosis of hyperthyroidism should not be excluded on the basis of a single normal serum T_4 value, especially in a cat with typical clinical signs, a palpable thyroid nodule and serum T_4 in the upper half of the normal range.[3] In these cases, serum free T_4 (fT_4), measured by equilibrium dialysis, may provide an alternative means of diagnosing hyperthyroidism in cats with normal serum total T_4 values. Studies document that up to 20% of sick euthyroid cats can have increased fT_4 concentration.[4] Therefore, it is most appropriate and reliable to interpret the two values together. Mid-to-high reference range total T_4 and increased fT_4 concentration is consistent with hyperthyroidism. In contrast, low total T_4 and increased fT_4 values are usually associated with non-thyroidal illness.

Management options

Once hyperthyroidism has been diagnosed, all management options (thyroidectomy, radioactive iodine, anti-thyroid drugs, nutritional management) should be discussed with pet owners. All options can be ≥ 90% effective for controlling hyperthyroidism when used appropriately. The selected management option will differ for each cat based on several considerations **(Table 1)**. Radioactive iodine therapy is considered the gold standard for treatment of hyperthyroidism; however, most pet owners currently opt for medical management. Until recently, this included oral or transdermal anti-thyroid drugs. Now nutritional management using a limited-iodine food is another option for cats with hyperthyroidism.

Radioactive iodine

Radioiodine treatment is often considered the best option for many hyperthyroid cats because:

- It has the potential to eliminate a benign thyroid tumor or abnormal thyroid tissue with a single treatment
- It treats extra-thyroidal thyroid tissue, which may occur in 10 to 20% of hyperthyroid cats
- No general anesthesia is required
- Reported side effects are minimal

Cats should be stable prior to radioiodine therapy; those with clinically significant cardiovascular, renal, gastrointestinal, or endocrine (e.g., diabetes mellitus) disease may not be very good candidates, especially because of the time necessary for boarding after treatment.[5]

After administration, radioactive iodine is actively concentrated by the thyroid gland and has a half-life of 8 days. It emits both ß-particles and γ-radiation; the ß-particles are responsible for the majority of tissue destruction, but are only locally destructive, traveling a maximum of 2 mm. Therefore, no significant damage to adjacent parathyroid tissue, atrophic thyroid tissue, or other cervical structures is expected. The main limitation to widespread use of radioactive iodine is the requirement for special licensing and the isolation of the cat for variable periods after treatment. This can range from several days to several weeks depending on state or local radiation regulations and the dose administered.[6]

The goal of treatment is to restore euthyroidism with the smallest possible single dose of radioactive iodine, while avoiding development of hypothyroidism.[6] Controversy exists as to the best method of calculating the optimum dose for individual cats. [5,6] Based on the majority of reported cases, post-treatment hypothyroidism is transient and generally uncommon (2 to 7% of cases); even fewer cats have clinical signs or appear to require thyroid hormone replacement. [7-11] However, up to 30% (50 of 165 cats) were hypothyroid 3 months after radioactive iodine therapy in one study; of these, 56% (19 of 34 hypothyroid cats with available information) had clinical signs of hypothyroidism and 52% (23 of 44 cats) were given thyroid hormone supplementation.[12] Thyroid hormone replacement may be needed in some cats, especially those with concurrent kidney disease, since hypothyroidism has been

associated with azotemia and decreased survival time in previously hyperthyroid cats.[13] Owners should be advised of this possibility, particularly if their motivation is to avoid long-term oral medication.

Anti-thyroid drugs

Anti-thyroid drugs (e.g., methimazole, carbimazole) are commonly used for treatment of hyperthyroidism in cats. [14-21] If administered appropriately, they reliably inhibit the synthesis of thyroid hormones and thereby lower serum thyroid hormone concentrations. These drugs do not affect the thyroid gland's ability to trap inorganic iodide or release preformed hormones. They are widely recommended to stabilize hyperthyroid cats prior to surgery and are the only drugs that can be used chronically for management of hyperthyroidism.[6] Almost all cats are potential candidates unless thyroid carcinoma is suspected.

Anti-thyroid drugs used most often in cats include methimazole and carbimazole; both can be given orally or formulated for transdermal application. Custom formulation of transdermal products may increase expense of therapy and stability of the product is not guaranteed. Results of a recent prospective study conducted in New Zealand showed that once daily treatment for 12 weeks with transdermal methimazole in a novel lipophilic vehicle was as effective as twice-daily carbimazole administered orally.[14]

While many cats have been successfully managed long-term with anti-thyroid drugs, it's important to monitor for potential side effects that have been associated with their use.[15,18,19,21] In the study with the largest number of cats, 18% had side effects associated with methimazole; a more recent study revealed that 44% of 39 cats had side effects.[15,19] In 44 cats receiving carbimazole for 1 year, 44% had associated side effects with gastrointestinal signs (decreased appetite, vomiting, diarrhea) being most common. In another study, 13% of 39 cats treated with carbimazole experienced side effects.[18] It's difficult to determine what % of side effects are caused by the drug versus something else such as concurrent disease.[21]

Most adverse reactions occur within the first few weeks to months after beginning therapy and include depression, inappetence, vomiting, and self-induced excoriations of the head and neck (facial pruritus). Gastrointestinal signs are less common with transdermal administration of methimazole.[16] Mild to serious hematological complications, including agranulocytosis and thrombocytopenia either alone or concurrently, and more rarely immune-mediated hemolytic anemia may also occur. Hepatic toxicity with marked increases in bilirubin concentration and hepatic enzyme activities has been described in less than 2% of cats treated with methimazole. Cessation of therapy is required if either serious hematologic or hepatic reactions develop. Serum antinuclear antibodies develop in approximately 50% of cats treated with methimazole for longer than 6 months, usually in cats on high-dose therapy (> 15 mg/day). Although clinical signs of a lupus-like syndrome have not been reported, decreasing the daily dosage is recommended.[6]

Nutritional management

Production of thyroid hormone requires uptake by the thyroid gland of sufficient amounts of iodine, which is provided by dietary intake. The only function for ingested iodine is for thyroid hormone synthesis.[5] This observation led to the hypothesis that limiting dietary iodine intake could be used to control thyroid hormone production and potentially manage hyperthyroidism in cats. After more than a decade of research and development, a limited-iodine therapeutic food (Hill's® Prescription Diet® y/d™ Feline) containing < 0.3 ppm (mg/kg) iodine on a dry matter basis (DMB), is now available as an option for managing cats with hyperthyroidism.

Iodine content of commercial cat foods

Iodine occurs naturally in many ingredients typically used in the manufacture of commercial pet foods (particularly fish, shellfish and fresh meats) and unless steps are taken to strictly control the iodine content of ingredients, the final iodine concentration in pet foods varies widely.[22-25] Commercial cat foods in New Zealand had iodine amounts ranging from 0.19 to 21.2 ppm in one study whereas in Germany a range of 0.22 to 6.4 ppm was reported.[22,26] Evaluation of 28 canned cat foods in the US revealed an iodine content ranging from 1.09 to 52.3 ppm (mean = 7.83) and 14 dry cat foods contained iodine amounts ranging from 1.34 to 5.94 ppm (mean = 2.77).[25] Based on these studies, the amount of iodine is much higher in many canned foods compared with dry foods and variability of iodine content is much greater in canned food. [22,25-26]

Multiple feeding trials have been conducted in a research colony using over 100 cats with naturally occurring hyperthyroidism to determine the safety and effectiveness of limited dietary iodine in the management of the disease. The results of all studies support that a therapeutic food with dietary iodine ≤ 0.3 ppm iodine (dry matter basis) provides a safe and effective management option for cats with naturally occurring hyperthyroidism. Serum total thyroxine concentrations return to the normal range within 4 to 12 weeks of initiating nutritional management and 90% hyperthyroid cats maintained on the limited-iodine food as the sole source of nutrition become euthyroid.

Three studies were designed to determine the magnitude of iodine control necessary to return newly diagnosed cats to a euthyroid state;[27] the maximum level of dietary iodine that maintains cats in a euthyroid state;[28] and the effectiveness of a therapeutic food formulated based on the previous studies to control naturally occurring hyperthyroidism in cats.[29] In summary, results of these studies

demonstrated that a food with 0.17 or 0.32 ppm iodine (DMB) maintained normal thyroid hormone concentrations in hyperthyroid cats, helping to further define the range of iodine effective for managing hyperthyroidism.

We have treated 22 cats to date with feline y/d with follow-up data for at least 6 months. All of the cats found at least one form of the diet (dry or canned) to be palatable. Nineteen of 22 (86%) cats experienced clinical improvement with normalization of their TT4 concentrations. Of the three cats that failed to achieve remission, 2 cats were discovered to be eating foods other than y/d and when the owners switched them to y/d exclusively remission of hyperthyroidism was achieved. One cat (5%) failed to respond to dietary therapy and was subsequently treated with 131-I.

We are currently conducting a prospective study evaluating the efficacy of feline y/d in managing feline hyperthyroidism to include monitoring of thyroid function (TT4, fT4ED, TSH), clinical signs, body weight, renal function and blood pressure pre and post-treatment. The study should be completed in 2015.

Newly diagnosed patients

After confirming the diagnosis and performing a thorough patient evaluation, nutritional management should be discussed along with other options for managing hyperthyroidism. If selected as the management option, gradual transition to the limited-iodine food (Hill's® Prescription Diet® y/d™ Feline) over at least 7 days is recommended. It is very important to counsel owners so they understand that success of nutritional management depends on the limited-iodine food being the sole source of nutrition for their cat.

The first recheck evaluation should be done 4 weeks after completing the transition to y/d Feline (i.e., once the cat has eaten y/d exclusively for 4 weeks) and as a minimum should include physical examination and measurement of T_4, BUN, serum creatinine, and urine specific gravity. All cats should have decreased T_4 concentrations compared with baseline and many will have returned to normal by the 4-week evaluation. Clinical improvement including weight gain, improved hair coat and decreased tachycardia/cardiac murmur also may be noted by the first evaluation. Clinical signs should continue improving by the next re-evaluation at 8 weeks and most cats will be euthyroid. Some cats require slightly longer to become euthyroid; however, it's expected that 90% will have normal T_4 concentrations if the limited-iodine food is their sole source of nutrition.

If euthyroidism is not achieved within 4 to 12 weeks, a thorough history is indicated to confirm that only the limited-iodine food is being fed.

Managing hyperthyroid cats with concurrent kidney disease

Chronic kidney disease (CKD) and hyperthyroidism are more likely to be diagnosed in older cats so it's not surprising that many hyperthyroid cats have CKD. Untreated hyperthyroidism complicates the diagnosis of CKD because it's associated with increased glomerular filtration rate (GFR) and therefore often masks biochemical markers of CKD. Regardless of the therapeutic modality (methimazole, surgical thyroidectomy, or radioiodine), decreased GFR, increased serum urea and creatinine concentrations and development of overt clinical signs of kidney disease have been reported after successful treatment of hyperthyroidism.[4,33-36] The presence of underlying CKD may affect the prognosis - one study documented a shorter survival time in hyperthyroid cats with azotemia.[7] However, two recent studies comparing survival of cats that developed azotemia with those that did not after treatment of hyperthyroidism found no significant difference between the two groups if cats did not become hypothyroid post-treatment.[38,39]

The reported occurrence of azotemia after treatment of hyperthyroidism ranges from 15 to 49%. [31,35-37,40] Iatrogenic hypothyroidism has been reported to decrease GFR in human patients.[41] Post-treatment iatrogenic hypothyroidism has been reported in cats after radioiodine therapy and bilateral thyroidectomy, which constituted the predominant therapeutic modalities in previous studies.[40] In one recent study, cats with iatrogenic biochemical hypothyroidism were almost twice as likely to develop azotemia post-treatment as euthyroid cats.[38] The hypothyroid cats with azotemia had shorter survival times than cats without azotemia, whereas, consistent with previous reports, there was no difference in survival times of euthyroid cats with or without azotemia.

It's not possible to consistently predict which cats will develop overt CKD after treatment of hyperthyroidism or have progression of their kidney disease. This should be considered when deciding on treatment options, particularly those that are irreversible (thyroidectomy, radioactive iodine). Regardless of the option selected for managing hyperthyroidism, it's important to remember that the only intervention shown to improve quality of life and prolong survival time in cats with naturally occurring CKD is feeding a therapeutic renal food.[42,43] Until recent availability of limited-iodine food, nutritional recommendations have not generally been considered for hyperthyroid cats without azotemia. In cats with compromised renal function, but without azotemia (IRIS Stage 1), the decrease in GFR associated with normalizing serum T_4 levels may be sufficient to prevent effective clearing of protein metabolic by-products (BUN and creatinine) when dietary intake of protein and phosphorus is high. This could contribute to the occurrence of post-therapy azotemia in hyperthyroid cats.

In our work with 22 cats with hyperthyroidism treated with feline y/d, 4/22 cats (18%) were azotemic (IRIS Stage 1 and 2 CKD) prior to starting the diet. All 4 cats experienced normalization of their BUN and creatinine within 30-150 days along with normalization of their TT4's. One potential explanation is that the expected decrease in GFR associated with normalizing serum T_4 may be offset by the nutrient profile of the limited-iodine food which is similar foods for mature adult cats or cats with early CKD.

Additional study is needed to better understand the effects of using limited-iodine food on hyperthyroid cats with concurrent kidney disease.

Conclusions/summary

Hyperthyroidism is the most common endocrine disease of older cats worldwide. While the pathogenesis is unclear, several effective management options are available. All should be discussed with pet owners, including pros/cons, so that the best option can be selected for individual patients and their owners. Feeding a limited-iodine food is now available as an option for effective management of hyperthyroid patients. When fed as the sole source of nutrition, approximately 90% of hyperthyroid cats become euthyroid within 4 to 12 weeks. To date, over 150 cats with naturally occurring hyperthyroidism have been managed successfully by feeding a limited-iodine food, most for 2-3 years and some cats for as long as 6 years.

Getting to the Bottom of Polyuria and Polydipsia

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Introduction

A. Polyuria and polydipsia (PU / PD) refer to excessive water consumption and urine production respectively. These are common clinical signs in both dogs and cats.

B. Water consumption exceeding 100 ml/kg or urine production exceeding 50 ml/kg body weight per day is considered abnormal and should be pursued. These numbers have been established in laboratory reared dogs and may not reflect "normal" water consumption in pets. They are to be used only as guidelines.

C. Water consumption can vary greatly from day to day so it is important to have owners subjectively assess water consumption in the home environment for several consecutive days in order to obtain an accurate picture before beginning unnecessary and expensive diagnostic tests. Actual quantification of water consumption can be very difficult and may not be practical for the majority of pet owners.

Normal water homeostasis

A. Extracellular fluid volume is maintained by regulation of fluid intake and urine production.

B. The thirst center is stimulated by an increase in plasma osmolality (sodium concentration) and/or a decrease in blood volume (hypovolemia) resulting in an increase in water consumption.

C. Increasing plasma osmolality and hypovolemia also stimulate osmoreceptors in the anterior hypothalamus and baroreceptors in the aortic arch resulting in the release of antidiuretic hormone (ADH) from the anterior pituitary.

D. ADH circulates and binds to receptors on the renal tubular cells of the distal tubules and collecting ducts resulting in the production of cAMP. This causes the opening of pores in the luminal membrane of the tubular cells and allows for reabsorption of water from the glomerular filtrate resulting in a concentrated urine. In order for water to be pulled out of the tubule it must move along a concentration gradient maintained by the hypertonic renal medullary interstitium. Loss of this gradient (medullary washout), will result in an inability to concentrate urine even in the face of normal ADH activity. Urea and sodium are largely responsible for maintaining the hypertonicity of the interstitium.

E. The sensation of thirst and secretion of ADH are suppressed when plasma osmolality and blood volume are returned to normal.

Differential diagnosis: Mechanisms of PU/PD

A. Renal disease:
   a. Chronic renal failure: A decrease in the number of functional nephrons causes an increase in tubular flow in the remaining nephrons and leads to a solute diuresis. A decrease in urine concentrating ability may be the only laboratory abnormality indicating renal disease (especially in feline patients) presented for PU/PD.
   b. Pyelonephritis: Bacterial induced tubular destruction and an increase in renal blood flow cause a decrease in medullary hypertonicity.
   c. Primary renal glycosuria (Fanconi's Syndrome): A proximal tubular defect results in renal glycosuria leading to an osmotic diuresis. The blood glucose is normal.
   d. Post-Obstructive diuresis: May be seen in previously blocked cats. Due to osmotic diuresis from loss of large amounts of sodium and urea into the urine following relief of urethral obstruction.

B. Diabetes mellitus:
   a. Hyperglycemia results in glycosuria and an osmotic diuresis. Threshold for renal glycosuria is a blood glucose of 180 – 220 mg/dl (dog) and 240 – 300 mg/dl (cat).

C. Liver disease:
   a. PU/PD may occur as the result of: (1) decreased production of urea which is a major component of the hypertonic medullary interstitium, (2) increased renin and cortisol levels due to a lack of hepatic degradation, (3) increased aldosterone concentration leading to increased sodium concentration, and (4) hypokalemia (see hypokalemic nephropathy).

D. Hyperthyroidism:
   a. Increased total renal blood flow reducing the tonicity of the medullary interstitium.
   b. Psychogenic polydipsia or primary polydipsia is reported in humans with hyperthyroidism.

E. Hypercalcemia:

a. Interference with cAMP activation by ADH,damage to ADH receptors, and mineralization of renal tubular cells.

F. Hyperadrenocorticism:
   a. Glucocorticoids interfere with the action of ADH at the renal tubule and decrease
   b. ADH secretion by reducing osmoreceptor sensitivity to rising plasma osmolality.

G. Hypoadrenocorticism:
   a. Renal sodium wasting leads to decreased medullary hypertonicity.

H. Pyometra:
   a. coli endotoxins interfere with sodium reabsorption and damage ADH receptors and may result in an immune-complex glomerulonephritis.

I. Hypokalemia:
   a. Degeneration of renal tubular cells, (2) decreased medullary hypertonicity, stimulation of thirst, and (4) stimulation of renin release.

J. Polycythemia:
   a. Mechanism unknown; may be related to sluggish blood flow in kidney or hypothalamus.

K. Medications:
   a. Exogenous steroids, diuretics, salt supplementation, primidone, phenobarbital, KBr and vitamin D.

L. Pituitary or central diabetes insipidus (CDI):
   a. Due to inadequate production, storage or release of ADH. May occur as a congenital defect or secondary to trauma, mass lesions, infection or infarction of the pituitary or hypothalamus.

M. Nephrogenic diabetes insipidus (NDI):
   a. Congenital structural or functional defects in ADH receptor. Rare in dogs and cats.

N. Primary polydipsia or psychogenic polydipsia:
   a. Underlying cause unknown (possible CNS lesion); results in increased renal blood flow and a decrease in medullary hypertonicity. Extremely uncommon in dogs and cats and is largely a diagnosis of exclusion.

Diagnostic approach to PU / PD

A. Document PU/PD actually exists. Recommend assessment of water consumption in the home environment. Hospitalized animals frequently do not drink as much as they would in their natural surroundings.

B. Quick evaluation of urine specific gravity and glucose is cheap, easy, and very helpful in evaluating animals for possible pathologic PU/PD. If the urine specific gravity of a non- glycosuric sample, obtained from a dog or cat without signs of dehydration, is greater than 1.030 (dog) or 1.035 (cat), the likelihood of pathologic PU/PD is small and further work-up may not be required.

C. Most causes of PU/PD will be identified following a good history, physical examination, and an initial data base consisting of a CBC, chemistry profile, and urinalysis with bacteriologic culture.

D. If a cause has not been discovered after step C, the most likely diagnoses are hyperadrenocorticism (dog only, cats with Cushing's are usually overtly diabetic), central and nephrogenic diabetes insipidus, and primary polydipsia. As hyperadrenocorticism is far more common than either of the other causes, an ACTH stimulation test, urine cortisol/creatinine ratio or low-dose dexamethasone suppression test should be performed before proceeding to the modified water deprivation test (See Canine Hyperadrenocorticism).

Modified water deprivation test (MWDT)

A. This test is designed to help differentiate CDI, NDI, and primary polydipsia. It is not very helpful unless other causes of PU/PD have been ruled out.

B. The test is designed to determine whether ADH is released in response to dehydration and whether the kidneys can respond to the circulating ADH.

C. VERY IMPORTANT !! THE TEST SHOULD NEVER BE PERFORMED ON AN ANIMAL WITH PRE-EXISTING AZOTEMIA OR OBVIOUS DEHYDRATION. DOING SO IN ANIMALS WITH RENAL INSUFFICIENCY MAY RESULT IN DECOMPENSATION AND THE DEVELOPMENT OF OLIGURIC RENAL FAILURE OR ANURIC RENAL FAILURE.

D. Severe dehydration can occur very rapidly (4-6 hours) especially in animals with diabetes insipidus. Leaving them unattended without water for several hours or overnight may result in severe hyperosmolality, coma, and death.

E. Gradual water restriction should be instituted at home for 2-3 days prior to performing the MWDT in order to help minimize medullary washout from long-standing PU/PD.

Phase one

1. Animal is weighed, bladder emptied and urine saved for specific gravity and osmolality (if available).
2. Blood is obtained for BUN and osmolality.
3. Water is withheld. BUN, plasma osmolality and body weight are obtained hourly. The bladder is emptied every hour and a sample is saved for specific gravity and osmolality.
4. Test concluded with either a 5% loss in body weight, azotemia (BUN > 30), or urine specific gravity > 1.030 (1.035 cats). The bladder is emptied and urine is saved for specific gravity and osmolality, and plasma is obtained for osmolality.

Phase two

1. Aqueous vasopressin (Pitressin) 2 - 3 units (dog) or 0.25 U/# (cat) is given SQ. Alternatively DDAVP may administered into the conjunctival sac (1 – 2 drops for dogs and 1 drop for cats).
2. Urine and plasma osmolality and urine specific gravity are obtained every 30 min for 90 minutes.
3. Bladder must be emptied at every 30 minute sampling period.
4. Water is withheld throughout the test.

Interpretation of the MWDT

A. Normal Animals: Following water deprivation will concentrate urine to > 1.030 (dog) or 1.035 (cat). Urine osmolality in excess of 1,200 mOsm/kg.

B. CDI: Unable to concentrate urine in excess of 1.008 (< 300 mOsm/kg). After ADH administration, urine specific gravity should increase to greater than 1.012 with a 50 - 500 % increase in urine osmolality.

C. NDI: Similar to CDI following water deprivation. No further response following ADH injection.

D. Partial CDI: Results depend on how much ADH is available. Following water deprivation urine specific gravity between 1.008-1.019 and urine osmolality between 300 to 1,000 mOsm/kg. Urine specific gravity and osmolality increase after ADH administration. Similar response seen with hyperadrenocorticism and a number of the other causes of PU/PD. This is why it is important to rule-out these processes prior to a MWDT.

E. Primary polydipsia: Depends on degree of medullary washout. With minimal washout results are similar to normal animals. More severe washout gives results similar to partial diabetes insipidus.

Treatment of polyuria and polydipsia

A. Treat the underlying disorder !

B. Treatment of CDI
   a. DDAVP (Desmopressin acetate) 1-2 drops into the conjunctival sac or 0.01 to 0.05 mls subcutaneously SID or BID. May also dose orally with 0.1 to 0.2 mg once or twice a day.
      i. 1 drop = 1.5 to 4.0 ug. Can use TB syringe to dose.
      ii. Duration 8 - 24 hours.
      iii. Redosed when polyuria returns.
      iv. Most commonly used treatment today.
      v. Use the intranasal preparation.
   b. Chlorpropamide (Diabenese)
      i. Oral hypoglycemic. Stimulates ADH release and potentiates ADH action. Hypoglycemia is the limiting factor.
      ii. 25 - 40 mg once or twice a day (cat). Limited experience.

C. Treatment of NDI
   a. Salt restriction
   b. Thiazide diuretics:
      i. Natriuresis results in a decrease in blood volume and increased sodium reabsorption in the proximal tubule.
      ii. Hydrochlorothiazide 12.5 - 25 mg once or twice a day (cat).
      iii. Chlorthiazide 20 - 40 mg/kg BID (dogs).
      iv. May also help with partial CDI.

D. Treatment of Primary Polydipsia
   a. Treatment to restore hypertonic renal medullary interstitium.
   b. Gradual water restriction over several days.
   c. Behavioral modification or referral to a behaviorist may be needed.

Canine Diabetes: Acute Care and Long-Term Management and Helping Clients Pay for it

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Karen Felsted, CPA, MS, DVM, CVPM
PantheraT Veterinary Management Consulting
Dallas, TX

Diabetes mellitus is a common endocrine disorder in dogs and cats. Recent data has shed light on the pathogenesis of the disorder in dogs and cats and has highlighted the role of diet, insulin and novel hypoglycemic therapies. In the majority of cases, the most appropriate therapy in both dog and cats includes the administration of insulin.

The key to successful management of the diabetic patient lies in close communication with the pet owner and prompt recognition and treatment of concurrent disorders.

Key facts

1. Insulin is still the mainstay of therapy in the majority of dogs and cats with diabetes mellitus.
2. Diet is an important part of diabetic management especially in obese patients and cats.
3. Auto-immune disease, pancreatitis and amyloidosis are the most common causes of diabetes in dogs and cats.

Successful management of the diabetic patient involves many factors. An understanding of dietary therapy, insulin preparations, oral and novel hypoglycemic agents and management of concurrent illness, are all required to optimize glycemic control. The goals of therapy are to control clinical signs, prevent or slow the progression of cataracts, avoid hypoglycemia and maintain ideal body weight. An additional goal in cats is to obtain remission. The challenge is to address these concerns while attempting to help the owners deal with what they may consider a time consuming, expensive and chronic medical condition.

Diabetes Mellitus in dogs and cats results from a decrease in insulin secretion from the beta cells of the pancreas and/or a decrease in insulin action. There are three classifications of diabetes:

Type I diabetes is comparable to insulin dependent diabetes mellitus (IDDM) in humans. It results in low basal insulin concentrations with impaired insulin secretion following a glucose load. Treatment requires insulin injections. It is the most common form of diabetes in dogs.

Type II diabetes is similar to non-insulin dependent diabetes (NIDDM) in humans and is managed with dietary therapy and oral hypoglycemics. It causes normal to increased basal insulin concentrations with decreased secretion following a glucose load. Insulin may or may not be required for animals with Type II diabetes.

Type III diabetes is seen most commonly in hormonally-induced diabetes in dogs and cats and is similar to impaired glucose tolerance (IGT) in humans. Diabetogenic hormones (epinephrine, cortisol, glucagon and growth hormone) or medications interfere with insulin action and cause glucose intolerance, which can lead to diabetes.

Etiology and signalment

Canine

There are some distinct differences in the etiology of canine and feline diabetes. In dogs, it is generally thought to be an immune mediated disease with gradual destruction of beta cells. The progression from normal, to glucose intolerant, to diabetes, is generally slow so that most islets (over 90%) are lost before diabetes occurs. Other causes of diabetes in dogs include genetic predisposition, chronic pancreatitis and medication-induced diabetes (*glucocorticoids* and *megestrol acetate*).

Genetic predisposition to diabetes is most common in the following breeds: German Shepherd dogs, Schnauzers, Beagles, and Poodles. Golden Retrievers and Keeshonds are more prone to juvenile diabetes.

Gender is a factor in dogs with females being three times more likely to develop diabetes than males. Generally, diabetes occurs in dogs in middle age (6-9 years) but can also present earlier for specific breeds, particularly the Golden Retriever and Keeshond.

Feline

The most common causes of diabetes in cats are obesity, pancreatitis and most commonly, amyloidosis of the pancreatic beta cells. There appears to be very little gender predisposition to this disease in cats, although it is slightly more common in males than females. As with dogs, the onset of diabetes in cats occurs most often in middle age.

Clinical signs

The clinical signs of diabetes include PU/PD (polyuria and polydipsia) from hyperglycemia, resulting in glycosuria and a resultant osmotic diuresis. Polyphagia and weight loss is common although many animals will still be obese upon presentation. In addition to the polyphagia, there may be variable degrees of dehydration especially in the cat. Cataract formation is very common in dogs with diabetes, but rare in cats. Cats often present with icterus as a result of concurrent hepatic lipidosis and/or pancreatitis. Icterus is not common in dogs unless they have pancreatitis. Cats may also exhibit a plantigrade stance (peripheral neuropathy) that is directly related to the severity and duration of hyperglycemia. Clinical neuropathies do occur in dogs, but are extremely rare.

Differential diagnoses include: hyperthyroidism (in cats), gastrointestinal lymphoma, hepatic disease, renal disease, pancreatitis, hyperadrenocorticism, and acromegaly.

Diagnosis

Diagnosis involves testing for persistent fasting hyperglycemia, with fasting blood glucoses greater than 200mg/dl. Clinicians also will need to rule out transient hyperglycemia that may be due to: post-prandial hyperglycemia; diabetogenic hormones (endogenous or exogenous); and stress hyperglycemia. Stress hyperglycemia can be a problem in cats due to the release of epinephrine when stressed or handled.

Laboratory abnormalities include:

- Hemogram
  - non-specific
  - signs of dehydration
- Biochemistry profile
  - hyperglycemia
  - increases in SAP and ALT
  - increases in bilirubin (usually in cats)
    - hepatic lipidosis
    - pancreatitis
- Urinalysis
  - glycosuria
    - renal threshold for glucose
      - canine 180-220mg/dl
      - feline 240-300 mg/dl
  - ketonuria
  - up to 40% of patients will have positive urine cultures in the absence of an active urine sediment.

Treatment

The number one cause of death in diabetic dogs and cats is not the disease itself, rather, it is the owner's frustration with the disease. This is an extremely important point to remember when treating diabetic animals. Good communication with the pet owner is perhaps the most important component of managing the disease.

It is recommended that clinicians schedule a 30-minute appointment with the client at the time of discharge before sending the diabetic patient home for the first time. During this appointment, clinicians should thoroughly discuss the care required for the patient. Include the following instructions in that discussion: how to give the animal injections; how to store insulin, what types of food to feed and how often; how to recognize the signs of hypoglycemia and how t react to this condition. Also include information on what clinical signs to look for in terms of monitoring water intake and urine production. The client should be give written instructions for use as a reference once they are caring for the patient at home. It is essential that the clinician and veterinary staff strive to educate the caregiver and motivate them to get involved in the care of their diabetic pet.

The goals of treatment include elimination of the clinical signs of diabetes, prevention or slowing of cataract formation and resulting blindness, prevention of potentially dangerous hypoglycemia, and prevention and/or treatment of concurrent illness.

Therapy for diabetes centers on three main areas: Treatment of concurrent illness (i.e., urinary tract infections, pydermas, etc.), insulin therapy, and dietary management.

Concurrent illness

Monitoring for concurrent illness is very important in effectively managing diabetic dogs and cats. Clinicians must effectively recognize and treat the other disorders because the concurrent illness will impact the diabetic regulation and many common diseases have similar clinical signs to diabetes mellitus. Even simple problems such as UTI's and pyodermas can result in activation of stress hormones and result in insulin resistance.

Insulin therapy

There has been a considerable amount of confusion over the various insulin preparations that are available. In general, animal origin insulins are being discontinued as the desire and ability to treat people with human derived insulin preparations has progressed.

There is concern that animals receiving human insulin will develop antibodies resulting in decreased insulin activity and/or effectiveness. Dogs receiving any insulin product that is not derived from pork may make antibodies. However, studies have shown that those antibodies do not interfere with the glucose control. In fact, dogs that made antibodies against insulin had a longer duration of insulin action, which actually enhanced the effect of the insulin rather than decreased its efficacy. A recent study in cats should that 13% developed anti-insulin antibodies. None of the cats should signs of insulin resistance.

The options with human insulin include ultra short acting, short acting, intermediate acting, and long-acting insulins. The short acting insulins are primarily used for ketoacidosis, and therefore, are not covered in this article. The intermediate acting insulins are classified as either NPH or Lente. It is important to note however, that even though they are classified as intermediate, they do not behave the same way in the dog or cat. Lente is actually a mixture of two different insulin preparations, which results in a bimodal onset of actions. This is helpful in some patients because is helps block post- prandial hyperglycemia. Conversely, a lente insulin is not recommended for use in an animal that does not develop post prandial hyperglycemia. It is recommended that NPH be used in the majority of dogs and cats with diabetes and it is also understood that most patients will require two injections a day to achieve glycemic control.

Canine patients

Newly diagnosed patients

1. Vetsulin (porcine origin lente): A zinc, porcine, intermediate acting insulin. Canine and porcine insulin have an identical amino acid sequence thereby eliminating the theoretical complication of anti-insulin antibodies and their effect on glycemic control. The suggested, initial starting dose is 0.5 units/kg BID. This insulin is only available at a concentration of 40 iu/ml (U-40) so please make sure that proper insulin syringes are provided to the owner. Re-assessment of clinical signs and a serial blood glucose curve should be performed 1 week after starting therapy. This insulin must be thoroughly shaken before administration. For additional information see: www.vetsulin.com.
2. Humulin N or Novolin N; These are both intermediate acting, human origin insulins. Suggested starting doses are 0.5 units/kg BID. Re-assessment of clinical signs and a serial blood glucose curve should be performed 1 week after starting therapy. I would avoid NPH insulins from Wal Mart due to product inconsistencies.
3. Glargine:
4. Detemir:
5. PZI:

Transitioning canine patients

If you have canine patients currently taking Humulin L lente insulin, I would switch them to either Vetsulin or Humulin N. The initial dose of Vetsulin or Humulin N will remain the same with re-assessment of clinical signs and a serial blood glucose curve performed 1 week after changing insulin preparations.

With the recent introduction of the AlphaTrak Blood Glucose Monitoring System (Abbott) we have the ability to very accurately measure blood glucose concentrations in both dogs and cats using very small quantities of blood. This will allow both veterinarians and pet owners to obtain very reliable results in both the hospital and home setting. This information can then be used to make informed decisions regarding the management of diabetic patients. These decisions impact the type and dose of insulin selected, the frequency of insulin administration, aid in the assessment of glycemic control, help in preventing hypoglycemic episodes and monitor for remission of diabetes especially in feline patients.

Glycemic control can be evaluated in a numbers of ways. Owner assessment of clinical signs (polyuria, polydipsia, weight gain or loss), progression of diabetic cataracts (dogs), presence of peripheral neuropathy (cats), and episodes of hypoglycemia are often the best indicators of glycemic control. Changes in insulin dosage or documenting remission of diabetes, is best determined by blood glucose measurement. Recognizing that the measurement of blood glucose concentrations can be problematic in the hospital setting (especially in cats as a result of stress induced hyperglycemia) recent work has evaluated the practicality and value of at home blood glucose monitoring in dogs and cats. At home blood glucose monitoring is essential in the management of human patients with diabetes given that a number of the complications associated with long term diabetes are directly related to persistent hyperglycemia. While diabetic retinopathy, nephropathy, painful neuropathies and cardiovascular disease are rare in our veterinary patients, adequate glycemic control is required to eliminate clinical signs and decrease morbidity and mortality in dogs and cats. Control of clinical signs does not require the restoration of euglycemia but rather involves keeping the blood glucose levels below renal threshold for the majority of the day. Renal threshold for glucose is 180 mg/dl in the dog and approximately 280 mg/dl in the cat. It is very important that we remember the owners of diabetic dogs and cats are being asked to do a great deal to help in the management of their pet’s

chronic illness and we need to do whatever we can to make the clients job easier while at the same time taking steps to assure maximal diabetic control.

Using the information derived using at home or in hospital glucose monitoring

Dogs

- Dogs on NPH or Lente Insulins
  - If the preinsulin blood glucose concentration is > 360 mg/dl and/or the nadir blood glucose concentration is > 180 mg/dl the dose of insulin is increased by 25%..
  - If the preinsulin blood glucose concentration is 270 to 360 mg/dl and/or the nadir blood glucose concentration is 90 - 180 mg/dl the dose of insulin is maintained.
  - If the preinsulin blood glucose concentration is 190 - 270 mg/dl and/or the nadir blood glucose concentration is 54 - 90 mg/dl use the nadir, clinical signs and the next preinsulin glucose concentration to determine if the dose is decreased (50%) or maintained.
  - If the preinsulin blood glucose concentration is < 180 mg/dl and/or the nadir blood glucose concentration is < 54 mg/dl the dose of insulin is decreased by 50%.

The use of the AlphaTrak Blood Glucose Monitoring System both in the clinic and at home will greatly improve our ability to assess glyemic control and improve insulin therapy. In conjunction with close observation of clinical signs, at home glucose monitoring should go a long way towards improving the quality of life of diabetic pets and their owners.

Diet

There is a considerable amount of reliable research data showing that diets high in carbohydrates, low in fat and high in fiber are helpful in regulating diabetic dogs. These types of diets lower the average insulin dose, the average blood sugar, the amount of urine being produced and glycosolated hemoglobins and fructosamine levels.

The carbohydrates in these diets are complex carbohydrates. It is important to avoid diets high in simple sugars, which includes any commercial semi-moist food, primarily those packaged in foil packets. Diets high in simple sugars are absorbed very rapidly before the insulin has time to work. The goal with diet is to balance the absorption of sugar with the onset of action of the insulin. A high carbohydrate/low fat diets also decreases plasma free fatty acid and cholesterol concentrations, and increases the number and activity of insulin receptors.

High fiber diets reduce insulin resistance. The fiber acts to decrease post prandial hyperglycemia, primarily because it delays gastric emptying. A high fiber diet also decreases absorption of glucose and increases insulin action at the receptor.

It has recently been suggested that diabetic cats be fed a high protein/low carbohydrate diet. This can be accomplished with several commercially available canned diets (Hill's M/D, IVD Development, Purina DM, many other canned kitten diets). These diets may result in remission of the diabetes and elimination of the need for exogenous insulin and/or oral hypoglycemic agents. High protein/low carbohydrate diets more closely resemble the diet of felines in the wild and may help reduce glucose intolerance, insulin resistance and obesity.

Feeding

Ideally, the feeding schedule should be coordinated with the onset of action of the insulin. With dogs, this is fairly easy to regulate, but with cats, it is nearly impossible due to their "grazing" style of eating. For cat owners who may not be able to follow a strict feeding schedule or those with multiple pet households, insulin therapy will have to be adjusted to meet the owner's needs. The most important component of the dietary plan is to stress consistency in the diet. The following feeding schedule can be used for dogs and some cats. With insulin given once a day, feed three meals a day (of equal calories) at six-hour internals. Give the first meal at the time of the insulin injection. For animals receiving insulin twice a day, feed four meals a day. Schedule them to coincide with the insulin injections and feed mid-afternoon and late evening.

If the owner is unable to follow this schedule, advise them to feed twice a day, at the time of injection and 8-10 hours later (for once a day insulin patients); or at the times of insulin injections (for twice a day insulin patients).

Home management

1. Instruct owner on proper injection techniques, injection locations, storage and handling of insulin.
2. Instruct owner on how to monitor clinical signs.
3. Continue feeding schedule and dietary therapy.
4. Instruct owners to initially monitor urine glucose/ketone levels daily, usually in the morning or evening prior to feeding. If persistent glycosuria or ketonuria is observed, ask owner to contact the veterinary hospital.
5. Advise owners of the signs of and treatment for hypoglycemia. Have owners keep a bottle of Karo syrup on hand if signs occur (i.e., weakness, ataxia, seizures) so they can rub syrup on the gums immediately. Instruct them to call the veterinary hospital.
6. Home monitoring of a diabetic cat is frequently based on observance of clinical signs only.
7. Serial sugars after the first week of home management.

Re-check evaluations

1. Obtain owner assessment of clinical signs.
2. Serial blood sugars are helpful due to:
    a. Variability of insulin action in a given patient.
    b. Inaccuracy of random blood or urine sugars in monitoring the degree of glycemic control.
    c. Not particularly helpful as a routine procedure in animals that are well controlled clinically.
3. Body weight
4. Physical examination/ophthalmic exam
5. Discuss urine log book with owner
6. Laboratory work as clinically indicated
    a. Role of glycosylated hemoglobin and frustosamine:
    b. Fructosamine may be helpful in distinguishing stress-induced hyperglycemia from diabetes in cats. These tests can be used every 3 – 4 months as an indicator of long term (2-3 weeks fructosamine; 4-6 weeks glycosylated hemoglobin) glucose control. Rising values indicate the need for further evaluation.

Problems with insulin therapy

- Insulin induced hyperglycemia (Somogyi phenomenon)
    - Hypoglycemia (<65mg/dl) followed by hyperglycemia (>300mg/dl) within 24 hours of insulin injection.
    - Suspect when insulin requirements exceed 2 U/kg and clinical signs persist.
    - Suspect when animal has signs of hypoglycemia in afternoon.
    - Diagnosis with serial sugars.
    - Treat by decreasing insulin dose 25-50% and review insulin administration with the owner to rule out management problems.
    - Re-check serial sugars in one week.
- Rapid insulin metabolism
    - Duration of insulin less than 18 hours.
    - Signs return in the evening.
    - Diagnosis is with serial sugars. Hyperglycemia (>250) within 18 hours of insulin injection without previous hypoglycemia.
    - Treatment:
        - Review management with owner
        - Switch to twice daily insulin administration. Most dogs and cats require insulin twice a day to achieve adequate glycemic control. Consider switching to PZI in cats.
- Insulin Resistance
    - Hyperglycemia (>300) throughout the day, despite insulin dosages > 2 U/kg.
    - Diagnosis based on serial sugars.
    - Potential causes of insulin resistance:
        - Management problems
        - Hyperadrenocoticism
        - Steroid or Ovaban administration
        - Diestrus or pregnancy
        - Acromegaly
        - Concurrent illness, infection
        - Anti-insulin antibodies
        - Hypothyroidism (dogs), hyperthyroidism (cats)
    - If insulin dose exceeds 2U/kg, the animal should be evaluated for one of these causes of resistance.
- Hypoglycemia
    - Insulin overdosage
    - Suspect if animal shows weakness, shaking, ataxia, seizures at time of insulin's peak effect.
    - Therapy (instructions for owners)
        - Mild signs - give food and call veterinarian
        - Moderate signs - apply Karo syrup to the mouth, offer food when alert and then notify veterinarian.
        - Comatose - apply Karo syrup to mouth and take animal to hospital.
    - When hypoglycemia occurs, serial sugars should be performed to re-assess insulin dose

Drink Up!
Fluid Therapy Considerations for Exotic Pets

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

The majority of the exotic pet cases presented to veterinarians are dehydrated as a result of a chronic disease. Animals primarily lose moisture through the gastrointestinal and respiratory tracts, although the integument and eye (non-spectacle) are also sites where moisture is lost. Diseases associated with the gastrointestinal tract (e.g., diarrhea) or traumatic injuries to the integument (e.g., thermal burns) can increase the amount of moisture lost in our patients.

Characterizing the extent of dehydration and providing appropriate fluid replacement is necessary to successfully rehabilitate the patient. An understanding of the "water" make-up of these patients should be considered before selecting a fluid. For example, reptiles have higher total body water than mammals and the extracellular space of reptiles contains higher sodium and lower potassium levels compared to mammals (the reverse is true for the intracellular space). Therefore, fluid selection should be based on both the type of dehydration and the physiological status of the patient. Hypertonic dehydration is common in animals that have limited access to water or do not drink. Isotonic dehydration generally occurs as a result of hemorrhage, diarrhea, and short-term anorexia. Hypotonic dehydration is a common sequella to prolonged anorexia. Characterizing the state of dehydration is important to ensure that the patient is re-hydrated correctly.

Historically, isotonic balanced fluids, such as lactated ringers solution (273mOsmol/l, pH 6.6)(Abbott Laboratories, North Chicago, IL) and Normasol® (294mOsmol/l, pH 6.6)(Abbott Laboratories, North Chicago, IL) have been used when large fluid volumes are required. These fluids generally expand the extracellular space without a significant shift into the intracellular space. Prolonged usage of these fluids can lead to hypokalemia. In mammals, physiologic saline (0.9%)(308mOsm/l, pH 5.6) is preferred when there is a need for a rapid expansion of the circulatory volume, or to correct hyponatremia or alkalosis. Hypertonic solutions, such as 5% dextrose (252 mOsm/l, pH 4.3), are used when fluids are required to expand both the intracellular and extracellular spaces. The caloric input from the glucose is probably negligible and veterinarians should use appropriate enteral sources of nutrition to provide essential calories and nutrition. Combination fluids, such as 0.45% saline and 2.5% dextrose (280 mOsm/l, pH 4.3), are also commercially available.

Maintenance fluids should be provided to those animals not consuming sufficient fluids, in addition to correcting their fluid deficit. In general, the fluid maintenance rate for rabbits and small exotic mammals is 80-100 ml/kg/day. For birds there is a wide range of recommended fluid rates (50-100 ml/kg/day), although the author always bases the maintenance level on the high end of the range (100 ml/kg/day). The maintenance fluid rate of reptiles is 10-30 ml/kg/day.

Fluids can be given per os (PO) in patients that are mildly dehydrated (<5%) and have a functional gastrointestinal tract. The PO route is less invasive than other techniques. Per os fluids are not recommended in cases where patients are regurgitating, vomiting or have diarrhea, as the administration of fluids by the PO route could potentiate an osmotic diarrhea. The patient must be restrained properly to ensure safe administration of fluids. Fluid administration generally requires two individuals, one to restrain the animal and one to deliver the fluids. Attempting to administer fluids PO using inappropriate techniques could lead to fluid aspiration. Fluids can be administered PO using a stainless steel gavage tube or red rubber feeding tube. The required tube length can be determined by measuring the distance between the snout and the midbody, which is the approximate location of the stomach.

Subcutaneous (SC) fluids can also be used to rehydrate mildly dehydrated patients (<5%). In severe cases of dehydration (>8%), other routes of fluid administration, such as intracoelomic, intraosseus, and intravenous fluids, should be used. There are a number of advantages to using SC fluids, including ease of administration and an ability to deliver large volumes of fluids. The primary disadvantage of using SC fluids is that the subcutaneous space in most animals is relatively avascular, leading to variable absorption rates. The most common site to administer SC fluids in snakes and lizards is the lateral body wall. In chelonians, SC fluids are generally administered in the inguinal/femoral space. In birds, the inguinal and scapular areas are the most common sites of SC fluid administration. In mammals, the dorsal thoracic (scapular) and lateral body walls are the preferred sites for SC fluid administration.

Intraosseus (IO) fluids can be used in cases with moderate to severe dehydration. The IO route may be used when peripheral vasoconstriction limits intravenous access. Intraosseous catheters are clinically advantageous and appropriate in small and fractious patients due to ease of placement, catheter stability and clinical response. The femur, tibia, and humerus may be used for IO catheter placement in reptiles. In birds, the ulna and tibiotarsus are preferred. The femur and humerus should never be used because they may be associated with air sacs. In mammals, the proximal femur and tibia are preferred sites for IO catheters. A local anesthetic, such as lidocaine, should be used to reduce the pain associated with catheter placement. The author prefers to use spinal needles for IO catheters, as they have a stylet that prevents plugging the needle with a bone core.

Intracoelomic (ICo) fluids can be administered to reptiles and mammals with moderate to severe dehydration; however, this route should never be used in birds as it can lead to accidental drowning. The large serosal surface area of the viscera and the coelomic/peritoneal membranes of reptiles and mammals serve to resorb the fluids. Irritating compounds should not be administered ICo. Intracoelomic fluids are not recommended in reptile patients that have respiratory compromise, as they may place an additional burden on the animal. Intracoelomic fluids should be given in the caudal coelomic cavity.

Intravenous fluid administration is the preferred route of fluid administration in moderately to severely dehydrated patients. The jugular vein can be used for lizards, chelonians, and snakes. Placement of the jugular catheter in the snake and lizard requires a surgical cut-down. A local anesthetic, such as lidocaine, should be used to reduce discomfort. The cephalic vein is another site for catheterization in the lizard, whereas the heart may be directly catheterized in severely moribund snakes. In birds, the jugular, basilic or medial metatarsal veins can be used to place IV catheters. The medial metatarsal vein is generally large (and approachable) in waterfowl, raptors, and large psittacines. In smaller psittacines, the basilic vessel is preferred. In mammals, the jugular, cephalic and lateral saphenous sites can be used for IV catheters. When collecting blood samples from exotic pet patients, it is important to consider possible IV sites prior to sample collection. For example, the author never collects a blood sample from a rabbit cephalic vein, preferring to save the site for IV catheterization.

Anesthetic Considerations for Exotic Pets: It's about More Than Just Passing Gas

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Clinicians working with exotic pets should establish consistent anesthetic and analgesic protocols to manage cases that require diagnostic or surgical procedures. Unfortunately, there are still cases where patients are being managed using "bruticaine" or analgesic limited protocols that aren't taking into account the potential pain that develops or continues after a procedure (e.g., only using isoflurane anesthesia with no other long term management plan). Advances in domestic animal anesthesia have provided safer, consistent compounds that may be used to anesthetize exotic pets and provide long term analgesia.

A patient should receive a thorough examination, including auscultation of the heart and lung(s), prior to any anesthetic procedure. In those cases where auscultation is limited, such as with reptiles, an ultrasonic Doppler may be used to assess the heart. Pre-surgical blood work, which is commonly performed in domestic species, can provide insight into the physiological status of an animal. A complete blood count and plasma chemistry panel should be performed when possible. In cases where blood volume or owner finances are limited, a packed cell volume, total solids, and blood smear can be performed to provide important information regarding the animal's status.

Ectotherms, such as reptiles and amphibians, should be provided supplemental heat during an anesthetic procedure that is consistent with their preferred environmental temperature. Endotherms, including birds and mammals, should also be provided supplemental heat during these procedures. Hypothermia in endotherms can result in the loss of essential energy to maintain an appropriate core body temperature. Animals maintained at an inappropriate temperature will experience a prolonged recovery. Water-circulating heat pads and forced air heating units provide good results and are unlikely to cause thermal burns. Radiant heat from an incandescent light can also be used to provide supplemental heat.

Variability in the physiology of exotic pets often results in variable responses between classes of animals. For example, anesthetics that provide surgical anesthesia in a mammal or bird may provide little to no anesthesia in a reptile or amphibian. Differences in anesthetic responses within animal classes have also been described. The anesthetic agents that have been found to provide the most reliable results in exotic pets include the dissociatives, benzodiazepines, alfaxalone, alpha-2 agonists, propofol, and inhalant anesthetics.

Benzodiazepines, such as midazolam, are excellent for sedating exotic pets for diagnostic procedures or as part of a pre-anesthetic protocol. The author routinely uses midazolam to sedate exotic small mammals for diagnostic imaging. Doses for rabbits range from 0.5-1 mg/kg, while for rodents may range from 0.5-2 mg/kg). Combining the midazolam with an opioid, such as buprenorphine (0.03-0.05 mg/kg), is useful if any painful procedures are expected (e.g., orthopedic manipulation for radiographs).

Dissociative agents are routinely used to anesthetize exotic pets. The most common dissociative agents used are ketamine (Ketaset, Ft. Dodge Laboratories, Ft. Dodge, IA, USA) and tiletamine (Telazol, Fort Dodge Laboratories, Ft. Dodge, IA, USA). Reported dosages for ketamine are quite varied. When a short, painless procedures (e.g., examination) or pre-anesthetic is required (e.g., facilitate intubation) for reptiles, a dose between 10-30 mg/kg IM is sufficient. Ketamine provides minimal analgesia and should be combined with an analgesic when a painful procedure is performed. A dose of 55-88 mg/kg IM has been recommended for surgical anesthesia in reptiles, but ketamine is inappropriate as a sole anesthetic in a surgical procedure. Ketamine is generally used in combination with alpha-2 agonists in mammals. If used alone, a dose from 15-30 mg/kg may be used, whereas the dose can be reduced when the drug is used in combination with an alpha-2 agonist. Side effects reported with ketamine usage include respiratory arrest, bradycardia, skin depigmentation, and prolonged recoveries. These side effects are usually associated with the administration of high doses (>80 mg/kg). Tiletamine is more potent than ketamine and provides similar results at a lower dose in reptiles (3-8 mg/kg). The addition of zolazepam is of benefit because it improves muscle relaxation and is an anticonvulsant. Tiletamine has been used in snakes, lizards and crocodilians with some success, but recoveries are still prolonged. Tiletamine should only be used for short, painless procedures or as a pre-anesthetic as it provides limited analgesia. The dissociatives have been used in birds, but generally result in violent recoveries.

The alpha-2 agonists, including xylazine and dexmedetomidine, have been used with good success in exotic pets. In general, they are used in combination with other drugs. Of the two drugs, dexmedetomidine is used more frequently because of its greater effect and potency. Dexmedetomidine provides muscle relaxation, analgesia and is reversible with atipamezole. The primary side effect associated with this drug is cardiopulmonary depression.

Propofol is a non-barbiturate anesthetic agent that can be used to provide general anesthesia. Propofol is readily metabolized, has no cumulative effect, and provides approximately 10-45 minutes of anesthesia. To be effective, propofol must be administered intravenously (IV) or intraosseusly (IO). The author has been able to anesthetize amphibians using the intracoelomic route, but the

dose is much higher (35 mg/kg) than the IV dose. A dose of 10-15 mg/kg IV will provide general anesthesia in birds, mammals, and reptiles. Additional boluses of propofol may be necessary during a procedure. Because propofol is a respiratory depressant, the patient should be intubated and ventilated.

Inhalant anesthetics are still considered the gold standard for anesthesia. The primary advantage of the inhalant anesthetics is that delivery is controlled via a precision vaporizer. The most common inhalant anesthetics used in veterinary practice are sevoflurane and isoflurane. Exotic pets, like domestic species, should be intubated to ensure consistent delivery of the anesthetic. Birds, chelonians, and crocodilians have closed tracheal rings and should be intubated with a non-cuffed endotracheal tube. Intubating a reptile or bird is a simple procedure because the glottis is located on the floor of the mouth. Intubating lagomorphs can be very difficult because of their long, narrow oral cavity. Birds and reptiles under general anesthesia may become apneic during the procedure and should be ventilated using intermittent positive pressure. Typically, 4-6 breaths per minute at a pressure less than 12 cm of water is satisfactory. Non-rebreathing systems are appropriate for animals under 5 kg.

Exotic pets should be monitored during an anesthetic procedure using standard procedures. Breathing can be monitored by observing contraction of the body wall, or with the assistance of an audible respiratory monitor. Auscultation of the heart is difficult, if not impossible, in reptiles. Esophageal stethoscopes may be used to monitor the heart rate in larger species, but are impractical in smaller animals. An ultrasonic Doppler produces an audible sound that insures cardiac function. An electrocardiogram (ECG) can also be used to monitor heart rate and rhythm. The pulse oximeter is a monitoring device that continues to gain popularity in veterinary medicine because it enables the anesthetist to monitor both heart rate and oxygen saturation. There are a number of different monitoring probes that can be purchased with these systems. Although these devices simplify anesthetic monitoring, placement and re-positioning may be required during the procedure. Mucous membrane color and hydration status of the patient should also be monitored during the surgical procedure. Any animal that experiences significant blood loss during a procedure should be given fluids (e.g. intravenous or intraosseous). Recovery from an anesthetic procedure should take place in a warm, dark, quiet area.

Infectious and Parasitic Diseases of Captive Reptiles: What is Lurking Under Those Scales?

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

In the past two decades, there has been a rise in the number of emerging and re-emerging infectious diseases reported in reptiles. Emerging infectious diseases include newly identified pathogens, while those characterized as re-emerging include those that may have been previously characterized but are being reported with increased frequency. Veterinarians play an important role in the diagnosis of infectious diseases in herpetological collections and should closely monitor the literature to keep abreast of new findings and current research.

The rise in emerging infectious diseases in reptiles may be attributed to several factors, including the increased number of reptiles being imported into the United States and Europe, poor quarantine and sanitation programs, and improved diagnostic assays. The popularity of reptiles in the United States remains high, with millions of reptiles being imported annually. The popularity of reptiles has led to the growth of reptile swap meets, where herpetoculturists have the opportunity to select from a large number of different reptile species. At these swap meets large numbers of reptiles are maintained in relatively small areas with minimal/no biosecurity. Herpetoculturists routinely handle different specimens without washing their hands, possibly introducing and disseminating pathogens through the reptiles. The sanitation methods used to control or eliminate pathogens in reptile collections may also be suspect. Inappropriate use of disinfectants may lead to the development of resistant strains of microbes.

The number of diagnostic tests available to the clinician treating reptiles has increased dramatically over the past ten years. Historically, clinicians treated all “infections” in reptiles as bacterial diseases. However, over the past ten years, there have been an increased number of reports of viruses and fungi being isolated from diseased reptiles. The advent of molecular diagnostic testing has led to the development of highly sensitive and specific enzyme-linked immunosorbent assays, polymerase chain reaction (PCR), and reverse-transcriptase PCR.

The incidence of herpesvirus infections in chelonians has been on the rise since originally being isolated from sea turtles in 1975. Herpesvirus infections have been identified in freshwater, marine, and terrestrial species of chelonians. Transmission of the herpesvirus is believed to be via the horizontal route, although it has been suggested that a vertical route of transmission is also possible. Affected animals may present with rhinitis, conjunctivitis, necrotizing stomatitis, enteritis, pneumonia, and neurological disease. Molecular diagnostics, electron microscopy, and viral isolation have been used to diagnose herpes infections in chelonians. Affected animals should be provided appropriate supportive care (e.g., fluids, enterals, and antibiotics) to control clinical signs. Acyclovir has been used with some success by reducing viral replication. However, there is no effective treatment for this virus. Affected animals should not be released into the wild to prevent translocation of the virus to naïve chelonians.

Mycoplasmosis is a bacterial infection that has been associated with severe disease in chelonians. Affected animals may present with nasal and ocular discharge, conjunctivitis, palpebral edema and pneumonia. Mycoplasmosis has also been identified in squamates and crocodilians. There are several diagnostic tests available to confirm mycoplasmosis in reptiles, including culture, an ELISA and a PCR assay. Microbiologic culture can be used to confirm an infection, but it is difficult to isolate this bacteria and time consuming. Currently, parallel testing using both the ELISA and PCR assays provides the highest degree of sensitivity. Treatment may be attempted using tetracyclines and flouroquinolones. Mycoplasmosis has been associated with declines in native tortoise populations in the United States and treatment of wild specimens is not recommended.

Cryptosporidium serpentis is considered a “plague” of captive snake collections. This apicomplexan parasite has been associated with both high morbidity and mortality in captive collections. Affected snakes commonly regurgitate their meals, have a mid-body swelling, and are dehydrated. A variety of methods may be used to diagnose cryptosporidiosis in snakes. Acid-fast cytology of a regurgitated meal or fecal sample is often diagnostic. Because there is currently no effective treatment, affected animals should be culled. *Cryptosporidium saurophilum* is a more recently diagnosed species associated with lizards. Whereas *C. serpentis* is associated with the stomach, *C. saurophilum* is associated with the intestine. Currently, no consistent treatment is available for *C. saurophilum* or *C. serpentis.*

Bearded dragon adenovirus was first reported in Australia in the early 1980’s. The virus was not characterized in the United States until more than a decade later. Since that time, the virus has spread through the bearded dragon population in the USA and should be considered endemic. Transmission of the virus is primarily by the direct route (fecal-oral), although vertical transmission may also be possible. Affected animals may present with anorexia, weight loss, limb paresis, diarrhea and opisthotonous. Concurrent dependovirus and coccidial infections have also been observed in neonatal bearded dragons. Biopsies of the liver, stomach, esophagus, and kidney may be collected to confirm diagnosis (ante-mortem). On histopathology, basophilic intranuclear inclusion bodies are strongly suggestive of adenoviral infection. Currently, there is no non-invasive ante mortem diagnostic test to confirm adenovirus in the reptile;

however, the author is currently working on a polymerase chain reaction (PCR) assay to detect adenovirus in the feces of affected animals. There is no effective treatment for adenoviral infections, although supportive care (e.g., fluids, enterals, antibiotics) may be useful in stemming the secondary effects of the disease. Again, very little is known regarding the epidemiology of this virus; therefore, special precautions should be taken when working with affected animals. Because there is no effective treatment, affected bearded dragons should be culled from breeding populations.

Coccidiosis is a major cause of morbidity and mortality in reptiles. A species of special concern, Isospora *amphiboluri*, is found in bearded dragons. These endoparasites are especially problematic in neonatal dragons, often resulting in stunting, diarrhea, and death. Whereas most coccidial infections in higher vertebrates are self-limiting, these infections often persist in bearded dragon colonies. Historically, eliminating coccidia from bearded dragons was difficult because most of the therapeutics used to eliminate the parasites were coccidiostatic. Penazoril (30 mg/kg per os once with a second treatment 48 hours later) is coccidiocidal and has excellent therapeutic value against *I. amphiboluri*. Quarantine and environmental disinfection/sanitation should also be done to eliminate coccidia from dragon colonies.

Microsporidians are obligate intracellular parasites. The life cycle of these parasites includes both merogenic and sporogenic phases. These parasites are common in lower vertebrates (e.g., fish), but have also been implicated as a concern in humans with acquired immunodeficiency virus. Bearded dragons infected with these parasites can present with a similar clinical picture as adenovirus or coccidiosis. Affected dragons are anorectic, unthrifty, cachectic, and may die acutely. Diagnosis is generally made at post-mortem. Hepatic and renal necrosis is common, although other organ systems (e.g., intestine and gonads) may also be affected. There is no effective treatment. To limit the likelihood of introducing this parasite into a collection, herpetoculturists should only acquire animals from reputable breeders and quarantine any new arrivals for a minimum of 60-90 days.

Ranavirus is an emerging disease of chelonians. This virus has a high morbidity and mortality. It has been isolated from both captive and wild chelonians. Affected animals typically develop upper respiratory signs (e.g., palpebral edema, conjunctivitis), lower respiratory signs, oral ulcers, cervical edema, and gastrointestinal signs. Diagnosis can be done using PCR. There is currently no effective treatment for affected animals.

Opening Up Pandora's Shell: Medical and Surgical Considerations for Chelonians

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Chelonians are commonly presented to veterinarians for a variety of health concerns. The purpose of this presentation is to provide a review of important biologic, husbandry, and disease information as it relates to these animals

Chelonians are long-lived reptiles that have always been of interest to humans, originally as a source of food, and more recently as pets. Chelonians are found on all of the inhabited continents. Since the 1980's the popularity of chelonians has increased dramatically. The primary reason for this has been the successful reproduction of these animals in captivity. As the popularity of these reptiles continues to rise, veterinarians can expect to encounter them more frequently in their practices.

Chelonians represent a diverse group of animals that can be found in different ecological niches, including aquatic, temperate, semi-arid and desert habitats. Characterizing the specific habitat required by a chelonian can be useful when designing a vivarium. These diurnal species prefer to bask in the morning and late afternoon hours in to avoid the excessive heat of the day. Because chelonians are ectotherms, it is important to provide them an appropriate environmental temperature range. In general, a diurnal range from 80-90^{o}F is appropriate; while a nighttime drop to 70-80^{o}F will suffice. Chelonians not provided an appropriate environmental temperature may have a decreased metabolic rate and immune response, resulting in limited growth and chronic infections.

For years there has been very little research focused at identifying the specific nutritional requirements of chelonians. Chelonians are generally classified as herbivorous, omnivorous or carnivorous. Herbivorous tortoises generally feed on a high degree of succulents and grasses within their native environments. The grasses are important sources of fiber, and provide essential cellulose for microbes in the colon of these reptiles. These microbes utilize these plant sources to generate volatile fatty acids (e.g., energy) for the tortoise. Captive tortoises should be provided a diverse diet comprised of vegetables, fruits, and grasses. The author prefers to use timothy or Bermuda grass hay, mustard and collard greens, and romaine lettuce as the basis for the diet. Fruits generally comprise 10-15% of the diet. Other green leafy vegetables, beans, and squash can be used to round out the diet. When offered a diverse diet, nutritional supplements are not generally required.

Omnivorous chelonians should be provided a diet comprised of both animal and plant materials. As juveniles, omnivorous chelonians tend to prefer animal proteins, while adult animals tend to consume more plant protein in their diet. Omnivorous chelonians should be provided the same plant based diet as described previously for herbivorous reptiles. In the United States, there are six invertebrates sold commercially, including the commercial cricket (*Acheta domesticus*), mealworm (*Tenebrio molitor*), superworm (*Zoophobias morio*), waxworm larva (*Galleria mellonella*), fruit fly (*Drosophila* spp.), and earthworm (*Lumbricus terrestris*). The primary advantage to using these invertebrates is that they are readily available through most pet distributors year round. Unfortunately, these prey items do not provide a complete and balanced diet for an omnivorous chelonian. Most of these invertebrates are deficient in calcium, the exception being earthworms maintained in high calcium soils. Feeding or "gut-loading" commercial invertebrates prior to offering them to a chelonian can help to increase the mineral content of the prey items. Dusting the prey item with a calcium carbonate powder may also help to increase the calcium content of the prey items.

Some pet owners elect to capture wild invertebrates to feed their chelonians. It is important to only collect invertebrates from areas that are free of insecticides. There are a number of invertebrates that produce toxins that can prove fatal to a reptile. The same considerations should be followed when allowing tortoises to free-graze in a yard. Pesticides or insecticides used to treat grass can also be toxic to tortoises.

Chelonians not provided a balanced diet might develop hypovitaminosis A. Hypovitaminosis A is a common finding in tortoises that are offered a vitamin A deficient diet. Affected tortoises may present with blepharoedema, nasal and ocular discharge, dermatitis, diarrhea, and pneumonia. In severe cases, affected animals can die from hypovitaminosis A. Fast-growing juveniles and reproductively active females are most commonly affected. Affected chelonians develop squamous metaplasia, which results in the loss of tight cell junctions and increases the risk of opportunistic infections. Diagnosis is generally made based on history, physical examination, and measuring vitamin A levels. Hematologic samples and radiographs should also be performed to determine the extent of the disease. Treatment should include correcting dietary and environmental deficiencies. Parenteral vitamin A (1,500-2,500 IU/kg) can be used to initiate treatment. Over dosing an affected chelonian with vitamin A can cause an iatrogenic hypervitaminosis A, which can lead to the sloughing of the integument. Special care should be taken to only use the parenteral vitamin A in cases where the veterinarian is confident in their diagnosis.

Obesity is a common problem identified in captive chelonians that are offered ad lib food and not provided any exercise. Obesity can lead to other health issues, including dystocia and hepatic disease, and clients should be provided dietary recommendations to reduce the weight of their chelonians.

In the past decade, there has been a rise in the number of “new” or emerging infectious diseases reported in reptiles. Emerging infectious diseases include both newly identified pathogens and those pathogens that may have been previously characterized and are being reported with increased frequency. Veterinarians play an important role in the diagnosis of infectious diseases in herpetological collections and should closely monitor the literature to keep abreast of new findings and current research.

The rise in emerging infectious diseases in reptiles may be attributed to several factors, including the increased number of reptiles being imported into the United States and Europe, poor quarantine and sanitation programs, and improved diagnostic assays. The popularity of reptiles in the United States remains high, with millions of reptiles being imported annually. The popularity of reptiles has led to the growth of reptile swap meets, where herpetoculturists have the opportunity to select from a large number of different reptile species. At these swap meets large numbers of reptiles are maintained in relatively small areas with minimal/no biosecurity. Herpetoculturists routinely handle different specimens without washing their hands, possibly introducing and disseminating pathogens through the reptiles. The sanitation methods used to control or eliminate pathogens in reptile collections may also be suspect. Inappropriate use of disinfectants may lead to the development of resistant strains of microbes.

The number of diagnostic tests available to the clinician treating reptiles has increased dramatically over the past ten years. Historically, clinicians treated all “infections” in reptiles as bacterial diseases. However, over the past ten years, there have been an increased number of reports of viruses and fungi being isolated from diseased reptiles. The advent of molecular diagnostic testing has led to the development of highly sensitive and specific enzyme-linked immunosorbent assays, polymerase chain reaction (PCR), and reverse-transcriptase PCR.

The incidence of herpesvirus infections in chelonians has been on the rise since originally being isolated from sea turtles in 1975. Herpesvirus infections have been identified in freshwater, marine, and terrestrial species of chelonians. Transmission of the herpesvirus is believed to be via the horizontal route, although it has been suggested that a vertical route of transmission is also possible. Affected animals may present with rhinitis, conjunctivitis, necrotizing stomatitis, enteritis, pneumonia, and neurological disease. Molecular diagnostics, electron microscopy, and viral isolation have been used to diagnose herpes infections in chelonians. Affected animals should be provided appropriate supportive care (e.g., fluids, enterals, and antibiotics) to control clinical signs. Acyclovir has been used with some success by reducing viral replication. However, there is no effective treatment for this virus. Affected animals should not be released into the wild to prevent translocation of the virus to naïve chelonians.

Mycoplasmosis is a bacterial infection that has been associated with severe disease in chelonians. Affected animals may present with nasal and ocular discharge, conjunctivitis, palpebral edema and pneumonia. There are several diagnostic tests available to confirm mycoplasmosis in reptiles, including culture, an ELISA and a PCR assay. Microbiologic culture can be used to confirm an infection, but it is difficult to isolate this bacteria and time consuming. Currently, parallel testing using both the ELISA and PCR assays provides the highest degree of sensitivity. Treatment may be attempted using tetracyclines and flouroquinolones. Mycoplasmosis has been associated with declines in native tortoise populations in the United States and treatment of wild specimens is not recommended.

Chelonians are routinely presented to veterinarians for traumatic injuries. The majority of these injuries generally result in the fracture of the shell. Shell fractures should be managed as an emergency. Fractures to the shell can result in the loss of body heat, fluids, and the natural barrier against pathogens. A thorough examination is performed to assess the extent of the animal’s injuries, with shell fragments stabilized to minimize pain. Analgesics should be given prior to reducing the shell fractures. To determine the chelonian’s general health condition, diagnostic tests including a packed cell volume, complete blood count, and plasma biochemistries analysis are needed. Survey radiographs should be taken to assess the extent of skeletal and soft tissue injuries. Shell fractures greater than six hours old are managed as a contaminated injury, and samples from within the wound collected for microbial culture. The author has isolated both Gram-positive and Gram-negative bacteria from these injuries and broad-spectrum systemic antimicrobials are warranted in these cases depending on the antimicrobial sensitivity pattern.

The first step is to managing a shell fracture is to remove any debris by liberally flushing the injury with sterile warm physiologic saline. Care should be taken not to introduce excessive amounts of saline into the coelomic cavity. Wet-to-dry bandages can be applied to the shell surface to facilitate removal of debris. I generally use physiologic saline or dilute chlorhexidine for the wet bandage. Wet-to-dry bandages should only be used until the exudate associated with the wound is under control, as long-term use of these bandages can result in the desiccation of the viable tissues.

There are a number of opinions on the best method to correct a shell fracture. The author generally uses surgical hardware to reduce the fractures or manage the injury as an open wound and allow it to heal completely by second intention. Surgical correction is necessary for shell fractures that are not stable or involve greater than 20% of the shell surface area. Cerclage wire, plates or metal braces have all been used to reduce shell fractures. These devices are generally not removed from the shell fracture unless the animal remains in captivity until the shell fracture is completely healed. Once the fractures are reduced, the injury can be allowed to heal by secondary intention healing or covered with an acrylic polymer. Wounds that are not covered should be irrigated daily and kept free of debris until a protective epithelial barrier is observed. Commercial epoxy resins are also routinely used to repair shell injuries.

However, these compounds are exothermic, and leakage into an injury could cause osteomyelitis or coelomitis. If the acrylic polymer is used to protect the fracture site, than the epoxy can be used to cover the acrylic and form a watertight seal for aquatic chelonians. The convalescence period for a chelonian shell fracture can range from 6-30 months, depending on environmental and physical variables (e.g., environmental temperature and age).

Understanding the Bowel Wrapped in Fur: Gastrointestinal Diseases of Rabbits and Rodents

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

The gastrointestinal tract of rabbits and rodents is unique in comparison to other domestic mammals. Veterinarians should become familiar with the anatomic and physiologic differences of the gastrointestinal tract of these animals in order to improve their management of diseases associated with this organ system. Diseases of the gastrointestinal system are a common finding in captive rodents and lagomorphs and have been associated with infectious diseases, parasites, toxins, and neoplasia. The purpose of this presentation is to provide attendees with a review of important anatomical features of the gastrointestinal system of rabbits and rodents and to discuss common diseases associated with the gastrointestinal system.

History and physical examination

A thorough history is essential to identifying any potential etiology(ies) responsible for gastrointestinal disease in rabbits and rodents. In many cases, there will be deficiencies in the animal's husbandry. Inappropriate diet is a common problem encountered in the author's practice. The physical examination should be thorough and complete. The ears, nares and eyes should be clear and free of discharge. The oral cavity should be examined closely. Because incisor and molar malocclusions are common in these animals, it is imperative that the teeth be closely inspected. The incisors can be evaluated by lifting the upper and lower lips, while examining the molars may require a more invasive approach, such as an oral speculum. The integument and furs should be evaluated for the presence of ectoparasites and injuries. The lungs and heart should be ausculted to determine in there are any problems with the cardiorespiratory systems. The extremities should be palpated. The plantar surfaces of rabbits should be closely inspected. Pododermatitis is a common problem in rabbits housed on wire bottom cages. The abdomen should be palpated. The kidneys, urinary bladder, stomach, and large intestine can generally be palpated during a routine examination. The anus and urogenital area should be examined, and these areas free of discharge. A rectal temperature should be taken. Rabbit body temperature is generally between 99-102^{o}F. The appearance of the droppings produced during the examination should be evaluated. Rabbit and rodent pellets should be well formed and moist. If the fecal component of the dropping is loose or watery, it is suggestive of a diarrhea. Changes in fecal color can also suggest a gastrointestinal abnormality.

Diagnostic testing

A complete blood count and plasma chemistry analysis should be done to assess the physiologic status of the rabbit or rodent patient. Inflammatory leukograms are frequent findings in animals with gastrointestinal disease, and are characterized by a heterophilia/neutrophilia and monocytosis. Anemia is also a frequent finding in chronic cases of gastrointestinal disease. Alterations in the enzymes, electrolytes, and proteins may be observed in animals with gastrointestinal disease. Survey radiographs can be used to assess the gastrointestinal tract. When the gastrointestinal tract of these animals becomes static, ileus will become evident. Microbiological culture should be done to isolate a specific pathogen, and an antimicrobial sensitivity assay performed to determine the most appropriate antibiotic for the case. A fecal examination should be done to rule-out parasitism and bacterial infections. Endoscopy can also be used to evaluate the gastrointestinal tract.

Bacterial diseases

Bacterial diseases are one of the most common causes of gastrointestinal disease in rabbits and rodents. The majority of the isolates recovered from animals with diarrhea are opportunistic Gram-negative bacteria, although certain Gram positive bacteria (*Clostridium* spp.) can also cause issues. Many of these isolates are typically found in the animal's environment. An antimicrobial sensitivity assay should be performed on the isolate to determine the most appropriate antibiotic. A fluroquinolone or potentiated sulfa may be used as a first order antibiotic while the sensitivity assay is pending. Penicillins and cephalosporins should never be given orally to rodents and rabbits.

Gastric stasis

Gastric stasis is a common finding in captive rodents and rabbits. Animals that develop gastric stasis may do so as a result of ingesting fur or another obstructive material (e.g., carpet) or as a result of some other medical gastrointestinal slow down. Fur ingestion may be accidental, which is thought to occur as a method to increase dietary fiber, or purposeful, as a result of nest building or barbering. Rabbits and rodents that present with trichobezoars may be anorectic, depressed and lethargic. Often these animals have a "doughy" abdomen. A firm mass can often be palpated in the stomach. Survey radiographs can be used to confirm the presence of hair in the stomach. In most cases the history will be that the animal has been anorectic, but their will be apparent ingesta (the fur) in the stomach. In many cases, ileus occurs secondarily to the trichobezoar. These cases can be treated medically or surgically. Medical management should consist of re-hydrating the animal and re-stimulating the gastrointestinal tract. Any fluid imbalances should be corrected first. Motility enhancers should not be used if an obstructive trichobezoar is suspected. Antimicrobials should be used if

enteritis develops. Mineral oil can also be used to assist in the passage of the trichobezoar. Surgical removal of a trichobezoar should be attempted if medical management is unsuccessful.

Parasites

Protozoal parasites (e.g., coccidian) are the most common endoparasites encountered in rodents and rabbits in the author's practice. Although coccidians are generally considered self-limiting in mammals, they do not appear to be in rabbits. *Eimeria* is the most common genera encountered. Diagnosis can be made from direct saline smears. Treatment can generally be accomplished using appropriate anti-coccidiocides such as ponazuril. The most common nematodes encountered in captive rabbits and rodents are pinworms. These parasites are considered by many to be commensals. The author generally recommends treating animals with pinworms when burdens appear heavy or it is a breeding operation.

Neoplastic diseases

Gastrointestinal neoplasia is an infrequent finding in rabbits and rodents. Neoplasia should always be considered in a differential diagnosis when an undetermined mass is associated with the gastrointestinal tract. Diagnosis is generally made using hematology, radiography, and biopsy/histopathology. Management of neoplasia in rabbits and rodents is dependent on the type of neoplasia.

Ornamental Fish 101:
Managing Pet Fish without Getting All Wet

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

There are two ways to approach a disease issue in fish: 1) ante-mortem tests and 2) post-mortem tests. Ante-mortem tests, or those done on live fish, are done when the aquarist is interested in saving a particular fish. The aquarist may pursue this route because of either personal (yes, the human-animal bond does occur with non-furry animals!) or financial (e.g., valuable breeding animal) reasons. Post-mortem tests, or those done on dead animals, are pursued when the aquarist is interested in saving a group of fish. A necropsy (animal form of an autopsy) can provide a great deal of insight into the disease condition of a particular fish, and therefore the population of animals that it originates from. The purpose of this presentation is to review the common diagnostic tests used to assess the disease status of a fish.

There are a number of different reasons that fish develop disease, including poor water quality, inappropriate husbandry, nutritional deficiencies, infectious disease (e.g., bacteria, viral, fungal), and parasitic disease. To determine which of these etiologies is responsible for disease in a particular fish (or fishes), diagnostic testing is required. Although the concept of performing these tests may appear overwhelming, with practice, diagnosing disease can become second nature.

The most common ante-mortem tests performed on fish are gill biopsies, skin scrapes, fin biopsies, complete blood counts, cultures, and fecal direct smears. Selecting which test to perform should be based on the clinical signs of the fish. Dyspnea (rapid breathing) in fish is suggestive of gill disease, and a gill biopsy would be appropriate. Lesions found on the skin (e.g., excessive mucous production) or fins (e.g., erosions) may be suggestive of infectious or parasitic disease, and a skin scrape or fin biopsy would be appropriate. Fish that are depressed, anorectic (not eating), or thin (muscle wasting) may have an internal disease (e.g., infectious or parasitic disease). A bacterial culture can be done to identify a specific bacterial pathogen. An antibiotic sensitivity profile can also be done to determine which antibiotic is best suited for eliminating the infection. A complete blood count can be used to interpret the animal's overall well-being or a fecal exam can be used to assess the potential for internal parasites. All of these tests can be done on alert or anesthetized animals, although the author prefers to anesthetize animals for the procedures. Tricaine methane sulfonate (MS-222; Argent Laboratories, Redmond, WA 98052)(100-200 mg/L) is the preferred anesthetic for anesthetizing fish.

Gill biopsies (clips) are an excellent method for assessing the quality of the gills. Teleosts, or bony fish, have 4 pairs of gills. The gills reside in the protective buccopharyngeal chamber under the operculum (gill cover). At the microscopic level, the gills can be divided into the primary and secondary lamellae. The primary lamellae represent the individual gill filaments that can be observed with the naked eye, while the secondary lamellae are comprised of a single layer of epithelial and endothelial cells and line the primary lamellae. The secondary lamellae are the site for gas exchange (e.g., oxygen absorption and carbon dioxide off-loading) and the excretion of wastes (e.g., ammonia). The surface area of the gills is vast, and allows for the rapid movement of water across the gill surface. Any damage to the gills can decrease the surface area associated with the secondary lamellae, and lead to dyspnea and death. Elevated levels of chlorine, ammonia, and nitrite, along with infectious and parasitic diseases, are the most common causes of gill disease in ornamental fish. To confirm which of these problems is associated with a specific case, diagnostic tests, such as a gill biopsy, should be done. If ammonia, nitrite or chlorine toxicity is suspected, than a water test should be done too. Elevated levels of any of these toxins, in combination with microscopic changes in the gills (e.g., excessive mucous production and a loss of respiratory surface area), are diagnostic. The presence of infectious (e.g., bacterial or fungal) or parasitic diseases with abnormal gills is also diagnostic. Once a diagnosis is made, an appropriate treatment plan can be devised. For example, water changes can be made to reduce the toxicity associated with ammonia or nitrite, sodium thiosulfate used to dechlorinate water, or an appropriate antibiotic or anti-parasitic given to treat infectious or parasitic agents.

A gill biopsy can be collected from an anesthetized or alert fish; however, the author performs this procedure on anesthetized patients. When handling fish it is best to wear latex exam gloves to minimize the likelihood of traumatizing the skin of the fish. The integument of fish is an important component of their innate (natural) immune system. Any damage to the skin can lead to an increased likelihood of opportunistic pathogens invading a fish. The gloves should also be moistened with the water from the animal's aquarium. The fish should be netted and removed from the aquarium. The thumb of your non-dominant hand should be inserted under the operculum, and the operculum raised slightly. Once elevated, a fine pair of scissors can be inserted under the operculum to collect the gill biopsy. A small cutting (4) of primary lamellae should be collected. A small amount of bleeding may occur, but generally ceases within seconds. The gill sample should be placed onto a glass microscope slide, a drop of water from the animal's aquarium placed on the sample, and a coverslip added to protect the sample. Water from the aquarium is preferred because it is isotonic (balanced) for any pathogens found on the gill. Adding water from another source that is not balanced can lead to the death of the organism and an inability to make a diagnosis. The sample should be reviewed immediately after collection to ensure best results.

A skin scrape should be done in cases where a fish has lesions on the skin. The skin scrape can be used to identify infectious or parasitic organisms. A glass microscope slide can be used to collect the sample. The slide should be held at a 45^{o} angle and drawn in a cranial to caudal direction (e.g., from head to tail). The sample should be placed on a second microscope slide, mixed with a drop of water from the aquarium, and covered with a coverslip. Again, the sample should be read immediately for best results. If bacteria are a concern, than a Gram stain or Diff-quik stain can be done to evaluate the types of bacteria present. To prepare these slides, the sample and drop of water are mixed, the sample heat fixed using a match or lighter, and the sample stained according to the manufacturer's recommendation.

A fin biopsy should be considered in cases where lesions are found on the fins. Many times these lesions are associated with a bacterial, fungal or parasitic infection. A fine pair of scissors should be used to collect the sample. If the sample can be collected between fin rays, that is preferred; however, this is not always possible, and the fin will regenerate. The sample should be handled in a similar fashion to the skin scrape, and either be placed on a slide with a coverslip or stained.

Fecal exams for parasites can be done on free-catch samples (e.g., found in the tank) or via enema. The samples should be placed on a slide with a drop of water and a coverslip and reviewed.

Post-mortem examinations should always be performed immediately after the fish has expired. Autolysis, or tissue disintegration, can occur rapidly in fish, and can severely limit the value of a necropsy. Fish that have been dead in the water for even a couple hours, depending on the water conditions and temperature, may have limited value. Therefore, it is important to perform the procedure as soon as possible after death. In cases where this is not possible, the animal should be stored in a refrigerator in an air tight bag. Freezing a fish can lead to tissue crystallization and eventual autolysis with thawing and is not recommended. Storing a fish in water is also not recommended, again, because of the potential for autolysis.

A fish post-mortem can be divided into two major parts: the gross examination and the microscopic examination. The gross examination will provide a significant amount of information; however, this is not generally diagnostic. The microscopic examination requires a review of the tissues under a light microscope. This aspect of the post-mortem examination generally requires the assistance of a veterinary pathologist. Veterinarians interested in submitting samples can find individuals capable of reviewing a case by searching the internet or local/state diagnostic laboratory. The author sends his samples to Dr. Michael Garner at Northwest ZooPath (www.zoopath.com).

When performing a necropsy on a fish, it is important to protect yourself against potential zoonotic diseases (e.g., those diseases that can be transmitted from animals to humans). The author highly recommends wearing latex exam gloves (or nitrile gloves for those with allergies to latex) when performing a necropsy. There are a number of bacterial and fungal fish diseases that can cause localized or even systemic diseases in humans. The cuts and scrapes we have on our hands can serve as excellent sites of entry for these pathogens, and thus the reason gloves are important.

The gross post-mortem examination will be the primary focus of this article, as the histologic examination is beyond the scope of this article. The post-mortem examination should start with an external examination of the fish. The general appearance of the fish should be closely inspected. How is the muscling? Is the animal thin? This can usually be determined by evaluating the large (epaxial) muscles along the spine. Animals with chronic disease typically lose muscle in an attempt to generate energy to defend against an infectious disease (e.g., mycobacteriosis). Are there erosions or ulcers on the skin? How large are they? Are they full thickness (e.g., can you see the underlying muscles)? These types of lesions may be indicative of aggressive bacterial infections that may be contagious to other fishes (e.g., *Aeromonas* spp.). A close external examination can provide a significant amount of insight into the health status of the animal. Not fully evaluating the fish can result in misdiagnosis. Once the external examination is completed, a thorough internal examination should be done.

Prior to opening the coelomic cavity (abdomen), it is important to evaluate the oral cavity and gills. The operculum should be removed and the gross appearance of the gills recorded. If the fish is only recently expired, they should remain moist and red. If the fish has been expired for an extended period of time, then they may appear deteriorated. Excessive mucous production or a loss of color is suggestive of disease. A clip of the gills can be taken and reviewed (unstained) under a light microscope to identify potential pathogens.

The author prefers to open the fish on the left side for the internal examination, as it provides better access to the spleen. The initial incision should be made on the ventral surface of the fish, cranial (in front of) to the anus. The incision should then be extended cranially to the level of the operculum. The incision should then be extended dorsally towards the spine. At this point, the incision can be extended caudally towards the tail, parallel to the spine. Finally, the incision can be extended ventrally back to the level of the initial incision. Once the incision is completed, the entire lateral aspect of the body wall can be removed. With the body wall removed, it will be possible to visualize the internal organs. With over 20,000 different teleosts, it is impossible to describe the variation in organ position, size, color, and texture in a single article. For the most part, these things are similar, but you can expect to be stumped on occasion. provide a review of the general locations of these organs in two different species of cichlids. For a more complete review of fish anatomy, the readers are directed to Michael Stosskopf's Fish Medicine (1992, W. B. Saunders Publishing). With time

and practice, a veterinarian can become quite adept at identifying organs and knowing what looks normal and what looks abnormal. The gross examination of the organs can certainly provide some insight into the health status of the animal, but is generally limited without histopathology (microscopic review of the tissues). Again, this is when submitting samples to a pathologist can prove invaluable. For example, the gills of a fish may appear grossly abnormal, but it would require histopathology to confirm the presence of a mycobacteriosis.

To truly characterize a specific cause of disease in a fish or a group of fish, diagnostic tests must be performed. For many veterinarians, the idea of performing these tests may be daunting; however, with practice any veterinarian can become proficient at performing and interpreting these tests.

What's Your Diagnosis?
Interactive Exotic Small Mammal Cases

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Veterinarians working with reptiles and exotic mammal patients are routinely presented with challenging cases. The purpose of this presentation is to provide attendees with a series of actual reptile and exotic mammal cases in an interactive forum and discuss different diagnostic and treatment approaches.

A thorough physical examination should be performed on every reptile and exotic mammal patient. If the animal presents in respiratory distress, the physical examination should be postponed until the animal is stabilized. Placing the animal into an oxygen chamber or delivering oxygen via a facemask or endotracheal tube should be done to reduce the likelihood of hypoxia in the animal. The physical examination can be used to develop an initial prognosis regarding the case. Veterinarians must be realistic when considering the potential outcome for a case.

Diagnostic tests can be invaluable in confirming a specific etiology associated with a case. A complete blood count (CBC) can be used to evaluate the likelihood of an inflammatory response within the animal. In general, reptile and exotic mammal cases presenting with white blood cell counts (WBC) > 15-20,000 cells/ml are the result of an inflammatory response. However, stress leukograms can occur in animals with WBC counts in this range too; therefore, it is imperative that a differential count be done to determine the most likely cause of a leukocytosis. With stress, neutrophilia (heteroplhilia), monocytosis, lymphopenia and eosinopenia are common. In general, inflammatory leukograms are characterized by neutrophilia (heterophilia), monocytosis, and a lymphocytosis. Inflammatory leukograms can occur as a result of an infectious disease, toxin, neoplasia, trauma, or foreign body. In many cases, veterinarians attempt to associate inflammatory leukograms with an infectious etiology, when the etiology may not be infectious. The CBC also provides information regarding the erythron. If anemia is suspected, then attempts to classify the anemia (regenerative, non-regenerative) should be made.

Reptile and exotic mammal patients are stoic animals that can mask their illness. Serum/plasma biochemistry analysis can be used to evaluate physiologic disturbances in these animals. Veterinarians may find it difficult to find reference data for many of the species being presented to their facilities. Fortunately, the values for many of the biochemistries are similar to those described for domestic species. Veterinarians should become familiar with the physiologic differences between different reptile and exotic small mammals (e.g., herbivorous rabbits versus carnivorous ferrets) to help with interpreting results.

Radiographs are necessary to characterize the extent of injury associated with a fracture. When evaluating a fracture, it is important to consider which bone is affected, the location of the fracture (e.g., metaphysis, epiphysis, diaphysis), type of fracture (e.g., transverse, spiral, oblique), whether the fracture is open or closed, and whether there is soft-tissue and joint involvement. Evaluating the extent of soft-tissue injury associated with a fracture is necessary to estimate the convalescence period that will be required for the patient. A minimum of two high-quality images is required to fully evaluate an injury. Radiographs can also be used to evaluate the extent of disease associated with non-traumatic injuries too. Ultrasound imaging may also be used to assess the exotic pet patient. The author finds ultrasound especially useful for characterizing the reproductive status of animals.

Microbiological culture is an important diagnostic tool for veterinarians. Historically, veterinarians managed most infectious diseases as a primary bacterial disease. We now realize that bacterial infections, at least in some cases, are secondary opportunists that occur following viral and fungal infections. When submitting microbiological samples it is important to consider not only bacterial microbes, but fungi too. Performing a cytological examination prior to submitting a sample is strongly recommended, and may be useful in guiding a diagnostic laboratory.

The advancement of serological and molecular diagnostic assays has improved the veterinarian's chances of making an ante-mortem diagnosis for an infectious disease. Currently, hemagglutination inhibition (HI) assays are available to characterize exposure to a variety of viral pathogens. Because these assays are subject to misclassification, other more specific assays should be pursued to characterize specific viruses. Enzyme-linked immunosorbent assays and serum neutralization assays are considered more sensitive and specific then HI assays. When using serological assays, serial tests are necessary to characterize active infections. Polymerase chain reaction-based assays enable veterinarians to characterize active infections in exotic pet patients.

Necropsy, and subsequent histopathology, is often necessary to confirm a diagnosis in a case. This is especially important in the face of an epizootic. Veterinarians should take appropriate precautions when performing a necropsy on an exotic pet patient. Because many infectious diseases can be transmitted via aerosolization, necropsy should be performed under a negative pressure hood. Veterinarians should submit samples to a pathologist that is familiar with exotic pet pathology.

Success with exotic pet cases requires a thorough and well thought out diagnostic plan. Historically, exotic pet cases were approached by performing few diagnostics and administering empirical therapeutics. By practicing the same good standard-of- care expected for domestic pets, veterinarians will find improved success with their exotic pet cases.

Diagnostic Imaging in Reptiles: Am I Supposed to See That?

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Diagnostic imaging is an underutilized resource in herpetological medicine. Survey radiographs and ultrasound can be used to evaluate many different systems simultaneously, and provide insight into possible problems in a case. To be successful with diagnostic imaging, veterinarians need to acquire a basic knowledge of anatomy regarding the species of interest, methods used to restrain reptiles to collect the images, and the most appropriate techniques used to collect and interpret the results.

There are a variety of resources available to the veterinarian that is trying to learn more about reptile diagnostic imaging. Mader's Reptile Medicine and Surgery (Elsevier/Saunders, 2006) provides an excellent review on the subject. Expert opinions can be obtained either via phone consults or via the internet (e.g., Veterinary Information Network). There are also board certified radiologists that offer consultation services. Regardless of the source, veterinarians have many options when attempting to interpret the findings of a diagnostic image

With over 9,000 different species of reptiles, it is impossible to become comfortable with the anatomic peculiarities of all the reptiles. Fortunately, reptile anatomy is highly conserved among the orders. For simplicity, the reptiles can be categorized into one of four groups: chelonians, lizards, snakes, and crocodilians. The tuatara is not mentioned because it is not considered a common captive reptile. Reptile morphology texts are excellent resources for learning the anatomy of these animals. Short descriptions can also be found in Reptile Medicine and Surgery (Mader, Elsevier/Saunders, 2006) and Clinical Anatomy and Physiology of Exotic Species (O'Malley, Elsevier/Saunders, 2005).

The quality of the equipment used to take radiographs is an important consideration. A radiographic machine to be used for reptiles should be capable of a taking a range of images, which might include day geckos (*Phelsuma* spp.) to varanids (komodo dragons, *Varanus komodoensis*). A machine capable of such a range should have a short exposure time. $1/60^{th}$ of a second or shorter is recommended. The machine should also have a high milliamperes capacity (>300). This is important because of the variability in detail that might be expected among different sized animals. The killivolt peak range should also be large, 40-100 killivolt peak, to accommodate the different sized patients a veterinarian may encounter. The ability to alter the killivolt peak by small increments (e.g., 2 killivolt peak) is important because it will enable the veterinarian to review small details between images. A machine in which the tube can be rotated to provide a horizontal beam is preferred. This will enable the veterinarian to take lateral images on animals in sternal recumbency. This is especially important with large chelonians.

For small patient, dental radiograph machines can be used. The author has used this type of equipment to take "whole body" radiographs of small lizards (e.g., juvenile bearded dragons). The detail from these images, although not always refined, does provide more detail than standard films.

Selecting the correct type of cassette or film is as important as using the correct machine. High-detail, rare earth cassettes are preferred. These cassettes should be used in combination with slow speed, single emulsion (gray) films. This combination provides the best detail for small lizards. Double emulsion (black) films can be used for larger reptiles when small detail is not required. Selecting the correct size cassette and film combination is also an important consideration.

When taking radiographs it is important to always collect at least two images. The most common images are a lateral and dorsoventral or ventrodorsal image. These two, two-dimensional images will provide the most insight into interpreting the anatomy of a three-dimensional reptile. Care should be taken when positioning an animal to ensure that the area of interest can be evaluated.

A reptile must be still to collect the "perfect" image. Taking radiographs on un-anesthetized or restrained reptiles can lead to motion and a loss of detail. The author has found that reptiles can be restrained manually for images or anesthetized. Manual restraint does result in increased radiation exposure for the handlers, so it should be kept to a minimum. Placing blinders over the eyes of a lizard can also be done to minimize movement. The author has found this technique to work well with iguanas, bearded dragons, and varanids. An ophthalmic eye lube is placed in the eyes of the animal and the head is wrapped with vet-wrap (3M products, St. Paul, MN). Dimming the lights and minimizing human movement and speaking in the room will also help reduce the stimuli on the reptile.

Interpreting reptile radiographs is more challenging than in mammals or birds. Lizards do not store their fat in a mesentery like mammals. This absence of fat between the internal organs reduces the contrast between the tissues, leading the viscera to appear as a single soft tissue structure. The absence of a diaphragm also limits the radiographic interpretation of the coelomic structures. The bone of reptiles is less radio opaque than mammals, which can make the interpretation of the cortical densities more difficult. To reduce the likelihood of misclassifying a case of secondary nutritional hyperparathyroidism, the author always evaluates the cortical densities of the long bones instead of the digits. The best way to become comfortable with interpreting radiographs is to practice, practice, and practice.

As veterinarians have become more familiar with ultrasonography, its application in reptile medicine has greatly expanded. When considering an ultrasound machine for a veterinary hospital, it is important to consider the range of patients the machine will be used on. If exotic species are going to be regularly screened using ultrasound, a machine with a fine transducer is recommended. The author has found that 7.5 and 10.0 mHz transducers are generally best for evaluating reptiles; however, 3 and 5-mHz transducers have also been used in larger species. One of the problems with using these lower mHz transducers is the loss of detail associated with upper surface lesions. Because of the relative small size of many of our reptile patients, the author also prefers the transducer to have a small footprint.

Capturing a high detail ultrasound image requires intimate contact between the transducer and the animal. There are two different methods for obtaining high quality ultrasound images: direct contact via a non-irritating coupling gel or direct/non-direct contact via an aquatic medium (e.g., water). Coupling gel is the most common method used for collecting ultrasound images in mammals. In reptiles, this technique can also be used, but it is important to spread the gel between the scales to reduce the loss of detail associated with trapped air bubbles. The transducer can also be placed against a water-filled examination glove that is directed against the reptile's body. This method is the least productive in the author's opinion. Another technique that many reptiles are tolerant of involves placing the animal and the transducer into water. The water acts as an excellent contact medium. The author works with a number of herpetoculturists that use this method for assessing the reproductive status of their reptiles.

Ultrasound can be used to evaluate any number of systems in a reptile. This diagnostic technique is primarily used by the author to assess the reproductive status of reptiles. Follicles can be measured to predict whether an animal is likely to ovulate. For some species this information can be used to determine the best time for introducing a male and female. Images of the ovaries are best obtained by placing the transducer on the lateral body wall just caudal to the last rib. Each ovary should be evaluated individually, as one gonad may be active while the other is not.

Ultrasound can also be used to evaluate the heart of reptiles. The heart of most lizards is located in the pectoral girdle, with varanids being an exception. Their heart is located more caudally in the body cavity. The snake heart is located approximately 1/3 the distance from the head. The chelonian heart is located dorsal to the thoracic scutes of the plastron. Access to the heart with ultrasound can be obtained via the axillary region in lizards and chelonians, and direct placement over the beating heart of a snake. Lizards, snakes, and chelonians have a three-chambered heart, while crocodilians are the only reptiles with a four-chambered heart. Rotating the transducer should enable the ultrasonographer to evaluate all three (or four) chambers.

Ultrasound can also be used to evaluate the viscera in the caudal coelomic cavity. The author generally uses ultrasound to assist with the collection of fine-needle aspirates or biopsies of different coelomic organs. Kidney disease is a common problem in captive, adult green iguanas. Iguana kidneys are located in the intra-pelvic canal in normal animals, but enter the coelomic cavity when enlarged. Ultrasound can be used to collect a percutaneous biopsy of these organs without the need for an exploratory coeliotomy.

Burned! Ultraviolet B Radiation for Exotic Pets: The Good, the Bad, and the Photokeratitis

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Because the majority of exotic pets are being housed indoors, it is important that they are provided lighting that mimics natural light. In addition to the provision of light, the amount of light provided in captivity should also mimic natural patterns. Photoperiods in the wild are generally between 12-15 hours a day, depending on season. To have success with exotic pets in captivity, it is important that we make recommendations to our clients that can ensure their long term success with their pets/breeding animals. The purpose of this presentation is to provide attendees an overview of the different types of lighting available for exotic pets held indoors, and how we can best use these lighting systems to provide the best captive environment for our patients.

Artificial lighting is provided in two different forms: incandescent and fluorescent lighting. Many of us are familiar with the standard forms of these lighting types, although there are some exceptions we may be less familiar with. One of the confusing aspects of lighting comes when manufacturers make claims about their light bulbs that are not true. The following review is meant to help clarify any misconceptions regarding the different types of lights.

Incandescent lighting is represented by the standard screw-in light bulb. This type of light has dominated the lighting scene for the provision of light in standard lighting fixtures in human domiciles. This type of light can generate a great deal of heat, especially at higher wattages, and requires a large amount of energy to run. There is a current movement to replace these bulbs for the more energy conserving fluorescent coli bulbs. The primary benefits associated with the incandescent bulbs are that they are inexpensive, can be used to generate heat, and can be made in different colors (e.g., red, black green, clear) and lighting spectrums (e.g., black light). To the author, incandescent lighting remains the best method for providing and regulating the environmental temperature within an exotic pet's enclosure. Incandescent lighting, with few exceptions, functions to provide visible light and infrared light (or heat). Although many manufacturers make a claim that their infrared lights are "full-spectrum" and can provide ultraviolet B radiation, it is not true. Two exceptions are the black lights and mercury vapor bulbs. Black lights do produce ultraviolet radiation, but it is not in the spectrum considered important for the photochemical stimulation of vitamin D. Some mercury vapor bulbs do provide ultraviolet B radiation within this spectrum, as well as heat. Actually, many of the mercury vapor bulbs can produce a significant amount of heat, making them only ideal for large vivariums.

Fluorescent light bulbs are sold in two forms, the original tube style and the more recent coiled screw-in type. Historically, when people discussed "full spectrum" light bulbs they were talking about the fluorescent tube light bulbs. The first to be sold as "full-spectrum", the Vita-light, was popular among hobbyists. It wasn't until later that research showed that this bulb did not produce an appreciable amount of ultraviolet B radiation in the appropriate range. This is an important point to consider, as there are a number of different manufacturers offering these bulbs and making claims regarding their value. It is important to research the bulbs prior to making the recommendations. The more recent coiled fluorescent bulbs appear to have the potential to produce even higher amounts of ultraviolet B radiation (in the appropriate range) than the tube bulbs. Again, the bulbs that can do this are specifically manufactured to do so. A fluorescent coli bulb from the local hardware store is not the same bulb as one produced specifically for reptile enclosures. The primary advantages associated with these bulbs is that they can provide ultraviolet B radiation in the appropriate range (290-310 nanometers) and provide high quality visible light. The primary disadvantages are that these bulbs produce little heat, requiring an additional bulb to generate infrared light heat, and can be expensive.

Ultraviolet light is produced by electromagnetic radiation. The wavelengths for ultraviolet radiation are shorter than those for visible and infrared light. Ultraviolet radiation is generally discussed in relation to those categories important to vertebrates: Ultraviolet A, B, and C. Ultraviolet C radiation represents the shortest wavelengths of the three classes (<280 nanometers). This range of ultraviolet radiation is germicidal, and is commonly used to control pathogens in aquatic systems. Ultraviolet B radiation provides the medium range ultraviolet radiation (280-315 nanometers). Ultraviolet A radiation represents the longest rays of the group and is characterized as "black light" (> 315-380 nanometers). Ultraviolet B radiation represents the range considered important in the synthesis of vitamin D3. Vitamin D3 is an essential hormone that plays many different important physiologic roles. Its role in calcium metabolism is probably its most recognized function, where it helps to ensure the development and maintenance of healthy bones. In some exotic pets, maintaining appropriate levels of vitamin D3 has also been found to be associated with increased reproductive success. Ultraviolet C is not generally discussed at any great extent, although it is considered important in regulating behavior in vertebrates.

There are two primary methods for obtaining vitamin D3: synthesizing it from exposure to ultraviolet B radiation or consuming a vertebrate that has synthesized the hormone through exposure to the sun. The production of vitamin D occurs as a result of the photosynthetic conversion of 7-dehydrocholesterol to pre-vitamin D3. Pre-vitamin D3 is converted to vitamin D3 via a temperature

dependent process. At this stage the hormone is transported to the liver where it is hydroxylated to 25-hydroxyvitamin D3. The kidneys serve as the site for the final conversion of the hormone to 1, 25-hydroxyvitamin D3, which represents the active form.

Vitamin D is considered important in vertebrates because it plays many different roles in the body. Because captive exotic pets are generally maintained indoors and derive no unobstructed sunlight, the use of "full spectrum" lighting has become an important consideration for ensuring that captive, non-carnivorous species can obtain vitamin D3. Until recently, studies evaluating the importance of full spectrum lighting in exotic pets have been limited to species of lizards. However, recently published original research from the author's laboratory has shown that 25-hydroxyvitamin D levels in a snake, Elaphe guttata, and chelonian, Trachemys scripta elegans, could be significantly increased after exposure to appropriate full spectrum lighting. Similarly, research evaluating these lights in rabbits and rodents has shown similar results. It has generally been accepted that these animals obtain their vitamin D through their diet; however, the results of these studies suggest that in these species, they can generate endogenous vitamin D, like humans, from direct stimulation to appropriate artificial lighting. Coiled fluorescent screw-in light bulbs were used for the study. The bulbs were placed within 6-9 inches of the study animal's basking spot. The findings of these studies confirm the importance of using full spectrum lighting for captive exotic pets.

When making recommendations regarding lighting that provides good quality ultraviolet B radiation it is important to recognize that not all bulbs are created equal. Although "full-spectrum" lights may appear similar, they can produce vastly different quantities of ultraviolet B radiation. To confirm the quantity of ultraviolet B radiation being produced by a bulb, it is important to measure the intensity of the radiation using an appropriate radiometer/photometer. The distance the bulb is placed to a basking reptile can also have an effect on the quantity and intensity of light reaching an animal. "Full-spectrum" lights should not be shown through glass, as it can defract the ultraviolet B radiation away from the pet. Historically, only fluorescent tube light bulbs produced any significant quantity of ultraviolet B radiation; however, some coiled fluorescent bulbs and mercury vapor bulbs can also produce appropriate to high levels of ultraviolet B radiation.

Visible light

Visible light is provided in the mid-light spectrum. The quality of visible light provided by different bulbs can vary. Some light bulbs provide poor-quality visible light across the color spectrum. In these cases, the light within the enclosure may have a "yellow" quality and the vibrant colors of the pet won't be apparent. Many exotic pets require high-quality visible light to identify the colors of foods, predators, and potential mates, among other things. Color rendering index is an important parameter to evaluate in the light bulbs. Fluorescent bulbs generally provide the best visible light. Most of the high quality "full spectrum" fluorescent tube and coil bulbs available through the pet trade provide good quality visible light.

Infrared light

Infrared radiation is in the upper end of the light spectrum, and the area in which heat is generated. Although there are a variety of different heating elements for exotic pet enclosures, the author prefers to use radiant heat sources in the form of light. This is the most natural method of providing heat to exotic pets, and mimics the primary method they absorb heat in the wild. It is possible to use variable wattage incandescent bulbs to provide a gradient of temperature for a pet's enclosure. The wattage for the bulbs will vary depending on the size and depth of the enclosure.

Conclusions

Artificial light is an important consideration for captive exotic pets being held indoors. It is important to use high quality light bulbs that meet the animal's needs across all three forms of the light spectrum, including ultraviolet, visible and infrared radiation. The provision of high quality light will help to ensure our client's success with their pet.

Ring the Bell, Dinner's Served: Nutritional Considerations for Captive Reptiles

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Reptiles may be herbivorous, omnivorous, or carnivorous, depending on the species. An ideal diet for captive reptiles should mimic their natural diet as closely as possible and provide a diversified selection of food. Some herbivorous species will often readily eat an omnivorous diet, but eventually these animals will reveal signs of nutritional deficiencies. Therefore, it is important to remember that food preferences do not always correlate with appropriate nutrition.

Herbivorous reptiles

Herbivorous reptiles are primarily classified as hind-gut fermenters, with microbial fermentation occurring in the large intestine. Consequently, the bulk of the diet of herbivorous reptiles should be vegetable fiber. The vegetable fiber offered should be rich in vitamins A and D3 and should have more available calcium than phosphorous. An ideal Ca:P ratio of at least 1.5-2:1 should be present. The diet should also be low in fats, oils, proteins, thiocyanates, and oxylates. In captivity, reptiles are typically fed weeds, flowers, and grasses on a daily basis. Herbivorous reptiles housed outdoors will forage for themselves if provided with an appropriately planted enclosure, but additional food is usually required. It is important to periodically peruse the yard and rule-out the presence of any poisonous plants. A variety of foods should be offered and can be mixed with calcium, iodine, vitamin D3, and vitamin A supplementation. It is important to remember that grocery greens are generally higher in protein and lower in fiber and may have an inverse calcium: phosphorus ratio when compared to natural forage. Spinach, cabbage, and beet greens should not be fed in excess due to their high oxylate content. The majority of foods designed for dogs, cats, humans, and other mammals should not be fed to herbivorous reptiles. Debilitated herbivorous reptiles requiring force-feeding or tube-feedings should be fed a critical care diet designed for their specific needs.

Omnivorous reptiles

It has been suggested that omnivorous reptiles do best when offered plant and animal matter in proportions that range from 75:25 to 90:10. Dietary requirements in these species tend to change with age, with most juveniles requiring a diet comprised of a higher proportion of animal matter. As the juveniles mature, their dietary requirements shift to a more herbivorous diet. The primary animal proteins offered should mimic a natural diet, including earthworms, slugs, snails, millipedes, pupae, and maggots (mealworms). It is essential to monitor the diets of captive invertebrates in order to avoid nutritional deficiencies in the reptiles eating them. Offering the invertebrates a diet rich in minerals and vitamins will help to ensure that the prey is "gut-loaded". Mammalian diets should generally be avoided as they may be too potent (e.g., excess protein and vitamins) for a reptile. Liver and yellow or dark orange colored vegetables (squash, carrots, sweet potatoes) are excellent sources of vitamin A, and Swiss chard, kale, beet greens, escarole, parsley, watercress, and green beans all have a positive Ca:P ratio.

Carnivorous reptiles

Carnivorous reptiles are generally the easiest group to provide food for in captivity, as there is a range of invertebrate and vertebrate prey species that can be offered. As was mentioned previously, however, those carnivores that specifically hunt invertebrates do need to have their prey species "gut-loaded". Most carnivorous aquatic species are piscivorous. If frozen fish are offered, then the diet needs to be supplemented with thiamine, as frozen-thawed fish can produce thiaminases.

Nutritional diseases

Nutritional disorders in reptiles commonly present as a chronic problem, and the diet is often times centered around limited food sources or human convenience. In most cases, deficient diets are comprised of limited numbers of food items and/or are not supplemented with calcium and vitamin powders.

Hypovitaminosis A

Vitamin A is a critical component in the production and maintenance of epithelial cells, and is also intimately associated with several structures related to vision. Hypovitaminosis A is a common clinical entity in reptile medicine, especially in chelonians fed predominately vitamin A deficient foods. The most obvious clinical abnormality associated with hypovitaminosis A is squamous metaplasia, which results in the degeneration of epithelial surfaces (e.g., conjunctiva, gingiva, pancreatic ducts, renal tubules, skin, and lung faveoli). Due to the multiple epithelial surfaces of the body, squamous metaplasia can manifest itself in several different ways. Blepharospasm, conjunctivitis, blepharoedema, blindness, rhinitis, blepharitis, lower respiratory tract disease (nasal discharge, depression, dyspnea, open-mouth breathing), and/or cutaneous abnormalities may be observed. Middle ear infections and aural

abscesses have also been linked with hypovitaminosis A. The diagnosis of hypovitaminosis A can be met via dietary history, clinical signs, measuring vitamin A levels, or histopathology of tissue samples (squamous metaplasia of the epithelia surfaces). Supportive treatment should be utilized concerning the clinical manifestations of vitamin A deficiency, and appropriate husbandry and dietary changes should be instituted. Vitamin A deficiency can be corrected by oral supplementation with vitamin A products, or by offering small amounts of liver once per week. Injectable vitamin A should be used very cautiously, as hypervitaminosis A can occur with a single injection.

Secondary nutritional hyperparathyroidism (metabolic bone disease)

Metabolic bone disease (MBD) is defined as any metabolic defect that alters the morphology and functioning of bones. MBD is usually related to low levels of calcium or excessive levels of phosphorus, which consequently bind to calcium and render it physiologically unavailable. Decreased calcium availability results in increased parathyroid activity and mobilization of stored calcium from the shell and bone cortices. Factors predisposing reptiles to the development of MBD include: dietary deficiency of calcium and/or suitable vitamin D3, inappropriate calcium: phosphorus ratio of the diet, lack of exposure to ultraviolet light (ultraviolet B radiation increases activation of vitamin D precursors and facilitates gastrointestinal absorption of calcium), dietary excess of protein during rapid growth periods, anorexia, or abnormal vitamin D3 metabolism secondary to renal, hepatic, intestinal, or parathyroid disease. MBD is commonly observed in rapidly growing juvenile reptiles and reproductively active females. Clinical signs consistent with MBD vary depending on the age and species of the patient. The most common clinical finding in reptiles with MBD include muscle tremors/fasiculations, seizures, soft-shell, pathologic fractures and acute death. A thorough history is required before a diagnosis of MBD can be met. Diagnostically, radiographs and blood work can provide insight into the reptile's disease state. Radiography may reveal fibrous osteodystrophy and pathologic fractures. Low blood calcium levels are highly suggestive of MBD, but calcium blood levels are frequently not low in cases of MBD because of hyperparathyroid activity. It must be remembered that blood levels of calcium are not reflective of physiologically available levels of calcium. Ionized levels of calcium are more indicative of the availability of calcium, but, unfortunately, published reference levels are difficult to find in the literature. Treatment of MBD is dependent upon the correction of inappropriate husbandry. An unsuitable calcium: phosphorus ratio of the diet should be corrected, the proper provision of ultraviolet light should be instituted, and oral supplementation of calcium and vitamin D3 should be initiated. Supplemental calcium during the treatment period is also strongly recommended.

Gout

Gout is defined as the deposition of uric acid and urate salts within visceral tissues and on articular surfaces. Gout occurs as a result of hyperuricemia, which arises secondary to increased production or decreased excretion of uric acid. Increased production of uric acid may occur secondary to the ingestion of excessive amounts of protein (e.g., an herbivorous chelonian that is regularly offered animal protein). Decreased excretion of uric acid may occur secondary to reduced perfusion of renal tissues, which may be a result of dehydration, hemoconcentration, water deprivation, or renal disease. Reduced glomerular filtration eventually leads to a decrease in the overall excretion of urate salts, which results in hyperuricemia. Hyperuricemia, in turn, leads to the precipitation of urate complex microcrystals within tissues. These deposits are known as "gout tophi". Common sites of deposition of uric acid include articular joints and viscera. Clinical signs associated with gout include joint swelling and pain, depression, and dehydration. Affected animals are also commonly anorectic and lethargic. The diagnosis of gout may be done with blood work and radiographs/ultrasound. The mainstay of therapy is rehydration to correct the hyperuricemia, and the correction of any dietary imbalances or other predisposing causes of gout. Allopurinol, a urease inhibitor, is commonly used in hyperuricemic animals to reduce uric acid production. It must be mentioned that studies concerning the efficacy of this drug and the possible long-term effects of the drug in reptiles have not be conducted. Probenecid, which increases the renal excretion of uric acid, should be not be used until the glomerular filtration rate is considered acceptable. Any concurrent infections in affected joints or organs that occur secondary to gout deposition should be treated appropriately. Surgery is occasionally indicated when uric acid deposits are compromising joints.

Modern Love-
Making Pets Happy at the Veterinary Hospital

Jonathan Bloom, DVM
Willowdale Animal Hospital
West Toronto, Ontario, Canada

Many pet owners fail to identify, and are reluctant to address, conditions such as dental disease and arthritis in their pet because they don't see the disease, and they don't appreciate the negative impact that it has on the body. In contrast, most pet owners are EXPERT at identifying fear and anxiety in their pets, and owners are very much aware of how a negative experience can impact both their pet's mental health and wellbeing. At a time when an overwhelming number of pet owners are citing stress and anxiety among the top reasons for reluctance to visit the veterinary hospital, implementing strategies to maximize patient comfort is the most prudent way to earn back those declining pet visits they have been experiencing in recent years. Pet owners visiting my practice have been overwhelmingly accepting and appreciative of any effort to ease their pet's fear and anxiety, and that keeps them coming back. My staff have never been more eager to accept a fresh and innovative healthcare initiative in the past as they have been for FEAR FREE™. They realized that they are surrounded by calmer, happier, and more easily handled pets. As a result, staff satisfaction and staff morale have never been higher. The creation of a Fear Free™ philosophy and culture benefits pets, pet owners, hospital staff, pet healthcare, and the business as a whole.

Identifying fear and anxiety

As with any medical condition, a proper exam starts with a good history. Almost 50% of pet owners feel that their pet is fearful or anxious coming to the veterinary hospital. Intuitively, veterinary healthcare providers need to pay more attention to signs of fear during the hospital visit such as trembling, hiding, reluctance to enter the veterinary facility, vocalizing, and body position etc. But veterinary healthcare providers also need to be more proactive and inquire about fearful events at home such as car rides, thunderstorms, fear of strangers, loud noises such as construction, and interaction with other pets. Surprisingly, simply asking "does your pet ever experience fear or anxiety" is often sufficient. Drawing attention to visual cues such as pheromone diffusers etc. can also be a subtle and effective approach to entering into discussion about fear and anxiety. Finally, healthcare providers need to be more transparent. Removing a pet from an owner for outpatient treatments such as nail trims, vaccination, and blood collection etc., may sometimes need to be acknowledged as an attempt, on the part of the healthcare provider, to conceal the pet's fear and anxiety from its owner.

Delivering a calm pet to the hospital

Conceptually, the office call often starts 30 minutes before arrival at the hospital. The process of placing the pet into a carrier, or placing the pet into the car for travel to the veterinary hospital should be considered the beginning of the office call experience. Healthcare providers who wish to create a Fear Free™ experience must create a communication process and protocol that prepares both pet, and pet owners for travel to the hospital. Efforts must be made to make both carriers and travel a positive experience. Bringing carriers out of storage several days before the appointment and placing them in an area of the home frequented by the pet is a good start. Blankets or towels, pheromone sprays, placing treats in and around carriers are all examples of efforts that can be undertaken to optimize the pets travel experience. Desensitizing pets to car travel through carefully planned reward based training is also beneficial. Several conventional anti-anxiety pharmaceuticals (ie. Trazodone, Gabapentin, oral Buprenorphine) and natural products (L-Theanine, Alpha-casozepine, Tryptophan) exists for those pets that are most anxious. Finally, where medically appropriate, withholding food for several hours prior to travel to the hospital can both reduce nausea during travel, and set the stage for a very food motivated pet (and positive experience) during the office call.

Entering the veterinary hospital

Pets should be greeted immediately with food treats (when medically appropriate). Both body position and voice intonation should be considered when approaching all pets. Various strategies exist for keeping pets, and pet odours, separated during visits. Hospital foyers can be divided into dog areas and cat areas, or pets can be immediately ushered into exam rooms. Where possible, rooms should be dedicated as either dog or cat rooms. At this stage, music and pheromones (Adaptil, Feliway) can influence the appointment experience long before the healthcare providers even arrive. Accommodations should be considered for where best to examine the pet. Some pets prefer consultation rooms that have windows, while others prefer to have less visual stimulation. Some pets will have a better experience being examined on floors, others prefer elevated table tops, and some cats even prefer to be examined in the base of their carrier after the top has been removed.

Calming pets during examination and procedures

There are numerous products that can, and should, be used to ease the stress of examination, diagnostic procedures, and therapeutic procedures such as nail trim, blood and urine collection, x-ray etc. While some products have sound scientific research to explain their basis for success, the success of other products are based largely on theory or anecdotal reports and experience. Regardless, all these products have been used with success in case specific circumstances. Healthcare providers need to adopt an approach to Fear Free™ visits much the same as they approach other medical issues in pets. Some products work better in some individuals than others, and treatment plans need to be modified and developed based on the specific individual's needs and responses. Products such as Thundershirts, Clipnosis, distraction techniques, nutritional supplements, conventional pharmaceuticals, therapeutic lasers, and AirMuzzles have all been used successfully either individually, or in combination as a "multi-modal" approach to reducing fear and anxiety in pets.

Getting started

Creating a hospital visit that is free of fear and anxiety is not an event, it's a process. Healthcare providers must evaluate their facility and look for opportunities to create or modify existing facilities into areas that limit stress and anxiety during pet visits. Species specific exam rooms, attention to pet odours and sounds etc. are amongst some of the factors that require consideration.

Healthcare providers should also meet as a team and acknowledge and accept that pets and pet owners are often not happy to visit veterinary clinics. Look no further than pets owned by staff members, and it is likely that you will find cases of fear and anxiety amongst even that small sample population. A commitment by all the staff to create a culture and environment aimed at reducing fear and anxiety of pets visiting the hospital must be adopted by all members of the hospital team. Create a list of hospital protocols and procedures that pets sometimes associate with stress. Create communication and procedural strategies to address these issues both internally amongst staff, and more publically with clients. Introduce a variety of tools such as compression shirts, pharmaceuticals, nutraceuticals, low volume vaccines, pheromones, training with treats etc. and experiment with their use in a variety of circumstances. Many of these can be mixed and matched using a multi-modal Fear Free™ approach. Create a policy for recording success/failures in the medical record so each future visit can be reconsidered until the perfect visit is achieved. Share stories of success with each other. Have fun! When clients smile and show their gratitude for your efforts, when staff report calm working environments and more easily handled pets, when pets come running to greet you upon entering the hospital, when healthcare is optimized, and when revenues are increasing – you know you have successfully created a Fear Free™ culture at your hospital.

The Simple Tooth:
Feline Skull and Tooth Anatomy

Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

Skull anatomy

The skull can be divided into the fused bones of the calvarium, the upper jaw, and the lower jaw. The cranial portion of the calvarium consists of the paired frontal bones, which articulate cranially with the nasal bones and maxillae, and caudally with the parietal bones. The nasal cavity contains an ethmoid bone and is bordered dorsally by the incisive, nasal and frontal bones, laterally by the incisive, maxilla, lacrimal, frontal and palatine bones, ventrally by the incisive, maxilla, and palatine bones and caudally by a single vomer bone which lies ventral to the ethmoid and dorsal to the hard palate. The lateral surface of the frontal bone shapes the dorsomedial and caudal aspect of the orbit. The medial and ventral part of the orbit is completed by articulation of the frontal bone with the lacrimal, ethmoid, maxilla, presphenoid and palatine bones. The zygomatic bone forms the lateral boundary of the orbit. The temporal process of the zygomatic bone articulates with the zygomatic process of the temporal bone, forming the zygomatic arch. Caudal to the frontal bones and forming the caudal portion of the cranial vault are the paired parietal bones, which articulate caudally with the occipital bone. Ventrally, the parietal bone joins the temporal and basisphenoid bones.

The upper jaw includes the incisive, maxillary, and palatine bones. The paired incisive bones form approximately one-sixth of the hard palate, and three incisors are rooted in each incisive bone. The incisive bones are bordered dorsally by the nasal bones, caudally by the vomer bone and laterally and caudally by the maxillae. The maxillae extend to the caudal border of the hard palate laterally, but are joined medially by the paired palatine bones to complete the hard palate. The roots of the canine tooth, three premolar teeth, and a single molar tooth are embedded within the alveolar process of each maxilla.

The lower jaw is composed of two mandibles, which are joined rostrally at the cartilaginous symphysis and form a synchondrosis. Each mandible consists of a body and a ramus. The three mandibular incisors, canine tooth, two premolars and single molar are anchored in the dorsal alveolar border of the body of the mandible. The ramus of the mandible contains three processes: the coronoid process, the condylar process, and the angular process. The coronoid process forms the most dorsal part of the mandibular ramus and the angular process is located at the caudoventral aspect of the ramus. The temporomandibular joint is formed by the condylar process of the mandible which articulates in the mandibular fossa of the squamous part of the temporal bone. The condylar process is bar-shaped in the cat, which is typical for carnivores. The mandibular fossa is bordered rostrally by the articular eminence and caudally by the retroarticular process. Both of these bony prominences are well developed in the cat, which creates a very deep mandibular fossa and normally prevents any movement of the mandibular condyle beyond these prominent bony processes.

The temporomandibular joint (TMJ) is a condylar synovial joint, which is separated into a dorsal and ventral compartment by a thin articular disk. The disc attaches around its entire periphery to the joint capsule which creates two separate articular spaces. Normally, when the mouth is opened, the medial aspect of the mandibular condyle is seated firmly in the mandibular fossa. The lateral aspect of the joint capsule is thickened in cats and tenses at maximum jaw opening which functions to limit lateral motion of the condyle. A caudal capsular reinforcement has also been demonstrated in the cat. Construction of the feline TMJ reduces rotary and lateral grinding movements.

Muscles of mastication

The muscles of mastication in the cat include the temporalis, masseter, medial and lateral pterygoids and rostral and caudal digastricus. The masseter, temporalis and pterygoid muscles close the jaw and the digastricus muscle opens the mouth.

Blood supply

The majority of blood supply to the feline oral cavity is provided by the maxillary artery. In the mandible the maxillary artery branches into the mandibular (inferior alveolar) artery which enters the mandibular canal through the mandibular foramen. The mandibular (inferior alveolar) artery courses rostrally within the mandibular canal and then exits laterally through the caudal, middle and rostral mental foramina. Blood supply to the maxilla is provided by the major palatine and infraorbital branches of the maxillary artery. The major palatine artery courses through the caudal nasal cavity, passes though the palatine foramen and courses on the ventral surface of the hard palate midway between midline and the maxillary arcade. The infraorbital artery branches from the maxillary artery and enters the infraorbital canal.

Innervation

Motor innervation to the muscles of mastication is supplied by the mandibular branch of the trigeminal nerve (except the caudal belly of the digastricus which is innervated by the facial nerve). Sensory innervation is received from the maxillary and mandibular

branches of the trigeminal nerve. The maxillary nerve courses through the pterygopalatine fossa to enter the infraorbital canal. The palatine nerves branch from the maxillary nerve prior at the caudal limit of the infraorbital canal. The caudal maxillary alveolar nerve branches from the maxillary nerve prior to it entering the infraorbital canal. The maxillary nerve becomes the infraorbital nerve when it enters the infraorbital canal. The middle and rostral maxillary alveolar nerves branch from the infraorbital nerve within the canal. The infraorbital nerve exits the infraorbital canal and innervates the lateral and dorsal cutaneous structures of the rostral maxilla and upper lip.

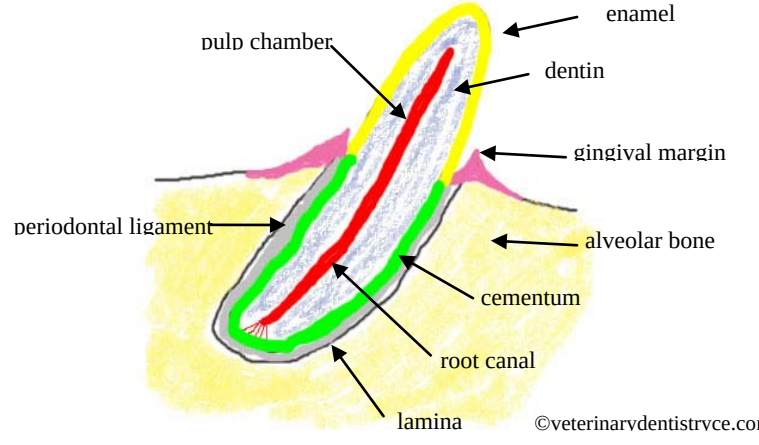
The mandibular branch of the trigeminal nerve enters the mandibular foramen on the lingual side of the mandible, travels in the mandibular canal and exits laterally as the caudal, middle and rostral mental nerves. The middle mental foramen is located in the diastema between the mandibular canine tooth and mandibular third premolar tooth halfway between the dorsal and ventral cortex of the mandible.

Salivary glands

The major salivary glands of the cat are the parotid, zygomatic, mandibular, and sublingual. The parotid salivary duct exits at the papilla which is located in the alveolar mucosa just caudal to the maxillary fourth premolar. The zygomatic salivary duct orifice opens in the alveolar mucosa near the maxillary first molar. The mandibular and sublingual salivary duct orifice opens on a small sublingual papilla located lateral to the rostral end of the tongue frenulum. There are two sets of molar salivary glands in the cat. The lingual molar glands are located linguodistal to the mandibular first molars. The buccal molar salivary glands empty into the oral cavity through several small ducts.

Tooth anatomy

- *Crown* is the portion of the tooth that is covered by enamel which is visible above the gumline.
- *Root* is the portion of the tooth that is covered by cementum located within the alveolus beneath the gingival tissue.
- *Apex* is the area of the root which is the deepest in the alveolar bone.
- *Enamel* is the hardest substance in the body which is the outer layer of the tooth crown. Enamel is formed by ameloblasts within the tooth bud prior to eruption. If enamel is damaged it is incapable of repair.
- *Cementum* is the outer layer of the tooth root which provides a surface for attachment of the periodontal ligament to the tooth.
- *Cementoenamel junction* is the neck of the tooth where the crown meets the root.
- *Periodontal ligament* is the fibrous connective tissue that surrounds the root of the tooth, separating it from and attaching it to the alveolar bone and serving to hold the tooth in place. The periodontal ligament also acts as a shock absorber.
- *Pulp cavity* is the central cavity of the tooth consisting of the pulp chamber and root canal containing blood vessels, nerves, lymph vessels and other cells (odontoblasts). The pulp chamber of the cat lies very close to the enamel surface, so any fracture in a cat's tooth requires endodontic or exodontic treatment.
- *Dentin* is the living tissue that comprises the bulk of the tooth surrounding the pulp cavity and covered by cementum and enamel. Dentin is 70% inorganic and 30% organic. Dentin is porous containing dentinal tubules which extend from the dentin-cementum or dentin-enamel surfaces of the tooth to the pulp and are responsible for transmission of painful stimuli if the dentin is exposed.
    - *Primary dentin* forms before tooth eruption.
    - *Secondary dentin* is produced by odontoblasts within the pulp after tooth eruption causing the dentin walls to thicken.
    - *Tertiary or reparative dentin* is morphologically irregular dentin that forms in response to an irritant.



- *Alveolar bone* is the thin layer of the mandibular and maxilla that comprises the 'tooth socket' and contains teeth.
- *Lamina dura* is a sheet of compact alveolar bone that lies adjacent to the periodontal ligament space. Radiographically it appears as a 'white line'.

Gingiva anatomy

- *Marginal gingiva* is the free gingival tissue that forms the gingival margin surrounding the crown of the tooth.
- *Attached gingiva* is located apical to the marginal gingiva and is tightly adhered to underlying alveolar bone. The attached gingival tissue is coronal to the mucogingival line. The attached gingiva is widest at the maxillary canine teeth in the cat.
- *Mucogingival line* is the junction between the alveolar mucosal tissue and the attached gingival tissue. The mucogingival line remains stationary although the gingival tissues around it may change in size or height (gingival enlargement or gingival recession).
- *Gingival sulcus* is the crevice surrounding the tooth located between the external tooth surface and the marginal gingival tissue. Normal sulcus depth in a cat is less than 1 mm.
- *Junctional epithelium* attaches to the enamel of the most apical portion of the crown. The floor of the gingival sulcus is on the most coronal portion of the junctional epithelial cells.
- *Interdental papilla* is the gingival peak between adjacent teeth.
- *Periodontium* consists of the tissues that surround and support the teeth, including the gingiva, periodontal ligament, cementum and alveolus.

Types of teeth

- *Incisors (I)* are small single rooted teeth located in the front of the mouth. They are utilized for cutting, picking up objects and grooming. Cats have six maxillary and six mandibular incisors.
- *Canines (C)* are large single rooted teeth, commonly called 'fang'teeth. They are utilized for holding prey, slashing and tearing. The lower canine teeth assist in holding the tongue in place. Cats have a right and left maxillary canine tooth and a right and left mandibular canine tooth.
- *Premolars (PM)* are located on the side of the mouth behind the canines. They are utilized for holding food and for breaking food into smaller pieces. Cats do not have a maxillary first premolar or mandibular first and second premolars. In each maxillary quadrant there is a single rooted second premolar, a two rooted third premolar and a three rooted fourth premolar. In each mandibular quadrant there is a two rooted third and fourth premolar.
- *Molars (M)* are in the back of the mouth and are used for grinding food. Cats have one maxillary first molar and one mandibular first molar.

Tooth eruption times

	Deciduous teeth (weeks)	Permanent teeth (months)
Incisor	2-3	3-4
Canine	3-4	4-5
Premolars	3-6	4-6
Molars		4-6

Remember there are no deciduous precursors for the molar teeth in a cat. The maxillary teeth usually erupt prior to their mandibular counterparts. The incisors generally erupt first, followed by the canine teeth then premolars and molars.

Feline dental formulas

Deciduous $\frac{3\ 1\ 3}{3\ 1\ 2}$ total teeth = 26

Permanent $\frac{3\ 1\ 3\ 1}{3\ 1\ 2\ 1}$ total teeth = 30

Permanent tooth development

At the time of permanent tooth eruption, the apex is incomplete and there is a very wide pulp cavity with primary dentin present. As the tooth continues to develop the apex closes and secondary dentin is produces by odontoblasts within the pulp cavity. As the cat continues to mature the pulp cavity continues to get smaller as the secondary dentin layer increases in thickness.

Directional nomenclature

- Mesial – toward the midline of the dental arch
- Distal – farthest away from the midline of the dental arch
- Vestibular – next to or toward the lips; buccal and labial are also acceptable
- Labial – next to or toward the lips
- Buccal – toward the cheek
- Lingual – next to or toward the tongue
- Palatal – toward the palate
- Apical – toward the apex (root)
- Coronal – toward the crown
- Rostral – anatomical term applicable to the head referring to a structure closer to the most forward structure of the head
- Caudal – anatomical term applicable to the head referring to a structure closer to the tail

Occlusion

Class 0 normal occlusion

- Scissors bite with the maxillary incisors overlapping, but touching the mandibular incisors in a scissor-type fashion. The maxillary incisors should be slightly rostral to the mandibular incisors. A level bite is also acceptable in cats.
- The mandibular canine teeth interdigitate in the interproximal space equidistant between the maxillary lateral incisor and canine tooth.
- The maxillary premolars interdigitate with the mandibular premolars in a "pinking shears" fashion.
- Cusp of the maxillary fourth premolar should be buccal to the mandibular first molar.

Class 1 malocclusion

- Neutrocclusion, normal jaw lengths
- Individual teeth are malaligned
- Lingually displaced mandibular canine tooth, mesioversion maxillary canine tooth, rostral crossbite, caudal crossbite

Class 2 malocclusion (mandibular distocclusion)

- Mandible is shorter than the maxilla (mandibular brachygnathism)'overbite' 'parrot mouth'

Class 3 malocclusion (mandibular mesiocclusion)

- Maxilla is shorter than the mandible (mandibular prognathism)'underbite'

Class 4 asymmetrical malocclusion

- Can occur in a rostro-caudal, side-to-side, or dorso-ventral direction

Triadan tooth identification system

The modified Triadan system (3 numbers for each tooth) is considered to be the tooth numbering system of choice in veterinary dentistry.

The first number indicates the quadrant that the tooth is in and whether the tooth is a permanent or deciduous tooth

- Permanent tooth first numbers
    - 1 – Right maxilla
    - 2 – Left maxilla
    - 3 – Left mandible
    - 4 – Right mandible
- Deciduous tooth first numbers
    - 5 – Right maxilla
    - 6 – Left maxilla
    - 7 – Left mandible
    - 8 – Right mandible

The second and third digits indicate the tooth position within the quadrant with the sequence starting at the midline. So, 01 is the first tooth on the midline (the first incisor) and the numbering continues sequentially away from the midline.

- *Rules to remember* Rule of 4, 8 and 9
    - 04 is always the canine tooth
    - 08 is always the fourth premolar
    - 09 is always the first molar

Remember there is not a maxillary right or left first premolar in the cat (105, 205) and there is not a mandibular right or left first or second premolar in the cat (405, 406, 305, 306).

Knowledge of normal anatomy of the cat skull and oral cavity allows the veterinarian to properly evaluate and treat oral and maxillofacial diseases.

Oral Surgery to Extract Teeth in Cats: Tips and Techniques to Avoid Complications

Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

The goal of all extractions is to extract the *entire* tooth and root without damage to surrounding structures. One of the most common complications of tooth extraction is fracture of the tooth root. In addition, tooth extraction can result in: displacement of the root tip into the mandibular canal, nasal cavity or maxillary sinus; hemorrhage; mandibular and maxillary fractures; oronasal fistulas; and ophthalmic complications.

The easiest way to avoid surgical complications is through adequate preparation. Preoperative radiographs should always be obtained prior to starting oral surgery to carefully evaluate the entire tooth, including the apex and the surrounding bone. Proper instrumentation, including a high speed handpiece and sharp dental elevators, will assist in successful extraction. It is important that the operator use controlled forces and proper technique when extracting teeth. In addition, the skill and knowledge of the veterinarian should always be considered. If you are not comfortable with a particular procedure based on your knowledge, skill and /or the pathology that is present, it is best to refer the patient to a board certified veterinary dentist.

Inadequate crown removal during coronectomy

Sometimes when completing coronectomy for a tooth that is very close to the adjacent tooth, a portion of the tooth crown is inadvertently left on the mesial or distal side of the tooth. When left behind, this small crown remnant is painful and usually results in a focal area of inflamed gingival tissue. Always obtain post coronectomy radiographs to ensure adequate crown removal.

Fractured tooth roots

It is important to remove adequate alveolar bone and section all multi-rooted teeth prior to attempting elevation of the tooth roots. Often the bad sound of a cracking root will give the operator a clue to the potential for an existing complication. *Always* inspect the extracted tooth root for a smooth round apex. If there is a rough or jagged edge to the root, chances are there is still a root remnant remaining in the alveolus. *Always* take post extraction radiographs to document the extraction of the entire tooth and root without damage to the surrounding bone. Sometimes, despite our best attempts, tooth roots fracture during oral surgery to extract the tooth.

The following steps will allow for easier retrieval of fractured tooth roots:

1. Keep the fractured tooth to 'recreate the scene of the crime'. The fractured root end will usually be sharp and irregular. If the fracture is oblique, visualization of this angle allows us to determine how the remaining tooth root is positioned within the alveolus. Starting with the portion of the retained root that is most coronal (circle), allows insertion of the dental elevator into the periodontal ligament space in that location for easier removal of the remaining root tip.

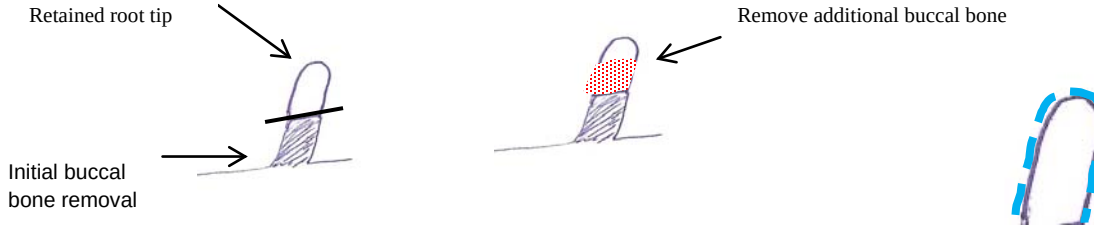
Remaining root segment

2. Radiograph the remaining root tip to evaluate how much root structure remains and how the remaining root structure appears. Note what structures the root apex is adjacent to, if there is any pathology associated with the surrounding bone, and if there is an abnormal shape to the remaining root segment.

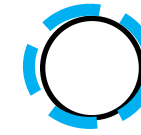
Crown portion of the tooth extracted

3. Elevate the remaining root fragment. If the fractured root tip is visible and it is possible to position the dental elevator or root tip pick into the periodontal ligament space, the first option is to elevate the remaining root segment without removal of additional bone. Carefully rotate the elevator to elevate and extract the remaining root tip. Do not place apical pressure on the root tip to avoid displacement of the root tip into the mandibular canal, nasal cavity or maxillary sinus. Be sure you can *clearly* visualize the periodontal ligament space and the root! If you cannot, remove additional buccal alveolar bone.
4. Remove additional buccal alveolar bone to outline the remaining root tip and periodontal ligament space on the mesial and distal root surfaces. Often the fracture occurs at the level of the initial alveolar bone removal. How much buccal alveolar bone can you remove? As much as necessary to safely remove the fractured tooth root without damaging the surrounding bone and soft tissues. Be careful with excessive bone removal in the mandibles of small dogs and cats. Be aware of the anatomy in the area, especially taking into consideration the neurovascular bundles.

In the illustration below, the initial buccal bone has been removed to the level where the root fractured (black horizontal line). Careful removal of additional buccal alveolar bone, as illustrated with the red shaded area, allows for exposure of more of the retained root tip and assists in identification of the periodontal ligament space.



1. Utilize small dental elevators in the periodontal ligament space with rotating pressure, *no apical pressure*, to carefully elevate and extract the remaining root fragment. Excessive apical pressure can displace the root segment into the nasal cavity, maxillary sinus or mandibular canal.
2. In the case of small fractured root tips a 20, 22 or 18 gauge needle can be utilized as an elevator by placing it in the periodontal ligament space and gently rotating the needle (do not apply apical pressure). The needle may also be utilized to gently 'lever' the root tip into the open alveolus.
3. Another aid to assist in the extraction of root tips is to introduce a small round bur (#1 or #1/2) into the alveolus to create a 'moat' around the root to allow introduction of an instrument (elevator or root tip pick) into this space for root tip elevation and removal.
4. Utilize root tip extraction forceps with gentle rotation to assist in removing fractured roots. Root tip extraction forceps are utilized *only* once the root tip is mobile.


Blue dashed line represents 'moat' outlining the root tip

What if the attempt to remove the root tip is unsuccessful? When can root tips be left in place? Root tips can be left in place only if the risks of surgery to remove the root tip outweigh the benefits of removing the root tip. A root tip may *not* be left in place if there is any evidence of periodontal disease or endodontic disease (periapical lysis) associated with the root tip. To leave a fractured root tip in place, the root tip must be small, deep within the alveolus and must not be infected or have periapical lysis. The risks of surgery that may outweigh the benefits of the root tip removal may include: the patient is not stable under anesthesia; continued attempts at root retrieval may impact vital structures (nerves and vessels within the mandibular canal, the nasal cavity or orbit); or continued attempts may result in significant destruction of surrounding bone or soft tissues. If the decision is that the benefit of fractured root removal does not outweigh the risks, and the root tip will remain in place, then an intraoral radiograph *must be taken* to document the remaining root structure. The owners *must* be informed of the decision, the reason for the decision and the possible clinical sequelae that may result from the decision. Radiographs of the retained root should be obtained annually to determine if there is any pathology associated with the remaining root fragment.

Fractured root tips are frustrating and sometimes difficult to remove. Proper extraction technique will minimize the chances for fracturing root tips. Intraoral radiographs prior to extraction are necessary to evaluate the tooth structure and surrounding alveolar bone. Removal of buccal alveolar bone and proper sectioning of teeth facilitates extraction. The use of proper, sharp instruments and slow controlled forces is recommended. Above all, be patient.

Displacement of root tips into mandibular canal, nasal cavity or maxillary sinus

While attempting to retrieve fractured root tips it is possible to displace a tooth root into the mandibular canal, nasal cavity or maxillary sinus. Careful elevation of fractured root tips with minimal apical force will assist the operator in preventing root tip displacement. After displacement, it is desirable to remove the root tip or tooth fragment. Removal is usually facilitated by removal of additional bone and careful evaluation to identify the displaced root tip. If this procedure is beyond the capability of the operator the case should be referred to a veterinary dental specialist.

Hemorrhage and trauma to soft tissues

Excessive bleeding may originate from the extraction site or from trauma to vascular structures or soft tissue during the extraction. Hemorrhage usually results from the use of uncontrolled forces with the dental elevator and 'slipping' into the sublingual area, buccal mucosal tissue, infraorbital vessels or mandibular canal. Bleeding may occur after the tooth root is extracted if there is a large area of granulation tissue present at the tooth apex. Hemorrhage can usually be controlled with ligation of the lacerated vessel, direct pressure, utilization of an absorbable hemostatic gelatin sponge, or suturing of the gingiva over the alveolar to allow formation of a clot.

Mandibular and maxillary fractures

Pathologic or iatrogenic mandibular fractures occur most commonly secondary to extraction of the mandibular canine tooth in the cat. The fracture may occur due to preexisting periodontal disease or excessive force used by the operator or a combination of both. Pre-extraction radiographs are always indicated as they allow for an accurate assessment of the surrounding alveolar bone and are necessary to assist the operator in planning for a successful surgical extraction. Creation of a mucogingival flap, removal of buccal bone, followed by very careful elevation and extraction of the affected tooth with controlled forces will assist in prevention of mandibular fractures secondary to tooth extraction.

Oronasal fistula

The shelf of bone separating the oral cavity from the nasal cavity is very thin on the palatal side of the maxillary canine tooth. Periodontal disease leads to vertical bone loss and the resulting oronasal fistula. An oronasal fistula may also occur if the maxillary first, second and third premolars are affected by severe periodontal disease. If an oronasal fistula is visible at the time of extraction, debridement and primary closure with a mucogingival flap is indicated. Chronic oronasal fistulas can lead to mucopurulent or hemorrhagic nasal discharge and/or sneezing.

Ophthalmic complications

The apices of the maxillary fourth premolar and first molar in the cat lie in close proximity to the ventral floor of the orbit. There is a thin shelf of alveolar bone surrounding these tooth roots. The orbit can be penetrated with a dental elevator if the tooth is affected by periodontitis and if a short finger stop is not utilized during extraction. Penetration of the globe may result in panophthalmitis or may ultimately result in enucleation of the affected eye. Use of controlled forces and a finger stop will assist the operator in prevention of this complication.

Neoplasia

Continued gingival inflammation in the area of previously extracted teeth or a non-healing oral surgery site in cats is may be due to underlying neoplasia. Pre-extraction radiographs allow for the evaluation of the alveolar bone surrounding the mobile teeth prior to extraction. Depending on the radiographic findings, the operator may elect to biopsy the soft tissue and bone rather than extract mobile teeth. Mobile teeth ALWAYS require intraoral radiograph prior to extraction.

The goal of all extractions is to extract the *entire* tooth and root without damage to surrounding structures. Unfortunately, we all will encounter complications during tooth extraction at some point in our career. Recognition of the potential complications and knowledge of appropriate treatment methods for those complications will assist in minimizing pain and discomfort for our patients. The easiest way to avoid surgical complications is through adequate preparation and evaluation of the tooth and surrounding bone structure and utilization of proper instrumentation with controlled forces during tooth extraction.

Bad Sound, Bad Word:
Complications During Tooth Extraction

Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

The goal of all extractions is to extract the *entire* tooth and root without damage to surrounding structures. One of the most common complications of tooth extraction is fracture of the tooth root. In addition, tooth extraction can result in: displacement of the root tip into the mandibular canal, nasal cavity or maxillary sinus; hemorrhage; mandibular and maxillary fractures; oronasal fistulas; and ophthalmic complications.

The easiest way to avoid surgical complications is through adequate preparation. Preoperative radiographs should always be obtained prior to starting oral surgery to carefully evaluate the entire tooth, including the apex and the surrounding bone. Proper instrumentation, including a high speed handpiece and sharp dental elevators, will assist in successful extraction. It is important that the operator use controlled forces and proper technique when extracting teeth. In addition, the skill and knowledge of the veterinarian should always be considered. If you are not comfortable with a particular procedure based on your knowledge, skill and /or the pathology that is present, it is best to refer the patient to a board certified veterinary dentist.

Inadequate crown removal during coronectomy

Sometimes when completing coronectomy for a tooth that is very close to the adjacent tooth, a portion of the tooth crown is inadvertently left on the mesial or distal side of the tooth. When left behind, this small crown remnant is painful and usually results in a focal area of inflamed gingival tissue. Always obtain post coronectomy radiographs to ensure adequate crown removal.

Fractured tooth roots

It is important to remove adequate alveolar bone and section all multi-rooted teeth prior to attempting elevation of the tooth roots. Often the bad sound of a cracking root will give the operator a clue to the potential for an existing complication. *Always* inspect the extracted tooth root for a smooth round apex. If there is a rough or jagged edge to the root, chances are there is still a root remnant remaining in the alveolus. *Always* take post extraction radiographs to document the extraction of the entire tooth and root without damage to the surrounding bone. Sometimes, despite our best attempts, tooth roots fracture during oral surgery to extract the tooth.

The following steps will allow for easier retrieval of fractured tooth roots:

5. Keep the fractured tooth to 'recreate the scene of the crime'. The fractured root end will usually be sharp and irregular. If the fracture is oblique, visualization of this angle allows us to determine how the remaining tooth root is positioned within the alveolus. Starting with the portion of the retained root that is most coronal (circle), allows insertion of the dental elevator into the periodontal ligament space in that location for easier removal of the remaining root tip.

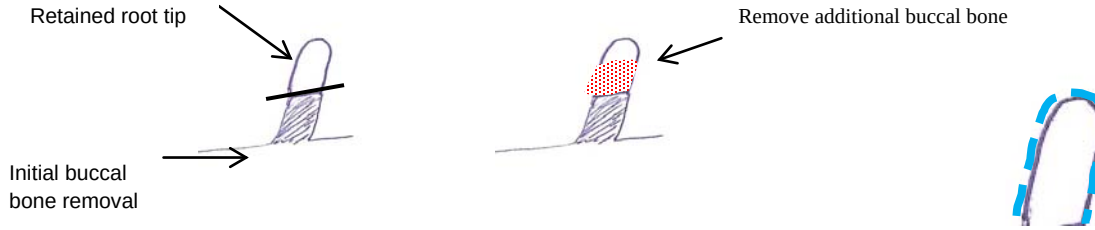
Remaining root segment

6. Radiograph the remaining root tip to evaluate how much root structure remains and how the remaining root structure appears. Note what structures the root apex is adjacent to, if there is any pathology associated with the surrounding bone, and if there is an abnormal shape to the remaining root segment.

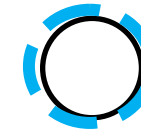
Crown portion of the tooth extracted

7. Elevate the remaining root fragment. If the fractured root tip is visible and it is possible to position the dental elevator or root tip pick into the periodontal ligament space, the first option is to elevate the remaining root segment without removal of additional bone. Carefully rotate the elevator to elevate and extract the remaining root tip. Do not place apical pressure on the root tip to avoid displacement of the root tip into the mandibular canal, nasal cavity or maxillary sinus. Be sure you can *clearly* visualize the periodontal ligament space and the root! If you cannot, remove additional buccal alveolar bone.
8. Remove additional buccal alveolar bone to outline the remaining root tip and periodontal ligament space on the mesial and distal root surfaces. Often the fracture occurs at the level of the initial alveolar bone removal. How much buccal alveolar bone can you remove? As much as necessary to safely remove the fractured tooth root without damaging the surrounding bone and soft tissues. Be careful with excessive bone removal in the mandibles of small dogs and cats. Be aware of the anatomy in the area, especially taking into consideration the neurovascular bundles.

In the illustration below, the initial buccal bone has been removed to the level where the root fractured (black horizontal line). Careful removal of additional buccal alveolar bone, as illustrated with the red shaded area, allows for exposure of more of the retained root tip and assists in identification of the periodontal ligament space.



5. Utilize small dental elevators in the periodontal ligament space with rotating pressure, *no apical pressure*, to carefully elevate and extract the remaining root fragment. Excessive apical pressure can displace the root segment into the nasal cavity, maxillary sinus or mandibular canal.
6. In the case of small fractured root tips a 20, 22 or 18 gauge needle can be utilized as an elevator by placing it in the periodontal ligament space and gently rotating the needle (do not apply apical pressure). The needle may also be utilized to gently 'lever' the root tip into the open alveolus.
7. Another aid to assist in the extraction of root tips is to introduce a small round bur (#1 or #1/2) into the alveolus to create a 'moat' around the root to allow introduction of an instrument (elevator or root tip pick) into this space for root tip elevation and removal.
8. Utilize root tip extraction forceps with gentle rotation to assist in removing fractured roots. Root tip extraction forceps are utilized *only* once the root tip is mobile.


Blue dashed line represents 'moat' outlining the root tip

What if the attempt to remove the root tip is unsuccessful? When can root tips be left in place? Root tips can be left in place only if the risks of surgery to remove the root tip outweigh the benefits of removing the root tip. A root tip may *not* be left in place if there is any evidence of periodontal disease or endodontic disease (periapical lysis) associated with the root tip. To leave a fractured root tip in place, the root tip must be small, deep within the alveolus and must not be infected or have periapical lysis. The risks of surgery that may outweigh the benefits of the root tip removal may include: the patient is not stable under anesthesia; continued attempts at root retrieval may impact vital structures (nerves and vessels within the mandibular canal, the nasal cavity or orbit); or continued attempts may result in significant destruction of surrounding bone or soft tissues. If the decision is that the benefit of fractured root removal does not outweigh the risks, and the root tip will remain in place, then an intraoral radiograph *must be taken* to document the remaining root structure. The owners *must* be informed of the decision, the reason for the decision and the possible clinical sequelae that may result from the decision. Radiographs of the retained root should be obtained annually to determine if there is any pathology associated with the remaining root fragment.

Fractured root tips are frustrating and sometimes difficult to remove. Proper extraction technique will minimize the chances for fracturing root tips. Intraoral radiographs prior to extraction are necessary to evaluate the tooth structure and surrounding alveolar bone. Removal of buccal alveolar bone and proper sectioning of teeth facilitates extraction. The use of proper, sharp instruments and slow controlled forces is recommended. Above all, be patient.

Displacement of root tips into mandibular canal, nasal cavity or maxillary sinus

While attempting to retrieve fractured root tips it is possible to displace a tooth root into the mandibular canal, nasal cavity or maxillary sinus. Careful elevation of fractured root tips with minimal apical force will assist the operator in preventing root tip displacement. After displacement, it is desirable to remove the root tip or tooth fragment. Removal is usually facilitated by removal of additional bone and careful evaluation to identify the displaced root tip. If this procedure is beyond the capability of the operator the case should be referred to a veterinary dental specialist.

Hemorrhage and trauma to soft tissues

Excessive bleeding may originate from the extraction site or from trauma to vascular structures or soft tissue during the extraction. Hemorrhage usually results from the use of uncontrolled forces with the dental elevator and 'slipping' into the sublingual area, buccal mucosal tissue, infraorbital vessels or mandibular canal. Bleeding may occur after the tooth root is extracted if there is a large area of granulation tissue present at the tooth apex. Hemorrhage can usually be controlled with ligation of the lacerated vessel, direct pressure, utilization of an absorbable hemostatic gelatin sponge, or suturing of the gingiva over the alveolar to allow formation of a clot.

Mandibular and maxillary fractures

Pathologic or iatrogenic mandibular fractures occur most commonly secondary to extraction of the mandibular canine tooth in the cat. The fracture may occur due to preexisting periodontal disease or excessive force used by the operator or a combination of both. Pre-extraction radiographs are always indicated as they allow for an accurate assessment of the surrounding alveolar bone and are necessary to assist the operator in planning for a successful surgical extraction. Creation of a mucogingival flap, removal of buccal bone, followed by very careful elevation and extraction of the affected tooth with controlled forces will assist in prevention of mandibular fractures secondary to tooth extraction.

Oronasal fistula

The shelf of bone separating the oral cavity from the nasal cavity is very thin on the palatal side of the maxillary canine tooth. Periodontal disease leads to vertical bone loss and the resulting oronasal fistula. An oronasal fistula may also occur if the maxillary first, second and third premolars are affected by severe periodontal disease. If an oronasal fistula is visible at the time of extraction, debridement and primary closure with a mucogingival flap is indicated. Chronic oronasal fistulas can lead to mucopurulent or hemorrhagic nasal discharge and/or sneezing.

Ophthalmic complications

The apices of the maxillary fourth premolar and first molar in the cat lie in close proximity to the ventral floor of the orbit. There is a thin shelf of alveolar bone surrounding these tooth roots. The orbit can be penetrated with a dental elevator if the tooth is affected by periodontitis and if a short finger stop is not utilized during extraction. Penetration of the globe may result in panophthalmitis or may ultimately result in enucleation of the affected eye. Use of controlled forces and a finger stop will assist the operator in prevention of this complication.

Neoplasia

Continued gingival inflammation in the area of previously extracted teeth or a non-healing oral surgery site in cats is may be due to underlying neoplasia. Pre-extraction radiographs allow for the evaluation of the alveolar bone surrounding the mobile teeth prior to extraction. Depending on the radiographic findings, the operator may elect to biopsy the soft tissue and bone rather than extract mobile teeth. Mobile teeth ALWAYS require intraoral radiograph prior to extraction.

The goal of all extractions is to extract the *entire* tooth and root without damage to surrounding structures. Unfortunately, we all will encounter complications during tooth extraction at some point in our career. Recognition of the potential complications and knowledge of appropriate treatment methods for those complications will assist in minimizing pain and discomfort for our patients. The easiest way to avoid surgical complications is through adequate preparation and evaluation of the tooth and surrounding bone structure and utilization of proper instrumentation with controlled forces during tooth extraction.

Shades of Gray:
Interpretation of Feline Dental Radiographs

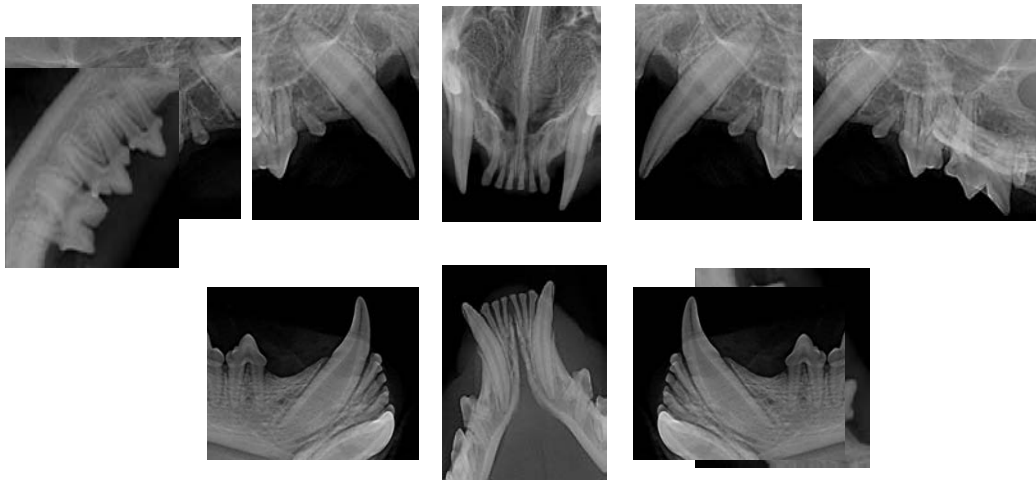
Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

As with any new piece of equipment in veterinary hospitals, there is a learning curve associated with dental radiography – both in obtaining diagnostic dental radiographs and interpretation of dental pathology.

With digital images, the image appears on the computer screen. When obtaining intraoral radiographs the following tips will help you orient the image in the same way each time for evaluation. Some veterinary software programs will label the images with the tooth number or tooth as you expose them. First, if the tooth being imaged is a maxillary tooth the tooth crowns should point down and if the tooth being imaged is a mandibular tooth the tooth crowns should point up. Remember that all three rooted teeth are located in the maxilla. The presence of the palatine fissures, nasal passages and sinuses indicate the tooth is in the maxilla. Visualization of the mandibular canal or ventral cortex of the mandible confirms that the tooth is a mandibular tooth. After determining if the tooth is in the maxilla or mandible then determine if you are viewing the right or left side. When viewing the right side of the mouth the anterior teeth are on the right side of the image and when viewing the left side of the mouth the anterior teeth are on the left side of the image. Depending on the imaging software the images may appear on the computer screen in the correct orientation.

When mounting full mouth radiographs, the patient's right maxilla and right mandible are on the viewer's left side and the patient's left maxilla and left mandible are on the viewer's right side. (Remember that the viewer is standing on the outside of the patient's mouth looking at the patient.)

Right Maxilla Left Maxilla



Right Mandible Left Mandible

Knowledge of normal anatomy of the tooth, mandible and maxilla is essential for the proper evaluation of dental radiographs. The components of the tooth and its supporting structures are usually well defined on dental radiographs. These structures include the following:

- *Enamel:* the outermost layer of the crown of the tooth
- *Cementum:* the outermost layer of the root of the tooth
- *Cementoenamel junction:* area where the cementum and enamel meet
- *Dentin:* radiopaque layer between the outermost surfaces of the crown and root and the radiodense pulp cavity
- *Pulp cavity:* radiodense area within the tooth and roots including the pulp chamber, pulp horns and root canal.
- *Periodontal ligament space:* thin radiolucent area between the root of the tooth and the lamina dura
- *Lamina dura:* the cribiform plate and dense alveolar bone surrounding the root which appears as a radioopaque line adjacent to the periodontal ligament space
- *Alveolar bone:* encases and supports the tooth structure
- *Alveolar margin:* most coronal portion of the alveolar bone, located between teeth, composed of dense cortical bone
- *Furcation:* the anatomic area of a multi-rooted tooth where the roots diverge

- *Periapical:* the area around the tooth apex

The mandibular canal is visible as a radiolucency of uniform width in the mandible parallel to the ventral border of the mandible. The caudal, middle and rostral mental foramen may be mistaken for periapical pathology in the area of the mandibular premolars. The middle mental foramen is located distal to the apex of the canine tooth in the cat. (To distinguish the foramen versus a periapical lucency, change the horizontal angle of the tubehead. If the lucency remains associated with the apex of the tooth it is indeed a periapical lucency. The foramen will move relative to the root as the horizontal angle of the tubehead is changed.) The mandibular symphysis appears as a linear radiolucent line between the central incisors.

In the maxilla the symmetrical radiolucent structures which appear distal to the maxillary incisors are the palatine fissures. The junction of the vertical body of the maxilla and its palatine process is visualized as a radiopaque line that crosses the midroot section of the maxillary canine tooth.

Radiographs should include the entire crown and root of the tooth being imaged and 3 mm of alveolar bone around the tooth apex. The following generalizations can be made about dental radiograph interpretation.

Radiographic signs of feline tooth resorption include defects present at the cementoenamel junction and/or roots with evidence of root replacement. Clinically, there are two types of tooth resorption in cats. Tooth resorption type I lesions have normal root density and a well-defined periodontal ligament space around the tooth root. Often these teeth have associated horizontal or vertical bone loss. Tooth resorption type II lesions have root replacement resorption with no discernible periodontal ligament space and the roots appear to blend in with the surrounding bone. Both types of tooth resorption can be found in the same cat and even in the same tooth. Differentiation between type I and type II tooth resorption in feline patients is important to determine the appropriate treatment for these teeth. Type I tooth resorption is treated by extraction of the entire tooth and root. Type II tooth resorption is treated by crown amputation with intentional root retention.

Radiographic signs of periodontal disease may include: widening of the periodontal space; resorption of the alveolar crest; decreased alveolar bone density and horizontal, vertical, angular or furcation bone loss. Remember that 30-60% of the bone must be lost before it is visible radiographically. Horizontal bone loss involves the buccal, lingual and interdental portions of bone and appears as decreased alveolar marginal bone around the tooth. Vertical bone loss usually appears as an area of decreased bone density surrounding the tooth root and may appear to as a ‘V’ shape adjacent to the tooth root. It is important to recognize that clinical examination in combination with dental radiographs is necessary to properly diagnose periodontal disease. Mild bone loss, stage 1 furcation exposure, vertical bone loss on the palatal side of the maxillary canine teeth may not be visible radiographically, only clinically. In addition, proper exposure is necessary to evaluate the alveolar bone margin. Overexposure of the dental radiograph may result in ‘burnout’ of the alveolar bone margin and interdental bone.

Radiographic signs of endodontic disease include changes associated with the bone surrounding the tip of the root (periradicular area) and changes within the pulp cavity or tooth itself. Radiographs to evaluate a tooth for endodontic disease should include the entire root tip and the surrounding bone. The characteristic radiographic lesion of endodontic origin (LEO) involves changes in the periapical radiodensity (often appearing as a radiolucency) or detail that results from apical periodontitis. Lesions of endodontic origin can also develop along the lateral aspect of the root at the site of a lateral canal. Remember that lack of radiographic lesions does not rule out endodontic disease.

Radiographic signs of endodontic disease that are associated with the tissues around the tooth may include: increased width of the periodontal ligament space, loss of the radiopaque lamina dura, diffuse periapical lucency, well defined periapical lucency, or a diffuse area of radiopacity.

Radiographic changes within the tooth are often associated with endodontic disease. When a permanent tooth first erupts, the apex is open, the pulp canal is very wide and the primary dentin layer is thin. Next, the apex closes and then as the tooth continues to mature, the odontoblasts within the pulp canal continue to lay down dentin (secondary dentin). As the tooth continues to mature, the secondary dentin becomes thicker as the pulp canal decreases in width. Radiographically, a tooth that became non-vital during the maturation process will have a pulp canal larger than the contralateral tooth indicating arrested tooth maturation. A seemingly narrow pulp cavity can result from pulpitis that is generalized over a section of the root canal.

Internal root or crown resorption, caused by inflammation in the pulp, appears as an irregularly shaped root canal system. Internal root resorption results from removal of dentin from the wall of the pulp cavity. An internal resorption lesion does not move with change in horizontal angle of the beam of the radiograph (it stays associated with the root canal system).

External resorption resulting from inflammation in the periodontal ligament appears as an irregular defect in the external surface of the tooth root An external root resorption that is overlying the root canal system will move relative to the root canal system with a change in horizontal angulation of the beam of the radiograph.

- Radiographic signs of aggressive jaw lesions include:
    - Lytic areas of variable size or uniformly pinpointed
    - Indistinct margins

    - Lysis of the cortex
    - Layers of varied opacity or sunburst effect
    - Teeth in position, floating in space
    - Bone is moth eaten in appearance
    - Root structure is irregular
    - Increased tooth mobility
- Radiographic signs of non-aggressive jaw lesions include:
    - Well defined areas of lysis
    - Distinct regular, smooth or sclerotic margins
    - Expanding or thinning of cortex
    - Uniform opacity or lamellar onion skin pattern
    - Displaced teeth
    - Tooth mobility may be affected

Dental radiography is an essential part of the evaluation of oral and maxillofacial diseases. In combination with a complete extraoral and intraoral examination, including the use of a dental probe and explorer, intraoral radiography makes dentistry a science based on fact and provides veterinarians with the tools to properly evaluate and treat oral disease.

Feline Oral Tumors: Diagnosis and Treatment

Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

Oral tumors account for 7- 12% of all feline tumors and 90% of oral tumors in cats are malignant. They may be of dental (odontogenic) or non-dental origin. Squamous cell carcinoma is the most common oropharyngeal cancer in cats accounting for 60-80% of all oral tumors, followed by fibrosarcoma which accounts 13-22% of feline oral tumors.

History and clinical signs

Cats with oral tumors may present with drooling, exophthalmos, facial swelling, epistaxis, sneezing, weight loss, dysphagia, anorexia, decreased appetite, reluctance to eat hard food, decreased activity, hiding and less interactive, halitosis, an unkempt haircoat due to poor grooming, and/or pain when opening the mouth. Beware that loose teeth in a cat with otherwise good dentition could indicate an underlying neoplastic process causing bone lysis.

Clinical staging

Clinical staging of the tumor should be completed utilizing the TMN system which involves assessment of the primary tumor (T), assessment for metastasis to distant sites (M) and to regional lymph nodes (N).

Evaluation of the primary tumor (T)

Evaluation of the primary tumor should include a clinical examination, diagnostic imaging and histopathological evaluation. The size and location of the tumor, the presence of any ulceration or necrosis, and any abnormal mobility of associated teeth should be noted. Clinical features suggestive of a malignancy include rapid growth, fixation to underlying tissue, displacement of teeth, facial deformity, ulceration, and poorly defined margins. Clinical features suggestive of a benign oral mass include and expansile, fluid filled mass.

Diagnostic imaging of the tumor

Dental radiographs should be obtained of the affected jaw to evaluate the extent of involvement of adjacent teeth and alveolar bone associated with the mass. Bone lysis is not radiographically apparent until more than 40% of the cortex of the bone is demineralized. Therefore, radiographs usually underestimate the extent of the tumor. Computed tomography is a valuable and more sensitive diagnostic tool for evaluation of bone invasion and possible extension of the oral tumor into the nasal cavity, caudal pharynx and orbit. CT imaging should be utilized for maxillary tumors and caudal mandibular tumors.

Incisional biopsy

An incisional biopsy is the procedure of choice for most oral soft tissue tumors. Punch biopsy has been shown to produce fewer artifacts than scalpel biopsy. Biopsies should be at least 4-6 mm in diameter with a depth of at least 2 mm. For incision of a hard tissue mass, consider the use of a Michel trephine. It is important to obtain the biopsy from within the oral cavity and not through the lip to avoid seeding the tumor cells into normal skin. Keep in mind the planned definitive surgical resection when obtaining biopsies. The biopsy should always be obtained within the the worst part of the lesion. Multiple biopsies may be obtained. Avoid necrotic and infected areas of the tumor and do not sample at the margin of the mass. When obtaining the biopsy consideration should be given to the plan for definitive surgery so the biopsy site is included in the definitive surgery.

Evaluation for distant metastasis (M)

Three view thoracic radiographs or thoracic CT should be evaluated for distant metastasis. CT is significantly more sensitive than thoracic radiographs for detecting soft tissue nodules. The lower size threshold is 1 mm to detect pulmonary nodules on CT images and 7-9 mm to reliably detect pulmonary nodules on radiographs. Cats less frequently develop the classical well defined appearance of lung metastasis. Metastatic disease can appear as ill-defined mass lesions or diffuse alveolar, interstitial or mixed patterns.

Lymph node evaluation (N)

Lymph nodes may be assessed by palpation to evaluate size, mobility, firmness, single vs multiple nodes, ipsilateral vs contralateral and bilateral distribution. Lymph node size is not a reliable predictor of metastasis. Remember that the lymph nodes that drain the oral cavity in the cat include the mandibular, parotid and medial retropharyngeal. Ruling out mandibular lymph node metastasis does not rule out metastatic disease. Lymph node evaluation may include fine needle aspirate of mandibular lymph nodes and/or evaluation of the other lymph nodes during CT evaluation of the oral mass.

Squamous cell carcinoma (SCC)

Squamous cell carcinoma is the most common oral tumor in cats accounting for approximately 65% of all oral tumors. Affected cats tend to be older, but may be as young as 5 months to as old as 21 years of age with a median age of 12 years. There is no gender predilection. Various studies have shown an increased incidence of squamous cell carcinoma in cats that wear flea collars, cats that are exposed to environmental smoke, and cats with high canned food intake.

Squamous cell carcinoma in cats most often affects the frenulum and ventral surfaces of the tongue. The gingival tissue adjacent to the maxilla and mandible is second most common site. It is uncommon for the tonsil in the cat to be the primary location for a squamous cell carcinoma. Most squamous cell carcinomas occur caudal to the canine teeth. Squamous cell carcinoma is very invasive into the gingival tissue and underlying bone and may extend to involve the palate, pharynx or ramus of the mandible.

Bone invasion in feline squamous cell carcinoma is usually extensive and radiographically these cancers cause an intensely sclerotic, periosteal proliferation in the mandible. Marked osteolysis can also occur. In a study of cats with mandibular swellings only 50% had a tumor and osteomyelitis could not be differentiated from cancer based on radiographic appearance.

Nodal metastasis is seen in about 10% of affected cats. When lymph node metastasis is present the mandibular and retropharyngeal lymph nodes are most commonly affected. Lung metastasis in cats is rare, though it is not possible to determine a true metastatic rate since so few cats have their local diseased controlled.

Squamous cell carcinoma in cats is very frustrating to treat as most cases are diagnosed at a late stage in the disease process, leading to few viable treatment options. There is no known effective treatment that consistently yields disease control or survival. If the tumor is located in the rostral mandible and discovered early in the course of disease a mandibulectomy and/or radiation treatment might be considered. Radiation therapy in conjunction with surgery or used alone still results in local recurrence of the tumor. Chemotherapy alone or in combination with radiation therapy has done little to improve survival times in cats with squamous cell carcinoma. The best treatment for squamous cell carcinoma has yet to be determined. Unfortunately palliative care is the most common method of treatment due to poor prognosis and extensive tumor involvement at the time of diagnosis. Palliative treatment may include tube feeding, analgesics and anti-inflammatory drugs. Overall median survival time in cats with squamous cell carcinoma is 44 days. Cats with squamous cell carcinoma have a poor prognosis with a one year survival of less than 10%.

Fibrosarcoma

Oral fibrosarcoma is the second most common oral tumor in cats and does not have a site predilection. Age of affected cats ranges from 1 to 21 years with a mean of 10.3 years. These tumors are locally invasive and metastasis is rare. The tumor arises from the submucosal stroma and is accompanied by local tissue destruction and invasion of skeletal muscle and bone. The preferred treatment is surgical excision with wide margins. As with squamous cell carcinomas, surgical excision is usually not possible due to the advanced disease at the time of diagnosis. Palliative radiation can be considered.

Osteosarcoma

Feline osteosarcoma accounts for 2.4% of all oral tumors and occurs most commonly in older cats with a median age of 10.5 years. Mandibulectomy alone or in combination with radiation or chemotherapy was associated with a 1-3 year survival rate and progression free rate of 83%.

Treatment of fibrosarcoma and osteosarcoma with mandibulectomy showed more than 80% of cats with osteosarcoma and 66% of cats with oral fibrosarcoma were alive three years after surgery. Radiation was used in some of these cases with incomplete surgical margins. Remember to support cats with feeding tubes after mandibulectomy.

Melanoma

Oral melanoma is rare in cats (less than 3% of oral tumors). Metastatic disease is common in cats with oral melanoma. In a small study, median survival of cats with oral melanoma was less than 5 months and no cat lived longer than 8 months.

Lymphoma

Oral and tonsillar lymphoma has been reported in cats, with 11 (2.9%) of a total of 371 cats affected. The appearance was described as single or multiple raised submucosal masses composed of unencapsulated sheets of neoplastic lymphoid cells. Radiation treatment alone or in combination with chemotherapy has been used to treat cats with oral lymphoma.

Salivary gland tumors

Salivary adenocarcinomas originate from the major (parotid, mandibular, sublingual, zygomatic) or minor salivary glands. Minor salivary glands include the lingual molar salivary gland and other salivary glands that can be found in the lip, cheek palate, gingival, tongue and floor of the mouth. Salivary adenocarcinomas can be very invasive. Up to 80% of cats have lymph node metastasis at the time of diagnosis. Pulmonary metastasis is less common. Surgical excision is the treatment of choice. The tumors are often very

invasive extending into surrounding skin and musculature. With surgical excision, regrowth and lymph node metastasis are common. Combination treatment with surgical excision, radiation treatment and chemotherapy is recommended.

Osteoma

Osteoma is an uncommon benign bone tumor in cats composed of mature compact or cancellous bone that generally grows continuously and at a slow rate. Osteomas occasional occur in the oral and maxillofacial region. Treatment is recommended early in the course of the disease and involves debulking and recontouring of the affected area. When diagnosed at an advanced state of disease a more aggressive surgical resection may be required. There is debate regarding the etiology and pathogenesis of the osteoma. Some suggest that it is a true neoplasm whereas others classify it as a developmental anomaly triggered by infection or trauma and exacerbated by muscle traction.

Odontogenic tumors

Odontogenic tumors originate from the remnants of the embryonic tissues destined to develop into teeth and associated structures and account for 2.5% of all feline tumors. They are classified as inductive tumors when they retain the ability to induce reactive proliferation of connective tissue. Inductive odontogenic tumors include feline inductive odontogenic tumor (FIOT), dentinoma and ameloblastic, complex and compound odontomas. Non inductive tumors in cats include ameloblastomas and calcifying epithelial odontogenic tumors (CEOT).

Odontoma

An odontoma is an odontogenic tumor containing epithelial and mesenchymal cells which results in formation of all dental tissue types. The tumor is benign and slow growing but they can be expansile and can create a mass like effect in the oral tissues. Clinically an odontoma will appear as an unerupted tooth or a partially erupted tooth with an associated swelling. A compound odontoma contains rudimentary tooth like structures. An odontoma in which the conglomerate of dental tissues bears no resemblance to a tooth is called a complex odontoma. Treatment for an odontoma is removal of the mass and associated tooth like particles and curettage of the defect.

Dentigerous cyst

A dentigerous cyst is a benign, non neoplastic, well circumscribed, cystic lesion associated with an impacted tooth. The fluid filled cyst forms around the tooth crown and is attached to the neck of the unerupted tooth. The resulting lesion is an expansile lesion and can cause a significant bone loss and destruction. Dental radiographs show a unilocular radiolucent area associated with the crown of the unerupted tooth. During normal adult tooth development the inner and outer enamel epithelium are responsible for the production of enamel. After the enamel is formed these tissues fuse to become the reduced enamel epithelium which is a tight sac around the enamel. As the tooth erupts this tissue becomes the junctional epithelium. When tooth does not erupt normally, the ameloblasts persist and form a sac lined with epithelium which may lead to formation of a dentigerous cyst. Treatment for a dentigerous cyst is surgical removal of the tooth and associated cyst lining.

Feline inductive odontogenic tumor (FIOT)

Feline inductive fibroameloblastomas is a raised submucosal soft tissue mass typically located in the rostral maxilla in young cats 8-18 months of age. The tumor is locally invasive and metastasis has not been reported. Intraoral radiographs show bone lysis, production and expansion of the maxillary and mandibular bones. and areas of mineralization within the tumor. Wide surgical excision is the treatment of choice and complete excision is considered curative.

Amyloid producing odontogenic tumors (APOT)

Although previously referred to as a calcifying epithelial odontogenic tumors, it has been determined that the amyloid producing odontogenic tumor is not equivalent to the human calcifying epithelial odontogenic tumors. The amyloid producing odontogenic tumors appear as a gingival enlargement which grows by expansion. Clinically the tumors appear similar to a squamous cell carcinoma as they are friable, ulcerated and often bleed easily. Some APOTs are darkly pigmented. It is locally invasive but not metastatic. They occur most commonly in older male cats with a median age of 9 years. It often has a cystic appearance on radiographs. Wide surgical excision is recommended. Complete surgical excision is considered curative.

Peripheral odontogenic fibroma

Peripheral odontogenic fibromas now include tumors that were previously classified as fibromatous and ossifying epulides. Peripheral odontogenic fibromas are uncommon in the cat. They can be pedunculated or sessile and may contain osseous material. Complete excision is usually curative.

Non neoplastic proliferative oral lesions

Eosinophilc granuloma

Eosinophilic granuloma can be located on the hard palate, soft palate or base of the tongue. Eosinophilic granulomas are more commonly found in young cats, 2-6 years of age. The etiology is rarely determined and it is often considered idiopathic. Treatment is usually steroids, hypoallergenic diets, RT, surgery, immunomodulation or cryosurgery. The prognosis for complete recovery is fair.

Eosinophilic ulcer

Eosinophilic ulcer is typically a well circumscribed lesion with raised edges and ulceration most frequently located on the upper lip. It is found in cats of all ages and breed, with a higher incidence in middle aged female cats.

Pyogenic granuloma

Pyogenic granuloma is a benign solitary nodules resembling granulation tissue. They are raised, friable and easily bleed. They most commonly occur at the vestibular mucogingival tissues of the mandibular first molar teeth. A pyogenic granuloma can resemble a squamous cell carcinoma clinically.

It is important to keep in mind the less common malignant oral tumors, odontogenic tumors and non-neoplastic proliferative oral lesions in the differential diagnosis list for oral masses as they are often clinically indistinguishable from common malignant oral tumors. A complete evaluation of the patient and the tumor allows the clinician to determine the appropriate treatment recommendations for oral tumors in cats.

Feline Gingivostomatitis: What We Know and How We Treat It

Cindy Charlier, DVM, DAVDC
Fox Valley Veterinary Dentistry and Surgery
Chicago, IL

Stomatitis is a term used to describe widespread inflammation of the oral cavity. Gingivostomatitis means inflammation of the gingival tissues and oral cavity. Cats with stomatitis may have inflammation or ulceration and/or proliferative lesions anywhere within the oral cavity. The lesions may involve the gingival tissues, alveolar mucosal tissues, caudal buccal mucosal tissues, the area lateral to the palatoglossal folds in the caudal oral cavity, the sublingual tissue and/or the oropharyngeal tissues.

Terms used to describe oral and oropharyngeal inflammation in the feline oral cavity include:

- Gingivitis: inflammation of the gingiva
- Periodontitis: inflammation of the non-gingival periodontal tissues (periodontal ligament and alveolar bone)
- Alveolar mucositis: inflammation of the alveolar mucosa (mucosa overlying the alveolar process and extending from the mucogingival junction without obvious demarcation to the vestibular sulcus and floor of the mouth)
- Sublingual mucositis: inflammation of the mucosa on the floor of the mouth
- Labial / buccal mucositis: inflammation of the lip / cheek mucosa
- Caudal mucositis: inflammation of the mucosa of the caudal oral cavity, bordered medially by the palatoglossal folds and fauces, dorsally by the hard and soft palate and rostrally by the alveolar and buccal mucosa
- Palatitis: inflammation of the mucosa covering the hard and soft palate
- Glossitis: inflammation of the mucosa of the dorsal and/or ventral tongue surface
- Cheilitis: inflammation of the lip (including the mucocutaneous junction area and skin of the lip)
- Osteomyelitis: inflammation of the bone and bone marrow
- Stomatitis: inflammation of the mucous lining of any of the structures in the mouth; in clinical use the term should be reserved to describe widespread oral inflammation (beyond gingivitis and periodontitis) that may also extend into submucosal tissues (i.e. marked caudal mucositis extending into submucosal tissues may be termed caudal stomatitis).

Etiology/pathogenesis

It is thought that stomatitis is a multifactorial disease where the cat's immune system responds inappropriately to chronic oral antigenic stimulation of various origins. Antigens may include plaque bacteria, feline calicivirus and food proteins. Periodontal disease, tooth resorption, as well as viral infections (FIV, Feleuk, calici, herpes) have been suggested to play a role. Genetic predisposition, food allergies, and bacteria may also play a role in feline oropharyngeal inflammation. Current thought is that cats with feline chronic gingivostomatitis have an inappropriate response or 'hyper' immune response to the dental plaque bacteria. Specific bacteria, as seen in periodontal disease, have been reported in these cats. *Pasteurella* and *Prevotella* species are more highly represented than others. Calici virus is present in 97% of cats affected by chronic oropharyngeal inflammation when compared to a control group (25%); however no cause and effect has been established. Some cats with stomatitis test positive for *Bartonella*, but again a cause and effect has not been established. We do not know for sure what causes the disease which makes treatment of the disease challenging.

Cats with chronic gingivostomatitis most often have bilateral disease. Differential diagnoses include eosinophilic granuloma complex, periodontitis, neoplasia (squamous cell carcinoma, fibrosarcoma), uremic stomatitis, caustic chemical ingestion, plant irritation, electrical cord burn, food allergies, and systemic autoimmune diseases (lupus, pemphigus).

History and clinical signs

A thorough history is the first step in evaluation of any patient with oral disease. Factors to be considered include the patient's diet, age at onset of clinical signs, onset and duration of clinical signs, environmental hazards, chronic illness, and / or systemic disease. The median age of affected cats is seven years. No gender predilection has been reported.

Clinical signs may include anorexia, weight loss, hypersalivation, pawing at the face, pain when opening the mouth or yawning, dropping food, and/or reluctance to eat hard food. The patient's haircoat may be matted and unkempt due to the decrease in self grooming that occurs secondary to oral pain. Halitosis and blood tinged saliva may also be present.

The second step in patient evaluation is a complete physical exam to evaluate all organ systems. A complete intraoral examination will help to determine the extent of disease and identify any teeth with tooth resorption or periodontal disease. A complete examination under general anesthesia including full mouth radiographs is the only way to determine the true extent of oral pathology.

Laboratory tests should include a CBC, biochemistry profile, thyroid panel and urinalysis to rule out concurrent systemic disease. A feline leukemia and FIV test should be completed to rule out concurrent viral disease. Many cats with stomatitis will have elevation

of total protein and globulins. Other tests that may be included in the patient evaluation are toxoplasmosis titer, Bartonella screening, viral testing for calici and herpes virus, immune profiles (ANA) and serum protein electrophoresis.

Treatment

Feline stomatitis is often a frustrating disease to treat. As there is no known single etiology, treatment success varies with every case. The goal of treatment is to restore the balance between the cat's immune response and the oral antigen burden. Currently there is no known medical protocol that consistently has positive *long term* results. Treating with medications usually is only masking the underlying issue of a hyperimmune response to plaque. Extraction of teeth in the vicinity of the alveolar mucositis and caudal stomatitis and extracting teeth with periodontal disease or tooth resorption in order to suppress any chronic oral antigenic stimulation has shown the best results.

The extent of disease at the time of presentation determines the appropriate first stage of treatment. If the patient presents with *very mild* disease, initial treatment includes periodontal therapy, full mouth radiographs and extraction of any teeth affected by periodontal disease or tooth resorption. The goal of treatment is to remove the bacterial plaque and bacterial byproducts that are toxic to the periodontal tissues with thorough supragingival and subgingival scaling and polishing. It is imperative to remove all inflammation within the oral cavity. Biopsy of affected tissue should be obtained to rule out neoplasia. Histopathology of the mucosa and submucosa reveals dense infiltrates of plasma cells with lesser numbers of lymphocytes, neutrophils and macrophages which is consistent with virtually any inflammation in a cat's mouth. After the procedure, daily home care is required to maintain a plaque free environment. A chlorhexidine gel applied daily may assist with plaque control. Daily brushing, if the cat will allow it, remains the most effective way to control plaque. In addition to daily brushing, use of Veterinary Oral Health Council (VOHC) accepted diets, treats and/or water additives to control plaque is recommended.

If the owner is unable or unwilling to provide homecare, or if the inflammation persists in spite of home care, or if the inflammation in the oral cavity is moderate to severe, then oral surgery to extract the premolars and molars and/or canines and incisors is recommended. The purpose of extraction is to lower the chronic antigenic stimulation from the plaque bacteria. Traditional medical therapy usually does not control the disease and resolve clinical signs. If there is no visible inflammation in the caudal buccal mucosal tissues or around the canine teeth and incisors then extraction of all of the premolars and molars is recommended. If there is periodontal disease or tooth resorption affecting the canine teeth and/or incisors they are extracted in addition to the premolars and molars. If there is inflammation involving the gingival tissue surrounding the canines and incisors or if there is inflammation in the caudal buccal mucosal tissues then initial oral surgery should be completed to extract *all* of the teeth.

With oral surgery it is essential to remove the entire tooth root. Full mouth radiographs *must* be obtained preoperatively. In each quadrant, a mucogingival flap is elevated and buccal bone is removed to expose the furcation of multi-rooted teeth. Each tooth is sectioned and the tooth roots are elevated and extracted. The alveolar bone should be smoothed with a diamond bur (alveoplasty). Each alveolus should be debrided and cleaned with either a diamond bur or hand curette to ensure removal of all tooth, root, and periodontal ligament and bone particles. Following extraction radiographs are obtained to confirm extraction of all tooth roots. NO tooth roots, root fragments or tooth remnants may remain. The periosteum of the flap is released and the alveolar gingival tissue is sutured to the lingual or palatal mucosal tissue utilizing absorbable sutures.

Pre-, intra- and postoperative analgesia is very important in these patients. Utilization of a multimodal preemptive pain management protocol is recommended.

If clinical symptoms persist after extraction of premolars and molars then the author recommends extraction of the remaining incisors and canine teeth to eliminate *all* plaque retentive surfaces. If inflammation still persists, then adjunctive medical treatment is recommended. Remember, most of these patients have had inflammation for a long time prior to presentation, so the inflammation within the oral cavity is not likely to resolve quickly after surgery. Medications may be necessary for an interim period while the patient's immune system responds. Frequent periodic monitoring of these patients is required to adjust medications and treatment based on each individual's response. There are no current studies to support the use of one particular medication over the others as the 'best' medical option.

Medical management of refractory cases

The primary goal of any treatment for a cat with gingivostomatitis is to decrease inflammation, pain, infection, and to modulate the host's immune response. Medical treatment is sometimes necessary *after* oral surgery to control disease in resistant cases.

Anti-inflammatory drugs

Use of these drugs as a sole treatment for cases with stomatitis is *not* recommended. Use of long term steroids can lead to diabetes mellitus and can decrease the body's ability to resist the inflammatory process. Often with long term use of steroids, cats seem to develop 'resistance' and their response to the drug decreases.

Prednisolone - 2 mg/kg daily for a week, then 1 mg/kg daily for a week then a maintenance dose of 0.5-1 mg/kg every other day (goal is to decrease to the lowest effective dose)

Oral triamcinolone - 1.5 mg per cat once daily for a week, then every other day for a week, then every 3 days. Then leave at twice a week for a few months and occasionally try weaning off medication. The pill can be crushed to a powder and suspended in water for administration.

Methylprednisolone acetate 15-20 mg/cat SQ every 3-6 weeks as needed

Antimicrobials

Use of antimicrobials will decrease the bacterial load in the oral cavity, but should *not* be utilized alone in cases of stomatitis. The most commonly used drugs include amoxicillin-clavulate acid, clindamycin, doxycycline and metronidazole. Azithromycin has been suggested for use in Bartonella positive cats with gingivostomatitis. Studies by Dower and Quimby did not find any correlation between cats with gingivostomatitis and Bartonella and found treatment with azithromycin unrewarding. Chlorhexidine gluconate oral rinses have a bacteriostatic action, though most cats with a painful mouth resist oral rinses. Doxycycline has an inhibitory effect on the secretion of matrix metalloproteinases (which destroy collagen and other matrix components) by gingival PMNs. Use of a submicrobial dose may result in a decrease of gingival collagen destruction. This author has used a dose of 10 mg/cat twice daily for two weeks, then once daily for two weeks, then every other day if the patient shows clinical response. Some patients may require doxycycline at the lowest effective dose forever.

Immune modulating drugs

Cyclosporine is an immunosuppressant that focuses on cell mediated immune responses. While the exact mechanism of action is unknown, it is believed that it acts by a specific, reversible inhibition of immunocompetent lymphocytes in the G_o or G_1 phase of the cell cycles. T-helper lymphocytes are the primary target, but T-suppressor cells are also affected. Lymphokine production and release (including interleukin-2, T-cell growth factor) are also inhibited by cyclosporine. Potential side effects include vomiting, diarrhea, hepatic dysfunction, impaired renal function, anemia, hypertrichosis, and gingival hyperplasia. Monitoring with complete blood counts and biochemistry profiles is recommended. Adjunct treatment with corticosteroids may be necessary.

Feline recombinant omega interferon (Virbagen Omega^R, Virbac) are immune modulating cytokines labeled for use in Europe to treat FeLV and/or FIV. It may also be of benefit in acute feline calicivirus infections and FIP. Its principle action is not as a direct anti-viral, but by acting on virus infected cells inhibiting mRNA and translation proteins, thereby inhibiting viral replication. Feline omega interferon has more antiviral effects against certain viruses than human alpha interferon. Virbagen Omega^R has been used in cats that are refractory to traditional treatments for gingivostomatitis. The therapeutic effect of interferon after oromucosal administration is due to the immunomodulatory activity through the oropharnygeal lymphoid tissues and via paracrine activity as this glycoprotein is destroyed during transit through the digestive tract. A randomized double blinded multicenter study was conducted studying calici positive cats presenting with persistent caudal stomatitis after dental extractions. The study showed that treatment with oral feline omega interferon resulted in significant clinical improvement and was found to be at least as good as short term prednisolone therapy in the treatment of calici virus positive cats presenting with caudal stomatitis after dental extractions. Virbagen Omega^R is not currently licensed for use in the US.

Other medical options

Lysine 250 - 500 mg/cat PO BID Lysine is an amino acid that is thought to compete with arginine for incorporation into many herpes viruses. As it is believed that arginine is required for producing infective virus particles, when lysine is incorporated the virus becomes less infective.

Niacinamide 500 mg ¼ tablet twice daily Used in canine medicine in combination with tetracycline to treat immune mediated skin conditions. It blocks IgE inducted histamine release and degranulation of mast cells. When used with tetracycline it may suppress leukocyte chemotaxis secondary to complement activation by antibody antigen complexes. It also inhibits phophodiesterases and decreases the release of proteases.

Esterified fatty acids

Esterified fatty acid complexes are administered orally and work transmucosally to modulate local inflammation.

Laser treatment

There is only one case study reporting the use of CO_2 laser treatment in a cat with gingivostomatitis. The study concluded that laser therapy is a viable adjunct, but should not be considered as a stand- alone modality or replacement for full mouth or nearly full mouth extractions. The goal of laser treatment is to remove the proliferative tissue to resolve the self-induced trauma and entrapment of food and debris in the tissue pockets; stimulate fibrosis to make the tissues less prone to continued inflammation and proliferation; and reduction of opportunistic bacteria. Laser treatment may also provide some pain relief as the surface nerve endings are cauterized.

Prognosis

Hennet studied the effectiveness of dental extractions: 60% of cats were clinically cured; 20% showed significant improvement with minor flare ups; 13% showed only little improvement and required continued medications; and 7% were refractory to treatment showing no improvement. A study of treatment outcome following full mouth extraction published by Girard in 2005 showed 50% resolved without further treatment, 37% improved but required continuing medical treatment and 13% did not improve. There is

continuing discussion regarding which teeth should be extracted - all premolars and molars only or extraction of all teeth (including canine teeth and incisors). There is currently no published data to support either treatment modality.

Owners of cats with stomatitis should understand that not all cats respond to treatment and this disease is often frustrating to treat. It requires consistent treatment and frequent monitoring of the cat's response to treatment.

Feline Urinalysis Update

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

Urinalysis – the body fluid of choice for disorders of the urinary tract and more

Collection of urine without contamination (non-urinary chemicals, cells, environmental elements) and without trauma to the urinary tract (which introduces cells and protein into the urine) is critical to the proper interpretation of results. The method by which urine is collected influences the cell and chemical content that will be reported, and should be clearly noted on the urinalysis form. Urine may be collected by voiding, catheterization, or cystocentesis; each method has its own advantages and disadvantages. The single most important kidney function test from the urinalysis is the degree of urine concentration as evaluated by urinary specific gravity (USG). Less than maximal urine concentration may provide clues to underlying renal and endocrine disorders. A complete urinalysis should be submitted whenever serum biochemistry and CBC are submitted in order to allow a clearer analysis of the patient's condition. Two handbooks/manuals of veterinary urinalysis are available as references.[1,2]

Voided urine

Voided samples are acceptable for evaluation of urinary specific gravity (USG). It is almost never possible to collect mid-stream voided samples from cats. Urine should NOT be expressed from the bladder of cats as trauma from this procedure often adds blood and protein to the sample. Wide fluctuations in USG do not occur throughout the day in cats as occurs in dogs, so timing of sample collection is usually not important. Non-absorbable kitty litter (e.g., Nosorb ®) placed in a cleaned and rinsed litter box may allow the collection of a voided sample from cats. Make certain there is no bleach contamination to the sample as this can give an artificially positive reaction for blood on dipstrip chemical analysis. Contamination from the distal urethra, genital tract, skin, and environment can make interpretation of results from voided urine samples difficult. Voided samples are not acceptable for bacterial culture due to the potential for heavy bacterial contamination of the sample from the distal urethra and genital tracts, although the degree of this type of contamination is far less in cats than in dogs. Analysis of a voided urine sample is often needed to determine whether blood observed from a previous sample collected by cystocenteisis was caused by the cystocentesis needle.

Catheterized urine

It is rarely justified to obtain routine urinalysis by catheter, since the possibility of introducing bacteria is always a threat to create iatrogenic urinary tract infection (UTI). If a urinary catheter is being placed for other reasons, collection of urine through the catheter may be acceptable, but some changes in the urinalysis may be the result of trauma from passing of the catheter. Routine catheterization of male cats should be avoided due to the possibility of causing urethritis and urethral obstruction following the procedure. Culture of catheterized samples may help document urinary infection. Results of urinalysis taken from animals with indwelling urinary catheters are more likely to have blood and protein present, secondary to the presence of the catheter. The initial 1-3 mL of urine from the catheter should be discarded (called a mid-stream catheterized sample), since the first few mL are most likely to be contaminated from the urethra and genital tracts.

Cystocentesis samples

In general, it is best to evaluate urine collected by cystocentesis (vesicopuncture), since this method bypasses potential contamination of the specimen with cells, protein, or bacteria from the urethra, vagina, prepuce, and perineum. This is unquestionably the method of choice for urine culture and microscopic evaluation of bacteria in sediment, since normal urine directly from the bladder should not contain any bacteria. Some problems with interpretation of results can occur when the tip of the needle has traumatized the bladder or if the bladder wall has inadvertently been aspirated into the needle during sampling (adding RBC or epithelial cells). Cystocentesis should also be avoided if there has been recent major caudal abdominal trauma due to the possibility of bladder wall devitalization from the trauma.

Cystocentesis is readily performed when the urinary bladder is palpable in cats. If the bladder is not palpable, cystocentesis should not be attempted with blind techniques as used with some success in dogs. Urinary urgency and pollakiuria can make it difficult to keep enough urine in the bladder to obtain a sample from a palpable bladder. It may be necessary to give the cat an analgesic and mild tranquilizer to decrease urgency so that the bladder will fill over the next few hours. Removing the litter tray the night before a first morning appointment increases the chances to be able to palpate the bladder and obtain a cystocentesis sample. This method is useful for cats scheduled to be examined for wellness visits or elective pre-operative procedures.

Sudden collapse following/during cystocentesis has been very uncommonly encountered in cats, probably a result of a vagal-vagal response. Though sometimes dramatic, this effect is quite transient. We have observed this in some male cats with urethral obstruction in which decompressive cystocentesis was very rapidly accomplished. A 22 gauge needle or smaller should be used for puncture of a palpable bladder using dorsal or lateral recumbency. A one-inch needle should be used for thin animals; up to a two inch needle can be used for large or obese cats. The needle should be pointed toward the pelvic inlet to allow collection of a sample as the bladder collapses without needle trauma during aspiration. Although cystocentesis can be performed in cats using dorsal recumbency, it is

safer and easier in most cases to perform the procedure with the cat restrained in lateral recumbency. The bladder can be palpated and isolated using one hand to position the bladder away from the bowel. With four fingers under the cat pull up lightly on the abdomen, using the thumb to isolate the bladder within the abdomen in the ideal position. With the other hand, direct the syringe and needle perpendicular to the body wall, through the abdomen, and into the bladder. Ultrasound (ULS) guidance usually allows cystocentesis of enough urine from a small bladder that could not be sampled during bladder palpation. Even with ULS the bladder may be too small to successfully obtain a sample. In these instances, waiting for the bladder to fill with more urine is advised. In some practices, all urine samples are obtained with ULS guidance whether the bladder is palpable or not. The advantage to this method is that it allows a brief structural evaluation of the bladder to exclude the presence of cystic calculi or bladder masses.

Performing the urinalysis

A complete urinalysis that includes evaluation of physical properties, chemical properties, and urinary sediment microscopy should always be performed when possible, otherwise potentially meaningful clinical information will not be evaluated. Acquisition of a very small urine sample volume may not allow the performance of all 3 components of the complete urinalysis, but there is almost always enough volume to analyze the chemical dipstrip and the USG. In some instances all of the small volume will be prioritized to submit for urine culture instead of components of the UA.

Should the UA be performed in-house or shipped to a veterinary referral laboratory? One answer does not fit all practice situations especially depending on technical personnel available and their level of expertise with urinalysis. UA results from fresh urine can differ from those following storage and shipping depending upon time before analysis and temperature conditions of the sample. Samples that sit overnight in the refrigerator before analysis may suffer loss of cells, loss of cellular detail, degradation of casts, and precipitation of crystals that were not there at the time of collection. To lessen the impact of this, an unstained dry mount of urine sediment may be sent along with the urine specimen allowing cellular detail to be preserved (Dr. Maxey Wellman personal communication) but this will not preserve casts or crystals for observation.

A standard quantity of urine should be centrifuged to allow semiquantitative comparison of any abnormal findings between animals or from the same animal over time. Usually 6 to10 mL is recommended for routine urinalysis, but smaller volumes are often analyzed. The volume of urine subjected to analysis should be specifically noted as used in your practice or sent to a referral laboratory. Comparison of urinary sediment results between large and small urinary volumes that were centrifuged at either high or low speed suggested minimal differences in a recent veterinary abstract but differences in the number of reported of casts were found.[3]

Urinalysis should be performed as quickly as possible following collection of the sample (within 15 to 30 minutes). Prolonged exposure of urine to room temperature before analysis can result in dissolution or degradation of delicate casts, change in pH, growth of bacterial contaminants, and loss of cellular detail due to intracellular degeneration. Refrigeration of the specimen is necessary if examination within 15 to 30 minutes after collection is not possible. The diagnostic value of the urinalysis is greatly enhanced when the urine sample is obtained prior to initiation of diuretic or intravenous fluid therapy that may alter urine concentration. Fresh urine sediment evaluation is likely to be most valuable/revealing in cats that are systemically ill or in the hospital receiving treatment.

USG is the weight of urine compared to that of distilled water. Highly concentrated urine is expected in the urine of healthy cats. USG is the only indicator of renal function in the urinalysis and consequently is very important. USG is estimated by refractometric methods that depend on the bending of light in proportion to the number of molecules dissolved in solution. Refractometers designed for analysis of human urine are often used in veterinary practices, but these have a limited range for the upper scale (1.001 to 1.035). Refractometers designed for veterinary use are more appropriate to use since the scale is calibrated from 1.001 to 1.060. USG most often exceeds 1.035 in cats with normal renal tubular function.[4] It is not acceptable to report USG values as "Greater than 1.035" or "Off the Scale," as potentially valuable quantitative information is lost regarding renal function and risk for idiopathic cystitis or urolithiasis. The refractive index for urine differs between dogs, cats, and humans, so it is best to use a veterinary refractometer that displays different scales to record the refractive index (estimate of USG) for dogs and cats.[5] Both digital and optical refractometry correlate well to urine osmolality, but digital methods remove the variability of subjective interpretation.[6]

Dipstrip reactions for urine chemistry are graded on a subjective scale from 0 to 4 plus, with 1 plus being a trace reaction and 4 plus being the most intense reaction possible. It is important that urine be at room temperature for dipstrip testing as some color reactions are temperature-dependent. Urine should be well-mixed prior to exposure to the dipstrip to ensure that all constituents of the urine will contact the reagent pads. Color reactions should be read in good light, as some of the reactions have subtle color changes, particularly notable for protein content. Highly pigmented urine (obviously bloody or dark with bilirubin) can make it difficult or impossible to accurately determine the degree of color reaction in some instances. Human dipstrip testing for WBC is very unreliable in urine from cats (many false positives).[7] Similarly, dipstrip testing should not be used to determine USG.[8] Automated devices to read the colorimetric reactions from dipstrips are becoming increasingly available in private practice and can remove some of the inherent subjectivity to reading the color reactions with the naked eye.[9,10]

Evaluation of urinary sediment

The goal of centrifugation is to concentrate otherwise undetectable abnormal urinary elements for microscopic evaluation. A pellet at the bottom may or may not be macroscopically visible following centrifugation. Sedi-Stain® may be added to the sediment to enhance contrast of cellular elements; although this is optional, it is recommended. Sedi-stain sometimes causes mucus strands to look like casts or precipitates to look like bacteria. The microscopic slide is first examined under low power to count casts and to detect areas of interest that need examination under high power. At least 10 high-dry microscopic fields are then evaluated to quantitate white blood cells, red blood cells, epithelial cells, and bacteria, and to examine crystals that might be present. Casts are counted per low-dry power field. It is a good idea to bias the examination to include the coverslip margins as elements often accumulate there. It is now easy to capture digital images of urinary sediment using a smart phone and an inexpensive adapter to the microscope eyepiece.[11] This allows a more permanent record to be captured and stored for part of the patient's medical record and also provides a means to send images to specialists for further identification of abnormal elements.

Urinary sediment from healthy animals contains very few cells or casts and no bacteria, but can contain certain crystals. The ability to properly identify red blood cells, white blood cells, and bacteria is most important. Do not expect cells in urine to look like they do on a blood film due to the widely varying effects of urinary osmolaitiy on the cells as well as that from urinary pH and urinary toxins. Highly concentrated urine will cause cells to shrink and very dilute urine will cause cells to swell. The presence of up to 5 red and 5 white blood cells per high-dry microscopic field is considered normal when the sample is obtained atraumatically by catheterization or cystocentesis. Some labs include up to 10 RBC per HPF to be "normal". Slightly higher numbers of cells (up to 8 red or white cells per HPF) may still be considered normal when a voided sample is examined. The presence of clumps of white blood cells increases the probability that an organism is the cause of pyuria, and clumps should be so noted on the form. Lipiduria is normal in cats – lipid droplets are highly refractile and vary greatly in size. Lipid droplets are often confused with RBC (and sometimes with crystals) but can be differentiated with more certainty following staining with Sudan stain.

Epithelial cells

Zero to occasional transitional epithelial cells should be present in urine from healthy cats. Transitional epithelial cells vary widely in size, and are usually rounded, but only small ones (approximately 1.5 to 2 times the size of white cells) are derived from the kidney. Unfortunately, small transitional epithelial cells can also originate from the lower urinary tract. Small transitional epithelial cells with a tail-like configuration (caudate cells) are thought to arise from the renal pelvis and consequently their presence may suggest upper urinary tract localization of disease. The presence of sheets or clumps (rafts) of transitional epithelial cells strongly suggests neoplasia, but may also occur with severe inflammation. A dry mount cytological preparation of urine should be examined for morphology of these epithelial cells if rafts are consistently identified in the urinary sediment. Squamous epithelial cells can be observed in voided specimens. These cells are of no particular significance in urine as they arise from non-urinary tract tissue.

Bacteria

When urine samples from healthy animals are properly collected and examined in a timely manner, none or very few bacteria should be seen. Particles of debris, stain precipitates, and very tiny crystals may look like cocci when subjected to Brownian motion in urine sediment, resulting in a false positive for bacteria to be reported by the laboratory. It is easier to be confident that bacteria are present when rod-shaped organisms are seen. Specimens which are reported positive for bacteria should be Gram stained or stained with Diff-Quick® for confirmation,[12-14] and a quantitative urine culture should be performed. The absence of microscopically visible bacteria does not ensure that bacteria are absent; at least 10,000 rods/mL or 100,000 cocci/mL of urine must be present to be visible during wet-mount microscopy.

Casts

Casts are molds of proteins and cells that form within the lumen of the distal tubule and should be rarely encountered in urine from healthy animals. Cellular casts in urine are always considered pathologic regardless of their quantity. Cellular casts are easily disrupted and can undergo rapid cellular degeneration. So it is essential to examine fresh urinary sediment if cellular casts are to be identified. The presence of cellular casts localizes a pathological process to the kidneys.

Cellular casts may consist of red blood cells, white blood cells, or renal tubular epithelial cells. Red blood cell casts are occasionally observed in acute glomerulitis and following severe renal trauma or renal biopsy. Acute glomerular disease is not common in cats. White blood cell casts (pus casts) are indicative of renal inflammation and are often thought to be caused by bacterial infection. Epithelial cell casts result as the lining of the renal tubule sloughs following a variety of injuries to the kidney – indicating severe tubular injury.

It is easy to identify the type of cellular cast when the morphology of the cells within the cast is well preserved. When cellular degeneration has occurred it can be difficult to tell the difference between white blood cell and epithelial cell casts. Where cell type cannot be accurately determined, the cast is referred to as a degenerating cellular cast. Since even a single cellular cast is of great diagnostic significance, it is important to note their presence. Cellular casts are especially fragile and their presence is easily missed if urine is stored too long prior to examination.

Granular casts are more commonly encountered in animals with renal disease than cellular casts. According to the classic theory of Addis, granular casts develop from degenerating renal epithelial cells, white cells, and red cells that have remained within the renal tubular lumen. Granules can also originate from precipitation of filtered serum proteins into tubular fluid.

Waxy casts consequently require the longest intrarenal time for their development. Waxy casts are translucent and sometimes take up stain intensely. They tend to be brittle, often with visible fractures and sharp, broken off ends. They are not fragile casts, and are stable for some time in alkaline or acid urine. Since it takes more intrarenal time to form this cast, their presence implies local nephron obstruction and often indicates advanced renal disease.

Hyaline casts are pure precipitates of matrix (Tamm-Horsfall) mucoprotein. Hyaline casts are transparent and have low optical density. They can be missed during brightfield microscopy if lighting intensity is not reduced. The presence of persistent hyaline casts usually indicates increased filtration of serum proteins which does not happen in healthy animals. Increased filtered proteins can occur from glomerular disease, passive congestion, and fever. Increased concentration of THP favors its precipitation – this can occur in highly concentrated urine and from increased tubular secretion. Decreased tubular flow rate and the presence of myoglbin or hemoglobin in the tubular fluid favor precipitation of THP.

Crystals

The presence of crystals in urine is often more confusing than helpful in providing meaningful information. Many amorphous crystals cannot be definitively identified based on morphology alone. Urinary pH can suggest which types of crystals are more like to precipitate out of solution at a particular pH. Crystals can be identified in those without stones, in those with stones, and sometimes in those with stones of another crystal composition, so their clinical significance is questionable in many instances. It is VERY IMPORTANT to remember that crystals can come out of solution after collection of the sample, especially during storage and even more so during refrigeration. Crystals that are reported may not have been there at the time the sample was collected.[15,16]

Struvite crystals are common in both normal and abnormal small animals and their presence in urinary sediment does not mean by this finding alone that the animal has urolithiasis due to struvite. Struvite crystals are the most common type encountered in small animals. The presence of struvite crystals is commonly encountered in urinalysis from normal dogs and cats. Struvite is easily identified when they assume the “coffin-lid” appearance but they can also assume amorphous forms. Struvite crystals form more often in alkaline urine and are commonly encountered as an artifact following storage and refrigeration.

Calcium oxalate crystals can be helpful in establishing a diagnosis of ethylene glycol (radiator fluid) poisoning in the appropriate clinical setting, but they can also be seen in the urine of healthy animals. So-called "hippurate" crystals also help to support a diagnosis of ethylene glycol poisoning, but they are really not hippurates as was once thought.[17,18] There are many different morphological appearances for calcium oxalate crystalluria, some of which are not easy to identify. These crystals are more often found in acid urine. The dihydrate form of calcium oxalate is relatively easy to recognize due to its rhomboid shape with internal Maltese cross pattern. Oxalate crystals may be an artifact of storage and refrigeration or may be associated with urolithiasis, hypercalcemia, or ethylene glycol ingestion.

The presence of cystine crystals is abnormal and in animals with urolithiasis does help to confirm their chemical composition. They are usually noted in acid urine. These hexagonal crystals are never normal and are associated with cystinuria or cystine urolithiais. These crystals may be confused with struvite crystals, but cystine crystals are flat and display little internal architecture.

Urate crystalluria is never normal in the cat. In the presence of confirmed urolithiasis their presenece suggests the chemical composition of the urinary stone. The presence of ammonium biurate, leucine, or tyrosine crystals can be seen in animals with liver disease, but are not commonly observed.

Bilirbuin crystalluria is never normal in the cat and should prompt further evaluation of liver function.

Pseudocasts/artifacts

Sometimes elements within urinary sediment will resemble casts when they are really artifacts, called pseudocasts. The presence of mucus in urine can trap debris in such a way that the resulting structure appears very similar to a cast. The pseudocast can be quite long and its diameter quite variable. Sometimes packing of crystals or many bacteria during centrifugation can produce structures that resemble casts. In these instances, examine a fresh drop of unspun urine for comparison. Squamous epithelial cells have a tendency to roll on themselves and can look like casts, but they are much larger than casts. Degenerated lower urinary tract epithelial cells can produce pseudocasts that resemble granular casts; however, usually these pseudocasts, unlike true casts, have rounded ends and walls which are not parallel.

Vegetative matter such as straw and fiber is observed frequently in specimens collected by voiding. Ova of Capillaria plica can occasionally be encountered in urine sediment of cats with and without signs of lower urinary tract disease.

Special tips - urinalysis

- Evaluate fresh sediment- everything is easier to identify
- Crystals from refrigerated urine may be artifacts– note if refrigerated
- Describe if WBC are clumped

- Look closely at clumped WBC for possible organisms
- Describe “bacteria” as cocci or rods
- Don’t rely on dipstrip pads for WBC in dogs or cats
- Don’t rely on dipstrip pads for USG
- If you see things that look like fungal elements, make sure they are not elongate bacteria.
- If fungal elements are seen, make sure they are not in the stain
- Consider Gram-stain of urine when “bacteria” are noted in the urinary sediment.
- Get pH by meter if it is important to know precise values
- Make sure you have the “real” specific gravity – not “off scale”
- Perform dispsticks on urine that has been warmed to room temperature if samples have been stored in the refrigerator
- Be careful to distinguish lipid droplets from RBC in urine from cats
- Quantitate the number of crystals, note if they are aggregating or not, and make sure to report if they were discovered in refrigerated urine

References

1. Osborne CA, Stevens JB. Urinalysis: A Clinical Guide to Compassionate Patient Care. Shawnee Mission, KS: Bayer; 1999.
2. Chew DJ, DiBartola SP. Handbook of canine and feline urinalysis. St Louis: Ralston Purina Co.The Gloyd Group 1998.
3. Layssol C, Geffr A, Braun JP, et al. Comparison of three different methods of urine canine sediment preparation for microscpic analysis In: European Society of Veterinary Clinical Pathology
(ESVCP) and European College of Veterinary Clinical Pathology (ECVCP) 11th Annual Congress. Thessaloniki, Greece – October 7–9, 2009: 2009:E-40.
4. Rishniw M, Bicalho R. Prevalence and causes of urine specific gravity ≤ 1.035 in apparently healthy cats presenting to first opinion practice. J Vet Intern Med 2013;27:741(NU-738).
5. George JW. The usefulness and limitations of hand-held refractometers in veterinary laboratory medicine: an historical and technical review. Vet Clin Pathol 2001;30:201-210.
6. Bennett AD, McKnight GE, Dodkin SJ, et al. Comparison of digital and optical hand-held refractometers for the measurement of feline urine specific gravity. J Feline Med Surg 2011;13:152-154.
7. Holan KM, Kruger JM, Gibbons SN, et al. Clinical evaluation of a leukocyte esterase test-strip for detection of feline pyuria. Vet Clin Pathol 1997;26:126-131.
8. Vonderen IKv, Kooistra HS, Bruijne JJd. Evaluation of a test strip for estimating the specific gravity of canine urine. Tijdschrift voor Diergeneeskunde 1995;120:400-402.
9. Defontis M, Bauer N, Failing K, et al. Automated and visual analysis of commercial urinary dipsticks in dogs, cats and cattle. Res Vet Sci 2013;94:440-445.
10. Bauer N, Rettig S, Moritz A. Evaluation the Clinitek status automated dipstick analysis device for semiquantitative testing of canine urine. Res Vet Sci 2008;85:467-472.
11. Mutter WP, Brown RS. Point-of-care photomicroscopy of urine. N Engl J Med 2011;364:1880-1881.
12. Way LI, Sullivan LA, Johnson V, et al. Comparison of routine urinalysis and urine Gram stain for detection of bacteriuria in dogs. J Vet Emerg Crit Care (San Antonio) 2013;23:23-28.
13. O'Neil E, Horney B, Burton S, et al. Comparison of wet-mount, Wright-Giemsa and Gram-stained urine sediment for predicting bacteriuria in dogs and cats. The Canadian veterinary journal La revue veterinaire canadienne 2013;54:1061-1066.
14. Swenson CL, Boisvert AM, Kruger JM, et al. Evaluation of modified Wright-staining of urine sediment as a method for accurate detection of bacteriuria in dogs. Journal of the American Veterinary Medical Association 2004;224:1282-1289.
15. Albasan H, Lulich JP, Osborne CA, et al. Effects of storage time and temperature on pH, specific gravity, and crystal formation in urine samples from dogs and cats. J Am Vet Med Assoc 2003;222:176-179.
16. Sturgess CP, Hesford A, Owen H, et al. An investigation into the effects of storage on the diagnosis of crystalluria in cats. J Feline Med Surg 2001;3:81-85.
17. Kramer JW, Bistline D, Sheridan P, et al. Identification of hippuric acid crystals in the urine of ethylene glycol-intoxicated dogs and cats. J Am Vet Med Assoc 1984;184:584.
18. Thrall MA, Dial SM, Winder DR. Identification of calcium oxalate monohydrate crystals by X-ray diffraction in urine of ethylene glycol-intoxicated dogs. Vet Pathol 1985;22:625-628.

Diagnosing and Treating Urinary Tract Infection in Cats

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

Urinary tract infection (UTI) exists when bacteria colonize portions of the urinary tract that are normally sterile (i.e., kidney, ureter, bladder, proximal urethra). UTI most commonly affects the bladder. Bacterial colonization may be superficial along the mucosa, or deeper within the mucosa or submucosa. Bacterial UTI is far less commonly diagnosed in cats compared to dogs and is estimated to affect 1-3% of cats in their lifetime. Dogs with no identifiable anatomical, metabolic, or urinary functional problems of the urethra or bladder can acquire UTI, which is quite different for UTI that develops in most cats. Cats that develop UTI are by definition considered "complicated" since healthy cats have exquisite urinary tract defense systems that simply do not allow a "casual" development of UTI. Cats with bacterial UTI will most often be discovered to have anatomical, metabolic, or functional problems of the bladder or urethra, or have undergone urinary tract instrumentation (e.g. urinary catheterization) that facilitate bacterial ascent and colonization of the urinary tract.

Diagnosis

Various combinations of hematuria, pyuria, and bacteriuria are observed in urinary sediment from cats with LUT signs associated with a positive quantitative urine culture (clinical UTI). In cats without LUT signs evaluated for other reasons, a positive urine culture in substantial quantity can be documented (occult or asymptomatic UTI – discussed later). The isolation of bacteria in large quantities does not determine whether the UTI is located in the upper or lower urinary tract, if the UTI is chronic or acute, or if the infection is deep within tissue or superficial along the mucosa.

It is important to remember that many particles in urinary sediment from cats, more so than dogs, resemble bacteria – lipid droplets, small crystals, cellular fragments, mucus, stain precipitates. Dry-mount examination of urinary sediment following either Wright's-Giemsa or Gram stain to further identify bacteria in urinary sediment from cats increases the certainty that UTI really exists or it does not.[1] Urinalysis and aerobic quantitative urine culture reported in colony-forming units per milliliter (cfu/mL) should be conducted in all cats suspected of having a UTI. Isolation of organisms in large quantitative growth (cfu/mL) from a properly collected and handled sample is the gold standard for definitive diagnosis. The number of cfu/mL needed to definitively confirm the existence of UTI varies depending on how the urine is collected and whether clinical signs are present. Lower cfu/ml are often considered clinically significant in patients with increased voiding frequency in which organisms may be eliminated from the bladder before they have time to replicate to higher numbers.

Do not submit sterile swabs soaked or dipped in urine since quantitative culture methods cannot be performed on this type of sample. Culture of urine following cystocentesis is the method of choice to most easily establish a definitive diagnosis of UTI as this bypasses potential contamination with organisms from the distal urethra or genital tract.[2,3] Far less contamination with bacterial organisms occurs during collection of voided or catheterized urine samples from cats compared to dogs. In 24 samples from healthy cats of both sexes, no growth occurred when urine was collected by cystocentesis. Minimal cfu/ml of bacterial growth occurred from samples collected by urinary catheter. In 9 of 12 samples from male cats no growth occurred; 3 samples grew between 10 and 100 cfu/ml. No growth occurred in 11 of 12 samples from female cats in samples collected by catheter; in 1 sample between 100 and 1,000 cfu/ml growth occurred. Quantitative growth (cfu/ml) was much greater in both male and female cats from urine samples collected by voiding. Organisms grew from all 11 urine samples collected by voiding from male cats. Quantitative growth ranged from 100 to > 100,000 cfu/ml in these samples; in 6 of 11 samples, growth exceeded 1,000 cfu/ml (> 10,000 cfu/ml in 2 samples). No growth occurred in 5 of 12 samples collected by voiding from female cats; in 4 of 7 positive cultures, growth was 1,000 to 10,000 cfu/ml and in 1 > 100,000 cfu/ml. In samples with positive growth, more than one organism was frequently isolated. *Escherichia coli, Staphylococcus* spp, *Streptococcus* spp, *Corynebacterium* spp, *Pasteurella* spp, and *Flavobacterium* spp were the organisms isolated in decreasing frequency from the urine of these normal cats.[4]

True bacterial UTI is likely in cats when ≥ 1,000 cfu/ml of organisms are isolated from urine collected by cystocentesis; < 1,000 cfu/ml is more likely to be from contamination during the collection process. Low-level growth from cystocentesis samples is possible in cats with true UTI when antibacterial treatment has been given recently. UTI is likely to exist when ≥ 1,000 cfu/ml are isolated from urine collected by urinary catheterization from either male or female cats; < 1,000 cfu/ml is most likely associated with contamination. Some criteria state that UTI is likely in cats isolating ≥ 10,000 cfu/ml from voided urine[5], but this may not always be true since high level contamination occasionally occurs in both male and female cats using this method of collection.[4] Culture of voided urine is not recommended since high level growth can occur from contamination rather than indicating true UTI, though no growth on voided urine samples does provide meaningful information.

The Uricult® Vet dip paddle system (LifeSign, Skillman, NJ) can be a useful in-house screening tool for identification of bacterial growth.[6] Quantitative results (cfu/mL) determined by comparing growth on the paddles with a standard illustration of organism

density provided by the manufacturer were not always accurate. Inaccuracy in identification of isolated organisms sometimes occurred when paddles were used, particularly when multiple uropathogens were present. This paddle system provides no method for susceptibility testing of isolated organisms, although the bacteria can be categorized into gram-positive or gram-negative status. When growth occurs, paddles or a fresh urine sample should be submitted to a commercial microbiology laboratory for identification and antimicrobial susceptibility testing. Veterinary hospitals should determine whether their referral microbiology laboratory will accept organisms already growing on paddles for definitive identification and minimum inhibitory concentration (MIC) testing. This paddle system for organism isolation appears most clinically useful as an in-house method to identify urine samples that are sterile or samples with low quantitative growth compatible with contamination during the sample collection.[6]

The Accutest Uriscreen® is an in-house color reaction based test designed to rapidly detect catalase from bacteria and from cells in the urine sample from dogs and cats. A negative test supports that UTI does not exist but there are false positives for UTI, so a positive test necessitates a follow-up quantitative urine culture.[7]

Organisms isolated from cats with UTI

Twenty-five percent of urine cultures from cats not biased toward those diagnosed with urinary disease were positive for bacterial growth considered indicative of a UTI in one report from a teaching hospital. The criteria to establish a UTI included any growth in a cystocentesis sample, ≥ 1,000 cfu/ml in catheterized samples, and ≥ 10,000 cfu/ml in voided urine. The number of cats with true UTI is likely overestimated in this study due to the entry criteria. Eighteen bacterial species were isolated in this study. *E. coli* accounted for 47% of the isolates, *Staphylococcus* spp for 18%, and *Streptococcus* spp for 13%. A single bacterial isolate occurred in 85%; > 1 isolate occurred in 15% of the positive cultures. The USG of cats infected with E. coli tended to be < 1.025 whereas those infected with Staph or Strep were usually > 1.025. Older female cats were over represented, as were Siamese cats.[8] *E.coli* and gram positive cocci were also the most commonly isolated organisms from Australian cats with UTI in other reports. Older female cats were also more likely to have a positive urine culture as in the previously mentioned study. *E. coli* was isolated in 37% of the positive cultures, *Enterococcus* species in 29%, *Staphylococcus felis* in 20% and *Proteus* species in 5%. *Enterococcus fecalis* accounted for 95% of enterococci spp with the remainder by *enterococcus faecium*. [9,10] *Enterocccus* accounted for 19% of positive urine culture from cats evaluated at the OSU CVM.[11] *Staphylococcus felis* is a coagulase-negative organism that has traditionally been considered a normal commensal organism from healthy cats present on the skin, eyelid margins, conjunctival sac, and in saliva, but appears that this organism can be a uropathogen for the cat.[9]

Occult UTI was documented in 38 of 132 urine specimens (44 isolates) collected by cystocentesis from cats without LUT signs, inappropriate urination, or previous UTI – these samples were submitted as part of other diagnostic workups for a variety of conditions including CKD, hypethyroidism, and diabetes mellitus. Hematuria and pyuria were common in the urinalyses from urine culture-positive cats and culture-positive urine specimens were more likely to come from older female cats. *Enterococcus faecalis* was the most common isolate (19 of 44 total isolates) followed by E. coli (17 of 44 isolates). A few isolates of *Proteus mirabilis*, *Staphylococcus felis*, and *Streptococcus bovis* were also documented in this group of cats. Heavy growth of bacteria at ≥ 100,000 cfu/mL was documented in 39 of 44 isolates and moderate growth at 10,000 to 100,000 cfu/mL was found in 5 of 44 isolates.[12] Occult bacteriuria that is either persistent or transient has been described in apparently healthy dogs or those presented for elective surgical procedures[13,14] but this has not been reported in healthy cats. Urine was collected by cystocentesis from 108 healthy cats (53 males and 55 females) with a median age of 4.0 years without previous or current LUT signs. Both urine and urine sediment underwent quantitative culture resulting in no growth in 107 of 108 samples. In the remaining sample >100,000 cfu/mL of 2 organisms was isolated, likely the result of contamination. [15]

A unique form of relapsing UTI is caused by *Corynebacterium urealyticum*[16,17] or *corynebacterium jeikeium* [18] in which encrustations of urinary tissue and struvite (so-called “encrusting cystitis”) prevent eradication of the organism with medical treatment alone. These organisms are rarely isolated as a cause for UTI in cats but may be under-diagnosed. These organisms are often reported as “dipitheroids” thought to be contaminants that are not further characterized. These organisms are often slow growing and require special media to facilitate their growth and identification. These organisms are highly resistant to commonly prescribed urinary antibacterials and the prognosis for cure is generally poor even with surgery and long-term antibiotics.

Conditions associated with UTI in cats

UTI occurs with increased frequency in special populations of cats that include those with metabolic disease (CKD, hyperthyroidism, diabetes mellitus), prior instrumentation of the urinary tract with urinary catheterization, urinary incontinence, acquired anatomical abnormalities (stones, tumors, perineal urethrostomy), and congenital anomalies. Chronic kidney disease (CKD), hyperthyroidism, and/or diabetes mellitus all increase the risk for cats to acquire a true bacterial UTI, [19] though clinical signs of UTI may not be present (asymptomatic bacteriuria). In one study 10–15% of cats with hyperthyroidism, diabetes mellitus or chronic renal disease had a bacterial UTI,[12] similar to findings of other studies.[19-21]

In a report comparing 155 cats with UTI to 186 cats without UTI, significant risk factors to acquire UTI were identified for cats with urinary incontinence, transurethral procedures, gastrointestinal diseases, decreased body weight, and decreased urine specific gravity. In this study, 35.5% of cats had no clinical signs associated with their UTI (asymptomatic bacteriuria). UTI in this study was defined as any growth from samples collected by cystocentesis and > 10^3 cfu/mL from samples collected by urethral catheterization[22]. Decreased urinary specific gravity was not identified as a risk for UTI in cats of another study.[19]

An early report drew attention to the apparently high rate of UTI in cats with azotemic CKD. Five of 15 CKD cat urine samples without obvious bacteriuria in urinary sediment grew organisms and 12 of 19 CKD cats with bacteriuria grew organisms. Whether or not these CKD cats had LUT signs associated with a positive urine culture was not addressed.[23] The finding of a positive urine culture in cats with CKD could be associated with infection within the kidneys but often this cannot be proven to exist. In a study of 42 female and 44 male cats with CKD undergoing routine urine culture surveillance, positive urine cultures in samples collected by cystocentesis were identified 31 times from 25 cats over a period up to 3 year of their CKD. Eighteen of the 25 cats (72%) were classified as having occult UTI. Eighty-seven percent of cats with positive urine cultures were found to have active urinary sediment. Increasing age was a significant risk factor to acquire occult UTI in female CKD cats. The presence of UTI was not associated with the severity of azotemia or survival in these cats[24].

The frequency of UTI in reports of young cats with non-obstructive LUT signs is quite low (often reported at less than 2%) in most studies in North America, the UK and Europe. [25-31]. Idiopathic/interstitial cystitis accounts for 60 to 70% of diagnoses in cats presenting for some form of urinary urgency. In cats older than 10 years, UTI appeared to be quite common (>50%) in those evaluated for signs of urinary urgency; idiopathic cystitis accounted for only 5% of cases in this group of cats.[32,33]

A study in 2007 of cats from Norway with a variety of obstructive and non-obstructive causes of LUT signs[34] found a surprisingly high number of cats with positive urine culture in large quantitative growth, far more so than in other reports. Findings from this study are difficult to interpret since many of the cultures were from voided midstream (46%) or catheterized urine samples (21%) rather than from the gold standard of cystocentesis (21%); in 10% the method of urine collection was not recorded. 44 of 118 samples cultured on the same day isolated bacteria > 10^3 cfu/ml. In 33 of these 44 samples, growth was > 10^4 cfu/ml and in 20 growth was > 10^5 cfu/ml. Quantitative growth from midstream voided samples from healthy cats is sometimes substantial as was shown in 55% of males and 40% of females that grew > 10^3 cfu/ml in another study [4].

Congenital anomalies of the urinary tract are occasionally the cause of UTI in young cats. Any condition associated with non-urge related incontinence can be expected to be associated with UTI. A common urogenital sinus malformation was found as the underlying cause for UTI and incontinence in 3 young female cats that were evaluated for recurrent lower urinary tract infections and incontinence (Ohio State University CVM 2014 – publication in preparation). Fusion of the vagina to the proximal urethra created a single vaginourethra. No vestibule existed as the vulva and urethra appeared as a continuous structure that allowed easy fecal contamination. Cystoscopy was the diagnostic tool used in these cases to confirm the abnormal anatomical status. Partial invagination of the urinary bladder was diagnosed in one cat with clinical signs of hematuria, stranguria, and inappropriate urination associated with UTI. This diagnosis may be made on the basis of detection of invaginated tissue in the bladder apex during abdominal ultrasonography.[35]

Treatment

Antibacterial susceptibility testing on isolated organisms is recommended to guide the best treatment selection. Results can reveal the presence of resistance organisms that can predict treatment failure and the need for greater surveillance following treatment. A change in urinary antimicrobial may be needed based on the results of susceptibility testing after the initial treatment was started at the time of submission of the culture.

The Working Group of the International Society for Companion Animal Infectious Diseases (ISCAID) recommends treatment with urinary antibacterial drugs that are likely to be effective against more than 90% of the urinary isolates when this information is available. In general, ISCAID recommends initial therapy for uncomplicated UTI with amoxicillin (11–15 mg/kg PO q8h) or trimethoprim–sulfonamide (TMP-sulfa; 15 mg/kg PO q12h); the group does not recommend amoxicillin–clavulanate for initial treatment in these cases because of lack of evidence for the need for clavulanate in addition to amoxicillin.[36] Additional detail and a free PDF download of this work published by Veterinary Medicine International is available at http://www.hindawi.com/journals/vmi/2011/263768/.

Amoxicillin/clavulanic acid was recommended for Gram-negative infections and amoxicillin for Gram-positive infections in one review of cats with UTI. Variation in bacterial prevalence and susceptibility patterns should also be taken into account when prescribing antibacterial treatment[10] Most isolates of *E.coli* in one study showed susceptibility to the 14 antimicrobials tested. *Staphylococcus* felis was susceptible to all antimicrobial agents tested. Enterococcus was universally sensitive to amoxicillin/clavulante and penicillin/amoxicillin in 2 studies of UTI in cats by the same group.[9,12] *Enterococcus faecalis* can vary greatly in its susceptibility pattern to antimicrobial agents and so may require higher dosage, longer duration or a combination of

therapeutic agents in some patients with overt LUT signs. A high proportion of *Enterococcus* isolates were resistant to clindamycin (97.3%) and cephalothin (72.3%). *Enterococcus* had intermediate susceptibility to enrofloxacin, (61.1%) and marbofloxacin (80.5%).[9] All cephalosporins, potentiated sulfas, and aminoglycosides are notoriously ineffective against *Enterococcus* even when the susceptibility test results return as sensitive for those drugs. *Enterococcus* is usually susceptible to imipenem and meropenem BUT use of these drugs should be restricted to those cases that have LUT signs and have failed treatment with amoxicillin or amoxicillin-clavulante. Current recommendations are to NOT treat asymptomatic UTI associated with *enterococcus* since this infection can come and go without treatment. Aggressive treatment for asymptomatic UTI runs the risk that the original *enterococcus* will become more resistant and then become symptomatic when it was not before. There is also the possibility that the *enterococcus* will be eradicated, but UTI with a more virulent and symptomatic organism will take its place.

Resistance patterns were reported for isolates of *E. coli* mostly from urine of dogs (301)and cats (75) in various regions of the United States. Resistance to amoxicillin was 46%, amoxicillin-clavulanate 37%, cefpodoxime 22%, doxycycline 22%, enrofloxacin 21%, trimethoprim-sufla 19%, and gentamicin at 12%. This pattern for E. coli resistance suggests that empirical treatment for UTI may have limited success in this geographic location. Treatment of *E. coli* with amoxicillin or with amoxicillin-clavulanate may be less likely to be effective than commonly believed.[37]

An early report documented the effectiveness of enrofloxacin treatment of UTI in cats. In this study all isolates were considered susceptible to enrofloxacin and post treatment sterility was documented in 21 of 23 cats.[38] As noted above, there are concerns for increasing resistance patterns for *E. coli* in the United States; there are no recent reports of UTI in cats treated with enrofloxacin. The total daily dose of enrofloxacin in cats should be limited to 5 mg/kg either once daily, or divided in order to limit retinal toxicity. Retinal toxicity is a fluroquinolone class risk, especially for those that achieve the highest retinal concentrations and can result in mydriasis and blindness.[39,40] It appears that cats as a species have developed a limited efflux mechanism to remove fluoroquinolones from the retina compared to other species.[41] High-dose short-duration protocols prescribing enrofloxacin to treat UTI have been developed for use in dogs with uncomplicated UTI[42] but these protocols should NEVER be used in cats due to retinotoxicity that predictably develops at high doses. Administration of the 3rd generationi fluroquinolone pradofloxacin at 6 to 10 times the recommended dose was shown to have no retinal toxic effects in cats based on rod and cone function evaluated with ERG. Retinal histopathology was unaltered during high dose pradofloxacin treatment. Cats treated with high doses of enrofloxacin showed diffuse retinal degeneration and poor rod and cone function.[40]

Cefovecin is an extended spectrum semi-synthetic 3rd generation cephalosporin approved in Europe for use in cats with UTI caused by *E. coli*, but not approved for this indication in the United States. It is designed to have a 14-day dosing interval after a single subcutaneous injection. Post treatment urine cultures revealed sterile urine in 75.9% of all cats treated with a single injection of cefovencin. *Escherichia coli* was eliminated in 76.7 per cent of cefovecin-treated cats compared with 62.5 per cent of cephalexin-treated cats. Cefovecin demonstrated statistical non-inferiority compared with cephalexin for bacterial

elimination in this study. [43] Efficacy of cefovecin to sterilize the urine in cats with UTI was less than that reported by the same group in dogs with UTI.[44]

Client-owned cats with bacteriologically confirmed UTI were treated with either pradofloxacin, doxycycline, or amoxicillin-clavulante[45] Urine culture revealed growth following treatment in 0 of 27 cats treated with pradofloxacin, 3 of 23 cats treated with doxycycline, and in 3 of 28 cats treated with amoxicillin-clavulante.[45] Pradofloxacin undergoes more hepatic excretion than does enrofloxacin but still achieves urinary concentrations that can be highly effective in the eradication of uropathogens. Pradofloxacin may be the preferred fluoroquinolone to prescribe for use in cats with UTI and impaired renal function due to the hepatic pathway for its excretion and its retinal safety profile should high concentrations of pradofloxacin accumulate in cats with decreased renal function. Pradofloxacin is FDA approved for soft tissue infections in cats; it can be considered for off-label treatment of UTI in cats.

Study of canine and feline *E.coli* isolates that were considered highly resistant to standard antimicrobial agents showed susceptibility to fosfomycin at concentrations well below the susceptible breakpoint. This finding makes it attractive to consider fosfomycin as a treatment for resistant *E. coli*.[46] Fosfomycin is considered a nephroprotectant in some species but in cats this drug can be highly nephrotoxic. When given to experimental cats for as little as 3 days, severe tubular lesions were evident and renal function declilned as BUN and serum creatinine increased.[47]

The recommendation of 7 to 14 days of an appropriate antimicrobial for treatment of an uncomplicated lower UTI has been based on conventional experience over the years, but surprisingly little data exist to support or refute these protocols. Ultimately, antimicrobials should be given for as long as is necessary to effect a bacteriologically sterile urine during administration of the medication and for a protracted time following discontinuation of treatment.

References

O'Neil E, Horney B, Burton S, Lewis PJ, MacKenzie A, Stryhn H. Comparison of wet-mount, Wright-Giemsa and Gram-stained urine sediment for predicting bacteriuria in dogs and cats. Can Vet J 2013;54:1061-1066.

Duijkeren Ev, Laar Pv, Houwers DJ. Cystocentesis is essential for reliable diagnosis of urinary tract infections in cats. Tijdschrift voor Diergeneeskunde 2004;129:394-396.
Ling GV. Antepubic cystocentesis in the dog: an aseptic technique for routine collection of urine. California Veterinarian 1976;30:50-52.
Lees GE, Simpson RB, Green RA. Results of analyses and bacterial cultures of urine specimens obtained from clinically normal cats by three methods. J Am Vet Med Assoc 1984;184:449-454.
Lees GE. Bacterial urinary tract infections. Vet Clin North Am Small Anim Pract 1996;26:297-304.
Ybarra WL, Sykes JE, Wang Y, Byrne BA, Westropp JL. Performance of a veterinary urine dipstick paddle system for diagnosis and identification of urinary tract infections in dogs and cats. J Am Vet Med Assoc 2014;244:814-819.
Kvitko-White HL, Cook AK, Nabity MB, Zhang S, Lawhon SD. Evaluation of a catalase-based urine test for the detection of urinary tract infection in dogs and cats. J Vet Intern Med 2013;27:1379-1384.
Davidson AP, Ling GV, Stevens F, Franti CE, Johnson DL, Lang SS. Urinary tract infection in cats: a retrospective study 1977-1989. California Veterinarian 1992;46:32-34.
Litster A, Moss SM, Honnery M, Rees B, Trott DJ. Prevalence of bacterial species in cats with clinical signs of lower urinary tract disease: recognition of Staphylococcus felis as a possible feline urinary tract pathogen. Veterinary Microbiology 2007;121:182-188.
Litster A, Thompson M, Moss S, Trott D. Feline bacterial urinary tract infections: An update on an evolving clinical problem. Vet J 2011;187:18-22.
Chew DJ, DiBartola SP, Schenck PA. Cystitis and urethritis: urinary tract Iinfection In: Chew DJ, DiBartola SP,Schenck PA, eds. Canine and feline nephrology and urolopgy, second edition: Elsevier Saunders, 2011;240-280.
Litster A, Moss S, Platell J, Trott DJ. Occult bacterial lower urinary tract infections in cats - urinalysis and culture findings. Veterinary Microbiology 2009;136:130-134.
Wan SY, Hartmann FA, Jooss MK, Viviano KR. Prevalence and clinical outcome of subclinical bacteriuria in female dogs. J Am Vet Med Assoc 2014;245:106-112.
McGhie JA, Stayt J, Hosgood GL. Prevalence of bacteriuria in dogs without clinical signs of urinary tract infection presenting for elective surgical procedures. Aust Vet J 2014;92:33-37.
Eggertsdottir AV, Saevik BK, Halvorsen I, Sorum H. Occurrence of occult bacteriuria in healthy cats. Journal of feline medicine and surgery 2011;13:800-803.
Bailiff NL, Westropp JL, Jang SS, Ling GV. Corynebacterium urealyticum urinary tract infection in dogs and cats: 7 cases (1996-2003). J Am Vet Med Assoc 2005;226:1676-1680.
Cavana P, Zanatta R, Nebbia P, Miniscalco B, Vittone V, Zanoni MG, Serra R, Farca AM. Corynebacterium urealyticum urinary tract infection in a cat with urethral obstruction. J Feline Med Surg 2008;10:269-273.
Puskar M, Lemons C, Papich MG, Vaden SL, Birkenheuer A. Antibiotic-resistant Corynebacterium jeikeium urinary tract infection in a cat. J Am Anim Hosp Assoc 2007;43:61-64.
Bailiff NL, Westropp JL, Nelson RW, Sykes JE, Owens SD, Kass PH. Evaluation of urine specific gravity and urine sediment as risk factors for urinary tract infections in cats. Veterinary clinical pathology / American Society for Veterinary Clinical Pathology 2008;37:317-322.
Mayer-Roenne B, Goldstein RE, Erb HN. Urinary tract infections in cats with hyperthyroidism, diabetes mellitus and chronic kidney disease. J Feline Med Surg 2007;9:124-132.
Bailiff NL, Nelson RW, Feldman EC, Westropp JL, Ling GV, Jang SS, Kass PH. Frequency and risk factors for urinary tract infection in cats with diabetes mellitus. Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2006;20:850-855.
Martinez-Ruzafa I, Kruger JM, Miller R, Swenson CL, Bolin CA, Kaneene JB. Clinical features and risk factors for development of urinary tract infections in cats. Journal of feline medicine and surgery 2012;14:729-740.
Lulich JP, O'Brien TD, Osborne CA, Polzin DJ. Feline renal failure: questions, answers, questions. Compendium on Continuing Education for the Practicing Veterinarian 1992;14:127...152.
White JD, Stevenson M, Malik R, Snow D, Norris JM. Urinary tract infections in cats with chronic kidney disease. Journal of feline medicine and surgery 2013;15:459-465.
Buffington CA, Chew DJ, Kendall MS, Scrivani PV, Thompson SB, Blaisdell JL, Woodworth BE. Clinical evaluation of cats with nonobstructive urinary tract diseases. J Am Vet Med Assoc 1997;210:46-50.
Kruger JM, Osborne CA, Goyal SM, Wickstrom SL, Johnston GR, Fletcher TF, Brown PA. Clinical evaluation of cats with lower urinary tract disease. J Am Vet Med Assoc 1991;199:211-216.
Defauw PA, Van de Maele I, Duchateau L, Polis IE, Saunders JH, Daminet S. Risk factors and clinical presentation of cats with feline idiopathic cystitis. J Feline Med Surg 2011;13:967-975.
Gerber B, Boretti FS, Kley S, Laluha P, Muller C, Sieber N, Unterer S, Wenger M, Fluckiger M, Glaus T, Reusch CE. Evaluation of clinical signs and causes of lower urinary tract disease in European cats. J Small Anim Pract 2005;46:571-577.
Barsanti JA, Brown J, Marks A, Reece L, Greene CE, Finco DR. Relationship of lower urinary tract signs to seropositivity for feline immunodeficiency virus in cats. J Vet Intern Med 1996;10:34-38.
Gunn-Moore DA, Cameron ME. A pilot study using synthetic feline facial pheromone for the management of feline idiopathic cystitis. J Feline Med Surg 2004;6:133-138.
Gunn-Moore DA, Shenoy CM. Oral glucosamine and the management of feline idiopathic cystitis. J Feline Med Surg 2004;6:219-225.
Bartges J. Lower urinary tract diseases in geriatric cats. American College of Veterinary Internal Medicine Forum 1997: 322–324.
Bartges JW, Barsanti JA. Bacterial urinary tract infection in cats In: Bonagura JD, ed. Kirk's current veterinary therapy XIII: small animal practice. Philadelphia: W.B. Saunders, 2000;880-882.
Eggertsdottir AV, Lund HS, Krontveit R, Sorum H. Bacteriuria in cats with feline lower urinary tract disease: a clinical study of 134 cases in Norway. Journal of feline medicine and surgery 2007;9:458-465.

Adin CA, Chew DJ, Heng HG, Townsend KL, Karnik K. Bladder inversion and secondary hematuria in a 6-month-old domestic shorthair cat. Journal of the American Veterinary Medical Association 2011;239:370-373.
Weese JS, J.M. B, Boothe D, Breitschwerdt EB, Guardabassi L, Hillier A, Lloyd DH, Papich MG, Rankin SC, Turnidge JD, Sykes JE. Antimicrobial use guidelines for treatment of urinary tract disease in dogs and cats: antimicrobial guidelines Working Group of the International Society for Companion Animal Infectious Diseases. Veterinary Medicine International 2011;2011 Article ID 263768.
Boothe D, Smaha T, Carpenter DM, Shaheen B, Hatchcock T. Antimicrobial resistance and pharmacodynamics of canine and feline pathogenic E. coli in the United States. Journal of the American Animal Hospital Association 2012;48:379-389.
Murasugi E, Amamori T, Ishii S, Matsou K, Watabe S, Hatakeyama H, Sekiguchi N, Fukumoto K. Clinical efficacy of enrofloxacin in dogs and cats with urinary tract infection. Journal of Veterinary Medicine, Japan 1995;48:801-806.
Gelatt KN, van der Woerdt A, Ketring KL, Andrew SE, Brooks DE, Biros DJ, Denis HM, Cutler TJ. Enrofloxacin-associated retinal degeneration in cats. Veterinary ophthalmology 2001;4:99-106.
Messias A, Gekeler F, Wegener A, Dietz K, Kohler K, Zrenner E. Retinal safety of a new fluoroquinolone, pradofloxacin, in cats: assessment with electroretinography. Documenta ophthalmologica Advances in ophthalmology 2008;116:177-191.
Ramirez CJ, Minch JD, Gay JM, Lahmers SM, Guerra DJ, Haldorson GJ, Schneider T, Mealey KL. Molecular genetic basis for fluoroquinolone-induced retinal degeneration in cats. Pharmacogenetics and genomics 2011;21:66-75.
Westropp JL, Sykes JE, Irom S, Daniels JB, Smith A, Keil D, Settje T, Wang Y, Chew DJ. Evaluation of the efficacy and safety of high dose short duration enrofloxacin treatment regimen for uncomplicated urinary tract infections in dogs. J Vet Intern Med 2012;26:506-512.
Passmore CA, Sherington J, Stegemann MR. Efficacy and safety of cefovecin for the treatment of urinary tract infections in cats. J Small Anim Pract 2008;49:295-301.
Passmore CA, Sherington J, Stegemann MR. Efficacy and safety of cefovecin (Convenia) for the treatment of urinary tract infections in dogs. J Small Anim Pract 2007;48:139-144.
Litster A, Moss S, Honnery M, Rees B, Edingloh M, Trott D. Clinical efficacy and palatability of pradofloxacin 2.5% oral suspension for the treatment of bacterial lower urinary tract infections in cats. Journal of Veterinary Internal Medicine 2007;21:990-995.
Hubka P, Boothe DM. In vitro susceptibility of canine and feline Escherichia coli to fosfomycin. Veterinary Microbiology 2011;149:277-282.
Fukata T, Imai N, Shibata S. Acute renal insufficiency in cats after fosfomycin administration. Vet Rec 2008;163:337-338.

Managing Cats with Idiopathic/Interstitial Cystitis (Parts 1 and 2)

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

What is Pandora syndrome ?

Is this terminology more helpful than FUS or FLUTD or IC ?

Results of studies over the past 20 years indicate that idiopathic/interstitial cystitis in cats is the result of complex interactions between the bladder, nervous system, adrenal glands, husbandry practices, and the environment in which the cat lives. A recent review emphasizes that many cats with a diagnosis of FIC have lower urinary tract- predominant clinical signs that are part of a larger systemic disorder referred to as "Pandora Syndrome"[1]. Clinical problems outside the lower urinary tract are common in those with a diagnosis of FIC and include signs related to the GI tract, respiratory system, skin, central nervous system, cardiovascular system and the immune system. It has been traditional to refer to cats that have obvious LUT signs as those having "feline urological syndrome", "feline lower urinary tract disease", or "feline interstitial cystitis" but this method of naming the disease focuses on the organ with the predominant clinical sign rather than a thorough evaluation of the entire cat and all of its organ systems. A diagnosis of Pandora Syndrome would apply to those cats that exhibit clinical signs in other organ systems (in addition to the LUT), waxing and waning of clinical signs associated with stressful events that presumably activate the stress response system, and undergo resolution of severity of clinical signs following effective environmental enrichment. Currently available evidence suggests that many cases of chronic idiopathic LUT signs presently diagnosed as having FIC actually do have a ''Pandora'' syndrome. The syndrome might result from early adverse experiences that sensitize the neuraxis to sensory input, increasing the frequency and duration of activation of the stress response system (SRS) when the individual is housed/living in a provocative environment. The chronic ''wear and tear'' of persistent activation of the SRS can upregulate the inflammatory response in a variety of tissues including the bladder.

Are there different types of presentations for cats with idiopathic/interstitial cystitis ?

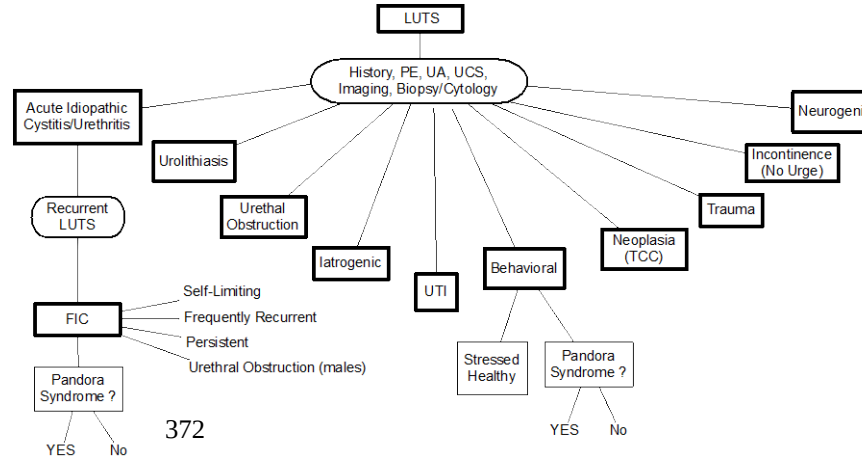
There are four possible urinary presentations associated with FIC. An acute seemingly self-limiting episode of FIC is thought to be the most common condition presenting to primary care practitioners with an estimated relative prevalence of 80 to 95%(Lulich ACVIM Forum Proceedings Anaheim 2010) – recurrence is likely if stressful situations become severe enough in the future. Frequently recurrent episodes of clinical signs related to FIC is next in occurrence (2 to 15%), followed by persistent forms of FIC (2 to 15%) in which the clinical signs never abate. The fourth possibility is for urethral obstruction to develop in male cats suffering from FIC (15 to 25%). These 4 types of presentations may represent a spectrum of signs from the same disease process, but this hypothesis has not been tested. Most publications reflect data from cats with frequent recurrences or persistent clinical signs that are presented to university referral practices. Based on our data, a potential fifth category could be healthy cats, especially males, that develop LUT signs when when exposed to sufficient stressors[2].

What are the differential diagnoses for cats with LUT signs?

Though FIC is the most common diagnosis associated with LUTS in young cats, it is important to exclude the diagnosis of bacterial UTI and urolithiasis in a population of cats with risk factors. Collection of a detailed history that includes queries regarding environmental issues and husbandry practices is an essential first step in deciding if the LUTS are related to irritative voidings or not, and how likely stress may be playing a role. In order to determine if Pandora Syndrome is part of the LUTS, the history and physical examination must be extended beyond that immediately related to the urinary tract. Quantitative urine culture and survey radiography are recommended in the evaluation of all cats with recurrent LUTS to exclude UTI and radiopaque calculi. Advanced imaging that includes contrast radiography, ultrasonography, and urethra-cystoscopy are useful for the exclusion of anatomical defects, radiolucent calculi, and proliferative lesions in some cats.

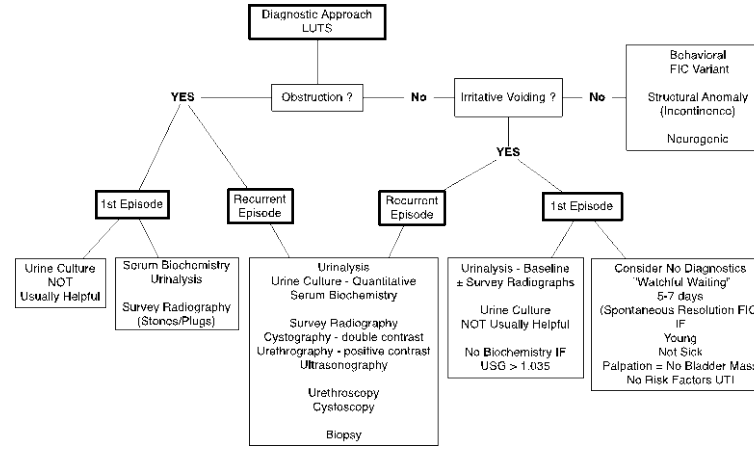
Figure 1.

Some possible causes of LUTS in cats after appropriate diagnostic evaluation. PE – physical examination; UCS- quantitative urine culture (cfu/ml); Imaging – some combination of radiography, contrast urography, ultrasonography, and/or uroendoscopy. Not all tests are appropriate for every cat, so diagnostic evaluations tailored to each individual cat are most likely to arrive at the correct diagnosis.



What diagnostic workup is needed f or cats with LUTS signs?

Figure 2.

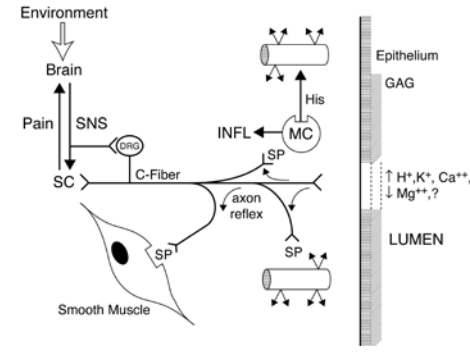


A diagnostic approach for cats with LUTS, emphasizing the distinction between those cats that are obstructed or not, and cats that do or do not have irritative voiding.

Can you summarize where we are in our understanding of the pathophysiology of FIC ?

Though all the pieces are not completely understood, the basic centerpiece is one of neurogenic inflammation – this type of inflammation is quite different from the standard kind of inflammation classically involving infiltration of neutrophils. Increased bladder permeability is an important part of this process, as this allows constituents of urine to gain access to the bladder wall- these compounds stimulate sensory nerve endings to carry excessive pain signals to the brain. The increase in bladder permeability likely involves changes in the GAG layer and the integrity of the structure and function of the urothelium. The stress response system (SRS) becomes activated but is not adequately terminated by release of cortisol as it is in normal cats. Unrestrained outflow of sympathetic nervous system activity characterizes this disease. Excess effects of norepinephrine are known to upregulate a variety of inflammatory processes including that in the bladder. Infiltration with mast cells is important in some cats with FIC – degranulation of mast cells then contributes to the inflammatory process (vasodilation, edema, diapedesis of RBC, recruitment of sensory nerves with NGF). Local axon reflexes within the bladder wall can result in vasodilation directly, degranulation of mast cells, and detrusor muscle contractions. Certain constituents of urine that gain access to the bladder wall are more potent stimulators of pain than others; absence of some substances in urine can magnify the pain response. The "bottom up" theory emphasizes defects in the bladder wall (GAG and or urothelium that increase permeability) and then over-activation of the noradrenergic nervous system. The "top-down" theory emphasizes that stressors from the environment can be potent enough to directly activate the SRS and turn on neurogenic inflammation[3]. Another piece of the pathophysiology is that cats with FIC appear to have mild adrenal insufficiency based on a blunted increase in cortisol concentration following ACTH stimulation compared to normal cats. The adrenal glands of cats are also smaller than those of normal cats and do not contain histopathologic lesions [4]. One explanation proposes that these small hypofunctioning adrenal glands are the result of a maternal perception of threat from the environment that is transmitted to the fetus from hormones that cross the placenta to effect the development of the fetal adrenal gland at a critical time for its development. [5]. It should be emphasized that only adrenocortical steroid measured was that of cortisol, and that many other adrenocorticosteroids have the potential to also be deficient[6], but this has not yet been studied in cats. Cats with idiopathic cystitis do not appear to experience long-term benefit from current glucocorticoid therapy regimens. The same in utero developmental story just described could also account for a fetal stress response that has been programmed toward enhanced vigilance that would then be manifested after birth by an intense SRS output when the cat faces provocateurs. FIC cats in colony housing have higher levels of circulating catecholamines and their metabolites compared to normal cats, especially when exposed to a stressful environment. A return to lower levels of circulating catecholamines occurred in stressed FIC cats following environmental modification, but this response was less complete and took longer than that which occurred in healthy cats [7]. FIC cats were recently reported to have a heightened response to sensory stimuli when measured by the acoustic startle reflex (ASR) compared to healthy cats [8]. The ASR is a defensive brainstem mediated response to sudden intense stimuli. Environmental enrichment led to a significant decrease in ASR in cats with IC compared to healthy cats. Habituation to new housing prior to environmental enrichment decreased ASR in female but not male cats with FIC[8]. Results of this study add to the concept that management of FIC benefits the cat when the patient's perception of unpredictability in the environment is reduced. Urodynamic evaluation of female cats with FIC revealed no finding of spontaneous detrusor muscle contraction that can occur in overactive bladder (OAB) further separating FIC from OAB [9]. Consequently, drugs that target detrusor muscle contraction do not appear warranted in cats with FIC. High maximal urethral closure pressure (MUCP) was documented in female cats with FIC of the same study, suggesting that alpha-1 –adrenoceptor antagonists, alpha-2 agonists, or skeletal muscle relaxants could potentially be useful treatment [9] but this has yet to be studied.

Figure 3. Neurogenic inflammation as it affects the urinary bladder in interstitial cystitis.



Sensory neurons (C-Fiber) seem to play a central role in transmission of action potentials via the dorsal root ganglia (DRG) to the spinal cord (SC) and brain. These signals may be perceived as painful by the brain. Sensory fibers also can propagate a local axon reflex without transmission of an axon potential. The axon reflex results in release of peptide neurotransmitters such as substance P (SP) by the nerve endings. Interaction of SP with receptors on vessel walls results in vascular leakage, which can be augmented by SP-induced release of histamine by mast cells. These actions may give rise to the submucosal petechial hemorrhages (glomerulations) observed at cystoscopy. Receptors for SP also occur on smooth muscle, which when activated stimulate muscle contraction. Also shown are the urothelium (epithelium) and the overlying glycosaminoglycan (GAG) layer adjacent to the bladder lumen. Damage or malfunction of either or both of these layers may permit constituents of the urine, such as protons, potassium ions, or hyperosmolar (>2,000 mOsm/L) fluid to activate the sensory fibers. The effects of stress on sensory fibers may be related to descending efferent sympathetic (SNS) signals stimulating the DRG and inducing peripheral release of neuropeptides. Local release of neurotransmitters by bladder sympathetic fibers also could stimulate sensory fibers. Another factor probably involved in chronic, neurogenic inflammation of the bladder, but not shown, is local and systemic release of nerve growth factors, which may promote sensory fiber terminal sprouting to increase the size of sensory fiber receptive fields.

Since GAG excretion is decreased in active and quiescent phases of FIC, is glycosaminoglycan (GAG) treatment helpful in the treatment of FIC ?

Three studies have employed glycosaminoglycan (GAG) as treatment for FIC, none of which were able to show a benefit over control. In the first study, 40 cats with recurrent idiopathic cystitis were treated with either 125 mg N-acetyl glucosamine or a placebo by mouth daily for six months. No significant differences were observed using the owner assessment of the mean health score, the average monthly clinical score, or the average number of days with clinical signs. Both groups improved over the course of the study, possibly due to salutary effects from dietary change initiated at the start of the study[10]. In a second study of 18 cats, injectable pentosan polysulphate (PPS) was compared to control injections in cats with non-obstructive idiopathic cystitis. Subcutaneous injections of PPS were given at 3mg/kg on days 1,2,5, and 10. Clinical signs were not different between treatment groups when evaluated on day 5, 10, 14, and then 2, 6, and 12 months[11]. A multicenter study involved 4 universities comparing BID oral PPS to placebo as treatment in 107 cats with interstitial cystitis. Enrolled cats had at least two episodes of LUTS within the past six months, cystoscopic findings of glomerulations, and absence of an alternative diagnosis. Cats were randomly assigned to 0.0 (vehicle placebo), 2.0, 8.0 or 16.0 mg/kg PPS orally twice daily for 26 weeks. No statistically significant differences were observed between any of the groups based on the owner's evaluation of clinical signs or overall improvement in cystoscopic score. A statistically significant decrease in friability score on cystoscopy was observed at the 16.0 mg/kg dose. Clinical improvement occurred in most cats (owner reported scores decreased by 75% in all groups), regardless of the dose of PPS administration or changes in cystoscopic appearance of the bladder. It is likely that accidental environmental enrichment occurred during this study which could account for the improvement scores in all cats overall [12,13]. In a 4th study, N-acetyl-d-glucosamine (NAG) at 250 mg PO once daily significantly increased plasma GAG concentrations in cats with IC after 21 days of treatment. Subjective improvements in LUT signs were suggested to occur in those treated with NAG but not those treated with placebo [14].

Is there a role for pheromontherapy in treatment of FIC ?

Feline facial pheromones (FFP) are commercially available (Feliway®) with the listed indication to decrease urinary spraying and marking. Activation of the sympathetic nervous system is part of the vigilance system that results in urinary spraying and marking and it is thought that these products lower the intensity of sympathetic nervous system output. Since unrestrained output of sympathetic nervous system activity is a central component in neurogenic inflammation that occurs in FIC, it seems reasonable that use of FFP could also be useful for treatment of FIC. In one study of hospitalized healthy and sick cats videography was used to score behavior and food intake of cats in which the cage was pre-treated with vehicle placebo or feline facial pheromones[15]. Increased grooming, facial rubbing, interest in food, and walking were found in cats exposed to FFP compared to vehicle. Results of this study suggested that hospitalized cats exposed to FFP were calmer and more comfortable in their cages than cats exposed to vehicle. It has been our observation that some cats are very affected by FFP while in others the effect is minimal to nil. A randomized, double-blinded, placebo-controlled, crossover study was performed in 12 cats (9 of 12 completed the full study) with recurrent FIC, comparing once daily environmental treatment with FFP (Feliway®) or placebo; treatment was for 2 months and then switched to the other treatment for the next 2 months [16]. This small number of cats exposed to FFP had fewer mean days displaying signs of cystitis, a reduced number of episodes of cystitis, and fewer negative behavioral traits, but this data did not achieve statistical significance for a difference over placebo treatment of the environment.

Is there a role for amitriptyline or other tricyclic anti-depressant (or analgesic) TCA for the treatment of FIC ?

In some cases YES. The need for this kind of therapy has dramatically lessened since we as a profession have become much more successful at implementing environmental modification, which usually works well without need for chronic drug therapy. We do prescribe amitriptyline for its beneficial effects for cats with FIC that have frequent recurrences or persistent LUT signs AFTER the client's best efforts to implement environmental enrichment have failed to improve the cat's clinical signs. This type of therapy should NOT be undertaken for an initial episode of FIC or a "flare" of signs that occur infrequently. We sometimes prescribe amitriptyline for cats owned by clients that are considering euthanasia for their cat with FIC – this can sometimes allow the client to see early benefits while implementing environmental enrichment. Maximal beneficial effects of TCA, if any, often require weeks to months to be observed and in general should not be abruptly discontinued (so called "abrupt withdrawal syndrome"). Treatment series of FIC with amitriptyline has been reported 3 times, 1 study of chronic FIC (frequently recurrent or persistent signs) and 2 of acute bouts of FIC. In the chronic study, 15 cats were enrolled with FIC that failed to respond to other treatments; no placebo group was treated. Amitriptyline treatment (10 mg PO every 24 hours in the evening) successfully decreased clinical signs of severe recurrent FIC in 9 of 15 cats treated for 12 months (11 of 15 cats for the first 6 months). Somnolence, weight gain, decreased grooming, and transient cystic calculi were observed during treatment in some cats. Despite clinical improvement, cystoscopic abnormalities persisted in all cats at the 6- and 12-month evaluations [17]. In one short term study, 31 untreated male and female cats with acute (<14 days signs), nonobstructive, idiopathic lower urinary tract disease were enrolled in a placebo controlled study. Cats were hospitalized and treated with 5mg amitriptyline or a placebo daily for 7 days and then treatment discontinued. Clinical signs and hematuria resolved similarly in both groups of treated cats by day 8. Cats were evaluated in the clinic 1 month later and by questions over the telephone 6, 12, and 24 months after treatment. Clinical signs recurred faster and more frequently (10.5 vs. 2.4 events/1,000 days) in the amitriptyline treated cats, a finding likely attributable to the abrupt withdrawal of amitriptyline treatments after 7 days- there was no difference in recurrence when the first 21 days were excluded from the analysis [18]. In another short-term study of FIC, amitriptyline at 10 mg once daily per os (11) or placebo (13) was given for 7 days by owners at home. All cats were also treated with amoxicillin BID for 7 days. The severity of clinical signs was assessed at days 0, 7, and 14 – no significant difference was found between amitriptyline and placebo treated cats of this study[19].

How do we treat an acute episode of LUT signs for either its first time, or an infrequently recurrent event ?

We treat nearly all FIC cats of this type with a combination of buprenorphine and acepromazine PO for 5 to 7 days. The combination of an analgesic and a tranquilizer with properties that also decrease urethral tone seem like a compassionate and appropriate choice of treatment. It is likely that the tranquilizer reduces the activity of the autonomic nervous system which is useful in the initial treatment of FIC. We believe that this helps to acutely decrease clinical signs in cats with acute episodes of FIC or flares of chronic FIC, though this has not been specifically studied. Whether this regimen reduces future episodes of FIC has also not been tested. We take the opportunity at the first visit to discuss with the owners that even a first event of FIC may be associated with recurrence and that there may be steps that can be taken to reduce this likelihood (not yet studied in a prospective way) when environmental enrichment and modification are successfully implemented.

What analgesic treatments should I consider?

The best approach to analgesia for bladder pain (visceral) has yet to be determined. Butorphanol has been used, but its effects are less long-lived or potent than those of buprenorphine [20,21] Sustained release formulations of buprenorphine have recently become available that can provide up to 72 hours of therapeutic drug levels for pain relief following a single injection. Fentanyl patches have been used in rare cases in which bladder pain was assessed as severe.

Should I consider NSAID treatment to provide anti-inflammatory and analgesic effects?

Anecdotal reports of the usefulness of non-steroidal anti-inflammatory drugs (NSAID)s, especially meloxicam and ketoprofen, abound, but no studies of safety or effectiveness are available for review. Some specialists have prescribed piroxicam for use on alternate days, but there are no controlled clinical trials of its effectiveness or safety. NSAIDs are not commonly used for treatment of interstitial cystitis in humans. NSAIDs that are licensed for use in cats list indications for pre-emptive pain management, usually as a single treatment before anesthesia and surgery. Chronic use of NSAIDs in cats can be dangerous due to the possibility for development of acute intrinsic renal failure; especially should the cat become dehydrated for any reason at the time of NSAID administration. The FDA recently required the following statement to be added to the label for meloxicam use in cats, "Repeated use of meloxicam in cats has been associated with acute renal failure and death. Do not administer additional injectable or oral meloxicam to cats. See Contraindications, Warnings, and Precautions for detailed information." Robenacoxib, a long acting NSAID recently has become available for use in cats; its effectiveness and safety for use in cats with FIC has yet to be reported to our knowledge.

What is the most-important therapy to recommend to owners of cats with frequently recurrent or persistent signs of FIC?

There is no simple answer to this question but a key component to a successful outcome is empowering the owner with skills that allow the cat's husbandry to be improved and the environment enriched to a point that decreases the cat's stress response system. We refer you to the Indoor Cat Initiative site that is maintained by Dr. Buffington- this site provides a great number of details and resources that can be considered to implement that will reduce the cat's perception of stress and improve its general sense of well

being while living largely in confined spaces with people (and often with dogs too). Environmental enrichment involves effective resource management, including; litter box (es) (type, location, number, substrate,cleaning regimen,), food and water (type, location, number), resting areas, opportunities to climb and scratch, interactions with people that are positive, and methods to reduce conflict in the living space with other cats, dogs, and humans [22-24]. Outcome of environmental enrichment and modification was proven beneficial to most FIC cats of a study in which they had failed multiple other treatments [25]. In addition to a dramatic increase in the use of the litterbox, there were benefits in behavior and some gastrointestinal signs.

Is there anything new regarding dietary treatment of FIC ?

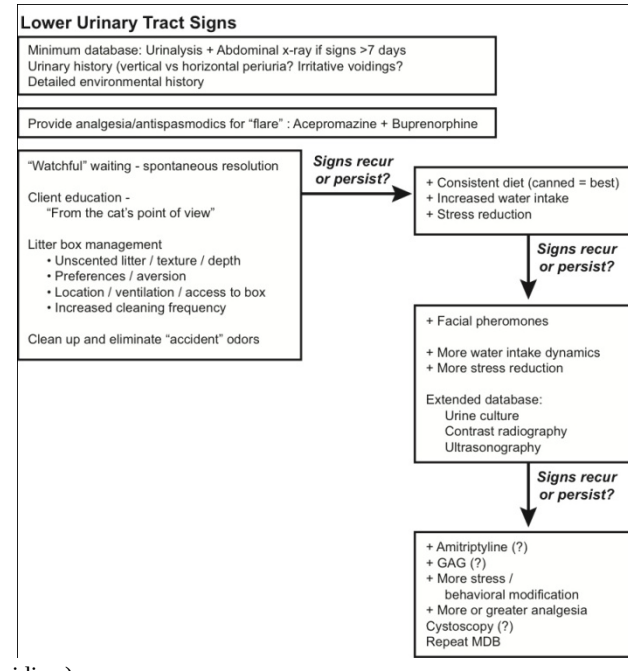
A non-blinded and non-randomized study of feeding canned vs. dry diets of similar formulation (Waltham pH Control®) in the treatment of 54 FIC showed a beneficial effect of the canned over the dry product [26]. 52 of 54 cats exhibited more than one episode of LUT signs in the prior 12 months. The study lasted for 12 months, or until signs of recurrence occurred. Signs of LUTD did not recur in 16 of 18 cats fed the canned diet, and 17 of 28 cats fed the dry diet ($P < 0.05$). The recurrence rate in cats being fed the dry food was also reduced compared to the rate encountered in the previous year, but not to the degree of benefit observed in cats consuming the wet formulation. The mean urinary specific gravity was lower in urine from cats fed the canned formulation but the basis for the salutary effect of this particular canned product over the dry formulation was not determined [26]. Other factors that could have influenced results of this study include hedonics (the mouth feel of the food) or the ritual associated with the feeding of canned foods and this effect on cat behaviors. The consumption of dry foods is known as a risk factor for the development of LUT disease in cats on a dose-related basis [27]. The results of a test food vs control food as treatment of FIC was recently reported as an abstract in 31 cats over 12 months. The test food contained more anti-oxidants and omega-3 dietary oil than the control food as the main difference. The feeding of the wet or dry formulation was determined by owner preference. The number of episodes for LUT signs and days exhibiting LUT signs (1.3 vs. 10.3 events/1000 days) were fewer in cats fed the test food of this study. Outcome was the same during the feeding of either the wet or dry formulations of the test food[28]. The event rate for the test diet was not significantly different from the same author's previously reported event rate in untreated cats [18]; the basis for the effect of the control or test formulations in this study was not determined. The test diet is not available commercially, as the original diet was altered to include stress-reducing compounds for the commercial diet that was launched but this specific formulation was not studied.

How important are non-specific therapeutic responses in treatment of FIC?

Nonspecific therapeutic responses might occur during treatment of cats with FIC, possibly by altering their perception of their surroundings as part of a placebo-response. The effectiveness of environmental enrichment suggests that pharmacological or other therapeutic interventions face an important barrier to demonstrate efficacy in the presence of the large therapeutic response to this approach in cats with the syndrome.

Figure 5.

What do WE Do ? Step-wise approach to treatment of cats with idiopathic lower urinary tract signs. More diagnostics should be performed when cats fail to spontaneously clear of their initial lower urinary tract signs and when signs recur to ensure that the diagnosis is really idiopathic lower urinary tract disease. Properly controlled clinical trials may provide better approaches to treatment in the future, but this is what we do in the interim.



"Pearls" Pandora syndrome – aka feline interstitial/idiopathic cystitis (FIC)

1. Signs of urinary urgency during FIC may be expressions of a systemic disease created by a highly active outflow (unrestrained) from the sympathetic nervous system in response to stressors (provocateurs) .
2. When multi-modal environmental modification (including environmental enrichment) is effectivel implemented, treatment with drugs is RARELY NEEDED.
3. Stress up-regulates the inflammatory potential of several organs, including the bladder.
4. Bacterial urinary infections (UTI) are rarely identified in cats with signs of lower urinary tract disease, unless they have specific risk factors (U-cath within last 6 months, perineal urethrostomy, dilute urine – CKD, diabetes mellitus, hyperthyroidism)
5. The term "Pandora Syndrome" should help to remind the clinician that LUT signs may be part of a bigger picture that involves other organ systems.

6. We advocate the use of analgesia (buprenorphine) during acute episodes of FIC.
7. We use tranquilization with acepromazine in combination with buprenorphine in most of our cases of non-obstructive episodes.
8. On occasion, the use of amitriptyline can be useful in the treatment of FIC.
9. The use of GAG (glycosaminoglycan) supplementation has failed to show an effect superior to placebo in several studies of FIC treatment.
10. The use of feline facial phaeromones has not been shown to be superior to placebo in the treatment of FIC.
11. The feeding of as much wet food as possible in the diet is advocated by some for its protective effect on the recurrence of the signs of FIC, and may be helpful as long as it does not result in additional threat to the cat.
12. There is no indication for surgery in non-obstructive FIC.
13. When surgery is performed in patients with FIC, obtain a full thickness bladder biopsy to allow evaluation of mast cells with special stains (toluidine blue).
14. Sometimes a so-called “placebo” treatment actually can have a positive effect between the cat, the owner, and the environment such that a positive outcome is achieved.
15. In most cases, antibiotic treatment does not have a role in the treatment of FIC.
16. Treatment of FIC with glucocorticosteroids has not shown an effect greater than that of placebo in limited study.
17. Chronic treatment of FIC with NSAIDs is NOT ADVOCATED due to the high sensitivity of the cat to sustain renal injury with this class of drugs, especially if there is any tendency toward dehydration.

References

Buffington CA. Idiopathic cystitis in domestic cats--beyond the lower urinary tract. Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2011;25:784-96.

Stella JL, Lord LK, Buffington CA. Sickness behaviors in response to unusual external events in healthy cats and cats with feline interstitial cystitis. Journal of the American Veterinary Medical Association 2011;238:67-73.

Westropp JL, Buffington CA. In vivo models of interstitial cystitis. The Journal of urology 2002;167:694-702.

Westropp JL, Welk KA, Buffington CA. Small adrenal glands in cats with feline interstitial cystitis. The Journal of urology 2003;170:2494-7.

Buffington CA. Developmental influences on medically unexplained symptoms. Psychother Psychosom 2009;78:139-44.

Dimitrakov J, Joffe HV, Soldin SJ, Bolus R, Buffington CA, Nickel JC. Adrenocortical hormone abnormalities in men with chronic prostatitis/chronic pelvic pain syndrome. Urology 2008;71:261-6.

Westropp JL, Kass PH, Buffington CA. Evaluation of the effects of stress in cats with idiopathic cystitis. American journal of veterinary research 2006;67:731-6.

Hague DW, Stella JL, Buffington CA. Effects of interstitial cystitis on the acoustic startle reflex in cats. American journal of veterinary research 2013;74:144-7.

Wu CH, Buffington CA, Fraser MO, Westropp JL. Urodynamic evaluation of female cats with idiopathic cystitis. American journal of veterinary research 2011;72:578-82.

Gunn-Moore DA, Shenoy CM. Oral glucosamine and the management of feline idiopathic cystitis. Journal of feline medicine and surgery 2004;6:219-25.

Wallius BM, Tidholm AE. Use of pentosan polysulphate in cats with idiopathic, non-obstructive lower urinary tract disease: a double-blind, randomised, placebo-controlled trial. Journal of feline medicine and surgery 2009;11:409-12.

Chew DJ, Bartges JW, Adams LG, Kruger JM, Buffington CAT. Evaluation of Pentosan Polysulfate Sodium in the Treatment of Feline Interstitial Cystitis: A Randomized, Placebo-Controlled Clinical Trial. J Urology 2011;185:e382 (abstract 952).

Chew DJ, Bartges JW, Adams LG, Kruger JM, Buffington CT. Randomized trial of pentosan polysulfate sodium for reatment of feline interstitial (Idiopathic) cystitis Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2009;23.

Panchaphanpong J, Asawakarn T, Pusoonthornthum R. Effects of oral administration of N-acetyl-d-glucosamine on plasma and urine concentrations of glycosaminoglycans in cats with idiopathic cystitis. American journal of veterinary research 2011;72:843-50.

Griffith CA, Steigerwald ES, Buffington CA. Effects of a synthetic facial pheromone on behavior of cats. Journal of the American Veterinary Medical Association 2000;217:1154-6.

Gunn-Moore DA, Cameron ME. A pilot study using synthetic feline facial pheromone for the management of feline idiopathic cystitis. Journal of feline medicine and surgery 2004;6:133-8.

Chew DJ, Buffington CA, Kendall MS, DiBartola SP, Woodworth BE. Amitriptyline treatment for severe recurrent idiopathic cystitis in cats. Journal of the American Veterinary Medical Association 1998;213:1282-6.

Kruger JM, Conway TS, Kaneene JB, et al. Randomized controlled trial of the efficacy of short-term amitriptyline administration for treatment of acute, nonobstructive, idiopathic lower urinary tract disease in cats. Journal of the American Veterinary Medical Association 2003;222:749-58.

Kraijer M, Fink-Gremmels J, Nickel RF. The short-term clinical efficacy of amitriptyline in the management of idiopathic feline lower urinary tract disease: a controlled clinical study. Journal of feline medicine and surgery 2003;5:191-6.

Warne LN, Beths T, Holm M, Carter JE, Bauquier SH. Evaluation of the perioperative analgesic efficacy of buprenorphine, compared with butorphanol, in cats. Journal of the American Veterinary Medical Association 2014;245:195-202.

Steagall PV, Monteiro-Steagall BP, Taylor PM. A review of the studies using buprenorphine in cats. Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2014;28:762-70.
Herron ME. Advances in understanding and treatment of feline inappropriate elimination. Top Companion Anim Med 2010;25:195-202.
Herron ME, Buffington CA. Feline focus-environmental enrichment for indoor cats. Compend Contin Educ Vet 2010;32:E1-5.
Herron ME, Buffington CA. Environmental enrichment for indoor cats: implementing enrichment. Compend Contin Educ Vet 2012;34:E3.
Buffington CA, Westropp JL, Chew DJ, Bolus RR. Clinical evaluation of multimodal environmental modification (MEMO) in the management of cats with idiopathic cystitis. Journal of feline medicine and surgery 2006;8:261-8.
Markwell PJ, Buffington CA, Chew DJ, Kendall MS, Harte JG, DiBartola SP. Clinical evaluation of commercially available urinary acidification diets in the management of idiopathic cystitis in cats. Journal of the American Veterinary Medical Association 1999;214:361-5.
Buffington CA. External and internal influences on disease risk in cats. Journal of the American Veterinary Medical Association 2002;220:994-1002.
Kruger J, Lulich J, Merrills J, et al. A year-long prospective, randomized, double-masked study of nutrition on feline idopathic cystitis(FIC). American College of Veterinary Internal Medicine Forum 2013; Seattle

Updates on Managing Male Cats with Urethral Obstruction

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

Pathophysiology of urethral obstruction (UO)

Thrity-nine % to 67% of male cats evaluated with lower urinary tract signs have been reported to have urethral obstruction.[1-4] Male cats with urethral obstruction (UO) were described to have urethral plugs as the most common cause in early reports,[3] but recent reports emphasize idiopathic causes.[1,2,5] In one study the cause of obstruction was considered to be idiopathic in all 82 cats studied,[6] but other studies report plugs, uroltihiasis and UTI in decreasing order behind idiopathic causes for UO.[1,2,5] When plugs do form, it is likely that they are extensions of the process leading to feline idiopathic/intersititial cystitis (FIC). This is consistent with findings from an unpublished study at The Ohio State University using urethroscopy at the time of initial evaluation in which plugs were rarely identified. Urethral plugs have minimal intrinsic cohesive structure but often are cylinder-shaped after extrusion from the urethra. Urethral plugs are fundamentally different from calculi that lodge within the urethra (i.e., urethroliths). Uroliths have an organized internal structure with much less matrix, and are not easily compressed or distorted. Urethral plugs consist largely of matrix mucoprotein with embedded minerals. The predominant mineral composition in most plugs is magnesium ammonium phosphate hexahydrate (i.e., struvite). This is true despite the fact that cats form calcium oxalate and struvite uroliths with nearly equal frequency. Most plugs are assumed to lodge within the penile urethra, but obstructions also can occur at more proximal sites. Definitive diagnosis of a urethral plug requires retrieval of the plug. Supportive evidence for the presence of a urethral plug can be seen on radiographs in some cats with UO. Previously, the crystalline-matrix hypothesis proposed that plugs formed secondary to precipitation of struvite crystals in the urine that then became embedded in a matrix. According to this hypothesis, plugs created UO and urethritis. It is now hypothesized that plugs form as a consequence of underlying idiopathic urethritis and cystitis (i.e., inflammation occurs first, followed by plug formation).

Some cats have signs of non-obstructive idiopathic/interstitial cystitis before UO, while many cats have lower urinary tract signs after relief of UO. Obstruction can be secondary to functional urethral spasm in addition to swelling of the urethra due to edema and hemorrhage. Pathologic or neurogenic processes cause contraction of the circular smooth or skeletal muscle of the urethra or both. Stimulation of adrenoreceptors (particularly α-1) within the urethra increases urethral tone in normal cats. Pain and stress after UO increase sympathetic outflow from the central nervous system which can lead to additional urethral spasm.

Bacterial urinary tract infection (UTI) is very uncommon before urethral catheterization.[3,7] UTI deserves more consideration in cats with recurrent UO that have undergone urinary instrumentation. Urethral stricture may occur, especially in cats that have had previous indwelling urinary catheters and for those with severe recurrent episodes of non-obstructive idiopathic/interstitial cystitis. Neoplasia of the urethra or bladder neck is rare. Urinary catheter fragment foreign body in urethra or bladder is rare, as is phimosis as a cause for UO.

Signalment, history, physical examination

Approximately 75% of cats presented with UO are experiencing their first episode.[6,8] Median duration of clinical signs before initial presentation was 3 days in a study of 223 cats. Signs include those of cystitis and partial obstruction before development of complete obstruction. The majority of cats with UO are relatively stable however, approximately 10% are critically ill.

Severe bradycardia (< 100 bpm) from the effects of hyperkalemia has been reported in 5% of cases, moderate bradycardia (100-140 bpm) in 6% of cases and mild bradycardia (140-160 bpm) in 12% of cases; arrhythmias were detected in 11% of cases. Fifty % of cats can be expected to have normal body temperature, hypothermia in about 40% and hyperthermia in 10%. Rectal temperature < 95-96.6°F or heart rate < 120 bpm was the most the accurate predictor of severe hyperkalemia. A combination of hypothermia and bradycardia was 98 to 100% predictive for severe hyperkalemia (> 8.0 mEq/L).[9] Twitching or seizures is very uncommon (0.5%) and related to ionized hypocalcemia. Systemic blood pressure most often is normal.[10] Mean arterial pressure correlated inversely with serum potassium and directly with total serum calcium concentrations. Major abnormalities on physical examination and serum biochemistry were encountered despite normal blood pressure in this study.

Diagnostics

A recent report noted that darker red urine observed at the time of urinary catheter placement was associated with azotemia, hyperkalemia, and lower USG. Color of the urine was not associated with the presence or absence of urinary stones.[11]

Hyperkalemia does not occur in isolation and often is accompanied by acidosis and low serum ionized calcium concentration. Serum potassium concentrations ranged from 3.4 to 10.5 mEq/L in 199 cats. Six % were below the reference range; 41% were above the reference range, and 53% in the reference range. Serum potassium concentration was < 6.0 mEq/L in 66% of cases, > 6.0 but < 8.0 mEq/L in 12% of cases, > 8.0 but < 10.0 mEq/L in 12% of cases, and > 10.0 mEq/L in < 1% of cases. Hyperkalemia most often was encountered with acidosis (pH < 7.2 in 74% of cases) and low serum ionized calcium concentration (< 1.0 mmol/L in 75% of cases).

Approximately 33% of cats with UO are expected to have clinically relevant hypocalcemia based on serum ionized calcium concentration. Serum ionized calcium concentration was below the reference range in 34%, above the reference range in 19%, and in the reference range in 47%. Serum ionized calcium concentration was > 1.2 mmol/L (> 4.8 mg/dL) in 23%, > 1.0 but < 1.2 mmol/L (> 4.0 but < 4.7 mg/dL) in 57%, > 0.8 but < 1.0 mmol/L (> 3.2 but < 4.0 mg/dL) in 14%, ≤ 0.8 mmol/L (≤ 3.2 mg/dL) in 6%. Serum total calcium concentration in 51 cats was below the reference range in 39%, above the reference range in 0%, and within the reference range in 61%. Cats with low serum total calcium concentrations had moderate to severely decreased serum ionized calcium concentrations.[8,12] In one study, more cats were found to have hypocalcemia when defined by measurement of serum ionized calcium concentration (75%) than when defined by serum total calcium concentration (27%).[12] Survival of cats with UO was influenced by ionized calcium status in another study. The median concentration of ionized calcium in survivors was 1.08 mmol/l (range 0.65 to 1.28 mmol/L) and in non-survivors was 0.88 mmol/l (0.66 to 1.11 mmol/L); P = 0.037). Hypocalcemia was detected in 51% of survivors vs 100% of non-survivors; P = 0.024.[6]

Struvite crystals may be observed at the time of obstruction, especially if urine pH is alkaline. The presence and amount of struvite crystalluria preceding UO has not been reported. Struvite crystalluria can be expected from any condition associated with urinary pH increased above 6.7. Crystals are more likely to be secondary to urine stasis or alkaline urine pH (secondary to sterile inflammation with extravasation of plasma proteins into urine) than a primary cause of obstruction. Struvite crystalluria was greater in male cats with obstruction than in male cats without obstruction (P 0.051), though cause or effect of the crystalluria was not established in one study. Struvite crystalluria was not associated with hematuria, proteinuria, or pyuria but was associated with urinary pH in this same study.[5]

Nearly all cats with UO have sterile urine on original presentation for obstruction. Zero of 18 cats with UO in one study[7] and in 0/36 cats in another study soon to be published out of The Ohio State University (Dr. Ed Cooper OSU - personal communication 2014) had bacterial growth. Bacteria were isolated from urine collected through the urinary catheter at initial presentation in 14% of cats (14/192) in one study, but quantitative methods as to cfu/mL were not used. Many of these cats were referred with an indwelling urinary catheter already in place.[13] Only 1 of 32 cats in another study had a positive urine culture from a cystocentesis sample at the time of UO relief.[14] Bacterial culture at the time of urinary catheter removal is more likely to identify pathogenic bacteria. Isolation of bacteria from cats with a previous history of UO is more likely than isolation from cats suffering an initial episode.

Imaging of cats during/after UO

All cats with UO should have radiography to determine if urolithiasis is contributing to obstruction. Attention is usually centered to determine the presence of urinary stones in the bladder and/or urethra. It is very important to include the perineal region in the radiographs to identify urethral calculi. Evaluation of the kidneys and ureters is important to be sure nephroliths or ureteroliths are not part of the overall process, because upper urinary tract involvement can markedly affect the overall prognosis. Free fluid resulting in a loss of abdominal detail can be seen in some cats with severely distended and highly permeable ("leaky") urinary bladders. A small amount of free abdominal fluid may be identified at initial presentation that is more easily detected on ultrasonography. In cats with recurrent UO, contrast radiography and ultrasonography may be informative as to the underlying diagnosis. Positive contrast urethrography is especially useful to disclose urethral trauma, urethral perforation, or urethral stricture, especially after recent instrumentation of the urethra. Radiography is the gold standard imaging method for the detection of urethral stones as ultrasonography only examines the most proximal portion of the urethra. If only ultrasonograpy is available to image the urinary tract (limitations of equipment, personnel, or cost), then it is advisable to perform the sonogram before AND after reverse flushing of the urethra in order to detect the presence of small stones that may now appear in the bladder after hydropulsion that were not initially visible. This however does not exclude the presence of stones still within the urethra.

Caudal abdominal effusion was detected in 10 of 34 cats on radiographs after placement of a urethral catheter without associated cystocentsis.[15] Nineteen of 34 cats with UO that underwent abdominal radiography had signs of abdominal effusion before or after cystocentesis and passage of a urinary catheter. Prior to cystocentesis, 11 of 20 cats had abdominal effusion in the same study.[14]In another study in which therapeutic cystocentesis was used as the sole treatment to relieve bladder pressure, 8 of 15 had evidence for abdominal effusion after bladder pressure was first relieved.[16] In yet another study, 87 cats underwent abdominal ultrasonography within 24 hours of the relief of UO by passage of a urethral catheter and no use of cystocentesis.[17] Hyperechogenic pericystic fat and pericystic effusion were each observed in 60% of these cats. Ninety % of evaluated cats had bladder thickening, 20% had suspended linear strands, and over 50% of cats had either moderate or severe increases in urinary sediment or hyperechogenicity. Cystolithiasis was documented in 47% of these cats. This frequency is much higher than that in another report in which only 2 of 35 cats were found to have stones (radiography in 34 cats and ultrasonography in 3 cats).[14] The reason for this disparity between ULS and radiography in detection in cystolithiasis is not obvious. ULS could be more sensitive in the detection of uroliths, but ultrasonography and radiography has not been compared in the same cats with UO at the same time of their clinical presentation, before or after instrumentation. It is also possible that more stones were detected in the study using ultrasonography since these images were acquired

after urethral flushing which could have retropulsed urethral stones into the bladder. Eight cats with pseudomembranous cystitis associated with UO have been described in two reports.[17,18]Thick echogenic septa were described traversing the bladder lumen. These bands could represent sloughing of necrotic areas of the bladder into the lumen and they were associated with fibrinous exudate, blood clots, and necrotic debris.

It has long been taught that acute UO in male cats adversely affects renal function but does not create structural changes in the kidneys. It has been known for decades that palpably enlarged kidneys are detected during physical examination in some cats before relief of UO. In cats with UO undergoing ultrasonography, either unilateral or bilateral renomegaly was detected in 42 %, pyelectasia in 60 % (10% > 3.4 mm), and perirenal effusion (retroperitoneal) in 35% of the cases. Ureteral dilatation was detected in 24%. How rapidly these changes resolve has not yet been reported.[17]

Relief of obstruction due to plugs or idiopathic causes

Decompressive (therapeutic) cystocentesis is the next step recommended to perform after sedation and IV catheter placement. The benefits of decompressive cystocentesis outweigh potential adverse effects. Decompressive cystocentesis has been considered controversial by some clinicians who fear that bladder rupture will occur or that urine will continue to leak from the bladder. No adverse effects were observed in a recent report of 47 UO male cats that underwent decompressive cystocentsis.[14] Cystocentesis to empty the bladder should be performed as soon as possible in cats with very large bladders to prevent rupture of the bladder and to allow renal excretory function to resume. Cystocentesis allows for rapid reduction of urinary tract pressure and resumption of GFR compared to catheterization, which can take considerable time. Decompressive cystocentesis may stabilize the cat before anesthesia for urinary catheter placement. Relief of bladder pressure before urethral catheterization also may facilitate efforts to dislodge urethral plugs, and allows collection of a superior urine sample for analysis before manipulation of the urinary tract and contamination by irrigation solutions.

Some leakage of urine immediately after decompressive cystocentesis may occur, especially if the bladder is not adequately emptied. The use of a 22-gauge needle on an extension set or use of a butterfly needle can minimize trauma and urine leakage during the procedure. In one study, the median volume of urine removed by urinary catheter at the time initial obstruction was relieved in 28 cats was 85 mL (range, 35 to 280 mL).[10] Plain abdominal radiographs (including the perineal region) should be obtained after decompressive cystocentesis to identify mineralized plugs, urethral calculi, or cystic calculi. Some clinicians obtain radiographs after catheter passage, but the presence of an indwelling urinary catheter can obscure the presence of urethral calculi.

Standard epidural techniques require special expertise and training but a new simplified method using sacro-coccygeal placement of local anesthetic to allow urethral catheterization and pain management appears promising.[19] This technique produces anesthesia to the perineum, penis, urethra, colon, and anus within 5 minutes of preservative-free lidocaine injection and lasts up to 60 minutes. The authors of this study concluded that relief of urethral obstruction was easier and quicker during placement of the urethral catheter, presumably associated with urethral relaxation. Cats of this study received pre-medication protocols but not full anesthesia. Cats did not appear to struggle during catheterization, flushing, or suturing after the lidocaine infusion and appeared to be less painful after catheter placement.

Studies in cats have shown that indwelling polyvinyl catheters create less urethral trauma and inflammation than do indwelling polypropylene catheters. Silicone urinary catheters have not been specifically studied in cats. Do not administer glucocorticoids to a cat while an indwelling urinary catheter is in place. The risk for bacterial pyelonephritis is great in this setting and glucocorticoids are unlikely to control urethritis in this setting (i.e. continuous trauma from an indwelling catheter).[20] The use of antibiotics does not prevent the development of UTI in patients with indwelling urinary catheters. Do not prescribe antibiotics while a urinary catheter is in place (unless you have documented by bacterial culture that a UTI already is present). Antibiotic use may promote development of resistant isolates when UTI does develop. Consider culturing the urine when the urinary catheter is removed. This recommendation is supported by the finding that 6 of 18 cats developed significant bacteriuria (3/6 at 24 hours and another 3/6 at 48 hours) within 48 hours while the indwelling urinary catheter was in place.[7] Recurrent UO at day 30 was significantly less common when the indwelling urinary catheter was left in place for more hours, though the median times were similar between those with recurrence and those that did not recur.[15]

The chronic prognosis for recurrence of LUTD signs following relief of UO is guarded. Eight of 22 (36%) cats with idiopathic UO re-obstructed after a median of 17 days in one study whereas 3 of 7 (43%) cats with UO associated with urethral plugs re-obstructed within 7 months. Recurrent obstruction was the cause for euthanasia in 21% of cats in this study.[2] The recurrence rate was 22% at 6 months and 24% at 2 years.[6] Ten of 68 cats were reported to developed recurrent UO within 30 days of release from the hospital in another study.[15] In an older study, the recurrence rate was 35% within 6 months.[21] No studies on recurrence rates for UO have been reported prospectively after implementation of aggressive environmental modification. Recurrence rates may be lower in cats for which environmental modification can be adequately implemented. A small number of cats develop urethral strictures. This is a complication that occurred in 11% of affected cats in one study.[22] Some cats develop bacterial UTI after instrumentation of their

urinary tract (i.e. catheterization) and we have observed positive urine culture in some cats as late as 6 months after relief of UO. Signs of ongoing idiopathic cystitis are expected in 30-50% of cats that have had an episode of UO. In one study, 50% of cats with idiopathic UO developed lower urinary tract signs after relief of obstruction.[2] In a study of 68 cats treated for UO, 50 cats had lower urinary tract signs following release from the hospital. Pollakiuria (50%), stranguria (46%) and periuria (40%) were the most common clinical signs. Clinical signs lasted ≥ 7 days in 29 of 68 cats.[15]

Non-conventional treatment for urethral obstruction in male cats

Non-invasive non-instrumentation treatment protocol

A report describing a method for relief of urethral obstruction in male cats without the use of urethral catheterization was recently described.[16] The reported treatment protocol was proposed for use only as an alternative to euthanasia due to financial constraints of owners unable to afford conventional treatment costs. Conventional treatment with passage of a urinary catheter and IV fluid infusion in the hospital was offered as the first choice. This non-invasive approach is not meant for cats with urethral calculi or those with severe metabolic derangements. The severity of azotemia does not determine use of this protocol. A plain lateral abdominal radiograph is taken to exclude calculi. Decompressive cystocentesis is performed initially and then as needed up to every 8 hours. The urethra is not irrigated or catheterized, though the distal penis is gently massaged. No IV catheter is placed and IV fluids are not administered. Drug treatments include: acepromazine (0.25 mg IM or 2.5 mg PO q8h), buprenorphine (0.075 mg PO q8h), medetomidine (0.1mg IM q24h if no urinations are noted in the first 24 hours). The cat is placed in a quiet, low stress environment. Some fluids may be given subcutaneously as needed, but the goal is to avoid excessive urine production from full hydration. Treatment success was defined as spontaneous urination within 72 hours and subsequent discharge from the hospital. Successful discharge from the hospital occurred in 11/15 cats (73%). Treatment failure occurred in 4/15 (27%) cats due to uroabdomen (3) or hemoabdomen (1). Cats that experienced treatment failure had significantly higher serum creatinine concentrations. At necropsy, severe bladder inflammation was found, but there was no evidence of bladder rupture.

Atracurium

The intraurethral installation of atracurium besylate was compared to that of physiological saline prior to retrograde flushing of the urethra. Atracurium besylate is a curare derivative that provides neuromuscular blockade of striated muscles by antagonizing acetylcholine at the nicotinic receptor in the neuromuscular junction. Atracurium besylate is rapidly inactivated by plasma esterases or by spontaneous degradation and does not depend on the liver or kidneys for excretion. Atracuium was first diluted from 10 mg/dl to 0.5 mg/dl and then injected under steady gentle pressure for 5 minutes while the external urethral orifice was occluded. Sixty-four percent of cats treated with atracurium were unobstructed during the first hydropulsion attempt compared to 15% of cats receiving the saline installation prior to flushing. The mean time to relieve obstruction was 21 seconds in those receiving atracuriurm compared to 235 seconds for those receiving the saline control.[23]

Lidocaine

The recurrence rate and clinical signs for UO in 26 cats were determined at 2 weeks, 1 month, and 2 months following intravesical installation of lidocaine vs placebo once daily for 3 days through the indwelling urinary catheter. The recurrence rate for obstruction (58% [7/12] in the lidocaine group and 57% [8/14]) in the control group and magnitude of clinical signs were not different between treatment groups.[24]

Prazosin vs phenoxybenzamine

In a recent report of UO cats, overall recurrent obstruction at 24 hours occurred in 21/192 cats(10.9%) and at 30 days in 37/157 (23.6%)cats.[13] The recurrence rate in cats treated with prazosin was 10/140 (7.1%) and 20/110 (18.8%) at 24 hours and 30 days following urinary catheter removal compared to 10/46 (21.74%) at 24 hours and 16/41 (39.02%) at 30 days in cats treated with phenoxybenzamine, which was different statistically. Recurrent urethral obstruction is most likely to occur within the first 7 days following urinary catheter removal in most studies. Recurrent urethral obstruction occurred within the first 4 days of urinary catheter removal in 32 of 37 (86.49%) male cats in this study. The use of a 3.5 Fr indwelling urethral catheter was associated with less recurrent obstruction at 24 hours following removal of the urethral catheter compared to the use of a 5.0 Fr indwelling urinary catheter.[13] The logic for the use of prazosin in the treatment of male cats with UO was challenged by one group on the basis that this drug blocks alpha receptors of urethral smooth muscle and that the obstruction usually involves the penile urethra which is surrounded by striated muscle.[25] We seemingly have also had success using drugs that are designed to block peripheral alpha adrenoceptors – there could be central nervous system effects that have yet to be studied in cats. It is also possible that there is “cross-talk” between the autonomic nerves and those controlling somatic tone to the urethra. Another possibility for a salutary effect could be some “down-stream” effect on the striated muscle after tone in the smooth muscle is reduced.

Intravesical GAG treatment

A proprietary GAG formulation designed for intravesical administration has recently been manufactured by Arthrodynamics and marketed as A-CYST® from Dechra Veterinary Products. This formulation consists of 5 mg/mL of hyaluronic acid and 100 mg/mL of chondroitin sulfates (C4 and C6) in a 10 % solution of n-acetyl-d-glucosamine [NAG].[26] The commercial preparation designed for

intravesical installation was studied for its safety when administered IM (0.1 mL/lb) to 8 healthy cats every 4 days for a total of 5 treatments. No systemic toxicity was observed and decreased oxidative stress was suggested based on one measured marker.[26] Sixteen male cats with acute urethral obstruction were enrolled in a randomized placebo controlled study comparing this GAG treatment to that of placebo installations.[27] After relief of urethral obstruction, the bladder was flushed to remove debris. After residual urine was removed, either the GAG preparation or saline placebo was instilled (2.5 mL) through the indwelling urethral catheter at times 0, 12, and 24 hours after placement of the indwelling urethral catheter. Saline or GAG solution was kept in contact with the bladder for 30 minutes prior to allowing urine to flow through the collection system again. All cats were followed for 7 days following removal of the urethral catheter the time of which varied to the individual cat's needs. Acute repeat obstruction occurred in 0/9 cats treated with the GAG preparation and in 3/7 cats treated with the saline placebo (P= 0.06). Two of the 3 cats that failed placebo treatment were crossed-over to enter the GAG treatment group to contribute to the final 9 cats in this group that did not reobstruct. No adverse effects were identified following intravesical infusion of either the GAG or saline solutions.[27] Though the GAG treatment group did not achieve statistical significance, zero cats treated with the GAG solution had recurrence of UO during the 7 days of this study. Further study is warranted to see how the data emerges in a larger series of cats with UO that are treated with this treatment protocol.

Amitriptyline

A report from Brazil suggests that oral amitriptyline may be useful in relief of UO in male cats caused by urethral plugs.[28] Obstructed cats had serum creatinine concentrations of > 4.0 mg/dL and BUN concentrations of >120 mg/dL before treatment. Treatment details were not provided in this publication but were obtained by me from the author with the help of a Portuguese-speaking translator (2009). Some cats had decompressive cystocentesis performed and all were given IV 0.9% NaCl. No cats had urethral flushing or placement of an indwelling urinary catheter. No other drugs or anesthetic agents were administered besides ampicillin for prevention of UTI. This protocol has been used in Dr. Achar's practice as the standard of care for many years. Amitriptyline (1 mg/kg) was given orally for 30 days. This time period was arbitrarily chosen to decrease the likelihood of recurrence of UO. Amitriptyline should never be abruptly discontinued because of possible development of "abrupt withdrawal syndrome." Urethral plugs were spontaneously eliminated and urinary flow was restored in all cats within 72 hours. Urethral plugs were analyzed and found to contain varying proportions of struvite, calcium oxalate, and ammonium urates. Transient somnolence was attributed to the use of amitriptyline, an effect that lessened as azotemia resolved. This effect has been described when amitriptyline is used in cats without azotemia. All cats had normal BUN and serum creatinine concentrations when measured 30 days later. No cats experienced recurrent UO during the 30 days of treatment. The beneficial effects of amitriptyline in cats with UO appear to be mediated by relaxation of urinary tract smooth muscle through mechanisms that involve voltage-dependent potassium channels.

References

1. Gerber B, Boretti FS, Kley S, Laluha P, Muller C, Sieber N, Unterer S, Wenger M, Fluckiger M, Glaus T, Reusch CE. Evaluation of clinical signs and causes of lower urinary tract disease in European cats. Journal of Small Animal Practice 2005;46:571-577.
2. Gerber B, Eichenberger S, Reusch CE. Guarded long-term prognosis in male cats with urethral obstruction. Journal of Feline Medicine and Surgery 2008;10:16-23.
3. Kruger JM, Osborne CA, Goyal SM, Wickstrom SL, Johnston GR, Fletcher TF, Brown PA. Clinical evaluation of cats with lower urinary tract disease. J Am Vet Med Assoc 1991;199:211-216.
4. Saevik BK, Trangerud C, Ottesen N, Sorum H, Eggertsdottir AV. Causes of lower urinary tract disease in Norwegian cats. J Feline Med Surg 2011;13:410-417.
5. Defauw PA, Van de Maele I, Duchateau L, Polis IE, Saunders JH, Daminet S. Risk factors and clinical presentation of cats with feline idiopathic cystitis. J Feline Med Surg 2011;13:967-975.
6. Segev G, Livne H, Ranen E, Lavy E. Urethral obstruction in cats: predisposing factors, clinical, clinicopathological characteristics and prognosis. J Feline Med Surg 2011;13:101-108.
7. Hugonnard M, Chalvet-Monfray K, Dernis J, Pouzot-Nevoret C, Barthelemy A, Vialard J, Goy-Thollot I. Occurrence of bacteriuria in 18 catheterised cats with obstructive lower urinary tract disease: a pilot study. Journal of feline medicine and surgery 2013.
8. Lee JA, Drobatz KJ. Characterization of the clinical characteristics, electrolytes, acid-base, and renal parameters in male cats with urethral obstruction. Journal of Veterinary Emergency and Critical Care 2003;13:227-233.
9. Lee JA, Drobatz KJ. Historical and physical parameters as predictors of severe hyperkalemia in male cats with urethral obstruction. Journal of veterinary emergency and critical care 2006;16:104-111.
10. Malouin A, Milligan JA, Drobatz KJ. Assessment of blood pressure in cats presented with urethral obstruction. Journal of Veterinary Emergency and Critical Care 2007;17:15-21.
11. Brabson TL, Bloch CP, Johnson JA. Correlation of gross urine color with diagnostic findings in male cats with naturally occurring urethral obstruction. J Feline Med Surg 2014.
12. Drobatz KJ, Hughes D. Concentration of ionized calcium in plasma from cats with urethral obstruction. Journal of the American Veterinary Medical Association 1997;211:1392-1395.
13. Hetrick PF, Davidow EB. Initial treatment factors associated with feline urethral obstruction recurrence rate: 192 cases (2004-2010). Journal of the American Veterinary Medical Association 2013;243:512-519.

14. Hall J, Hall K, Powell LL, Lulich J. Outcome of male cats managed for urethral obstruction with decompressive cystocentesis and urinary catheterization: 47 cats (2009-2012). J Vet Emerg Crit Care (San Antonio) 2015;25:256-262.
15. Eisenberg BW, Waldrop JE, Allen SE, Brisson JO, Aloisio KM, Horton NJ. Evaluation of risk factors associated with recurrent obstruction in cats treated medically for urethral obstruction. J Am Vet Med Assoc 2013;243:1140-1146.
16. Cooper ES, Owens TJ, Chew DJ, Buffington CA. A protocol for managing urethral obstruction in male cats without urethral catheterization. Journal of the American Veterinary Medical Association 2010;237:1261-1266.
17. Nevins JR, Mai W, Thomas E. Associations between Ultrasound and Clinical Findings in 87 Cats with Urethral Obstruction. Vet Radiol Ultrasound 2015.
18. Le Boedec K, Pastor ML, Lavoue R, Reynolds BS. Pseudomembranous cystitis, an unusual condition associated with feline urine outflow obstruction: Four cases. J Feline Med Surg 2011;13:588-593.
19. O'Hearn AK, Wright BD. Coccygeal epidural with local anesthetic for catheterization and pain management in the treatment of feline urethral obstruction. J Vet Emerg Crit Care (San Antonio) 2011;21:50-52.
20. Barsanti JA, Shotts EB, Crowell WA, Finco DR, Brown J. Effect of therapy on susceptibility to urinary tract infection in male cats with indwelling urethral catheters. Journal of Veterinary Internal Medicine 1992;6:64-70.
21. Bovee KC, Reif JS, Maguire TG, Gaskell CJ, Batt RM. Recurrence of feline urethral obstruction. Journal of the American Veterinary Medical Association 1979;174:93-96.
22. Barsanti JA, Brown J, Marks A, Reece L, Greene CE, Finco DR. Relationship of lower urinary tract signs to seropositivity for feline immunodeficiency virus in cats. J Vet Intern Med 1996;10:34-38.
23. Galluzzi F, De Rensis F, Menozzi A, Spattini G. Effect of intraurethral administration of atracurium besylate in male cats with urethral plugs. J Small Anim Pract 2012;53:411-415.
24. Zezza L, Reusch CE, Gerber B. Intravesical application of lidocaine and sodium bicarbonate in the treatment of obstructive idiopathic lower urinary tract disease in cats. J Vet Intern Med 2012;26:526-531.
25. Lulich J, Osborne C. Prazosin in cats with urethral obstruction. J Am Vet Med Assoc 2013;243:1240.
26. Veir JK, Webb CB, Lappin MR. Systemic effects of a commercial preparation of chondroitin sulfate, hyaluronic acid and nacetyl-D-glucosamine when administered parenteral to healthy cats. International Journal of Applied Research in Veterinary Medicine 2013;11:91-95.
27. Bradley AM, Lappin MR. Intravesical glycosaminoglycans for obstructive feline idiopathic cystitis: a pilot study. J Feline Med Surg 2013.
28. Achar E, Achar RA, Paiva TB, Campos AH, Schor N. Amitriptyline eliminates calculi through urinary tract smooth muscle relaxation. Kidney Int 2003;64:1356-1364.

Acute Kidney Disease in Cats: Diagnosing, Managing, and Preventing

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

Acute kidney injury (AKI) is the term used to describe a spectrum of acute alterations in kidney function and structure that range from mild (clinically inapparent) to overt acute renal failure (varying degrees of azotemia). Portions of the nephron may be temporarily injured or they may sustain lethal injury resulting in permanent loss of nephron mass depending on the severity of the insult. Recovery of full renal function and histopathological structure is possible in some cases. Partial recovery with substantial nephron loss will result in recovery as a CKD patient in some. In other patients, severe injury results in substantial loss of nephron mass and renal function that will not allow a reasonable quality of life without dialysis. Severely azotemic AKI patients often require dialysis to be managed adequately.

The details of a new grading system for categorization of acute kidney injury (AKI) developed by IRIS (International Renal Interest Society) are available for further review at http://www.iris-kidney.com/guidelines/grading.shtml. Much like the IRIS staging system for CKD, this grading system is designed to detect AKI at early stages when it is more likely that therapeutic interventions can avert further injury and allow recovery of renal function and tissue repair. The clinical prognosis is likely to align with the AKI grade that develops. Historically, attention was mostly directed to patients with serum creatinine that exceeded the reference range. In the IRIS AKI scheme, even a small increase in serum creatinine within the reference range is considered an important marker for potential acute renal injury. The IRIS AKI grading system involves evaluation of fasting serum creatinine concentration as the first step and then the staging is refined based on urine output if it is known (see Table 1). The same cutoffs for creatinine and urine output have been chosen for use in the dog and the cat. Oliguria, normal urine production, or polyuria can all occur depending on the specific cause and severity of renal injury sustained during AKI. History and physical examination parameters also enter into assignment of the grade. AKI typically focuses on those with acute injury to kidneys that were intrinsically normal prior to the acute injury. Pre-renal and post-renal disorders can occur in the absence of primary renal injury but they can also occur on top of a primary renal injury. Patients with CKD often have an "acute-on-chronic" presentation with changes in level of azotemia that falls into the AKI grading scheme. An inability to regulate solute and water balance is often present and renal synthetic and degratory functions are impaired to varying degrees during AKI. It should be noted that this AKI staging scheme is dynamic in that the grade may increase or decrease in severity over time and treatment. Extensive diagnostic evaluation may be needed to determine the specific cause(s)/diagnosis underlying the AKI; specific diagnosis is not specified by the AKI grading status.

Differential diagnosis and frequency of AKI – See Table 2. Causes of AKI in cats

The frequency of underlying conditions associated with AKI varies with the nature of the veterinary practice. Nephrotoxicity is the leading cause for AKI at The Ohio State University Veterinary Hospital, followed by ischemia. The aggressive use of potentially nephrotoxic antibiotics, particularly the aminoglycosides, can contribute to nephrotoxic AKI. The exposure to cholecalciferol rodenticides, use of non-steroidal anti-inflammatory drugs (NSAID), and exposure of veterinary patients to extensive surgical procedures and aggressive post-traumatic resuscitative maneuvers as emergency patients can result in AKI. Ischemic and nephrotoxic AKI occur more readily in patients that have underlying chronic renal disease or renal failure.

Diagnosis of AKI

Rapid increases of BUN, serum creatinine, and serum phosphorus may be observed during severe AKI. This is particularly helpful to document AKI in the absence of recent serum biochemistry values for comparison. For example, a patient's serum creatinine of 4.3 mg/dl, 6.0 mg/dl, and 7.5 mg/dl sequentially over three consecutive days supports a diagnosis of azotemic AKI. Serum creatinine and BUN do not increase over this short a time period in hydrated patients with CKD. Hyperphosphatemia may be out of proportion to the degree of increase in BUN or serum creatinine in those with AKI compared to CKD. The magnitude of elevation in BUN or serum creatinine concentrations is not helpful in the diagnosis of azotemic AKI vs CKD or in the differentiation of pre-renal, intrinsic renal, or post-renal azotemia. See Table 1 AKI grading for how to detect AKI at earlier levels of increasing serum creatinine. Urinalysis reveals a low specific gravity (USG) during the maintenance phase of azotemic AKI (SG less than 1.030, but most-often in the 1.007 to 1.015 range). Decreased maximal USG may be detected before an increase in serum creatinine is detected. Dipstrips may show proteinuria, hematuria or glucosuria on occasion. UPC can be increased due to increase in protein excretion normally handled by renal tubules. Urinary sediment is typically "active" at early stages of the maintenance phase of severe AKI exhibiting increased numbers of casts (particularly cellular casts) and small epithelial cells compatible with renal tubular epithelium. Animals with AKI as the sole problem should have smooth kidneys with normal or increased kidney size whereas those with chronic renal failure may show small and or irregular kidneys both on palpation and abdominal radiographs. Renal ultrasonography can provide additional anatomic

information to confirm intrarenal lesions, but cannot be relied on to distinguish acute from chronic renal failure or to suggest a specific microscopic lesion. Failure to document ultrasonographic renal changes does not exclude a diagnosis of AKI. Kidneys may enlarge during AKI but this may not be detected if they are still within the normal range for kidney size; kidneys tend to become "plump" before they measure elongated. Peri-renal effusion was described in 6 cats with azotemic AKI.[1] Renal biopsy may be helpful to determine that an azotemia is due to primary renal lesions and to characterize the changes as acute or chronic. A positive urine culture in the face of AKI is of concern for upper urinary tract infection, but this finding alone is not definitive to establish a diagnosis of pyelonepohritis.

It is imperative to exclude acute post-renal azotemia due to ureteral stones or stricture in cats presenting with azotemia that appears to have developed suddenly. In some cats ureteral stones cause complete obstruction of one or both ureters resulting in varying degree of oliguria or anuria and rapidly escalating magnitude of azotemia. Due to the frequency of this syndrome associated with calcium oxalate urolithiasis, survey radiographs need to be evaluated in all cats suspected to have AKI. If renal or ureteral stones are noted, ultrasonography to determine the degree of any hydronephrosis and or hydroureter is the next step. Many of these cats have pre-existing chronic kidney disease that makes it relatively easy for azotemia to develop even when only one ureter is obstructed. In many instances, there is the presence of "big-kidney little-kidney" syndrome likely reflecting previous chronic kidney injury reducing the size of one kidney and hydronephrosis increasing the size of the second kidney.[2] Though the azotemia can be quite striking and rapid in development, these cases represent acute post-renal azotemia on top of chronic primary kidney disease. Medical therapy is not often successful in management of these cats and relief of the ureteral obstruction by minimally invasive stenting or traditional surgery will be needed in order to sustain life without dialysis. The prognosis following relief of the obstruction is often guarded due to the underlying chronic kidney disease.

Prognosis of AKI

The attending veterinarian and client often have greater expectations for immediate improvement following treatment than is realistic, remembering that the maintenance phase of azotemic AKI can last weeks in some cases before adequate renal repair and function can occur. The most likely causes for death during the initial management of the azotemic AKI patient in the maintenance phase are from the effects of hyperkalemia, metabolic acidosis, and severe azotemia. Overhydration and resulting pulmonary edema are the next major causes of death during vigorous fluid therapy.

There is no magnitude of increased serum creatinine concentration measured at one time point that determines prognosis. Serial serum creatinine measurements over time are much more informative. Acute changes in the concentration of serum creatinine were associated with prognosis in one study of 209 cats with an initial serum creatinine of < 1.6 mg/dl and at least 2 serum creatinine measurements within 7 days. A poorer prognosis was found in cats that increased their highest serum creatinine to > 1.6 mg/dl with at least an increase of 0.3 mg/dl. If this increase in serum creatinine were achieved within 3 or 7 days, cats were about 3 times more likely to die at 30 days and 4 times more likely to die within 7 days. When this increase in serum creatinine occurred within 2 or 3 days, death within 90 days was 3 times more likely.[3] Azotemic AKI was diagnosed in 32 cats of an earlier study (serum creatinine >2.5 mg/dl); 18 cats were oliguric at the time of diagnosis. About half of these AKI cats survived (53%) with complete resolution of azotemia in 25% and persistent azotemia (CKD recovery) in 28%. The initial BUN or serum creatinine concentration did not predict survival nor did oliguria. Serum potassium increases seemed to be the most important predictor of survival; a 57% decreased chance in survival occurred for each mEq/L increase over the initial serum potassium concentration. Low initial serum albumin and bicarbonate were also associated with less survival.[4]

A grave prognosis is warranted for cats that develop anuric AKI after IV fluid treatment, a situation most-likely to develop in ethylene glycol intoxication but may also be encountered in cats following ingestion of Easter or day lilies. It should be noted that dogs and cats with severe oliguric AKI have recently been shown to survive with return of renal function and urine production following several months of hemodialysis. The presence of non-oliguria does not guarantee survival either. Due to the poor to grave prognosis for many cases with severely azotemic AKI, prevention is far preferred to treatment.

General goals for treatment of azotemic AKI during the maintenance phase

Placement of an indwelling intravenous catheter is necessary to adequately administer fluids and drugs in the management of azotemic AKI. Rapid correction of dehydration is indicated and can be individually calculated (estimated % dehydration x body weight in kg = Liters of dehydration) or given as 2 to 3 times maintenance fluid needs (60 to 90 ml / pound per day). Further fluids are given to match sensible (urinary volume), insensible (respiratory losses at about 10 ml/lb/day),and contemporary (an estimated volume from vomiting and diarrhea) fluid losses. Since urine output is widely variable in AKI, it is advisable to place an indwelling urinary catheter to monitor urine output to facilitate fluid therapy decisions for the initial 24 to 48 hours. The recognition of oliguria is important initially as it dictates the volume of IV fluid therapy that can be safely given. Urine production less than 1.0 ml/kg/hour (24 ml/kg/day) qualifies for oliguria in our hospital prior to rehydration and volume expansion. Relative oliguria exists if urine production is form 1.0 to 2.0 ml/kg/hour while on IV fluids. Urine output should be from 2.0 to 5.0 ml/kg/hour during vigorous administration of

IV fluids if the kidneys are healthy. It is essential to curtail the fluid prescription for volume to be further infused once hydration has been established especially when urine output does not increase. It is the author's impression that it is easier for cats with AKI to develop overhydration compared to dogs with AKI even with careful monitoring.

Newer thinking about the dangers of IV fluid therapy in the critically ill

If insufficient fluids are given to the AKI patient, the kidneys are not optimally perfused and sustain further ischemic injury. If too much fluid is given, then overt overhydration with pulmonary edema, congestive heart failure, and death follow. A new paradigm suggests that too many fluids and subclinical development of overhydration also result in further renal injury from visceral overhydration and reductions in renal blood flow and GFR as renal interstitial edema develops.[5-9] Renal edema can be an early development following some forms of renal injury. It appears that renal edema can also develop as a consequence of too aggressive fluid therapy. Conventional wisdom has been that it is better to have a little over-hydration than to have the damaged kidneys endure any chance for underperfusion and ischemic injury. It now appears that contrary to popular opinion, it is better to be a little on the "dry" side following rehydration and moderate resuscitation rather than to risk the development of over-hydration. It is possible that declining renal functions in the face of aggressive fluid therapy (reflected by rising BUN, creatinine, and phosphorus) may actually be caused by this treatment and resulting renal edema. Interstitial edema decreases renal blood flow by compression of renal vessels, and opposes GFR by compression of Bowman's capsule and compression of renal tubules. This concept needs to be further evaluated in both human and veterinary medicine. For now, caution is advised so that minimal fluids following correction of hypotension and rehydration are administered. The concept that "less is more" has been advocated in a veterinary review of AKI in cats.[10]

Conversion from oliguria to non-oliguria

Mannitol, furosemide, dopamine, or combinations of these are the diuretics most often employed in attempts to convert oliguria to non-oliguria or to increase renal function (RBF, GFR) Rehydration prior to use of diuretics should occur first to allow greater delivery of the diuretic to its site of action. There are no reports that detail the response of cats or dogs with clinical AKI to these treatments. The so-called "renal-dose" of dopamine (below the vasopressor dose, often from 2 to 5 micrograms/kg/minute) has surprisingly little clinical documentation to support its use in either human or veterinary medicine.[11,12] A combined infusion of dopamine and furosemide to awake normal cats increased urine output but did not increase GFR.[13] Fenoldopam as a selective DA-1 receptor agonist has the potential to cause renal vasodilatation with increased RBF, GFR, and natriuresis without activation of alpha and beta adrenergic receptor effects that occur with dopamine at higher doses.[14]

Ethylene glycol nephrotoxicity

The gold standard to prove the presence of ethylene glycol or its toxic metabolites following bioconversion remains testing with HPLC on serum or plasma samples. This type of testing is not commonly available, though it can be performed at local human hospital laboratories. The EG Test Kit (Allelic Biosystems, Kearnesville WV) is supposed to be able to detect 50 mg/dl of ethylene glycol in a serum/plasma sample but this has not been studied in cats. Test strips designed to detect ethylene glycol (Kacey ethylene glycol test, Kacey Inc, Asheville, NC.) were found to have too many false positives and false negatives to be useful for clinical work in cats.[15] The Catachem test kit (Catachem Inc., Oxford, Connecticut) detected the presence of EG when added to serum or plasma of dogs and cats but did have a positive bias in slightly overestimating actual EG concentrations.[16] This company provides both a quantitative and qualitative test to detect EG. The utility of the osmole gap has been ignored by many in the critical care community. A large osmole gap is proportional to the amount of unmetabolized ethylene glycol in many cases. A large osmole gap is most commonly created by ethylene glycol ingestion in small animals, but a large osmole gap could also result in animals that have consumed propylene glycol as an alternate and less toxic formulation of antifreeze. The presence of calcium oxalate crystalluria is supportive for the diagnosis of ethylene glycol intoxication in the appropriate setting – cat that is sick, possible history or observation of ingestion, and sub-maximally concentrated urine. Calcium oxalate crystalluria is observed in fewer cats than in dogs with ethylene glycol intoxication.[17,18] Calcium oxalate monohydrate crystalluria is more commonly detected than calcium oxalate dihydrate crystal following EG ingestion. Calcium oxalate monohydrate has several different morphologic appearances that can be difficult to identify whereas calcium oxalate dehydrate is more easily recognized.[19] An extremely hyperechogenic renal cortex and medulla may be observed soon after ingestion of lethal quantities of EG in the cat as in the dog.[20,21]

Fomepizole at high doses is the antidote of choice to treat cats following EG ingestion. Fomepizole is administered in higher doses than needed in dogs in order to effectively inhibit alcohol dehydrogenase[22], which otherwise is the first step in the bioactivation of EG to its toxic intermediary metabolites. Fomepizole is given to cats with an initial dose of 125 mg/kg IV followed by 31.25 mg/kg at 12, 24, and 36 hours. Use of this treatment protocol was effective in prevention of azotemic AKI in experimental cats treated within 3 hours of exposure to an otherwise lethal dose of EG. Fomepizole was a more effective treatment than ethyl alcohol and provided less CNS depression (some sedation was observed).[23] This fomepizole protocol was successfully used to treat 3 cats with naturally occurring EG poisoning that were not azotemic at presentation.[24] If fomepazole is not available and it is within 3 hours of EG

ingestion, 20% ethanol at 5mL/kg IV initially, followed by the same dose every 6 hours for 5 treatments and then every 8 hours for 4 treatments could be a life-saving alternative antidote. Ethyl alcohol should ALWAYS BE DILUTED prior to administration, otherwise IV administration can cause cardiac arrest.

Lily nephrotoxicty [25-32]

The cat is exquisitely and perhaps uniquely sensitive to the nephrotoxic effects following lily ingestion. The specific toxic principle is unknown but all parts of the lily are toxic to cats. Nephrotoxicity has been observed in cats that have chewed only a small portion of a single lily leaf. The Lilium genus contains nearly 100 species and hundreds of hybrids that are thought to be toxic too. Aqueous extracts of the flower and leaf from the Easter lily contain the toxic principle, with the flower being more potent. Calla lily and peace lily are not real lilies and are not associated with AKI in cats. Lily of the valley does not contain a nephrotoxin, but does contain a digitalis-like toxin. Pancreatic histopathology is observed in some cats.

A history that the cat was observed chewing on lily plants or the finding of fragments of the plant observed in the cat's vomitus provides pivotal clues to the diagnosis. Hypersalivation and vomiting may occur soon after ingestion of lilies due to local irritant effects on the GI tract. Vomiting and lethargy are commonly described 1 to 5 days after plant ingestion in those suffering AKI. Renomegaly and abdominal pain may be detected on physical examination. Varying degrees of azotemia may be documented in cats presenting days after lily ingestion. On urinalysis, isosthenuria, proteinuria, glucosuria, cylindruria, and occasionally ketonuria are present in those with severe AKI but crystalluria is notably absent. Oliguria or anuria may persist despite intravenous fluid therapy in those with severe AKI.

Decontamination combined with fluid diuresis for 48 hours prevents development of azotemic AKI for up to 6 hours after ingestion of lilies. Decontamination 18 hours or more after lily ingestion does not prevent development of azotemic AKI. Induction of vomiting followed by administration of activated charcoal and a cathartic is recommended by the Animal Poison Control Center. Vomiting should not be induced in cats that already are vomiting as a consequence of lily ingestion. No antidote is available to counteract effects of the absorbed nephrotoxin. Nearly all cats presented early with GI signs alone survive after decontamination and induction of diuresis.

As many as 33% to 50% of cats that ingest lilies will develop azotemic AKI if not treated within a few hours following lily ingestion. Anuric AKI can occur 18 to 24 hours after ingestion. Prognosis for recovery is poor after lily-induced development of severely azotemic AKI. The magnitude of azotemia that develops during AKI does not predict survival, but urine output does. Cats with aoztemic AKI that are polyuric are more likely to survive. Cats with azotemic AKI and persistent oliguria or anuria are unlikely to survive. Cats that survive severe azotemic AKI after lily ingestion tend to have substantial permanent loss of renal mass and go on to develop various stages of CKD.

In a recent abstract, 30 cats were treated for lily ingestion associated AKI and 22 cats survived. Eighteen of the 30 cats were managed with aggressive medical treatment in which 89% survived. Twelve of the 30 cats were treated with intermittent hemodialysis with a 50% survival rate. Urine output and hydration status at time of diagnosis were not related to survival. Cats with a serum creatinine > 2.0 mg/dl at the time of diagnosis were more likely to die.[33]

NSAID AKI

NSAIDs are not directly nephrotoxic, but rather work as nephrotoxicants that cause their damaging effect through intense vasoconstriction that develops under special circumstances. NSAID cause AKI only if systemic vasoconstrictor signals have been activated following hemodynamic insult (sodium depletion, volume contraction, hypotension, shock, anesthesia). Normal renal vascular resistance and renal blood flow are relatively well maintained during times of vasoconstriction if synthesis of renal vasodilator substances is normal. Renal vasoconstriction however proceeds unopposed if the synthesis of renal vasodilatory prostaglandins has been blocked by NSAID administration. In these instances, progression to acute azotemic AKI and papillary necrosis may occur. An increased frequency of azotemic AKI was reported in 16 young cats given NSAID at the time of routine desexing without IV fluid administration. Four of these cats were euthanized due to failure of severe azotemia to resolve, 4 cats survived with azotemic CKD, and 8 cats recovered with complete resolution of azotemia[34] In 21 cats with NSAID AKI of another study, the mortality rate was 25% mostly in cats associated with papillary necrosis. Supportive therapy for up to 4 weeks was required for some survivors.[35] The FDA recently required the following statement to be added to the label for meloxicam use in cats, "Repeated use of meloxicam in cats has been associated with acute renal failure and death. Do not administer additional injectable or oral meloxicam to cats…" Robenacoxib, a long acting NSAID, recently has become available for use in cats in North America. Whether the incidence of NSAID-associated AKI is less during treatment with newer generation NSAIDs touted to have less GI side effects remains to be determined.

Table 1. IRIS AKI grading criteria – 2013 guidelines

Each grade is sub-graded as non-oliguric (NO) or oligoanuric(O) and if needing renal replacement therapy (RRT)

AKI Grade	Serum Creatinine	Clinical Description
Grade 1	< 1.6 mg/dL < 140 μmol/L	Non Azotemic AKI: a. Documented AKI: Historical, clinical, laboratory, or imaging evidence of acute kidney injury, clinical oliguria/anuria, volume responsiveness**, and/or b. Progressive non azotemic increase in blood creatinine; ≥ 0.3 mg/dl (≥ 26.4 μmol/L) within 48 hours c. Measured oliguria (< 1 ml/kg/hr) or anuria over 6 hours
Grade 2	1.7 – 2.5 mg/dl 141 – 220 μmol/L	Mild AKI: a. Documented AKI and static or progressive azotemia b. Progressive azotemic increase in blood creatinine; ≥ 0.3 mg/dl (≥ 26.4 μmol/L) within 48 hours, or volume responsiveness** c. Measured oliguria (< 1 ml/kg/hr) or anuria over 6 hours
Grade 3	2.6 – 5.0 mg/dl 221 – 439 μmol/L	Moderate to Severe AKI: a. Documented AKI and increasing severities of azotemia and functional renal failure
Grade 4	5.1 – 10.0 mg/dl 440-880 μmol/L	
Grade 5	> 10.0 mg/dl > 880 μmol/L	

** Volume responsive is an increase in urine production to > 1 ml/kg/hr over 6 hours; and/or decrease in serum creatinine to baseline over 48 hours

Table 2. Causes for AKI in cats

Renal ischemia (hypoperfusion)

Dehydration	Shock
Trauma	Hemorrhage
Anesthesia	Surgery
Sepsis	Burns
Hyperthermia	Hypothermia
Hemolysis	Myoglobinuria
ACE Inhibitors	Non-Steroidal Anti-Inflammatory Drugs (NSAID)

**Note that renal ischemia can occur in the absence of systemic arterial hypotension.

Nephrotoxins

More common

- Glycols (Ethylene Glycol)
- Antimicrobials
  - Aminoglycosides
  - Amphotericin-B
  - Sulfonamides - dehydration
  - Tetracyclines – IV
  - Fosfomycin – not dogs[36]
- Easter Lilly – Cats

Less common

- Hypercalcemia
  - Cholecalciferol Rodenticide
  - Cholecalciferol – Diet
  - Calcipotriene – antipsoriasis cream
- Cancer Chemotherapeutics
  - Platinum compounds alone and more so when combined with piroxicam

- Radiocontrast Agents - IV
- Heavy Metals

Miscellaneous causes of AKI

- Renal thromboembolism – renal infarction
- Acute-on-chronic renal failure
- Renal amyloidosis with acute papillary necrosis

Acute hyperphosphatemia

- Tumor lysis syndrome
  - Phosphate enema
  - Phosphate acidifier
  - Massive soft tissue trauma
- Pancreatitis
- Food-associated renal failure – FARF
- (melamine with cyanuric acid tainting)

References

1. Holloway A, O'Brien R. Perirenal effusion in dogs and cats with acute renal failure. *Vet Radiol Ultrasound* 2007;48:574-579.
2. Dalby AM, Adams LG, Salisbury SK, Blevins WE. Spontaneous retrograde movement of ureteroliths in two dogs and five cats. *Journal of the American Veterinary Medical Association* 2006;229:1118-1121.
3. Harison E, Langston C, Palma D, Lamb K. Acute azotemia as a predictor of mortality in dogs and cats. *J Vet Intern Med* 2012;26:1093-1098.
4. Worwag S, Langston CE. Acute intrinsic renal failure in cats: 32 cases (1997-2004). *J Am Vet Med Assoc* 2008;232:728-732.
5. Prowle JR, Kirwan CJ, Bellomo R. Fluid management for the prevention and attenuation of acute kidney injury. *Nat Rev Nephrol* 2014;10:37-47.
6. Prowle JR. Acute kidney injury: an intensivist's perspective. *Pediatr Nephrol* 2014;29:13-21.
7. Prowle JR, Liu YL, Licari E, Bagshaw SM, Egi M, Haase M, Haase-Fielitz A, Kellum JA, Cruz D, Ronco C, Tsutsui K, Uchino S, Bellomo R. Oliguria as predictive biomarker of acute kidney injury in critically ill patients. *Crit Care* 2011;15:R172.
8. Prowle JR, Echeverri JE, Ligabo EV, Ronco C, Bellomo R. Fluid balance and acute kidney injury. *Nat Rev Nephrol* 2010;6:107-115.
9. Liu YL, Prowle J, Licari E, Uchino S, Bellomo R. Changes in blood pressure before the development of nosocomial acute kidney injury. *Nephrol Dial Transplant* 2009;24:504-511.
10. Langston CE, Eatroff A. Less is more - fluid therapy for kidney disease. *J Fel Med Surg* 2012;14:773.
11. Sigrist NE. Use of dopamine in acute renal failure. *Journal of Veterinary Emergency and Critical Care* 2007;17:117-126.
12. Wohl JS, Schwartz DD, Flournoy WS, Clark TP, Wright JC. Renal hemodynamic and diuretic effects of low-dosage dopamine in anesthetized cats. *Journal of Veterinary Emergency and Critical Care* 2007;17:45-52.
13. McClellan JM, Goldstein RE, Erb HN, Dykes NL, Cowgill LD. Effects of administration of fluids and diuretics on glomerular filtration rate, renal blood flow, and urine output in healthy awake cats. *Am J Vet Res* 2006;67:715-722.
14. Simmons JP, Wohl JS, Schwartz DD, Edwards HG, Wright JC. Diuretic effects of fenoldopam in healthy cats. *Journal of Veterinary Emergency and Critical Care* 2006;16:96-103.
15. Acierno MJ, Serra VF, Johnson ME, Mitchell MA. Preliminary validation of a point-of-care ethylene glycol test for cats. *Journal of Veterinary Emergency and Critical Care* 2008;18:477-479.
16. Scherk JR, Brainard BM, Collicutt NB, Bush SE, Almy FS, Koenig A. Preliminary evaluation of a quantitative ethylene glycol test in dogs and cats. *J Vet Diagn Invest* 2013;25:219-225.
17. Thrall MA, Grauer GF, Mero KN. Clinicopathologic findings in dogs and cats with ethylene glycol intoxication. *J Am Vet Med Assoc* 1984;184:37-41.
18. Grauer GF, Thrall MA. Ethylene glycol (antifreeze) poisoning in the dog and cat. *Journal of the American Animal Hospital Association* 1982;18:492-497.
19. Thrall MA, Dial SM, Winder DR. Identification of calcium oxalate monohydrate crystals by X-ray diffraction in urine of ethylene glycol-intoxicated dogs. *Vet Pathol* 1985;22:625-628.
20. Adams WH, Toal RL, Brieder MA. Ultrasonographic findings in dogs and cats with oxalate nephrosis attributed to ethylene glycol intoxication: 15 cases (1984-1988). *Journal of the American Veterinary Medical Association* 1991;199:492-496.
21. Adams WH, Toal RL, Breider MA. Ultrasonographic findings in ethylene glycol (antifreeze) poisoning in a pregnant queen and 4 fetal kittens. *Veterinary Radiology* 1991;32:60-62.
22. Dial SM, Thrall MA, Hamar DW. Comparison of ethanol and 4-methylpyrazole as treatments for ethylene glycol intoxication in cats. *Am J Vet Res* 1994;55:1771-1782.
23. Connally HE, Thrall MA, Hamar DW. Safety and efficacy of high-dose fomepizole compared with ethanol as therapy for ethylene glycol intoxication in cats. *J Vet Emerg Crit Care (San Antonio)* 2010;20:191-206.
24. Tart KM, Powell LL. 4-Methylpyrazole as a treatment in naturally occurring ethylene glycol intoxication in cats. *J Vet Emerg Crit Care (San Antonio)* 2011;21:268-272.

25. Bennett AJ, Reineke EL. Outcome following gastrointestinal tract decontamination and intravenous fluid diuresis in cats with known lily ingestion: 25 cases (2001-2010). *J Am Vet Med Assoc* 2013;242:1110-1116.
26. Fitzgerald KT. Lily toxicity in the cat. *Topics in Companion Animal Medicine* 2010;25:213-217.
27. Hadley RM, Richardson JA, Gwaltney-Brant SM. A retrospective study of daylily toxicosis in cats. *Veterinary and Human Toxicology* 2003;45:38-39.
28. Hall JO. Nephrotoxicity of Easter lily (Lilium longiflorum) when ingested by the cat. *Journal of Veterinary Internal Medicine* 1992;6:121.
29. Langston CE. Acute renal failure caused by lily ingestion in six cats. *J Am Vet Med Assoc* 2002;220:49-52, 36.
30. Rumbeiha WK, Francis JA, Fitzgerald SD, Nair MG, Holan K, Bugyei KA, Simmons H. A comprehensive study of Easter lily poisoning in cats. *J Vet Diagn Invest* 2004;16:527-541.
31. Slater MR, Gwaltney-Brant S. Exposure circumstances and outcomes of 48 households with 57 cats exposed to toxic lily species. *J Am Anim Hosp Assoc* 2011;47:386-390.
32. Tefft KM. Lily nephrotoxicity in cats. *Compendium on Continuing Education for the Practicing Veterinarian* 2004;26:149-157.
33. Lippi I, Ross S, Cowgill L. Acute kidney injury secondary to lily intoxication in 30 cats. . *J Vet Internal Med* 2013;27:738.
34. Robson M, Chew D, van Aalst S. Intrinsic acute renal failure (ARF) associated with non-steroidal anti-ionflammatory drugs (NSAID) use in juvenile cats undergoing routine desexing- 16 cases 1998-2005 *J Vet Intern Med* 2006;20:740.
35. Pagès JP. Nephropathies associated with NSAIDs in cats: 21 cases (1993-2001). *Pratique Médicale & Chirurgicale de l'Animal de Compagnie* 2005;40:177-181.
36. Fukata T, Imai N, Shibata S. Acute renal insufficiency in cats after fosfomycin administration. *Vet Rec* 2008;163:337-338.

Special Aspects of Diagnosing and Managing Chronic Kidney Disease in Cats

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

The incidence of the diagnosis of CKD in cats is made 2 to 3 times as frequently compared to dogs and is especially common in geriatric cats.[1] CKD is clinically characterized by the development of variably progressive irreversible intrarenal lesions and loss of renal functions. Compensatory increases (so called adaptations) in glomerular hemodynamics and glomerular volume may actually be maladaptive in the long term as they cause increased protein trafficking across the glomerulus.

The initial diagnosis of CKD is made on some combination of findings from clinical signs, physical examination (especially large or small kidneys, irregular kidneys), renal imaging, urinalysis, and serum biochemistry. A surprising number of cats with CKD have upper urinary tract uroliths at the time of initial diagnosis.2-4 Abdominal radiographs should be routinely obtained to determine the presence or absence of radiopaque stones. Renal and ureteral ultrasonography should be performed in all cats in which renal or ureteral stones were found on radiography in order to tell whether or not there is an obstructive component to the CKD. T4 should be measured in all cats with suspected CKD since hyperthyroidism can mask the detection of azotemia by its effects that increase GFR and RBF; hyperthyroidism may also contribute to progression of CKD through a variety of mechanisms including intraglomerular and systemic hypertension. 5 Conventional wisdom and experience suggests that client owned cats with healthy kidneys elaborate urine with a specific gravity of >1.035. This concept was recently validated in a study of cats evaluated at first opinion clinics.6 Cats with USG < 1.035 should undergo further diagnostic investigation to determine if they have an endocrine or renal disorder with or without associated clinical signs. A surprising number of experimental 7 and clinical cats with CKD continue to be able to elaborate urine with a USG > 1.035, so the presence of "concentrated" urine and mild to moderate azotemia does NOT exclude the presence of primary kidney disease in cats as it often does in dogs. Cats that have thin body condition, prior periodontal disease or cystitis, anesthesia or documented dehydration in the preceding year, or being a neutered male (vs spayed female) were reported to be at increased risk for the diagnosis of CKD.8

A staging system initially based on the level of serum creatinine concentration has been developed by IRIS (International Renal Interest Society) for use in cats that are hydrated and stable. Serum creatinine is measured again on at least 2 occasions 2 weeks apart by the same lab. Sub-staging is then based on the degree of proteinuria as measured by UPC and also the magnitude of blood pressure. Staging using this system is designed to detect CKD much earlier than with traditional methods and also to potentially match treatments by stage. Normal and stage 1 CKD cats have serum creatinine concentrations < 1.6 mg/dl (< 140 µmol/L). Normal cats usually have a UPC < 0.2, with 0.2-0.4 considered borderline increased, and > 0.4 overtly proteinuric. Details of this staging system can be found online at http://www.iris-kidney.com. This staging system does not indicate the underlying cause for the CKD which requires other diagnostic workup to determine. It is important to remember that nearly all studies on the effect of diet or drugs have studied overtly azotemic cats (serum creatinine > 2.0 mg/dl). It has not been determined whether or not the salutary effects of treatment in azotemic cats confer the same benefits to CKD cats at earlier stages.

Tubulo-interstitial nephritis of unknown origin is the most common cause of azotemic CKD in the cat, as in the dog. However, cats have several renal diseases that deserve additional consideration as compared to dogs including breed related predilection for renal amyloidosis (Abyssinian, Oriental Short Hair) and polycystic kidney disease (Persian, Himalayan). Cats have greater frequency of CKD associated with renal LSA than dogs. Peri-nephric pseudocyst can be associated with CKD in cats and should be considered as a differential diagnosis for apparent renal enlargement in addition to renal LSA and hydronephrosis.

A variety of interventions (diet and drugs) can slow the progression of the renal disease, improve the quality of life for the patient, and/or extend the quantity of life. Dennis-I just moved this here as it opens your discussion re treatment.

Dietary interventions for CKD

Dietary therapy remains the cornerstone of management of CKD. Diet modifications include phosphorus restriction (most important), providing reduced quantity but high quality protein, adequate non protein calories from fat and CHOs, modifying sodium content (not the degree of restriction once recommended by some), supplementing potassium, B vitamins, alkali as needed and providing omega three fatty acids. In one 2-year study, cats with a serum creatinine > 2 mg/dl fed a renal diet had a median survival time that was 2.4 times longer than cats fed a maintenance diet (633 days vs 264 days). [9] In another study, IRIS stage 2 & 3 cats were followed for 24 months. Cats fed the maintenance diet had more uremic episodes and more renal-related deaths compared with cats fed the renal diet. [3] In a study of 175 CKD cats fed 1 of 7 different renal diets, the median survival time was 16 months (12 to 23 months) compared to a median survival time of 7 months for cats eating their maintenance diet. Interestingly, the longest survival period was found in cats eating a renal diet with the highest eicosapentaenoic acid (diet not available in North America), otherwise the renal diets were similar

in composition. [10] Patients are more likely to accept a new renal diet if offered before uremia develops and a gradual transition may be needed.

The number one reason to restrict dietary protein is to provide an adequate degree of restricted intake of phosphorus, especially those associated with animal tissues in the diet. Decreased production of nitrogenous wastes can occur in those with large increases in BUN, and consequently improve the clinical well-being of the pet even though renal function remains unchanged. If proteinuria is present, dietary protein restriction may lower the magnitude of proteinuria through obscure mechanisms. Reduced dietary protein intake may also lessen inflammatory, fibrogenic and oxidative stress pathway.[11] The amount to restrict dietary protein is not known, so it is currently recommended to provide at least maintenance levels. For cats with CKD, the minimum dietary protein requirement suggested is 20% of calories, which equates to 24% protein on a dry-matter basis.[11-14]Others suggest 28–35% (DMB).[15]It is emphasized that less total dietary protein can be fed if high biologic value proteins, such as egg, are fed.[13] Lowering animal-derived protein (source of phosphates) in the diet may be essential to lower dietary phosphorus intake needed to achieve target levels of serum phosphorus.[16] Too much dietary protein restriction can and often does result in protein: calorie malnutrition. Protein malnutrition from any cause is strongly correlated with morbidity and mortality. If protein malnutrition becomes evident in a patient (hypoalbuminemia, anemia, weight loss or loss of lean muscle mass), then the amount of protein should be increased until signs are no longer evident. Cats with sarcopenia, regardless of the stage of renal disease, may require more protein than a renal diet can provide-careful monitoring and adjustment will be needed in these cats.

Pets with CKD often suffer from poor appetite that can contribute to poor body condition. This is often associated with decreased prognosis as the owner's often euthanize when quality of life is perceived as unacceptable. *Mirtazapine (Remeron)* helps not only with appetite but with uremic-associated nausea. Recent work in cats indicates mirtazapine can be administered at a low dose (1.88 mg) every 48 hours to cats with CKD, but was only studied for its effects for 3 weeks.[17,18] Remember that mirtazapine and cyproheptadine cannot not be administered concurrently. Cyproheptadine is in fact used as an antidote for serotonin effects of mirtazapine overdose. *Maropitant (Cerenia*): NK-1 receptors are in the chemoreceptor trigger zone, in the emetic center itself, as well as peripherally. Consequently, Cerenia is a great choice to treat vomiting/nausea in renal cats. Despite the label recommendation, many specialists are recommending Cerenia for longer than 5 days (personal communication with specialists and with Zoeitis scientists). Dose: 1 mg/kg PO once daily. Refrigerate to help alleviate the sting associated with injectable cerenia.[19] *Omeprazole* (*Losec*): Studies in cats have also shown Omeprazole to be more effective than H2 blockers such as famotidine and ranitidine in decreasing gastric acidity.[20] Dosage: 0.5-1 mg/kg once a day. If H2 blockers are used, dosages recommended are *Famotidine* (Pepcid®) 0.5 mg/kg IM, SQ, PO q 12 hours or *Ranitidine* (Zantac®) 1-2 mg/kg q 12 hours (cat). Studies have shown most cats with uremia do have elevated gastrin levels (and likely corresponding hyperacidity) but no GI ulcers. [20,21] Consequently, *sucralfate* is not usually indicated. The GI bleed with uremia could be from dysregulation of the vasculature and platelet dysfunction associated with uremia.[20,21] If used, a dose of 0.25 -0.5 g/cat q 12 hours is recommended. In some countries *sucralfate* is used as an intestinal phosphate binder due to its aluminum content. *Ondansetron* at the time of this writing is not highly recommended. The bioavailability is not high (maybe 30% at best in cats) and the half-life is very short (it would be best to give this drug 4 times/day).[22]

Phosphorus

Higher concentrations of serum phosphorus predicted an increase in serum creatinine > 25% above baseline over 12 months in 47% of CKD cats. [23] Serum phosphorus was the only clinicopathologic variable predictive of survival in one study of CKD cats. There was an increase in risk of death of nearly 12% for each mg/dl increase in phosphorus in the same study.[24] Higher phosphorus concentration was associated with a higher risk of death within1 month in another study.[25] Even when serum phosphorus was within the reference range, cats with CKD of one study that had phosphorus concentration > 4.7 to ≤ 6.8 mg/dl serum phosphorus had a higher risk of death compared to CKD cats in which circulating phosphorus concentration was ≤ 4.7 mg/dl. [26]

Dietary phosphorus restriction is critical at least from Stage 2 onwards; there is no data to evaluate any potential benefit of Pi restriction in Stage 1. Compared to the average grocery or pet store foods, the renal friendly veterinary diets are restricted in phosphorus by 70 to 80%. Serum phosphorus concentration may increase in CKD pets that increase their food intake following other supportive CKD treatments. Renal diets may provide sufficient dietary phosphate restriction during early stages of CKD but often the addition of dietary phosphate binders will be needed to reach targeted control of serum phosphorus. Early phosphorus restriction in CRF has been shown in dogs and cats to blunt or reverse renal secondary hyperparathyroidism.[27]

Intestinal phosphate binders

Aluminum salts are the most widely used phosphate binders in cats. Aluminum based phosphate binding agents (aluminum hydroxide, aluminum carbonate) are highly effective in lowering serum phosphate levels, forming insoluble and nonabsorbable aluminum phosphate precipitates in the intestinal lumen. THERE IS NO KNOWN SAFE DOSE OF ALUMINUM SALTS FOR HUMANS WITH CKD. Detrimental effects of aluminum based phosphate binders as described in humans seen in humans have not been systematically evaluated in small animal patients and are rarely clinically appreciated. As cats with CKD can live for years on

treatment, concerns for aluminum accumulation deserve more study as to long-term safety. Calcium-based binders are not as effective as aluminum salts, having a lower affinity for phosphorous, thus effective binding of dietary phosphorous requires large doses of calcium, often enough to induce hypercalcemia in humans. The most commonly used calcium based phosphate binders are calcium carbonate and calcium acetate. Animals should be monitored for development of hypercalcemia whenever calcium-containing phosphorus binders are used. Sevelamer hydrochloride (Renagel®, Genzyme Corporation) and the more recently FDA approved Sevelamer carbonate (Renvela®, Genzyme Corporation) are organic polymers that do not contain aluminum or calcium and are not absorbed from the gastrointestinal tract (excreted entirely in feces). Their effects on dogs and cats with clinical CRF have not been reported. Epakitin® (Vetoquinol Inc.) is marketed as a complementary feed on the veterinary market. It contains the adsorbent chitosan (8% crab and shrimp shell extract), 10% calcium carbonate, and 82% lactose and is designed to reduce GI phosphorus absorption and to lower urea nitrogen due to effects of reduced protein digestibility. The results of two studies [28,29] suggest that this supplement could be an alternative to prescription of renal veterinary diets thereby allowing some cats to continue on their regular diets while still reducing the risks for progression of CKD associated with total body phosphorus burden. We have, however, observed the development of hypercalcemia in a few CKD cats with the use of this product probably as a consequence of the calcium carbonate. Lanthanum carbonate (Fosrenol®, Shire Pharmaceuticals) is a non-aluminum and non-calcium containing intestinal phosphate binder and is indicated for use in human patients with end-stage renal failure to reduce serum phosphorous. Very little lanthanum is absorbed across GI tract and lanthanum accumulates to a far less degree following absorption compared to aluminum since lanthanum undergoes extensive hepatic excretion whereas aluminum is excreted mostly by the kidneys. Lanthanum appears to have minimal toxicity in humans. A recent abstract in a small number of CKD cats administered lanthanum carbonate in food at 95 mg/kg/day to achieve very modest serum phosphate control.[30] Several reports of the efficacy and safety of lanthanum carbonate treatment in cats have been published. [31] Lanthanum carbonate octahydrate (Lantharenol® Bayer HealthCare AG) is marketed as a feed additive for adult cats in order to decrease intestinal phosphate absorption. Renalzin® (Bayer HealthCare AG) is the proprietary name for the delivery system of Lantharenol® and comes as a pump system that delivers lanthanum carbonate along with kaolin and vitamin E at appropriate doses to food for cats. This system is widely available in the UK and Europe, but not in the USA or Canada. The proprietary formulation of human lanthanum carbonate is soon to become available as a generic product.

Pronefra® recently has been launched (Virbac, France) as a dietary supplement for cats with CKD. This product provides a combination of calcium and magnesium carbonate as the intestinal phosphate binders, chitosan for “uremic toxin” binding, vasoactive peptides (designed to maintain normal blood pressure) and an extract of Astragalus membranaceus (Chinese herb for anti-inflammatory and anti-fibrotic effects). Safety of this product was reported in 10 normal cats in which Pronefra was added to the food once daily for 12 weeks[32,33] No changes in circulating calcium or magnesium were noted at during this study. Presently there are no reported studies of safety or efficacy in clinical cats with CKD treated with this supplement.

Novartis has developed a new oral phosphate binder for cats called Lenziaren ® (SBR759). Iron oxide with starch and sucrose exist in this preparation as an insoluble complex. A dose of 0.5 to 1.0 Gm/cat/day is recommended when added to standard diets.[34] A dose of 0.25 Gm/cat/day to 1.0 Gm/cat/day is recommended when adding this phosphate binder to a renal diet. [35] Safety and efficacy of Lenziaren® in cats with CKD are not yet reported. Lenziaren is touted by the authors as a phosphate binder that does not contain aluminum, calcium, or lanthanum that could be problematic in cats with CKD. That is true for the aluminum and calcium as a factor in favor of its use, but there is no known toxicity of lanthanum yet reported.

Control of proteinuria

Cats with azotemic CKD increased their risk for death or euthanasia when the UPC was 0.2 to 0.4 compared to <0.2 and was further increased in cats with UPC of >0.4.[36] The prognosis for survival is influenced by the UPC despite what has traditionally been thought to be low-level proteinuria. The effect of treatments that lower proteinuria on survival have not been specifically studied. Since even low-level proteinuria is a risk factor for cats to not survive, it is prudent to consider treatments that lower the amount of proteinuria in those with CKD. See discussions about the potential benefits of dietary protein restriction (above) and RAAS inactivation (below) to reduce the magnitude of proteinuria.

RAAS inactivation

RAAS inactivation results in decreased generation of angiotensin-2 and aldosterone that can exert benefits to reduce progression of CKD. These beneficial effects can occur through variable combinations of reduction in systolic blood pressure, decreased intra-glomerular hypertension, decreased glomerular proteinuria, and less generation of pro-inflammatory and pro-fibrotic cytokines in patients with CKD.

Benazepril is labeled for treatment of azotemic CKD in cats in the UK, Europe, and Canada (Fortekor®), but not in the USA. The ACE-inhibitor benazepril consistently reduces proteinuria in various stages of CKD in cats even when the base line level of proteinuria is seemingly trivial. Benazepril has been shown in two clinical studies to reduce the UPC in cats with azotemic CKD.[37,38]

Despite reduction in proteinuria in CKD cats with initial UPC > 1.0 that were treated with benazepril in one study, increased survival time was not found over placebo.[37] The average survival time of all benazepril treated cats in this study was 501 days vs. 391 days for placebo treated cats but this effect did achieve statistical significance. [37] In another study of 61 cats with CKD, benazepril treatment for 189 days appeared to stabilize those in IRIS stage 2 or 3 with less transition to stage 4 compared to treatment with placebo, though this effect did not achieve statistical significance (low number of cats and short duration of study.[38]

The angiotensin receptor blocker (ARB) telmisartin (Semintra® Boehringer Ingelheim) was approved by the European Commission in 2013 for use in the European Union as a drug for use in cats with CKD and is available for use in Canada but not yet in the USA. Semintra was found to be at least as effective as benazepril in reducing proteinuria in cats with CKD and was well tolerated.[39,40] A US Patent application was filed in July 2013 by Boehringer Ingelheim. It is not clear when or if an ARB should be chosen to reduce RAAS activity instead of an ACE-Inhibitor for treatment of CKD in veterinary patients to reduce proteinuria, systemic blood pressure, or intra-renal inflammation. A veterinary review of the RAAS system, ACE-Inhibitors and ARB's provides more detail for the interested reader.[41]

Activated vitamin-D metabolites: calcitriol

Calcitriol treatments help to decrease PTH or prevent its increase in those with renal secondary hyperparathyroidism. This occurs largely through genomic effects to block PTH synthesis in addition to a mild calcemic effect, and anti-proliferative effect that prevents parathyroid gland hyperplasia. It has become increasingly apparent that calcitriol has major beneficial anti-inflammatory and anti-fibrotic intrarenal effects that are independent of effects on PTH.[27]During treatment of CRF patients with calcitriol, simultaneous monitoring of serum ionized calcium, serum phosphorus and PTH concentrations is the ideal way to document successful and safe control of renal secondary hyperparathyroidism. Calcitriol should not be administered until hyperphosphatemia has been controlled. If the Ca X P solubility product exceeds 60-70, calcitriol should be avoided because of the risk of soft-tissue mineralization.

In a recent study of dogs with azotemic CKD that were treated with calcitriol a median of 365 days survival was observed compared to 250 days in dogs treated with placebo (renal diet in both groups).[42] Similar studies were performed in cats by the same investigators who concluded that there is no advantage to calcitriol treatments in cats with CRF but the study followed cats for just one year. In order to show a difference in treatment effect, if one exists, studies in cats with CKD must be conducted for at least 2 and possibly 3 years due to the inherently slow nature of the progression of chronic renal disease in this species. The authors believe that beneficial effects of calcitriol treatment are likely to occur in cats with CKD.

A compounding pharmacy will be needed to reformulate calcitriol from the human parent drug to a concentration suitable for the dosing of cats. We recommend intermittent rather than daily dosing treatment protocols as the standard of care since less hypercalcemia occurs using this protocol. The equivalent dose given at 2.5 ng/kg daily is given instead every 3.5 days. This works out to a dose of 9 ng/kg (8.75 ng/kg rounded to 9 ng/kg). It is important to give the dose every 3.5 days, rather than on day 1 & 4. For example if a dose is given Tuesday PM the next dose should be given Saturday AM. This is the longest time in between dosing that will still suppress the parathyroid gland. This method of dosing is especially attractive for cat owners since medication will only be given twice weekly.

Systemic hypertension

Systemic hypertension is common in cats with CKD with 13-28% of cats presenting with hypertension when CKD is first diagnosed and up to 65% of cats developing hypertension at some point during the progression of their renal disease.[43-51] Cats that have systemic hypertension from a variety of causes have been shown to survive longest when their blood pressure is well controlled.

Enalapril or benazepril as monotherapy has not been very effective for treatment of hypertensive cats or dogs. The calcium channel blocker, amlodipine has been used successfully in cats at a dosage 0.625 to 1.25 mg per cat given orally once per day. Follow-up evaluations should be scheduled for one week after beginning treatment with amlodipine. Adverse effects (including hypotension) are very uncommon with the use of amlodipine in cats.[43,46,47]

References

Lulich JP, O'Brien TD, Osborne CA, Polzin DJ. Feline renal failure: questions, answers, questions. *Compendium on Continuing Education for the Practicing Veterinarian* 1992;14:127-152.

Pimenta MM, Reche-Júnior A, Freitas MF, Wang L. Nephrolithiasis and ureterolithiasis prevalence in cats with chronic kidney disease presented at the Univeristyof Sao Paul Veteirnary Hospital. NEPHROLITHIASIS AND. *JFMS* 2013;15 823.

Ross SJ, Osborne CA, Kirk CA, Lowry SR, Koehler LA, Polzin DJ. Clinical evaluation of dietary modification for treatment of spontaneous chronic kidney disease in cats. *Journal of the American Veterinary Medical Association* 2006;229:949-957.

Ross SJ, Osborne CA, Lekcharoensuk C, Koehler LA, Polzin DJ. A case-control study of the effects of nephrolithiasis in cats with chronic kidney disease. *J Am Vet Med Assoc* 2007;230:1854-1859.

van Hoek I, Daminet S. Interactions between thyroid and kidney function in pathological conditions of these organ systems: a review. *Gen Comp Endocrinol* 2009;160:205-215.

Rishniw M, Bicalho R. Prevalence and cuases of urine specifc gravity ≤ 1.035 in apparently healthy cats presenting to first opinion practice. *J Vet Intern Med* 2013;27:741(NU-738).
Adams LG, Polzin DJ, Osborne CA, O'Brien TD. Effects of dietary protein and calorie restriction in clinically normal cats and in cats with surgically induced chronic renal failure. *Am J Vet Res* 1993;54:1653-1662.
Greene JP, Lefebvre SL, Wang M, Yang M, Lund EM, Polzin DJ. Risk factors associated with the development of chronic kidney disease in cats evaluated at primary care veterinary hospitals. *J Am Vet Med Assoc* 2014;244:320-327.
Elliott J, Rawlings JM, Markwell PJ, Barber PJ. Survival of cats with naturally occurring chronic renal failure: effect of dietary management. *J Small Anim Pract* 2000;41:235-242.
Plantinga EA, Everts H, Kastelein AM, Beynen AC. Retrospective study of the survival of cats with acquired chronic renal insufficiency offered different commercial diets. *Vet Rec* 2005;157:185-187.
Bartges JW. Chronic kidney disease in dogs and cats. *Vet Clin North Am Small Anim Pract* 2012;42:669-692, vi.
Bartges JW. Dietary protein and chronic kidney disease: how much is enough? ACVIM Forum 2014.
Polzin DJ. Chronic kidney disease in small animals. *Vet Clin North Am Small Anim Pract* 2011;41:15-30.
Baldwin K, Bartges J, Buffington T, Freeman LM, Grabow M, Legred J, Ostwald D, Jr. AAHA nutritional assessment guidelines for dogs and cats. *J Am Anim Hosp Assoc* 2010;46:285-296.
Kirk CA, Hickman MA. Dietary protein requirements of cats with spontaneous renal disease. *J Vet Intern Med* 2000;14:351.
Burkholder WJ. Dietary considerations for dogs and cats with renal disease. *J Am Vet Med Assoc* 2000;216:1730-1734.
Quimby JM, Gustafson DL, Lunn KF. The pharmacokinetics of mirtazapine in cats with chronic kidney disease and in age-matched control cats. *J Vet Intern Med* 2011;25:985-989.
Quimby JM, Lunn KF. Mirtazapine as an appetite stimulant and anti-emetic in cats with chronic kidney disease: a masked placebo-controlled crossover clinical trial. *Vet J* 2013;197:651-655.
Narishetty ST, Galvan B, Coscarelli E, Aleo M, Fleck T, Humphrey W, McCall RB. Effect of refrigeration of the antiemetic Cerenia (maropitant) on pain on injection. *Veterinary Therapeutics* 2009;10:93-102.
Goldstein RE, Marks SL, Kass PH, Cowgill LD. Gastrin concentrations in plasma of cats with chronic renal failure. *J Am Vet Med Assoc* 1998;213:826-828.
McLeland SM, Lunn KF, Duncan CG, Refsal KR, Quimby JM. Relationship among serum creatinine, serum gastrin, calcium-phosphorus product, and uremic gastropathy in cats with chronic kidney disease. *Journal of Veterinary Internal Medicine* 2014;28:827-837.
Quimby JM, Lake RC, Hansen RJ, Lunghofer PJ, Gustafson DL. Oral, subcutaneous, and intravenous pharmacokinetics of ondansetron in healthy cats. *J Vet Pharmacol Ther* 2014;37:348-353.
Chakrabarti S, Syme HM, Elliott J. Clinicopathological Variables Predicting Progression of Azotemia in Cats with Chronic Kidney Disease. *J Vet Intern Med* 2012.
Boyd LM, Langston C, Thompson K, Zivin K, Imanishi M. Survival in cats with naturally occurring chronic kidney disease (2000-2002). *J Vet Intern Med* 2008;22:1111-1117.
Kuwahara Y, Ohba Y, Kitoh K, Kuwahara N, Kitagawa H. Association of laboratory data and death within one month in cats with chronic renal failure. *J Small Anim Pract* 2006;47:446-450.
King JN, Tasker S, Gunn-Moore DA, Strehlau G. Prognostic factors in cats with chronic kidney disease. *J Vet Intern Med* 2007;21:906-916.
de Brito Galvao JF, Nagode LA, Schenck PA, Chew DJ. Calcitriol, calcidiol, parathyroid hormone, and fibroblast growth factor-23 interactions in chronic kidney disease. *J Vet Emerg Crit Care (San Antonio)* 2013;23:134-162.
Wagner E, Schwendenwein I, Zentek J. Effects of a dietary chitosan and calcium supplement on Ca and P metabolism in cats. *Berl Munch Tierarztl Wochenschr* 2004;117:310-315.
Brown SA, Rickertsen M, Sheldon S. Effects of an intestinal phosphorus binder on serum phosphorus and parathyroid hormone concentration in cats with reduced renal function. *International Journal of Applied Research in Veterinary Medicine* 2008;6:155-160.
Hall MJ, Marino CL, Eatroff AE, Ross SJ, Pressler BM. Efficacy amd adverse effects pf ;amtjami, carbonate in cats. *J Vet Intern Med* 2013;27:737-738.
Schmidt BH, Dribusch U, Delport PC, Gropp JM, van der Staay FJ. Tolerability and efficacy of the intestinal phosphate binder Lantharenol(R) in cats. *BMC Vet Res* 2012;8:14.
Bernachon N, Fournel S, Gatto H, Monginoux P, McGahie D. Comparative palatability of five supplements designed for cats suffering from chronic renal disease. *Irish Veterinary Journal* 2014;67:(19 May 2014).
Bernachon N, Fournel S, Gatto H, Monginoux P, McGahie D. Effect of a product containing the dietary phosphate binders calcium and magnesium carbonate associated with other reno-protectant substances (Pronefra®) on blood parameters and mineral balance in adult cats. *International Journal of Applied Research in Veterinary Medicine* 2014;12:8-17.
King JN, Erasmus HL, Delport PC, Bester I, Seewald W. Efficacy, acceptability and tolerability of the new oral phosphate binder Lenziaren(R) in healthy cats fed a standard diet. *BMC Vet Res* 2014;10:258.
King JN, Delport PC, Luus HG, Erasmus HL, Barnes PM, Speranza C. Efficacy and acceptability of the new oral phosphate binder Lenziaren in healthy cats fed a renal diet. *J Vet Pharmacol Ther* 2014.
Syme HM, Markwell PJ, Pfeiffer D, Elliott J. Survival of cats with naturally occurring chronic renal failure is related to severity of proteinuria. *J Vet Intern Med* 2006;20:528-535.
King JN, Gunn-Moore DA, Tasker S, Gleadhill A, Strehlau G. Tolerability and efficacy of benazepril in cats with chronic kidney disease. *J Vet Intern Med* 2006;20:1054-1064.
Mizutani H, Koyama H, Watanabe T, Kitagawa H, Nakano M, Kajiwara K, King JN. Evaluation of the clinical efficacy of benazepril in the treatment of chronic renal insufficiency in cats. *J Vet Intern Med* 2006;20:1074-1079.

Sent U, Goessl R, Lang I, Stark M. Efficacy of long-term treatment with telmisartan oral solution on quality of life and disease progression in cats wioth chronic kidney disease. *JFMS* 2013;15:820-821.
Sent U, Lang I, Moore G. Characterisation of telmisartan in cats. *JFMS* 2013;15:824-825.
Pressler B. A practical guide to antiproteinuric drugs in dogs. *Veterinary Medicine* 2013;108:392-397.
Polzin D, Ross S, Osborne C, Lulich J, Swanson L. Clinical benefit of calcitriol in canine chronic kidney disease. *Journal of veterinary internal medicine / American College of Veterinary Internal Medicine* 2005;19:433.
Jepson RE, Elliott J, Brodbelt D, Syme HM. Effect of control of systolic blood pressure on survival in cats with systemic hypertension. *J Vet Intern Med* 2007;21:402-409.
Jepson RE. Feline systemic hypertension: Classification and pathogenesis. *J Feline Med Surg* 2011;13:25-34.
Syme HM, Barber PJ, Markwell PJ, Elliott J. Prevalence of systolic hypertension in cats with chronic renal failure at initial evaluation. *J Am Vet Med Assoc* 2002;220:1799-1804.
Brown S, Atkins C, Bagley R, Carr A, Cowgill L, Davidson M, Egner B, Elliott J, Henik R, Labato M, Littman M, Polzin D, Ross L, Snyder P, Stepien R, American College of Veterinary Internal M. Guidelines for the identification, evaluation, and management of systemic hypertension in dogs and cats. *J Vet Intern Med* 2007;21:542-558.
Elliott J, Barber PJ, Syme HM, Rawlings JM, Markwell PJ. Feline hypertension: clinical findings and response to antihypertensive treatment in 30 cases. *J Small Anim Pract* 2001;42:122-129.
Cowgill LD. The role of fluid volume in hypertension of kidney disease in dogs and cats. ECVIM-CA Congress 2012.
Henik RA, Snyder PS. Treatment of systemic hypertension in cats with amlodipine besylate. *Journal of the American Animal Hospital Association* 1997;33:226-234.
Kobayashi DL, Peterson ME, Graves TK, Lesser M, Nichols CE. Hypertension in cats with chronic renal failure or hyperthyroidism. *J Vet Intern Med* 1990;4:58-62.
Mishina M, Watanabe T, Fujii K, Maeda H, Wakao Y, Takahashi M. Non-invasive blood pressure measurements in cats: clinical significance of hypertension associated with chronic renal failure. *J Vet Med Sci* 1998;60:805-808.

Treating Idiopathic Hypercalcemia in Cats: Case Studies- Diets or Drugs?

Dennis Chew, DVM, DACVIM
The Ohio State University
Columbus, OH

How common is hypercalcemia in cats?

The frequency of the detection of hypercalcemia in cats has dramatically increased in many regions of the world over the past 20 years mostly due to the diagnosis of idiopathic hypercalcemia (IHC).[1-7] Hypercalcemia is most often initially defined in primary care practice by the finding of increased serum total calcium on routine serum biochemistry. Mild hypercalcemia based on serum total calcium is often overlooked during analysis of serum biochemical profiles, so the frequency of hypercalcemia is likely to be more common than generally recognized. Mild serum total hypercalcemia is frequently attributed to hemoconcentration from dehydration.

Total serum calcium cannot be reliably used to predict the metabolically active ionized calcium fraction in cats.[8] There was an overall diagnostic discordance of 40% during evaluation of 434 feline serum samples using total calcium to predict ionized calcium in cats of one study. Ionized hypercalcemia and normocalcemia were underestimated and ionized hypocalcemia was overestimated.

Characterization of hypercalcemia

Once ionized hypercalcemia has been identified, the next step is to determine if the process is PTH-dependent (high PTH from failure to suppress abnormal parathyroid glands) or PTH-independent (PTH is appropriately suppressed as the response of normal parathyroid glands). In a study of 322 cats, ionized hypercalcemia was parathyroid independent in 82%, equivocal in 10%, and parathyroid-dependent in 8% of these cats.[9] In cats with parathyroid-independent hypercalcemia, malignancy-associated hypercalcemia (MAH) needs to be excluded. MAH most often results from humoral mechanisms as the tumor secretes calcemic substances such as PTHrP into the circulation; local osteolytic hypercalcemia is far less common. When PTHrP is reported to be high, the presence of malignancy is likely. A low or undetectable PTHrP does not exclude malignancy as the cause for hypercalcemia since other cytokines that cause calcemia can be elaborated by the tumor instead of PTHrP on occasion.

If the diagnostic evaluation does not reveal malignancy as the cause for parathyroid-independent hypercalcemia (PTHrP and body cavity imaging), evaluation of circulating vitamin D metabolites may be useful in determining the underlying cause or mechanism for the hypercalcemia. Hypervitaminosis D is classically characterized by increased concentrations of circulating 25(OH)-vitamin D (calcidiol) following excess ergo/cholecalfierol exposure from food[10,11] or from cholecalciferol-containing rat-bait.[12,13] Increased circulating calcitriol has been reported in cats with granulomatous disease and hypercalcemia, likely the result of unregulated conversion of calcidiol to calcitriol by activated macrophages.[14-16]

What are the causes of hypercalcemia in cats?

The frequency for the occurrence of total serum hypercalcemia from biochemical panels from sick or well cats is not known. The only large survey of the causes of hypercalcemia in cats was reported from a veterinary teaching hospital based on the measurement of serum total calcium in 2000.[17] Ionized hypercalcemia concentration has been sporadically reported in cats with specific diseases, but not in a series of cats with varying causes of hypercalcemia. Idiopathic hypercalcemia, CKD, and neoplasia are the most common and important differential diagnoses to exclude as the cause for parathyroid independent hypercalcemia. Overt hypervitaminosis D, granulomatous disease, and hypoadrenocorticism are other far less common causes of hypercalcemia in cats. Calcium oxalate urolithiasis was reported to be associated with hypercalcemia in cats; however, it is likely that hypercalcemia preceded the formation of stones rather than the urolithiasis acting as a stimulus for the formation of hypercalcemia.[17,18] IHC was not considered as a diagnostic category in one large study of cats with hypercalcemia,[17] but in another study the occurrence of IHC in 20 cats was published that same year.[18] Primary hyperparathyroidism was infrequently diagnosed as the cause of the hypercalcemia at a teaching hospital (4 of 71 cats),[17] but this diagnosis is far more frequently made by veterinary endocrine referral laboratories.[1,9] Based on the number of consultations by veterinary internists and endocrinologists, as well as sample submissions to endocrine laboratories, idiopathic hypercalcemia (IHC) is currently the most-common cause of hypercalcemia in cats in North America and likely so in other parts of the world.[1,2,5-7]

While MAH is the number one cause of pathological hypercalcemia in the dog,[19] it occurs far less frequently in the cat. Based on serum total calcium and how the data is parsed, MAH is 3rd in frequency behind IHC and CKD in cats with hypercalcemia.[17] In dogs, the overwhelming cause of MAH is lymphoma with occasional carcinoma as the diagnosis,[19] whereas in cats lymphoma and carcinomas each account for about 1/3 of the cases.[17] Patients with MAH are usually “sick” as it takes a reasonably large tumor burden to synthesize the messengers that result in hypercalcemia.

Signalment and clinical signs of IHC cats

In a report from 427 cats with IHC evaluated at an endocrinology laboratory, the age at diagnosis ranged from 0.5 to 20 years (mean 9.8 ± 4.6 yr). Males and females were equally represented in this study. Long-haired cats were noted to be overrepresented at 27% of the cases in this report,[20] but not in a recent case-control epidemiological study (data analyzed post Todd Green Master's Ohio State University 2008).

No clinical signs were noted in 46% of IHC cats. Other clinical signs were largely related to gastrointestinal signs, including mild weight loss (18%), chronic constipation (5%), vomiting and decreased appetite. IBD was diagnosed in 6% of the IHC cats of this study. Lower urinary tract signs may be observed, especially if urolithiasis is present. Uroliths or renoliths were observed in 15%, and calcium oxalate stones were specifically noted in 10% of cases. Polyuria/polydipsia has not been frequently reported in cats with IHC.[20]

In many instances, hypercalcemia based on measurement of total serum calcium is fortuitously discovered following submission of serum samples from wellness examinations, pre-anestheic evaluation of seemingly healthy individuals, those with routine medical conditions, and those from cats forming calcium-oxalate stones. Hypercalcemia is also sometimes discovered following submission of samples from cats with seemingly trivial clinical complaints like intermittent vomiting of hairballs. Though many cats with IHC do not have obvious clinical signs at first look, a more careful review of the history and physical examination often discloses some abnormality that could be explained by persistence of chronic ionized hypercalcemia. This includes low-grade weight loss, loss of muscle mass, and lethargy. Intermittent vomiting and constipation are also possibly due to adverse effects of ionized hypercalcemia on gut motility. Chronic ionized hypercalcemia is a risk factor for the genesis of calcium oxalate urolithiasis and for the development of chronic renal injury resulting in CKD that may take months to years to develop.

How is the diagnosis of IHC established ?

The diagnosis of IHC is one of exclusion after initially confirming that the ionized calcium is increased. All the known causes of hypercalcemia should ideally be eliminated – this kind of workup can be exhaustive and expensive. The increase in circulating ionized calcium in IHC can be mild, moderate, or severe, as it can also be with other causes of hypercalcemia. Often mild increases in total or ionized calcium that are discovered fortuitously tend to increase over time, but to a varying magnitude. We have observed the ionized calcium concentration to fluctuate into and above the reference range, especially when the hypercalcemia is marginal in magnitude. We have observed large fluctuations in total and ionized calcium concentrations on occasion in some cats with IHC and those with primary hyperparathyroidism.

In order to exclude other causes of hypercalcemia, a minimum database including a CBC, biochemistry profile and urinalysis, should be performed. Additionally, analysis of PTH and 25-hydroxyvitamin D are necessary to rule out hyperparathyroidism and hypervitaminosis D as the cause of the hypercalcemia. The typical pattern for calcium regulatory hormones in IHC would be for the PTH concentration to be within the reference range (often lower end), the PTHrP concentration to be undetectable, and to have a normal serum ionized magnesium concentration.[20] Most 25-hydroxyvitamin D and calcitriol concentrations are usually within the reference range, but a few cats with IHC have been noted to have values increased above the reference range.[18,20]

Chest radiographs are useful to rule out metastatic pulmonary nodules and mediastinal lymphoma that may be associated with hypercalcemia. Unlike in dogs, mediastinal lymphoma is not common in cats. A combination of abdominal radiographs and ultrasonography can be useful to determine the presence of urolithasis (kidney, ureter, bladder, urethra), obstructive nephropathy from the stones, or the presence of inflammatory/infiltratitve masses that could be associated with the genesis of the hypercalcemia. Treatment recommendations and prognosis may change with the presence of stones and their location.

Should all cats with IHC receive treatment?

Cats with minimal increases in circulating calcium concentrations are often ignored in clinical practice since many of these cats have mild or no apparent clinical signs. Even though obvious clinical signs are often not apparent, subtle clinical signs often exist. Excess calcium can be toxic to cells, exerting either physiological or structural effects particularly in the central nervous system, gastrointestinal tract, heart, and kidneys. Mineralization of soft tissues is an important potential complication related to the presence of ionized hypercalcemia that is in part determined by the concomitant concentration of serum phosphorus, but this does not develop in all IHC cats. The clinical outcome for cats with IHC that have not been treated has not been established following the initial diagnosis. An argument can be made to withhold treatment when an IHC cat has no recognizable signs, no identified risk factors for urolithiasis or CKD, and the increase in ionized calcium is minimal. A stronger argument can be made to treat IHC cats in which the ionized calcium concentration continues to escalate. The strongest argument to start treatment exists for cats that have ongoing weight loss, depression, vomiting, constipation, urinary stones, emergence of CKD and or development of sub-maximally concentrated urine.

Treatment of IHC – diet

Management of IHC usually begins with a dietary recommendation to attempt to restore normocalcemia. Reports of treatment outcome following dietary change are quite limited, so diet recommendations are largely based on expert opinion and uncontrolled case studies in small numbers of cats. We have observed decreased circulating ionized calcium in some cats following dietary change, but the magnitude and duration of this decrement can be quite variable. Future studies comparing test and control diets are needed to determine the effects, if any, of altering intake of nutrient(s) on concentrations of the calcium regulatory hormones PTH, calcidiol, calcitriol, and 24,25(OH)2-vitamin D in addition to that for ionized calcium.

Is there one specific dietary nutrient on which we should focus that will consistently decrease circulating ionized calcium?

Regulation of the circulating calcium concentration is dynamic and complex. It has not been determined how much of the hypercalcemia in IHC cats results from too much dietary calcium intestinal absorption, increased bone resorption, reduced renal excretion of calcium, or combinations of these processes. Many of the nutrients in the diet interact with each in ways that affect dietary calcium absorption and not all calcium in the diet is biologically available for absorption.[21] Vitamin D is one obvious dietary nutrient that can affect intestinal absorption of calcium and it also has effects on osteoclastic bone resorption that can contribute to the degree of calcemia.[22] Vitamin A has effects on the osteoclast that can work in concert with vitamin D to increase bone resorption.[23]

What do we know about dietary calcium content in the management of IHC?

Some veterinary nutritionists recommend diets to treat IHC based on a decreased calcium content on a g calcium/1000 kcal (Mcal) energy basis.[24] Minimal and maximal nutrient recommendations for cat food are provided by the Association of American Feed Control Officials (AAFCO) and the National Research Council (NRC). Most diets sold over-the-counter should meet AAFCO requirements; however, veterinary therapeutic diets may be specifically modified in order to provide certain nutrients at concentrations less than AAFCO minimums. The average calcium content of grocery store foods in the USA is approximately 2.0 to 3.0 g calcium per Mcal (200-300 mg/100 kcal), though some contain up to 6.0 g calcium per Mcal (600 mg per 100 kcal).[25] Some of the highest calcium diets are “high-fiber” diets; thus one must carefully weigh the pros and cons of recommending a high-fiber diet for dietary management of IHC when there is some evidence that reducing dietary calcium may be effective in restoring normocalcemia. Nutrient concentrations of diets can be found either in product guides or by contacting the diet manufacturer, but this information is not readily available from the routine diet label. Nutrient profiles are constantly evolving and this information may change up to every 6-12 months. For feline adult maintenance, the NRC recommended allowance (RA) is 0.72 g calcium per Mcal [26] and the AAFCO minimum is 1.5 g calcium per Mcal.[27]

Feeding of a high protein and low carbohydrate food similar to what cats would eat in the wild (i.e., 40-60% of calories from protein; 30-50% of calories from fat, and <15% of calories from carbohydrates) has been recommended to effectively lower serum calcium concentration in some cats with IHC, especially those with low magnitude hypercalcemia.[4,28] This nutrient profile is what would be expected from veterinary therapeutic diets designed for cats with diabetes mellitus and also many over-the-counter canned feline diets. In reviewing these types of diets however, it should be noted that calcium content varies from about 1.5 to 5.5 g per Mcal.

What do we know about dietary vitamin D content in the management of IHC?

IHC is not the result of obvious excess dietary vitamin D intake since serum concentrations of 25(OH)-vitamin D have been within the reference range in most cats with IHC. However, the minimal requirement for vitamin D in cats is debatable since reference ranges have been established in cats fed vitamin D–supplemented diets. Normal concentrations of 25(OH)-vitamin D could still potentially be associated with IHC in cats if there are up-regulating mutations in the VDR (vitamin D receptor). These possibilities have not yet been investigated.

For adult cats, the NRC-RA for dietary vitamin D3 (cholecalciferol) is 70 IU per Mcal. The safe upper limit (SUL) is listed as 7,520 IU per Mcal.[26] AAFCO minimum and maximum recommendations for feline adult maintenance are 125 and 2,500 IU per Mcal, respectively.[27] Clearly, there is a wide range of acceptable dietary vitamin D in commercial cat foods. Feeding a diet formulated to be low in vitamin D content at < 200 IU per Mcal has been recommended in dietary treatment of cats with IHC.[4,28]

How helpful are high fiber diets in restoration of normocalcemia in cats with IHC?

Higher fiber diets were associated with the restoration of normocalcemia in 5 of 5 cats with calcium oxalate stones and a likely diagnosis of IHC (high ionized calcium concentration) in one report.[29] The effects of fiber on intestinal absorption of calcium are complex and depend on the type and amount of fiber in the diet and the interactions with other nutrients in the diet. It has been theorized that supplemental fiber may lead to increased binding of intestinal calcium, preventing its absorption, and also to decreased intestinal transit time through the small intestine, reducing calcium absorption.[29,30] The salutary effect of a higher fiber diet, if any, is not simply due to the binding of calcium to fiber. It appears to be common practice for most manufacturers to increase the concentration of calcium in high-fiber diets to offset the potential for decreased absorption.

How helpful are higher salt diets in management of IHC?

Treatment with higher salt content diets has not been studied in IHC cats, with or without calcium oxalate stones. Higher salt intake potentially could promote increased water intake, volume expansion, and a dilution effect that would decrease circulating ionized calcium to some degree. Increased water turnover would then create more dilute urine that should help prevent calcium oxalate stone

growth by reducing RSS. Increasing salt intake up to 3.7 g per Mcal has been reported to be safe without detection of deleterious effects on renal function, cardiovascular function, and systemic blood pressure when studied in normal cats, geriatric cats, and cats with surgically reduced renal mass.[31-35] Future studies of higher dietary salt intake for treatment of cats with IHC are warranted.

Treatment of IHC- glucocorticosteroids and oral alendronate

We do not recommend starting drug therapy immediately after the diagnosis of IHC since dietary treatment is effective in restoration of normocalcemia in some cats. Treatment with glucocorticoids restores normocalcemia or dramatically reduces the ionized calcium concentration in most cats with IHC, at least initially. A maximal decline in calcium to within the reference range often requires dose escalation and the beneficial effect may be transient. Approximately 80% of cats with IHC become normocalcemic with 1.5 to 2.0 mg/kg/day prednisone per day, but some may require increasing doses to remain normocalcemic over time.[36] It is important to not prescribe glucocorticosteriods before the diagnosis of the hypercalcemia has been established with some certainty, otherwise cytolytic effects in LSA and myeloproliferative disorders will make definitive diagnosis difficult or impossible. A mild calcium-lowering effect can be exerted by use of glucocortocosteroids in other forms of malignancy-associated hypercalcemia and in those with primary hyperparathyroidism. It is also preferred to have biopsy-proven IBD before the start of glucocorticosteroids. Oral prednisolone achieves greater maximal concentration in the circulation than does oral prednisone in the cat, possibly due to greater GI absorption of prednisolone or less hepatic conversion of prednisone to prednisolone.[37] Prednisolone is given orally at 5 – 10 mg/cat/day for 1 month before reevaluation. Though prednisolone can be effective in restoration of normocalcemia in IHC cats, we now usually consider prednisolone as treatment after oral bisphosphonate treatment has failed to restore normocalcemia. In these instances, prednisolone is prescribed in addition to the oral bisphosphonate, but much lower doses of prednisolone may now be effective during combination drug therapy. Long-term treatment with prednisolone contributes to muscle wasting[4-6] and possible induction of diabetes mellitus in some cats.

Bisphosphonate treatment for IHC cats

Historically, oral bisphosphonates have been recommended to treat IHC cats when dietary modification and prednisolone treatment have been unsuccessful in restoration of normocalcemia. Oral alendronate has become our preferred option to treat IHC cats after dietary modification has failed to restore normocalcemia.[28] Even though not extensively reported, we now consider bisphosphonate therapy a safer alternative to glucocorticosteroid use in cats that failed dietary intervention. Treatment with bisphosphonates may be useful to decrease the magnitude of hypercalcemia in cats with IHC by altering osteoclastic bone resorption. IV treatment with bisphosphonates is almost never needed in IHC since the hypercalcemia is chronic and the cats are usually not in an acute crisis.

The long-term safety and efficacy of oral alendronate therapy has not been reported in cats. The safety and efficacy of oral alendronate treatment given once weekly for 6 months was reported in 12 cats with IHC.38 Two of the 12 cats developed mild ionized hypocalcemia at 6 months of treatment. We have followed some IHC cats undergoing alendronate treatment for over 2 years without reported clinical side effects.36 The safety of oral alendronate treatment for cats with IHC and CKD has not been specifically studied, but we have not observed any documented decreases in renal function that we could attribute directly to the alendronate. Drug-induced esophageal damage (erosive esophagitis and esophageal stricture) and gastritis are of concern in humans taking oral bisphosphonates.39-42 We have not observed the development of these lesions, nor have they been reported by others, following oral alendronate treatment in IHC cats.

An increased risk for bone fracture has been reported in humans on long-term bisphosphonate treatment presumably because of the increased brittleness of bone due to bisphosphonate therapy.43 Bisphosphonate treatment in humans generally does not exceed 3 years due to concerns that acquired bone pathology outweighs previous benefits.44 We have become aware of two cats that developed pathologic fractures following 9 and 5 years of treatment with weekly oral alendronate.

Any food in the stomach can drastically reduce the absorption of alendronate to near zero – bisphosphonates are poorly absorbed at best under optimal conditions. To maximize intestinal absorption of alendronate, we recommend fasting cats overnight for 12 hours prior to the administration of medication, giving the pills in nothing other than tap water, and then feeding the cat two hours later. Though not specifically studied, an 18-hour fast prior and 4-hour fast post-pill might be a better protocol to achieve the highest possible intestinal absorption.45 We do not recommend the administration of alendronate in pill pockets due to concern about decreased intestinal absorption that could occur. For the same reason, we do not recommend alendronate that has been formulated by compounding pharmacies in flavored solution or suspension.

Given the risk of esophagitis and stricture associated with oral bisphosphonate treatment in humans, we advise extra caution to prevent esophageal tissue damage following oral alendronate administration in cats. The starting dose is usually 10 mg/cat (NOT per kg) per week initially. We recommend administration of whole tablets only, as cut tablets may increase exposure of the esophagus and stomach to adverse effects. We recommend “buttering” the cat’s lips/nose as this has been shown to increase salivation and swallowing which contributes to decreased transit time and less time for mucosal contact from the pill.46 The effect of butter on intestinal absorption of alendronate has not been specifically studied, but use of butter as part of our treatment protocol has effectively

restored normocalcemia in many cats. Five to 6 ml of tap water is administered via syringe to provide an additional measure to prevent the pills from getting caught in the esophagus.47 Using these preventative measures, we have not yet observed any signs of esophagitis in cats treated with alendronate.

Some cats return to normocalcemia on 10 mg oral alendronate per week, whereas other cats require dose escalation to do so. If the ionized calcium remains above the reference range at the 4 to 6 week visit, increase the dose to 20 mg once each week, or alternate giving 10 mg one week followed by 20 mg the next week to provide an average of 15 mg per week. Once the ionized calcium enters the reference range, we recommend reevaluation in 1, 3, and 4 to 6 months if the ionized calcium remains stable within the reference range. Many IHC cats return to normocalcemia following a 10 mg once weekly dose of oral alendronate, whereas some IHC cats will require 20 mg weekly to achieve normocalcemia. Rarely, 30 or 40 mg/cat/week oral alendronate will be needed to restore normocalcemia. Alendronate dose reduction should be prescribed for cats that achieve very low reference range ionized calcium in order to prevent the development of overt hypocalcemia. For cats that develop overt hypocalcemia, alendronate treatment should be discontinued, at least temporarily.

When should bisphosphonate treatment be stopped for IHC cats?

Alendronate treatment should be stopped in IHC cats that fail to regain normocalcemia despite 30 to 40 mg weekly doses after ascertaining strict adherence to the pre-pill fasting protocol. Alternatively, prednisolone can be added on top of alendronate to see if a beneficial effect can be gained to lower circulating calcium during combination therapy.

It is not known how long oral alendronate treatment should be continued in those IHC cats that have regained normocalcemia for long periods of time. It is possible that the salutary effects to keep circulating calcium concentrations within the reference range may last long after alendronate is discontinued due to its long half-life in bone, but this has not been specifically studied.

Though bisphosphonate treatment is very often effective in restoration of normocalcemia in IHC cats, it would be far preferable to find the underlying cause(s) of IHC so that drug therapy would no longer be needed. Guidelines as to how long bisphosphonate treatment can safely be given to cats with any disease have yet to be established. We are concerned that some cats are now receiving bisphosphonate therapy for years that may be detrimental to the cat's long-term bone health (based on emerging reports of pathological fractures in some cats). It may not be enough to just monitor calcium and renal function status in IHC cats during treatment interventions. The measurement of calcium regulatory hormones (PTH, calcitonin, calcidiol, calcitriol, 24,25$(OH)_2$-vitamin D, FGF-23, Klotho) before and after treatment interventions will likely reveal important components for the pathophysiology of IHC in cats and may provide targets to be altered during therapy, and also information to ensure long-term safety. Our new recommendation is to include baseline long bone radiographs for all IHC cats being treated with oral bisphosphonates for more than one year, and then yearly thereafter to more readily detect early bone injury that may be developing. Long-term safety studies in cats treated with oral alendronate are needed.

References

1. Schenck PA, Chew DJ, Nagode LA, et al. Disorders of calcium: hypercalcemia and hypocalcemia. In: DiBartola SP, ed. Fluid, electrolyte, and acid-base disorders in small animal practice, 4 ed. St. Louis: London: Saunders Elsevier; 2011:120-194.
2. Schenck PA, Chew DJ. Hypercalcemia: a quick reference. Vet Clin North Am Small Anim Pract 2008;38:449-453, viii.
3. Refsal KR, Provencher-Bolliger AL, Graham PA, et al. Update on the diagnosis and treatment of disorders of calcium regulation. Vet Clin North Am Small Anim Pract 2001;31:1043-1062.
4. Peterson M. Feeding the Cat with Endocrine Disease. In: ACVIM Forum 2013.
5. Peterson ME. Nutritional management of idiopathic hypercalcemia in cats. In: Peterson ME, ed. Insights into Veterinary Endocrinology2012 November 3.
6. Peterson ME. What's causing idiopathic hypercaclemia in cats? In: Peterson ME, ed. Insights into Veterinary Endocrinology2012 October 28.
7. de Brito Galvao JF, Schenck PA, Chew DJ. Hypercalcemia: Diagnosis and treatment options in dogs and cats. Veterinary Focus 2011;21:27-34.
8. Schenck PA, Chew DJ. Prediction of serum ionized calcium concentration by serum total calcium measurement in cats. Can J Vet Res 2010;74:209-213.
9. Bolliger AP, Graham PA, Richard V, et al. Detection of parathyroid hormone-related protein in cats with humoral hypercalcemia of malignancy. Vet Clin Pathol 2002;31:3-8.
10. Wehner A, Katzenberger J, Groth A, et al. Vitamin D intoxication caused by ingestion of commercial cat food in three kittens. J Feline Med Surg 2013;15:730-736.
11. Morris JG, Earle KE, Anderson PA. Plasma 25-hydroxyvitamin D in growing kittens is related to dietary intake of cholecalciferol. Journal of Nutrition 1999;129:909-912.
12. Peterson EN, Kirby R, Sommer M, et al. Cholecalciferol rodenticide intoxication in a cat. J Am Vet Med Assoc 1991;199:904-906.
13. Moore FM, Kudisch M, Richter K, et al. Hypercalcemia associated with rodenticide poisoning in three cats. J Am Vet Med Assoc 1988;193:1099-1100.
14. Mealey KL, Willard MD, Nagode LA, et al. Hypercalcemia associated with granulomatous disease in a cat. J Am Vet Med Assoc 1999;215:959-962, 946.
15. Sharma OP. Hypercalcemia in granulomatous disorders: a clinical review. Current opinion in pulmonary medicine 2000;6:442-447.

16. Stern JA, Chew DJ, Schissler JR, et al. Cutaneous and systemic blastomycosis, hypercalcemia, and excess synthesis of calcitriol in a domestic shorthair cat. J Am Anim Hosp Assoc 2011;47:e116-120.
17. Savary KC, Price GS, Vaden SL. Hypercalcemia in cats: a retrospective study of 71 cases (1991-1997). J Vet Intern Med 2000;14:184-189.
18. Midkiff AM, Chew DJ, Randolph JF, et al. Idiopathic hypercalcemia in cats. J Vet Intern Med 2000;14:619-626.
19. Messinger JS, Windham WR, Ward CR. Ionized hypercalcemia in dogs: a retrospective study of 109 cases (1998-2003). J Vet Intern Med 2009;23:514-519.
20. Schenck PA, Chew DJ, Refsal K, et al. Calcium metabolic hormones in feline idiopathic hypercalcemia. In: J Vet Intern Med (Abstract) 2004;442.
21. Camara-Martos F, Amaro-Lopez MA. Influence of dietary factors on calcium bioavailability: a brief review. Biological trace element research 2002;89:43-52.
22. Cline J. Calcium and vitamin d metabolism, deficiency, and excess. Top Companion Anim Med 2012;27:159-164.
23. Johansson S, Melhus H. Vitamin A antagonizes calcium response to vitamin D in man. J Bone Miner Res 2001;16:1899-1905.
24. Fascetti AJ, Delaney SJ. Nutritional management of endocrine disease. In: Fascetti AJ, Delaney SJ, eds. Applied Veterinary Clinical Nutrition. Chickester, West Sussex: Wiley-Blackwell,; 2012:289-300.
25. Parker V. Calcium content in commercial cat diets - Personal communication. In: 2013.
26. Nutrient Requirements for Adult Dog Minimum Requirements and Recommended Allowances. National Research Council. In: Nutrient requirements of dogs and cats. Washington, DC: Ad Hoc Committee on Dog and Cat Nutrition; 2006:152.
27. . Oxford: Offical Publication; 2012.
28. de Brito Galvao JF, Chew DJ, Parker V. Management of idiopathic hypercalcemia. In: August J, ed. August's Consultations in Feline Internal Medicine, 7th ed. St. Louis: Saunders Elsevier; 2015.
29. McClain HM, Barsanti JA, Bartges JW. Hypercalcemia and calcium oxalate urolithiasis in cats: a report of five cases. J Am Anim Hosp Assoc 1999;35:297-301.
30. Parivar F, Low RK, Stoller ML. The influence of diet on urinary stone disease. J Urol 1996;155:432-440.
31. Chetboul V, Reynolds BS, Trehiou-Sechi E, et al. Cardiovascular effects of dietary salt intake in aged healthy cats: a 2-year prospective randomized, blinded, and controlled study. PloS one 2014;9:e97862.
32. Reynolds BS, Chetboul V, Nguyen P, et al. Effects of dietary salt intake on renal function: a 2-year study in healthy aged cats. J Vet Intern Med 2013;27:507-515.
33. Luckschander N, Iben C, Hosgood G, et al. Dietary NaCl does not affect blood pressure in healthy cats. J Vet Intern Med 2004;18:463-467.
34. Cowgill LD, Segev G, Bandt C, et al. Effects of Dietary Salt Intake on Body Fluid Volume and Renal Function in Healthy Cats. J Vet Intern Med 2004;18:415.
35. Biourge VC, Devois C, Morice G, et al. Increased dietary NaCl significantly increases urine volume but does not increase urinary calcium oxalate relative supersaturation in healthy cats. J Vet Intern Med 2001;15:301.
36. de Brito Galvao JF. Treatment of idiopathic hypercalcemia in 29 cats (1999-2010) (unpublished observations). In: The Ohio State University; 2013.
37. Graham-Mize CA, Rosser EJ, Hauptman J. Absorption, bioavailability and activity of prednisone and prednisolone in cats. Advances in Veterinary Dermatology 2005;5:152-158.
38. Hardy BT, de Brito Galvao JF, Green TA, et al. Treatment of Ionized Hypercalcemia in 12 Cats (2006-2008) Using PO-Administered Alendronate. J Vet Intern Med 2015;29:200-206.
39. Abraham SC, Cruz-Correa M, Lee LA, et al. Alendronate-associated esophageal injury: pathologic and endoscopic features. Mod Pathol 1999;12:1152-1157.
40. Aibar Arregui MA, de Escalante Yanguela B, Munoz Villalengua M, et al. Esophageal stenosis caused by alendronate. Rev Esp Enferm Dig 2011;103:338-339.
41. Peter CP, Handt LK, Smith SM. Esophageal irritation due to alendronate sodium tablets: possible mechanisms. Dig Dis Sci 1998;43:1998-2002.
42. Ueda K, Muto M, Chiba T. A case of esophageal ulcer caused by alendronate sodium tablets. Gastrointest Endosc 2011;73:1037-1038.
43. Isaacs JD, Shidiak L, Harris IA, et al. Femoral insufficiency fractures associated with prolonged bisphosphonate therapy. Clin Orthop Relat Res 2010;468:3384-3392.
44. Papapetrou PD. Bisphosphonate-associated adverse events. Hormones 2009;8:96-110.
45. Mohn KL, Jacks TM, Schleim KD, et al. Alendronate binds to tooth root surfaces and inhibits progression of feline tooth resorption: a pilot proof-of-concept study. J Vet Dent 2009;26:74-81.
46. Griffin B, Beard DM, Klopfenstein KA. Use of butter to facilitate the passage of tablets through the esophagus in cats. J Vet Intern Med 2003;17:445.
47. Westfall DS, Twedt DC, Steyn PF, et al. Evaluation of esophageal transit of tablets and capsules in 30 cats. J Vet Intern Med 2001;15:467-470.

Navigate Bumps in the Road:
Steps to Create a Thriving Cat Friendly Practice

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

The single biggest opportunity to grow small animal practices lies in the chronically underserved feline patient. With nearly 1500 participating practices there is emerging a body of knowledge that is critical for prospective practices to understand. Overcoming resistance on the part of unconvinced staff members and building a team to accomplish Cat Friendly designation are critical to accomplishing the establishment-wide changes that improve the experience that cats and their owners have. 83% of adopted cats are seen within the first year of adoption. Fewer than 50% of those return for regular veterinary care. Based upon HSUS adoption data, approximately 1.7 million cats are seen once and do not return. If 3000 practices became Cat Friendly Practices and the population was divided equally among them, there would be over 550 new patients per practice per year.

The Bayer Veterinary Care Usage Study 3 – Feline Findings focused on the population of cats and their owners that do not seek regular veterinary care and the views veterinarians and practice owners have of this underserved population. More than half of these 401 practice owners reported less than 70% of appointment times were filled. This represents a significant opportunity to better utilize veterinarians, professional staff and improve the work flow of the practice. When asked what could impact growth, the top two choices were increasing cat and dog visits. However, more than 50% had no method in place to monitor or evaluate the efficacy of their reminder systems. They did not, then, know whether their existing clients were being effectively encouraged to return to the practice.

While increasing cat visits was the second most cited way to grow and practices did not believe they would need to make many changes in the practice to increase visits, less than 1 in 5 had actually taken any steps to do so. More than 1 in 3 practice owners had no intention of implementing changes that would reduce stress for cats. Almost as many had made no attempt to train staff to make feline visits less stressful.

As research has shown, there are more companion cats than dogs. This should mean that veterinary practices see more cats than dogs, but the opposite is true. Many cat owners avoid veterinary visits for a variety of reasons. One major reason is that they are convinced that their cat hates the experience. Another is a lack of understanding of the need for preventive health care for creatures who seem to be independent and healthy. Clients also dislike the experience of the 30+ minutes that precede the visit during which conflict arises around the carrier, the traumatic experiences in the automobile and the disruption of routine that is so important to cats.

Cats seem to experience forceful handling by their otherwise predictable and beloved human as a betrayal of their trust. The car, carrier and veterinary establishment are unfamiliar to a creature who values a sense of control and familiar routine. As a veterinary team, we may not understand cats, their behavior cues, or normal behaviors. We may feel as if cats are more of a nuisance, take too much time or will potentially cause injury. Our attitude is conveyed through approach, body language and other forms of communication apparent to both cats and their owners.

When a cat visit becomes disruptive we lose the fundamental opportunity to form the trusting relationship we need to have with our clients so that we can practice the best medicine. We lose the chance to calmly build rapport, establish trust and educate clients that is so crucial to our future with them and their cat.

The solution to declining cat visits, to resulting welfare issues, and to our ability to serve this patient population is to become cat friendly. We must create a practice culture in which the entire staff is committed to improving the experience of the feline patient and their owner. We must incorporate this into staff training and education, into the practice physical environment and into our plans for the future.

We must begin by educating our clients. By sharing with them our knowledge of the characteristics of the feline, we can teach them to have reasonable expectations, to understand the subtle signs of illness, and to prevent unacceptable behavior before it starts. By understanding the social groups in multiple cat households and how the social structure of cats has evolved, we can decrease the stress experienced by companion cats and their owners. We can teach breeders and “accidental” breeders to raise well-adjusted flexible, social kittens who will become wonderful cats for the people who adopt them. We can teach them how to lower the household stress by giving them a better understanding of their cats’ needs, sensory awareness, and perception of safety.

Our outreach has to be where our clients are, i.e., on the internet. We need lively web sites with important educational links. We need Facebook pages that are constantly updating and providing tips and entertaining topics that engage the clients before we meet them in the practice. Our educational efforts can result in happier households and healthier cats. Clients need to understand how cats prefer being alone when eating, why play is important and how cats interact with each other and humans.

The Bayer Brakke study showed that the recession did not cause the decline in visits but rather, unmasked a phenomenon that has been going on since the late 1990's. This investigation made several recommendations regarding the goals that would improve cat visits including understanding the client household, addressing handling, communication, and safe transport.

Becoming cat friendly is not a construction project; it is seizing this opportunity to harness the talent and intellect of the staff to change behavior and attitudes. Cat friendly practices nurture relationships with clients by employing open communication and active listening. The staff becomes deeply committed to achieving skills in gentle handing, understanding behavior, and the unique medical and surgical needs of cat patients.

Change in the busy veterinary practice is difficult. One of the most important roles in affecting the practice culture is to assign a Cat Advocate to the project. That person is not responsible for doing all the work to become cat friendly but to make sure the work is done. Cat friendly is not a project, it is a cultural shift within the practice that must be continually monitored and assessed. Education plans, physical changes, communication training are ongoing. By evaluating the cat and client's experience from before the visit to the time they leave, we can establish a plan for improving that experience.

The first experience of the practice environment is often the first phone call. Using that contact to educate clients or potential clients about resources available to help make the pre-visit experience less stressful are key. Questions about carriers, automobile transport and other cats in the household can be satisfactorily answered. Resources can be sent in a variety of ways from web links, pdfs or written brochures.

The physical presence of other animals in the reception area is a key consideration for reduction of stress. Many strategies for reducing the negative effects can be implemented including, separate entrances, separate waiting areas, or "cat only" days. Voices should be kept low, sounds kept to a minimum, unnecessary odors like perfume or cologne avoided. Visual barriers can be employed to keep cats from seeing dogs or other cats. Staff members must be counseled not to look directly in the face/stare at cats.

In the exam room, the cat should be allowed to walk out of the carrier while the doctor is speaking calmly with the client. If the cat leaves the carrier, remove it from sight as it has become the most familiar thing in the room and the cat will be inclined to return to the carrier. If, after an appropriate time, the cat remains in the carrier unwilling to exit voluntarily, remove the lid of the carrier. This is far less stressful than other ways of removing the cat. Towels can be employed to help fearful cats remain calmer.

One of the most critical skills required for becoming cat friendly is to learn to read how cats communicate their emotional state through their body posture, facial expression and movement. Fear is the #1 cause of "bad behavior" in the veterinary environment. By learning to assess emotional states, we can avoid a fully aroused state that takes a cat 30-40 minutes to recover from. Cats leave behind a scent from their pads that indicates stress. Careful cleaning between appointments is not only important for disinfection but also to remove this form of communication between cats.

A cat examination room should contain all of the equipment and supplies needed to perform most outpatient services. By approaching in a calm manner, keeping the people in the room to a minimum, using quiet voices, towels for restraint if needed, and being flexible about the order the exam is performed in, there will be more successful experiences than usual. Scruffing or stretching should never be necessary and is counter-productive. In a calm environment the doctor can talk through the exam, making sure clients understand what is being done and the value and importance of the physical exam.

Many gentle techniques are described in the photos in the Cat Friendly Practice (CFP) program that offer ideas regarding restraint. The examination table may be the least necessary piece of equipment in the room. Cats may prefer the bottom of a carrier, a lap, a chair or the floor and should be accommodated. Moving cats by picking them up adds a level of stress to an already fearful cat. The reflex response to fear is to flee thus maintaining all four feet on the floor is very important to a sense of control and reassurance. Every effort should be made to avoid taking the cat to the "back" of the hospital. The exam room is now somewhat familiar. To move to a foreign space offers new stressors, different smells, bright lights, more animals, people, and noises.

Cats who must be admitted to the hospital have an increased need for a sense of familiar comforts. This can be provided by asking the client to bring known items from home; bedding, brushes, food, bowls or toys. Soft bedding, a place to hide and gentle nursing techniques are critical. For cats who enjoy social interaction, petting, brushing and other forms of interaction can be employed.

The cat ward should be separate from dogs and other animals, big enough so that cats cannot see one another. Cages should not face each other. Cats passing each other for treatment or discharge should be shielded from view. When removing a cat from a hospital enclosure, allow the cat to come forward or use bedding, towels or the bottom of the carrier to slide the patient forward. Do not loom about the cat or block the light.

The entire inventory of equipment, instrumentation, physical facility should be examined to make sure they are appropriately sized for the feline patient.

The Cat Friendly Practice program provides veterinary practices with ALL of the information, tools and techniques for becoming cat friendly. There are ten areas to evaluate with resources to achieve compliance with all of them. This program will continue to evolve and grow as new phases are implemented. The next of these will be Preventative Health Care. To participate the practice must

have one AAFP member, identify the Cat Advocate for the practice and use the website, manual and checklist to achieve either gold or silver CFP status.

In recognition of this effort, the program provides you with a toolkit to market your practice as one that has made this significant effort and to distinguish yours from other practices that have not. A searchable website will allow clients to look for Cat Friendly Practices in their region. Beginning in the fourth quarter of 2012, the AAFP began a national consumer awareness campaign to encourage cat owners to seek a Cat Friendly Practice. Refinements and additions to this campaign will continue.

As we discuss each aspect of the program, specific examples of creative and innovative methods CFP practices used to overcome barriers to certification, to market themselves and to significantly benefit by the effort made to implement the program will be discussed. Almost every CFP practice currently certified plans to renew their certification when the two -year membership period expires. Recertification is intended to reinforce the CFP concepts and to introduce new tools and resources made available since the program began.

The CFP task force and internal team are continually analyzing the feedback from member practices, both designated and working on becoming so. Based upon that feedback there are videos directed at both the veterinary team and clients to demonstrate techniques important to improving the experience. New tools are being developed through out the year to meet their needs for social media, staff meetings, owner education and staff development. In 2015, the task force and AAFP board will create a strategic plan for the future of Cat Friendly Practice. It is our intention to keep evolving the program to add value to participating practices, to create tools and resources for practices to attract cat owners and to drive cat owners to practices that participate.

Communications Boot Camp: See More Cats!

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

In human medicine much research has occurred regarding the "Patient-centered Interview", resulting in evidence based method used to train medical students, nurses, physicians and other health care workers who must have a successful interview with a patient in order to assure the best possible outcome. This evidence based approach to patient interviewing has valuable parallels in our desire to build trusting relationships with our clients.

With client-centered skills, we encourage them to express what is most important to them. This approach recognizes the importance of their personal concerns, feelings, and emotions. The patient is not isolated from its context. For example, a patient of mine recently presented for inappetance, lethargy and icterus, which the owner thought, had only developed in the last 2 days. This client is a very aware client and one who recognizes the subtlety of feline symptom exhibition. It was clear, however, from the physical exam that this patient had been ill for quite a bit longer than the owner thought. After we talked for awhile, she shared with me that her husband had an inoperable tumor and was about to start a new round of chemotherapy and radiation before referral to a tertiary hospital for very complex surgery. My patient's condition was clearly a part of a complex emotional time for this owner. She said, too, that her cat was the one who gave her the love and affection she needed when she was upset by everything that was arising and that she could not bear to lose her. The emotional context and family circumstances are often part of the reason a cat is presented to us and we need to be able to elicit and understand them. The level of satisfaction a client will express is directly associated with feeling understood.

Clients usually have more than one concern. Indeed the first concern mentioned may not be the most important one to the client. Sometimes the last concern raised is the most important one but was saved for last because it is the more frightening or sad. By asking the right kind of questions, we can be sure that we understand the whole story. It is also therapeutic for the client to tell their story rather than be asked a series of questions. It can be cathartic. Most of us have experienced feeling unburdened and less alone after sharing a story of difficulty with a good listener. Our clients don't expect us to "fix" everything. They understand that we cannot. Sharing the struggle a client is experiencing and responding empathetically is often enough.

Three broad types of skills need to be addressed in communication skills training:

1. Content skills – what we communicate. The substance of clients' questions and our responses, the information we gather and give, the treatment plans we discuss
2. Process skills – how we do it. The ways we communicate with clients, how we discover history, provide information. The verbal and nonverbal skills we use, how we develop a relationship with the client, the way we organize and structure communication

Perceptual skills – what the clients and we are thinking and feeling. The internal decision-making, clinical reasoning and problem solving skills we bring to the encounter. Our attitudes, personal capacities for compassion, mindfulness, integrity, respect and flexibility are critical to understanding how to create a successful relationship and achieve the best outcomes. We need to be aware of our feelings and thoughts about the client, about the patient's condition and other issues that may be concerning the client; awareness of our own self-concept and confidence, of our own biases and distractions.

It is important to emphasize that content, process, and perceptual skills are inextricably linked and cannot be considered in isolation.

In 1998, the Calgary-Cambridge guide was created to provide a structure for teaching and learning communication skills. It provided a comprehensive repertoire of skills validated by research and theoretical evidence. It provided guidance on skills that make a difference in medical communications. In 2003, enhancement to the guide were developed which visually and conceptually improved the way communications skills training took place. Three diagrams helped to place the skills in relationship and context. With this enhancement came a new content guide for skills training. Since then communication experts in veterinary medicine have utilized this evidence based approach to adapt the guide to client communications. Studies in JAVMA since 2001 have demonstrated strong evidence of the value of this approach over the paternalistic approach favored by physicians in the past. For example, a study published in JAVMA in 2012 demonstrated a clear relationship between client compliance and satisfaction with their relationship with the veterinarian

References

Fortin, AH et al. *Smith's Patient Centered Interviewing* An Evidence Based Method 3rd Edition: New York: McGraw Hill, 2012. Frank. *Veterinarian-Client Communication Initiative:* An Interactive Workshop, Learners Guide. New York: Pfizer Animal Health, 2012.
Frankel, Richard M. Pets, Vets and Frets: What Relationship-Centered Care Research Has to Offer Veterinary Medicine. *Journal of Veterinary Medical Ethics* 2006; 33 (1): 20-27. Silverman, J. et al.

Skills for Communicating with Patients Third Edition: London: Radcliffe Publishing Ltd. 2013.
Kanji, N. et al. Effect of veterinarian-client-patient interactions on client adherence to dentistry and surgery recommendations in companion-animal practice JAVMA, Vol 240, No. 4, February 15, 2012

Old Thin Cats:
Is it Really Just Old Age?

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

In both people and companion animals, cachexia and sarcopenia are 2 important syndromes that occur in a variety of chronic diseases and aging, respectively. Although cachexia has been recognized in people for over 2,000 years, only recently has it become acknowledged as a common and detrimental finding that is associated with increased morbidity and mortality, and with this observation has come rapidly expanding interest and research. Both of these syndromes are becoming increasingly important in human and veterinary medicine because of their high prevalence and adverse clinical effects, and a better understanding of the mechanisms underly- ing these syndromes is critical for optimal patient care, whether human or veterinary.

Cachexia is defined as loss of weight and muscle mass secondary to chronic inflammation or disease. Sarcopenia, “poverty of flesh”, is an age-related loss of lean body mass. Sarcopenia is not caused by disease, is a gradual process and progresses with age. Loss of muscle can occur without fat loss or a decrease in Body Condition Score (BCS). Individual cats, particularly those with long coats or a history of obesity may appear to have a high BCS and yet be under muscled.

One of the keys to the management of cachexia and sarcopenia in dogs and cats is recognizing it in its earliest stages. To achieve this, BCS and Muscle Condition Score (MCS) must be consistently assessed. The goal for BCS in a healthy cat is 4–5 on a 9-point BCS scale. However, in certain diseases (eg, CHF, CKD), a slightly higher BCS may be desirable (ie, a BCS of 6–7/9), although further research is required to make specific recommendations. Even in animals with these diseases, obesity (BCS > 7/9) should be avoided.

The MCS differs from the BCS in that it specifically evaluates muscle mass. Evaluation of muscle mass includes visual examination and palpation of the head, scapulae, epaxial muscles over the thoracic and lumbar vertebrae, and pelvic bones.

In people, the loss of LBM has direct and deleterious effects on strength, immune function, wound healing, and survival. In fact, cachexia is an independent predictor of survival in people. The specific deleterious effects of muscle loss have not been as well studied in dogs and cats although there are studies associating thin body condition with decreased survival.

The weight loss that occurs in cachexia is unlike that seen in a healthy animal that loses weight. In a healthy animal that is receiving insufficient calories to meet requirements, metabolic adaptations allow fat to be used as the primary fuel source, thus preserving LBM. Conversely, acute and chronic diseases alter concentrations of a variety of mediators (eg, inflammatory cytokines, catecholamines, cortisol, insulin, glucagon), which then decrease the ability to make metabolic adaptations required to switch to fat utilization, and amino acids continue to be used as a primary source of energy. Therefore, muscle and LBM quickly are catabolized.

Numerous other factors can contribute to muscle and weight loss. Maintenance energy requirements vary with age, genetics, health status and gender (intact or altered). In presence of some disease states, maintenance energy requirements increase significantly. Decreased nutrient absorption is another possible mechanism for muscle loss in cachexia and sarcopenia. Studies in cats have shown decreased digestive ability. One investigator showed a reduced ability to digest protein in 20% of geriatric cats with about 33% having a significant reduction in ability to digest dietary fat. Micronutrient absorption, potassium, phosphorus, sodium, choline, B vitamins and Vitamin E, is also decreased.

Cats derive most of their energy requirements from protein and are metabolically less able to handle decreased amounts of protein and increased amounts of carbohydrates to maintain their energy requirements. Omnivores adapt to lower dietary protein by down regulation of their protein metabolism (protein sparing) but cats have been proven to be unable to make this physiologic adaptation. This preferential use of protein for energy can have clinical effects when cats are ill or anorectic as protein malnourishment can occur.

An important problem in cardiac and other forms of cachexia is a decreased calorie intake. The anorexia may be secondary to fatigue, dyspnea, or may be because of medication toxicity or alterations in appetite that often accompany CHF, cancer, and CKD in cats. Absolute food intake may decrease in animals with these diseases, but there also may be altered food preferences, cyclical appetite, and other issues that negatively affect overall food intake. Anorexia, for example, is present in 34–84% of dogs and cats with heart disease.

Increased energy requirements, alterations in nutrient absorption, and decreased energy intake all likely play important roles in the pathogenesis of cachexia by causing a net calorie deficit. However, a healthy animal that has a calorie deficit, either as a consequence of decreased food intake or increased energy requirements, would primarily lose fat. Therefore, these factors are not sufficient to explain the muscle and LBM loss and relative sparing of fat that are the hallmarks of cachexia and sarcopenia. This discrepancy suggests that metabolic alterations also are present.

Because of the important implications of cachexia and sarcopenia on morbidity and mortality in people, there is now extensive research into the prevention, diagnosis, and treatment of these syndromes. There are exciting opportunities for new and effective

targets to decrease energy requirements, enhance energy intake, improve nutrient absorption, and modify metabolic alterations to prevent and even reverse the effects of both cachexia and sarcopenia.

A 2008 study on longevity in aging cats studied in a controlled environment for 5 years showed that all cats lost weight over time. However, cats supplemented with dietary antioxidants, prebiotic chicory root and a blend of Omega 3 and 6 fatty acids had a beneficial effect over a commercially fed diet alone or one supplemented only with antioxidants (Vitamin E and beta carotene). Cats in the fully supplemented group lost less weight, lived longer, had better LBM scores, improved fecal flora and fewer diseases.

In many cases, practical methods to help owners manage their animal's appetite are critical to success. This is particularly important because anorexia is one of the most common contributing causes to an owner's decision to euthanize his or her pet.

Any issues that potentially can affect food intake should be addressed, whether physical or environmental. Dental disease, for example, can substantially impair food intake in an otherwise healthy or sick animal. Pain (eg, back or joint) can decrease an animal's mobility and make it more difficult to secure adequate food intake. Environmental issues also can negatively impact food intake. Multipet households may impede the ability of an individual animal to gain access to food (eg, a more frail or timid animal may be crowded out from the food bowl). Stress often can increase for animals after diagnosis of any illness because of lifestyle changes (eg, medication administration, new foods), as well as increased stress on the part of the owner, which may be detected by the animal.

Once environmental issues are ruled out as a cause of weight loss, a nutritional screening is crucial. Older cats may need 5-6 g of protein/kg to prevent protein catabolism. Reduced digestive ability indicate that a high energy, highly digestible diet may be needed. Some kitten formulas may be more appropriate. Folate and cobalamin supplementation may be useful. Commercial cat foods vary quite widely in caloric density. Specific formulas should be investigated for adequacy.

Cachexia should be anticipated in animals with chronic diseases such as CHF, CKD, cancer, and others. Consistently evaluating MCS in all patients will help identify muscle loss at an early, mild stage in aging or ill animals, rather than waiting until muscle loss is moderate or severe, when it may be more difficult to successfully manage. Similarly, as animals age, muscle loss is likely to occur, even in healthy individuals. Therefore, muscle mass should be thoroughly evaluated in geriatric cats and dogs.

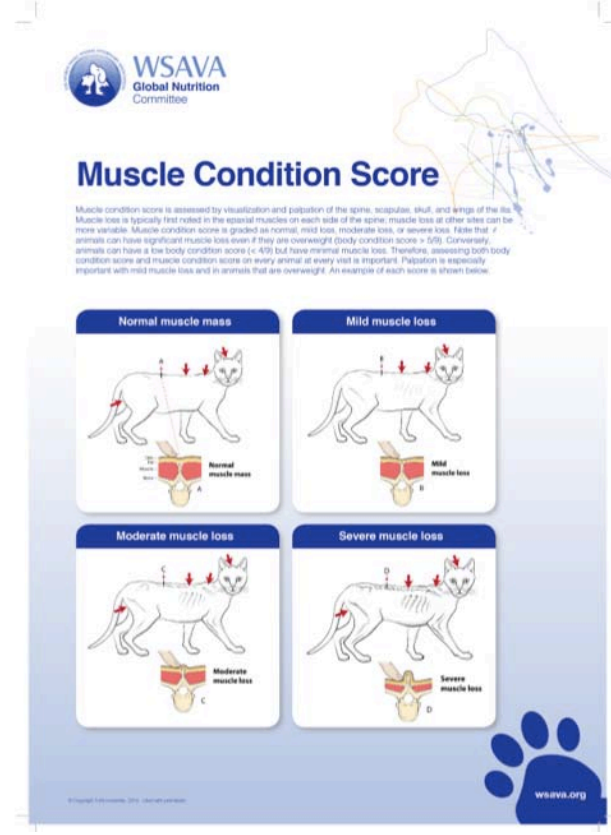
References

Freeman, L. Cachexia and Sarcopenia: Emerging Syndromes of Importance in Dogs and Cats. J Vet Intern Med 2012;26:3–17

V. Paul Doria-Rose, DVM, and Janet M. Scarlett, DVM, PhD. Mortality rates and causes of death among emaciated cats. JAVMA Feb 2000, Vol. 216, No. 3, Pages 347-351

Finn E, Freeman LM, Rush JE, et al. The relationship between body weight, body condition, and survival in cats with heart failure. J Vet Intern Med. 2010;24:1369–1374.

http://www.wsava.org/nutrition-toolkit



Complicated Senior Cats: Managing Multiple Conditions in One Patient

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

Old age is not a disease. Both veterinarians and owners must resist the temptation to ascribe signs of illness to aging. Some signs of illness such as chronic pain, dehydration or hypokalemia may lead to clinical signs that owners scribe to "slowing down" with old age. Many problems of senior cats are chronic and progressive so that early diagnosis and treatment is important for pain management and quality of life. It can also be tempting to find a "diagnosis" and treat for that without continually evaluating the "whole" cat. The focus on a single diagnosis and treatment plan can neglect common comorbid conditions that can dramatically affect quality of life. A hyperthyroid cat, for example, may suffer from other conditions more common in older cats; overgrown nails, decreased olfactory sensing, which can impact appetite, muscle atrophy and osteoarthritis or periodontal disease.

For these reasons and a host of others, comprehensive wellness examinations, history assessment and a minimum database are recommended every 6 months for seniors. Health status may change rapidly in this group and early detection and treatment is important to preserve quality of life. Signs of illness in cats are often quite subtle and easy for owners to overlook. The minimum database includes a compete blood count (CBC), a full serum chemistry panel with electrolytes, a full urinalysis and total T4. Early detection of a decline in renal function will be found in declining urine specific gravity before BUN and Creatinine are beyond the normal range, making the urinalysis a critical part of information gathering. Depending upon risk factors, fecal examination and retrovirus testing may also be indicated. Blood pressure measurement should also be included in any cat with known risk factors.

Because senior cats' response to vaccination is largely unknown and immune function may be affected by both aging and the presence of chronic disease, vaccinations should be given according to the AAFP Feline Vaccine Advisory Panel for all cats.

The home environment is critical to wellness. Staff members should be trained to educate owners about enrichment, stress identification and modification for aging changes. Senior cats may benefit by an additional heat source such as a heated bed or one placed close to a heat source. Resting or hiding areas that are inaccessible to other pets, quiet and easily accessible for the senior may help with stress reduction. Litterboxes should be large and shallow with low sides and placed in quiet locations. If the home has multiple stories, boxes should be placed on each. Night-lights may be helpful with declining vision. Multiple fresh water sources can encourage moisture consumption in cats that may be prone to dehydration because of reduced urine concentrating ability.

In senior cats, cognitive dysfunction (CD) is now recognized as an important problem. Formal diagnostic criteria have yet to be established. It is a diagnosis of exclusion. The most common signs are disorientation in time and space, altered learning, house soiling, altered interactions (e.g. attention seeking, anxiety, irritability) changes in activity (wandering or pacing) changes in sleep patterns, decreased appetite, decreased grooming and increased vocalization. Medical problems such as hyperthyroidism, hypertension, pain of osteoarthritis, or chronic kidney disease can mimic many of these signs and so must be excluded before presuming CD.

Published studies are lacking on the efficacy of treatment. Therapies extrapolated from studies in humans and dogs include anti-oxidant enriched diets, supplements phosphatidyserine, omega-3 fatty acids, Vitamins E and C, L-carnitine. One ingredient found in supplements for dogs, alpha-lipoic acid, is toxic in cats. SAMe improved activity and awareness in dogs and is commonly used in cats with hepatic disease. No trials with these supplements have been published for cats with CD. Therapies for cats with CD are anecdotal.

There is evidence of cholinergic decline in senior cats so drugs with anticholinergic activity (e.g. some SSRIs such as paroxetine and TCAs) should be avoided. Selegiline (Anipryl), which has been anecdotally reported to be useful in cats and proven beneficial in dogs for CD, should not be combined with SSRIs or TCAs. Environmental enrichment and Feliway have often been recommended but no studies in cats show benefit. In fact, in cats with CD modifications to the environment may be detrimental. Regular and predictable routines are most desirable. Any changes should take place slowly.

Hyperthyroidism and chronic kidney disease (CKD)

The presence of these occurring concurrently affects not only the diagnosis but also the treatment and prognosis. A more cautious approach to treatment is required. The relationship between the two is not known. Hyperthyroidism may damage the kidneys or the consequent hypertension may contribute to renal damage. Hyperthyroid ism seems to mask a decline in renal function by increasing renal blood flow and hence glomerular filtration rate (GFR).

Diagnosis is complicated by the suppression of thyroid hormones by a concurrent illness or "sick euthyroid". Cats with both an upper reference range normal Creatinine and TT4 are likely to have both hyperthyroidism and CKD. A TT4 can be repeated in a few weeks or a free T4 by equilibrium dialysis can be done though it carries a slightly higher risk of false-positive results. The presence of CKD can affect hematology results. Erythrocytosis occasionally seen in hyperthyroidism may be masked by anemia of CKD.

Presently the assessment of kidney function depends upon elevated BUN and Creatinine with a reduced urine specific gravity. However concentrations of BUN can be increased by the polyphagia of hyperthyroid, Creatinine reduced because these cats are thin and have lost lean body condition, while increased GFR can reduce both. Urine specific gravity can be low because of either disease; both increase the risk of urinary tract infection.

All treatments for hyperthyroid ism can worsen kidney function. Hyperthyroidism increases renal blood flow and GFR. Treatment may lower GFR by up to 50%, which may unmask previously unrecognized kidney disease. Treatment may initiate a crisis. Affected cats become azotemic and may start to show significant decreases in renal function by 4 weeks of treatment. No significant differences in pretreatment parameters have been shown between cats that will become azotemic after treatment and cats that will not. GFR, iohexol clearance and other assessment tools are not readily available in practice yet.

For these reasons, treatment with medical management for all cats should precede any other form of therapy. Medical management is reversible, can be reduced, and induces euthyroid states more gradually. Radioiodine and surgery may result in acute destabilization. Medical management should continue for a period of time, months before considering curative, permanent treatments.

I f a cat is known to have CKD at the time of diagnosis, treatment with a lower dose of medication should be given at the start. For methimazole, 1.25mg- 5 mg once daily with frequent checks of renal parameters, titrating the dose upward. Renal parameters should be monitored at 3 and 6 weeks following start of therapy.

Attaining a euthyroid state should be the goal unless this level of thyroid hormone worsens renal parameters. Ongoing management should aim for a balance between the two conditions. Individual response to therapy should guide treatment. For example, if euthyroidism causes significant renal dysfunction, suboptimal control of hyperthyroidism may yield a patient that maintains weight and body condition.

Heart failure and chronic kidney disease (cardiorenal syndrome or CRS)

In the cat, the incidence of chronic abnormalities in cardiac function (e.g. congestive heart failure) causing progressive and permanent chronic kidney disease is unknown. A study of 102 cats with hypertrophic cardiomyopathy reported 59% prevalence for azotemia as compared to 20% for age-matched controls.

CRS occurs when worsening renal function limits diuresis despite clinical volume overload associated with heart failure. In cats being treated for chronic heart failure, declining renal function should be anticipated. The diagnostic marker for CKD, isosthenuria, cannot be relied upon in cats being treated with diuretics. Monitoring of Creatinine especially should be used to discern trends in renal function. A progressive rise even within the normal range should alert the practitioner, along with clinical signs: PU/PD, hyporexia, anorexia, weight loss and vomiting.

A minimum database should include abdominal ultrasound to assess for typical changes in renal architecture and to identify underlying causes that may have specific treatments, such as neoplasia, pyelonephritis, and nephrolithiasis. Blood pressure monitoring should be included as well as hypotension from therapy can decrease renal perfusion. The usual diagnostic imaging; echocardiogram, thoracic radiographs are important for type of cardiac disease, risk assessment, and treatment planning.

Goals of treatment are to recognize CRS, reverse it as much as possible and deal with the renal consequences of heart failure and the complex relationship between heart failure and renal injury. The difficult balance is to “dry out” the heart failure and hydrate the kidneys. Different therapeutic strategies are based upon the degree of compromise of each organ.

Ace inhibitors are the mainstay of therapy for CRS especially in the presence of hypertension or proteinuria. Cats with CRS should be hydrated before starting therapy. Low dose benazepril or enalapril 0.25mg/kg Q 24 hours can be increased to proved better control for heart failure. Benazepril is metabolized in the liver, Enalapril in the kidneys. Therefore, cats with CRS may need a lower dose of enalapril than benazepril. Initiation of therapy may show a transient increase in BUN/Creatinine concentrations. If persistent, lowering the dose is usually sufficient.

If azotemia is becoming a concern, the first step is to lower the dose of diuretics. The goal is to find the lowest effective dose that controls heart failure. The dose must be continuously reassessed. The ideal dose for an individual patient achieves the threshold rate of drug excretion. An individual HF patient that is not responsive to 5mg of furosemide per 24 hour for example will need 10 mg per 24 hours, not 5mg every 12 hours. Adequate natriuresis can be grossly assessed by observation of increased urine volume and decreased specific gravity. Periodic drainage of pleural fluid or ascites can be used to avoid excessive diuretic use.

In the event that diuretic resistance occurs, several options are available to correct fluid balance. A CRI of furosemide (0.3-0.6mg/kg/hour IV inhibits sodium resorbtion more effectively than oral or IV Boluses. Once the volume overload has resolved, most cats will again respond to oral therapy. Another loop diuretic, torsemide has superior diuretic action and long half-life. (0.3mg/kg PO Q 24 hours) It appears to be 10 times more potent than furosemide. Dual-diuretic therapy can be considered when furosemide dose needs to be decrease. Spironolactone (1-2 mg/kg Q 12 hours) may cause severe facial pruritus and must be used with caution. Aldosterone sometimes causes significant hyperkalemia. Each work at different sites within the nephron and if tolerated may be helpful.

Systemic hypertension is common in CKD and by increasing afterload increases the cardiac workload. Hypertension worsens both CKD and heart failure. If present, amlodipine (0.625 mg/cat PO Q 24 hours) should be added. Blood pressure monitoring is critical to avoid the effects of iatrogenic hypotension.

In advanced CRS, a positive inotrope (pimobendan) may improve azotemia, demeanor and appetite and allow reduction in diuretic dose.

Dietary modification should consider both conditions. Sodium restriction is sometimes needed and the extent to which it is required will vary. Distilled or low sodium water may be offered for drinking if more sodium restriction is needed than can be provide with diet. Clients should be cautioned not to feed high sodium treats. Lower phosphorus diets may be helpful in managing kidney disease but may result in the loss of lean body condition. High quality protein should be given to the level that it does not worsen azotemia. Omega -3 polyunsaturated fatty acids have been shown to be beneficial in both cardiac and renal conditions. Many renal diets are supplemented or if given separately EPA 40mg/kg/day, DHA 25mg/kg/day.

Fluid administration is a balance between improving renal blood flow without precipitating congestive heart failure. Fluids should be given slowly to correct azotemia, tailored to the individual's ability to tolerate. Abrupt changes in weight, a new gallop heart sound and/or heart rate may indicate impending congestive event and justify fluid rate reduction. Sometimes a low-dose CRI of furosemide will be indicated concurrently in cats with end-stage CRS. SQ fluids may be less likely to trigger a congestive event and can be given every 24 -48 hours via a balanced electrolyte solution and adjusted to the individual patient's ability to tolerate. In fragile patients, a smaller volume of fluids, as little as 30mls every 48 hours may be necessary, titrating slowly upward if the expected effect on uremia is not evident. Electrolytes should be monitored closely, especially potassium, as hypokalemia can trigger arrhythmia. Correction can take place through fluid therapy or oral means.

Although renal function may remain stable for a period of time in cats with heart failure, when CRS occurs it leads to frequent hospitalization, difficulty maintaining good quality of life and eventually euthanasia. The therapy described here is directed at improving quality of life for cats with CRS. Whether they contribute to prolonged survival is unknown.

.

Death and Dying:
The Blessing and Curse of Euthanasia

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

In an AVMA sponsored conference on euthanasia, slaughter and depopulation called "Humane Endings" in October, 2014, the keynote speaker described the change in public perception of the importance of animals of all kinds. He described the increasingly pervasive public perception of animals as connected to humans and the associated increased public aversion to animal deaths and killing. He concluded that animal death and killing will become more emotional and more contentious. While his remarks were directed at all the participants, the implications for the experience clients have of euthanasia are clear. Our obligation to provide a painless death for the beloved animal and an acceptable experience for owners of companion animals is becoming more complex.

With the decreasing nuclear family, an outcome of the decline of agricultural community, the rise of industrialization, climbing divorce rates and prolonged life spans, comes the increase in isolation from family, neighbors and community. Yet people need love, companionship and emotional support. This has given rise to the redefinition of pets as family members. About 90% of respondents in one study of 100,000 US households rated a pet as important or extremely important to the family. For many complex reasons, the emotional attachments which many humans develop for their pets not only equals but frequently transcends the emotional attachment which they form with humans and can be a source of unconditional love, support, comfort, safety, security and stability.

When highly attached owners recognize that a moment has arisen in the clinical management of a life-limiting medical condition when a cure is not an attainable goal, it is normal for them to experience strong emotions, generally termed anticipatory grief. Anticipatory grief is the psyche's way of preparing for impending loss. This is often the beginning of a period of powerful emotional states which can blur judgment at a time when clear thinking and planning may be key to resolution of grief and ending the suffering of a beloved pet.

Pet owners often trust veterinarians and/or see them as authority figures. During loss, clients may look to the veterinarian to provide strength, guidance, leadership. Given clients expectations and the impact of end-of-life conversations on pet owner and the veterinary team, compassionate communication should be considered both a core clinical skill and an ethical obligation for veterinarians.

One core belief that must be developed in clients is that preserving quality of life takes precedence over measures to prolong life. With the sophistication of veterinary medicine and technology comes the ability to prolong suffering by engaging in many more forms of therapy than were previously unavailable for beloved pets. Veterinarians now have to advocate for the animal interest to end a life when further intervention will cause or exacerbate suffering. This life-prolonging technology has rendered the term "natural death" progressively meaningless, giving rise to complex ethical struggles with medical futility and who decides when to pull the plug and why.

The owner becomes the animal's proxy and will decide if and when euthanasia is a better option than life for an animal that is suffering despite receiving the best comfort care available. The strongest desire of highly attached pet owners facing the loss of a beloved pet is to do what is best for the animal. It is an elusive goal and one which requires the owner's interpretation of the animal's state.

A veterinarian can help by educating an owner in how to assess quality of life, attributing relative weight to specific experiences like the presence or absence of joy, pain, or frustration. In the general practitioners' relationships with clients there is very often a long more intimate connection than there is with specialists to whom the animal may have been referred for care. Therefore, the generalist should stay involved after a referral and advocate for what is right for the pet. This is also important for the emotional state of the owner. Powerful emotions can ensue when decisions are second-guessed. Decisions made too early may cause profound guilt. A decision thought to be made too late may be interpreted as causing suffering for a beloved family member. The uncertainty that is a natural part of being a proxy for another's best interest is always present.

In the best possible situation, before the anticipatory grief has begun, Quality of Life considerations are best made, once a trusting relationship is built between a client and the veterinarian. A journal kept from the time a potentially life-threatening condition has been recognized can be helpful in recognizing the balance between levels of happiness and distress based upon the behavior of the pet. Since there are no generally acceptable lines between what is acceptable and not acceptable Quality of Life, the individual observations can help reduce the burden on the client. We must build the client's confidence that they can comprehend their pet's condition and "walk in his shoes". By trusting the ability of persons most closely bonded to feel in their gut what the animal is experiencing, we encourage good choices.

The skills of educating, supporting, guiding and facilitating are key to assisting the client. More importantly, the veterinarian must not try to solve the owner's problems by making decisions for them, by giving them advice on what course they should take, rationalizing their choices or rescuing them. Presenting options gives families control over the process leading to inevitable loss by

helping them find their own view of what constitutes the best way to care for their animal. A sense of control – even if limited – has been shown to correlate with healthy grieving and emotional healing. The manner in which a veterinarian provides care for a client whose pet has died has the potential to alleviate or aggravate grief, influence client and veterinarian satisfaction and create or destroy long-lasting relationships.

It is essential to listen to what is most important to the family under the circumstances, what their concerns are, how they want to spend their time as options become limited and what kind of tradeoffs they are willing to make. The sense of control should extend to the physical and social environment surrounding a beloved pet during the last moments. Planning in advance, before powerful emotions hold sway over decisions, will allow the family to think clearly through their plan. As emotional states become more ascendant, remind the owners of their decisions. They may choose the form of death, natural or euthanasia, who should be present, the tenor of the ritual and whether children should be involved. If euthanasia is elected, the mechanics of the process should be discussed. If the client is comfortable with placement of an IV catheter or not, how to administer a sedative if one is needed and so on. The location may be of concern as well, whether outdoors, in the owner's lap, at home, on the floor. Conventional rituals that support and comfort people at the time of the loss of a human loved one, funerals, calling hours, or celebrations of life, have not evolved around pet loss. This one event may be all the ritual possible for a highly attached client whose family may not perceive the death as a loss of a loved one.

References

AVMA Guidelines for Euthanasia; 2013 Edition

Shearer, Tamara. *Veterinary Clinics of North America* Palliative Medicine and Hospice Care. Philadelphia: WB Saunders 2011.

Little, Susan, ed. *The Cat* Clinical Medicine and Management, 1st ed. St. Louis: Elsevier, 2012.

McMillan, Franklin. Rethinking Euthanasia:Death as an Unintentional Outcome. JAVMA 2001: 219(9): 1204-1206

Wrobel TA, et al. Grieving Pet Death: Normative, Gender, and Attachment Issues. *Omega* 2003;47(4):385-393

Gage, MG, et al. Couples' Preception of Stressfulness of Death of the Family Pet. *Family Relations* 1991: 40 (1): 103-105

Fat Cats:
New Therapy and Dietary Management

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

There is no question of the “growing problem” of obesity among adult cats around the world. In a study of 12 owner-owned cats in the United Kingdom, even referral to a weight loss center did not insure rapid weight loss. Many factors were found to be significant in this study, owner compliance with directions was considered one of the most significant. All cats lost weight, but more slowly than predicted. Exercise may not have been encouraged or treats may have been added. In the end, we humans are the most important reason for this dangerous trend. Of particular interest in this study was the lost of lean body mass during weight loss. While fat loss was the most significant, the loss of lean body mass meant that muscle and basal metabolic rate declined. In another study of cats on a weight loss plan, the owners of the cats who did not lose weight consistently under-estimated the body condition score of their cat. The perception of normal on the part of the individual responsible for feeding had an impact on weight management.

Because obesity is a world wide trend in both adults and children, there may be some instructive value in examining the characteristics of successful weight loss and management in humans. Those who lost weight and successfully maintained their target weight were far more likely to plan meals, measure food, track calories, plan exercise, exercise for at least 30 minutes a day and weigh themselves every day. The use of over the counter weight loss supplements was negatively correlated to weight loss. While several of these strategies may not be relevant to cats as we shall explore, the idea of tight control appears to be the most significant concept that can be derived from human research on weight loss.

Cats are obligate carnivores and as such have specific nutrient requirements that reflect their evolutionary background. The natural diet of the cat is high protein, low carbohydrate diet derived from the prey they consume in the wild.

As obligate carnivores cats differ from dogs and other omnivores in their nutritional requirements and physiologic adaptations. Cats have not developed many of the metabolic pathways for processing higher carbohydrate diets that omnivorous have and because of the lack of these pathways have different requirements in their diet than dogs and other omnivores.

Commercial dry cat foods are convenient to give to cats, many cats enjoy or even prefer them and they are tolerated well by many in cats in most situations. However, because of the inherent differences in metabolism feeding high carbohydrate diets to cats may predispose them to obesity and may also have untoward effects during times of illness malnutrition. Higher protein, low carbohydrate diets may also be more effective in managing certain diseases such as hepatic lipidosis, diabetes mellitus and obesity.

Weight reduction requirements differ between omnivores and cats and reflect the cat's inability to store excess starch as glycogen. Glucose exceeding energy requirements is stored as fat.

Feeding high fiber, low fat diets to obese cats does result in weight loss but at the expense of lean body mass. The basal metabolism of the cat may be lowered, predisposing the animal to regaining of the weight. In several studies Cats fed a high protein; low carbohydrate diet lost weight but maintained their lean body mass in comparison to cats fed a high carbohydrate low fat diet. The amount of food available to cats on such a diet should be regulated.

When feeding cats a high protein low carbohydrate diet for obesity management canned foods provide the optimal amounts of protein and carbohydrate and canned kitten food provides the closest approximation to the cat's natural diet.

Unlike dogs, 'domestic' cats are not evolved to scavenge. They have a small liver and a simple digestive system that is not able to cope with toxic or bacterial contamination. Their feeding is therefore restricted to live, healthy prey. Whilst dogs hunt cooperatively and are able to bring down prey that is much bigger than themselves, the cat, being a solitary hunter, is only able to catch relatively small prey. It also does not have pressure to share its prey with other members of its roup, because it does not depend upon them to help catch it.

The wild and feral cousins of the domestic cat spend 6–8 hours per day hunting. Of the 100– 150 hunting attempts per day perhaps 10% will be successful. With a failure rate as high as this a cat may expect to have periods during which the amount of prey captured barely meets energy expenditure. On successful days the cat may catch a surfeit of food.

The result is that in the cat, hunting activity is not related to hunger or satiation. The cat would soon die if it took a break for several hours after every meal, because this would mean it would miss the best hunting opportunities. Hunting is also not related to the pleasurable taste of the prey. Small mammals and birds do not come in a variety of appetizing flavors, and in any case the cat's perception of flavor is geared to detect spoilage, not to enable it to be a gastronome.

Given the tightly regulated activity and feeding pattern of cats, and the lack of social significance of feeding, it would be expected that obesity would be unlikely in this species.

However, obesity is an increasing issue, and relates to feeding patterns that fail to take into account the natural behavior of the cat, and which are designed to satisfy human attitudes to the value of offering food as an attempt to show care.

A typical domestic cat expends very much less energy on finding and consuming food than its feral counterpart. Meals are presented in a bowl and may be consumed in seconds. No elements of the hunting strategy are activated.

In the domestic environment cats may have few opportunities to climb or explore three- dimensional space so their energy expenditure is typically very low compared to wild cats. This tips energy utilization in favor of increased storage, and hence obesity.

Cats do not go shopping, so the food we give them is designed to appeal to human shoppers and not to cats. Humans are social eaters and expect to enjoy shared meals and social interaction. Many owners expect that a happy cat is one that shows appreciation for the food we give by clearing the food bowl in the way that a person or a dog might.

Food and feeding regimes are therefore designed to reinforce these human misconceptions. Owners feed highly appetizing foods that are likely to encourage the cat to eat more than it might otherwise choose. This is much the same as the effect of intense flavor on overwhelming satiation in man. We also know that feeding multiple flavor variations of foods will increase a cat's total food intake.

Without reeducation, owners will constantly seek to 'improve' the food they give their cats so that they begin to eat in the same way as people. A meal that is not immediately consumed is taken as an indication that the cat is dissatisfied with its food.

The consumption of larger than normal quantities of food at each meal is likely to distend the cat's stomach and create the same false perception of hunger that is seen in man, the satiation of which is further reinforced by the extremely appetizing nature of the food. Most cats will approach their owners for attention or play many times during the day. Sociable cats have quite a high demand for interaction of this kind. Many of the cat's resources are focused in the kitchen area; food, latrines, cat door, etc. Cats will therefore approach their owners in the kitchen or will entice their owners there.

Unfortunately this is misinterpreted as an indication that the cat wishes to have more food. Owners will often replace old food with fresh. Given that the owner has offered no other interaction this may be attractive to the cat, which is unwilling to eat spoiled or old food. When the cat begins to eat the owner reinforces this by showing attention, or by playing a game after the cat has eaten.

In this way the cat may eat as a substitute for other activities, or may learn to eat in order to get the attention and play that it actually wanted. The cat therefore eats more than it might normally choose to, because its demands for other kind of interaction are not met, or are conditional on eating.

In addition, recent evidence indicates that owners of overweight cats interpret the needs of their pets differently from owners of cats of normal weight. Obese-cat owners do understand that when a cat vocalizes or approaches that this is for attention and social interaction. In this respect they are no different from owners of normal cats. However, they are more likely to perceive hunger in the vocalizations of cats, which drives them to offer food. This is quite similar to the way that humans interact with each other; if we have a visitor we don't assume that this person has come round to get food but we still offer it as a sign of hospitality. This is because one of the primary methods of showing care toward another person is to identify and satisfy their undeclared needs.

This appears to be at the root of the reason for why owners of obese cats find it hard to stick to diet programs. Cats may evoke a greater emotional response from some people due to the type and pitch of their vocalizations, which are more like those of a human infant. In some cases owners of obese cats can become quite distressed as a result of the emotional conflict they experience when balancing the need to diet the cat for health reasons, and the stress they experience when deliberately not meeting the animal's apparent physical need for food.

Cats do not eat as a social group, and find it uncomfortable and stressful to feed close to one another. If food is restricted to two meals per day, fed by the owner, then a group of cats will be forced to eat in close proximity to one another. This not only increases anxiety and aggression because food cannot be consumed in private, but also pressures the individual cat to eat an uncomfortably large amount of food at one sitting, because that food will otherwise be rapidly eaten by the other cats. Cats therefore eat beyond natural satiation due to the stress of reduced food availability.

References

Svetkey, L. et al. Comparison of Strategies for Sustaining Weight Loss The Weight Loss Maintenance Randomized Controlled Trial. JAMA, March 12, 2008—Vol 299, No. 10

German, L. et al. Changes in body composition during weight loss in obese client-owned cats: loss of lean tissue mass correlates with overall percentage of weight lost, Journal of Feline Medicine and Surgery (2008) 10

Kruger, J. et al. Dietary and physical activity behaviors among adults successful at weight loss maintenance. *International Journal of Behavioral Nutrition and Physical Activity* 2006, **3**:17

Zoran, D. The carnivore connection to nutrition in cats.J Am Vet Med Assoc. December 2002;221(11).

Varaday, K. Intermittent versus daily calorie restriction: which diet regimen is more effective for weight loss?obesity reviews (2011) 12, e593–e601

Pandora Syndrome:
Not Just the Bladder Any More

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

Lower urinary tract signs (LUTS) – dysuria, periuria, pollakiuria and stranguria – are a common reason pet cats are brought to veterinary practices. When presented with a cat with these signs clinicians need to know whether this is the first episode or whether it is a chronic, recurrent disease as well as what other health problems the cat may have. Armed with this information an appropriate diagnostic plan can be made.

Cats may have multiple reasons for their clinical signs as well as other medical conditions and environmental requirements that need to be addressed. For example, Buffington et al. have presented evidence that some cats with severe, chronic LUTS seem to have a functional rather than a structural lower urinary tract disorder and that periuria can occur in apparently healthy cats exposed to stressful circumstances. There is significant overlap at the present time among treatment recommendations for some LUT disorders particularly with regard to ensuring that the patient's environmental needs are met.

Severe chronic idiopathic LUTS has been described as a naturally occurring model of interstitial cystitis in women. Interstitial cystitis (IC) has been defined as a disease of chronic irritative voiding signs, sterile and cytologically negative urine and cystoscopic observation of submucosal petechial hemorrhages. The same description in which cystoscopy was not performed in cats but in which other appropriate diagnostic procedures did not identify a cause became defined as Feline Interstitial Cystitis (FIC)

In addition to epithelial abnormalities identified in the bladder of cats with FIC, investigators found significant alterations in components of acetylcholine synthesis and release in the esophageal mucosa from cats with FIC. This suggested that changes in the nonneuronal cholinergic system may contribute to alterations in cell-to-cell contacts and possibly communication with underlying cells that may, in turn, contribute to changes in sensory function and visceral hyperalgesia. Differences in sensory neuron anatomy and physiology also are present in cats with FIC suggesting a more widespread abnormality of sensory neuron function.The acoustic startle response is a reflex motor protective response to a perceived threat. It is a brainstem reflex response to unexpected auditory stimuli and is increased in cats with FIC.

Differences in sympathetic nervous system function have also been identified in cats with FIC. Among them are changes in the brain stem in the region associated with the most important source of norepinephrine in cats and humans. It is involved in such brain functions as vigilance, arousal and analgesia and mediates the visceral response to stress. Other changes in brainstem help to explain the waxing and waning course of symptoms and the aggravation of signs by environment stressors .

Some cats with FIC appear to have abnormalities in the hypothalamic-pituitary-adrenal axis such that there is a decrease in serum cortisol secretion compared with healthy cats. Adrenal glands in these cats were grossly smaller in cats with FIC when compared to healthy cats.

Cats with FIC often have variable combinations of comorbid disorders such as behavioral, endocrine, cardiovascular and GI problems. External stressors appear to exacerbate clinical signs of these disorders. Many human beings with IC suffer from variable combinations of comorbid disorders as well. These appear to have no consistent pattern of onset and so cannot be attributed to LUTS but rather may be some common disorder affecting more than one organ which then responds in its own way.

Ongoing research in both humans and cats with chronic LUTS has begun to include a more comprehensive evaluation of the entire patient. Nosology is defined as the classification of diseases. Until a better understanding of the larger picture of cats presenting with LUTS, naming this constellation of symptoms and organs systems involved should remain vague and not reflect only LUTS. Dr. Buffington has suggested "Pandora's Syndrome" He and his colleagues, Drs. Westropp and Chew propose tentative criteria for diagnosis of Pandora syndrome:

1. Presence of clinical signs referable to other organ systems in addition to chronic idiopathic signs for which the patient is being evaluated
2. Evidence of early adverse experience (e.g abandonment, orphaning) and which may differ by individual
3. Waxing and waning of severity of clinical signs with events that (presumably) activate the central stress response system
4. Resolution of sings with effective multimodal environmental modification

Whatever the eventual name, restricting the description of these patients to their LUTS does not capture all of the currently recognized features of the syndrome. A more comprehensive evaluation of cats with these and other chronic idiopathic signs may result in a more complete diagnosis and lead to additional treatment approaches that may improve outcomes. For example, the relationship between the environment and health is quadratic rather than linear, with both deficient and threatening environment increasing the risk of poor health outcomes.

Individual patients presenting with chronic LUTS benefit by a more comprehensive evaluation to elucidate the effect on risk for Pandora syndrome. Included in this history should be:

- Where the cat was obtained
- Any other health or behavior problems that may be present
- Structure of the cat's environment – amount of time indoors, activity level, availability and management of resources, other cats in the home, people living with the cat.
- Presences of signs referable to other organ systems
- Perceived allergic responses to skin, lung or GI tract
- Any unusual or problematic behaviors

The physical exam should be performed with evaluation of the lower urinary tract last to avoid being distracted and missing other abnormalities such as over-grooming, obesity, acne, cardiac abnormalities or GI tract issues.

For an initial episode in an apparently healthy, young unobstructed patient, the most likely explanation is either a sickness behavior in an otherwise healthy cat or acute idiopathic LUTS. After ruling out other causes of LUTS, the client should be counseled regarding individually tailored multimodal environmental modification (MEMO) to make sure the cat's environmental needs are being met. The client can also be taught to look for other signs of sickness behaviors and to evaluate response to MEMO for adequacy of accommodation.

Table 1

Forms used as part of the evaluation of cats presented the Ohio State University Veterinary Medical Center for evaluation of chronic lower urinary tract signs. These forms have not been formally validated beyond their face validity for cases in the authors' practice area. They are offered as an example of an instrument that could be developed and validated for broader use

Cat and client history form

Cat's name_____ **Owner name**_____ **Date**_____

Contact information: Telephone: ☐___ E-mail: ☐ ___

☐ Please check preferred method of contact

Cat Information: Breed_____ Color_____ Date of Birth _____ Weight _☐ lb ☐kg

Owned for? _____ years _____months; ☐ M ☐F ☐Neutered? If yes, date: _____

(month/year)

Declawed? ☐N ☐Y If yes, Front only ☐ All four paws ☐

Body Condition (please check box that looks most like your cat):

☐Skinny	☐Lean	☐Moderate	☐Stout	☐Obese
				

Please check the boxes that best apply to your cat:

Diet: (please be as specific as you can, eg, Buckeye Best (company) Adult Chicken and Rice (flavor)

Wet food: name_____ **☐None** **☐25%** **☐50%** **☐75%** **☐100%**

Dry food: name_____ **☐None** **☐25%** **☐50%** **☐75%** **☐100%**

How many hours each day, on average: does your cat spend indoors?

☐Indoor only **☐18-24** **☐12-18** **☐6-12**

☐0-6 Is time outside supervised? ☐Yes ☐No

If you have more than one cat, what is their relationship? ☐Not related

☐Littermate ☐ Sibling ☐Parent-Offspring ☐Other (_____)

Where did you obtain your cat (source)?

☐Shelter ☐Offspring from a pet I already own(ed)
☐Purchased from a friend ☐Gift
☐Purchased from a breeder ☐Purchased from a pet shop
☐Stray/orphan ☐Other _____

Does your cat frequently (please check all that apply):

☐ Try to escape
☐ Pace at outside doors
☐ Cry at outside doors
☐ Hide
☐ Act fearful
☐ Act friendly
☐ Follow owners around the home
☐ Destroy things when left alone
☐ Act 'depressed' (little interest in feeding, grooming, environment, etc.)

Housing (_____): *Apartment*: ☐ studio ☐1-2 bedrooms ☐3 or more bedrooms,
Zip Code
House: ☐attached/twin duplex ☐ attached, 3 or more units, ☐single
☐other_____

Total Cats_____ Total Dogs_____ Other Pets_____

Other People_____

Please help us understand what your cat does around the house by placing a check (✓) in the box next to each behavior that best describes how commonly your cat does each of the behaviors described below

Does your cat:	All of the time	Most of the time	A good Bit of the Time	Some of the time	A little bit of the time	None of the Time	Does Not apply
Leave household articles (furniture, drapes, clothing, plants, etc) alone	☐	☐	☐	☐	☐	☐	☐
Eat small amounts calmly at intervals throughout the day	☐	☐	☐	☐	☐	☐	☐
Drink small amounts calmly at intervals throughout the day	☐	☐	☐	☐	☐	☐	☐
Use the litterbox	☐	☐	☐	☐	☐	☐	☐
Get along with people in the home	☐	☐	☐	☐	☐	☐	☐
Get along with other pets in the home	☐	☐	☐	☐	☐	☐	☐
Remain calm when left alone	☐	☐	☐	☐	☐	☐	☐
Stay relaxed during normal, everyday handling (grooming, petting)	☐	☐	☐	☐	☐	☐	☐
Calm down quickly if startled or excited	☐	☐	☐	☐	☐	☐	☐
React calmly to everyday events (telephone or doorbell ringing)	☐	☐	☐	☐	☐	☐	☐
Play well with people	☐	☐	☐	☐	☐	☐	☐
Play well with other family cats	☐	☐	☐	☐	☐	☐	☐
Show affection without acting clingy or annoying	☐	☐	☐	☐	☐	☐	☐
Tolerate confinement in a carrier (including travel)	☐	☐	☐	☐	☐	☐	☐
Groom entire body calmly	☐	☐	☐	☐	☐	☐	☐
Use scratching posts	☐	☐	☐	☐	☐	☐	☐
Play with toys	☐	☐	☐	☐	☐	☐	☐

Comments; anything else your cat regularly does or does not do that you think might be helpful for us to know about?

Health history
The cat's condition today is _____
Previous illnesses or surgeries _____
Current medications _____

***Directions*:** For items below, please use the following choices to describe how many times you have seen your pet experience the symptom, adding **comments/explanation** as appropriate.
Score =
0 = I have **NEVER** seen it
1 = I have seen it **at least ONCE**
2 = I see it **at least ONCE per YEAR**
3 = I see it **at least ONCE per MONTH**
4 = I see it **at least ONCE per WEEK**
5 = I see it **DAILY**

Score	How often does your cat:	Comments/explanation
	Cough	
	Sneeze	
	Have difficulty breathing	
	Stop eating	
	Vomit ☐food ☐hair ☐bile ☐other	
	Have hairballs	
	Have diarrhea	
	Have constipation	
	Defecate outside the litter box	
	Strain to urinate	
	Have frequent attempts to urinate	
	Urinate outside the litter box	
	Have blood in the urine	
	Spray urine	
	Groom more than cats usually do	
	Shed more than cats usually do	
	Scratch him/herself more than cats usually do	
	Have discharge from eyes	
	Seem fearful	
	Seem to need a great deal of contact or attention	
	Destroy things when left alone	

Please check any of the following diseases your cat has been diagnosed with:

☐ Periodontal (dental) disease ☐ Asthma
☐ Inflammatory bowel disease ☐ Skin disease
☐ Allergies ☐ Diabetes mellitus
☐ Cardiomyopathy (heart problems) ☐ Obesity
☐ Other_____

Household resource checklist

The following questions ask about your cat's resources so we can learn more about the environment your cat(s) live in. Please ✓ **DK** if you don't know, **NA** if it does not apply, or **Yes** or **No** after each question. If you have more than one cat, please answer for **all** cats. Resources (food, water, litter and resting areas) for each cat are assumed to be out of (cat) sight of each other, such as around a corner or in another room. If they are in sight of each other, please answer **No**.

Space		**DK**	**NA**	**Yes**	**No**
1	Each cat has its own resting area in a convenient location that provides some privacy	☐	☐	☐	☐
2	Resting areas are located such that another animal cannot sneak up on the cat while it rests	☐	☐	☐	☐
3	Resting areas are located away from appliances or air ducts that could come on unexpectedly (machinery) while the cat rests	☐	☐	☐	☐
4	Perches are provided so each cat can look down on its surroundings	☐	☐	☐	☐
5	Each cat can move about freely, explore, climb, stretch, and play if it chooses to	☐	☐	☐	☐
6	Each cat has the opportunity to move to a warmer or cooler area if it chooses to	☐	☐	☐	☐
7	A radio or TV is left playing when the cat is home alone	☐	☐	☐	☐
Food and water					
8	Each cat has its own food bowl	☐	☐	☐	☐
9	Each cat has its own water bowl	☐	☐	☐	☐
10	Bowls are located in a convenient location to provide privacy while the cat eats or drinks	☐	☐	☐	☐
11	Bowls are located such that other animals cannot sneak up on the cat while it eats or drinks	☐	☐	☐	☐
12	Bowls are washed regularly (at least weekly) with a mild detergent	☐	☐	☐	☐
13	Bowls are located away from machinery	☐	☐	☐	☐
Litter boxes					
14	Each cat has its own box (one box per cat, plus one)	☐	☐	☐	☐
15	Boxes are located in convenient, well-ventilated locations that still give each cat some privacy while using it	☐	☐	☐	☐
16	Boxes are located on more than one level in multi-level houses	☐	☐	☐	☐
17	Boxes are located so another animal cannot sneak up on the cat during use	☐	☐	☐	☐
18	Boxes are located away from machinery that could come on unexpectedly during use	☐	☐	☐	☐
19	The litter is scooped daily	☐	☐	☐	☐
20	The litter is completely replaced weekly	☐	☐	☐	☐
21	Boxes are washed regularly (at least monthly) with a mild detergent (like dishwashing liquid), rather than strongly scented cleaners	☐	☐	☐	☐
Litter boxes (continued)		**DK**	**NA**	**Yes**	**No**
22	Unscented clumping litter is used	☐	☐	☐	☐
23	A different brand or type of litter is purchased infrequently (less than monthly)	☐	☐	☐	☐
24	If a different type of litter is provided, it is put in a separate box so the cat can choose to use it (or not) if it wants to	☐	☐	☐	☐
Social contact					
25	Each cat has the opportunity to play with other animals or the owner if it chooses to on a daily basis	☐	☐	☐	☐
26	Each cat has the option to disengage from other animals or people in the household at all times	☐	☐	☐	☐
27	Do any cats interact with outdoor cats through windows?	☐	☐	☐	☐
Body care and activity					
28	Horizontal scratching posts are provided	☐	☐	☐	☐
29	Vertical scratching posts are provided	☐	☐	☐	☐
31	Chew items (eg, cat-safe grasses) are provided	☐	☐	☐	☐
32	Toys to chase that mimic quickly moving prey are provided	☐	☐	☐	☐
33	Toys that can be picked up, carried, and tossed in the air are provided	☐	☐	☐	☐
34	Toys are rotated on a regular basis (at least weekly) to provide novelty	☐	☐	☐	☐

If you have additional comments on any of the questions, please write them below, including the question #.

By submitting this form, you agree that anonymous information from it may be used for cat health-related research

The Kidney and the Parathyroid: A Tale of Substance and Longevity

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

The interrelationship between calcium, phosphorus, parathyroid hormone, activated vitamin D and fibroblast growth factor has a profound impact on the progression of chronic kidney disease (CKD) in dogs and cats. Beneficial effects of calcitriol treatment during CKD have traditionally been attributed to regulation of parathyroid hormone (PTH). New analysis of information emphasize direct renoprotective actions independent of PTH and calcium. It is now apparent that calcitriol exerts an important effect on renal tubular Vitamin D which may be important in maintaining adequate circulating Vitamin D. This in turn may be vital for important actions of Vitamin D on peripheral tissue.Limited information is available reporting the benefit of calcitriol treatment in dogs and cats with CKD. However, a survival benefit has been shown in dogs with CKD treated with calcitriol compared to placebo. The concentrations of circulating Vitamin D have recently been shown to be low in people and dogs with CKD and are related to survival in people. In 2015, there will be compelling data regarding the benefit of calcitriol use in cats with CKD.

Rather than focus on the dearth of evidence for several forms of intervention, this talk will focus on a historic review of the use of dietary therapy, phosphorus binding agents and calcitriol over a ten year period. These are all client-owner cats. Therefore, these are not randomized, blinded, controlled studies. Rather, these cases are a demonstration of practical interventions that have prolonged good quality of life in cats who may not have agreed to all of the recommendations made in the literature.

In assessing renal disease in cats, the most sensitive indicator is the loss of urine concentrating ability. The use of an early morning urine sample to assess urine specific gravity (USG) may help to counter effects of diet or drugs on a tested sample. Using the International Renal Interest Society (IRIS) values for classification of renal disease can be helpful in planning therapy. In some classifications IRIS 2 is divided in to 2a (Cr. 1.6-2.4 mg/dl) and 2b (2.5-2.8 mg/dl). In our practices the classification of 2a with USG less than 1.030 eating a mostly dry diet formula, for example, are started on treatment for chronic progressive renal disease (CPRD). Early intervention prolongs quality of life, good body condition score and wellbeing in a number of key ways. We use ultrasound guided cystocentesis in every cat from whom urine is obtained. This allows a quick early morning visit by the owner, a sterile sample for culture if indicated, a full assessment of the appearance of the urinary bladder and observation of complications such as uroliths.

One of the most frustrating aspects of treating this and any condition requiring lifelong therapy in cats is the difficulty clients have complying with our recommendations. Cats resist contact or intervention they haven't agreed to and clients want to preserve the relationship they have with their cat, often at the expense of appropriate therapy. It is essential then to choose the most effective forms of therapy, to provide options when resistance is experienced and to communicate a willingness to the client to assist in preserving the relationship they have with their beloved cat.

While it has been shown that dietary modification has the most positive long-term effect on outcome, the relationship between survival and protein restriction or the attendant restriction of phosphorus has yet to be illuminated fully. Strong evidence, however, supports dietary phosphorus restriction in animals with kidney disease. Serum phosphorus is an independent predictor of disease in cats with chronic kidney disease. Cats with induced renal disease fed phosphorus –restricted diets had less severe histological renal changes than cats fed normal diets.

Phosphate retention and hyperphosphatemia are primarily due to impaired renal phosphate excretion. If renal function is normal, clinically significant hyperphosphatemia seldom develops. In the early stages of CPRD increased levels of PTH can keep serum phosphorus within the reference range by decreasing expression of the sodium-phosphate transport system in the proximal tubule resulting in increased urine phosphate excretion. This allows for normalization of serum phosphorus at the expense of hyperparathyroidism.

As cats are quite specific about preferences in taste, texture and flavor, the use of renal formulated diets may not always be possible. Alternatives may not have been thoroughly tested to the extent that prescription diets are but the truth of the statement "It is more important THAT he eats than WHAT he eats" is undeniable. Treatment goals of dietary modification start with maintaining body weight and a normal body condition score. If renal diets are not tolerated, warm canned diets diluted with some form of flavored moisture are a good choice. Other alternatives include adding other forms of moisture to food to increase fluid intake, providing flavored waters to encourage moisture consumption, water fountains and multiple drinking places throughout the house.

IF a renal diet is not fed, most cats will tolerate low doses of aluminum hydroxide in food to act as a phosphorus binder, before serum phosphorus levels leave the normal range. Serum phosphorus should remain in the 4-5 mg/dl range, especially if calcitirol is considered. Low body condition scores and malnutrition are negative prognostic indicators in dogs and the same is likely to be true in cats. If adequate caloric intake and preservation of lean body mass does not occur, quality of life will decline.

Studies done to confirm preservation of lean body mass in cats fed a low protein diet, about 28% on an as-fed basis, were, as one would anticipate, time restricted to around 4 months. With the advent of a better plan for managing renal patients, they are living for

years with stable renal values and hematocrits within the normal range. The effects of protein restriction on the body condition scores of cats with CPRD should be evaluated. Until then, we all have observed the protein cachexia of our renal patients. It is crucial to preserve adequate caloric intake and adequate protein for these patients.

The effects of uremia on appetite are well known, particularly in human renal patients. The use of H2 blockers for uremic gastritis can be helpful in encouraging consumption of adequate calories. The use of mirtazapine as an appetite stimulant is helpful in those cats who can tolerate it. We use 1/8 of a 15 mg tablet every day to every third day depending upon response to therapy. Many cats with CPRD are underweight and dosing of ¼ of a tablet as has been recommended is often followed by restlessness, anxiety and vocalizing in cats who are sensitive to it. Clients can be quite upset by this and may be less inclined to follow other treatment recommendations. Both of these forms of therapy imply being able to accomplish giving fragments of a pill to a cat on a regular basis and over a prolonged period of time. Strategies for this should be included in client education including the use of "sticky" high value food like cheese in a can, cream cheese or pill pockets and other soft treats.

Calcitriol has long been reported to provide benefits to the human uremic patient by lowering parathyroid hormone concentration. This has also been reported in dogs and cats. Oral calcitriol has been shown to increase survival in human patients with CPRD including those treated prior to dialysis. The antiproteinuria effects of Vitamin D analogs are of crucial significance because proteinuria is a major risk factor for the progressive decline of renal function in both dogs and cats. Podocytes are critically important in overall glomerular fuction and structure. Injury to podocytes commonly leads to proteinuria and glomerulosclerosis. A marker for podocyte injury, desmin, was lowered by calctriol in one model of CPRD in rats. Fibrosis as either glomerulosclerosis or tubulointerstitial fibrosis is a common sequelae in CPRD. Calcitriol in physiologic doses interfered with glomerular proliferation and growth, lessening glomerulosclerosis in a rat model. Calcitriol treatement of an experimental glomerulonephritis model in rats inhibited medangial cell proliferation, glomerulosclerisis and albuminuria.

The renin-angiotensin-aldosterone system (RAAS) is a major mediator of progressive renal injury in CPRD. The RAAS system is present entirely within the kidney and is present in most renal cells including tubular epithelia.

Calcitriol is a negative endocrine regulator of RAAS. Calctriol suppresses renin biosynthesis and has a protective role against hyperglycemia-induced renal injury in diabetic human patients. Through its effect to inhibit RAAS, calcitriol decreases production of Angiotensin II and thus lessens these fibrogenic consequences as well as other harmful renal effects.

A glomerular mesangial or interstitial inflammatory reaction with marked involvement of macrophages and lymphocytes attends all forms of renal disease. Together with control of RAAS, the ability of calcitriol to control inflammation are hallmarks of renoprotective actions.

In our practices, early diagnosis of CPRD at the IRIS 2a or b level is the key to successful management. A cat with or without proteinuria, with or without hypertension with a USG less than 1.030 and normal Calcium and Phosphorus will be started on Calcitriol at a dose of 2.5-3.5 ng/Kg per day. This is compounded into a chicken or fish flavored oil base by a compounding pharmacy licensed to produce compounded pharmaceuticals for the human market. Calcium, Phosphorus and their product will be measured in 2 weeks.

While the literature is clear that iCA is a far more accurate measure of total body calcium, it is an expensive test. Our protocol calls for frequent testing of renal values including calcium and phosphorus. We would be treating a fraction of the cats we can help if this costly test were included. Instead we use a protocol advocated by Larry Nagode and Dennis Chew, Pathology and Urology professors respectively at the Ohio State University Veterinary College.

One of the benefits of the preservation of renal tissue using this protocol is the preservation of erythropoietin production and the consequent preservation of normal hematocrits. Cats with IRIS Stage 3-4 CPRD are still feeling better, more active and eating better with adequate circulating red cells. Anemia is a quality of life issue.

Hepcidin excess prevents iron absorption from the diet and blocks iron release from body stores by binding to and inducing the degradation of the iron export protein ferroportin. A mechanism for the EPO sparing effects of vitamin D is suggested by recent data demonstrating a hepcidin lowering effect of vitamin D. In vitro treatment with vitamin D of monocytes isolated from hemodialysis patients downregulated hepcidin transcription. Furthermore, oral administration of vitamin D in healthy volunteers lowered serum levels of hepcidin by 50% compared to baseline levels within 24 hr and persisted for 72 hr. Supplementation with vitamin D has also been reported to have beneficial effects on increasing erythropoiesis and decreasing inflammation. These initial results are promising, and a randomized controlled study is warranted to determine whether correction of vitamin D deficiency can ameliorate ACD.

References

Journal of Feline Medicine and Surgery, Feline CKD – past, present, and future. Sage Press, September 2013, Volume 15, Supplement 1.
Journal of Veterinary Emergency and Critical Care, Calcitrol, Calcidiol, Parathyroid hormone and fibroblast growth factor-23 interactions in chronic kidney disease. Volume 23 (2) 2013, pp 134-162.
Journal of Feline Medicine and Surgery, Treatment Options for Hyperphosphatemia in Feline CKD: What's Out There? Sage Press, November 2009, Vol 11, no. 11 pp 913-924.

Acute and Chronic Pancreatitis: What to do?

Elizabeth Colleran, DVM, MS, DABVP
Chico Hospital for Cats
Chico, CA

Pancreatitis is an inflammatory disease of the exocrine pancreas. It can be divided into acute and chronic types based upon histological findings. Two main forms have ben described. Neutrophilic inflammation and varying amounts of pancreatic acinar cell and peripancreatic fat necrosis characterize acute pancreatitis. Chronic pancreatitis is characterized by lymphocytic inflammation, fibrosis and acinar atrophy. While the cell types involved differ in this description, they appear to represent, in some studies, different points on a continuum of disease.

Diagnosis of both forms is difficult. There may be comorbidities that complicate signs. Clinical signs may be vague or mild. The diagnostic tools like imaging or clinical tests can lack sensitivity and specificity. Biopsy samples may be difficult to interpret or unavailable for many reasons.

There appears to be a strong association in several studies between pancreatitis, inflammatory bowel disease (IBD) and cholangitis, giving rise to the term “triaditis”. This may be partially explained by the proximity of the common bile duct and major pancreatic duct in the duodenal papilla. Enteric bacteria were found in >1/3 of cases supporting the suspicion of a relationship between pancreatitis and the translocation of bacteria from the gut. Vomiting, a common sign in cats with IBD or cholangitis may also raise intraluminal pressure and further increase the risk of pancreaticobiliary reflux. The relationship between cholangitis and pancreatitis has recently been challenged however, though its relationship with IBD has not.

Ischemia is another recognized cause of acute pancreatitis. Inadvertent compression or ligature and hypotension during surgery can cause ischemia of the pancreas. Careful surgical technique and anesthetic monitoring prevent these events from occurring. The pancreas can be the cause of ischemia if fibrosis, edema or inflammation compromise pancreatic blood flow. Other causes like infectious agents, hypercalcemia, drug reactions and nutritional imbalances have been reported but are rare. Most commonly pancreatitis is considered idiopathic as no obvious cause can be found.

Serum feline pancreatic lipase immunoreactivity (fPLI) is the most recent addition to laboratory tests seeking a useful diagnostic ante-mortem test for feline pancreatitis. There are two tests, developed by the same laboratory. SpecfPLI is a quantitative test for which concentrations > 5.3 are consistent with pancreatitis. A grey zone is found from 3.5-5.3ug/l and is notable on the Spec test and on the Snap fPLI test, which is a semi-quantitative test. A positive Snap fPLI includes the grey zone when it is positive so results should be confirmed by Spec fPLI. The sensitivity of the Spec fPLI is still without adequate data. Moderate to severe pancreatitis was 100% sensitive in one study but much lower, 54%, for mild pancreatitis based upon histopathology. However, the number of patients was small and there was some bias evident on patient selection for histopathology. More studies are needed to properly evaluate sensitivity and specificity of SpecfPLI. Snap fPLI has not been independently validated. Importantly, fibrosis or atrophy from long-standing chronic pancreatitis would not be expected to increase fPLI.

Other abnormal laboratory findings have been observed but are not diagnostic as well. From 26-55% of cats have a normocytic, normochromic nonregenerative or regenerative anemia. Less than half have a leukocytosis. Leukopenia may be present and has a poorer prognosis. Other hematological findings are non-specific and cannot distinguish between acute, chronic or suppurative pancreatitis. Biochemistry abnormal values are often present but are not specific for pancreatitis and may represent comorbid conditions with pancreatitis.

Abdominal radiographs are may be suggestive of cranial loss of serosal detail or a mass effect but are largely useful to rule out concomitant conditions like intestinal obstruction. Ultrasound is relatively specific in differentiating pancreatitis from other GI disease but cannot differentiate between acute and chronic forms. Hypoechoic pancreas, hyperechoic peripancreatic adipose or abdominal effusion is relatively specific for pancreatitis in cats. Mild forms of pancreatitis are more difficult to discern than moderate to severe forms on ultrasound. In some cats, the pancreas is more difficult to detect and is dependent on operator experience.

The use of endosonography may improve the general visualization but did not alter the diagnosis of pancreatitis in one study. Ultrasound is still recommended for diagnosis of pancreatitis and will reveal other abnormal findings such as pancreatic masses, cysts or stones. Computed tomography has not been helpful and is not recommended for diagnosis. Magnetic resonance imaging is the modality of choice in humans and may be helpful in cats.

Histopathology remains the gold standard for ante-mortem diagnosis though there are limitations to this as well. Cats with severe pancreatitis are poor candidates for anesthesia. Even for those patients stable enough, the results may not alter treatment planning and patient management. Patients undergoing laparotomy or laparoscopy for other reasons should have the pancreas biopsied. Focal lesions may be visible as well as more generalized changes that will guide sample collection. Multiple samples are recommended as lesions can be geographically distributed or very mild and difficult to discern. Mild changes may not explain the patient’s clinical signs as well

Despite the challenges of diagnosis, pancreatitis is an important condition. Anorexia and weight loss found with pancreatitis can cause concurrent hepatic lipidosis. Several studies have shown the relationship between Diabetes Mellitus (DM) and pancreatitis. Other concurrent diseases can be complicated by the presence of pancreatic inflammation most notably IBD. End-stage CP can result in exocrine pancreatic insufficiency.

Management of pancreatitis is comprised of three main aspects: nutrition and antiemetic therapy, fluid and electrolyte correction and analgesia. A high protein, low carbohydrate, moderate fat diet is the recommended formulation. While fasting is not recommended, gradual reintroduction of food should be instituted to avoid the electrolyte and other disturbances that occur with refeeding syndrome. Though nausea may be difficult to discern, it should be treated to insure adequate intake of food. NK-1 receptor antagonist maropitant and 5HT3 antagonists are beneficial. Maropitant may also relieve some of the pain associated with pancreatitis. Cobalamin deficiency is common in cats and should be addressed with B12 injections weekly for 6 weeks and every 1-2 months thereafter. Appetite improvements with the use of cobalamin supplementation have been reported.

If voluntary food intake is not rapidly restored a nasoesophageal tube for short-term use or an esophagostomy or gastrostomy tube may be required. The goal of a nasoesophageal tube is for stabilization until anesthetic risk is lowered adequately to permit a more lasting tube to be placed. In the case of severe malnutrition and persistent anorexia, partial parental nutrition along with some enteral nutrition has been shown to maintain gut wall barrier function in humans.

Vomiting, anorexia and diarrhea can lead to severe dehydration and electrolyte disturbances. Hypokalemia and hypocalcemia are no uncommon. Aggressive fluid therapy is required to correct pancreatic hypoperfusion.

Pain is a common feature of pancreatitis though difficult to evaluate in cats. Buprenorphine, oxymorphone or fentanyl may be good choices. .

Comorbidities must be treated at the same time, insulin for DM, therapy for diabetic ketoacidosis, cholangitis or inflammatory bowel disease. Plasma (20ml/kg i.v.) or colloids (10-20ml/kg/day i.v.). may be indicated in the presence of hypoproteinemia or shock. Colloids such as dextran 70 and hetastarch may also have antithrombotic effects that help maintain the microcirculation.

Prophylactic broad-spectrum antibiotics (e.g. amoxicillin ± enrofloxacin depending on severity) may be warranted in patients with shock, fever, diabetes mellitus or evidence of breakdown of the GI barrier. Bacterial translocation has been demonstrated in experimental feline pancreatitis using distinct *E.coli* placed in the colon, and other sites e.g. bile, and colonization was prevented with cefotaxime (50mg/kg TID). A recent study revealed that bacterial infection is present in the pancreas of 35% (11/31) of cats with moderate to severe pancreatitis. The high frequency of infection (71%, 5/7) in acute necrotizing and suppurative pancreatitis may be linked to the poor prognosis associated with this form of pancreatitis. These localization and type of intrapancreatic bacteria suggests translocation of enteric bacteria is a likely source of infection

Coagulation abnormalities should be pursued and treatment with parenteral vitamin K can be assessed. Where a coagulopathy e.g. DIC, or hypoproteinemia are present, or the patient with pancreatitis is deteriorating, fresh frozen plasma (10-20 ml/kg) may be beneficial in alleviating the coagulopathy, hypoproteinemia and restoring a more normal protease-antiprotease balance. The administration of heparin (75-150 IU/kg TID) may be potentially useful in ameliorating DIC, promoting adequate microcirculation in the pancreas and clearing lipemic serum. In experimental pancreatitis isovolemic rehydration with dextran has also been shown to promote pancreatic microcirculation in dogs. A dopamine infusion (5µg/kg/min) had a protective effect when administered to cats within 12 hrs. of induction of experimental pancreatitis . H1 and H2- antagonists blocked the progression of edematous to hemorrhagic pancreatitis in experimental cats and may be beneficial in patients .

Oral pancreatic enzyme extracts have been reported to reduce pain in humans with chronic pancreatitis, though this is controversial. The presence of a protease mediated negative feedback system has not been described in cats.

GI Endoscopy in Cats: What Can We Learn?

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Gastrointestinal endoscopy is commonly performed in cats and is useful in the diagnosis of many (GI) gastrointestinal disorders. Many GI diseases require mucosal biopsy for diagnosis and endoscopy is a minimally invasive technique, with less morbidity when compared to surgical exploratory and full-thickness biopsy. Gastrointestinal endoscopy also has therapeutic value as foreign bodies can be removed, esophageal strictures dilated, and percutaneous endoscopic gastrostomy tubes placed. Endoscopic skills can easily be developed by practitioners that 1) acquire knowledge of the normal endoscopic anatomy, 2) become familiar with the appearance of common lesions, 3) receive appropriate hands-on instruction, and 4) devote the time and effort required to learn proper technique.

Although rigid endoscopic equipment can be useful in diagnosing some esophageal and colonic disorders, the author routinely performs flexible endoscopy in cats. Flexible endoscopes provide better mucosal visualization and allow the tip to be advanced around flexures and through many sphincters of the gastrointestinal tract. Endoscopes to be used in cats should have four-way tip deflection, automatic air-water insufflation, a large biopsy channel, a diameter less than 10mm and a working length of at least 100 cm. Available accessories should include biopsy forceps, cytology brushes, and a variety of foreign-body retrieval forceps.

It is the author's opinion that endoscopic capability should be available to the average private practice. Endoscopy encourages the practice of high quality medicine by providing a minimally invasive, highly useful, diagnostic and therapeutic procedure.

Indications

There are numerous indications to perform gastrointestinal endoscopy in cats (Table 1). Some of the disorders that can be diagnosed via endoscopy are included in Table 2. Endoscopic examination of the esophagus will provide valuable diagnostic information in cats examined for regurgitation. Esophagoscopy should be performed if barium contrast radiographs demonstrate an intraluminal mass, mucosal irregularity or ulcer, a narrowed lumen or a motility disorder associated with normal luminal diameter. Esophagoscopy is also indicated if survey thoracic and barium contrast radiographic examinations are normal. Foreign bodies (string, fish hooks, pins, needles, bones, and hair balls) observed on radiographs can be removed endoscopically with less morbidity than thoracotomy. Strictures can be dilated via balloon catheters passed through the endoscope biopsy channel.

Gastroduodenoscopy is a very important diagnostic procedure in cats that chronically vomit. The author performs endoscopy, rather than upper GI barium studies, because endoscopy offers the following advantages: 1) direct mucosal inspection; 2) directed mucosal biopsy; 3) ability to remove foreign bodies; 4) ability to visualize subtle mucosal lesions; 5) assessment of respectability of neoplastic masses; and, 6) is rapid to perform. Some potential disadvantages of endoscopy include: 1) necessity of general anesthesia; 2) inability to examine the entire small intestine; 3) inability to detect lesions in the muscularis and serosa; and, 4) inability to evaluate gastric motility and emptying. Gastric and small intestinal mucosal samples can be collected via endoscopy with less morbidity than exploratory celiotomy with gastrotomy and enterotomy.

Therapeutically, gastroduodenoscopy is indicated if foreign bodies are visualized on radiographs or if an owner has observed or suspects foreign-body ingestion. In cases of suspected foreign body ingestion radiographic studies should always confirm the presence of a foreign body prior to endoscopy. Endoscopic retrieval of gastric foreign bodies is readily accomplished in most cases. Foreign bodies in the small intestine are very difficult to remove endoscopically and exploratory surgery is indicated in most cases.

A final indication for gastroduodenoscopy is placement of percutaneous endoscopic gastrostomy tubes (PEG). This rapid and simple procedure provides a convenient avenue for nonstressful enteral nutritional support in cats with prolonged anorexia or oral, pharyngeal, or esophageal disorders.

Duodenoscopy is a valuable diagnostic procedure in cats with chronic small intestinal diarrhea. If laboratory evaluation does not establish a diagnosis, small intestinal biopsy is indicated. Endoscopy can provide small intestinal mucosal samples for histopathologic evaluation. In most cats, samples can be obtained from the duodenum and sometimes the jejunum. It is difficult and often dangerous to enter the ileum in cats via colonoscopy. However, biopsy forceps can be gently passed through the ileocolic sphincter and tissue samples obtained. After instillation of saline, a fluid aspirate can also be collected from the small bowel which can aid in the diagnosis of *Giardia*. Because the common histologic causes of chronic small bowel diarrhea usually diffusely involve the small intestine, a diagnosis can often be reached with endoscopic biopsy.

The major indication for performing colonoscopy is obtaining mucosal biopsy samples in cats with chronic large-bowel diarrhea. Some cats with acute, large-bowel diarrhea associated with moderate-to-severe hematochezia rapidly require a definitive diagnosis. Colonoscopy can often provide an answer in a minimally invasive fashion.

Unique characteristics of endoscopy in cats

The principles and techniques of performing fiberoptic endoscopy in cats are very similar to those employed in dogs. However, there are some important differences encountered when performing endoscopy in cats (Table 3). The most important species difference is the small diameter and length of cats' gastrointestinal tracts. This is most critical in the antrum, pylorus, duodenum, and ileum where the diameter limits endoscopic maneuverability, making mucosal examination and advancement of the endoscope more difficult. However, this difficulty can be overcome by patience, proper technique, and endoscopic experience.

Small diameter (pediatric) endoscopes (7.8mm) can be maneuvered through these difficult areas in cats easier than larger endoscopes (9.8mm). However, the major disadvantage of pediatric endoscopes is that they have smaller biopsy channels (2.0 vs 2.8mm) which result in smaller biopsy samples that may be more difficult for the pathologist to interpret. In addition, the variety and size of foreign-body retrieval forceps is limited for pediatric endoscopes. With experience, larger endoscopes (9.8mm) can be successfully maneuvered through a cat's gastrointestinal tract. However, an all-feline practice might benefit from purchasing and using a smaller pediatric endoscope.

The feline esophagus differs anatomically from the canine esophagus, which is composed of striated muscle. The caudal one-third of the esophagus in cats contains smooth muscle which results in a series of transverse folds . Additionally, submucosal blood vessels can be commonly seen .

The relatively small feline stomach can easily and quickly become over-distended by insufflation of air during gastroscopy. Gastric distention can cause respiratory compromise and may activate vagal reflexes that produce bradycardia. The endoscopist should constantly monitor the amount of air within the stomach and apply suction when necessary to maintain a minimally distended stomach.

The antral portion of the stomach is small and is attached at a more acute angle to the gastric body than in dogs . Endoscopic manipulation in this area is limited by the small luminal diameter, and the endoscopist may have difficulty advancing the endoscope into the antrum. Often the endoscope will retroflex into the gastric body instead of entering the antrum. The small antrum also makes it difficult to obtain a direct frontal view of the angularis incisura, an important endoscopic landmark, which is easily visualized in dogs. The pyloric sphincter is often open in cats.

Cats have a single duodenal papilla, that transports bile and pancreatic secretions, that is located in close proximity to the pylorus and can be difficult to visualize in many cats. The relatively short esophagus and stomach is an advantage in cats because more endoscope length is available for advancement into the small intestine. In many cats it is possible to advance the endoscope through the duodenum into the jejunum, allowing a greater area of mucosa to be observed and sampled.

The feline colon also differs from the canine colon in several respects. The rectal area of cats usually has less mucosal folding than dogs, resulting in easier and quicker endoscope passage through the descending colon. The feline cecum is extremely short (approximately 1cm in length) and it can be entirely viewed from the ascending colon. The cecocolic sphincter is often open.

Patient preparation

Proper preparation for esophagogastroduodenoscopy requires withholding food for 12 hours prior to the procedure. Endoscopy is performed with the cat under general anesthesia and positioned in left lateral recumbency. This will position the antrum “away” from the table-top and will help facilitate endoscopic intubation of the duodenum. Various pre-anesthetic agents have been shown to not affect the endoscopist’s ability to pass through the gastroesophageal and pyloric sphincters.

Colonoscopy requires a feces-free colon and a clear ileal effluent. Food should be withheld for 24 hours prior to the procedure. The author routinely uses an iso-osmotic GI lavage solution of polyethylene glycol and electrolytes, that is not absorbed as it moves through the gastrointestinal tract, GoLYTELY®, to prepare cats for colonoscopy. Antiemetics should be administered 15-30 minutes prior to GI lavage solutions to minimize vomiting due to gastric distention. Metoclopramide 0.2-0.4 mg/kg SC or maropitant 1 mg/kg SC can be utilized. Using nasogastric installation, two doses (30ml/kg) of GoLYTELY® two hours apart, the afternoon prior to endoscopy, are administered. This large volume of fluid flushes feces from the colon. Sedation is not used during GI lavage solution administration as aspiration of these solutions can be fatal. Warm water enemas (20ml/kg) are given after each dose and prior to anesthesia induction. Sodium phosphate enemas should never be used to prepare cats for colonoscopy because they can lead to fatal hyperphosphotemia. Some experts do not use GI lavage solutions, administering multiples enemas instead. To perform colonoscopy, the cat should be placed under general anesthesia and positioned in left lateral recumbency. This will position the ascending colon “away” from the table and facilitate advancement of the endoscope into the orad colon.

This seminar has reviewed the indications for performing GI endoscopy in cats, listed the common diseases encountered, and has emphasized the unique features of performing endoscopy in cats. It is the author's hope that practitioners without endoscopic capability will seriously consider purchasing equipment and receiving endoscopic instruction. The practice of feline medicine can be improved by frequently using this minimally invasive procedure to obtain diagnostic biopsy samples, remove foreign bodies, or place a percutaneous endoscopic gastrostomy tube.

Table 1 - Indications for gastrointestinal endoscopy

Esophagoscopy

- Foreign Body Retrieval
- Intraluminal Mass
- Irregular Mucosa or Ulcer
- Stricture Dilation
    - Regurgitation with Normal Survey and Barium Radiographs
- Motility Disorder with Normal Luminal Diameter

Gastroduodenoscopy

- Chronic Vomiting
- Foreign Body Retrieval
- Placement of Percutaneous Gastrostomy Tube
- Acute Vomiting with Hematemesis
- Chronic Small Bowel Diarrhea

Colonoscopy

- Chronic Large Bowel Diarrhea
- Acute Large Bowel Diarrhea with Hematochezia
- Ileal Biopsy with Chronic Small Bowel Diarrhea
- Demonstrated on Survey or Barium Contrast Radiographs

Table 2 - Disorders diagnosed by endoscopy

Esophagus

- Foreign Body
- Esophagitis
- Stricture
- Neoplasia

Stomach

- Gastritis
- Gastric Ulcer
- Foreign Body
- Neoplasia

Small intestine

- Inflammatory Bowel Disease
- Neoplasia
- Foreign Body
- Duodenal Ulcer

Large intestine

- Inflammatory Bowel Disease
- Neoplasia

Table 3 - Unique features of endoscopy in cats vs dogs

- Small diameter of gastrointestinal tract
- Short length of GI tract
- Transverse folds in caudal esophagus
- Visible submucosal esophageal blood vessels
- Ease of achieving gastric over-distention
- Acute angle of gastric antrum
- Single duodenal papilla
- Jejunum often accessible
- Fewer rectal mucosal folds
- Short cecum with cecocolic sphincter usually open

References

Jones BD, Guilford WG. Options in endoscopic equipment. Vet Med Rep 2:204-208, 1990.
Jones BD. Choosing an endoscope: Financial and practical considerations. Vet Med Rep 2:175-178, 1990.

Johnson SE. Diseases of the esophagus. in Sherding RG (ed), The Cat, Diseases and Clinical Management. Churchill Livingstone, New York, 1989:910-912.
Burk RL, Zawie DA, Garvey MS. Balloon catheter dilation of intramural esophageal strictures in the dog and cat: A description of the procedure and a report of six cases. Sem Vet Med Surg (Sm Anim) 2:241-247, 1987.
Armstrong PJ, Hardie EM. Percutaneous endoscopic gastrostomy. Vet Med Rep 1:404-411, 1989.
Pitts RP, Twedt DC, Mallie KA. Comparison of duodenal aspiration with fecal flotation for diagnosis of giardiasis in dogs. J Am Vet Med Assoc 187:162-163, 1985.
Richter KP, Cleveland MB. Comparison of an orally administered gastrointestinal lavage solution with traditional enema administration as preparation for colonoscopy in dogs. J Am Vet Med Assoc 195:1727-1731, 1989.
Burrows CF. Evaluation of a colonic lavage solution to prepare the colon of the dog for colonoscopy. J Am Vet Med Assoc 195:1719-1721, 1989.
Atkins CE, Tyler R, Greenlee P. Clinical, acid-base, and electrolyte abnormalities in cats after hypertonic sodium phosphate enema administration. Am J Vet Res 46:980-988, 1985.
Smith A, Posner L, Goldstein R, et. al. Evaluation of the effects of premedication on gastroduodenoscopy in cats. J Am Vet Med Assoc 225: 540-544, 2004.
Leib MS. Gastrointestinal Endoscopy. in August JR (ed.). Consultations in Feline Internal Medicine 2. W.B. Saunders, Philadelphia, PA 2004: 119-126.
Tams TR. Gastroscopy. in Small Animal Endoscopy, CV Mosby Co., St. Louis, 1992:27.

Acute Pancreatitis in Dogs: An Update

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Acute vomiting – diagnostic approach

The first step in the approach to the acutely vomiting dog is to determine that vomiting and not regurgitation is present. Vomiting is associated with signs of nausea (depression, salivation, and frequent swallowing,) that is followed by abdominal contractions prior to the expulsion of material. Regurgitation is associated with esophageal disorders and occurs passively, usually associated with increased intrathoracic pressure that may be caused by excitement, activity, or changes in body position.

Once you have determined the dog is vomiting rather than regurgitating,, the next step is to determine if a self-limiting or life threatening problem is present. This assessment is crucial and must be based on a thorough history, careful physical examination, clinical experience and judgment, and a sound understanding of the differential diagnosis of acute vomiting. Dogs with acute pancreatitis can present with both types of vomiting. Animals should be considered to have a potential life-threatening problem if some of the following are present: Moderate or severe abdominal pain, lethargy, dehydration or pyrexia, enlarged distended bowel, frequent and severe diarrhea, hematemesis, frequent vomiting or increasing frequency of vomiting, signs of systemic disease, or puppies with an incomplete vaccination history. If a clear distinction cannot be reached, it is better to error on the cautious side and consider a potential life-threatening problem.

Dogs with a self-limiting problem require minimal diagnostic testing and symptomatic treatment, and often cease vomiting within 12-24 hours of initial presentation. A minimum data base for animals with self-limiting vomiting should include determination of packed cell volume and total solids, zinc sulfate fecal flotation, and digital rectal examination. Some common causes include acute gastritis or enteritis, dietary indiscretion, drug administration, toxin ingestion, foreign body ingestion, parasites, and coronavirus. Reclassification to life-threatening status may be indicated if an animal initially assessed as having self-limiting acute vomiting continues to vomit despite appropriate symptomatic therapy.

Life-threatening cases of acute vomiting require an in-depth diagnostic evaluation, vigorous symptomatic management, and often specific therapy directed at the underlying cause. The initial minimum data base for life-threatening acute vomiting includes a complete blood count, biochemical profile with amylase and lipase, urinalysis, zinc sulfate fecal flotation, and survey abdominal radiographs. After the initial evaluation, additional diagnostic studies may be indicated in some instances, such as upper GI endoscopy, upper GI barium series, abdominal ultrasonography, ACTH response testing, or surgical exploration of the abdomen. Some common causes include acute gastritis, dietary indiscretion, hookworms, foreign body obstruction, intussusception, parvovirus, distemper, HGE, acute renal failure, acute liver failure, hypoadrenalcorticism, diabetes mellitus, and pyometra.

Acute pancreatitis

Acute pancreatitis commonly occurs in the middle-aged, obese female dog. Clinical signs include vomiting, diarrhea, abdominal pain, and fever. Historical association may be made with ingestion of a fatty meal or corticosteroid administration. Acute pancreatitis rapidly leads to severe dehydration (dry mucous membranes, loss of skin turgor, prolonged capillary refill time, or enophthalmos) and may progress to hypovolemic shock (tachycardia and weak peripheral pulses). In a recent necropsy study, 64% had pancreatic inflammation, many with chronic changes. Most of these dogs had another primary necropsy diagnosis, suggesting that chronic subclinical inflammation with lymphocytes may be an age related change. These findings question the utility of pancreatic biopsy as a gold standard for diagnosis.

The pathogenesis of AP is complex. It is a self-perpetuating auto-digestive process. As auto-digestion of the pancreas occurs, potent digestive enzymes are released into the parenchyma of the pancreas, blood vessels, and to the adjacent abdominal cavity. This causes severe hemodynamic alterations, localized inflammation, and can trigger disseminated intravascular coagulation. Depletion of circulating and tissue anti-proteases occurs. Vascular collapse develops due to a combination of the following: fluid loss from vomiting and diarrhea, release of vasoactive substances, release of cardiodepressant substances, or fluid sequestration within the abdominal cavity. Progression of the disorder may depend on preservation of pancreatic microcirculation, which can be maintained by fluid therapy.

Cases of AP can have inconsistent laboratory parameters. Diagnosis should not be based on any single test. Common changes include: leukocytosis with a left shift, elevated hematocrit, total protein, and prerenal azotemia (dehydration), elevated ALT and ALP, hypercholesterolemia, hyperglycemia, hypocalcemia, and lipemia. Classically, serum amylase, lipase, and trypsin-like immunoreactivity (TLI) should be elevated. However, elevations are not definitive for pancreatitis as amylase is contained in many tissues and lipase has recently been identified in the stomach. Amylase, lipase, and TLI depend on the kidney for elimination, thus prerenal azotemia due to dehydration from any cause of vomiting results in mild elevations. Some cases of AP have normal or only

slightly elevated serum amylase, lipase, and TLI. In experimental AP, serum trypsin-like immunoreactivity (TLI) increases prior to amylase and lipase. Based on preliminary results, a new serum test is showing promise in diagnosing pancreatitis in dogs. The test, serum canine pancreatic lipase immunoreactivity (cPLI), was developed by Texas A&M researchers and immunologically measures lipase from the pancreas. The test showed a sensitivity of 82% in the diagnosis of acute pancreatitis; these results are from a low number of cases (11), but are promising. A modification of this test using a monoclonal antibody and a recombinant antigen for calibration has been marketed by IDEXX as the Spec cPL. This test compares favorably with the cPLI and because of plate stability can be run daily with results rapidly reported. In a recent study of necropsied dogs with macroscopic evidence of pancreatitis the cPLI and SPEC cPL correlated and their overall sensitivity was 64%. IDEXX has also developed a in-house screening test (SNAP cPL) that has been shown to correlate with the Spec cPL. More data are needed, but these tests may be the most accurate serum tests for diagnosing acute pancreatitis in dogs.

Radiographic signs of AP are nonspecific and don't often contribute to diagnosis except by eliminating the presence of intestinal obstruction. Ultrasonographic evaluation of the abdomen can be very helpful and may identify a pancreatic mass or an enlarged hypoechoic pancreas that may surrounded by a hyperechoic rim. Pancreatic abscesses and cysts can also be identified.

Treatment

The therapeutic plan should prevent pancreatic secretion and manage hypovolemia while supporting pancreatic circulation. In severe cases, the dog should be maintained NPO and vigorous fluid therapy administered. Lactated ringers is an appropriate fluid to use at a volume necessary to correct dehydration, provide maintenance (44-66 ml/kg/day), and to replace losses due to vomiting and diarrhea. Potassium supplementation, 20 mEq/l KCl, is necessary to replace losses in diarrhea, vomitus, and urine and supplement the lack of food intake. Potassium supplementation should be based on measurement of serum potassium levels. Plasma transfusion (6-12 ml/kg) has been recommended to provide a fresh source of protease inhibitors. Mildly affected dogs may be held NPO and given fluids subcutaneously until the vomiting ceases for 12 hours. Vigorous pain control should be utilized, as pain may be one trigger for continued vomiting. Enteral nutrition should be administered as soon as reasonably possible.

Treatment should continue until parameters used to make a diagnosis return to normal, often 3-5 days in moderately affected dogs. Gradual oral alimentation can be initiated. Initially, ice cubes or small amounts of water are frequently offered. If vomiting does not occur, small amounts of a bland diet can be frequently offered. This diet should be soft and low in fiber, highly digestible, high in carbohydrates, low in fat, and low in protein. Boiled rice, rice with chicken, low fat cottage cheese, or prescription diets such as i/d® (Hills Pet Products), EN® (Ralston Purina), or Low Residue (Iams) are effective. The size of the meals should be slowly increased and the frequency of feeding decreased if vomiting does not recur. If the dog does not vomit for 3 days, the normal diet can be slowly added. Low fat diets have been recommended to prevent relapse.

If vomiting is severe, antiemetics can be used. Usually maropitant 1mg/kg q 24h is used. However, a phenothiazine, chlorpromazine 0.5 mg/kg q 4-6h, or metoclopramide, 0.2-0.4 mg/kg q 8h can be used. Because phenothiazines cause vasodilation they cannot be started until the dog has been rehydrated. Metoclopramide is contraindicated in cases with GI obstruction so obstruction should be eliminated prior to its use. If prolonged fluid therapy is necessary (7-10 days) total parenteral nutrition should be considered.

The prognosis for cases of AP is variable. Self-limiting cases respond to minimal therapy. Life-threatening cases warrant a guarded prognosis. Response to therapy in 3-5 days is a favorable prognostic sign. Dogs requiring intensive therapy for longer than 7 days carry a guarded prognosis. Because the etiology is unclear, recurrent bouts can occur.

Because the diagnosis of AP is difficult to prove, a thorough evaluation of other causes of acute vomiting, acute diarrhea, and abdominal pain should be performed. Classic findings of AP include: 1) acute vomiting, 2) cranial abdominal pain, 3) pyrexia, 4) leukocytosis with a left shift, 5) elevated serum amylase, lipase, cPLI, and SNAP cPLI and 6) ultrasonographic findings of an enlarged hypoechoic pancreas. Supportive findings include: 1) signalment 2) recent fatty meal, 3)corticosteroid administration, 4) lipemia, 5) hypocalcemia, 6) elevated ALT, ALP, and bilirubin, and 7) hypercholesterolemia.

References

McCord K, Morley PS, Armstrong J, et al. A multi-institutional study evaluating the diagnostic utility of the spec cPL and SNAP(R) cPL in clinical acute pancreatitis in 84 dogs. Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2012;26:888-896.

Mansfield C. Pathophysiology of acute pancreatitis: potential application from experimental models and human medicine to dogs. Journal of veterinary internal medicine / American College of Veterinary Internal Medicine 2012;26:875-887.

Trivedi S, Marks SL, Kass PH, et al. Sensitivity and specificity of canine pancreas-specific lipase (cPL) and other markers for pancreatitis in 70 dogs with and without histopathologic evidence of pancreatitis. J Vet Intern Med 2011;25:1241-1247.

Neilson-Carley SC, Robertson JE, Newman SJ, et al. Specificity of a canine pancreas-specific lipase assay for diagnosing pancreatitis in dogs without clinical or histologic evidence of the disease. Am J Vet Res 2011;72:302-307.

Mansfield CS, James FE, Steiner JM, et al. A pilot study to assess tolerability of early enteral nutrition via esophagostomy tube feeding in dogs with severe acute pancreatitis. J Vet Intern Med 2011;25:419-425.

Beall MJ, Cahill R, Pigeon K, et al. Performance validation and method comparison of an in-clinic enzyme-linked immunosorbent assay for the detection of canine pancreatic lipase. Journal of veterinary diagnostic investigation : official publication of the American Association of Veterinary Laboratory Diagnosticians, Inc 2011;23:115-119.
Weatherton LK, Streeter EM. Evaluation of fresh frozen plasma administration in dogs with pancreatitis: 77 cases (1995-2005). J Vet Emerg Crit Care (San Antonio) 2009;19:617-622.
Thompson LJ, Seshadri R, Raffe MR. Characteristics and outcomes in surgical management of severe acute pancreatitis: 37 dogs (2001-2007). J Vet Emerg Crit Care (San Antonio) 2009;19:165-173.
Steiner JM, Newman S, Xenoulis P, et al. Sensitivity of serum markers for pancreatitis in dogs with macroscopic evidence of pancreatitis. Vet Ther 2008;9:263-273.
Mansfield CS, James FE, Robertson ID. Development of a clinical severity index for dogs with acute pancreatitis. J Am Vet Med Assoc 2008;233:936-944.
Lem KY, Fosgate GT, Norby B, et al. Associations between dietary factors and pancreatitis in dogs. J Am Vet Med Assoc 2008;233:1425-1431.
Hecht S, Henry G. Sonographic evaluation of the normal and abnormal pancreas. Clin Tech Small Anim Pract 2007;22:115-121.
Newman S, Steiner J, Woosley K, et al. Localization of pancreatic inflammation and necrosis in dogs. J Vet Intern Med 2004;18:488-493.
Steiner J, Williams D. Development and validation of a radioimmunoassay for the measurement of canine pancreatic lipase immunoreactivity in serum of dogs. AJVR 2003;64:1237-1241.
Mansfield C, Jones B. Plasma and urinary trypsinogen activation peptide in healthy dogs, dogs with pancreatitis and dogs with other systemic diseases. Aust Vet J 2000; 78: 416-422.
Hess RS, Kass PH, Shofer FS, et al. Evaluation of risk factors for fatal acute pancreatitis in dogs. J Am Vet Med Assoc 1999; 214: 46-51.
Hess RS, Saunders HM, Van Winkle TJ, et al. Clinical, clinicopathologic, radiographic, and ultrasonographic abnormalities in dogs with fatal acute pancreatitis: 70 cases (1986-1995). J Am Vet Med Assoc 1998; 213: 665-670.
Cook AK, Breitschwerdt EB, Levine JF, et al. Risk factors associated with acute pancreatitis in dogs: 101 cases (1985-1990). J Am Vet Med Assoc 1993; 203: 673-679.
19 Mulvany MH, Feinberg CK, Tilson DL. Clinical Characterization of Acute Necrotizing Pancreatitis. Comp Cont Educ Pract Vet 394: 394-407, 1982.
Murtaugh RJ. Acute Pancreatitis: Diagnostic Dilemmas. Sem Vet Med Surg 2: 282-295, 1987.
Hall JA, Macey DW. Acute Canine Pancreatitis. Comp Cont Educ Pract Vet 10: 403-417, 1988.
Simpson K, Batt R, McLean L, et al. Circulating concentrations of trypsin-like immunoreactivity and activities of lipase and amylase after pancreatic duct ligation in dogs. Am J Vet Res 50: 629-632, 1989.
Simpson KW. Current concepts of the pathogenesis and pathophysiology of acute pancreatitis in the dog and cat. Comp Cont Educ Pract Vet 2: 247-254, 1993.

Therapy of GI Diseases: What's New with Antiemetics, Antacids, and Probiotics?

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Many drugs are available to treat the clinical signs associated with GI diseases or to treat the disease process itself. A though knowledge of these drugs, including several of the newer developments, is necessary for the practitioner to effectively treat dogs and cats with GI diseases.

Antiemetics

Antiemetics are effective in reducing the frequency of vomiting or in some cases completely eliminating it. In the outpatient it relieves a very objectionable clinical sign for the owner. In the hospitalized patient it reduces the severity of dehydration and electrolyte changes and allows the animal to rest. Antiemetics should be used cautiously, as continued vomiting is an important sign that the underlying condition may be progressing or that an incorrect diagnosis has been made. Masking this important parameter may give the clinician a false sense of security that the animal is improving, when actually heightened surveillance and therapy is indicated. The author is most comfortable prescribing antiemetics when a definitive diagnosis has been reached or when used for only a brief period in animals with self-limiting vomiting.

Metoclopramide

Metoclopramide (Reglan) is a highly effective antiemetic with both central and peripheral effects. Metoclopramide is a dopamine antagonist that very effectively blocks the CRTZ and raises the threshold of the vomiting center. Peripherally it augments acetylcholine release from postganglionic nerves and increases the tone and amplitude of gastric contractions and increases gastroesophageal sphincter pressure. These actions oppose some of the physical events necessary for the vomiting reflex to occur. Short term side effects are uncommon and include depression, nervousness, and restlessness. Metoclopramide is contraindicated in intestinal obstructions. Dosages of 0.2-0.4 mg/kg TID SQ are often effective. Because it has a short half life it may need to be administered by constant infusion 1.0-2.0 mg/kg/day IV.

Metoclopramide can also be used to treat esophagitis. Increasing tone of the GES helps to reduce the reflux of acid which would impede healing of the esophageal mucosa. Increasing gastric motility and emptying will help to move acid and ingesta out of the stomach into the duodenum, reducing the amount available to reflux into the esophagus. Metoclopramide's prokinetic effects are useful in treating gastric motility disorders, a group of under diagnosed conditions causing chronic vomiting (see article on gastric motility disorders.

Ondansetron

Ondansetron (Zofran) is a serotonergic antagonist that is very effective in blocking the nausea and vomiting associated with chemotherapy. It is effective in blocking neural transmission in both the chemoreceptor trigger zone and in vagal afferent pathways. Dosages of 0.5-1.0 mg/kg PO can be given 30 minutes prior to administration of chemotherapy. It can also be used to reduce vomiting associated with GI disorders at 0.1-0.15 mg/kg slow IV BID-QID. The author has not found it necessary to use the drug in this manner, although others have found it very effective. Presently, the drug is very expensive.

Maropitant – cerenia ™

Maropitant is a neurokinin receptor antagonist that blocks the actions of substance P in the central nervous system. It was released in the summer of 2007. It is approved for the prevention and or treatment of acute vomiting (dogs and cats) and motion sickness (dogs) > 8 weeks of age. Dosage for motion sickness is 8 mg/kg PO q 24H. Dosage for acute vomiting is 1 mg/kg SC q 24 H for up to 5 days. The drug is metabolized via hepatic P450 enzymes. It is considered a safe drug and side effects were similar to placebo. It was more effective than metoclopramide in a European clinical study in reducing vomiting in a large number of dogs with a variety of common causes for acute vomiting. It has also been shown to reduce vomiting associated with cisplatin administration in dogs with neoplasia.

Erosion and ulcer therapy

Erosion and ulceration of the gastric and duodenal mucosa commonly occur in chronic gastritis and gastric-duodenal ulcer disease. Back-diffusion of acid across a damaged mucosa leads to further damage and retards healing processes. Reduction of gastric acid secretion, protection of ulcerated mucosa, or augmentation of cytoprotection promotes healing of erosions and ulcers.

H-2 receptor blockade

Drugs such as cimetidine (Tagamet), ranitidine (Zantac), famotidine (Pepsid), and nizatidine (Axid) block the H-2 receptor on the gastric parietal cell and dramatically decrease acid production. Cimetidine (5-10 mg/kg QID) and ranitidine (2 mg/kg BID-TID) have been used most commonly in veterinary medicine. Both can be given orally or parenterally and have not been commonly associated with adverse effects. Cimetidine can inhibit hepatic cytochrome P-450 enzymes, potentially interfering with the metabolism of other

drugs. Famotidine, 0.5 mg/kg SID-BID, and nizatidine, 5 mg/kg SID (this dosage has not been well established), have not been used as frequently in veterinary medicine, but are also effective. All four of these drugs are now available over the counter in smaller dosage forms than prescription strength, making treatment of cats and small dogs easier. Elixirs are available for cimetidine, ranitidine, and famotidine.

Sucralfate

Sucralfate (Carafate) is a sulfated disaccharide that forms an adherent gel and binds to an ulcer crater, protecting it from acid and pepsin. It also stimulates the synthesis of prostaglandin, increases mucosal cytoprotection, and binds epithelial growth factor at the ulcer, where it stimulates cellular proliferation. It has been shown to be as effective as H-2 receptor blockers in healing ulcers in humans. Because sucralfate can bind other drugs, medications should be given 1-2 hours prior to sucralfate administration. The recommended dose is 1 gm/25 kg TID-QID in dogs and 0.25 gm TID in cats. Because absorption is minimal, toxicity is uncommon. Long-term use may lead to constipation because of its aluminum content. There is no evidence to support that combination therapy with an H-2 receptor antagonist provides added benefit compared to therapy with either sucralfate or an H-2 blocker alone.

Sucralfate is also effective to treat esophagitis because of its ability to coat ulcerated mucosa. The suspension form is necessary for this indication.

Proton pump inhibitors (PPI's)

PPI's inhibit the action of the proton pump at the apical portion of the parietal cell that exchanges H+ for luminal K+, thus preventing secretion of acid. As a weak base they accumulate in the acid compartment of the parietal cell, necessitating only SID administration. Omeprazole (Prilosec) is the most commonly used PPI in veterinary medicine. The recommended dose is 1.0 mg/kg SID. The enteric-coated granules (20 mg) are packaged in gelatin capsules to resist degradation by gastric acid. If less than one capsule is to be administered (20 mg), the granules should be repackaged in gelatin capsules. Zegerid is an omeprazole powder that is mixed with bicarbonate to protect the drug from gastric acid. It can be divided into smaller doses. Another PPI, lansoprazole (Prevacid) granules can be mixed in an acid juice, such as apple juice and administered. Other PPI's such as pantoprazole (Protonix), rabeprazole (Aciphex), esomeprazole (Nexium) must be reformulated into a form that protects the drug from gastric acid damage. Omeprazole also inhibits hepatic p-450 enzymes. Several recent studies have shown that PPI's in dogs are better at inhibiting acid secretion than H2 blockers. In humans H2 blockers begin to suppress acid faster than PPI's. Many clinicians will concurrently use an H2 blocker for 2-3 days when starting PPI therapy. Also in humans, PPI's result in faster ulcer healing and relieve clinical signs sooner than H2 blockers. These effects are not proven in dogs or cats.

Probiotics

Probiotics are live bacteria that confer a health benefit to the host. Common bacteria include lactobacilli, bifidobacteria, and enterococci. In humans a daily dose is often 5-10 million. To be effective viability must be maintained throughout production, storage, distribution, passage through the upper GI tract into the colon. Many commercially available products do not survive transit into the colon and are not as effective as "advertised". The bacteria should be able to be cultured from the feces during treatment, but will usually disappear once oral administration ends. The bacteria must be nonpathogenic and not transmit antibiotic resistance.

Probiotic bacteria have been reported to have many beneficial effects on the host including conditioning the immune system, synthesizing B vitamins, producing digestive enzymes, producing antibacterial factors, competing with pathogens for adhesion sites and nutrients, enhancing epithelial repair, increasing mucus production, decreasing luminal pH, and protecting tight junctions. However, all probiotics do not do all of the above. In humans some probiotics have been shown to be beneficial in acute infectious diarrhea, prevention of antibiotic associated diarrhea, pouchitis, cow's milk allergy, IBD, and irritable bowel syndrome. Currently there is accumulating but weak evidence demonstrating benefits of probiotics in dogs and cats with diarrhea.

References

Johnson SE. Clinical pharmacology of antiemetics and antidiarrheals. in Eighth Kal Kan Sym Treat Sm Anim Dis. 1984. Columbus, OH: .

Thayer GW. Vomiting: A clinical approach. Comp Cont Educ Pract Vet 3**:** 49-52, 1981.

Forrester SD, Boothe DM, Willard MD. Clinical Pharmacology of Antiemetic and Antiulcer Drugs. Sem Vet Med Surg 4**:** 194-201, 1989.

Davis LE. Pharmacologic control of vomiting. J Am Vet Med Assoc 176**:** 241-242, 1980.

Richter KP. Treating acute vomiting in dogs and cats. Vet Med 87**:** 814-818, 1992.

Burrows CF. Metoclopramide. J Am Vet Med Assoc 183**:** 1341-1343, 1983.

Washabau RJ, Elie MS. Antiemetic therapy. In: Bonagura JD, Kirk RW (ed.). *Current Veterinary Therapy XII.* Philadelphia, W. B. Saunders Company, 1995; 679-684.

Tams T. Management of the Canine Viral Enteritis Patient. in Infectious Gastroenteritis Symposium at the North American Veterinary Conference. 1995. Orlando, FL: .

DeNovo RC. Medical management of gastritis, ulcers, and erosions. in The 17th Annual Waltham/OSU Symposium. 1993. Columbus, Ohio: .

Richter KP. Therapy for vomiting patients with gastrointestinal ulcers. Vet Med 87**:** 819-824, 1992.

Moreland KJ. Ulcer Disease of the Upper Gastrointestinal Tract in Small Animals: Pathophysiology, Diagnosis, and Management. Comp Cont Educ Pract Vet 10**:** 1265-1280, 1988.

Papich MG. Antiulcer therapy. Vet Clin North Am: Sm Anim Pract 23**:** 497-512, 1993.

Jenkins CC, DeNovo RC. Omeprazole: a potent antiulcer drug. Comp Cont Educ Pract Vet 13**:** 1578-1582, 1991.
Jenkins CC, DeNovo RC, Patton CS, *et al.* Comparison of effects of cimetidine and omeprazole on mechanically created gastric ulceration and on aspirin-induced gastritis in dogs. Am J Vet Res 52**:** 658-661, 1991.
De La Puente-Redondo VA, Siedek EM, Benchaoui HA, et. al. The anti-emetic efficacy of maropitant (Cerenia™) in the treatment of ongoing emesis caused by a wide range of underlying clinical aetiologies in canine patients in Europe. J Sm Anim Pract 48: 93-98, 2007.
Vail DM, Rodabaugh, HS, Conder GA, et. al. Efficacy of injectable maropitant (Cerenia™) in a randomized clinical trial for prevention and treatment of cisplatin-induced emesis in dogs presented as veterinary patients. Vet Comp Oncol 5: 38-46, 2007.
Tolbert K, Bissett S, King A, et al. Efficacy of oral famotidine and 2 omeprazole formulations for the control of intragastric pH in dogs. J Vet Int Med 2011;25:47-54.
Bersenas AM, Mathews KA, Allen DG, et al. Effects of ranitidine, famotidine, pantoprazole, and omeprazole on intragastric pH in dogs. Am J Vet Res 2005;66:425-431.
Williamson KK, Willard MD, Payton ME, et al. Efficacy of omeprazole versus high-dose famotidine for prevention of exercise-induced gastritis in racing Alaskan sled dogs. J Vet Intern Med 2010;24:285-288.
Rau SE, Barber LG, Burgess KE. Efficacy of maropitant in the prevention of delayed vomiting associated with administration of doxorubicin to dogs. J Vet Intern Med 2010;24:1452-1457.
Hickman MA, Cox SR, Mahabir S, et al. Safety, pharmacokinetics and use of the novel NK-1 receptor antagonist maropitant (Cerenia) for the prevention of emesis and motion sickness in cats. J Vet Pharmacol Ther 2008;31:220-229.
Ramsey DS, Kincaid K, Watkins JA, et al. Safety and efficacy of injectable and oral maropitant, a selective neurokinin 1 receptor antagonist, in a randomized clinical trial for treatment of vomiting in dogs. J Vet Pharmacol Ther 2008;31:538-543.
Benchaoui HA, Cox SR, Schneider RP, et al. The pharmacokinetics of maropitant, a novel neurokinin type-1 receptor antagonist, in dogs. J Vet Pharmacol Ther 2007;30:336-344.
Wynn SG. Probiotics in veterinary practice. J Am Vet Med Assoc 2009: 234: 606-613.
Weese JS, Martin H. Assessment of commercial probiotic bacterial contents and label accuracy. Can Vet J 2011;52:43-46.
Bybee SN, Scorza AV, Lappin MR. Effect of the probiotic *Enterococcus faecium* SF68 on presence of diarrhea in cats and dogs housed in an animal shelter. J Vet Int Med 2011;25:856-860.
Herstad HK, Nesheim BB, L'Abee-Lund T, et al. Effects of a probiotic intervention in acute canine gastroenteritis--a controlled clinical trial. J Small Anim Pract 2010;51:34-38.
Simpson KW, Rishniw M, Bellosa M, et al. Influence of Enterococcus faecium SF68 probiotic on giardiasis in dogs. J Vet Intern Med 2009;23:476-481.
Kelley RL, Minikhiem D, Kiely B, et al. Clinical benefits of probiotic canine-derived Bifidobacterium animalis strain AHC7 in dogs with acute idiopathic diarrhea. Vet Ther 2009;10:121-130.
Weese JS, Arroyo L. Bacteriological evaluation of dog and cat diets that claim to contain probiotics. Can Vet J 2003;44:212-216.

Chronic Diarrhea in Dogs and Cats: A Practical Diagnostic Approach

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Chronic diarrhea is a common problem in dogs and cats. Diagnosis can be difficult and challenging for veterinarians due to the large number of possible causes of chronic diarrhea. Following a logical and thorough diagnostic plan is essential to efficiently arrive at an accurate diagnosis. This seminar will review the author's approach to the diagnosis of chronic diarrhea.

Clues obtained during the history and physical examination may suggest a diagnosis or help to rank the differential diagnosis. A thorough description of the diarrhea should be obtained (Table 1: diarrhea history form). The dietary history should include the diet being fed, meal size, meals / day, past diet changes and effects on clinical signs, supplements, and the existence of dietary indiscretion. Dietary indiscretion includes a recent and sudden diet change, feeding of table scraps, free roaming behavior allowing ingestion of garbage, ingestion of foreign objects, exposure to toxins (including house plants), excessive ingestion of hair, or feeding a low-quality poorly digestible diet. The duration of the problem should be identified and the diarrhea should be categorized as continuous or intermittent. If intermittent, how long are the episodes and how frequently do they occur? Are there any inciting factors the owner can relate to the origin of the diarrhea or that make the clinical signs worse? Examples include any stress, travel thunderstorms, new pet, loss of a pet, new family member, household move, etc. Does vomiting accompany diarrhea? How many times a day does vomiting occur, how many days / week, what is its association with eating, and what does the vomitus look like? What is the animal's deworming history? What previous treatments have been used, including dosage, frequency / day, and duration, and what response has been seen?

Specific information should be obtained describing and characterizing the diarrhea. What is the frequency / day, is there melena or hematochezia, mucus, tenesmus, or accidents in the house? What is the volume of stool / defecation, compared to what is normal for the dog or cat? Is the animal's appetite normal, reduced, or increased? Has weight loss occurred, and how much? Finally, the consistency of the stool should be graded from 1 (watery diarrhea) to 5 (formed stool). The above characteristics should be based on the animal’s average clinical signs during the period prior to your examination. Based on a thorough history, the initial step in evaluation of dogs and cats with chronic diarrhea is to determine if diarrhea is of small bowel, large bowel, or mixed bowel origin (Table 2). Small bowel diarrhea is characterized by weight loss, a mildly increased frequency of defecation, and a large quantity of stool produced per defecation. Blood, if present, is partially digested (melena). On the other hand, large bowel diarrhea is characterized by the absence of weight loss, and a moderate to greatly increased frequency of defecation, with a reduced to scant volume produced per defecation. Tenesmus, excess fecal mucus, and frank blood (hematochezia) is often present. Mixed bowel diarrhea has some characteristics of both. This initial distinction between small and large bowel is extremely important because the diagnostic plans and differential diagnoses are different.

Physical examination is often normal in dogs and cats with chronic diarrhea with the exception of weight loss. Mildly thickened bowel wall may be palpated. If a severe episode of clinical signs is present, signs of dehydration may be detected (delayed capillary refill time, enophthalmos, decreased skin turgor, tachycardia, pale mucous membranes, and cold extremities). Careful attention should be devoted to abdominal palpation to detect abnormalities such as dilated (gas, fluid, or ingesta) loops of bowel or extremely thickened bowel wall, abdominal masses, intraluminal foreign bodies, or ascites. These abnormalities are detected in <5% of cases seen at the author's hospital. Digital rectal examination may elicit pain and reveal an intraluminal mass, rough corrugated mucosa, sublumbar lymphadenopathy, narrowed lumen, foreign material, blood on the glove, or a perineal hernia.

Laboratory diagnosis of chronic diarrhea

Many laboratory tests may be used in the diagnosis of patients with chronic diarrhea. Routine complete blood count, biochemical profile and urinalysis is often normal. Evidence of anemia and hypoproteinemia may reflect protein and blood loss into the GI tract. Anemia initially may be regenerative, but as iron deficiency develops, it may become nonregenerative. In addition, a nonregenerative anemia associated with chronic disease may be found. Eosinophilia may reflect the presence of inflammatory bowel disease or gastrointestinal parasites. Hypoproteinemia associated with protein losing enteropathy is a panhypoproteinemia with decreased albumin and globulins. The FeLV / FIV test may be positive. Serum thyroxine levels may be elevated in older cats with hyperthyroidism and chronic small bowel diarrhea.

Perhaps the most important test for evaluation of dogs and cats with chronic diarrhea is fecal examination for parasites. Many problem diarrhea cases are caused by the protozoan parasite *Giardia*. Routine fecal flotation techniques rarely identify this parasite. The zinc sulfate sedimentation technique is sensitive for the diagnosis of *Giardia* and other GI parasites. One to two grams of feces is well mixed in a tube with a 33% zinc sulfate solution and strained. The tube is centrifuged for 3-5 minutes at 1,500 rpm. If a free-swinging head centrifuge is used, the tube is topped with a coverslip and the coverslip examined for parasites. If a fixed-head

centrifuge is used, a drop of the surface layer is collected and examined. A single zinc sulfate floatation has identified approximately 75% of *Giardia* infected dogs, while 3 samples examined every other day identified >95% of infected dogs! The SNAP *Giardia* fecal ELISA is a recent addition to aid in the diagnosis of *Giardia*. In most cases the author feels that a single zinc sulfate flotation combined with a *Giardia* SNAP test are adequate to diagnose the presence or absence of *Giardia*.

Feces can also be examined microscopically by adding a few drops of saline to a thin smear of fresh feces. This may allow visualization of trophozoites. *Giardia* trophozoites move across the field as a leaf falls from a tree. A saline fecal smear been shown to detect about 20% of dogs infected with *Giardia*. By repeating the test on three successive stool samples, detection rates have increased to approximately 40%. In addition, highly motile, spiral-shaped bacteria may suggest a *Campylobacter* infection.

Fecal or rectal cytology can also be performed by staining a thin fecal smear with Wrights stain. A rectal cytology specimen can be collected by scrapping the rectum with a gloved finger and gently rolling the finger across a glass slide. Alternatively, a moistened cotton swab or conjunctival spatula can be used. Normal fecal or rectal cytology should contain colonic epithelial cells, a mixed population of bacteria, yeast, and unidentifiable debris. Increased numbers of white blood cells or red blood cells may be indicative of inflammatory, infectious, or hemorrhagic disorders. The presence of more than 3-5 spores / hpf of *Clostridium perfringens* suggests the possibility of enterotoxicosis. Spores appear as large rods with a clear center and dark staining ends (safety pins). *Campylobacter* organisms may appear gull-shaped. Occasionally, neoplastic cells may be seen or inclusions may be found within macrophages suggesting fungal infection with *Histoplasma*.

The gold standard test for diagnosing pancreatic exocrine insufficiency in dogs is determination of serum trypsin-like immunoreactivity. Trypsinogen, a pancreas specific substance, leaks from the pancreas into blood. It is filtered by the kidney. After a 12-hour fast, one ml of serum can be assayed. Concentrations >5 ug/l indicate normal pancreatic exocrine function. The test has recently been validated for cats, although this is a rare condition in this species.

Determination of serum vitamin B_{12} and folic acid concentration can be beneficial in diagnosis of bacterial overgrowth of the small intestine (SIBO) in dogs. These bacteria bind and metabolize vitamin B_{l2} and produce additional folic acid, resulting in decreased B_{12} levels and increased folic acid levels. However the test is insensitive and only fairly specific. Diagnosis of SIBO requires quantitative aerobic and anaerobic culture of duodenal juice. However, many cats with chronic GI are deficient in vitamin B12, and benefit from parenteral supplementation.

Radiographic evaluation of dogs and cats with chronic diarrhea is not a very high yield procedure. Changes seen on survey films may include dilated, gas-filled loops of small bowel, an abdominal mass, radiodense foreign body, or ascitic fluid. An upper GI contrast series may demonstrate evidence of enteritis, a dilated loop of bowel not previously identified, a soft tissue mass, or decreased motility. Abdominal ultrasound can be useful in the cases with palpable abdominal abnormalities detected during physical examination. Masses, thickened bowel walls, and mesenteric lymphadenopathy can be localized and fine needle aspiration or Tru-Cut biopsy samples obtained. Abdominal ultrasound should be done in animals in which lymphoma or other neoplasms are high on the rule out list. In a group of dogs with chronic diarrhea the following factors were associated with a higher diagnostic utility of abdominal ultrasound: the presence of weight loss, palpation of an abdominal or rectal mass on initial physical examination, localization of diarrhea to mixed bowel (vs. large bowel), diseases that commonly have mass lesions that should be visible on ultrasound examination, and a clinical diagnosis of GI neoplasia.

For many small intestinal disorders biopsy is necessary for diagnosis. Endoscopic examination of the duodenum with mucosal biopsy is a minimally invasive method of obtaining tissue. In the author's experience, evaluation of the duodenum and proximal jejunum results in accurate diagnosis in at least 75% of dogs and cats with chronic small bowel diarrhea. A duodenal aspirate for *Giardia* can be performed. If endoscopy is not available, exploratory celiotomy can be performed. Multiple full-thickness biopsies of the small bowel should be taken, mesenteric lymph nodes biopsied, and a duodenal aspirate examined for *Giardia* trophozoites. Ten ml of saline can be injected into the duodenum, aspirated, centrifuged, and the pellet examined for motile trophozoites.

For animals with large bowel diarrhea, colonoscopic examination is a high yield diagnostic test. Rigid colonoscopy allows evaluation of the descending colon which should be diagnostic in approximately 90% of cases with large bowel diarrhea. Flexible colonoscopy allows evaluation of the transverse and ascending colon, cecum, and possibly the ileum. Proper preparation for colonoscopy is essential to allow visualization of the entire mucosal surface. The animal should be held off food for 24 hours. Two doses of GoLYTELY should be given 2 hours apart, the afternoon prior to endoscopy. Dogs receive 60 ml/kg via orogastric tube while cats get 30 ml/kg via nasoesophageal tube. A warm water enema should follow each GoLYTELY and a third prior to anesthesia. When doing endoscopy, biopsies should always be taken, even if the mucosa looks normal.

Bacterial culture is a low yield diagnostic procedure. Specific pathogens that should be cultured for include *Salmonella*, *Campylobacter*, and *Yersinia*.

Differential diagnosis

Table 3 lists some causes of chronic small and large bowel diarrhea. The most common causes of small bowel diarrhea include GI parasites, highly digestible diet-responsive small bowel diarrhea, and inflammatory bowel disease. In cats, it is important to consider hyperthyroidism and infection with FeLV /FIV. Common causes of chronic large bowel diarrhea include *Trichuris vulpis*, highly digestible diet-responsive large bowel diarrhea, plasmacytic lymphocytic colitis, irritable bowel syndrome, *Clostridium perfringens* enterotoxicosis, fiber-responsive diarrhea, and neoplasia.

Diagnostic plan (figure 1)

Based on history and physical examination, diarrhea should be localized to the small bowel, large bowel, or mixed bowel. In cases of small bowel diarrhea, the next distinction to be made is based upon abdominal palpation. If abdominal palpation is abnormal (<2% of cases) diagnostic evaluation should proceed with survey abdominal radiographs, abdominal ultrasound, a barium upper GI series, and exploratory laparotomy. If neoplasia is very likely, 3-view thoracic radiographs should be performed to evaluate the presence of metastasis. Many practitioners will skip the barium series and go straight to surgery, reducing the cost to the client and the time to diagnosis.

If abdominal palpation is normal, multiple fecal examinations should be performed to rule out gastrointestinal parasites. Treatment for *Giardia* with metronidazole or fenbendazole is indicated prior to invasive diagnostic procedures. In addition, a dietary trial using a highly digestible diet for 3-4 weeks is also indicated. The diet should contain a highly digestible carbohydrate, be low in fat, low in fiber, and lactose and gluten-free. Many commercially available diets are available, including several diets for cats.

If diarrhea continues despite negative fecal examinations, treatment for *Giardia*, and a 3-4 week dietary trial, further evaluation should include measurement of serum trypsin-like immunoreactivity in dogs with a strong clinical suspicion of exocrine pancreatic insufficiency. In cats, tests for FeLV / FIV should be performed. Middle-aged and older cats should be tested for hyperthyroidism.

Further evaluation should include a complete blood count, biochemical profile, and urinalysis. Survey abdominal radiographs may be taken (or abdominal ultrasound performed) to rule out any abnormalities not detected by palpation. Multiple small intestinal biopsies should be collected by endoscopy if available, or via exploratory laparotomy. Serum B_{12} and folic acid may be measured to indirectly assess bacterial overgrowth, if a diagnosis has not been reached or the dog is not responding to appropriate therapy.

If chronic large bowel diarrhea is present, the initial diagnostic plan should consist of multiple fecal examinations for parasites, a 3-4 week dietary trial with a highly digestible diet, therapeutic deworming for whipworms and rectal cytology. In cases of large bowel diarrhea, a dietary trial utilizing higher levels of fiber may be beneficial. If diarrhea persists after these steps, an expanded database should include a complete blood count, biochemical profile, urinalysis, T_4 and FeLV / FIV testing for cats, and colonoscopy with multiple mucosal biopsies. If available, fecal assay for Clostridium enterotoxin or a therapeutic trial with amoxicillin should be performed prior to colonoscopy. If the colon is found to be normal with rigid endoscopy and a flexible endoscope is not available, a barium enema may be administered to evaluate the transverse and ascending portions of the colon. On rare instances, fecal cultures should be submitted, especially if increased numbers of neutrophils are seen on colonic or fecal cytology.

Figure 1- Chronic diarrhea history

Date _____

Duration of diarrhea:

Continuous or intermittent (circle)

If intermittent: Length of episode:

Frequency of episode:

Inciting factors (dietary indiscretion, stress, travel, thunderstorms, separation anxiety, nervous temperament etc.):

When diarrhea is present:

Frequency / day

Blood (indicate melena or hematochezia):

Mucus:

Tenesmus:

Accidents in house (how often):

Volume of stool : decreased normal increased (circle):

Stool grade: 1-5:

Appetite (circle) normal or slightly reduced or greatly reduced or none or increased (circle)

Weight loss? Yes or No (circle)

If present how much?

Abdominal pain? Yes or No (circle)

Excessive borborygmus / flatulence? Yes or No (circle)

Vomiting? Yes or No (circle)
If present: frequency / day:
days / week:
association with eating:
character of vomitus:
Diet (type, changes, effects):

Meals / day:

Maintenance medications:

Previous treatments (drug, dose, duration, response): continue on back of form if necessary

small bowel large bowel mixed bowel (circle)

Answer each question for the average clinical sign. If frequency or severity has progressed, indicate (frequency was 5/day, during last 4 weeks 9/day).

Chronic diarrhea activity index (CDAI)
Score each of the categories based on the severity of clinical signs during the 2 weeks prior to the animal's visit.

Category	**Points possible**
Attitude / activity	0 – normal 1 – slightly reduced 2 – moderately reduced 3 – severely reduced
Appetite	0 – normal 1 – slightly reduced 2 – moderately reduced 3 – severely reduced
Vomiting	0 – none 1 - < 4/week 2 - < 8/week 3 - > 7/week
Stool consistency	0 – Mostly grade 4 or 5 1 – Mostly grade 3, some grade 4 2 – Mostly grade 2, some grade 3 3 – Mostly grade 1, some grade 2 4 – Always grade 1
Stool frequency	0 – normal 1 – 1-2x normal 2 – >2-3x normal 3 - >3x normal
Weight loss	0 – none 1 - < 5% 2 – >5 - <10% 3 - >10%
Blood – Melena or hematochezia	0 – none 1 – positive
Mucus	0 – none 1 – positive
Tenesmus	0 – none 1 - positive
Total Points	

Adopted from Jergens st. al. A scoring index for disease activity in canine inflammatory bowel disease. JVIM 2003; 17: 291-297.

Table 2: Localization of chronic diarrhea

SIGN	SMALL BOWEL	LARGE BOWEL
Weight loss	Positive	Negative
Frequency	Normal - mild increase	Normal - Moderate - large increase
Volume	Normal - Increased	Normal - Decreased
Tenesmus	Negative	Positive
Blood	Melena	Hematochezia
Mucus	Negative	Positive

Table 3: Chronic diarrhea- differential diagnosis

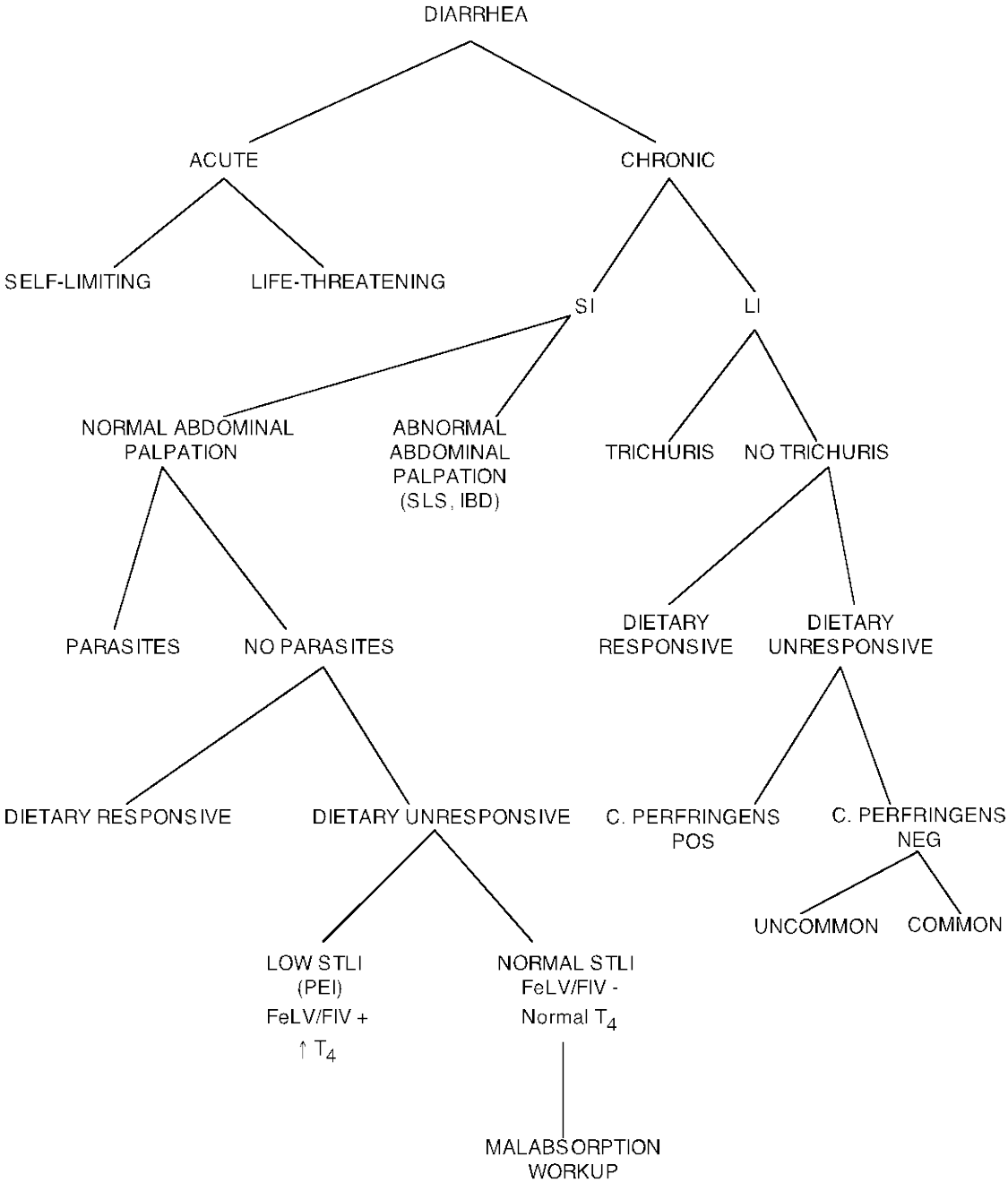
Chronic small bowel diarrhea

- Giardia, hookworms, roundworms
- Dietary indiscretion / Highly digestible diet - responsive
- Pancreatic exocrine insufficiency
- Inflammatory bowel disease
- Stagnant loop syndrome
- Feline hyperthyroidism
- Lymphosarcoma - diffuse
- Lymphangiectasia
- Neoplasia
- Antibiotic responsive diarrhea / Small intestinal bacterial overgrowth
- Feline leukemia virus
- Feline immunodeficiency virus
- Histoplasmosis

Chronic large bowel diarrhea

- Whipworms,
- Dietary indiscretion / Highly digestible diet - responsive
- Plasmacytic lymphocytic colitis
- Irritable bowel syndrome
- Neoplasia
- Fiber-responsive diarrhea
- *Clostridium perfringens* enterotoxicosis
- Histoplasmosis
- Eosinophilic colitis

Figure 1: Diagnostic approach to chronic diarrhea



Chronic diarrhea case 1

Signalment

2.5 yr SF Irish setter

History

- Diarrhea of 5 months duration
- Frequency: once every 4-5 days, gradually progressed to 2/day
- Quantity/defecation: normal
- Tenesmus, hematochezia, excess mucus, Grade III
- No weight loss, good appetite
- Fecal examination: hookworms, treated with pyrantel
- Treated with mebendazole and fenbendazole

- Negative fecals x3
- Diet i/d and Ken-L-Ration Biscuit
- Environment: fenced in yard
- Other pets: 3 dogs, 4 cats all normal

Past history

Hit by car: traumatic myocarditis, acetabular fracture, stray dog

Physical examination

Normal

Localization of diarrhea (Circle one) –

Small bowel - Large bowel - Mixed bowel

Differential diagnosis

- IBD - plasmacytic lymphocytic / eosinophilic colitis
- *Clostridium perfringens* enterotoxicosis
- Fiber-responsive large bowel diarrhea
- Irritable bowel syndrome
- Lymphoma

Diagnostic plan

- Fecals x3 - done
- RX whipworms - done x2
- GI diet - done
- Rectal cytology
- RX Clostridium
- +/- Clostridium enterotoxin
- Colonoscopy

Diagnostic results/diagnosis

- Fecal neg
- Rectal cytology - normal
- Clostridium enterotoxin neg
- Colonoscopy - 15 cm superficial erosion, histopathology - PL colitis

Therapy

- Hypoallergenic diet - d/d
- FU 4 weeks - 2 short episodes diarrhea, colonoscopy - hemorrhagic ascending colon, granular descending colon, histopathology - PL colitis with inc eosinophils, RX sulfasalazine 1 g TID
- FU 3 months - infrequent diarrhea, colonoscopy and histopathology normal, tear production dec 50%, dec sulfasalazine 500 mg TID
- FU 7 months - diarrhea with dec sulfasalazine, RX tylosin 20 mg/kg BID - no response
- FU 28 months - prednisone 1 mg/kg SID tapered to 0.25 mg/kg q 48H

Chronic diarrhea case 2

Signalment

Male German shepherd dog, 2 yrs

History

- Diarrhea for 4 months, 20 kg weight loss, voracious appetite.
- Frequency: 3-8 times/day
- Large amount of feces per defecation, Grade II
- Environment: runs lose on farm
- Diet: Purina dog chow and canned Alpo

Previous therapy

- Metronidazole 1 gm SID x 6 days
- Fenbendazole 50 mg/kg SID for 3 days
- Pancreatic enzyme powder (1 TBS/meal)
- No improvement

Physical examination

Emaciation. Normal abdominal palpation. Rectal examination normal.

Localization of diarrhea (circle one)

Small bowel - Large bowel - Mixed bowel

Differential diagnosis

- Giardia
- PEI
- IBD
- SIBO
- Lymphoma
- Lymphangiectasia
- Partial SI obstruction

Diagnostic plan

- Fecals x3, SNAP *Giardia*
- STLI
- +/- abdominal radiographs
- +/- abdominal ultrasound
- CBC, biochemical profile, UA
- Endoscopy
- +/- serum B12 / folate
- Exploratory laparotomy

Diagnostic results/diagnosis

- MDB normal
- Fecal x3 neg, SNAP *Giardia* not available
- STLI <1 (5-35)
- B12 352 (225-660)
- Folate 21.7 (6.7-17.4)
- Endoscopy and histopathology normal, quantitative aerobic anaerobic duodenal culture - ?
- DX - PEI with secondary bacterial overgrowth

Therapy

- Pancreatic enzyme powder 2 TBSP TID
- Low fat diet
- Doxycycline 5 mg/kg BID x 21
- FU day 3 - normal stool
- FU day 14 -3 kg weight gain, died mesenteric volvulus

References

Leib M, Matz M. Diseases of the intestines. In: Leib MS Monroe WE (ed.). *Practical Small Animal Internal Medicine.* Philadelphia, WB Saunders, 1997; 685-760.

Twedt DC. *Clostridium perfringens*-associated enterotoxicosis in dogs. In: Kirk RW, Bonagura JD (ed.). *Current Veterinary Therapy XI.* Philadelphia, W B Saunders Company, 1992; 602-604.

Leib MS, Codner EC, Monroe WE. A diagnostic approach to chronic large bowel diarrhea in dogs. Vet Med 1991; 86**:** 892-899.

Leib MS, Monroe WE, Codner EC. Performing rigid or flexible colonoscopy in dogs with chronic large bowel diarrhea. Vet Med 1991; 86**:** 900-912.

Penninck D, Nyland T, LY K, *et al.* Ultrasonographic evaluation of gastrointestinal diseases in small animals. Vet Radiol 1990; 31**:** 134-141.

Williams DA. New tests of pancreatic and small intestinal function. Comp Cont Educ Pract Vet 9:1167-1175, 1987.

Moon M, Myer W. Gastrointestinal contrast radiology in small animals. Sem Vet Med Surg 1986; 1**:** 121-143.

Hill FWG. Persistent diarrhoea. Br Vet J 1984; 140**:** 150-158.

Burrows CF. Chronic diarrhea in the dog. Vet Clin Nor Am: Sm Anim Pract 13:521-540, 1983.

Sherding RG. Canine large bowel diarrhea. Comp Cont Educ Pract Vet 2:279-240, 1980.

Chronic Vomiting in Dogs and Cats: The Roles of Ultrasonography in Diagnosis and *Helicobacter* in Treatment

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Chronic vomiting (intermittently or continuously for at least 7 days) in dogs and cats is a common and frustrating problem for clients and veterinarians. Because many diseases cause chronic vomiting, a thorough evaluation must be performed to arrive at an accurate diagnosis. Definitive diagnosis of many diseases requires mucosal biopsy. In the past, exploratory celiotomy was necessary to obtain biopsy specimens. However, the increased availability of flexible fiberoptic endoscopy in veterinary medicine has allowed less invasive tissue biopsy.

The first step in the approach to the chronically vomiting patient is to determine that vomiting and not regurgitation is present. Vomiting is associated with signs of nausea (depression, salivation, frequent swallowing, and vocalization in some cats) that is followed by abdominal contractions prior to the expulsion of material. Regurgitation is associated with esophageal disorders and occurs passively, usually associated with increased intrathoracic pressure that may be caused by excitement, activity, or changes in body position.

Once you have determined vomiting is present the history and physical examination can contain many clues to the etiology. A thorough dietary history should be obtained. In some cases, correcting dietary indiscretion or instituting a highly digestible diet for 3-4 weeks will resolve the vomiting. Dietary indiscretion can be due to a recent diet change, feeding of table scraps, free-roaming behavior allowing ingestion of garbage, ingestion of foreign objects, exposure to toxins (including house plants), excessive ingestion of hair, or feeding a low quality poorly digestible diet. The history may identify the use of drugs, such as NSAIDs, that can cause vomiting due to gastritis or ulceration. The presence of diarrhea or signs of systemic disease may help to rank the rule-out list.

Physical examination may be normal or only demonstrate signs of weight loss. An abdominal mass or dilated loop of small bowel may be identified as a cause of high partial small bowel obstruction. If vomiting has recently become more frequent, signs of dehydration may be present (delayed capillary refill time, enophthalmos, decreased skin turgor, tachycardia, pale mucous membranes, and cold extremities). Signs suggesting systemic disease include: polyuria / polydipsia, polyphagia, hepatomegaly, cataract formation, icterus, encephalopathy, ascites, pyrexia, bradycardia, tachycardia, small irregular kidneys, oral ulceration, pale mucous membranes, splenomegaly, or an abdominal mass.

Table 1 lists some causes of chronic vomiting in dogs and cats. Systemic diseases can usually be ruled out by a thorough history, careful physical examination and routine laboratory tests (complete blood count, biochemical profile, urinalysis, amylase, lipase, and cPLI, heartworm antibody test, and T4). Correction of dietary indiscretion or a 3-4 week trial with a highly digestible diet should be performed before more invasive testing. Gastrointestinal causes of chronic vomiting may involve either the stomach or orad small intestine. An efficient plan to evaluate gastrointestinal causes includes fecal examination for parasites, survey abdominal radiography, and endoscopic examination with mucosal biopsy. If endoscopy is not available, a barium contrast upper GI series and exploratory laparotomy can be used (Table 2). Although helpful in some cases, the diagnostic utility of abdominal ultrasound has not yet been fully determined. Abnormalities that can be detected include thickened stomach or small bowel, gastric, small bowel or pancreatic mass, enlarged regional lymph nodes, enlarged hypoechoic pancreas, dilated small bowel, abnormal gastric or small bowel motility, or evidence of an intraluminal foreign body.

Survey abdominal radiographs rarely establish a cause for chronic vomiting (unless a radiodense foreign body is seen) and a barium upper GI series is usually indicated. Advantages of contrast radiography versus endoscopy and laparotomy include the following: 1) available in all practices, 2) noninvasive, 3) does not require general anesthesia, 4) always visualizes the duodenum, 5) evaluates gastric size and position, 6) provides a qualitative description of gastric motility and emptying of liquids, and 7) detects extraluminal and submucosal / muscular masses. A barium series is time consuming to perform, costly to the client, and is a source of radiation exposure to the hospital staff. If lesions are identified, tissue biopsy is needed to confirm a diagnosis. If a foreign body is detected, it must be removed via endoscopy or exploratory laparotomy. The upper GI series is insensitive for mucosal lesions.

Abdominal ultrasonography has recently been added to the diagnostic plan for many dogs and cats with chronic vomiting or chronic diarrhea. Ultrasound has been shown to be very helpful in animals with a mass lesion, especially neoplasia. An ultrasound guided fine needle aspirate or tru-cut biopsy can be performed. Ultrasound has also been shown to helpful in cases with chronic pancreatitis. Other advantages of ultrasound include: being noninvasive, imaging of the liver and biliary system, imaging of the small and large bowel and mesenteric lymph nodes, and assessment of the layers of the GI tract and its motility. Disadvantages include the need for expensive equipment and specialized training, interference by gas within the GI tract, and difficulty in imaging the pancreas.

A recent study has been performed in which the diagnostic utility of abdominal ultrasound in dogs with chronic vomiting has been evaluated. A single radiologist performed each abdominal ultrasound. Two internists, who did not directly participate in case

management, reviewed each medical record. In each case, the contribution the ultrasound made towards the final diagnosis was assessed and scored from 1-5, based on the following scale:

1. Diagnosis was obtained via ultrasonography (including ultrasound-guided aspirate or biopsy). Additional biopsy via endoscopy or exploratory celiotomy was not necessary.
2. Ultrasonography provided data that suggested endoscopy was not indicated and exploratory celiotomy should be performed to obtain a diagnosis. Ultrasonography suggested how to obtain a tissue biopsy, making it very important for diagnosis.
3. Ultrasonography provided important diagnostic information that helped assess other data, including endoscopic findings. Ultrasonography was important in arriving at a diagnosis.
4. Ultrasonography provided descriptive information that did not affect assessment of other data obtained via endoscopy or exploratory celiotomy. The same diagnosis would have been reached without performing ultrasonography.
5. Ultrasonography provided conflicting information that did not support, or may have hindered obtaining the final diagnosis.

In the group of dogs with chronic vomiting, the following factors were associated with a higher diagnostic utility of abdominal ultrasound: presence of weight loss, higher percentage of body weight lost, increasing age, increasing duration of vomiting, an increased frequency of vomiting/week, and a final diagnosis of GI lymphoma or gastric adenocarcinoma. Based on diagnostic utility scores, abdominal ultrasonography was vital or beneficial to obtaining a diagnosis in 22.5% of cases, not helpful in 68.5%, and of marginal value in 9%. Considering all contributions to case management (including factors unrelated to the vomiting problem), abdominal ultrasound was considered helpful in 27% of dogs with chronic vomiting.

Exploratory celiotomy can be performed in veterinary hospitals and allows visual inspection of serosal surfaces, palpation of the stomach and small intestine, and limited mucosal visualization. It also allows for exploration and biopsy of the pancreas, mesenteric lymph nodes, and the entire small and large intestines. Directed large full-thickness biopsies can be obtained from the stomach and small intestine. Definitive treatment for some conditions (foreign bodies and tumors) can be accomplished. A duodenal aspirate for *Giardia* can be collected. Disadvantages include the need for general anesthesia, the surgical risk to the patient, post-operative morbidity and the risk for complications, and expense to the client.

Endoscopic examination lacks some of the disadvantages of the upper GI series and exploratory laparotomy. Advantages include the following: 1) visual mucosal inspection of the entire stomach and some of the duodenum, 2) directed tissue biopsy, 3) few false-negative procedures (related to the endoscopist's skill), 4) less invasive than laparotomy, 5) quick to perform, 6) the ability to remove foreign bodies, 7) assessment of the feasibility of surgical resection of tumors, and 8) ability to obtain a duodenal aspiration sample for *Giardia*. Disadvantages include the cost of equipment, the clinical skills necessary to perform endoscopy, the small size of biopsy samples, biopsy of mucosa only, the inability to resect masses, failure to enter the duodenum, evaluation of the orad small bowel only, and the necessity of general anesthesia. Because of the usefulness of endoscopy in cases with chronic vomiting, the author routinely performs endoscopy (and reaches a diagnosis) instead of performing a barium upper GI series or exploratory laparotomy.

Thorough endoscopic examination of the stomach and duodenum of the dog and cat can be performed with a flexible fiberoptic gastroscope with an outside tip diameter of <10 mm or less. Four-way control of the tip of the endoscope is necessary. Biopsy channels of 2.8 mm in diameter or greater will provide adequate biopsy samples for histologic evaluation and accept a wide range of foreign body forceps.

The endoscopic examination is performed after an overnight fast with the animal under general anesthesia and placed in left lateral recumbency. The endoscope should only be advanced if the gastrointestinal lumen is clearly visible, reducing the possibility of tissue perforation. The endoscope is passed through the lower esophageal sphincter into the cardiac region of the stomach. Initial assessment of the rugal folds should be made before insufflation and gastric distention. Gastric mucosa appears pinker than esophageal mucosa. It is smooth, glistening, and tough. The endoscope is advanced along the greater curvature until the angularis incisura is located. Deflection of the endoscope tip towards the antrum (control knob down) will allow visualization of the antral and pyloric region. Movement of the tip towards the cardia (control knob up) will provide a retroflexed view of the gastric body, fundus and cardia. To enter the duodenum, the scope should be advanced towards the pylorus and gently pushed through. If difficulty is encountered, rolling the animal into dorsal recumbency may allow successful passage. The duodenal mucosa has a more granular appearance than the stomach and is slightly paler. A duodenal aspirate for *Giardia* should be performed.

If abnormalities are found, multiple biopsies of lesions should be taken. If gross abnormalities are not present, biopsies of standard regions should be obtained (cardia, greater curvature, angularis incisura, antrum, pylorus, and duodenum). A biopsy sample should be placed in a rapid urease test to detect the presence of *Helicobacter spp*. Multiple samples can be placed into the test media, although the author routinely places a single biopsy from the angularis into a CLO test (Tri-Med Specialties Inc. 9531 Arden, Lenexa, KS 66215, 800 874 6331). Foreign bodies can be removed with grasping forceps. In addition, brush cytology of lesions may allow rapid diagnosis.

By following the diagnostic plan outlined above, most cases with chronic vomiting can be efficiently diagnosed, allowing for development of an appropriate therapeutic plan. Systemic diseases should be thoroughly evaluated before more invasive and expensive tests are performed. Correction of dietary indiscretion or institution of a highly digestible diet may eliminate clinical signs.

The use of endoscopy allows a less invasive, more efficient and accurate diagnosis of gastrointestinal causes of chronic vomiting to be reached. Serious complications such as perforation of the stomach are very uncommon and can be avoided with careful endoscopic technique.

Helicobacter gastritis in dogs

Helicobacter pylori infection is the most common cause of chronic gastritis and peptic ulceration in humans. It is also associated with an increased risk of gastric lymphoma and adenocarcinoma. Spiral bacteria were described in 1896 in humans and several animal species. They were "rediscovered" in 1983 when they were reported to cause of peptic ulceration in humans. *Helicobacter pylori* is a microaerophilic curved spiral gram negative organism with 4 flagella. The bacterium lives in gastric mucus, can attach to epithelial cells, and may penetrate intercellular junctions. High bacterial urease concentration cleaves urea to produce ammonia, which helps to neutralize the acid environment surrounding the bacterium. The immune system does not result in removal of the organisms; without treatment infection is life-long. Some studies have shown as many as 90% of people are infected with *H. pylori*. Luckily, most infections are not associated with clinical signs. Diagnosis can be made with serology, cytology of gastric mucus, culture of biopsies, histopathology of biopsies with H&E or silver stains, C-13 or C-14 labeled urea breath tests, or rapid urease tests. Many treatments have been studied, but the gold standard to which they are all compared to is omeprazole, ampicillin or tetracycline, metronidazole, and bismuth for 2 weeks.

Many species of spiral bacteria have been identified in dogs and cats: *H. felis, H. pylori, and H Heilmannii* (formerly called *Gastrospirillum hominis), H. Salomonis*, and *H. bizzozeronii* are the most common. Experimentally, infection has been established in both dogs and cats and lymphoid follicular gastritis developed. However, in these experimental studies, clinical signs were absent or very mild. Several surveys of laboratory, shelter, and pet populations (with and without GI signs) have shown a very high prevalence rate in dogs and cats, nearing 100% in some studies. Peptic ulceration is very rare in dogs and cats, demonstrating the pathophysiologic difference between *H. pylori* and the spiral bacteria commonly found in dogs and cats. Little is known about the effects of treatment of dogs and cats with chronic vomiting and *Helicobacter spp*. infection. At the present time there are many unanswered questions regarding *Helicobacter* in dogs and cats. Some questions include: 1) What is the relationship between *Helicobacter* and dogs and cats with chronic gastritis and vomiting? 2) What is the optimal treatment to eradicate the organism? 3) After treatment, is reinfection or recrudescence a common occurrence in dogs and cats? 4) What factors can help predict if a dog or cat with chronic gastritis and *Helicobacter* would benefit from treatment for *Helicobacter*? 5) Does *Helicobacter* have a role in other diseases such as gastric cancer and inflammatory bowel disease?

Because of the potential pathophysiologic relationship between *Helicobacter spp.* in dogs and cats and chronic gastritis and vomiting, the author has treated clinical cases for *Helicobacter*. In some cases, treatment has resulted in resolution or improvement in clinical signs. Until additional studies about *Helicobacter* in dogs and cats are available, it seems prudent to at least determine if spiral bacteria are present in dogs and cats with chronic vomiting, during gastroscopic examination or exploratory celiotomy. Spiral bacteria can be identified in gastric biopsy or brush cytology specimens, or indirectly identified by rapid urease testing of gastric mucosal samples. Obtaining results from histologic evaluation of biopsy samples requires 24-72 hours. Results of rapid urease tests and gastric brush cytology are available much sooner.

I have completed a clinical study comparing 2 treatments for *Helicobacter* in dogs. Dogs with chronic vomiting for at least 2 weeks, with *Helicobacter spp*. identified in gastric biopsy samples and gastritis, with or without inflammatory bowel disease, were entered into the study. The diagnostic workup included a CBC, biochemical profile, UA, fecal examination, abdominal ultrasonography, gastroduodenoscopy with mucosal biopsy, gastric cytology, and CLO test. Dogs with systemic diseases, gastric foreign bodies, gastric / duodenal neoplasia, pyloric hypertrophy, or *Physaloptera* infection were not eligible for the study. Dogs were randomly assigned to receive either triple therapy (amoxicillin 15 mg/kg, metronidazole 10 mg/kg, and Pepto Bismol tablets [(<5 kg; 0.25 tablet, 5-9.9 kg; 0.5 tablet, 10-24.9 kg; 1.0 tablet, and >25 kg; 2.0 tablets]) or quadruple therapy (triple therapy plus famotidine 0.5 mg/kg). All drugs were given BID for 2 weeks. Owners kept a daily diary of clinical signs and endoscopy was repeated 4 weeks and 6 months after treatment was completed. Results of the study have not yet been published but have been reported in abstract form. Six months after completing either therapy, approximately 40% of dogs had gastric biopsy specimens that were negative for *Helicobacter*. There was no difference between the 2 treatments in the percentage of dogs that remained negative. Both treatments reduced the frequency of vomiting by approximately 85%. Dogs that were negative for *Helicobacter* had a greater reduction in vomiting frequency that those that were positive and almost 80% of this group had at least a 90% reduction in vomiting frequency.

Because of the high rate of treatment failure in this study after 6 months, I have been investigating the use of clarithromycin based protocols; clarithromycin (7.5 mg/kg BID), in combination with amoxicillin (15 mg/kg BID) or omeprazole (0.7mg/kg SID). Unfortunately, preliminary data 4 weeks and 6 months after completion of therapy appears to be similar to triple or quadruple therapy. Overall reduction in vomiting was about 80%, but only about 40% of dogs negative for *Helicobacter* had at least a 90% reduction in vomiting frequency. Additionally a recent study treated a small number of dogs and cats for 3 weeks using triple therapy. Eradication results were encouraging.

It will take many controlled clinical studies before we can understand the potential role of *Helicobacter* in dogs and cats with chronic gastritis, and can answer many of the questions I have proposed. Although treatment of *Helicobacter* offers another, and very different, therapeutic route for animals with chronic gastritis, we must remember that a direct cause and effect relationship between *Helicobacter* and chronic gastritis has not yet been established in dogs or cats. Failure of a patient to rapidly respond to antimicrobial treatment suggests that something besides *Helicobacter* is causing the chronic gastritis and vomiting. Presently, based on current evidence, I recommend 3 weeks of therapy with clarithromycin, amoxicillin, and omeprazole.

Table 1 - Some causes of chronic vomiting

Systemic

- Diabetes mellitus
- Chronic renal failure
- Hepatobiliary diseases
- Chronic pancreatitis
- Feline hyperthyroidism
- Hypoadrenocorticism
- Lead poisoning
- Feline heartworm disease
- Systemic mastocytosis
- Drug therapy: NSAID

Gastrointestinal - stomach

- Chronic gastritis
    - Dietary indiscretion
    - Hair-induced
    - Plasmacytic lymphocytic
    - Eosinophilic
    - *Helicobacter*
- Foreign body
- Ulcer
- Neoplasia
- Pyloric hypertrophy
- *Physaloptera*
- Gastric motility disorder

Gastrointestinal - small intestine

- Inflammatory bowel disease
    - Plasmacytic-lymphocytic
    - Eosinophilic
- Partial obstruction-stagnant loop syndrome
    - Neoplasia
    - Foreign body
    - Intussusception
    - Extra-luminal obstruction
- Diffuse mucosal lymphosarcoma
- Histoplasmosis
- Ulcer

Table 2: Comparison of diagnostic modalities

Diagnosis	Survey Rad	Barium UGI	Ultrasound	Endoscopy	Exp Surgery
Dietary indiscretion intolerance	-	-	-	-	-
Gastritis	-	-	-	++++	++++
IBD	-	-	-	++++	++++
Foreign body	++	++++	+/++	++++	++++
Neoplasia diffuse	-	++	++/++++	++++	++++
Neoplasia nodular	-	++	++/++++	++++	++++
Pyloric hypertrophy	-	++	+/++	++++	++++
Motility disorder	-	+++	+/+++	++	++

Chronic vomiting case 1

Signalment

Himalayan, 3.5 years, NM

History

- Chronic intermittent vomiting for 1 year
- Food followed by mucus
- Several hours after eating
- Frequency: 2 x / week, progressed to once every day
- Vomiting associated with abdominal contractions and retching
- No weight loss, good appetite, no diarrhea
- Diet: c/d and table scraps

Physical examination

Normal

Regurgitation or vomiting (circle one)

Differential diagnosis

- Systemic Heartworm disease
- Liver diseases
- Hyperthyroidism
- GI Dietary indiscretion
- Hair-induced gastritis / duodenitis
- Chronic gastritis
- IBD
- Gastric foreign body

Diagnostic plan

- CBC, biochemical profile, UA, heartworm antibody, T4, fecal
- +/- abdominal radiograph
- +/- abdominal ultrasound
- Endoscopy
- Upper GI barium series
- Exploratory laparotomy

Diagnostic results/diagnosis

- MDB - normal
- HW antibody - neg
- T4 - 2.4 (1-2.5)
- Fecal - neg x2, large amount of hair
- Endoscopy - granular / friable duodenum, duodenal aspirate neg for *Giardia*, CLO – neg
- Histopathology - normal stomach, mild IBD in SI

Diagnosis

- Dietary indiscretion?
- Hair-induced gastritis / duodenitis?
- IBD?

Therapy

- Hypoallergenic diet - d/d, frequent grooming, no table scraps
- FU 4 weeks - rare vomiting, challenge with c/d - no vomiting

- FU 1.5 yrs - vomiting associated with table scraps

Chronic vomiting case 2

Signalment

6 year old, MN, Shetland sheepdog

History

- Vomiting 1x / q48H for 2 years
- Yellow foam, twigs
- Vomiting associated with abdominal contractions
- Normal appetite, no diarrhea
- Present diet: Purina EN, fruits and vegetables
- HW: Filarabits plus

Physical examination

Normal

Regurgitation or vomiting (circle one)

Differential diagnosis

- Systemic No likely rule outs
- GI Dietary indiscretion
- Chronic gastritis
- Inflammatory bowel disease
- *Physaloptera*
- Gastric foreign body

Diagnostic plan

- CBC, biochemical profile, UA (anesthesia workup)
- Fecal
- +/- abdominal ultrasound
- +/- abdominal radiograph
- Endoscopy
- +/- upper GI barium series
- exploratory laparotomy

Diagnostic results/diagnosis

- CBC, biochemical profile, UA - normal
- Endoscopy - mucosal follicles, superficial erosions, granular duodenum, CLO pos
- Histopathology - gastritis, IBD, spiral bacteria

Therapy

- Triple therapy- amoxicillin, metronidazole, Pepto Bismol BID x 14 days
- Continue EN, avoid table food
- FU 6 weeks - vomited 3x, normal endoscopy, normal histopathology, CLO neg, silver stain neg
- FU 6 months - Vomited 4 times, added fruits, cheese, dog treats, and hot dog!
- Endoscopy - stomach contained grass and bird seed, CLO neg, histopathology normal

References

Leib MS, Larson MM, Panciera DL, et. al. Diagnostic utility of abdominal ultrasonography in dogs with chronic vomiting. J Vet Int Med 2010; 24: 803-808.

Leib M. Diseases of the stomach. In: Leib MS, Monroe WE (ed.). Practical Small Animal Internal Medicine. Philadelphia, W B Saunders, 1997; 654-679.

Leib MS. Gastrointestinal Endoscopy. In: August JR (ed.). Consultations in Feline Internal Medicine. Philadelphia, W B Saunders, 1994; 119-126.

Tams TR. A diagnostic approach to vomiting in dogs and cats. Vet Med 1992; 87: 785-793.

Kantrowitz B, Biller D. Using radiography to evaluate vomiting in dogs and cats. Vet Med 1992; 87: 806-813.

Guilford WG. Upper gastrointestinal endoscopy. Vet Clin North Am: Sm Anim Pract 1990; 20: 1209-1227.

Tams TR. Gastroscopy. In: Tams TR (ed.). Small Animal Endoscopy. St. Louis, C V Mosby, 1990; 89-166.

Penninck D, Nyland T, LY K, et al. Ultrasonographic evaluation of gastrointestinal diseases in small animals. Vet Radiol 1990; 31: 134-141.

Leib MS. Chronic vomiting: a diagnostic approach. In: August JR (ed.). Consultations in Feline Internal Medicine. Philadelphia, W. B. Saunders Company, 1991; 403-407.

Moon M, Myer W. Gastrointestinal contrast radiology in small animals. Sem Vet Med Surg 1986; 1: 121-143.

Kleine LJ: Interpreting radiographic signs of abdominal disease in dogs and cats - 3. Vet Med 80:73-85, 1985.

Sullivan M, Miller A: Endoscopy (fiberoptic) of the oesophagus and stomach in the dog with persistent regurgitation or vomiting. J Small Anim Pract 26:369-379, 1985.
Happe RP, van der Gaag I: Endoscopic examination of the esophagus, stomach and duodenum in the dog. J Am Anim Hosp Assoc 19:197-206, 1983
Thayer GW: Vomiting: A Clinical Approach. Comp Cont Educ Prac Vet 3:49-52, 1981.

Icterus in Dogs and Cats: A Practical Diagnostic Approach

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Icterus, or jaundice, is defined as yellowish discoloration of the serum, skin, and mucous membranes. It is caused by excessive amounts of bilirubin, which occurs when the rate of production exceeds the rate of elimination. Bilirubin is a waste product of red blood cell metabolism without benefit to the body, but has major diagnostic implications in disease. Serum bilirubin must be approximately 2.5-3.0 mg/dl or greater to produce clinically detectable icterus.

Pathophysiology

Bilirubin is a waste product of red blood cell metabolism that has important diagnostic implications in animals with hepatobiliary diseases. Most bilirubin is derived from the normal breakdown process of hemoglobin from senescent RBCs. Hemoglobin is phagocytosed by the reticuloendothelial system and converted into bilirubin. It is bound to albumin and transported to the liver, where it is taken up by the hepatocyte, conjugated with glucuronic acid, and secreted into bile canaliculi by active transport, which is the rate limiting step. Bile is stored within the gallbladder until feeding, when it enters the duodenum. Bacterial metabolism occurs in the small intestine producing several urobilins. One of these, urobilinogen, is reabsorbed within the small intestine, but most of it is removed from the portal blood by the liver and excreted back into bile. Urobilinogen which remains in circulation is removed by the kidney. In dogs, the renal tubules can convert hemoglobin to bilirubin, conjugate it, and excrete it into the urine. Urobilinogen remaining within the bowel may be passed in the feces or metabolized to stercobilins which impart color to the feces. Cats differ from dogs in that their renal threshold is considerably higher, and bilirubinuria does not occur in normal cats.

Elevated serum bilirubin is commonly found in hemolytic diseases, intrahepatic or extrahepatic cholestasis, or less commonly due to rupture of the biliary system, which is usually associated with trauma. The liver has a tremendous ability to metabolize excessive bilirubin, thus prehepatic, or hemolytic icterus, only results when moderate or severe red blood cell destruction is present. In general, higher levels are found in cases with extrahepatic cholestasis vs. intrahepatic cholestasis. However, it is possible to have normal serum bilirubin in a variety of hepatobiliary disorders. In cholestatic disorders, elevated serum AP occurs prior to any changes in bilirubin metabolism in both dogs and cats. As the cholestatic process progresses, bilirubinuria precedes hyperbilirubinemia in dogs, but hyperbilirubinemia precedes bilirubinuria in cats due to their higher renal threshhold. Icteric plasma can usually be detected when bilirubin reaches1.5-2.0 mg/dl. Serum bilirubin level must be >2.5-3.0 mg/dl to detect clinical icterus. Although it is possible to measure conjugated levels (as thus determine unconjugated levels) with the Van den Bergh test, the author has found little clinical significance for utilizing this test.

Obstruction of bile flow within the liver or during its extrahepatic transport, results in regurgitation of conjugated bilirubin from hepatocytes back into the sinusoids and into systemic circulation. Hepatocellular swelling, inflammation, necrosis, or fibrosis, especially in the periportal area, can obstruct bile flow. Hepatocyte dysfunction may interfere with the uptake, conjugation, or excretion of bilirubin and cause icterus. Thus, most hepatic disorders can cause intrahepatic icterus.

Several surveys of icteric cats have shown that the most common causes of icterus include: lipidosis, cholangitis, feline infectious peritonitis, toxic hepatopathy, hepatic neoplasia, sepsis, and hemolytic anemia. Post-hepatic disorders that obstruct bile flow occur more commonly in dogs than cats; examples include: gallbladder mucocoele, cholecystitis, cholelithiasis, pancreatitis, biliary carcinoma, pancreatic adenocarcinoma, and duodenal neoplasia. Trauma to the biliary system (gallbladder, common bile duct, cystic duct, or intrahepatic bile ducts) can result in leakage of bile into the abdomen, bile peritonitis, resorption of the bilirubin into plasma, and icterus.

Bile retained within the liver is toxic and leads to hepatocellular degeneration. Thus, prolonged extrahepatic cholestasis can lead to hepatic disease and complicate the distinction between hepatic and post-hepatic icterus.

Clinical signs

Owners may notice icterus or it may be identified during physical examination. It is easiest to detect icterus in the sclera, conjunctiva, gingiva, hard palate, vulva or penis. It is more difficult to detect discoloration of the skin, but it can be noticed on the inside surfaces of the ears or on the caudoventral abdomen. The history may reveal exposure to potentially hepatotoxic drugs or chemicals. Abdominal trauma, often 5-10 days previously, may have occurred and resulted in leakage of bile.

Other clinical signs are dependent on the cause of icterus. Prehepatic, or hemolytic cases, are often weak, lethargic, and tachypneic, and may have dark discolored urine, a systolic heart murmur, not previously detected, or hepatosplenomegaly. Animals with hepatic or post-hepatic disorders may have some of the following signs: anorexia, weight loss, pyrexia, vomiting, diarrhea, abdominal distention, encephalopathy, polyuria / polydipsia, or bruising or bleeding tendencies. Abdominal distention due to hepatomegaly or ascites or cranial abdominal pain may be detected during physical examination.

Diagnostic plan

The most important initial diagnostic step with the icteric patient is to evaluate the hematocrit to determine if prehepatic, or hemolytic icterus, is present. Moderate or severe anemia with a normal total protein suggests hemolysis . The presence of hemolysis is also supported by hemoglobinuria or autoagglutination, although neither must be present. Further evaluation of hemolysis should include a review of red blood cell morphology for spherocytosis, hemoprotozoa, determination of the reticulocyte count, a Coombs test, and a FeLV ELISA test in cats.

If the hematocrit is normal or if mild anemia is present, the icterus is due to either hepatic or post-hepatic causes. The distinction between hepatic and post-hepatic disease is very important because hepatic disease can be diagnosed with a minimally invasive liver biopsy (often with the assitence of ultrasonography), while post-hepatic disorders often need more invasive exploratory surgery to diagnose and potentially relieve the obstruction. To obtain a liver biopsy via exploratory celiotomy, when less invasive methods are available, is not in the animal's best interests. The best method to distinguish hepatic from post-hepatic disorders is abdominal ultrasonography. Post hepatic disorders are associated with a distended gall bladder, and enlarged and tortuous cystic, bile, or intrahepatic bile ducts. A potentially neoplastic mass of the biliary system or pancreas, signs of pancreatitis (an enlarged hypoechoic pancreas with a hyperechoic rim and potentially plication of the duodenum), gallbladder mucocoele (immoble bile with fine striations) an echogenic cholelith, or a thickened gallbladder wall may be found. With intrahepatic disorders the liver may be enlarged and diffusely hyper or hypoechoic or contain focal or multifocal abnormalities .

Without ultrasonographic assistance the distinction between hepatic and post-hepatic disorders is much more difficult. If the animal is relatively bright and alert, post-hepatic disease is more liekly present. Elevated resting or post-tolerance serum ammonia levels support hepatic disease. A serum AP increased 3 or more times more than an elevated serum ALT suggests post-hepatic cholestasis. Finally, very high serum bilirubin levels (>10-15 mg/dl) are most often associated with post-hepatic disorders. Finally, hypoalbuminemia and a low BUN support hepatic icteris. None of these criteria are absolutely reliable, but they do provide some assistance in making the decision to perform closed liver biopsy vs. exploratory surgery.

The complete diagnostic evaluation of a case of hepatic icterus should include a CBC, biochemical profile, urinalysis, FeLV / FIV ELISA in cats, abdominocentesis and fluid analysis (if ascites is suspected), coagulation profile, hepatic ultrasound, and a liver biopsy utilizing the least invasive method available. If examination of the ascitic fluid suggests bile peritonitis, diagnosis and treatment requires exploratory celiotomy. The pivotal step in evaluation of a suspected case of post-hepatic disease is ultrasonography. A laboratory minimum data base should be collected to evaluate concurrent disease as well as the metabolic effects of the primary disorder. Additional diagnostic tests depend on sonographic findings but may include thoracic radiographs to look for metastasis, and exploratory celiotomy for definitive diagnosis and relief of the obstructing process.

Icterus case 1

Signalment

Welch corgi, MN, 8 year old

History

- Icterus
  - Acute hemorrhagic diarrhea RX with metronidazole 500 mg BIDx7
  - Diarrhea returned and RX again
  - Anorexia on day 8, icterus day 11
  - RX IV fluids and enrofloxacin
  - Previous HX – acute pancreatitis 3 months ago, increased water consumption since then 2x
  - Vaccinations current, monthly milbemycin

Physical examination

Icterus

Trifurcate icterus

- Prehepatic – hemolytic
- Hepatic
- Posthepatic

Initial diagnostic plan

- PCV – rule out hemolysis
- CBC, biochemical profile, UA
- Abdominal ultrasound

Diagnostic results

	Presentation
PCV	42
BUN (6-28)	4
Bilirubin	7.3
ALT	2831
AP	1700
Cholesterol	562
USG	1.030
Urine bilirubin	4+

Abdominal ultrasound – liver slightly small, normal hepatic parenchyma, normal gall bladder and biliary system

Differential diagnosis – hepatic icterus

- Drug-induced hepatoxicity
- Chronic hepatitis
- Cholangitis
- Toxic hepatopathy
- Hepatic neoplasia - lymphoma
- Cirrhosis

Diagnsotic plan

- Coagulogram – PT and PTT
- Parenteral vitamin K
- Liver biopsy

Diagnostic results

- PT 7.3, PTT 9.3
- Laparoscopy – yellow liver, swollen rounded edges, lobular surface pattern
- Hepatic culture – negative aerobic / anaerobic
- Histopathology – suppurative hepatitis, lymphoplasmacellular cholangiohepatitis, hepatocyte vacuolation
- Hepatic copper 258 ppm (120-400)

Therapy

- Hills K/d
- Cefadroxil – 4 weeks
- Ursodeoxycholic acid 15 mg/kg/day
- SAMe, milk thistle, vitamin E

Case follow-up

	Presentation	2 weeks	4 weeks	10 weeks	20 weeks
Bilirubin	7.3	4.1	1.6	0.9	1.1
ALT	2831	1252	1604	995	81
AP	1700	3581	2875	5795	252
Cholesterol	562				

- 2 weeks – eating chicken, rice, cottage cheese, more active
- 4 weeks – eating well most days, active, vomits q 2-3 days
    - Prednisone 2 mg/kg/day
- 10 weeks – eating well, active, gaining weight
- 20 weeks – eating well active, gained 3 kg, intermittent diarrhea – resolved following withdrawal of prednisone, continuing ursodeoxycholic acid, SAMe, vitamin E
- 2 years – clinically normal, normal biochemical profile, ursodeoxycholic acid, SAMe, vitamin E discontinued after7 months

References

Anderson JG, Washabau RJ. Icterus. Comp Cont Educ Pract Vet 14: 1045-1059, 1992.

Meyer DJ. The liver part 1. Biochemical tests for the evaluation of the hepatobiliary system. Comp Cont Educ Pract Vet 4: 663-674, 1982.

Engelking LR. Disorders of bilirubin metabolism in small animal species. Comp Cont Educ Pract Vet 10: 712 - 722, 1988.

Meyer DJ, Chiapella AM. Cholestasis. Vet Clin North Am: Sm Anim Pract 15: 215-227, 1985.

Hall RL. Laboratory evaluation of liver disease. Vet Clin North Am: Sm Anim Pract 15: 3-19, 1985.

Rogers KS, Cornelius LM. Feline icterus. Comp Cont Educ Pract Vet 7: 391 - 402, 1985.

Osborne CA, Stevens JB, Lees GE, et al. Clinical significance of bilirubinuria. Comp Cont Educ Pract Vet 1: 897-903, 1980.

Center SA, Baldwin BH, King JM, et al. Hematologic and biochemical abnormalities associated with induced extrahepatic bile duct obstruction in the cat. Am J Vet Res 44: 1822-1829, 1983.
Cornelius LM, DeNovo RC. Icterus in cats. In: Kirk RW (ed.). Current Veterinary Therapy VIII. Philadelphia, W B Saunders, 1983; 822-829.
Fahie MA, Martin RA. Extrahepatic biliary tract obstruction: A retrospective study of 45 cases (1983-1993). J Am Anim Hosp Assoc 31: 478-482, 1995.
Martin RA, MacCoy DM, Harvey HJ. Surgical management of extrahepatic biliary tract disease: A report of eleven cases. J Am Anim Hosp Assoc 22: 301-307, 1986.
Boothe HW, Boothe DM, Komkov A, et al. Use of hepatobiliary scintigraphy in the diagnosis of extrahepatic biliary obstruction in dogs and cats: 25 cases (1982-1989). J Am Vet Med Assoc 201: 134-141, 1992.
Neer TM. A review of disorders of the gallbladder and extrahepatic biliary tract in the dog and Cat. J Vet Int Med 6: 186 - 192, 1992.
Reed AL. Ultrasonographic findings of diseases of the gallbladder and biliary tract. Vet Med 90: 950-958, 1995.
Biller DS, Kantrowitz B, Miyabayashi T. Ultrasonography of diffuse liver disease. J Vet Int Med 6: 71 - 76, 1992.
Lamb CR. Abdominal ultrasonography in small animals: Examination of the liver, spleen and pancreas. J Sm Anim Pract 31: 6-15, 1990.
Yeager AE, Mohammed H. Accuracy of ultrasonography in the detection of severe hepatic lipidosis in cats. Am J Vet Res 53: 597-599, 1992.
Voros K, Vrabely T, Papp L, et al. Correlation of ultrasonographic and pathomorphological findings in canine hepatic diseases. J Sm Anim Pract 32: 627-634, 1991.
Nyland RG. Ultrasound patterns of canine hepatic lymphosarcoma. Vet Radiol 25: 167-172, 1984.
Crews LJ, Feeney DA, Jessen CR, et al. Clinical, ultrasonographic, and laboratory findings associated with gallbladder disease and rupture in dogs: 45 cases (1997-2007). J Am Vet Med Assoc 2009;234:359-366.
Cornejo L, Webster C. Canine gallbladder mucoceles. Compend Contin Educ Pract Vet 2005;27:912-928.
Besso JG, Wrigley RH, Gliatto JM, et al. Ultrasonographic appearance and clinical findings in 14 dogs with gallbladder mucocele. Vet Radiol Ultrasound 2000;41:261-271.
Center SA. Diseases of the gallbladder and biliary tree. Vet Clin Nor Am 2009;39:543-598.

Giardia and *Tritrichomonas Foetus*: An Update

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Giardia

Giardia is a flagellate protozoan parasite commonly encountered in small animal veterinary practice. The most common clinical syndrome associated with *Giardia* is acute small bowel diarrhea, but in some cases acute large bowel diarrhea, chronic small or large bowel diarrhea, or rarely acute or chronic vomiting may occur. Studies throughout the world have found infection rates ranging from 1%-39% in pet and shelter dogs and cats. Recently a study utilizing PCR found 80% of cats in Perth Australia to be positive. Many of the *Giardia* infected animals did not have diarrhea. Younger animals had a higher rate of infection.

It appears that various strains posses differing degrees of pathogenicity. Clinical signs may be self-limiting in some patients. Severe disease may occur in puppies or kittens, animals with other gastrointestinal parasites or diseases, or debilitated animals, but also can occur in otherwise healthy patients. *Giardia* cysts are not routinely identified by commonly used fecal flotation solutions because cysts become shriveled and cannot be identified. In addition, the numbers of cysts shed in the feces fluctuate over time. Many commonly used anthelmintics are not effective against *Giardia*. Although the issue is presently unresolved, some strains of *Giardia* are a zoonotic threat. This paper will review the important clinical aspects of giardiasis and will present a practical diagnostic plan and differential diagnosis.

Infection is acquired by ingestion of cysts, only a small number are necessary. Most dogs and cats infected with *Giardia* remain asymptomatic. When clinical signs occur, acute small bowel diarrhea is most common. Small bowel diarrhea has the following characteristics: liquid to semi-formed feces, moderately increased frequency of defecation, and normal to increased quantity of feces per defecation. The presence of melena (digested blood) is uncommon in cases of giardiasis. Diarrhea usually is self-limiting in animals that develop clinical signs, and has been described as pale, malodorous, and fatty. Severe diarrhea may be accompanied by dehydration, lethargy, and anorexia. However, most affected patients remain bright and alert, afebrile, and maintain a normal appetite. Occasionally acute vomiting may accompany diarrhea. The author has endoscopically observed severe erosion of the duodenum in some cases that resolved following successful treatment for *Giardia*. A mild eosinophilia has been demonstrated.

Chronic small bowel diarrhea with weight loss, poor body condition, and intermittent vomiting may also occur. In addition, the author occasionally has identified *Giardia* in cases of chronic vomiting. *Giardia* may be found in dogs and cats that have other gastrointestinal diseases, especially inflammatory bowel disease. In these cases, the clinical signs and laboratory findings reflect the underlying disease. In humans, *Giardia* may mimic inflammatory bowel disease.

Acute or chronic large bowel diarrhea with hematochezia, excess fecal mucus, and tenesmus may occur on occasion. In cases of large bowel diarrhea, the frequency of defecation is moderately to greatly increased and quantity of feces per defecation in reduced. Excess fecal mucus is often seen in infected cats.

Differential diagnosis and diagnostic plan

There are many causes of diarrhea in dogs and cats. Common causes for acute diarrhea include the following: *Giardia*, hookworms, roundworms, coccidia, dietary indiscretion, foreign body, toxins, drugs, hemorrhagic gastroenteritis (HGE), coronavirus, parvovirus, and intussusception. A thorough and logical diagnostic plan should be followed to facilitate reaching an accurate diagnosis, minimizing stress to the patient and expense for the owner.

The initial step in evaluation of cases with acute diarrhea is to distinguish between self-limiting and life-threatening causes. Most cases are self-limiting and can be diagnosed with a thorough history, careful physical examination, and fecal examination. Life-threatening cases may be associated with some of the following findings: frequent diarrhea, moderate to severe dehydration or abdominal pain, frequent vomiting, or systemic signs such as fever, icterus, lymphadenopathy, coughing, nasal discharge, or dyspnea. Puppies and kittens with severe clinical signs, especially if unvaccinated, should be suspected of having an infectious disease.

A recent dietary change, dietary indiscretion, or administration of medication may be identified in the history and suspected as the cause of self-limiting diarrhea. If the history does not identify an underlying problem, a fecal examination should be performed to identify *Giardia* or other parasites. Appropriate therapy for GI parasites, correction of dietary indiscretion, discontinuing suspect medications, or feeding a low-fat, highly digestible diet will often resolve clinical signs. Animals that are mildly dehydrated may require subcutaneous fluid therapy while those with very frequent diarrhea may benefit from motility modification with narcotics. Failure of the diarrhea to resolve indicates that a more thorough diagnostic approach should be followed.

Animals suspected of having a potentially life-threatening problem should receive: fecal examinations for parasites, complete blood count, biochemical profile, urinalysis, and survey abdominal radiographs. Additional procedures may be necessary to confirm specific disorders.

Giardia can be identified in animals with either self-limiting or life-threatening acute diarrhea. Because fecal examination should be the initial diagnostic test ordered, a diagnosis can often be reached without performing many unnecessary and expensive diagnostic tests.

Diagnosis of *Giardia* can usually be made by appropriate fecal examination techniques. If giardiasis is suspected, but cannot be confirmed, a therapeutic trial may be indicated. However, cessation of diarrhea after treatment does not confirm a definitive diagnosis of giardiasis.

Microscopic examination of a drop of fresh feces mixed with a drop of normal saline may allow identification of motile trophozoites. Trophozoites can be identified by their rapid "falling leaf" motion and concave ventral surface. Trophozoites may be associated with mucus and the only motility visible may be the flagella. Trichomonads are the only other motile organism similar in size (11x7um) to *Giardia*. They may be differentiated from *Giardia* by an undulating membrane along the entire length of the body, rolling rapidly progressive and erratic motility, lack of a concave surface and a single nucleus. Trophozoites are not often found in semi-formed or firm feces. One study in dogs showed that examination of fresh feces on 3 separate days identified approximately 40% of dogs infected with *Giardia*. In that study, approximately 90% of infected dogs were identified with three zinc sulfate fecal examinations.

Examination of feces by zinc sulfate flotation is considered to be the most accurate, practical, rapid, and inexpensive, diagnostic test available. In addition to identifying *Giardia* cysts, eggs of common parasites can also be seen. Approximately 2 gm of feces are mixed with 15 ml of a 33% solution of zinc sulfate, strained, the tube filled with additional zinc sulfate, and centrifuged for 3-5 minutes at 1500 rpm. If a free-swinging head centrifuge is available, additional zinc sulfate is added to create a meniscus and the tube covered with a coverslip. The coverslip can be transferred to a microscope slide for examination after centrifugation. If a fixed-head centrifuge is used, the surface layer of fluid can be transferred to a microscope slide with the bottom of a small glass tube or bacteriologic loop. The microscope slide or coverslip can be examined for cysts. Lugol's iodine may be added to the centrifuge tube to stain cysts and make identification easier. However, with experience, cysts can be identified without staining. Yeast can sometimes be confused with *Giardia*. Most yeast are approximately half as large as *Giardia* cysts and don't contain internal structures. Barium sulfate, several proprietary antidiarrheals, and enemas administered prior to collection of feces may interfere with *Giardia* detection. A recent study clearly demonstrated the importance of centrifugation of zinc sulfate fecal flotations. In fecal samples in which the solution was not centrifuged, 1/50 samples was positive for *Giardia* cysts. When the samples were centrifuged, 11/50 samples were positive for *Giardia* cysts and an additional 8 cases of whipworms were also identified.

Duodenal aspiration of fluid with examination of the sediment for motile trophozoites was at one time considered the gold standard for diagnosis of *Giardia* in dogs. Unfortunately this requires either endoscopy or exploratory laparotomy. Ten ml of saline can be infused into the duodenum, through a polyethylene tube passed through the biopsy channel of an endoscope or with a needle and syringe during exploratory laparotomy. The fluid should be aspirated, centrifuged, and immediately examined microscopically for motile trophozoites. A study published in 1983 comparing duodenal aspiration and zinc sulfate flotation found that duodenal aspiration was positive in 89% of cases while a single zinc sulfate flotation was positive in only 39% of cases. Two more recent studies performed in the author's institution have contradicted these findings. In a group of research dogs carefully monitored for parasites during a 17 month period, a single zinc sulfate examination identified 77% of infected dogs while a duodenal aspirate identified 67%. More recent investigation found that 3 zinc sulfate examinations identified 96% of infected dogs verses 88% with duodenal aspiration. These recent studies support the validity of zinc sulfate flotation as the diagnostic test of choice for *Giardia* in dogs. A recent review of clinical cases in which duodenal aspiration was performed during upper GI endoscopy, found very few positive tests for *Giardia*. The reasons why so few *Giardia* infections were identified were thought to be due to the frequent treatment with metronidazole and the use of zinc sulfate fecal flotation prior to endoscopy. Thus, cases with *Giardia* were either identified or responded to treatment, avoiding the necessity of endoscopic examination. The authors recommended that duodenal aspiration be performed in cases undergoing upper GI endoscopy if treatment for *Giardia* has not administered or if zinc sulfate floatation was not performed.

Several fecal ELISA tests have been marketed for human use. These tests identify *Giardia* specific antigens from trophozoites. Use of one of these tests (Prospect T/Giardia™, Alexon Inc., Mountain View, CA) yielded similar results to zinc sulfate flotation in 84% of examinations in dog feces. However, in 15% of examinations, the ELISA was positive when a single zinc sulfate examination was negative. *Giardia* was subsequently identified in approximately half of these cases when two additional zinc sulfate flotations were examined. In 1% of fecal samples, the ELISA was negative while the fecal examination was positive. Another report found that a fecal ELISA test was falsely negative in 14% of zinc sulfate positive samples from dogs. This study also found a positive ELISA in 10% of zinc sulfate negative samples. These studies point out that falsely negative ELISA tests occur, and suggest that a negative fecal ELISA does not eliminate the possibility of *Giardia* infection. In addition, it is possible that the fecal ELISA may be a more sensitive test and identify some cases of *Giardia* missed with zinc sulfate examination. Because of the expense of the fecal ELISA tests, the time required to perform the assay, the lack of identification of other parasite eggs, and the lack of data from cats, the author recommends using zinc sulfate flotation as the test of choice in identifying animals infected with *Giardia*. The Prospect/Giardia assay

has been modified and is available as a rapid in-office test. In one study of natural infection in research dogs, in 31.6% of fecal samples cysts were identified by zinc sulfate flotation, but the rapid ELISA was negative. In 4.3 % of fecal samples cysts were not seen with zinc sulfate but the ELISA was positive. Recently, a rapid in-office ELISA has been marketed for veterinarians (IDEXX SNAP® Giardia). Preliminary sensitivity and specificity data look promising.

Treatment

The author recommends using either metronidazole or fenbendazole for treating giardiasis in dogs and cats. The dosage of metronidazole should be 50 mg/kg SID for 5 days. It has been previously suggested to split the dosage and administer it BID. In one study it was effective in 67% of infected dogs at 22 mg/kg BID for 5 days. In a different study in a group of research cats, 25mg/kg BID of metronidazole benzoate suspension resulted in negative fecal samples 15 days after treatment. Tablets should not be divided as the medication is bitter and unpalatable. Compounding with tasty flavors, such as tuna or sardine juice, will increase palatability for cats and small dogs that receive less than one tablet. Some authors have found that a lower dosage, 10 mg/kg BID, is effective in cats. Severe neurologic side effects, including seizures and coma, have been reported in dogs receiving higher dosages or prolonged treatment. However, neurologic signs can occur with lower dosages, but are usually reversible if the drug is discontinued. Metronidazole is a potential mutagen and carcinogen, so treatment of pregnant animals should be avoided. Metronidazole enters the parasite by passive diffusion. Under anaerobic conditions, the compound is reduced, forming toxic derivatives that bind to DNA, RNA, and other proteins, leading to denaturation and strand breakage. In humans, metronidazole is metabolized in the liver. Sixty to eighty percent of the metabolites and parent compound is eliminated by the kidney. Approximately 15% is eliminated in the feces. Drug interactions are uncommon, but phenobarbital and prednisone may increase hepatic metabolism while cimetidine may decrease it.

Fenbendazole, a drug that has been utilized for many years in dogs without toxicity, has been shown to be very effective in treating research dogs with *Giardia* at a dosage of 50 mg/kg SID for three days. Fenbendazole has the advantage of being effective against hookworms, roundworms, whipworms, and some tapeworms. It is poorly soluble in water and rapidly passes through the gastrointestinal tract. It mechanism of action is believed to be binding with the parasite tubulin and inhibiting microtubule assembly. It is safe to administer to pregnant animals. Fenbendazole has been shown to be safe in cats at up to 250 mg/kg SD for 9 days. Fenbendazole, 50 mg/kg SID for 5 days, resulted in negative fecal samples 23 days after treatment in 4 of 8 research cats that were co-infected with *Cryptosporidium parvum*. Febantal, which is metabolized to fenbendazole, combined with praziquantel and pyrantel was effective in research dogs naturally infected when treated for either 3 or 5 days. In this research setting bathing the dogs after treatment and moving to a clean environment was very important. The large animal anthelmintic, albendazole (Valbazen® Suspension, SmithKline Beecham) was reported to be safe and effective in treating dogs with *Giardia* at a dosage of 25 mg/kg bid for 2 days. However, recent clinical data has demonstrated bone marrow depression can develop in dogs and cats. The author does not currently recommend the use of albendazole.

Furazolidone (Furoxone® Suspension, SmithKline Beecham) is available as a suspension and is convenient to administer to cats and small dogs (4 mg/kg BID for 7 days). It has been shown to be effective in cats. Quinacrine has been shown to be 100% effective in dogs at 6.6 mg/kg BID For 5 days. Approximately half of the dogs treated developed minor and reversible anorexia, fever, or lethargy. Quinacrine has been shown to improve clinical signs in cats but not to eliminate infection. Unfortunately, quinacrine is not currently available in the United States.

Persistent clinical signs or shedding of cysts after treatment may suggest treatment failure, lack of client compliance, reinfection (can be from the animal's hair coat), misdiagnosis, or underlying gastrointestinal disease. Confirming the diagnosis by a different diagnostic test or having a fecal sample evaluated by a commercial laboratory, evaluating client compliance, treating for 10 days, using a different medication, changing the animal's environment, or further diagnostic testing to identify a primary gastrointestinal disorder is indicated.

Zoonosis

Estimates of the number of human infections within the United States in 2002 ranged from 424,000 to 2.1 million. Human infection is acquired via consumption of contaminated food or water, or person to person or animal to person transmission (the Centers for Disease Control and Prevention consider *Giardia* to be a potentially zoonotic disease). Direct animal to person transmission may be responsible for only a mall percentage of human cases. However, the contribution of animals to contamination of water is unknown. Some *Giardia* strains are capable of infecting humans and dogs and cats, In the past, studies evaluating zoonosis have yielded contradictory results. The genetic diversity and population structure of *Giardia* has not been fully understood until recently. Molecular genetic studies have recently found that most strains that infect humans are different from most strains that infect dogs and cats. However, it is prudent to consider zoonotic transmission from dogs and cats possible, so adequate precautions should always be taken when contacting feces or infected animals.

Large numbers of cysts can be intermittently shed for long periods of time. Cysts are very susceptible to drying and many common disinfectants. Quaternary ammonium compounds inactivated cysts more rapidly and at lower concentrations than phenolic or a group of miscellaneous compounds. Phenolic compounds were effective but required longer application times. Many of the miscellaneous disinfectants were effective only at higher temperatures. Dog and cat feces should be disposed of promptly and hands washed immediately after contact with feces or infected pets. If the hair coat is soiled with feces, the pet should be shampooed to remove fecal material. Children and immunocompromised adults should avoid contact with feces or infected pets.

Trichomoniasis

Tritrichomonas foetus is an anaerobic protozoa with an undulating membrane and 3-5 flagella. It varies in length from 10-25 um and 3-15 um in width. It has been described as causing chronic large bowel diarrhea and fecal incontinence, especially in purebred cats from catteries. Clinical signs often develop around 1 year of age. Greatly increased frequency of defecation and hematochezia are typical. Diarrhea often spontaneously resolves after approximately 1 year, although it may take up to 2 years in some cats. In one study, approximately 50% of cats were found to be positive by PCR despite resolution of diarrhea for almost 3 years! In a study from a cat show, approximately 30% of catteries were found to have a positive cat and about 30% of all cats tested were positive. Recently the organism was found to be a separate species from that found in cattle and renamed *Tritrichomonas blagburni*.

Diagnosis can be made by examination a fresh fecal / saline smear, InPouch TF culture, or PCR of feces. On a saline smear the organisms move in a jerky erratic and rapid manner. Movement can be observed on the following websites:
www.vetmed.auburn.edu/~blagbbl/blagburn.mpg

www2.ncsu.edu/unity/lockers/project/cvmaprhome/gookin_jody.htm

Examination of a fecal smear may be positive in only about 15% of cases. The BioMed Feline InPouch^{TM} contains antibiotics to limit bacterial growth. Approximately 0.05 g of fresh feces is incubated at 25°C and examined under 400x every 48H. This method may detect approximately 55% of positive cats. PCR evaluation of feces has been shown to detect approximately 95% of infected cats.

Treatment of cats is difficult. The best currently available treatment is ronidazole 30mg/kg SID-BID for 10 days. Many cats will develop reversible neurologic toxicity 3-9 days into treatment. Clinical signs include anorexia, lethargy, trembling, agitation, instability, and a blank stare. In many cats, signs of toxicity will resolve 6-10 days after stopping the treatment. Feces often become normal within 10 days of treatment. Treatment with paromomycin cannot be recommended as acute renal failure may occur!

References

Leib M, Zajac A. Giardiasis in dogs and cats. Vet Med 1999; 94: 793-802.

Zajac AM. Giardiasis. Comp Cont Educ Pract Vet 1992; 14: 604-611.

Barr SC, Bowman DD. Giardiasis in dogs and cats. Comp Cont Educ Pract Vet 1994; 16: 603-610.

Leib M, Dalton M, King S, et al. Endoscopic aspiration of intestinal contents in dogs and cats: 394 cases. J Vet Int Med 1999; 13: 191-193.

Leib M, Matz M. Diseases of the intestines. In: Leib M, Monroe W (ed.). Practical Small Animal Internal Medicine. Philadelphia, WB Saunders, 1997; 685-760.

Leib MS, Zajac AM. Giardia: Diagnosis and treatment. In: Bonagura JD, Kirk RW (ed.). Current Veterinary Therapy XII. Philadelphia, W. B. Saunders Company, 1995; 716-720.

Zimmer JF, Burrington DB. Comparison of four techniques of fecal examination for detecting canine giardiasis. J Am Anim Hosp Assoc 1986; 22: 161-167.

Zajac AM, Leib MS, Burkholder WJ. Giardia infection in a group of experimental dogs. J Sm Anim Pract 1992; 33: 257-260.

Leib MS, Zajac AM, Hahn N, et al. Comparison of diagnostic tests in dogs experimentally infected with Giardia (abst). J Vet Int Med 1992; 6: 129.

Barr SC, Bowman DD, Erb HN. Evaluation of two test procedures for diagnosis of giardiasis in dogs. Am J Vet Res 1992; 53: 2028-2031.

Scorza AV, Lappin MR. Metronidazole for the treatment of feline giardiasis. J Fel Med Surg 2004; 6: 157-60.

Keith CL, Radecki SV, Lappin MR. Evaluation of fenbendazole for treatment of Giardia infection in cats concurrently infected with Cryptosporidium parvum. Am J Vet Res. 2003: 64: 1027-1029.

Schwartz RD, Donoghue AR, Baggs RB, et. al. Evaluation of the safety of fenbendazole in cats. Am J Ver Res 2000; 61: 330-332.

Stein JE, Radecki SV, Lappin MR. Efficacy of Giardia vaccination in the treatment of giardiasis in cats. J Am Vet Med Assoc 2003; 222: 1548-1551.

Payne PA, Ridley RK, Dryden MW, et. al. Efficacy of a combination febantel-praziquantel-pyrantel product, with or without vaccination with a commercial Giardia vaccine, for treatment of dogs with naturally occurring giardiasis. J Am Vet Med Assoc 2002; 220: 330-333.

Zajac AM, Johnson J, King SE. Evaluation of the importance of centrifugation as a component of zinc sulfate fecal flotation examinations. J Am Anim Hosp Assoc 2002; 38: 221-224.

McGlade TR, Robertson ID, Elliot AD, et. al. High prevalence of Giardia detected in cats by PCR. Vet Parasitol 2003; 110: 197-205.

Monis PT, Thompson RCA. Crytosporidium and Giardia-zoonosis: fact or fiction? Inf Gen Evolut 2003; 3: 233-244.

Thompson RCA. Giardiasis as a re-emerging infectious disease and its zoonotic potential. Int J Parasitol 2000; 30: 1259-1267.

Rosado TW, Specht A, Marks SL. Neurotoxicosis in 4 cats receiving ronidazole. J Vet Intern Med 2007;21:328-331.

Gookin JL, Copple CN, Papich MG, et al. Efficacy of ronidazole for treatment of feline Tritrichomonas foetus infection. J Vet Intern Med 2006;20:536-543.

Stockdale H, Spencer J, Dykstra C, et al. Feline trichomoniasis: an emerging disease? Compend Contin Educ Pract Vet 2006;28:463-471.

Foster D, Gookin J, Poore M, et al. Outcome of cats with diarrhea and Tritrichomonas foetus infection. J Am Vet Med Assoc 2004;225:888-892.

Gookin JL, Stebbins ME, Hunt E, et al. Prevalence of and risk factors for feline Tritrichomonas foetus and giardia infection. J Clin Microbiol 2004;42:2707-2710.

Reprinted in part from Vet Med 94:793-802, 1999 and ACVIM Proceedings May 2000: 586-588.

GI Grab Bag:
Cool Stuff Not Covered Elsewhere

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Medication-induced esophageal strictures in cats

Doxycycline is commonly used in cats to treat many potentially infectious diseases. The drug is acidic and can be caustic to esophageal epithelial cells. It may accumulate within epithelial cells, where it can decrease protein synthesis and potentially decrease mucosal repair. Esophagitis can progress to stricture formation after doxycycline administration in cats. These strictures result in dramatic reduction of the esophageal lumen and severe regurgitation and dysphagia. Clinical signs usually develop within 7-10 days of administration of doxycycline. Treatment requires repeated endoscopic balloon dilation, with is an expensive and invasive procedure. Doxycycline induced esophageal strictures in cats usually occur in the proximal esophagus. Stricture diameter is often very small (often 1-5 mm) at initial diagnosis, smaller than strictures associated with anesthesia and gastroesophageal reflux. Usually re-stricturing is a major problem and affected cats often require more frequent dilations than cats with strictures due to other causes. Intralesional corticosteroid injection may reduce the frequency of repeated dilations. Post-dilation treatments often include and H2 blocker, metoclopramide, sucralfate, prednisone, and in some cats placement of a PEG tube. Oral feeding with a liquid or blenderized diet is often necessary after dilation.

Two recent studies in normal cats have clearly demonstrated that transport of capsules and tablets through the esophagus after "dry" swallows was very delayed. This delay is thought to be responsible for the development of esophagitis and subsequent esophageal stricture formation. As many sick cats are anorectic and potentially dehydrated, it is possible that esophageal transport of tablets and capsules may actually be slower than demonstrated experimentally. To aid transport of tablets and capsules and avoid stricture formation, a 6 ml water flush or a small amount of food should always follow doxycycline administration in cats. Doxycycline should be discontinued at the first signs of regurgitation or dysphagia. Recently esophagitis and strictures have also been seen with clindamycin.

The diagnostic utility of abdominal ultrasound in dogs with chronic vomiting and with chronic diarrhea

Abdominal ultrasonography has recently been added to the diagnostic plan for many dogs and cats with chronic vomiting or chronic diarrhea. Ultrasound has been shown to be very helpful in animals with a mass lesion, especially neoplasia. An ultrasound guided fine needle aspirate or tru-cut biopsy can be performed. Ultrasound has also been shown to helpful in cases with chronic pancreatitis. Other advantages of ultrasound include: being noninvasive, imaging of the liver and biliary system, imaging of the small and large bowel and mesenteric lymph nodes, and assessment of the layers of the GI tract and its motility. Disadvantages include the need for expensive equipment and specialized training, interference by gas within the GI tract, and difficulty in imaging the pancreas.

Two studies have been performed in which the diagnostic utility of abdominal ultrasound in dogs with chronic vomiting or chronic diarrhea has been evaluated. A single radiologist performed each abdominal ultrasound. Two internists, who did not directly participate in case management, reviewed each medical record. In each case, the contribution the ultrasound made towards the final diagnosis was assessed and scored from 1-5, based on the following scale:

1. Diagnosis was obtained via ultrasonography (including ultrasound-guided aspirate or biopsy). Additional biopsy via endoscopy or exploratory celiotomy was not necessary.
2. Ultrasonography provided data that suggested endoscopy was not indicated and exploratory celiotomy should be performed to obtain a diagnosis. Ultrasonography suggested how to obtain a tissue biopsy, making it very important for diagnosis.
3. Ultrasonography provided important diagnostic information that helped assess other data, including endoscopic findings. Ultrasonography was important in arriving at a diagnosis.
4. Ultrasonography provided descriptive information that did not affect assessment of other data obtained via endoscopy or exploratory celiotomy. The same diagnosis would have been reached without performing ultrasonography.
5. Ultrasonography provided conflicting information that did not support, or may have hindered obtaining the final diagnosis.

In the group of dogs with chronic vomiting, the following factors were associated with a higher diagnostic utility of abdominal ultrasound: presence of weight loss, higher percentage of body weight lost, increasing age, increasing duration of vomiting, an increased frequency of vomiting/week, and a final diagnosis of GI lymphoma or gastric adenocarcinoma. Based on diagnostic utility scores, abdominal ultrasonography was vital or beneficial to obtaining a diagnosis in 22.5% of cases, not helpful in 68.5%, and of marginal value in 9%. Considering all contributions to case management (including factors unrelated to the vomiting problem), abdominal ultrasound was considered helpful in 27% of dogs with chronic vomiting.

In the group of dogs with chronic diarrhea the following factors were associated with a higher diagnostic utility of abdominal ultrasound: the presence of weight loss, palpation of an abdominal or rectal mass on initial physical examination, localization of

diarrhea to mixed bowel (vs. large bowel), diseases that commonly have mass lesions that should be visible on ultrasound examination, and a clinical diagnosis of GI neoplasia.

New treatments for IBD

Budesonide

Can be used when corticosteroid side effects are present although clinical signs have improved with prednisone. Budesonide is a corticosteroid related to 16- α -hydroxyprednisolone. Rapid hepatic metabolism (90% first pass) to compounds with minimal biologic activity occur. It has strong affinity for corticosteroid receptors within GI mucosa. It is formulated in 3 mg coated capsule that dissolve at pH>5.5 and deliver medication to distal ileum and proximal colon. Less systemic effects than prednisone but does suppress the pituitary adrenal axis in dogs. Dosage is empirical, but 1-3 mg/day has been suggested. Anecdotal evidence supports its efficacy in IBD.

Cyclosporine

Diminishes cytokine production and exerts and antiproliferative effect on T-lymphocytes. It prevents production of IL-2, IFN-gamma, TNF-alpha, granulocyte-macrophage colony stimulating factor, and IL-4. It is metabolized in the liver via P450 enzymes. Drugs such as ketoconazole, that inhibit hepatic cytochrome P450, increase blood levels of cyclosporine. Toxicity in dogs includes vomiting, diarrhea, anorexia, gingival hyperplasia, papillomatosis, hypertrichosis, alopecia and excessive shedding. Seizures may develop in cats. Dosages 5mg/kg/day. Blood levels can be monitored. It has been shown to be effective in dogs with IBD that were nonresponsive to prednisone. Pharacokinetics in dogs with IBD have been shown to be similar to healthy dogs.

Chlorambucil

Chlorambucil is an alkylating agent with cytotoxic effects similar to cyclophosphamide. It alkylates DNA in proliferating cells, with greater effects on B cells than T cells. Myelosuppression is less severe than cyclophosphamide. It has been utilized in cats with GI small cell lymphoma. Recently it was reported to have success in a group of dogs with IBD and protein losing enteropathy. When used with prednisolone it was more effective compared to a group treated with prednisolone and azathioprine. Serum albumin and body weight improved and survival was lengthened. Starting dosage was 4-6 mg/m^2 q 24 H for 7-21 days and then reduced to q 48H.

Helicobacter gastritis in dogs

Helicobacter pylori infection is the most common cause of chronic gastritis and peptic ulceration in humans. It is also associated with an increased risk of gastric lymphoma and adenocarcinoma. Spiral bacteria were described in 1896 in humans and several animal species. They were "rediscovered" in 1983 when they were reported to cause of peptic ulceration in humans. *Helicobacter pylori* is a microaerophilic curved spiral gram negative organism with 4 flagella. The bacterium lives in gastric mucus, can attach to epithelial cells, and may penetrate intercellular junctions. High bacterial urease concentration cleaves urea to produce ammonia, which helps to neutralize the acid environment surrounding the bacterium. The immune system does not result in removal of the organisms; without treatment infection is life-long. Some studies have shown as many as 90% of people are infected with *H. pylori.* Luckily, most infections are not associated with clinical signs. Diagnosis can be made with serology, cytology of gastric mucus, culture of biopsies, histopathology of biopsies with H&E or silver stains, C-13 or C-14 labeled urea breath tests, or rapid urease tests. Many treatments have been studied, but the gold standard to which they are all compared to is omeprazole, ampicillin or tetracycline, metronidazole, and bismuth for 2 weeks.

Many species of spiral bacteria have been identified in dogs and cats: *H. felis, H. pylori, and H Heilmannii* (formerly called *Gastrospirillum hominis), H. Salomonis,* and *H. bizzozeronii* are the most common. Experimentally, infection has been established in both dogs and cats and lymphoid follicular gastritis developed. However, in these experimental studies, clinical signs were absent or very mild. Several surveys of laboratory, shelter, and pet populations (with and without GI signs) have shown a very high prevalence rate in dogs and cats, nearing 100% in some studies. Peptic ulceration is very rare in dogs and cats, demonstrating the pathophysiologic difference between *H. pylori* and the spiral bacteria commonly found in dogs and cats. Little is known about the effects of treatment of dogs and cats with chronic vomiting and *Helicobacter spp*. infection. At the present time there are many unanswered questions regarding *Helicobacter* in dogs and cats. Some questions include: 1) What is the relationship between *Helicobacter* and dogs and cats with chronic gastritis and vomiting? 2) What is the optimal treatment to eradicate the organism? 3) After treatment, is reinfection or recrudescence a common occurrence in dogs and cats? 4) What factors can help predict if a dog or cat with chronic gastritis and *Helicobacter* would benefit from treatment for *Helicobacter*? 5) Does *Helicobacter* have a role in other diseases such as gastric cancer and inflammatory bowel disease?

Because of the potential pathophysiologic relationship between *Helicobacter spp.* in dogs and cats and chronic gastritis and vomiting, the author has treated clinical cases for *Helicobacter*. In some cases, treatment has resulted in resolution or improvement in clinical signs. Until additional studies about *Helicobacter* in dogs and cats are available, it seems prudent to at least determine if spiral bacteria are present in dogs and cats with chronic vomiting, during gastroscopic examination or exploratory celiotomy. Spiral bacteria can be identified in gastric biopsy or brush cytology specimens, or indirectly identified by rapid urease testing of gastric mucosal samples. Obtaining results from histologic evaluation of biopsy samples requires 24-72 hours. Results of rapid urease tests and gastric brush cytology are available much sooner.

The least expensive and most practical diagnostic method of the 3 commonly used tests, that also has the quickest turnaround time, is gastric brush cytology. After completion of the endoscopic examination and collection of biopsy samples from the duodenum and stomach, a brush cytologic specimen can be collected. A guarded cytology brush is passed through the endoscope's biopsy channel into the gastric body along the greater curvature. The cytology brush is extended from the sheath, and gently rubbed along the mucosa from the antrum towards the fundus, along the greater curvature. Hemorrhagic areas associated with previous biopsy sites should be avoided. The brush is retracted into the protective sheath and withdrawn from the endoscope. The brush is extended from the sheath, gently rubbed across several glass microscope slides, which are air died, and stained with a rapid Wright stain.[a] The slide is examined under 100x oil immersion. Areas with numerous epithelial cells and large amounts of mucus are initially viewed. If present, the spiral bacteria are easily seen. They are usually at least as long as the diameter of a red blood cell and their classic spiral shape is obvious. The author examines at least 10 oil immersion fields on 2 slides before the specimen is considered negative. Unlike diagnostic tests that involve using a single (or several) small biopsy samples, brush cytology gathers surface mucus and epithelial cells from a much larger area, increasing the chances for identification of bacteria. Brush cytology was found to be more sensitive than urease testing or histopathological examination of gastric tissues in identifying *Helicobacter* organisms in dogs and cats.

The rapid urease test detects the presence of bacterial urease, produced by the *Helicobacter spp.*, in a gastric biopsy sample. A commercially available test, the CLOtest®, is utilized in the author's clinic. Individual tests cost approximately $6.00. The test consists of an agar gel with urea and a pH indicator, phenol red, placed within a small plastic well. The tests should be kept refrigerated prior to use. A biopsy sample obtained from the angularis incisura of the stomach is pushed into the gel. The test is maintained at room temperature and examined frequently for a 24-hour period. If bacterial urease is present, urea will be hydrolyzed to ammonia, which will change the pH of the gel. The color of the gel will turn from yellow to magenta. The rate at which the gel changes color is proportional to the number of *Helicobacter spp.* present. When large numbers of bacteria are present in the biopsy sample, the rapid urease test quickly changes color, often within 15-30 minutes. If the color of the gel has not changed within 24 hours, the test is interpreted as negative. Because of false positives and negatives, the cost of the tests, the turn around time for test results (especially if negative), and the ease and reliability of brush cytology, the author feels that the rapid urease test is the least valuable of the 3 commonly utilized methods of diagnosis in my clinic.

Histopathologic identification of *Helicobacter spp.* within gastric biopsy samples, utilizing hematoxylin and eosin (H&E) or special stains, has a specificity of 100% and a sensitivity of greater than 90% in studies in humans. Because of the patchy distribution of organisms within the stomach, examination of samples from multiple gastric locations will increase sensitivity. In my clinic, samples from the pylorus, angularis incisura, gastric body along the greater curvature, and the cardia are routinely examined. Spiral bacteria can be seen within the mucus covering the surface epithelium, within the gastric pits, glandular lumen, and the parietal cells. In cats, bacteria have been identified submucosally within gastric lymphoid follicles. Spiral bacteria associated with the mucosal surface or within gastric pits are relatively easy to detect with routine H&E staining of tissues. However, if the distribution of bacteria favors gastric glands and glandular epithelial cells, bacteria are much more readily detected with a silver technique. Therefore, if bacteria are not identified with H&E staining, a modified Steiners Silver stain is used. Because of similarities in morphologic characteristics it is not possible to identify specific species using routine histologic staining techniques. Besides the identification of *Helicobacter*, histopathologic evaluation of biopsy samples allows assessment of underlying inflammation or neoplasia, which may be the cause of the animal's clinical signs.

I have completed recently a clinical study comparing 2 treatments for *Helicobacter* in dogs. Dogs with chronic vomiting for at least 2 weeks, with *Helicobacter spp*. identified in gastric biopsy samples and gastritis, with or without inflammatory bowel disease, were entered into the study. The diagnostic workup included a CBC, biochemical profile, UA, fecal examination, abdominal ultrasonography, gastroduodenoscopy with mucosal biopsy, gastric cytology, and CLO test. Dogs with systemic diseases, gastric foreign bodies, gastric / duodenal neoplasia, pyloric hypertrophy, or *Physaloptera* infection were not eligible for the study. Dogs were randomly assigned to receive either triple therapy (amoxicillin 15 mg/kg, metronidazole 10 mg/kg, and Pepto Bismol tablets [(<5 kg; 0.25 tablet, 5-9.9 kg; 0.5 tablet, 10-24.9 kg; 1.0 tablet, and >25 kg; 2.0 tablets]) or quadruple therapy (triple therapy plus famotidine 0.5 mg/kg). All drugs were given BID for 2 weeks. Owners kept a daily diary of clinical signs and endoscopy was repeated 4 weeks and 6 months after treatment was completed. Results of the study have not yet been published but have been reported in abstract form. Six months after completing either therapy, approximately 40% of dogs had gastric biopsy specimens that were negative for *Helicobacter*. There was no difference between the 2 treatments in the percentage of dogs that remained negative. Both treatments reduced the frequency of vomiting by approximately 85%. Dogs that were negative for *Helicobacter* had a greater reduction in vomiting frequency that those that were positive.

Because of the high rate of treatment failure in this study after 6 months, I have been investigating the use of clarithromycin based protocols; clarithromycin (7.5 mg/kg BID), in combination with amoxicillin (15 mg/kg BID) or omeprazole (0.7mg/kg SID). This study is ongoing, but preliminary data 4 weeks after completion of therapy appears to be similar to triple or quadruple therapy. A recent study treated a small number of dogs and cats for 3 weeks using triple therapy. Eradication results were encouraging.

It will take many controlled clinical studies before we can understand the potential role of *Helicobacter* in dogs and cats with chronic gastritis, and can answer many of the questions I have proposed. Although treatment of *Helicobacter* offers another, and very different, therapeutic route for animals with chronic gastritis, we must remember that a direct cause and effect relationship between *Helicobacter* and chronic gastritis has not yet been established in dogs or cats. Failure of a patient to rapidly respond to antimicrobial treatment suggests that something besides *Helicobacter* is causing the chronic gastritis and vomiting.

Giardiasis and zoonosis

Estimates of the number of human infections within the United States in 2002 ranged from 424,000 to 2.1 million. Human infection is acquired via consumption of contaminated food or water, or person to person or animal to person transmission (the Centers for Disease Control and Prevention consider *Giardia* to be a potentially zoonotic disease). Direct animal to person transmission may be responsible for only a mall percentage of human cases. However, the contribution of animals to contamination of water is unknown. Some *Giardia* strains are capable of infecting humans and dogs and cats, In the past, studies evaluating zoonosis have yielded contradictory results. The genetic diversity and population structure of *Giardia* has not been fully understood until recently. Molecular genetic studies have recently found that most strains that infect humans are different from most strains that infect dogs and cats. However, it is prudent to consider zoonotic transmission from dogs and cats possible, so adequate precautions should always be taken when contacting feces or infected animals.

References

Melendez L, Twedt D, Wright M. Suspected doxycyline-induced esophagitis with esophageal stricture formation in three cats. Fel Pract 2000;28:10-12.

German A, Cannon M, Booth M, et al. Oesophageal strictures in cats associated with doxycycline therapy. J Fel Med Surg 2005;7:33-41.

Graham J, Lipman A, Newell S, et al. Esophageal transit of capsules in clinically normal cats. Am J Vet Res 2000;61:655-657.

Westfall D, Twedt D, Steyn P, et al. Evaluation of esophageal transit of tablets and capsules in 30 cats. J Vet Intern Med 2001;15:467-470.

Beatty JA, Swift N, Foster DJ, et. al. Suspected clindamycin-associated oesophageal injury in cats: five cases. J Fel Med Surg 2006; 8:412-419.

Leib MS, Larson MM, Panciera DL, et. al. Diagnostic utility of abdominal ultrasonography in dogs with chronic vomiting . J Vet Int Med 2010; 24: 803-808.

Geyer C, Colbatzky F, Lechner J, et al. Occurrence of spiral-shaped bacteria in gastric biopsies of dogs and cats. Vet Rec 133: 18-19, 1993.

Happonen I, Saari S, Castren L, et al. Comparison of diagnostic methods for detecting gastric Helicobacter-like organisms in dogs and cats. J Comp Path 115: 117-127, 1996.

Happonen I, Linden J, Saari S, et al. Detection and effects of helicobacters in healthy dogs and dogs with signs of gastritis. J Am Vet Med Assoc 213: 1767-1774, 1998.

Yamasaki K, Suematsu H, Takahashi T. Comparison of gastric lesions in dogs and cats with and without gastric spiral organisms. J Am Vet Med Assoc 212: 529-533, 1998.

Happonen, I, Linden J, Westermarck E. Effect of triple therapy on eradication of canine gastric helicobacters and gastric disease. J Sm Anim Pract 41: 1-6, 2000.

Neiger R, Simpson K. Helicobacter infection in dogs and cats: facts and fiction. J Vet Int Med 14: 125-133, 2000.

Flatland B. Helicobacter infection in humans and animals. Comp Cont Educ Pract Vet 24: 688-698, 2002.

Leib MS, Duncan RB, Ward DL. Triple antimicrobial therapy and acid suppression in dogs with chronic vomiting and gastric Helicobacter spp. J Vet Int Med 21: 1185-1192, 2007.

Monis PT, Thompson RCA. Crytosporidium and Giardia-zoonosis: fact or fiction? Inf Gen Evolut 2003; 3: 233-244.

Thompson RCA. Giardiasis as a re-emerging infectious disease and its zoonotic potential. Int J Parasitol 2000; 30: 1259-1267.

Dietary Management of Diarrhea

Michael Leib, DVM, MS, DACVIM
Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA

Dietary management is a vital component of successful treatment of many Gastrointestinal (GI) diseases that cause diarrhea. Some conditions can be managed with diet alone, while others require concurrent medical management. In these cases, dietary management may facilitate the use of lower medication dosages, reducing the potential for side-effects. This seminar will provide an overview of "GI" diets and will briefly review the principles of dietary management of selected diarrheal disorders of the dog and cat.

"GI" diets

The traditional GI diet should be highly digestible, low in fat, low in fiber, and contain high quality nutrients. Some diets are lactose and gluten free, although the necessity of omitting these substances has not been proven. Decreasing fat content often reduces palatability, so many of the commercially available GI diets contain low-moderate fat levels compared to maintenance diets. Although many home-made recipes are available, most veterinarians utilize commercially available diets "GI" diets for client practicality and ease and consistency of treatment. Each of the major prescription pet food companies markets a "GI" diet. These diets adhere to the nutritional profile discussed above and are more similar to each other than different. Each company has components of their diet that they feel make it superior to their competitors, however published results proving benefits of these diets or direct comparisons between these diets in spontaneous canine and feline diseases are lacking.

Hills markets dry and canned i/d which can be fed to puppies and kittens and adult dogs and cats. The diet contains a low level of soy fiber, which has properties of both insoluble and soluble fibers. Nestle Purina markets EN in both dry and canned formulations for dogs and as a pouch for cats. In the canine diet approximately 30% of the fat is supplied as medium chain triglycerides, which are easier to assimilate than long chain triglycerides and are absorbed directly into the portal system. EN can also be fed to puppies. The feline product contains added soluble fiber. Both diets contain a ratio of omega-3 and omega-6 fatty acids which may be beneficial in managing inflammation. The Iam's product is low-residue, available as a dry formulation for puppies, and dry and canned for adult dogs and cats. These products contain beet pulp fiber, which is insoluble, but highly fermentable. They also contain fructooligosaccharides, which are metabolized by enteric bacteria and promote a healthy gut flora. They also are enhanced with omega-3 fatty acids. Waltham diets are marketed by their recent merger partner Royal Canin. Their low fat diet is available as a dry and canned product which is suitable for puppies and adult dogs. It contains the lowest level of fat of any of the prescription products. Innovative Veterinary Diets markets canine sensitive for adult dogs in a dry and canned formulation and a dry formulation for adult cats. The canine diet contains fructooligosaccharides and is supplemented with amylase, lipase, and protease. The feline product has enhanced levels of omega-3 fatty acids.

Acute vomiting and/or diarrhea

There are many causes of acute vomiting/diarrhea. Most cases are mild and self-limiting and can be easily managed. Dietary indiscretion is a very common cause of acute vomiting and/or diarrhea. For most vomiting cases, withholding food and water (NPO) and maintaining hydration with subcutaneous fluids is important. The animal should be held NPO until vomiting does not occur for 12-24 hours. Initially water should be offered in small amounts. If vomiting does not occur a "GI" diet or a homemade equivalent should be fed in small frequent meals. If vomiting does not occur the amount fed is gradually increased to meet maintenance requirements. The "GI" diet should be fed for 3-5 days after vomiting ceases and the animal's original diet slowly reintroduced over 3-5 days. Causes of dietary indiscretion should be corrected.

In cases of diarrhea, holding animals NPO is somewhat controversial. I usually without food for 12 hours and then initiate feeding a "GI" as described for acute vomiting. Digestibility of the diet is extremely important when treating diarrhea as malabsorbed nutrients can lead to worsening of diarrhea due to osmotic forces and potentially bacterial overgrowth. In addition, low fat content is important because malabsorbed fats can be acted on by intraluminal bacteria and form hydroxy fatty acids, which can worsen diarrhea by decreasing mucosal absorption, increasing secretion, altering mucosal permeability, and altering intestinal motility.

Lymphangiectasia

Dilation of small intestinal lymphatics and rupture into the lumen leads to protein losing enteropathy and low serum proteins in dogs. Cases may be idiopathic, or secondary to chronic inflammatory conditions of the small intestine. The aim of dietary management is to decrease lymphatic flow by supplying a very low fat diet. Reduced fat diets used for weight control, such as Hills r/d, Purina OM, Iams reduced calorie dry, or Royal Canin calorie control dry can be effective. Caloric supplementation with medium chain triglyceride oil (MCT) may be necessary. Medium chain triglycerides are absorbed into the venous system, not via lymphatics, and do not stimulate lymphatic flow. Ultra-low fat home made diets consisting of low fat cottage cheese, rice and potatoes can be very effective.

Plasmacytic lymphocytic enterocolitis – Inflammatory bowel disease

Inflammatory bowel disease is a common idiopathic condition in dogs and cats that causes vomiting and/or diarrhea of small and/or large bowel origin. Diagnosis requires histologic demonstration of intestinal inflammation in the absence of known causes of intestinal disease. Increased mucosal permeability leads to penetration of the mucosa by food antigens and initiation of hypersensitivity, that worsens the inflammatory process. it is also possible that dietary hypersensitivity may play a role in the initiation of mucosal damage.

Because of the potential role of dietary antigens as either a primary or secondary factor in the pathogenesis of IBD, hypoallergenic diets have been recommended as the initial treatment. A hypoallergenic diet must contain protein and carbohydrate sources novel to the patient. A thorough dietary history should be obtained to determine which ingredients the animal has not been previously exposed to. Many hypoallergenic diets are commercially available and utilize lamb, egg, rabbit, venison, duck, fish, or kangaroo as a protein source (Table 1). A homemade diet can also be formulated using these protein sources, or others such as cottage cheese or tofu with rice or potatoes as a carbohydrate source. Homemade diets can be deficient in vitamins and minerals. They can be safely fed for trial periods, but must be completely balanced for long term use. Vitamin and mineral supplements must be carefully selected because many contain extracts and flavorings.

The hypoallergenic diet should be fed for four weeks and must be the only nutrient source that the dog or cat receives. Other household pet's food, table scraps, treats, and flavored vitamin, heartworm, and flea products must be avoided. Free roaming animals must be strictly supervised to avoid the potential for dietary indiscretion. If the clinical signs resolve when the hypoallergenic diet is fed, the animal should be challenged with its original diet. Clinical signs should rapidly return if dietary hypersensitivity is a component of IBD.

Although hypersensitivity can occur to any dietary constituent, common offending allergens include beef, cows milk, eggs, fish, wheat, soybeans, oats, or corn. There is some clinical evidence the animal can subsequently develop hypersensitivity to other antigens. Some have advocated rotating diets to prevent this from occurring. In addition, use of a "sacrificial" hypoallergenic diet along with anti-inflammatory medications, until the mucosal barrier is repaired, and then switching to a different hypoallergenic diet has be suggested. Poorly digestible novel proteins may induce hypersensitivity in patients with increased mucosal permeability because protein digestion usually renders it non-allergenic. Cooked eggs and cottage cheese are assimilated more readily than many meats and may be more hypoallergenic to intestinal mucosa than meat-based diets.

Recently, hydrolized protein diets have been developed in which protein size has been reduced and are no longer antigenic. Hills z/d ultra (dogs) and z/d low allergen (cats) contains hydrolyzed chicken liver and muscle. Purina HA (dogs) and royal Canin Hypoallergenic HP (dogs and cats) contain hydrolyzed soy protein. These products are available as dry formulations only. The diets meet many of the criteria for “GI” diets also, as they are relatively low in fat, low in fiber, and highly digestible.

A recent study in cats with chronic GI signs emphasizes the importance of hypoallergenic diets in the treatment of IBD. Out of 55 cats with idiopathic IBD treated with an elimination diet, based on dietary history, 16 were confirmed to have dietary sensitivity and 11 others responded to the hypoallergenic diet. These 11 cats did not have their clinical signs return when challenged with their original diet. The most common offending substances were beef, wheat, corn, gluten.

Probiotics

Probiotics are live bacteria that confer a health benefit to the host. Common bacteria include lactobacilli, bifidobacteria, and enterococci. In humans a daily dose is often 5-10 million. To be effective viability must be maintained throughout production, storage, distribution, passage through the upper GI tract into the colon. Many commercially available products do not survive transit into the colon and are not as effective as “advertised”. The bacteria should be able to be cultured from the feces during treatment, but will usually disappear once oral administration ends. The bacteria must be nonpathogenic and not transmit antibiotic resistance.

Probiotic bacteria have been reported to have many beneficial effects on the host including conditioning the immune system, synthesizing B vitamins, producing digestive enzymes, producing antibacterial factors, competing with pathogens for adhesion sites and nutrients, enhancing epithelial repair, increasing mucus production, decreasing luminal pH, and protecting tight junctions. However, all probiotics do not do all of the above. In humans some probiotics have been shown to be beneficial in acute infectious diarrhea, prevention of antibiotic associated diarrhea, pouchitis, cow’s milk allergy, IBD, and irritable bowel syndrome. Currently there is accumulating but weak evidence demonstrating benefits of probiotics in dogs and cats with diarrhea.

Chronic idiopathic large bowel diarrhea

I routinely add soluble fiber to a highly digestible diet in dogs with chronic idiopathic large bowel diarrhea, even if irritable bowel syndrome has been diagnosed. In cases of fiber-responsive large bowel diarrhea (FRLBD), chronic intermittent or continuous large bowel diarrhea is usually accompanied by hematochezia, excess fecal mucus, and tenesmus. Abdominal pain and vomiting can occur in some dogs. Nervousness, abnormal personality factors, and stressors have been identified in approximately 40% of cases. However, in some of these cases, a temporal relationship to the diarrhea could not be established.

Soluble fiber, psyllium hydrophilic mucilloid (Metamucil®, Procter & Gamble), added to a highly digestible diet (i/d® Hills), has resulted in excellent or very good results in approximately 80% of dogs with chronic idiopathic large bowel diarrhea. In the authors' cases, the median amount of Metamucil® added to the diet was two TBSP / day which was approximately 1.3 g psyllium / kg / day. I have not been able to identify any clinical findings that help to predict whether a dog will respond to fiber supplementation. In some dogs, the amount of fiber added to the diet can be reduced or withdrawn entirely, while in others the highly digestible diet can be replaced with a grocery store brand of food after the diarrhea resolves.

Dietary fiber is a collective term for a wide variety of plant polysaccharides and lignins that are resistant to mammalian digestive enzymes. There are many types of dietary fiber, each with diverse chemical, physical, and physiologic properties. Water soluble fibers include pectin, gums, mucilages, and some hemicelluloses. They are found in the parenchymatous portions of fruit and vegetables, and in the seeds of leguminous plants. Water insoluble fibers includes cellulose, lignin, and some hemicelluloses. They are found in cereal grains and seed coats.

There are several potential mechanisms by which dietary fiber supplementation may result in clinical improvement in dogs with FRLBD. Soluble fiber adsorbs a large quantity of water, improving fecal consistency. Colonic bacteria, which make up approximately 40-55% of the dry stool mass, ferment soluble fiber, which results in a vast increase in the numbers (but not types) of colonic bacteria and quantity of bacterial byproducts. Bacterial fermentation of fiber leads to the production of short chain fatty acids, of which butyrate serves as an energy source for colonocytes. Insoluble fiber greatly adds to fecal volume. Thus, dietary fiber can increase fecal bulk which increases colonic distention, the major stimulus for normal colonic motility. With increased colonic distention, an improved motility pattern in dogs with FRLBD may result in resolution of clinical signs.

Psyllium comes from the seeds or husks of the plant ispaghul and consists of approximately 90% soluble fiber. Although there are no other reported studies evaluating the use soluble fibers in dogs with diarrhea, there are in human beings. Treatment with psyllium has been shown to be beneficial in children with nonspecific chronic diarrhea of childhood, adults with chronic idiopathic diarrhea, patients with ulcerative colitis in remission, and some with irritable bowel syndrome. Psyllium has also been shown to improve diarrhea in human burn patients receiving enteral nutrition and in another group of tube-fed patients. Psyllium also improved fecal consistency in humans with experimentally induced secretory diarrhea and also reduced the acceleration of colonic transport in those with lactulose-induced diarrhea.

Table 1. Some limited antigen foods

Company	Food name	Major ingredients	dog or cat	dry or canned
Hills	d/d	Egg, rice	dog	dry
Hills	d/d	Duck, rice	dog	dry
Hills	d/d	Salmon, rice	dog	dry
Hills	d/d	Lamb, rice	dog / cat	canned
Hills	d/d	Whitefish, rice	dog	canned
Purina	LA	Salmon, trout, rice	dog	dry
Iams	Response FP	Catfish, potato	dog	dry, canned
Iams	Response KO	Kangaroo. oats	dog	dry
Iams	Response LB	Lamb, barley	cat	canned
Innovative Veterinary Diets	Limited ingredient diet	Lamb, potato	dog, cat	dry, canned
Innovative Veterinary Diets	Limited ingredient diet	Venison, potato	dog, cat	dry, canned
Innovative Veterinary Diets	Limited ingredient diet	Duck, potato	dog, cat	dry, canned (dog only)
Innovative Veterinary Diets	Limited ingredient diet	Rabbit, potato	dog, cat	dry, canned
Innovative Veterinary Diets	Limited ingredient diet	Whitefish, potato	dog	dry, canned
Royal Canin	Sensitivity RC, LR	Catfish, rice	dog	dry (RC), canned (LR)
Royal Canin	Sensitivity RD, VR	Duck, rice	cat	dry (RD), canned (VR)
Wysong	Anergen	Lamb, rice	dog, cat	dry, canned
Nature’s Recipe	Allergy	Venison rice	dog	dry, canned
Nature’s Recipe	Allergy vegetarian	Rice, soy,barley	dog	dry, canned
Natural Life	Lamaderm	Lamb, rice	dog, cat	dry, canned
Sensible Choice		Lamb, rice	dog,	dry

References

Leib M. Treatment of chronic idiopathic large-bowel diarrhea in dogs with a highly digestible diet and soluble fiber: A retrospective review of 37 cases. J Am Vet Med Assoc 2000; 14: 27-32.

Guilford W, Jones B, Markwell P, et al. Food sensitivity in cats with chronic idiopathic gastrointestinal problems. J Vet Intern Med 2001; 15: 7-13.

Simpson JW, Maskell IE, Markwell PJ. Use of a restricted antigen diet in the management of idiopathic canine colitis. J Sm Anim Pract 1994; 35: 233-238.

Nelson R, Dimperio M, Long G. Lymphocytic-plasmacytic colitis in the cat. J Am Vet Med Assoc 1984; 184: 1133-1135.

Nelson RW, Stookey LJ, Kazacos E. Nutritional management of idiopathic chronic colitis in the dog. J Vet Int Med 1988; 2: 133-137.

Dimski DS, Buffington CA. Dietary fiber in small animal therapeutics. J Am Vet Med Assoc 1991; 199: 1142-1146.

Wynn SG. Probiotics in veterinary practice. J Am Vet Med Assoc 2009: 234: 606-613.

The "GI Panel": Use, Abuse, and Interpretation

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

The components of the "GI panel"

Most clinicians, when referring to a GI panel, are referring to the measurement of serum concentrations of specific pancreatic lipase immunoreactivity (Spec-cPL in the dog, Spec-fPL in the cat), serum trypsin-like immunoreactivity (cTLI in the dog, fTLI in the cat), and the serum concentrations of two water soluble, B-group vitamins, cobalamin (Vitamin B_{12}) and folate (Vitamin B_9). Together, these compounds can provide valuable information regarding the presence and localization of disease in the pancreas and small intestine, and they may also suggest the need for therapeutic supplementation. The normal physiology and significance of abnormalities of these compounds are discussed individually below. While most clinicians will use the full panel of all four compounds, particularly in cases where clinical signs are vague or inconsistent, in some situations it can be cost effective to measure only one of the pancreas markers. For instance, if the clinical suspicion is of exocrine pancreatic insufficiency in a dog, due to the presence of compatible clinical signs, little additional value is obtained from measuring Spec-cPL, cTLI is the test of choice. Equally, in a dog with a strong suspicion of pancreatitis there is usually little additional value in measuring cTLI and Spec-cPL is the test of choice. In the cat, however, the clinical signs and histories of both exocrine pancreatic insufficiency and pancreatitis are sufficiently vague and non-specific that it is generally advisable to at least initially measure both fTLI and Spec-fPL in this species.

Trypsin-like immunoreactivity (cTLI, fTLI)

The serum concentration of trypsin-like immunoreactivity represents the presence of (mainly) trypsinogen and (rarely) active trypsin in the circulation. Trypsinogen, the zymogen precursor to active trypsin, is essentially exclusively synthesized in the pancreatic acinar cells, where it is packaged in secretory granules before excretion in to the pancreatic duct system. Pancreatic acinar cellular damage, for instance with pancreatitis, can result in the loss of trypsinogen into the pancreatic interstitium and circulation, resulting in a higher than normal concentration. Loss of acinar cell mass, as occurs in both pancreatic acinar atrophy in dogs and as an end stage of chronic pancreatitis in dogs and cats, can result in subnormal concentrations of TLI. Detection of a serum TLI concentration <2.5µg/L is highly sensitive and specific for the diagnosis of exocrine pancreatic insufficiency in the dog. In the cat, a serum fTLI concentration ≤8 µg/L is suggestive of exocrine insufficiency. Values within the reference range, even if "low normal", rule out exocrine insufficiency due to reduced functional acinar cell mass.

Elevations in serum TLI will be seen in some animals with acute pancreatitis. Serum TLI concentrations rise rapidly early in the course of acute inflammatory disease of the pancreas, but also return to baseline relatively rapidly, and are typically at or slightly below baseline values within 48 to 72 hours after the onset of a bout. Consequently, a normal serum TLI concentration does not reliably rule out the presence of inflammatory pancreatic disease.[1] In the context of the GI panel, the greatest utility of the serum TLI concentration lies in the diagnosis or ruling out of exocrine pancreatic insufficiency as a cause of small intestinal diarrhea.

In some cats the serum fTLI concentration is mildly to moderately elevated, even though the clinical signs reported (diarrhea, weight loss) are more consistent with small intestinal disease. In many of these cats, serum Spec-fPL concentrations are normal. While the mechanism underlying this pattern of results is uncertain, it likely relates to a loss of normal negative feedback from the small intestine to the pancreas. This particular pattern of results (high TLI, normal PLI) in the cat is strongly suspicious of small intestinal disease, and warrants assessment of the serum cobalamin and folate concentrations.

Specific pancreatic lipase (Spec-cPL™, Spec-fPL™)

As with trypsin/trypsinogen, specific pancreatic lipase is synthesized only in the exocrine pancreas. Release of enzymes into the circulation is via leakage, and increased release is generally held to be consistent with acinar cellular damage occurring during pancreatitis. Generally speaking, serum concentrations of PLI show greater magnitudes of increase and longer durations of elevation above baseline than TLI in the same patient.

Detection of elevated serum concentrations of specific pancreatic lipase (fPLI or Spec-fPL) has a higher reported sensitivity and specificity than fTLI for diagnosis of pancreatitis in the cat. In one study, where fTLI achieved overall sensitivity and specificity of 28% and 82%, respectively, fPLI achieved overall sensitivity and specificity of 67% and 67%, respectively.[2] In the same study, sensitivity of fPLI for the diagnosis of "moderate to severe" pancreatitis was 100%. A larger study (n=182 cats) of the Spec fPL assay reported an overall sensitivity for this test of 79%, with a specificity of 82% for detection of pancreatitis in this group.[3] Overall, the Spec-fPL assay has the highest currently reported sensitivity and specificity of any diagnostic modality for the detection of pancreatitis in the cat.[1]

While pancreatic lipases are highly specific for the exocrine pancreas, the normal range of these assays in both dogs and cats includes values close to or equal to zero. Consequently, the Spec-c/fPL assays cannot be used to diagnose exocrine pancreatic

insufficiency. The main utility of the pancreatic lipase concentrations lies in the detection of exocrine pancreatic inflammation in both species, this is particularly valuable in the cat as clinical signs of pancreatitis in this species are often subtle or vague.

Serum folate

Folate is a water-soluble, B-group vitamin (Vitamin B_9) that is abundant in most small animal diets. As dietary deficiency of this vitamin is highly unlikely, the serum concentration of folate is an indicator of the small intestinal absorptive capacity for this vitamin. Folate monohydrate, the major form of folate absorbed from the small intestine, is absorbed exclusively via a receptor mediated process in the duodenum, thus a low serum folate concentration suggests a lack of duodenal receptors, and implies duodenal mucosal disease with a very high specificity.

Folate availability from the GI tract can be increased in some disease states. Many intestinal bacteria, including some *Lactobacillus* spp and representative flora from the large intestine, are net synthesizers of folate and release significant quantities of folate into their environment. In the dog an increased serum concentration of folate has traditionally been considered suggestive of bacterial overgrowth (see below), based on the assumption that a more "large intestinal" flora has migrated up into the small intestine. However, as mentioned above, some *Lactobacillus* organisms are net folate synthesizers as well as being "desirable" flora. With increasing use of partially fermentable fiber sources such as fructose-oligosaccharides in pet diets, there has been a population wide increase in serum folate concentrations.

Relatively recent studies of dogs with chronic enteropathy and suspected small intestinal bacterial overgrowth have found no difference is serum folate concentrations between dogs that responded to antibiotic therapy and those that did not.[4] In the author's experience at least, elevated folate concentrations are common in many animals with minimal to no evidence of typical "bacterial overgrowth", and this finding is of little impact to the management of clinical cases. The obverse of this observation, though, is that a low serum folate is highly meaningful, and a strong indicator of significant small intestinal disease of some form.

Serum cobalamin

Cobalamin is also a water-soluble, B-group vitamin (Vitamin B_{12}). In common with folate, this vitamin is abundant in small animal diets and it is extremely difficult to induce cobalamin deficiency in companion animals via dietary means. Also in common with folate, the serum concentration of cobalamin reflects the small intestinal absorptive capacity for this vitamin. Cobalamin undergoes a complex receptor-mediated absorptive process that occurs exclusively in the ileum in all species studied to date, including both dogs and cats. As the absorption of cobalamin occurs exclusively in the ileum, a low serum concentration of this vitamin strongly suggests ileal mucosal dysfunction.

Absorption of cobalamin relies on the formation of complexes between cobalamin and a binding protein called intrinsic factor, this protein is synthesized in the pancreas and gastric mucosa in dogs, [5] and exclusively in the pancreas in the cat. Thus exocrine pancreatic insufficiency is almost invariably associated with low cobalamin concentrations in cats.[6,7] As the clinical signs of exocrine insufficiency in many cats are vague and often dominated by weight loss and poor appetite, it is important to measure serum fTLI in cats with low cobalamin to help rule in/rule out this disease. While exocrine insufficiency is certainly a potential cause of low cobalamin in cats, it is not the primary cause. Infiltrative disease of the ileum, either inflammatory enteropathies or lymphoma, remain the most common cause of low serum cobalamin in cats and dogs.[8,9]

Some enteric bacteria, particularly some species of *Clostridium*, are able to degrade the cobalamin/intrinsic factor complexes and then utilize the cobalamin for their own needs, thus patients with the conditions referred to as "bacterial overgrowth" may present with low serum cobalamin due to bacterial competition. Decreased serum cobalamin concentration was identified in 16/29 dogs with chronic enteropathies, however there was no differences noted in dogs with differing definitive diagnoses.[4]

Cobalamin malabsorption can lead to a state of body-wide cobalamin deficiency, with deleterious effects on many cell types in the body, including enterocytes. Recognition of low serum cobalamin and parenteral supplementation to address this is an important part of the management of dogs with chronic enteropathies. Interestingly, low serum cobalamin concentration has been identified as a negative prognostic factor for dogs with chronic enteropathies,[10] and cats with gastrointestinal lymphoma. [11]

The combination of low serum cobalamin and folate concentrations is a very specific indicator of diffuse small intestinal mucosal pathology of some form. Any infiltrative disease, including the various forms of inflammatory bowel disease and intestinal lymphoma, may lead to this combination of abnormalities. Documentation of this combination of abnormalities in a dog with clinical signs of a chronic enteropathy warrants further, more invasive diagnostic testing, such as endoscopy with mucosal biopsy or exploratory laparotomy with biopsy.

Folate and cobalamin are intrinsically linked biochemically, with most enzyme systems that rely on cobalamin as a co-factor also utilizing folate as a methyl group donor. This means that animals that are cobalamin deficient are often not utilizing folate particularly efficiently, which can result in accumulation of folate in the circulation. When the low cobalamin is detected and supplementation begins, it is common for serum folate concentrations to drop quite markedly, in some cases folate drops low enough to suggest the presence of duodenal mucosal disease.

The clinical significance of elevated cobalamin concentrations remains unclear. At least one publication in the veterinary literature has associated high cobalamin concentrations with some hepatic and neoplastic diseases in cats,[12] similar data are lacking for dogs.

Common patterns of results and interpretation for cobalamin and folate

The table below summarizes the common patterns of results that may be detected when measuring serum cobalamin and folate concentrations in dogs and cats with gastrointestinal disease. It is important to remember that these tests have high specificities due to the very localized absorption sites, but they have relatively low sensitivities and thus these tests **cannot** be used to rule out the presence of small intestinal mucosal disease.

Cobalamin	Folate	Potential DDx
Low	Low	Diffuse SI mucosal diseases: Infiltrative (IBD, LSA) Structural (lymphangectasia, Short Bowel Syndrome)
Low	High	Disturbed intestinal flora: "SIBO". Diffuse SI mucosal Exocrine Pancreatic Insufficiency (particularly in cats), check [TLI]
Low	Normal	Distal SI disease (infiltrative or structural) MOST LIKELY Abnormal bacterial population/dysbiosis Exocrine Pancreatic Insufficiency (particularly in cats), check [TLI]
High	Normal	Possible association with hepatic and neoplastic disease in cats, consider iatrogenic sources, coprophagia
Normal	High	Intestinal dysbiosis if compatible signs Possibly no significance, consider iatrogenic sources, coprophagia

Indications for supplementation

As well as acting as a marker for intestinal mucosal disease, there is an increasing body of evidence that cobalamin deficiency, which can manifest with serum cobalamin concentrations in low end of the normal range for both dogs and cats,[13,14] is associated with poorer response to therapy and poorer prognosis in a variety of diseases.[15-17] While a full discussion of cobalamin supplementation dosing and schedules is outside the scope of these notes, a substantial amount of information is available from the GI Lab at Texas A&M website, at: http://vetmed.tamu.edu/gilab/research/cobalamin-information

Low serum folate concentrations will also often prompt supplementation, and anecdotally there does appear to be a link between low serum folate and poorer response to therapy, but objective data regarding thresholds for supplementation and doses required are lacking at this time. The author typically recommends folic acid supplementation, 5-10 µg/kg *per os* daily for dogs and cats with serum folate concentrations <4.5µg/L. Additionally, animals with low normal serum folate and subnormal cobalamin concentrations receive folate supplementation preemptively, due to the common occurrence of low folate following cobalamin supplementation.

References

1. Xenoulis PG. Diagnosis of pancreatitis in dogs and cats. *Journal of Small Animal Practice*. 2015;56(1):13-26.
2. Forman MA, Marks SL, De Cock HEV, et al. Evaluation of serum feline pancreatic lipase immunoreactivity and helical computed tomography versus conventional testing for the diagnosis of feline pancreatitis. *J Vet Intern Med*. 2004;18(6):807-815.
3. Forman MA, Shiroma J, Armstrong PJ, Buch J. Evaluation of Feline Pancreas-Specific Lipase (Spec-fPL™) For The Diagnosis of Feline Pancreatitis. *J Vet Intern Med*. 2009;23(3):733–734(Abstr).
4. German AJ, Day MJ, Ruaux C, Steiner JM, Williams DA, Hall EJ. Comparison of direct and indirect tests for small intestinal bacterial overgrowth and antibiotic-responsive diarrhea in dogs. *J Vet Intern Med*. 2003;17:33-43.
5. Batt RM, Horadagoda NU. Gastric and pancreatic intrinsic factor-mediated absorption of cobalamin in the dog. *Am J Physiol*. 1989;257(3 Pt 1):G344-G349.
6. Steiner JM, David AW. Feline Exocrine Pancreatic Disorders. *Veterinary Clinics of North America: Small Animal Practice*. 1999;29(2):551-575.
7. Thompson K, Parnell N, Hohenhaus A, Moore G, Rondeau M. Feline exocrine pancreatic insufficiency: 16 cases (1992-2007). *J Feline Med Surg*. June 2009.
8. Simpson KW, Fyfe J, Cornetta A, et al. Subnormal concentrations of serum cobalamin (vitamin B12) in cats with gastrointestinal disease. *J Vet Intern Med*. 2001;15(1):26-32.
9. Jergens AE, Simpson KW. Pitfalls and progress in the diagnosis and management of canine inflammatory bowel disease. *Vet Clin North Am Small Anim Pract*. 2011;41(2):381-398.
10. Allenspach K, Wieland B, Gröne A. Chronic enteropathies in dogs: evaluation of risk factors for negative outcome. *J Vet Intern Med*. 2007;21:700-708.
11. Kiselow MA, Rassnick KM, McDonough SP, et al. Outcome of cats with low-grade lymphocytic lymphoma: 41 cases (1995-2005). *J Am Vet Med Assoc*. 2008;232(3):405-410.
12. Trehy MR, German AJ, Silvestrini P, Serrano G, Batchelor DJ. Hypercobalaminaemia is associated with hepatic and neoplastic disease in cats: a cross sectional study. *BMC Vet Res*. 2014;10(1):175.
13. Berghoff N, Suchodolski J, Steiner JM. Association between serum cobalamin and methylmalonic acid concentrations in dogs. *Vet J*. 2011;191(3):1-6.

14. Ruaux C, Steiner JM, Williams DA. Relationships between Low Serum Cobalamin Concentrations and Methylmalonic Acidemia in Cats. *J Vet Intern Med*. 2009;23(3):–475.
15. Reed N, Gunn-Moore D, Simpson K. Cobalamin, folate and inorganic phosphate abnormalities in ill cats. *J Feline Med Surg*. 2007;9(4):278-288.
16. Ruaux C. Cobalamin in companion animals: Diagnostic marker, deficiency states and therapeutic implications. *The Veterinary Journal*. March 2013:1-8.
17. Cook AK, Suchodolski J, Wright ZM, Brown MR, Steiner JM. Prevalence and prognostic impact of hypocobalaminemia in dogs with lymphoma. *J Am Vet Med Assoc*. 2009;235(12):1437-1441.

IBD, FRD, SIBO…WTH?
Rational Management of Chronic GI Disease

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

Chronic gastrointestinal disease is one of the most common reasons for companion animal owners to seek veterinary care. Clinical signs such as diarrhea, vomiting and inappetance are common in dogs and cats with chronic gastrointestinal disease, these signs are distressing to owners. Many underlying diagnoses can lead to chronic gastrointestinal signs, and conclusive diagnoses are often difficult to achieve. Successful management of these cases relies on a multi-pronged approach, involving dietary manipulations, identification and elimination of parasites, assessment of gastrointestinal function and, in some cases, pharmacological manipulation to mitigate inflammation.

A common feature of many of the diseases leading to chronic gastrointestinal signs is the presence of gastrointestinal inflammation, this inflammation may be the result of dietary intolerance (so called "Food-Responsive Diarrhea"[1]), intestinal dysbioses or chronic colonization by bacterial pathogens (so called "Small Intestinal Bacterial Overgrowth"[2] or "Antibiotic-Responsive Diarrhea"[3]), or may be idiopathic. As classically understood, canine idiopathic inflammatory bowel disease (IBD) is characterized by persistent or recurrent clinical signs of GI disease of unidentified cause, associated with histologic evidence of inflammatory infiltration of the intestinal mucosa.[4,5] The final diagnosis of an individual patient as food-responsive, antibiotic-responsive or idiopathic inflammatory bowel disease depends upon rigorous completion of therapeutic trials to rule out the food- and antibiotic-responsive diseases. In many cases a definitive diagnosis cannot be made due to imprecise or non-specific findings from diagnostic tests and the difficulty of accurately assessing the GI tract in an non-invasive manner. Thus many authors prefer the less restrictive term "chronic enteropathy" to refer to patients with these signs.[6] This term throughout these notes in recognition that in many patients a true diagnosis of idiopathic inflammatory disease cannot be made with a high degree of certainty.

Historical and clinical findings

The small intestine is the main site of digestion and absorption of dietary nutrients. Disease in the small intestine may result in decreased ability to digest dietary nutrients (maldigestion syndromes) or decreased ability to absorb the products of digestion (malassimilation). In most small intestinal diseases both of these processes, i.e. maldigestion and malassimilation are present to varying degrees. Normal digestive function in the small intestine relies on the maintenance of a normal luminal pH, presence and function of normal brush border enzymes on the microvilli and the maintenance of normal tight-junction function, amongst other critical factors. Any disease process affecting the small intestine may potentially interfere with one or more of these processes, leading to clinical signs of small intestinal disease.

Typically small intestinal disease leads to clinical signs of diarrhea and weight loss. Reduced absorptive surface area in the small intestine, decreased brush border enzyme activities and compromise of the epithelial tight junctions may all decrease the ability of the small intestine to absorb the products of digestion. The products of digestion are typically small molecules, and with the loss of the ability to absorb these molecules effectively there is an increased osmotic pull into the small intestinal lumen, leading to increased fluidity of the small intestinal content. This is manifested as diarrhea in most cases. As there is a failure of small intestinal absorption and increased net water losses from the small intestine, small intestinal diarrhea typically manifests with large volume bowel movements, the total volume of feces passed in the day is increased. In animals where the disease is isolated to the small intestine, the large intestine may be able to increase its water absorptive function and produce feces with only mildly increased water content. Clinical signs such as tenesmus, urge incontinence and excessively frequent defecation are more suggestive of large intestinal disease. In many patients, however, both the small and large intestine are involved in the disease process and a mixture of small and large intestinal diarrheal signs may be seen.

If the large intestinal water absorptive capacity is able to cope with the increased fluid input from the small intestine, diarrhea may not manifest and the major clinical sign may be weight loss. Vomiting and inappetance are also common complaints in animals presenting with small intestinal disease. In many animals there is an increased appetite and polyphagia, a consequence of the decreased efficiency of utilization of nutritional input. Clinical signs of weight loss or failure to thrive, polyphagia and large volume diarrhea are also typical of exocrine pancreatic insufficiency, and it is important to conclusively rule this condition in or out during the diagnostic assessment of an animal with a chronic enteropathy.

Approach to the assessment of a chronic cnteropathy patient

Routine biochemistry and complete blood count panels are indicated in the initial approach to a chronic enteropathy patient. As there are no specific tests that directly assess the small intestine in either of these panels, it is not unusual for a patient with a chronic enteropathy to have a complete lack of abnormal findings. This step is important, however, to assess the physiology of the patient,

screen for signs of other disease processes that may result in weight loss and diarrhea, and as a preliminary step before anesthesia in many patients for the collection of biopsy samples. Identification of significant abnormalities in other organ systems (ie azotemia/uremia, elevated liver enzyme activities, abnormal Na^+:K^+, elevated cholesterol or triglycerides) may prompt the clinician to work up the patient for other diseases.

In addition to routine clinical chemistry and complete blood count, a group of more specialized tests should be considered during the work up of a gastrointestinal disease case. For companion animals with small intestinal diarrhea, the author recommends measurement of serum TLI, cobalamin and folate concentrations. These tests are described in more detail below. Unless pancreatic inflammatory disease is suspected, the addition of a pancreatic lipase immunoreactivity assay (Spec cPL/Snap cPL or Spec fPL/Snap fPL) rarely advances the diagnosis and is not recommended for most chronic enteropathy patients as a first line diagnostic test.

Direct, specific assessment of the small intestine is complicated by the difficulty of accessing the tract for collection of samples. Ideally, a marker for small intestinal disease should be sensitive (i.e., detect most diseased patients) and specific (able to rule out disease in normal patients). At this time there are no non-invasive diagnostic tests for small intestinal disease that are both highly sensitive and highly specific. The most commonly used, minimally invasive tests currently available involve the measurement of serum concentrations of specific water-soluble vitamins to establish a lack of mucosal absorption. Specifically, the serum concentrations of cobalamin and folate can be measured, and abnormalities in these vitamins may indicate the presence of mucosal disease. The practical assessment of "The GI Panel" in dogs and cats with chronic enteropathies is discussed in more detail in separate proceedings for this meeting.

"Inflammatory bowel disease"

Inflammatory bowel disease is one of the most commonly diagnosed, and likely one of the most commonly missed, small intestinal diseases in the dog. Ironically, this condition is also likely over-diagnosed, or diagnosed inappropriately in animals that have not had a sufficiently thorough work up. In essence, inflammatory bowel disease is an idiopathic diagnosis based on histological findings, which means that we really should not be making the diagnosis of idiopathic IBD without intestinal biopsies and a complete, quite stringent work up to exclude other diseases (such as food responsive and antibiotic responsive enteropathies) that have similar histopathologic appearances. Intestinal inflammation falls in to a variety of histological categories. These types are summarized in Table 1 below.

Table one – Histopathological categories of inflammatory bowel disease in dogs

Histological Category	Frequency	Comments
Lymphocytic/Plasmacytic	~60%	The most common form of inflammatory bowel disease diagnosed in dogs nationwide. Often idiopathic, but the same histological changes are seen with dietary intolerance/allergy.
Eosinophilic	~15%	As with LP disease, may be idiopathic or associated with dietary intolerance/allergy. Often associated with GI parasitism. Relatively common in the Rottweiler. Anecdotally, more common in the Pacific Northwest than elsewhere.
Neutrophilic	<5%	Common in humans, often antibiotic- or probiotic-responsive.
Granulomatous	Rare	In veterinary medicine, granulomatous colitis of boxers is the most common manifestation of granulomatous intestinal inflammatory disease encountered.

Inflammatory bowel disease is, by definition, a histological diagnosis. The majority of cases diagnosed with inflammatory enteropathies via intestinal biopsy are lympho-plasmacytic or eosinophilic, with some regional variations in prevalence. Unfortunately there is a lack on consensus on histological descriptions and definitions of the severity of disease amongst veterinary histopathologists. Histopathology scores, as currently assigned, correlate poorly with the clinical severity of inflammatory bowel disease in canine patients and suffer from poor inter- and intra-observer consistency.[4,5] Histopathology remains useful for definitive diagnosis of an inflammatory disease process and identification of differential diagnoses such as lymphoma or lymph drainage abnormalities such as lymphangectasia.

Therapeutic planning in patients with chronic enteropathies

On diagnosis of an inflammatory enteropathy, therapeutic planning can take place. A remarkably large proportion of dogs with a diagnosis of lymphocytic/plasmacytic enteritis will show at least partial food responsiveness. A dietary exclusion trial is indicated in most cases, the author's preference is for use of a novel protein source diet selected on the basis of a thorough dietary history. Partially hydrolyzed and modified antigen diets may also be beneficial. The patient is started on the elimination diet exclusively for a minimum period of 14 days. In most patients with diet-responsive disease a notable improvement in clinical signs will have occurred at 14 days, and those that have failed to show a good response are unlikely to show much benefit from a longer period on the diet. If the dog responds to the diet change, the diagnosis becomes one of food-responsive diarrhea or dietary intolerance. "Dietary allergy" implies

demonstration of a hypersensitivity response to a dietary component, as this is not achieved in most veterinary patients this term is not appropriate to most cases.

Dogs failing to respond to dietary modification, particularly when a rigorously controlled elimination diet trial has been carried, out are diagnosed with idiopathic inflammatory bowel disease. The mainstay of therapy for idiopathic inflammatory bowel disease is anti-inflammatory to immune suppressive drug therapy, typically with glucocorticoids. Prednisone or prednisolone is started at doses of approximately 2mg/kg *per os* SID, typically in the morning, for at least 14 days. If clinical signs are well controlled at this time, a gradual taper to the minimum effective dose is begun, with dose reductions of approximately 25% per week. In some animals, more aggressive immune suppressive therapy may be required. Azathioprine (2mg/kg SID to every other day) has traditionally been the next step for immune suppression, this drug requires several weeks to manifest full effect. Recent publications have examined the utility of cyclosporine-A in therapy of dogs with refractory IBD and saw benefit in many patients, however expense may limit the use of this drug in some patients.[7] Drugs such as mycophenalate mofetil and leflunomide have been investigated for use in these patients, but to date limited information is available regarding their efficacy.

Most patients respond well to dietary change and judicious use of anti-inflammatory or immune-suppressive medical therapy and have a fair to good prognosis. Some animals, unfortunately, show more refractory disease and the prognosis is more guarded. In a review of risk factors for adverse outcomes with inflammatory bowel disease in dogs, 18% of patients were eventually euthanized due to intractable disease.[8] High clinical severity scores, severe changes visible on endoscopy, low serum cobalamin and hypoproteinemia were all associated with a higher likelihood of an adverse outcome.[8] Where low serum cobalamin or folate concentrations are detected, supplementation of these vitamins is recommended.

"Ecological" diseases – "SIBO", ARD and tylosin-responsive diarrhea

The small intestine is home to a large, diverse population of bacteria and other microflora. The microflora is essential to the normal anatomy and physiological function of the gastrointestinal tract, and abnormalities in this microflora are commonly associated with clinical signs of disease. The total number of organisms present in the canine GI tract has been a point of controversy. The term "Small Intestinal Bacterial Overgrowth" (SIBO) was originally defined in the context of culture studies that defined the upper limit of normal for the bacterial population of the duodenum as 10^5 colony-forming units/ml.[2] We now know from more recent culture-based and genetic diversity studies of the canine intestinal microflora that these original culture studies likely underestimated the numbers and diversity of bacteria present.[9] The term "antibiotic-responsive diarrhea" is gaining currency in the recent literature, recognizing the antibiotic responsive nature of this condition without applying arbitrary criteria regarding expected bacterial numbers.

Disturbances in the gastrointestinal flora are likely common in dogs with other chronic enteropathies, such as idiopathic IBD or dietary intolerances. The maintenance of the normal flora relies on normal mucosal function, secretory function of the stomach and pancreas and gastrointestinal motility. Any of these functions may be abnormal in dogs with small intestinal disease, leading to an abnormality in the gastrointestinal flora.

In many dogs with chronic enteropathies, therapy directed against the bacterial flora may be advantageous. As the disturbed flora is typically secondary to some other disease process, and these primary disease processes are usually managed rather than cured, long durations of therapy are necessary. Given the need for repeated or chronic therapy, alternative approaches via dietary modification or supplementation are desirable. Potential modalities include supplementation with prebiotic compounds, such as fructo-oligosaccharides or inulin, that are preferentially fermented by "beneficial" organisms (typically *Lactobacillus* or *Bifidobacterium* spp). Empirically, diets containing these compounds (for instance, many of the "intestinal health" diets) are often helpful in managing dogs with chronic enteropathies. Probiotic organisms may also act via a displacement mechanism, and in some cases they are of benefit. There is a plethora of probiotic products on the market with very little data from well-controlled studies.

A more traditional approach would be to use antibiotic medications. The author's preference is to use tylosin (Tylan Powder™, Elanco), at a dose of 20-25 mg/kg *per os* BID. Treatment is given for a minimum of 6 weeks, however it is not unusal for clinical signs to recur within weeks of antibiotic withdrawal. In some patients a pulse therapy approach, with 2 weeks on and 1 week off tylosin, is able to control clinical signs adequately. Some patients require constant, lifelong tylosin therapy.

References

1. Luckschander N, Allenspach K, Hall J, et al. Perinuclear antineutrophilic cytoplasmic antibody and response to treatment in diarrheic dogs with food responsive disease or inflammatory bowel disease. J Vet Intern Med 2006;20:221–227.
2. Batt RM, Hall EJ, McLean L, et al. Small intestinal bacterial overgrowth and enhanced intestinal permeability in healthy beagles. Am J Vet Res 1992;53:1935–1940.
3. Hall EJ. Antibiotic-Responsive Diarrhea in Small Animals. Veterinary Clinics of North America: Small Animal Practice 2011;41:273–286.
4. Collins MT. Canine inflammatory bowel disease: current and prospective biomarkers for diagnosis and management. Compend Contin Educ Vet 2013;35:E5.
5. Jergens AE, Simpson KW. Pitfalls and progress in the diagnosis and management of canine inflammatory bowel disease. Vet Clin North Am Small Anim Pract 2011;41:381–398.

6. Burgener IA, König A, Allenspach K, et al. Upregulation of toll-like receptors in chronic enteropathies in dogs. J Vet Intern Med 2008;22:553–560.
7. Allenspach K, Rüfenacht S, Sauter S, et al. Pharmacokinetics and clinical efficacy of cyclosporine treatment of dogs with steroid-refractory inflammatory bowel disease. J Vet Intern Med 2006;20:239–244.
8. Allenspach K, Wieland B, Gröne A. Chronic enteropathies in dogs: evaluation of risk factors for negative outcome. Journal of Veterinary … 2007.
9. Suchodolski J, Ruaux C, Fetz K, et al. Assessment of the qualitative variation in bacterial microflora among compartments of the intestinal tract of dogs by use of a molecular fingerprinting technique. 2005;66:1556–1562.

Diagnosing and Managing Pancreatitis in the Era of PLI

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

The conclusive diagnosis of inflammatory disease of the pancreas in dogs and cats is difficult. While the presence of compatible clinical signs such as vomiting, abdominal pain, dehydration, and pyrexia increase our index of suspicion for the disease, no specific findings on clinical examination are pathognomonic for pancreatitis.

As there are no specific findings on clinical examination or in an animal's history that point conclusively to pancreatitis, confirmation of this clinical suspicion is based on clinical pathology results, imaging studies and the use of more specialized tests. The purpose of this presentation is to overview the various methods now available to the clinician that are used for the diagnosis of pancreatitis and their clinical utility in both diagnosis and management of dogs and cats with pancreatic inflammatory disease. With the availability of semi-quantitative 'cage-side' diagnostic tests measuring pancreatic lipase immunoreactivity, increasing numbers of animals are diagnosed with pancreatic inflammatory disease in practice. With this increased ability to specifically diagnose exocrine pancreatic disease, we are realizing that pancreatic disease may be more common, and more variable, than previously appreciated.

Markers of pancreatic disease

The most commonly used markers of pancreatic disease, and more specifically pancreatitis, are digestive enzymes. Serum amylase and lipase activities are the "traditional" markers used to support a clinical diagnosis of pancreatitis, in the presence of compatible history and findings on examination.

Low or normal serum lipase activity has been said to "almost always rule out the possibility of pancreatitis" in dogs, but increased serum lipase activity is not pathognomonic for pancreatic disease.[1] While serum lipase activity is often empirically felt to be of higher sensitivity and specificity for the diagnosis of pancreatitis in dogs, controlled studies to demonstrate this are lacking. In cats, the performance of amylase and lipase as diagnostic markers of acute pancreatitis is even worse than in dogs. Experimentally, lipase and amylase activities are increased in induced pancreatitis in cats, but in spontaneous clinical cases these enzymes have no value in making the diagnosis. This likely relates to the typical timing of presentation of cats with pancreatitis, and the underlying pathological process in most cats, as discussed later.

While amylase and lipase activities may be the easiest biochemical markers of pancreatic inflammation to measure in dogs, the pancreas is a source of many other potential marker compounds. Of the digestive enzymes other than amylase and lipase, the enzymes most studied with respect to pancreatic disease are trypsin-like-immunoreactivity (cTLI and fTLI) and specific pancreatic lipase (Spec-cPL™ and Spec-fPL™).

Experimentally, serum TLI concentrations increase rapidly following induction of pancreatitis or ligation of the pancreatic duct in both dogs and cats. Serum TLI concentrations then drop rapidly, and are often back to normal or slightly sub-normal concentrations within 48 to 72 hours after disease induction. This is probably due to a protective down-regulation of trypsin synthesis by the pancreatic acinar cells, without further production of trypsinogen the serum concentrations decline rapidly.

Lipase produced in the pancreas is structurally distinct from the other lipases in circulation, although it shares the same substrate specificity. This means that, while activity assays are relatively non-specific for pancreatic disease, immunoassays for pancreatic lipase have a much higher specificity.

Canine pancreatic lipase immunoreactivity (PLI) has been measured via several differing immunoassay methods in recent years. The original studies using immunoassays to measure this protein were carried out at the GI Laboratory at Texas A&M University, using an ELISA method. Subsequently, the assay was commercialized as Spec cPL™ by IDEXX Laboratories, using differing antibodies and a recombinant protein for standards.[2,3] Finally, IDEXX has produced "cage-side" diagnostic tests, SNAP cPL and Snap fPL, that measures the same protein in a semi-quantitative manner, defining a patient as normal or abnormal by reference to the intensity of the color spot developed. These assays are absolutely species specific, feline pancreatic lipase immunoreactivity cannot be determined using Spec cPL or the SNAP cPL tests, and vice versa.

As pancreatic lipase is found only within pancreatic acinar cells, an increase in the serum concentration of PLI is consistent with increased release of this enzyme from the acinar cells. The most common mechanism whereby pancreatic lipase is likely to be released is through increased "leakiness" of the acinar cells, this may occur as a result of mishandling of enzyme granules by the acinar cells, or due to compromised acinar cellular membrane permeability secondary to inflammation.

While the pancreatic lipase protein (and trypsinogen/TLI) are pancreas-specific, and thus elevated concentrations of these compounds in a serum sample are strongly suggestive of pancreatic pathology, the actual serum concentration of these compounds is altered by several factors other than just the presence and degree of pancreatitis. In particular, differences in the routes and speed of clearance of these proteins from the circulation can have a great bearing on the concentration measured.

Changes in the serum concentrations of TLI and PLI with pancreatitis

Trysinogen, the precursor to active trypsin and the major protein measured in the TLI assay, is a relatively small protein with an overall negative charge. These factors both favor clearance by renal mechanisms, and the clearance half-life of trypsinogen is relatively short. Active trypsin is also detected by the TLI assay, however this protein is very rapidly complexed to scavenger proteins in the circulation and cleared from the circulation within minutes, thus active trypsin is rarely a significant contributor to the serum TLI concentration. This rapid clearance of trypsinogen/TLI, in combination with the dramatic down-regulation of pancreatic enzyme synthesis discussed above, results in serum TLI concentrations within the reference range, or in some cases even below the reference range, in many animals with pancreatic inflammatory disease. These rapid changes in TLI concentration following onset of the disease contribute to the relatively low sensitivity of serum TLI concentrations for the diagnosis of acute pancreatitis in both dogs and cats.

In comparison to trypsinogen/TLI, the PLI protein in both dogs and cats is much larger (approximately twice as large) and has an overall positive charge. These features both prevent renal clearance of the PLI protein. The actual mode of clearance of PLI from the circulation is unknown at this time, but it is presumed to be via the hepatic reticuloendothelial system. The actual clearance half life of pancreatic lipase in the dog has been reported to be about 90 minutes, however the duration of elevation of PLI in dogs with pancreatitis is often a week or longer. This slower return to baseline/cessation of pancreatic lipase release increases the sensitivity of the test for detection of pancreatitis, as the clinician is more likely to be sampling a patient when the concentration is increased. In the cat, with experimentally induced pancreatitis, the degree of elevation of PLI is greater than that of TLI, and the serum PLI concentration remains elevated for an average of 10 days.

One of the many factors influencing pancreatic enzyme synthesis and release is feedback regulation from the small intestine. When active proteolytic enzymes enter the distal small intestine, a negative feedback signal that cuts off pancreatic enzyme synthesis and release is generated by the small intestinal mucosa. In the cat (but, interestingly, not the dog), small intestinal disease is often associated with a mildly but persistently increased serum TLI concentration. This most probably results from the mucosal disease and the loss of this negative feedback signal. This effect often leads to confusion amongst clinicians, as the clinical signs of marked small intestinal disease in the cat (steatorrhea, marked small intestinal diarrhea, weight loss, ± polyphagia) are often remarkably similar to exocrine pancreatic insufficiency. In many cats with significant small intestinal disease the serum TLI concentration is elevated, while the PLI concentration is within normal.

Test selection and interpretation in animals with suspected pancreatic disease

When selecting TLI or PLI tests for use in clinical patients, appropriate test selection will depend upon the clinically suspected diagnosis and the duration of clinical signs. In most cases where the clinician suspects the presence of pancreatitis, either acute or chronic, the PLI test is the best choice. Care must be taken with interpretation when using the “Snap” tests. These test are interpreted on the basis of the degree of color development seen, not as positive or negative (i.e. color development is expected in most cases, a very dark spot indicates high serum PLI). A positive Snap test should be confirmed by running the quantitative version of the test at a reference laboratory.

One consequence of the increasing availability of the PLI tests has been the recognition that chronic pancreatic disease, particularly chronic pancreatitis, is both much more common and in many cases more subtle than we originally thought. Particularly in the cat, most cases of pancreatic disease appear to be chronic and often clinically silent. In a case with chronic pancreatitis, the expectation is that the serum concentrations of PLI will remain persistently elevated. As the average time for decline to below the cut off value for a diagnosis of pancreatitis is around ten days, documentation of persistent elevation of PLI in serum samples taken at least 14 days apart can support the clinician’s suspicion of chronic pancreatitis. If the PLI returns to within the normal range at 14 days, this supports a retrospective diagnosis of an isolated bout of acute pancreatitis. These distinctions can be important, as the therapeutic approach to chronic pancreatitis is in many respects different to our approach to a patient who has had a single bout of acute pancreatitis and subsequently recovered.

Do TLI or PLI concentrations have prognostic value?

The degree of elevation of TLI or PLI in an animal with pancreatic inflammatory disease, as discussed above, is influenced by many factors. The amount of tissue compromised, the time from the beginning of the disease process, factors such as fluid losses that influence clearance; all of these factors may influence the final concentration measured in a patient. To date there is a limited amount of well-controlled data assessing the prognostic importance of varying degrees of abnormality in serum PLI concentrations. In one recent study, cats hospitalized for pancreatitis with serum Spec-fPL concentrations >20µg/L on the day of hospitalization were more likely to die or be euthanized.[4]

Within an individual, resolution of elevated PLI concentrations, or a trend towards normality, appear logically to indicate progress towards a more “normal” state. Certainly the persistence of elevated PLI concentrations in a patient who continues to show clinical signs of pancreatic disease is consistent with ongoing inflammation in the pancreas, and an increasing concentration in this patient would be consistent with worsening or deterioration of the patient’s condition. The absolute degree of abnormality, however, does not seem to correlate with the symptoms seen or the duration of illness in many spontaneous pancreatitis cases.

Some observations on therapy for acute pancreatitis

Acute pancreatitis is an unusual disease process as total loss of exocrine pancreatic function is not immediately life threatening. Most general practitioners will be familiar with dogs that have pancreatic acinar atrophy leading to exocrine pancreatic insufficiency. These dogs may have virtually no functional exocrine pancreatic tissue, yet they do not suffer immediate life-threatening biological derangement because of this lack of pancreatic tissue. By comparison, the complete loss of hepatic, renal, cardiovascular, or respiratory function is associated with immediate, life threatening metabolic disturbances. While loss of pancreatic exocrine function is not typically life threatening, inflammation of this gland will often induce systemic metabolic derangement and organ failures distant from the pancreas itself. These distant organ failures, rather than the failure of the pancreas itself, are commonly the causes of death in acute pancreatitis.

In animals with complicated pancreatitis of high severity, the replacement and maintenance of circulating fluid volumes, attention to plasma colloid oncotic pressure, and the promotion of oxygen delivery to the tissues are all critical to successful therapy. Dogs with severe acute pancreatitis have a form of circulatory shock with many similarities to septic shock, and the clinical approach to these two forms of shock is essentially identical. Animals with pre-existing severe inflammatory disease, hypoalbuminaemia and multiple organ failure as a result of acute pancreatitis are beyond the therapeutic and management capabilities of most veterinary hospitals, and typically require referral for intensive care if treatment is desired. The prognosis for dogs with acute pancreatitis once they have developed this extent of metabolic derangement is guarded to grave, with mortality rates greater than 75% in some studies.

'Feeding through' bouts of acute pancreatitis, multimodal antiemetics

The idea that the pancreas should be "rested" during the treatment and recovery period from acute pancreatitis has long been held in the veterinary world. The theoretical basis for this recommendation was to decrease pancreatic enzyme synthesis and secretion, under the assumption that release of enzymes into the pancreatic interstitium and circulation was responsible for many of the clinical signs and complications of pancreatitis. While this approach still has some currency in the veterinary community, it flies in the face of our current understanding of the best management of critically ill patients. Animals with acute abdomen presentations are typically in a catabolic state, have additional metabolic demands due to the inflammatory process, and the development of functional ileus can result in substantial additional morbidity.[5]

One of the main reasons for the *nil per os* approach to treatment of acute pancreatitis was in an attempt to reduce frequency and severity of vomiting in these patients. In recent years we have had a dramatic increase in the number of effective antiemetic medications available to us, most notably the neurokinin-1 receptor antagonist maropitant citrate (Cernia®, 1 mg/kg q24 hr), and the 5-HT_3 receptor antagonists such as dolasteron (Anzemet®) or ondansetron (Zofran®), 0.3-0.5 mg/kg IV q24 hr). These medications are highly effective at controlling vomiting and nausea in our patients, and have the advantage that they can be administered by injection or orally, and need only once daily dosing. They act via different mechanisms, and there does not appear to be any meaningful interaction between these drug classes. Maropitant also has some benefit as a visceral analgesic,[6] which is of significant benefit in acute pancreatitis cases.

With the use of a multimodal antiemetic regime, vomiting and nausea are controlled rapidly in most cases of acute pancreatitis. This allows consideration of an early return to feeding. While controlled studies of early enteral nutrition in severe pancreatitis in veterinary species are relatively few, the data available so far suggest that early enteral nutrition in dogs with acute pancreatitis is associated with less incidents of vomiting, lower incidences of complications than parenteral nutrition, and no difference in outcomes.[7] The author's approach to dogs with pancreatitis is to reintroduce feeding as soon as possible, often within hours of ICU admission. Early enteral nutrition of cats with pancreatitis is arguably even more important, due to the risk of hepatic lipidosis in this species.

Dietary manipulations in the management of chronic pancreatitis

In the dog, use of a fat-restricted diet in the post-recovery period from a bout of acute pancreatitis is commonly accepted, and most authors will recommend fat restriction in dogs with chronic pancreatitis. The use of fat restricted diets is not recommended in cats, however, as this species has an obligate requirement for relatively high intake of essential fatty acids. Additionally, most fat-restricted commercial diets substitute carbohydrates for fat to maintain an iso-caloric formulation, this represents a problem for cats are their obligate carnivore nature means that they are less able to adapt to carbohydrate rich diets, and have a tendency towards protein catabolism if dietary fat is restricted. In many cats pancreatitis accompanies enteritis and cholangitis or cholangiohepatitis, so-called "triaditis" or "feline inflammatory syndrome".[8,9] While the underlying pathology of triaditis is not fully understood, overall it appears that the presence of inflammatory disease in the small intestine may be a common precipitating factor.[9] Given the relatively low sensitivity of non-invasive tests for small intestinal disease in cats, and the low frequency with which biopsies are obtained, it is reasonable to assume that many cats with chronic pancreatitis will actually also have intestinal inflammatory disease that goes undiagnosed. Many cats with these diseases respond to dietary protein-source modification, using either a novel protein source or a modified antigen type diet. The author's typical approach to a cat with a diagnosis of chronic pancreatitis is identical to the approach for inflammatory disease of the intestine, with carefully managed dietary elimination trials and screening for comorbid deficiencies in

water soluble vitamins such as cobalamin and folate. The protein type of the diet, rather than dietary fat content, has a much greater influence on diet selection in feline chronic pancreatitis cases.

References

1. Ruaux C. Diagnostic approaches to acute pancreatitis. Clinical techniques in small animal practice. 2003 Nov;18(4):245–9.
2. Neilson-Carley SC, Robertson JE, Newman SJ, Kutchmarick D, Relford R, Woosley K, et al. Specificity of a canine pancreas-specific lipase assay for diagnosing pancreatitis in dogs without clinical or histologic evidence of the disease. Am J Vet Res. 2011 Mar;72(3):302–7.
3. Huth SP, Relford R, Steiner JM, Strong-Townsend MI, Williams DA. Analytical validation of an ELISA for measurement of canine pancreas-specific lipase. Veterinary Clinical Pathology. 2010 Aug 2;39(3):346–53.
4. Stockhaus C, Teske E, Schellenberger K, Huisinga E, Konietschke U, Mangelsdorf S, et al. Serial serum feline pancreatic lipase immunoreactivity concentrations and prognostic variables in 33 cats with pancreatitis. J Am Vet Med Assoc. 2013 Dec 15;243(12):1713–8.
5. Jensen KB, Chan DL. Nutritional management of acute pancreatitis in dogs and cats. J Vet Emerg Crit Care (San Antonio). 2014 May;24(3):240–50.
6. Boscan P, Monnet E, Mama K, Twedt DC, Congdon J, Steffey EP. Effect of maropitant, a neurokinin 1 receptor antagonist, on anesthetic requirements during noxious visceral stimulation of the ovary in dogs. Am J Vet Res. 2011 Dec;72(12):1576–9.
7. Mansfield CS, James FE, Steiner JM, Suchodolski J, Robertson ID, Hosgood G. A pilot study to assess tolerability of early enteral nutrition via esophagostomy tube feeding in dogs with severe acute pancreatitis. J Vet Intern Med. 2011 May;25(3):419–25.
8. Freiche V, Faucher MR, German AJ. Can clinical signs, clinicopathological findings and abdominal ultrasonography predict the site of histopathological abnormalities of the alimentary tract in cats? J Feline Med Surg. SAGE Publications; 2015 Feb 26;:1098612X15573091.
9. Simpson KW. Pancreatitis and triaditis in cats: causes and treatment. Journal of Small Animal Practice. 2015 Jan;56(1):40–9.

Protein-Losing Enteropathies: The Black Diamond Cases

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

Protein loss through the GI tract (protein-losing enteropathy, PLE) presents in a spectrum of severities, ranging from cases with insidious weight loss and mild diarrhea through to highly challenging cases complicated by the development of ascites, peripheral edema and coagulopathies. Recognition of PLE can be quite challenging, particularly in cases where overt hypoproteinemia is not yet present. The presence of PLE in dogs with chronic inflammatory enteropathies has been shown to be a negative prognostic factor in these cases, and warrants more aggressive therapy.[1] While cases with PLE secondary to inflammatory enteropathies tend to be the most challenging to manage, a variety of other mechanisms can result in significant intestinal protein losses. Selection of the appropriate therapy for a PLE case depends upon accurate identification of the pathology present, as differing modes of therapy are indicated for some of the non-inflammatory, structural diseases.

Clinical signs in PLE

Depending on the degree of severity and duration of the disease, clinical signs of PLE can range from the development of ascites, peripheral edema or acute severe respiratory distress due to pulmonary thromboembolism, through to vague signs such as weight loss and poor appetite.[2,3] If an inflammatory enteropathy is present diarrhea may be noted, but many cases with PLE present with normal stools.[2] Consequently, PLE should be considered as a differential diagnosis for any dog presenting with hypoalbuminemia, even if gastrointestinal signs as lacking.[3]

Mechanisms of protein loss in PLE cases

With some specific breed-related exceptions, the major mechanisms of protein loss in most cases of PLE in dogs (and cats, but this condition is recognized infrequently in that species[4]) can be divided into two major groups: primary lymphatic drainage abnormalities such as lymphangectasia, lipogranulomas or mesenteric lymphatic obstructions, and secondary to mucosal inflammatory disease. While these major categories account for the majority of PLE cases encountered in clinical practice, gastrointestinal ulcers, significant gastrointestinal parasitism and gastrointestinal neoplasms (both lymphosarcom and carcinoma[5]) can also result in marked GI protein loss. Intestinal motility accidents, such as intussusception, partially obstructing foreign bodies, and diverticulae can also result in quite marked protein loss, however their clinical signs and initial examination findings are usually sufficiently distinct from the more typical PLE cases to allow rapid identification.

Breed predispositions

While any dog can present with PLE, particularly as a complication of severe inflammatory enteropathies, some breeds are recognized to have particularly marked breed predispositions. Often the manifestations of PLE in these breeds are quite severe.

Lymphatic drainage abnormalities such as lymphangectasia have been reported in the Rottweiler, Yorkshire terrier, Shar-peis and the Maltese terrier.[2,3,6] In the Rottweiler lymphangectasia commonly accompanies eosinophilic inflammatory disease of the intestine, but a direct relationship between these two conditions has not been established and both diseases are commonly diagnosed in this breed in isolation.

As well as primary lymphangectasia, the Yorkshire Terrier is commonly diagnosed with significant inflammatory lesions of the intestinal crypts.[2,7] These crypt lesions are commonly associated with severe gastrointestinal protein loss. The mechanism of crypt abscess formation in these dogs has not been well defined, but there does not appear to be any association with bacterial invasion.[3]

The Norwegian Lundehund, a relatively rare dog breed in the USA, has been reported to have 50% or more of individuals affected with intestinal lymphangectasia, with associated PLE.[8]

The Soft-coated Wheaten terrier presents with a breed specific PLE and protein-losing nephropathy that can be quite challenging to manage.[9] This disease has been linked to food hypersensitivities in this breed,[10] and is apparently worsened by high level exposure to gluten and other dietary allergens, but does not appear to be a true gluten hypersensitivity.[11] Soft-coated Wheaten terriers may present with protein-losing enteropathy alone, protein-losing nephropathy alone, or may have both conditions simultaneously.[9]

Diagnostic approaches to a suspect PLE case

In most dogs with PLE, the suspicion that this disease is present first arises when a low serum albumin concentration is detected. This may be noted as part of the work up for chronic gastrointestinal disease, but as noted above many dogs with significant PLE may first present with ascites or edema and with little in the way of gastrointestinal signs, thus the presence of a low albumin should always prompt the consideration that PLE may be present.

When presented with a case with low albumin (typically <2.0g/dL), we have a relatively limited number of ways in which this could have come about. Major routes for protein loss include via the kidneys (protein-losing nephropathies), through significant skin lesions or open wounds, through the gastrointestinal tract, and as a result of hepatic synthetic failure/hepatic insufficiency.

A rational approach to a suspect PLE case with hypoalbuminemia, then, is to screen for and rule out as many of these conditions as possible. Protein losses due to cutaneous lesions or open wounds can be readily ruled out via physical examination, as the extent and severity of these lesions necessary to cause this volume of protein loss is quite dramatic. Protein losses due to protein-losing nephropathies can be ruled out by the detection of a normal protein-creatinine ratio. It is important to remember that lower urinary tract infections, or any other disorder leading to an active urinary sediment, can also cause an elevation in urinary protein:creatinine, screen for and if necessary treat urinary tract infections first before assessing this test for evidence of a protein-losing nephropathy.

Detection of hepatic insufficiency and synthetic failure can be more complicated, as liver enzyme activity elevations and hyperbilirubinemia are not present in many animals with end stage liver disease. Other common clinical chemistry findings with hepatic failure, such as low cholesterol and blood urea nitrogen, are also common findings with PLE.[2]

The best method for non-invasively assessing hepatic function is to perform a pre- and post-prandial bile acids tests. Normal pre- and post-prandial bile acid concentrations rule out hepatic insufficiency as a cause of hypoalbuminemia with a high degree of certainty. Some clinicians will measure only the resting, pre-prandial bile acid concentration, but this reduces both the sensitivity and specificity of this test. Some animals with synthetic failure are still able to clear bile acids to a normal pre-prandial value while fasting, and evidence of loss of hepatic function is only seen after the bile acid challenge. Alternatively, animals with gastrointestinal disease can show mildly to moderately elevated pre-prandial bile acids due to the reduced efficiency of clearance of bile acids from the portal circulation that have undergone bacterial deconjugation.[12]

In a suspected PLE case with hypoalbuminemia, where skin disease and protein-losing nephropathy have been ruled out and pre-/post-prandial bile acid tests are normal, the diagnosis of PLE can be made with a high degree of certainty through simple exclusion.

The diagnosis of PLE in dogs that have not reached a state of overt hypoalbuminemia is more challenging. This can be quite important in dogs from the breeds previously listed with predispositions for PLE, as some of the adverse outcomes of PLE such as hypercoagulability and thromboembolic potential can manifest before the albumin is markedly low, and thus in these breeds early diagnosis and management is important.

Unfortunately, albumin itself cannot be detected in stool samples as it undergoes bacterial degradation. A surrogate for albumin losses, α-1 Proteinase Inhibitor (α-1PI), is able to survive transit through the GI tract and can be detected in fecal samples.[13,14] This protein has a very similar molecular mass and charge to albumin, thus elevated α-1PI in stool samples is suggestive of increased albumin loss into the GI tract. This test is somewhat complicated, requiring multiple stool samples to be collected and stored frozen, and is only available from one laboratory (The GI Lab at Texas A&M). The author typically only uses this test in the previously mentioned, predisposed breeds, particularly if they present with weight loss and mild GI signs without hypoalbuminemia. The majority of PLE cases seen in our clinic are diagnosed by exclusion, as detailed above, and a combination of diagnostic imaging and endoscopic biopsy findings.

Diagnostic imaging findings with lymphangiectasia of the intestine.

Abdominal ultrasound examination is a valuable modality for the assessment of dogs with potential PLE. As well as giving some idea of the hepatic size and potentially revealing the presence of low volume ascites, occasional dogs will show characteristic hyperechoic striations in the intestinal mucosa, often referred to as a “tiger stripe pattern”. This finding is strongly suggestive of intestinal lymphatic dilation, either due to lymphangectasia or distal lymphatic obstruction.[15]

Therapy for PLE: “Uncomplicated” cases

As the mechanism of protein loss in many “uncomplicated” cases of PLE revolves around loss of intestinal lymph, strategies to reduce lymph loss are useful in the management of PLE cases. The major driver of intestinal lymph production is the intake of dietary fat. (Recall that the intestinal lymphatics are called “lacteals” due to the presence of high concentrations of fat in chylomicrons). Thus the use of extremely low fat diets is recommended in most dogs with PLE, and is the mainstay of treatment for most dogs with primary lymphangectasia.[2] The use of ultra-low fat diets has been shown to be effective in dogs with lymphangectasia that had failed to respond to glucocorticoid therapy or showed a relapse as glucocorticoid doses were reduced.[16]

The author’s first choice of diet for management of relatively uncomplicated PLE cases is typically one of the commercially manufactured, ultra-low fat diets such as Royal-Canin’s LF or Hill’s I/D-LF (NB: the I/D low fat formulations. I/D GI health is too high in fat). Alternatively, home cooked diets have been described for dogs that are also extremely low in fat, and with careful attention to vitamin and mineral supplementation can be used long-term.[2]

Many dogs with PLE due to lymphatic drainage abnormalities within the mucosal will also develop lipogranulomas or other inflammatory lesions in the mesenteric lymphatics. Patients showing only partial response to ultra-low fat diets after 2-3 weeks of

therapy will often benefit from the addition of prednisone at 1-2 mg/kg/day. This will also assist in management of secondary inflammatory disease in these patients.

Therapy for PLE: "Difficult" cases

"Difficult" PLE cases fall into two main groups: severe disease with marked hypoalbuminemia, ascites and/or edema, and cases where the PLE is a complicating factor for other diseases, such as severe inflammatory enteropathies.

Cases with markedly severe hypoalbuminemia represent a significant therapeutic challenge. Ideally, colloid oncotic support should be given before any invasive diagnostic intervention, to reduce the risk of wound dehiscence and anesthetic complications due to embolic events. Fresh frozen plasma transfusions can be very useful, as they replace clotting factors as well as albumin, but the volumes of plasma necessary to replenish albumin in many dogs can become cost prohibitive. If available, 20% human albumin solutions can provide rapid oncotic support at relatively low cost and risk in dogs, but this product is often difficult to obtain. Synthetic colloids may also be used, often in combination with fresh frozen plasma.

Ascites fluid is usually not drained, except if the volume of fluid is sufficient to cause respiratory compromise. Only sufficient fluid should be drained to relieve respiratory compromise. Removal of large volumes induces a large body-wide protein deficit in the patient that will promote a catabolic state and cachexia, and also activates the renin-angiotensin-aldosterone system to normalize blood pressure following substantial volume loss, this can increase blood pressure and increases the rate of further ascites accumulation. Animals who are recurrently effusive may benefit from diuretic therapy.

Animals with this degree of PLE are usually assumed to be hypercoagulable.{Goodwin:2011eb} This hypercoagulable state persists in many dogs after therapy that increases albumin, and thus these dogs should be considered at long-term risk for thromboembolic complications.[17]

The presence of significant PLE in dogs with inflammatory enteropathies is a poor prognostic sign, and the early use of more aggressive immune suppression therapy is indicated. Interestingly, in a recent study of dogs with inflammatory enteropathies and PLE, patients treated with chlorambucil-prednisolone showed a better outcome than those treated with azathioprine-prednisolone.[18] The reason for this difference is not clear, but at least in this one study the differences in outcome were quite dramatic (azathioprine-pred group had a median survival of 30 days, while chlorambucil-pred group did not reach a median survival as 10/14 were still alive at the end of the study).

References

1. Allenspach K, Wieland B, Gröne A, Gaschen F. Chronic enteropathies in dogs: evaluation of risk factors for negative outcome. *Journal of Veterinary Internal Medicine*. 2007;21:700-708.
2. Peterson PB, Willard MD. Protein-losing enteropathies. *Veterinary Clinics of North America: Small Animal Practice*. 2003;33(5):1061-1082.
3. Dossin O, Lavoué R. Protein-losing enteropathies in dogs. *Vet Clin North Am Small Anim Pract*. 2011;41(2):399-418.
4. Burke KF, Broussard JD, Ruaux C, Suchodolski J, Williams DA, Steiner JM. Evaluation of fecal α1-proteinase inhibitor concentrations in cats with idiopathic inflammatory bowel disease and cats with gastrointestinal neoplasia. *Vet J*. 2013;196(2):189-196.
5. Nakashima K, Hiyoshi S, Ohno K, et al. Prognostic factors in dogs with protein-losing enteropathy. *The Veterinary Journal*. 2015;205(1):28-32.
6. Kull PA, Hess RS, Craig LE, Saunders HM, Washabau RJ. Clinical, clinicopathologic, radiographic, and ultrasonographic characteristics of intestinal lymphangiectasia in dogs: 17 cases (1996-1998). *J Am Vet Med Assoc*. 2001;219(2):197-202.
7. Simmerson SM, Armstrong PJ, Wünschmann A, Jessen CR, Crews LJ, Washabau RJ. Clinical Features, Intestinal Histopathology, and Outcome in Protein-Losing Enteropathy in Yorkshire Terrier Dogs. *J Vet Intern Med*. 2014;28(2):331-337.
8. Berghoff N, Ruaux C, Steiner JM, Williams DA. Gastroenteropathy in Norwegian Lundehunds. *Compend Contin Educ Vet*. 2007;29(8):456–65, 468–70, quiz 470–1.
9. Littman MP, Dambach DM, Vaden SL, Giger U. Familial protein-losing enteropathy and protein-losing nephropathy in Soft Coated Wheaten Terriers: 222 cases (1983-1997). *J Vet Intern Med*. 2000;14(1):68-80.
10. Vaden SL, Hammerberg B, Davenport DJ, et al. Food hypersensitivity reactions in Soft Coated Wheaten Terriers with protein-losing enteropathy or protein-losing nephropathy or both: gastroscopic food sensitivity testing, dietary provocation, and fecal immunoglobulin E. *J Vet Intern Med*. 2000;14(1):60-67.
11. Vaden SL, Sellon RK, Melgarejo LT, et al. Evaluation of intestinal permeability and gluten sensitivity in Soft-Coated Wheaten Terriers with familial protein-losing enteropathy, protein-losing nephropathy, or both. *Am J Vet Res*. 2000;61(5):518-524.
12. Ruaux C, Steiner JM, Williams DA. Postprandial changes in serum unconjugated bile acid concentrations in healthy beagles. *Am J Vet Res*. 2002;63(6):789-793.
13. Heilmann RM, Ruaux C, Burgener IA, Hern JD, Suchodolski J, Steiner JM. Serum alpha1-proteinase inhibitor concentrations in healthy dogs - method validation and determination of reference interval and intra-individual variation. *Vet Clin Pathol*. 2013;42(2):190-195.
14. Heilmann RM, Paddock CG, Ruhnke I, Berghoff N, Suchodolski J, Steiner JM. Development and analytical validation of a radioimmunoassay for the measurement of alpha1-proteinase inhibitor concentrations in feces from healthy puppies and adult dogs. *J Vet Diagn Invest*. 2011;23(3):476-485.

15. Sutherland-Smith J, Penninck DG, Keating JH, Webster CRL. Ultrasonographic intestinal hyperechoic mucosal striations in dogs are associated with lacteal dilation. *Vet Rad*. 2007;48(1):51-57.
16. Okanishi H, Yoshioka R, Kagawa Y, Watari T. The Clinical Efficacy of Dietary Fat Restriction in Treatment of Dogs with Intestinal Lymphangiectasia. *J Vet Intern Med*. 2014;28(3):809-817.
17. Goodwin LV, Goggs R, Chan DL, Allenspach K. Hypercoagulability in Dogs with Protein-Losing Enteropathy. *J Vet Intern Med*. 2011;25(2):273-277.
18. Dandrieux JRS, Noble P-JM, Scase TJ, Cripps PJ, German AJ. Comparison of a chlorambucil-prednisolone combination with an azathioprine-prednisolone combination for treatment of chronic enteropathy with concurrent protein-losing enteropathy in dogs: 27 cases (2007-2010). *J Am Vet Med Assoc*. 2013;242(12):1705-1714.

Blastocystis:
A New Pathogen, or Just a "Thing

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

The genus *Blastocystis* is a complex grouping of enteric protozoa commonly detected in a broad variety of species, including most mammals, many avian species, reptiles and amphibians. Phylogenetically, *Blastocystis* is a member of the Stramenopiles (phylum Heterokonta), an extremely diverse and complex phylum of predominantly algal genera. This organism is one of the most common gastrointestinal parasites of human beings, with reported prevalence rates ranging from 5% in some western countries to >76% in some parts of the developing world.[1,2] Originally, species were named on the basis of the host organism (i.e. *Blastocystis hominis, B. ratti*), however it is now well recognized that there is no single species that infects only humans (or any other host organism), and the entire group of organisms is now identified as genus *Blastocystis* with numbered subtypes, these subtypes being determined by small subunit ribosomal DNA (SSU-rDNA) gene sequences.[3] At the time of writing there are at least 14 known subtypes of *Blastocystis* identifiable on the basis of SSU-rDNA sequences.

In addition to the remarkable genetic diversity within this genus, there is a high degree of morphologic variation, with vacuolar, "granular", amoeboid, and cystic forms identified. Any subtype from any host organism may be identified in any of the morphologic forms, although the amoeboid form is thought to be closely linked to disease in humans.[4] Transmission is thought to be predominantly fecal-oral; there is also some evidence for water-borne transmission. The high prevalence rates reported from human beings in the developing world likely reflect differences in public sanitary infrastructure, closer exposure to open sewers, and closer exposure to animal waste than in the developed world.

Blastocystis as a human enteric pathogen

There exists considerable controversy in the human medical literature regarding the pathogenic potential of *Blastocystis* organisms.[5] Many workers feel that there is a link between this organism and irritable bowel syndrome (IBS) in humans,[6-8] and some reports have shown a relatively high risk of carriage in human patients with ulcerative colitis.[7] Interestingly, there appears to be quite marked geographic and subtype differences in the potential pathogenicity of this organism. Workers in the developing world have demonstrated increased risk of *Blastocystis* carriage in human patients with IBS and inflammatory bowel disease,[7,8] while workers in the developed world (particularly Europe) have reported a low prevalence of these organisms in human patients with chronic gastrointestinal disease.[9,10]

When considered a specific disease entity, Blastocystosis in humans is associated with anorexia or hyporexia, diarrhea, bloating, abdominal pain, skin rashes, steatorrhea, and weight loss.[1] The natural history of this disease can be prolonged (months to years), there are no known reliably effective therapies, and spontaneous resolution, rapid re-infection following apparently successful therapy, and resolution of clinical signs without effective clearance of the organism have all been reported.[11]

Possible mechanisms of pathogenicity

While the actual pathogenic potential of the various *Blastocystis* subtypes for their hosts is an area of ongoing controversy, there are recognized characteristics of these organisms that are consistent with a potential role as a gastrointestinal pathogen. At least some isolates of Subtype 4 (previously *B. ratti*) are able to induce apoptosis, actin rearrangement and loss of barrier function in cultured rat intestinal epithelial cells.[12] This same strain has been shown not to activate toll-like receptor signaling in a human monocyte cell line, suggesting that the parasite may be able to avoid recognition by the innate immune system.[13] In unpublished data from my laboratory, we have observed this same lack of induction of TLR-2 in CACO-1 cells, along with apparent inhibition of the serotonin-reuptake transporter protein.

Several subtypes have been shown to produce a variety of cysteine proteinases, these proteases have been shown to be capable of cleaving secretory IgA, and similar proteases are recognized as virulence factors in other enteric protozoal pathogens, including a variety of *Trichomonas* spp., *Giardia* spp. and *Entamoeba histolytica*.[14,15]

In a recently reported study of fecal microbiome structure and diversity in humans with IBS symptoms, infection with *Blastocystis* was associated with decreased numbers of *Faecalibacterium prausnitzii* and Bifidobacteria,[16] a pattern that is commonly recognized in a variety of chronic enteropathic and dysbiotic diseases. Interestingly, this pattern was also present in asymptomatic male control patients that were positive for *Blastocystis*, but at this time this finding is one of correlation rather than causation.

Diagnosis (in human beings)

In human beings the most commonly used method for diagnosis of *Blastocystis* carriage is via direct light microscopy of either unstained, wet mount or stained fecal preparations. Enrichment culture and fecal PCR are also commonly used, with fecal PCR

methods having the additional advantage of allowing subtype identification via sequencing of the small subunit ribosomal RNA gene. Fecal PCR has greater sensitivity than direct light microscopy.[17]

Clinical presentation (in human beings)

Interestingly, there appears to be quite marked geographic and subtype differences in the potential pathogenicity of this organism in human beings. Workers in the developing world have demonstrated increased risk of *Blastocystis* carriage in human patients with IBS and inflammatory bowel disease, while workers in the developed world (particularly Europe) have reported a low prevalence of these organisms in human patients with chronic gastrointestinal disease. When considered a specific disease entity, Blastocystosis in humans is associated with anorexia or hyporexia, diarrhea, bloating, abdominal pain, skin rashes, steatorrhea, and weight loss. The natural history of this disease can be prolonged (months to years), there are no known reliably effective therapies, and spontaneous resolution, rapid re-infection following apparently successful therapy, and resolution of clinical signs without effective clearance of the organism have all been reported.

Within the veterinary and parasitology literature there is a remarkable dearth of data regarding any link between *Blastocystis* carriage and clinical signs of disease in companion animals. A solitary case report describes a significant parasite burden in a mixed-breed dog with vomiting, diarrhea, and weight loss. This animal was definitively diagnosed with exocrine pancreatic insufficiency and marked hypocobalaminemia, which is sufficient to explain the observed clinical signs.[18]

Prevalance in companion animals, zoonotic potential?

The true prevalence of *Blastocystis* carriage in companion animals is unclear at this time, with most of the parasitology literature in this area focused on the domestic dog. Early data from subtropical and tropical environments suggested quite high carriage rates for *Blastocystis* in dogs, with rates as high as 70% reported for carriage in shelter-resident dogs in a subtropical environment,[19] although this finding has been thrown into some doubt by recent PCR-based studies from the same environment.[20] Carriage rates as high as 100% have been reported in domestic dogs from Thailand, however this was in a limited number of samples (n=3).[21] By comparison, in a cross-sectional study of military working dogs and personnel at a military dog center in Thailand, the prevalence in 189 dogs was 3.7%, while the prevalence in military personnel (n=317) at the same center was 14.5%.[22] This pattern of lower prevalence in dogs than humans is repeated in several other studies, leading some authors to conclude that dogs are unlikely to act as either natural hosts or primary zoonotic reservoirs for infection.[20]

In a study of asymptomatic individuals and pet animals living in the same household as humans symptomatic for Blastocystosis (n=11), 8/8 in-contact animals (5 dogs, 3 cats) were positive for *Blastocystis* via fecal PCR, with 7/8 of the in-contact animals carrying the same strain as the symptomatic in-contact human.[23] Interestingly, none of the in-contact animals or in-contact humans (n=17) in this admittedly small study showed clinical signs consistent with Blastocystosis. These data suggest that transmission between humans and companion animals is possible, however this is most likely a transient phenomenon and it appears unlikely that domestic dogs and cats represent a significant risk for zoonotic transmission.

Data recently reported from our laboratory assessed the prevalence and subtypes of *Blastocystis* in shelter-resident and client owned dogs in the US Pacific Northwest (specifically, Portland, OR and the southern Willamette valley).[24] In this study, we screened 104 shelter-resident dogs, 105 shelter-resident cats, 51 client-owned dogs and 52 client owned cats using a standard nested PCR methodology. In this study 10/103 dogs and 12/105 cats were positive for *Blastocystis*, however only 4/22 identified *Blastocystis* were of Subtype 1 (a potential human pathogen strain), with the remainder being Subtypes 10, 8 and 14, none of which are typically considered human enteric pathogens. All of the animals testing positive for *Blastocystis* in this study were shelter-resident, only one client-owned dog showed a faint positive result on PCR, this finding could not be replicated and thus the sample was considered negative. Shelter-resident animals (both cats and dogs) were significantly more likely to test positive for *Blastocystis* than client-owned animals, this is consistent with several prior observations that shelter-resident animals are more prone to enteric parasite infection.[25,26]

Is b*lastocystis* a pathogen in companion animals?

Within the veterinary and parasitology literature there is a remarkable dearth of data regarding any link between *Blastocystis* carriage and clinical signs of disease in companion animals. A solitary case report describes a significant parasite burden in a mixed-breed dog with vomiting, diarrhea, and weight loss. This animal was definitively diagnosed with exocrine pancreatic insufficiency and marked hypocobalaminemia, which is sufficient to explain the observed clinical signs.[18]

In our recent study of *Blastocystis* prevalence in companion animals in the Pacific Northwest we assessed the relationship between the presence of a parasite burden and signs of gastrointestinal disease of any kind. While records of gastrointestinal disease signs, typically diarrhea, were common in the medical records of the shelter-resident cats (26/105, 24.7%) and less so in dogs (9/103, 8.7%), there was no significant relationship seen between carriage of *Blastocystis* and the presence of gastrointestinal signs in the shelter-resident animals. Four of 52 (7.7%) client owned cats showed owner-reported gastrointestinal signs in the week prior to collection,

while 2/51 (3.9%) of client-owned dogs showed gastrointestinal signs in the week prior to collection. None of the client-owned animals showing gastrointestinal signs tested positive for *Blastocystis*. Shelter-resident cats were significantly more likely to have gastrointestinal disease signs overall than client-owned cats (P=0.0099, Relative Risk 3.21, Fischer's Exact Test), while there was no significant relationship between shelter-residence and presence of gastrointestinal signs in dogs (P=0.339, Fischer's Exact Test). Similar data regarding the frequency of diarrhea in shelter-resident dogs and cats have been reported previously.[27] From the data reported in this study, it appears unlikely that the presence of *Blastocystis* infection is a significant contributor to diarrhea in shelter-resident cats in the Pacific Northwest of the USA.

Conclusions

At this time there is a distinct lack of evidence for a relationship between *Blastocystis* carriage and the presence of gastrointestinal disease in companion animals, however the rate of infection and subtypes present in animals with chronic enteropathies is currently unknown. There is at least some concern that animals in contact with humans with Blastocystosis may act as secondary reservoirs for infection, but there is little evidence at this time that domestic animals represent a significant source of zoonotic spread of these organisms to uninfected human beings. Given the widely varying apparent pathogenicity of differing subtypes, and apparent geographic variation in common subtypes in other species, it would be interesting to determine if similar differences in prevalence and common subtypes are present in domestic animals in differing geographic areas.

References

1. Tan KSW. New Insights on Classification, Identification, and Clinical Relevance of Blastocystis spp. *Clinical Microbiology Reviews*. 2008;21(4):639-665.
2. Amin O. Epidemiology of Blastocystis hominis in the United States. *Res J Parasitol*. 2006;1(1):1-10.
3. Stensvold CR, Traub RJ, Suresh GK, et al. Terminology for Blastocystis subtypes – a consensus. *Trends Parasitol*. 2007;23(3):93-96.
4. Tan TC, Suresh KG. Predominance of amoeboid forms of Blastocystis hominis in isolates ... - PubMed - NCBI. *Parasitol Res*. 2005;98(3):189-193.
5. Sekar U, Shanthi M. Blastocystis: Consensus of treatment and controversies. *Trop Parasitol*. 2013;3(1):35-39.
6. Poirier P, Wawrzyniak I, Vivarès CP, Delbac F, Alaoui El H. New insights into Blastocystis spp.: a potential link with irritable bowel syndrome. Knoll LJ, ed. *PLoS Pathog*. 2012;8(3):e1002545.
7. Cekin AH, Cekin Y, Adakan Y, Tasdemir E, Koclar FG, Yolcular BO. Blastocystosis in patients with gastrointestinal symptoms: a case-control study. *BMC Gastroenterol*. 2012;12(1):122.
8. Jimenez-Gonzalez DE, Martinez-Flores WA, Reyes-Gordillo J, et al. Blastocystis infection is associated with irritable bowel syndrome in a Mexican patient population. *Parasitol Res*. 2012;110(3):1269-1275.
9. Rossen NG, Bart A, Verhaar N, et al. Low prevalence of Blastocystis sp. in active ulcerative colitis patients. *Eur J Clin Microbiol Infect Dis*. 2015;34(5):1039-1044.
10. Petersen AM, Stensvold CR, Mirsepasi H, et al. Active ulcerative colitis associated with low prevalence of Blastocystis and Dientamoeba fragilis infection. *Scand J Gastroenterol*. 2013;48(5):638-639.
11. Traub RJ, Stensvold CR, Nagel R, Smith HV, Olsen KEP. Eradication of Blastocystis carriage with antimicrobials: reality or delusion? *J Clin Gastroenterol*. 2010;44(2):85-90.
12. Puthia MK, Sio SWS, Lu J, Tan KSW. Blastocystis ratti Induces Contact-Independent Apoptosis, F-Actin Rearrangement, and Barrier Function Disruption in IEC-6 Cells. *Infection and Immunity*. 2006;74(7):4114-4123.
13. Teo JD, MacAry PA, Tan KSW. Pleiotropic effects of Blastocystis spp. Subtypes 4 and 7 on ligand-specific toll-like receptor signaling and NF-κB activation in a human monocyte cell line. Wang T, ed. *PLoS ONE*. 2014;9(2):e89036.
14. Mirza H, Tan KSW. Blastocystis exhibits inter- and intra-subtype variation in cysteine protease activity. *Parasitol Res*. 2009;104(2):355-361.
15. Sio SWS, Puthia MK, Lee ASY, Lu J, Tan KSW. Protease activity of Blastocystis hominis. *Parasitol Res*. 2006;99(2):126-130.
16. Nourrisson C, Scanzi J, Pereira B, et al. Blastocystis Is Associated with Decrease of Fecal Microbiota Protective Bacteria: Comparative Analysis between Patients with Irritable Bowel Syndrome and Control Subjects. *PLoS ONE*. 2014;9(11):e111868.
17. Stensvold CR, Arendrup MC, Jespersgaard C, Mølbak K, Nielsen HV. Detecting Blastocystis using parasitologic and DNA-based methods: a comparative study. *Diagn Microbiol Infect Dis*. 2007;59(3):303-307.
18. Chapman S, Thompson C, Wilcox A, Russell K. What is your diagnosis? Rectal scraping from a dog with diarrhea. *Veterinary Clinical Pathology*. 2009;38(1):59-62.
19. Duda A, Stenzel DJ, Boreham PF. Detection of Blastocystis sp. in domestic dogs and cats. *Vet Parasitol*. 1998;76(1-2):9-17.
20. Wang W, Cuttell L, Bielefeldt-Ohmann H, Inpankaew T, Owen H, Traub RJ. Diversity of Blastocystis subtypes in dogs in different geographical settings. *Parasites & Vectors*. 2013;6(1):215.
21. Parkar U, Traub RJ, Kumar S, et al. Direct characterization of Blastocystis from faeces by PCR and evidence of zoonotic potential. 2007;134(03):359.
22. Leelayoova S, Siripattanapipong S, Naaglor T, Taamasri P, Mungthin M. Prevalence of intestinal parasitic infections in military personnel and military dogs, Thailand. *J Med Assoc Thai*. 2009;92 Suppl 1:S53-S59.
23. Nagel R, Cuttell L, Stensvold CR, Mills PC, Bielefeldt-Ohmann H, Traub RJ. Blastocystis subtypes in symptomatic and asymptomatic family members and pets and response to therapy. *Intern Med J*. 2012;42(11):1187-1195.

24. Ruaux C, Stang BV. Prevalence of Blastocystis in Shelter-Resident and Client-Owned Companion Animals in the US Pacific Northwest. *PLoS ONE*. 2014;9(9):e107496.
25. Hill SL, Cheney JM, Taton-Allen GF, Reif JS, Bruns C, Lappin MR. Prevalence of enteric zoonotic organisms in cats. *J Am Vet Med Assoc*. 2000;216(5):687-692.
26. Scaramozzino P, Di Cave D, Berrilli F, et al. A study of the prevalence and genotypes of Giardia duodenalis infecting kennelled dogs. *Vet J*. 2009;182(2):231-234.
27. Bybee SN, Scorza AV, Lappin MR. Effect of the Probiotic Enterococcus faecium SF68 on Presence of Diarrhea in Cats and Dogs Housed in an Animal Shelter. *J Vet Intern Med*. 2011;25(4):856-860.

Exocrine Pancreatic Insufficiency: An Old Friend with Some New Tricks

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

Exocrine pancreatic insufficiency (EPI) is a syndrome characterized by maldigestion, malassimilation and marked, large volume small intestinal diarrhea. In the dog, this condition is usually the result of complete loss of pancreatic acinar tissue secondary to Pancreatic Acinar Atrophy (PAA). This condition is well known in the German Shepherd Dog, and is usually easy to recognize. In the cat, the underlying pathology leading to loss of exocrine pancreatic tissue mass is more likely to be chronic pancreatitis. This presentation will review the general features of EPI in both cats and dogs, including pathophysiology and diagnostic testing. Therapy of dogs with EPI is usually straightforward, and will be reviewed. In cats, therapy can be more challenging and other issues, including chronic cobalamin deficiency, must be addressed to ensure a good outcome. While most cases of EPI are the consequence of complete loss of exocrine pancreatic tissue, apparent selective pancreatic enzyme deficiencies have recently been recognized in several dogs, resulting in atypical presentations of exocrine insufficiency that can be diagnostically challenging.

Pathophysiology of diarrhea in exocrine pancreatic insufficiency

A lack of digestive enzyme synthesis and release into the small intestine results in a lack of digestion of dietary substrates. The osmotic draw produced by the unabsorbed, partially degraded nutrients within the small intestine will then produce an osmotic diarrhea. Fats are particularly strong inducers of diarrhea, as bacterial degradation of the fat produces large quantities of free fatty acids. These fatty acids can not be absorbed, and thus are potent osmotic agents, and in many cases the fatty acid products of bacterial fat degradation are toxic to the enterocytes, setting up secondary inflammation and motility disorders.

The pancreatic duct system, which is the source of pancreatic bicarbonate secretion, is spared in most dogs with EPI, and thus pancreatic bicarbonate secretion is normal. Trophic factors for the intestinal mucosa are lost, resulting in secondary abnormalities in structure and surface area of the villi and loss of brush-border enzymes.[1] The exocrine pancreas has a sizable reserve capacity, and clinical signs are usually not seen until there has been a loss of >90% of the acinar tissue.[2]

Pancreatic acinar atrophy vs. chronic pancreatitis

In the dog, the most common cause of primary pancreatic exocrine insufficiency is pancreatic acinar atrophy (PAA). This condition is associated with progressive loss of pancreatic acinar tissue, in at least some groups of dogs PAA appears to be associated with or preceded by a lymphocytic/plasmacytic pancreatic infiltrate.[2,3] In both German Shepherd dogs and the Rough-coated Collie there is evidence for heritability of this disease, most likely as an autosomal recessive.[4,5]

In the cat, EPI is most commonly due to loss of exocrine tissue due to ongoing chronic pancreatitis, the end-point of chronic pancreatitis being fibrosis and scarring. Juvenile onset disease, similar to PAA in dogs, has not been described in the cat to date. Chronic pancreatitis as a cause of primary exocrine insufficiency has been described in dogs,[6,7] and is the most common cause of late-onset exocrine insufficiency (i.e. in dogs >4 years of age).

Signalment and breed factors

Pancreatic acinar atrophy is usually diagnosed in young dogs, with a peak time of diagnosis at around 18 months of age. Development of clinical signs consistent with EPI in dogs older than three years should prompt the clinician to search for small intestinal disease. The German shepherd breed is most commonly recognized, as previously discussed this breed and the Rough-coated collie have a heritable predisposition for PAA in some family groups. PAA may be diagnosed in any breed of dog, although overall large breed dogs are diagnosed more commonly.

In the cat, EPI is usually diagnosed in middle-aged to older cats, reflecting the occurrence of EPI as an end result of chronic pancreatitis in this species. The time for development of EPI in cats with chronic pancreatitis is unknown, but given that this is a relatively rare (but increasingly recognized) diagnosis in the cat, and chronic pancreatitis appears to be remarkably common (See “Finicky feline: Pancreatitis in cats”), development of EPI is probably a relatively slow process in the cat.

Making the diagnosis of exocrine pancreatic insufficiency

Measurement of the serum concentration of trypsinogen (TLI) is the diagnostic test of choice to rule in/rule out exocrine pancreatic insufficiency due to a loss of pancreatic acinar tissue. As loss of acinar tissue is the most common cause of exocrine insufficiency, assessment of serum TLI should be carried out early in the diagnostic assessment of animals with compatible clinical signs.

In the dog, a serum TLI concentration of 2.5 µg/L or less is highly sensitive and specific for pancreatic acinar atrophy. [8] In the cat, exocrine insufficiency is diagnosed when the serum TLI concentration is less than 8 µg/L.[9] Detection of > 5 µg/L serum TLI in the

dog or > 12 µg/L serum TLI in the cat effectively rules out a loss or absence of pancreatic acinar tissue, and thus makes the diagnosis of primary pancreatic exocrine insufficiency much less likely.

The major differential diagnosis for EPI is small intestinal disease. A failure of the small intestinal mucosa to absorb digested nutrients will result in osmotic diarrhea and steatorrhea, with large volume diarrhea and weight loss. Animals with small intestinal disease may also present with a ravenous appetite and failure to thrive, a result of the decreased efficiency of utilization of dietary nutrients. Empirically, many animals with small intestinal disease will show mild improvement in their clinical signs with digestive enzyme supplementation, but this is an expensive and usually only mildly beneficial therapy for these cases. For this reason, digestive enzyme supplementation (see therapy below) should typically be reserved for cases where EPI/PAA has been confirmed by measurement of serum TLI concentrations.

In the cat, small intestinal disease is much more common than EPI. Most cats in which serum TLI is measured due to a suspicion of EPI actually have normal or mildly elevated serum TLI concentrations. This finding rules out loss of pancreatic acinar tissue, and should prompt the clinician to investigate more thoroughly for small intestinal disease.

As small intestinal disease is a major differential for EPI, measurement of serum concentrations of cobalamin and folate is often helpful. In both cat and dog, but particularly in the cat, serum concentrations of cobalamin are often low in EPI patients due to lack of pancreatic intrinsic factor. The presence of low serum cobalamin with a normal TLI is a highly specific indicator of small intestinal disease. Even in patients with confirmed EPI, cobalamin malabsorption and subsequent deficiency may lead to poor response to therapy.[10 11]

Several other methods for assessing pancreatic exocrine function have been described. Before the development of the TLI assay, determination of fecal proteolytic activity, measurement of the fecal fat content and microscopic examination of fecal smears for undigested muscle fibers have both been used in the past. Recently, measurement of canine fecal elastase activity has been promoted as an alternative to the TLI assay, with the benefit of an ELISA methodology that can be run in-house (the canine TLI assay is a radioimmunoassay, limiting its availability to specialty laboratories). Without exception, these other tests show a lower sensitivity and specificity for diagnosis of EPI than the TLI assays. Fecal proteolytic activity assays are still occasionally used in exotic species (ferrets, meerkats), but their use is strongly deprecated in dogs and cats.

Therapeutic considerations in the dog

The mainstay of therapy for EPI in the dog is replacement of pancreatic enzymes with any of a variety of porcine-pancreas derived products. Powdered forms are generally preferred; enteric-coated tablet forms have poorer bioavailability in the dog and are often associated with treatment failure.

Using a powdered form, a typical starting dose is 2 teaspoons/20 kg of dog, given with every meal. There are no benefits to pre-incubation of the meal with the enzymes. A standard maintenance diet is usually adequate for initial treatment, although some dogs will show additional benefit from a lower fat diet to reduce the osmotic load from fatty acids. Higher fiber diets should be avoided, as these may bind to the digestive enzyme supplement and reduce its availability. Fat absorption is particularly problematic for dogs with EPI, and development of fat-soluble vitamin deficiencies has been documented.[12] Parenteral supplementation with vitamin K should be provided in affected individuals. Serum cobalamin concentrations should be monitored every 3-6 months, and supplementation provided if the serum cobalamin concentration is decreased.

Two meals a day of a balanced canine maintenance diet are usually adequate for weight gain and normalization of the nutritional state. Diarrhea usually resolves within 4-5 days, however up to 20% of dogs in one study showed poor response to therapy. [13]

Therapeutic considerations in the cat

In common with the dog, effective treatment of exocrine pancreatic insufficiency in the cat relies on the effective replacement of digestive enzymes with powdered porcine pancreas extracts. A reasonable starting dose for the cat is approximately 1/4 teaspoon of extract per meal. Pre-incubation of the meal with the enzymes should be avoided as this may lead to food aversion in the cat. Compounding of the enzyme powder into gelatin capsules can be used in cats with severe food aversion, however this relies on the ability of the owner to administer the capsules to the cat. Gelatin-encapsulated enzyme powder capsules must be kept scrupulously dry or the capsule will be degraded.

Cats with EPI are almost invariably cobalamin deficient, the exocrine pancreas is the only source of intrinsic factor in the cat. Parenteral cobalamin supplementation (250 µg/cat by subcutaneous injection, once weekly to every second week) is necessary in most cats with EPI, response to treatment is often poor if cobalamin is not supplemented.

“Subclinical” EPI

Occasionally dogs are encountered with mild clinical signs of small intestinal malabsorption and serum concentrations of TLI that are lower then the bottom end of the reference range (5.7 µg/L), but not at or below 2.5 µg/L. If the dog is a young, large breed dog with a known predisposition for PAA, this may represent a subclinical state of PAA and warrants monitoring for progression to full-blown PAA and EPI. This “subclinical” state may persist for extended periods in some dogs, and if clinical signs are not seen, specific

therapy is not indicated. Dogs with this gray zone TLI concentration and mild or only sporadic clinical signs often respond well to diet change, preferably to a lower fat diet.[14] Digestive enzyme supplements benefit some of the dogs in this group, but the efficacy of this treatment is usually no greater than that achieved with fat restriction, and enzyme therapy is significantly more expensive.

Comorbidities and complications

Lymphocytic/plasmacytic enteritis and intestinal dysbiosis are common complicating conditions in dogs with EPI, thus in those cases with poor responses to therapy the use of glucocorticoids (prednisone/prednisolone at ~1mg/kg SID) and broad-spectrum antibiotic therapy (the author's preference is tylosin (Tylan Powder®, Elanco) at 25 mg/kg BID) may be indicated.

Gastric acid degradation is not usually a significant problem, but in some cases where appropriate doses of enzymes, antibiotics and glucocorticoids are being administered yet response to therapy is poor, additional benefit may be seen from treatment with a proton pump inhibitor such as omeprazole.

Both dogs and cats developing EPI as an end result of chronic pancreatitis may also be at increased risk for the development of insulin-dependent diabetes mellitus. [15,16] Dogs developing EPI due to pancreatic acinar atropy, however, are at no greater risk for development of diabetes as the islet tissue is spared.

Selective pancreatic enzyme deficiencies

A limited number of dogs have recently been described with a clinical syndrome that appears to reflect a selective deficiency in pancreatic enzyme synthesis, rather than a complete loss of acinar cellular mass.[17,18] These dogs presented at a comparatively young age (4 months to 1.5 years) with ravenous appetites, long histories of small intestinal diarrhea, poor body condition and failure to thrive. All of but one of these dogs showed normal serum TLI concentrations, with only one dog having TLI below the reference range, but greater than 2.5µg/L. All other diagnostic testing on these dogs was relatively unremarkable. In several of these dogs Spec-cPL values were below the lower limit of detection of the assay, but this is also commonly observed in normal dogs and is not considered diagnostic for exocrine insufficiency or pancreatic acinar atrophy.[19]

Interestingly, after failure of all other diagnostic tests to yield a diagnosis, and only limited response to dietary modification trials, all dogs showed marked clinical response to pancreatic enzyme supplementation, supporting the hypothesis that clinical signs in these dogs were due to absence of at least one of the pancreatic digestive enzymes.

While these recent case reports indicate that at least some dogs can present with a condition that requires pancreatic enzyme replacement therapy while serum TLI concentrations were within the normal range, it is important to note that these dogs had all undergone rigorous diagnostic work ups to exclude all other potential differential diagnoses. Small intestinal disease due to other etiologies, such as dietary intolerance or chronic parasitism, are far more likely causes for dogs to present with these clinical signs, and should be rigorously excluded before therapeutic trials of digestive enzymes are considered.

Prognosis

The prognosis for dogs with EPI due to PAA is fair to good for recovery of normal intestinal function and weight gain with appropriate therapy. While this is often a straightforward condition to manage, it can become expensive. Particularly in larger breed dogs, where this diagnosis is made most often, the cost of enzyme replacement therapy for the life of the dog can be substantial, and may represent a hardship for some owners. For this reason, accurate diagnosis and differentiation of PAA/EPI from other small intestinal diseases is very important.

Overall the prognosis for cats with EPI is more guarded than for the dog, due to the greater tendency to food aversion, more difficult administration of enzyme supplements and the existence of comorbid conditions such as chronic pancreatitis, enteritis and other age-related diseases.

References

1. Batt RM, Bush BM, Peters TJ. Biochemical changes in the jejunal mucosa of dogs with naturally occurring exocrine pancreatic insufficiency. *Gut*. 1979;20(8):709-715.
2. Westermarck E, Batt RM, Vaillant C, Wiberg M. Sequential study of pancreatic structure and function during development of pancreatic acinar atrophy in a German shepherd dog. *Am J Vet Res*. 1993;54(7):1088-1094.
3. Wiberg ME, Saari SA, Westermarck E. Exocrine pancreatic atrophy in German Shepherd Dogs and Rough-coated Collies: an end result of lymphocytic pancreatitis. *Veterinary Pathology*. 1999;36(6):530-541.
4. Westermarck E, Saari SAM, Wiberg ME. Heritability of exocrine pancreatic insufficiency in German Shepherd dogs. *J Vet Intern Med*. 2010;24(2):450-452.
5. Moeller EM, Steiner JM, Clark LA, et al. Inheritance of pancreatic acinar atrophy in German Shepherd Dogs. *Am J Vet Res*. 2002;63(10):1429-1434.
6. Watson P. Exocrine pancreatic insufficiency as an end stage of pancreatitis in four dogs. *JSAP*. 2003;44(7):306-312.
7. Watson P. Chronic pancreatitis in dogs. *Topics in Companion Animal Medicine*. 2012;27(3):133-139.
8. Williams DA, Batt RM. Sensitivity and specificity of radioimmunoassay of serum trypsin-like immunoreactivity for the diagnosis of canine exocrine pancreatic insufficiency. *J Am Vet Med Assoc*. 1988;192(2):195-201.

9. Steiner JM, Williams DA. Serum feline trypsin-like immunoreactivity in cats with exocrine pancreatic insufficiency. *J Vet Intern Med*. 2000;14(6):627-629.
10. Ruaux C. Cobalamin in companion animals: Diagnostic marker, deficiency states and therapeutic implications. *The Veterinary Journal*. March 2013:1-8.
11. Ruaux C, Steiner JM, Williams DA. Early biochemical and clinical responses to cobalamin supplementation in cats with signs of gastrointestinal disease and severe hypocobalaminemia. *J Vet Intern Med*. 2005;19(2):155-160.
12. Rutz GM, Steiner JM, Bauer JE, Williams DA. Effects of exchange of dietary medium chain triglycerides for long-chain triglycerides on serum biochemical variables and subjectively assessed well-being of dogs with exocrine pancreatic insufficiency. *Am J Vet Res*. 2004;65(9):1293-1302.
13. Wiberg ME, Lautala HM, Westermarck E. Response to long-term enzyme replacement treatment in dogs with exocrine pancreatic insufficiency. *J Am Vet Med Assoc*. 1998;213(1):86-90.
14. Wiberg ME, Westermarck E. Subclinical exocrine pancreatic insufficiency in dogs. *J Am Vet Med Assoc*. 2002;220(8):1183-1187.
15. Watson P, Archer J, Roulois AJ, Scase TJ, Herrtage ME. Observational study of 14 cases of chronic pancreatitis in dogs. *Veterinary Record*. 2010;167(25):968-976.
16. Bazelle J, Watson P. Pancreatitis in cats: is it acute, is it chronic, is it significant? *J Fel Med Surg*. 2014;16(5):395-406.
17. Xenoulis PG, Fradkin JM, Rapp SW, Suchodolski J, Suchodolski JS, Steiner JM. Suspected isolated pancreatic lipase deficiency in a dog. *J Vet Intern Med*. 2007;21(5):1113-1116.
18. Viviano KR, Ziglioli V. Suspected isolated pancreatic enzyme deficiencies in dogs. *J Vet Intern Med.* 2013;27(3):588-591.
19. Huth SP, Relford R, Steiner JM, Strong-Townsend MI, Williams DA. Analytical validation of an ELISA for measurement of canine pancreas-specific lipase. *Veterinary Clinical Pathology*. 2010;39(3):346-353.

Let's Just Monitor It:
The Pitfalls and Problems with Serial Serum Chemistries

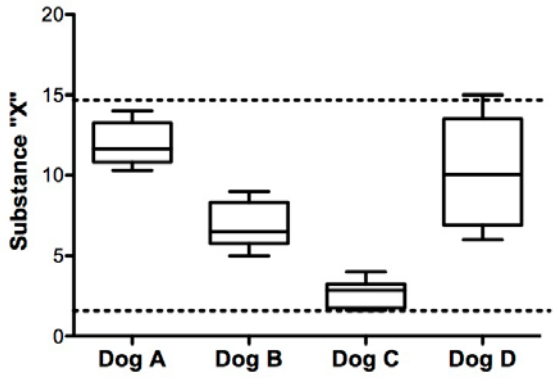
Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

It is well known that clinical chemistry analytes vary naturally over time, both as a result of disease processes and due to intrinsic biological variation within the individual.[1] Variation occurs at the level of the individual, as a result of analytical imprecision, and within groups of individuals. The degree of within individual variation is itself quite variable, some analytes showing marked changes over time, while other analytes are under more rigid homeostatic regulation and thus vary less within an individual.

In both human and veterinary medicine the diagnosis and management of chronic disease conditions is becoming increasingly important. As a profession we promote the idea of "screening blood tests" performed on a regular basis. The American Animal Hospital Association (AAHA) Senior Care Guidelines for Dogs and Cats, for instance, recommend regular clinical chemistry panels for "senior" dogs, defined as dogs in the last 25% of their expected lifespan.[2] Similarly, the American Association of Feline Practitioners-AAHA Feline Life Stage Guidelines recommend a panel of clinical chemistry parameters that are considered part of the "minimum database" for regular assessment of mature and elderly cats.[3] An implicit assumption in these recommendations is that clinically meaningful changes will be detectable, and that early, beneficial interventions will be prompted by the detection of changes. In order for the clinician to accurately gauge the presence and importance of changes in these "screening" biochemistry panels, we need a reasonable understanding of just how much these tests change over time in an individual, and just how great a change needs to be documented to most likely reflect a change in the patient's physiology.

Concepts and terminology of biological variation

When considering biological variability and how it impacts the use of serial blood work, there are two important concepts that need to be understood: the Index of Individuality and the Reference Change Value. The index of individuality of any particular test is derived from the ratio of variation over time *in an individual patient* to variation *within the population as a whole*. If a test has a high degree of individuality, results from a patient will tend to cluster together over time, and the results of tests from one patient will often not overlap with results from another patient. If a test has a high degree of individuality, important changes for an individual may be missed if comparing to a broader, population based reference range. This concept is illustrated in Figure 1 (right). In this figure, each dog's results are tightly grouped within the individual, with little overlap between individuals. The broken lines represent a theoretical reference range based on the 95th percentile of all the data. Note that quite large deviations from Dog B's "normal", in either direction, would still fall within the reference range and thus meaningful change may be missed.



Tests with a high degree of individuality are best used by taking serial measurements over time and comparing the individual's test results to prior values, rather than taking a single measurement and comparing it to a population based reference range.

Most diagnostic tests in veterinary medicine are traditionally compared to population-based reference ranges derived from large populations of "normal" individuals. This means we make an underlying assumption that most diagnostic tests we use have a low individuality and comparison to a reference range is appropriate. There is actually relatively little information regarding the individuality of tests commonly used in dogs and cats in the veterinary literature, but what is available would suggest that a substantial majority of the tests that we use regularly actually have quite high individuality,[4,5] leading to the unsettling thought that we miss important changes in our patients **in spite of** regular biochemistry screenings.

If we are monitoring a value over time, we need to have some idea of the magnitude of change that most likely represents a change in the patient's physiology (either a worsening or an improvement, depending on the context of the testing). This is the Reference Change Value (RCV), which is derived from measurements of the within patient variability and the variability of the measurement technique itself. In most cases, the reference change value is stated as a percentage change, statistically associated with a *P* value of <0.05; in other words a change of this size has a <1:20 chance of being random, and thus is more likely due to a change in the patient's physiology. A change in a test result less than this value, regardless of whether it is "better" or "worse", is statistically unlikely to represent a real change, and therapeutic decisions should be made with caution if less than this degree of change is seen.

Factors that influence biological variability

As previously indicated most chemistry parameters that we measure in our patients have high individuality, and many have high reference change values. Generally speaking analytes that are actively regulated by some form of physiological homeostatic process will have lower individualities and relatively low reference change values. Examples of substances with low individualities and comparatively low reference change values include serum electrolytes (particularly potassium and calcium) and blood glucose concentrations. This intuitively makes sense; these electrolytes are rigorously regulated by the renin-angiotensin-aldosterone system and parathyroid/calcitonin hormone production respectively, while under normal circumstances glucose is regulated via the insulin/glucagon system within a relatively tight range of values.

Release of "leakage" enzymes, such as alanine transaminase (ALT) and the specific pancreatic lipases is not under any form of homeostatic control, their release into the circulation varies with their rate of synthesis (which may vary with disease), rate of loss from the cells (which may also vary with disease), and may also vary with changes in the clearance mechanisms of these enzymes from the circulation. Consequently, these enzymes often feature a very high degree of within-individual variation, resulting in high reference change values. This has been reported for both pancreatic lipase immunoreactivity and liver enzyme activities in dogs,[5,6] and for liver enzyme activities in cats.[4]

The effect of disease states on biological variability

Disease states can also influence the degree of biological variability, and thus the reference change values for individuals who are already diseased may actually be markedly different from healthy individuals. This has been reported for the cardiac biomarker NT-proBNP in dogs,[7] where the reference change value for dogs with mitral regurgitation was estimated at approximately 50%, while the RCV for healthy dogs was nearly 100%, the lower RCV in the dogs with mitral regurgitation was mainly due to lower within-individual variation in that group.

Data on biological variability and reference change values for other enzymes and other disease states are currently lacking for many important diseases and for many enzymes that are routinely measured in practice. While data for biological variation in specific canine pancreatic lipase (Spec-cPL) has been reported for healthy dogs (where a very high RCV of approximately 450% was reported),[6] data from dogs with chronic pancreatitis or on the feline specific pancreatic lipase assay (Spec-fPL) in any group of cats (healthy or diseased) are not available at the time of writing.

The importance of biological variability depends upon magnitude of change with disease

While many analytes used in clinical practice have high individuality, suggesting that the application of population based reference ranges is of limited utility, the degree of deviation from normal is often sufficiently high that, when used as a screening test, diseased individuals are still readily distinguished from the normal range. An example would be cardiac troponin-I in individuals with myocardial ischemia, where several hundred-fold elevations in cardiac troponin-I concentrations are regularly documented, a vastly greater change than the estimated RCV (approximately 110% for healthy dogs) for this marker. Similarly, even though the RCV for canine specific pancreatic lipase is approximately 450% (4.5 fold), the cut off value considered consistent with pancreatic disease (> 400µg/L) is actually greater than 4.5-fold higher than the average healthy dog's Spec-cPL value (which is about 63µg/L). Because of the very large deviations from normal seen with these tests, the implication of their high individual variability is mitigated when using these tests in a clinically appropriate manner to establish a diagnosis. The application of these tests to ongoing monitoring of the disease state post-diagnosis should still be approached with caution, however, until better data regarding RCV's for these markers in animals with chronic disease is available.

For some tests, the analyzer is the limiting factor

To this point the discussion has mainly been about understanding why remaining aware of biological variation and reference change values are important, and less about how we actually go about getting the values that we are monitoring. This does not mean that how the sample is obtained and how the instruments doing the test are performing is not important, but in most cases we assume that samples are handled correctly and analyzed on machines that are well maintained and calibrated appropriately.

When we are interested in changes that are occurring in substances that show very little intra-individual variation, however, the performance of the analyzer doing the test can actually become very important. The criteria for acceptable analyzer variability when calculating and using reference change values are that the analyzer's contribution to the variability seen must be less than half of the biological variation (in our case, this is the intra-individual variation).

In one study of biological variation carried out by the author, the performance of three different levels of clinical chemistry instruments were compared using the same set of samples. The instruments tested were a Beckman Coulter AU480 (a very high end-machine used in large clinical pathology practices), a Sirrus chemistry system (middle-range, would be used in a busy human urgent care facility) and the IDEXX VetTest 8008, a common system used in veterinary practices. All of the analytical systems used were precise enough that they could be used to derive reference change values and monitor for changes in all of the analytes measured. The AU 480, interestingly, was insufficiently precise to derive a reference change value for serum cholesterol in the dog, and none of the

three instruments showed sufficient precision to derive reference change values for total calcium.[5] The implications of these findings are not entirely clear, but they do illustrate that even under the best of conditions and using rigorously maintained and calibrated instruments, our actual ability to actually detect meaningful changes in blood chemistry values is sometimes a lot lower than we would think.

References

1. Fraser CG. Inherent biological variation and reference values. *Clin Chem Lab Med.* 2004;42(7):758-764.
2. Epstein M, Kuehn NF, Landsberg G, et al. AAHA senior care guidelines for dogs and cats. *Journal of the American Animal Hospital Association*. 2005;41(2):81-91.
3. Vogt AH, Rodan I, Brown M, et al. AAFP-AAHA: Feline life stage guidelines. *Journal of the American Animal Hospital Association*. 2010;46(1):70-85.
4. Baral RM, Dhand NK, Freeman KP, Krockenberger MB, Govendir M. Biological variation and reference change values of feline plasma biochemistry analytes. *J Feline Med Surg*. 2014;16(4):317-325.
5. Ruaux C, Carney PC, Suchodolski J, Steiner JM. Estimates of biological variation in routinely measured biochemical analytes in clinically healthy dogs. *Vet Clin Pathol*. 2012;41(4):541-547.
6. Carney PC, Ruaux C, Suchodolski J, Steiner JM. Biological variability of C-reactive protein and specific canine pancreatic lipase immunoreactivity in apparently healthy dogs. *J Vet Intern Med.* 2011;25(4):825-830.
7. Ruaux C, Scollan K, Suchodolski J, Steiner JM, Sisson DD. Biologic variability in NT-proBNP and cardiac troponin-I in healthy dogs and dogs with mitral valve degeneration. *Vet Clin Pathol*. June 2015.

Finicky Feline:
Pancreatitis in Cats

Craig Ruaux, BVSc, PhD, DACVIM
Oregon State University
Corvallis, OR

In recent years, with greater availability of high-level diagnostic imaging and minimally invasive methods for the determination of pancreas-specific marker proteins in the serum, we have undergone a paradigm shift with respect to pancreatic disease in the cat. Once thought to be uncommon, we now know that a very large proportion of feline patients have chronic pancreatitis. In one remarkable study, the overall prevalence rate for chronic pancreatitis was 67% in ill cats, and even more remarkably, 45% in normal cats, based on histopathologic examination of 115 feline pancreata.[1] Far from being uncommon, it is now apparent that pancreatic pathology, and particularly chronic pancreatitis, is common in the domestic cat. This disease likely represents a large proportion of feline cases presenting with reduced appetite, lethargy or chronic vomiting disorders, hopefully further large-scale epidemiologic studies will help to confirm or deny this hypothesis.

Chronic pancreatitis in the cat is distinctly different from chronic pancreatitis in most dogs, and shares more features with chronic pancreatitis in humans. In particular, marked lymphocytic infiltration and the presence of profound fibrosis are common in feline chronic pancreatitis.[1]

Clinical signs of pancreatitis in the cat

One of the great challenges in managing the cat with pancreatitis is the vague nature of clinical signs typically manifested in these cats. Based on the aggregation of data from three studies, involving a variety of underlying histological diagnoses and apparent disease severities, the most common clinical signs of pancreatitis in the cat are reduced appetite, lethargy, dehydration and vomiting (Table 1, below).

Table 1

Common historical and clinical signs of pancreatitis in cats aggregated from three separate studies.[2-4] Cats from one study (Ferreri *et al.*[3]) are subdivided into acute necrotizing (ANP, n=30) and chronic nonsuppurative (CP, n=33) presentations. NS = Not Specified. Overall prevalence is rounded to the nearest whole percentage value.

	Study					
Clinical Sign	Stockhaus[2]	Ferreri[3] (ANP)	Ferreri[3] (CP)	Hill[4]	Total	Overall Prevalence
Number of Cats	33	30	33	40	136	
Inappetance	32 (97%)	19 (63%)	23 (70%)	39 (98%)	113	83%
Lethargy	33 (100%)	15 (50%)	17 (52%)	40 (100%)	105	77%
Dehydration	24 (73%)	10 (33%)	17 (51%)	37 (93%)	88	65%
Vomiting	18 (55%)	13 (43%)	13 (39%)	14 (35%)	58	43%
Icterus	6 (18%)	5 (16%)	8 (24%)	21 (53%)	40	29%
Weight Loss	3 (9%)	12 (40%)	7 (21%)	NS	22	16%
Abdominal Pain	17 (52%)	NS	NS	10 (25%)		

Abdominal pain, a very common clinical sign of pancreatitis in the dog, is much less frequently recognized in the cat. Accurate assessment of abdominal pain in the cat can be quite difficult, and thus the true frequency of this problem in cats with pancreatitis may be underestimated,[5] however the central observation that abdominal pain is rarely appreciated by clinicians assessing cats with pancreatitis remains true. Given the vague nature of clinical signs of pancreatitis in the cat, this disease should be considered in the differential diagnosis of any cat with vomiting, anorexia/hyporexia or lethargy where another, more proximate cause has not been identified.

An interesting observation from the aggregated retrospective studies is that these signs were the same regardless of underlying type of pancreatitis in the cats, with both severe necrotizing disease and more chronic, fibrotic disease having the same general signs. Based on these observations, it is not possible to distinguish acute from chronic pancreatitis in cats based on clinical presentation, duration of clinical signs or apparent severity of the disease.[3,6,7] While chronic pancreatic disease is commonly thought to be less severe than acute pancreatitis in the cat,[6] either disease can present with complications or comorbidities that are potentially life-threatening, and attempting to draw a distinction between these two conditions is not particularly clinically helpful.

Diagnostic approach to pancreatitis in the cat

In order to make the diagnosis of pancreatitis in the cat, obviously a clinical suspicion is necessary. Given the highly vague and variable nature of pancreatic disease signs in the cat, essentially any sick cat should have pancreatitis on their differential diagnosis list

at first assessment. Routine chemistry panels are very useful for screening for other significant diseases that can causes lethargy and a poor appetite, such as renal insufficiency. Routine chemistry panels may also provide evidence of hepatobiliary disease, which is a common comorbidity with pancreatitis in the cat.

In many patients routine chemistry panels are unremarkable, reflecting the fact that there are no diagnostic tests on a typical screening chemistry panel that are sensitive and specific for pancreatic disease. This includes amylase and lipase activities, which are generally thought to have no diagnostic utility for detection of pancreatitis in the cat.[3,5] Further assessment of these patients typically involves both abdominal ultrasound examination and the use of more specialized blood tests, particularly the feline specific pancreatic lipase assay (Spec-fPL).

At the time of writing Spec-fPL has the highest sensitivity and specificity for the diagnosis of pancreatitis of any diagnostic test in the cat, exceeding ultrasound, plain radiography and computed tomography scanning.[8,9] This test also has the advantage of being minimally invasive and relatively inexpensive.

Spec-fPL values increase dramatically early in the development of pancreatic inflammatory disease, and then are cleared from the circulation relatively slowly, taking up to 14 days to return to the baseline value after the onset of acute pancreatitis. When the clinician suspects that chronic pancreatitis is present, determination of Spec-fPL concentrations repeatedly at 2-3 week intervals can bolster this diagnosis. The expectation is that serum Spec-fPL will remain elevated above the reference range throughout this period, even if the cat is showing few or no clinical signs.

The low sensitivity and specificity of traditional amylase and lipase activities for the diagnosis of pancreatitis, in all species, may be partly explained by low substrate specificity for most of the catalytic assays. The substrates used in these assays vary in terms of selectivity for pancreatic lipase, with some substrates showing much higher selectivity for pancreatic-origin lipases in the circulation. 1-2-o-Dilauryl-*rac*-glycero-3-glutaric acid-(6'-methylresorufin) ester (DGGR) is a lipase substrate with relatively high substrate specificity for pancreatic lipases. In a recently published study of 251 client owned cats with a clinical suspicion of pancreatitis, DGGR-lipase activity >26 U/L showed a sensitivity of 48% with a specificity of 63%, while Spec fPL >5.3 µg/L showed a sensitivity of 57% and specificity of 63%.[10] This study suggests that DGGR-lipase activity may have some clinical utility in the assessment of cats, however this would be reliant on the use of this specific substrate in whichever analytical system is being used. Information regarding the actual substrates used by the various reference laboratories and in-house chemistry systems commonly found in veterinary practice is not readily available at this time.

Therapeutic approaches to the outpatient case

Given the very high frequency of dietary intolerance recognized in some studies of cats with chronic gastrointestinal disease, a rational initial step in the approach to a cat with a diagnosis of pancreatitis is an elimination trial using a hypoallergenic diet. The author's preference is to use a novel protein source, selected based on a thorough dietary history, rather than the modified/partially hydrolyzed protein diets, however in some cases these modified diets are effective and well received. Dietary modification to a novel protein source often seems to be helpful in cats with chronic pancreatitis as well as in those with gastritis. Fat restriction, the mainstay of therapy for chronic pancreatitis in the dog, is less beneficial in most cats with chronic pancreatitis.

The patient is started on the elimination diet exclusively for a minimum period of 14 days. In most patients with diet-responsive disease a notable improvement in clinical signs will have occurred at 14 days, and those that have failed to show a good response are unlikely to show much benefit from a longer period on the diet. If the cat responds to the diet change, the diagnosis becomes one of food-responsive gastritis or dietary intolerance. "Dietary allergy" implies demonstration of a hypersensitivity response to a dietary component, as this is not achieved in most veterinary patients this term is not appropriate to most cases. Reintroduction of the previous diet or dietary components (protein sources etc) can be attempted, and if clinical signs recur the diagnosis of food intolerance is confirmed, subsequent therapy emphasizes the avoidance of the offending food component. In many cases owners are unwilling to reintroduce the original diet if clinical signs have abated and the new diet is continued empirically.

If the patient shows no response to the first diet change at 14 days, another new diet can be trialed. Most owners are unwilling to persist beyond two dietary trials, and additional therapy is needed. Failure to respond to dietary modification in a cat with infiltrative gastric mucosal disease allows the diagnosis of idiopathic chronic gastritis to be made. Therapy for this condition usually requires anti-inflammatory therapy, typically using glucocorticoids. Many cats with chronic pancreatitis also show satisfactory responses to glucocorticoid therapy, typically starting with prednisone/prednisolone at 1-1.5 mg/kg SID for approximately 14 days. There is no evidence to date that glucocorticoid therapy is associated with increased risk of worsening pancreatitis in the cat. If good control of clinical signs has been achieved, a gradual taper of the glucocorticoid to the minimum effective dose is started.

Pain control, maintenance of adequate nutritional intake in cats with inappetance, and maintenance of hydration are all critical to success. Most cats with pancreatitis presenting to companion animal practices are able to be managed on an outpatient basis, but the owner should be counseled on the need for close monitoring of food intake and the possibility of worsening of the disease which may require hospitalization for fluid therapy and assisted nutrition (see below).

A common empirical therapy is the use of pancreatic enzyme supplements to attempt to "down regulate" the pancreatic synthesis of digestive enzymes, the theory being that this will reduce ongoing pancreatic pathology. There is no evidence that this is efficacious. Given that the main pancreatic pathology in the cat is a chronic lymphocytic and fibrotic process, rather than an autocatalytic degradative/necrotic process, we now know that there is little physiological rationale for this therapy, and it is not recommended.

Therapeutic approach to the cat with severe disease

Cats with suspected pancreatitis presenting with marked abdominal pain, tachypnea, tachycardia, significant fever, collapse or other evidence of systemic inflammatory syndrome or circulatory shock are considered to have severe disease, and require immediate and aggressive, hospital-based care. The existence of multiple abnormalities in screening clinical chemistries, particularly hypoalbuminemia and hypocalcemia, is a strong indicator of severe and potentially life threatening disease.[5]

As with dogs, cats presenting with severe pancreatic inflammatory disease require aggressive therapy, including fluid therapy, effective analgesia, and early planning for nutritional support given the risk of hepatic lipidosis as a comorbidity. The aims of therapy are to replace circulating fluid volume, restore and maintain end organ perfusion (particularly of the pancreas, as pancreatic ischemia is a significant contributor to the development of necrotizing pancreatitis[6]), restore and maintain plasma colloid oncotic pressure. Colloid fluids, such as synthetic hydroxyethyl starches, are often highly beneficial in the initial resuscitation of these cases. Fresh-frozen feline plasma can also be considered, and likely provides oncotic support while replenishing coagulation cascade proteins, however there is little information in the veterinary literature regarding use of plasma in severe feline pancreatitis cases. We typically use a combination of synthetic colloid and crystalloid fluids for initial resuscitation and volume maintenance in these cats in our clinic. Substantial electrolyte abnormalities, particularly hypokalemia and hypocalcemia, should be anticipated in these cats.[5,7] Supplemental potassium is administered in combination with crystalloid fluids following routine guidelines for concentrations based on serial determination of serum potassium.

Effective analgesia and control of vomiting are important aspects of management of severe pancreatitis in all species, including the cat. Narcotic pain control is typically indicated in cats with sufficiently severe pancreatitis to warrant hospitalization. Transdermal fentanyl patches (25µg/hr) can be very effective for longer term (up to 72 hrs) analgesia without the need for frequent handling and injection in these patients, but initial therapy with an injectable or sublingual agent (commonly buprenorphine) is necessary as it can take up to 12 hours for therapeutic fentanyl concentrations to be reached.[7] Maropitant, a neurokinin-1 receptor antagonist, is both an effective antiemetic and has antinociceptive effects in the viscera.[11] The combination of maropitant with a 5-HT_3-receptor antagonist, such as ondansetron or dolasetron, provides an effective control for vomiting and nausea in these patients with minimal need for repeated handling during the day.

The special case of the diabetic cat

Cats with diabetes mellitus and chronic pancreatitis represent a significant challenge, particularly if they are poorly or minimally improved by rigorous use of an elimination diet. The use of glucocorticoids in these cats risks the loss of glycemic regulation, increased insulin requirements or the development of insulin resistance. When faced with this particular quandary, the author's personal preference is to emphasize dietary modification and weight loss to attempt to improve the glycemic state of the cat, rather than use of glucocorticoids to control gastric or pancreatic inflammation. Many cats will show an improvement in their chronic vomiting as they enter a euglycemic state, and anecdotally many cats with chronic pancreatitis show an improvement in their clinical signs and a normalization of serum fPLI concentrations after they are switched to the higher protein, low carbohydrate dietary regimes currently recommended for management of diabetic cats.[12]

References

1. De Cock HEV, Forman MA, Farver TB, Marks SL. Prevalence and histopathologic characteristics of pancreatitis in cats. *Veterinary Pathology*. 2007;44(1):39-49. doi:10.1354/vp.44-1-39.
2. Stockhaus C, Teske E, Schellenberger K, et al. Serial serum feline pancreatic lipase immunoreactivity concentrations and prognostic variables in 33 cats with pancreatitis. *J Am Vet Med Assoc*. 2013;243(12):1713-1718. doi:10.2460/javma.243.12.1713.
3. Ferreri JA, Hardam E, Kimmel SE, et al. Clinical differentiation of acute necrotizing from chronic nonsuppurative pancreatitis in cats: 63 cases (1996-2001). *J Am Vet Med Assoc*. 2003;223(4):469-474.
4. Hill RC, Van Winkle TJ. Acute necrotizing pancreatitis and acute suppurative pancreatitis in the cat. A retrospective study of 40 cases (1976-1989). *J Vet Intern Med*. 1993;7(1):25-33.
5. Zoran DL. Pancreatitis in cats: diagnosis and management of a challenging disease. *Journal of the American Animal Hospital Association*. 2006;42(1):1-9.
6. Xenoulis PG, Steiner JM. Current concepts in feline pancreatitis. *Topics in Companion Animal Medicine*. 2008;23(4):185-192.
7. Armstrong PJ, Williams DA. Pancreatitis in cats. *Topics in Companion Animal Medicine*. 2012;27(3):140-147.
8. Forman MA, Marks SL, De Cock HEV, et al. Evaluation of serum feline pancreatic lipase immunoreactivity and helical computed tomography versus conventional testing for the diagnosis of feline pancreatitis. *J Vet Intern Med*. 2004;18(6):807-815.
9. Xenoulis PG. Diagnosis of pancreatitis in dogs and cats. *Journal of Small Animal Practice*. 2015;56(1):13-26.

10. Oppliger S, Hartnack S, Riond B, Reusch CE, Kook PH. Agreement of the Serum Spec fPL (TM) and 1,2-O-Dilauryl-Rac-Glycero-3-Glutaric Acid-(6 '-Methylresorufin) Ester Lipase Assay for the Determination of Serum Lipase in Cats with Suspicion of Pancreatitis. *J Vet Intern Med*. 2013;27(5):1077-1082.
11. Boscan P, Monnet E, Mama K, Twedt DC, Congdon J, Steffey EP. Effect of maropitant, a neurokinin 1 receptor antagonist, on anesthetic requirements during noxious visceral stimulation of the ovary in dogs. *Am J Vet Res*. 2011;72(12):1576-1579.
12. Zoran DL. The carnivore connection to nutrition in cats. *J Am Vet Med Assoc*. January 2002.

Urogenital Imaging:
Can I Do a Contrast Procedure in Practice?

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Urinary tract infections are a very common cause for stranuria and hematuria seen in the general veterinary practice. Usually, a urinalysis is obtained and appropriate therapy is provided with limited imaging and the hope is that the patient's symptoms will resolve due to a self-limiting problem. This lecture will focus on all the modalities available to help the clinician assess the urinary tract with examples of specific diseases to help illustrate key points.

Radiographs are considered the first line of diagnostic imaging obtained in a urinary patient. This is to look for urinary calculi since struvite and calcium oxalate crystals are radiopaque. The problem is that soft tissue and fluid have the same opacity so cystitis and a thick wall of the urinary bladder. Ectopic ureters cannot be seen, hydronephrosis secondary to obstruction, pyelonephritis and even a renal mass or perinephric pseudocyst cannot be seen because of similar opacities. For this reason intravenous contrast medium can be used to create contrast between the urine and the soft tissues of the organs, bearing in mind that the contrast medium can damage the kidneys and cause renal failure.

Despite the inherent risk of contrast medium, the benefits of excretory urography (also called intravenous pyelogram or IVP) and the ease of the procedure still make it a viable modality in patients with urogenital disorders. The basic types of contrast medium procedures that will be discussed are retrograde urethrograms, positive contrast cystograms, double contrast cystograms and excretory urograms. Generally, procedures are performed in the order listed above of a complete evaluation of the urinary system.

The contrast medium of choice for all urinary procedures is iodinated contrast medium. Ionic (hypertonic) or nonionic (closer to isotonic) contrast medium is less important for urethrograms or cystograms, but the choice may come into play with intravenous administration. Ionic contrast medium, such as MD-76 and Conray, are very hypertonic and as such can cause a tachycardia and reflex bradycardia due to the increased blood volume by pulling fluid from the periphery into the vascular space, much like hypertonic saline. Non-ionic contrast medium, such as Omnipaque and Isovue, is generally closer to isotonic saline and so the vascular changes are minimal. The other complication with contrast medium is the simulation of the chemoreceptor trigger zone in the brain, which can cause vomiting. This is believed to be the direct result of the high level of iodine within the blood when contrast medium is administered. This response is avoided by administering the contrast as a slow bolus over 30 seconds to 1 minute or having the patient under general anesthesia. Due to the potential damage to the nephrons and the multiple images obtained for the contrast medium procedures, all animals should be heavily sedated or under general anesthesia and placed on at least twice maintenance intravenous fluids during the procedure. The risk of an anaphylaxis event is considered equally likely between ionic and non-ionic contrast medium.

Retrograde urethrograms can be performed in males by placing a catheter directly into the penile urethra and infusing contrast medium. Generally a small volume of contrast medium diluted with sterile saline is used. In the author's experience, 2 mL of contrast medium diluted with 8 mL of saline is sufficient to infuse the urethra with contrast medium. In females, a vaginourethrogram is usually performed using a Foley catheter within the vestibule and 30 mL of contrast medium and saline in a 1:5 dilution. A tissue clamp may be needed on the labia to keep the contrast medium within the vestibule. A lateral and ventrodorsal radiographic projection is then obtained at the end of the infusion of contrast medium so that the pressure of the contrast medium administration dilates the urethra.

Positive contrast cystograms are generally used to evaluate for urinary bladder ruptures whereas double contrast cystograms help evaluate the wall of the urinary bladder, evaluate for calculi and help identify ectopic ureters. A positive contrast cystogram is performed with a patient in left lateral recumbency and a foley catheter is placed in the urinary bladder. The catheter balloon can be filled with air or saline and the urine removed from the urinary bladder. Then approximately 60 mL contrast medium is infused into the urinary bladder diluted with saline in a 1:5 ratio. A lateral and ventrodorsal radiographic projection is obtained while infusing the contrast medium to look for leakage in the urinary bladder wall. If the urinary bladder is insufficiently dilated with 60 mL of dilute contrast medium, another 60 mL is administered and radiographs are repeated. Fluoroscopy, when available, will aid in evaluating the volume of contrast medium administered as well as watching the distention of the urinary bladder.

After the positive contrast cytogram is perform, the contrast medium and urine are removed and carbon dioxide or room air is administered into the urinary bladder. Carbon dioxide is recommended if available as the risk of air emboli, especially in cats, is greatly reduced since carbon dioxide is more soluble in blood compared to room air. If room air is used, maintaining the patient in left lateral recumbency and monitoring the heart for "gurgling" sounds is necessary. If air emboli occur, you should elevate the pelvis of the patient to allow the right ventricle to be higher than the pulmonary outflow tract. This will trap the gas in the right ventricle and allow time for it to dissolve before entering the pulmonary system as an emboli. It generally takes approximately 20 minutes for the air to dissolve; however, a radiograph of the thorax can be used to identify the air within the ventricle.

After infusion of the negative contrast medium (air or gas), a small volume of positive contrast medium is administered. Generally 1-3 mL is sufficient to create a small pool of contrast medium. Right and left lateral as well as ventrodorsal and dorsoventral radiographs are obtained to evaluate the urinary bladder wall.

Excretory urography is performed by administering 1 mL of contrast medium per pound of patient body weight intravenously up to 50 mL. The toxic dose of contrast medium is 4 mL per pound and the 50 mL cut off is more for convenience and cost rather than safety as most bottles of contrast medium are 50 mL. Generally the patient is in lateral recumbency for the injection in case vomiting occurs and then immediately placed in ventrodorsal recumbency to obtain the first radiograph. This will provide a vascular phase of the kidneys. After 3 min, repeat radiographs, both ventrodorsal and lateral radiographs are obtained to evaluate the kidneys, called the nephrogram phase. After 5 minutes, both ventrodorsal and lateral are obtained and contrast medium should be seen within the renal pelves (called the pyelogram phase) and within the ureters. Oblique radiographs and subsequent images can be obtained until you seen the ureters enter the urinary bladder. Having negative contrast (air or gas) within the urinary bladder will aid in this contrast and help to identify the ureteral papilla and any ectopic ureters that are present. During this procedure, if contrast medium is present within the urethra, an ectopic ureter is strongly suspected.

Contrast procedures of the urinary bladder can be labor intensive, but with digital radiographic equipment, it requires less technical skill than ultrasound and can provide a large amount of diagnostic information in a patient with a urinary tract disorder.

Aggressive Versus Non-Aggressive Bone Lesions

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

The evaluation of the musculoskeletal system is difficult due to the numerous soft tissues as well as the bone structures involved. Rapid assessment of the bone structure is routinely performed using radiographs; however, the subtlety of disease and joint compared to bone pathology can be confusing. The purpose of this lecture is to cover the identification of aggressive compared to non-aggressive bone lesions as well as erosive compared to non-erosive joint pathology.

When evaluating the skeletal system, the first thing to determine is if the lesion is aggressive or non-aggressive. A non-aggressive lesion diagnoses include callous, malunion fractures, bone cysts, osteomas, osteochondritis dessicans, panosteitis, fragmented medial coronoid process, osteoarthritis or metabolic disorders. Aggressive lesions are due to neoplasia or osteomyelitis.

When deciding about aggressive lesions, there are 6 radiographic signs that are used: bone lysis, periosteal reaction, rate of progression, zone of transition, cortical lysis. Bone lysis has three different appearances, geographic (focal) moth-eaten and permeative. The difference between the degree of lysis is mainly on the rate of progression. It requires approximately 50% of the bone per unit area to be destroyed before it is visible on radiographs. This is because the bone is a three dimensional object viewed from two dimensions. Because of this, bone is superimposed on itself, making subtle lesions hard to detect. The more lysis that is present, the easier it is to see on radiographs. Also, by the time lysis is seen on a radiograph, the lesion is quite severe.

Periosteal reaction can either be smooth (continuous) or interrupted. The easiest way to determine this is if you could trace the outline of the periosteal reaction with a pencil and never have to lift the pencil from the radiograph. Smooth periosteal reactions are generally associated with trauma whereas interrupted periosteal reactions are due to an aggressive process.

Rate of progression is probably the most overlooked method to assess an aggressive lesion. By the time a questionable aggressive lesion is seen on a radiograph, the lysis is quite substantial. Therefore, the rate of progression in 2-4 weeks will also be dramatic. If a question exists between an aggressive and non-aggressive lesions, supportive medical management for 2-4 weeks then repeat radiographs to look for progression can aid in determining if the lesion is aggressive.

Zone of transition is a more nebulous sign, but the idea is that if a clear-cut demarcation between normal and abnormal bone is seen, then the lesion is more likely non-aggressive. If there is a long zone of transition, the difference between normal and abnormal bone is blurred and the lesion is more likely to be aggressive. In addition, cortical lysis as opposed to overall bone lysis can be used to determine aggressive bone lesions. If the cortex is thin, but no lysis is present, then it is more likely that the lesion is non-aggressive.

After determining these radiographic signs, the next clue is based on the location of the lesion. If the lesion is generalize in that it effects all bones equally, then the primary differential diagnosis is a metabolic or nutritional abnormality. If only one bone is involved, this is a focal or monostotic lesion and a primary bone tumor or soft tissue tumor with secondary bone involvement is considered most likely. If multiple bones in the same region (locally extensive), different bones that are not in close proximity or multiple areas in the same bone are involved, this generally indicates a hematogenous spread disease as bacterial osteomyelitis or metastatic neoplasia. A soft tissue tumor with secondary bone involvement is possible with locally extensive lesions, such as aggressive lesions that cross a joint.

Anatomic location is also a key into the differential diagnoses. If the lesion is epiphyseal or physeal in origin, then it is likely secondary to infection, trauma or potentially a nutritional abnormality. These lesions are generally in juvenile dogs and cats. If the lesion is in the metaphyseal region, then a primary bone tumor or hematogenous infection is most likely due to the proximity of the nutrient foramen. If the lesion is diaphyseal, then the lesion is likely metastatic neoplasia, a soft tissue mass with secondary bone involvement or a focal infection related to a penetrating trauma.

After all these signs and locations are taken into account, then the differential diagnoses are prioritized based on the signalment and history of the patient. A 2 year old hunting dog with an aggressive bone lesion in the proximal metaphysis of the humerus is more likely to have a fungal infection; however an 8 year old Rottweiler with the exact same radiographic findings is more likely to have osteosarcoma. These considerations should be made when assessing aggressive lesions. Since osteosarcoma is a common tumor type, it is not uncommon for clinicians to see an aggressive lesion, even if it is locally extensive and crosses a joint, and consider a primary bone tumor like osteosarcoma. However, other tumors such as malignant histocytosis, synovial cell (histocytic) sarcoma, or even fibrosarcoma, chondrosarcoma and metastatic neoplasia can all be considered possible. Biopsy (excisional or incisional), thoracic radiographs and history may aid in further prioritizing the lesion.

Lesions centered on joints are similar to those in bone. These lesions are centered on the epiphysis of both sides of the joint. Just as aggressive and non-aggressive lesions exist in bone, erosive and non-erosive lesions are in joints. A non-erosive lesion is osteoarthritis. Everything else is considered erosive. Osteoarthritis is a degenerative condition due to joint instability or trauma. It is characterized by the presence of osteophytes and enthesiophytes. An osteophyte is smooth bone production within the joint capsule

that serves as a buttress to tighten ligaments and stabilize the joint. Enthesiophytes are bone production at the attachment of the joint capsule and ligaments due to abnormal tension that is present on the soft tissues from joint instability.

Erosive lesions in small animals are usually infectious and mostly autoimmune in origin. Causes of erosive arthropathy also include chronic hemarthrosis or neoplasia, but these are less likely in small animals. Just as with bones, joint lesions are characterized by the number involved. A monoarthrosis (one joint) is usually osteoarthritis or a traumatic infection, such as a puncture wound. A polyarthropathy (multiple joints involved) usually indicates a hematogenous infection or immune mediate disease.

The radiographic signs for an erosive arthropathy include subchondral bone lysis, presence of osteoarthritis, decreased joint space (especially when weightbearing), luxation or subluxation of the joint and fragmentation of adjacent bone. Based on these signs, and the presence of one or multiple joints involved, a arthrocentesis can be performed to determine the cause for the erosive arthropathy.

Radiographic findings of joint an bone lesions can be confusing if one does not consider the vast number of differential diagnoses possible and then makes an educated decision to prioritize the lesion. This is generally done by the clinician automatically due to the geographic location and the likelihood of disease in a given area. If a dog in southern Michigan presents to Michigan State University for an aggressive bone lesion, neoplasia is more likely. However, if the patient is from northern Michigan, then fungal osteomyelitis should be considered possible. At the end of this lecture the hope is that the veterinarian will have numerous examples and a better overall appreciation of how to evaluate a radiograph for aggressive and erosive lesions.

Radiographic Assessment of Developmental Bone Disorders

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Neonatal imaging is riddled with problems, not the least of which is that it is not performed routinely. When you have an acutely lame puppy, the growth plates and the lack of ossification of the bones can cause confusion. The purpose of this lecture is to show various congenital disorders including osteochondritis dessicans, panosteitis, elbow dysplasia, hip dysplasia and nutritional abnormalities.

Osteochondritis dessicans is likely the most commonly diagnosed congenital disorder. This disorder is a failure of endochondral ossification that occurs in young growing animals. The key to this disorder is that to have failure of endochondral ossification, it must finish and therefore the diagnosis should only be made after the dog is 5-6 months of age. This disorder can occur in the tarsus, elbow, shoulder and stifle. For the tarsus, since it can occur in the talus, a flexed dorsoplantar projection of the tarsus and a flexed lateral can help to remove the superimposition of the distal tibia to identify the lesion.

Panosteitis is a self-limiting disorder that is hard to diagnosis because of the subtlety of the radiographic changes. It ranges from increased opacity of the medullary cavity to a decreased opacity or smooth periosteal proliferation. The ulna, radius and distal humerus are the most commonly affected areas and the contra-lateral limb should be obtained for comparison. Generally, lateral radiographs are all that is needed to make the diagnosis.

Elbow dysplasia is a current hot-topic in the breeding world with the Orthopedic Foundation for Animals (OFA) creating a 0-3 grading scale as part of the routine screening test for dogs. Small ridges on the anconeal process causes an elbow to go from a grade 0 to a grade 1, but when evaluated with CT, this irregularity is a normal variant in most cases and not associated with osteophyte formation. In fact, a current study at Michigan State University being performed by Dr. Chelsea Kunst is finding that grade 0 elbows can sometimes have osteoarthritic changes on CT whereas grade 1 elbows sometimes do not. The bottom line is that radiographic assessment of the elbow is mainly to determine the severity of disease rather than the presence. Such is the case with an united anconeal process. This is a normal finding in dogs < 5 months of age, but the apophysis should be fused by the age of 6 months. It is the cut point when an anconeal process is considered united. Fragmented medial coronoid processes are the most commonly suspected elbow disorder, but with the superimposition of the radius, are difficult to evaluate on standard radiographs. Computed tomography is the modality of choice for evaluating the elbow to minimize the superimposition and detect small fragments or lucencies within the bone.

Canine hip dysplasia is an orthopedic disorder that causes widespread confusion among breeders mainly due to the difficulty of predicting the likelihood of young animals developing osteoarthritis later in life due to hip laxity. Currently, two methods to evaluate the hips are used. The first is a standard ventrodorsal projection. This view is accepted by OFA in animals greater than 2 years old as a good predictor of hip health. The idea that is osteoarthritis or incongruity is present, the degree of the laxity can be assessed and a grade of Excellent, Good, Fair, Borderline and Dysplastic can be made. Three board certified radiologists score the radiographs independently and then the assessment is average. The main limitation to this is that it is a subjective measure and does not take into account the breed of the animal. The other method is PennHip, which uses a distractor to assess the amount of passive joint laxity. This measure is then compared to all the dogs in the database of the same breed and a percentile is given. Greater than 50% is considered a pass and hips with a distraction index of < 0.3 are considered unlikely to develop osteoarthritis later in life. The benefits of this method is that it is an objective measure that is breed specific and that all evaluations must be submitted to PennHip to provide a general database of the breeds. In addition, this method can be used to accurately predict hip laxity after 6 months of age.

Nutrition in animals is also something that in these economic times can manifest as growth plate disorders or delayed ossification. Understanding the timelines when growth plates close and having normal radiographs or textbooks that show bone development of puppies helps with this assessment. Careful history and physical examination as well as thorough blood work can also aid in making this determination.

Neonatal radiographs can be difficult, but due to more concerned owners and the better resolution of radiographic examinations, care must be taken to adequately obtain and evaluate these images. Although not routinely performed, radiographs of the immature skeleton can show far more than just a fracture, but also can show growth plate disorders, nutritional deficiencies as well as developmental disorders. If detected early enough, these developmental disorders can be corrected and treated appropriately prior to irreparable damage.

Exploring the Pleura and Mediastinum

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Thoracic radiography generally focuses on the lung and pulmonary patterns; however, the presence of the pleural fluid, the esophagus, thymus, heart and lymph nodes within the mediastinal and pleural space, there is a lot more to evaluating the thorax besides the lungs. The goal of this lecture is to provide anatomic review of the mediastinal space, the use of positional radiography on the pleural space and cardiac silhouette and common diseases that affects these regions.

The pleural space is a potential space that surrounds the lungs and contacts the ribs. The primary abnormality that occurs with the pleural space is the accumulation of fluid. This fluid accumulation causes havoc with evaluating the lungs and heart since the fluid opacity and soft tissue opacity are the same. This causes silhouetting with the other organs making it impossible to see inside the thoracic cavity. The best way to work around this issue is to use gravity by taking upright images allowing the evaluation of cranial mediastinum or lateral horizontal beam radiographs to look at the lungs. This would keep fluid separate from the underlying organs.

When pleural fluid is present, the most overlooked cause is a rib lesion. Care should be taken to evaluate each rib individually and compared to the contralateral rib as well as the rib cranial and caudal to look for lysis and periosteal reaction. Other causes for fluid includes a mediastinal mass, such as a thymoma, heart failure (primarily in cats), foreign bodies, and in rare cases secondary to pulmonary neoplasia and pneumonia.

The mediastinum contains the heart, esophagus, lymph nodes including sternal, cranial mediastinal, and tracheobronchial as well as the thymus and trachea. The mediastinum also directly communicates with the cervical soft tissues and the retroperitoneal space. This is important since a pneumomediastinum may lead to pneumothorax but a pneumothorax will not led to pneumomediastinum.

In addition to determining the location of pneumomediastinum, the enlargement of the lymph nodes can help localize lesions. The sternal lymph node drains the cranial three pairs of mammary glands and the peritoneal space. The cranial mediastinal lymph node drains the head, thoracic limbs and the sternal lymph node and the tracheobronchial lymph nodes drain the trachea and bronchus. An important point of this is that generally these lymph nodes are not seen during reactive hyperplasia and therefore if present neoplasia or severe fungal infection are the primary differential diagnosis.

The esophagus has a large number of disorders that range from congenital abnormalities causing compression such as persistent right aortic arch, foreign bodies or neurologic disorders causing megaesophagus. Fluoroscopy is useful for evaluation of the esophagus but with the quick cycling of digital radiographs, some information can be gained from serial images after administration of contrast medium.

The pleural space and mediastinum are overlooked regions that have a large number of abnormalities that are generally overlooked and usually considered idiopathic, but a large amount of information can be gained by evaluating these spaces on radiographs. After this lecture, you should have a better understanding of the use of positional radiographs as well as the various diseases that occur in the pleural and mediastinal space.

Thoracic Radiography Cases:
Real World Examples That Make You Think

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Thoracic radiographs are the mainstay of diagnostic imaging. The debate between two view and three view thoracic radiographs may continue, but no one argues that imaging the thoracic is the most complicated and more informative radiographic procedure available. With the contrast provided by the lungs, soft tissue opacities and radiographic changes within the lungs are easy to see, but hard to interpret. By far, a normal thoracic radiograph is still the most difficult to interpret.

Radiographic technique and positioning is the most important thing to thoracic radiographic interpretation. The first priority is the proper radiographic technique. Due to respiratory motion, the kVp setting is set high (generally 100 or 120) and the mA is also maximized to keep a small exposure time to minimize motion artifacts. Recumbency is also a major factor in radiographic interpretation. The lung needs to be aerated in order to see radiographic changes since the soft tissue opacity of the lesion needs to contrast with the aerated lung. Therefore if a lesion is in the right cranial lung lobe, then a left lateral radiograph is needed. Alternatively if the lesion is in the left caudal lung lobe, especially in the dorsal aspect, a dorsoventral projection should be performed.

Once the radiograph is obtained, the next step is to determine if the lungs are too white, too dark or normal. The second question is if this change is secondary to technique or pathology. To determine if the increased opacity is secondary to technique, one should evaluate the degree that the first and second thoracic spinous process can be seen, also the degree of contact between the diaphragm and the heart as well as the the ability to see the pulmonary vasculature and the superimposed triceps musculature on the thoracic inlet.

Once you decide a lesion is present, the next debate that is currently going on is the importance of pulmonary patterns versus location. Pulmonary patterns are divided into alveolar, interstitial and bronchial lung patterns. These patterns were based on air bronchograms, increased opacity to the lung fields or increased thickness of the bronchial wall creating increased lines and rings, respectively. That said, generally, it is easier to consider the radiographic pattern as a degree of severity with alveolar being the most severe, interstitial is moderate and bronchial being mild pulmonary disease. The alternative way to evaluate the lungs is to decide on the location and the distribution of the pathology identified.

For location, you can divide pulmonary disease into cranioventral, caudodorsal or diffuse disease. Cranioventral disease has 3 differential diagnoses: bronchopneumonia, hemorrhage or neoplasia. If it is caudodorsal there are 2 differential diagnoses: cardiogenic and non-cardiogenic pulmonary edema. Diffuse can be any of the five diagnoses. If the lesion is not occupying a lung lobe and is more structured, it can have a focal or multifocal distribution. A focal pulmonary lesion can be a tumor, granuloma, abscess or bulla (if radiolucent), whereas multifocal lesions tend to be neoplasia, fungal granulomas or pulmonary osteomas (which are < 5 mm soft tissue to mineral opacities throughout the lungs, generally seen in Collies).

If pleural fluid is present, retraction of the lung lobes away from the body wall can be seen. In cats, if this retraction remains after the fluid is removed, restrictive cardiomyopathy is considered most likely. If a cranial mediastinal mass is suspected, a standing horizontal beam radiograph can be obtained with the dog or cat standing on their hindlimbs and a ventrodorsal projection obtained to cause the fluid to be caudal to the heart. If pleural fluid is seen, the first thing to evaluate is the ribs, as rib tumors are a frequent, overlooked cause for pleural fluid. Also, radiographs can help identify a site to obtain a sample of the fluid, which can provide insight to the cause.

The cardiovascular structures of the lungs can also be evaluated to provide further information if a cardiogenic pulmonary edema is suspected. The cardiac silhouette is comprised of the heart and the blood within the heart as well as the surrounding pericardium. Since fluid and soft tissue have the same opacity, a difference between these structures cannot be identified. If the heart is enlarged, generally chamber enlargement is seen such as the left atrium or right atrium. Cardiac changes are generally vague and only occur when the changes are severe. When the heart hypertrophies, it undergoes concentric or eccentric hypertrophy. Concentric hypertrophy is secondary to a pressure overload. If the heart can compress hard enough, it can push the blood out of the chamber. The heart then hypertrophies the muscle to create a smaller lumen. The heart shape remains the same and therefore cats with hypertrophic cardiomyopathy and dogs with pulmonic or subaortic stenosis will not have radiographic signs of cardiomegaly until the disease is very advanced. Alternatively, eccentric hypertrophy is secondary to a volume overload. No matter how strong the contraction, the fluid cannot clear the chamber so the hypertrophic muscle is formed on the outside of the lumen. This change can be seen radiographically, but is a rare condition, mainly occurring with dilated cardiomyopathy.

Pulmonary vasculature can also be evaluated to help to determine the cause for a caudodorsal lung pattern. If the pulmonary artery is dilated, the primary cause is pulmonary hypertension from any cause. In adult dogs, the main cause is secondary to heartworm disease or pulmonary thromboembolic disease. If the pulmonary vein is enlarged, then generally it is a sign of left-sided heart failure. This vein enlargement is first seen in the right caudal lung lobe and then progresses to the remaining lung lobes with time. If both the

arteries and veins are enlarged, then that is caused by over circulation, such as a patent ductus arterious or ventricular septal defect. Small vasculature is a rare finding, but may be secondary to hypovolemia, hypoadrenocorticism or severe pulmonic stenosis.

Radiographic interpretation of cardiac disease is considered difficult and numerous studies have tried to identify the easiest methods to simplify the interpretation. Using vertebral heart score, inverting the image so that black is white and white is black, even rotating the image to look for rib lesions. All these methods have found that nothing is better than experience at image interpretation and practice. In addition, with the rapid expansion of digital imaging, bronchial lung patterns are being over diagnosed due to the increased image resolution. Having normal radiographs and evaluating the entire image, included the surrounding musculature and skeletal structures is essential to make accurate diagnoses.

Thoracic radiography is considered a challenging region to interpret not because the lesions are difficult to see, but rather because the lesions identified are generally non-specific and are difficult to interpret. Generally, most practitioners see a cranioventral alveolar lung pattern and diagnose aspiration pneumonia and a caudodorsal lung pattern as pulmonary edema. In truth, the thoracic radiographs should be evaluated as a whole, is there a megaesophagus or history of vomiting? Is there are heart murmur, enlarged pulmonary veins or enlargement of the left atrium of the heart? These questions should be asked prior to starting therapy with the hope the diagnosis is correct. Thoracic radiographs are not obtained to determine if a disease is present, but rather to identify the extent of disease and determine the progression or regression. Bearing in mind that radiographic improvement may lag behind clinical improvement by several days.

Although thoracic radiography is challenging, this lecture will provide an overview of normal anatomy as well as case examples of common disease processes to help provide the participant with an increase knowledge and level of comfort interpreting pulmonary and cardiac changes.

Musculoskeletal Radiography: When is a Fracture a Tumor?

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Fractures in the small animal patient are very common occurrences that are repaired with external bandages, splints or fixators or internal fixation with a large choice of bone plates, intramedullary pins, wires or screws. Although the repair is challenging, a further challenge is evaluating these lesions post-operatively to determine if the fracture is healing, infected or if the lesion is a tumor. This lecture will review the types of fractures, locations and the ways to determine if the fracture is pathologic. Time will be spent talking about fracture repair, healing and implant failure.

When a fracture occurs, the type of torque will determine the type of fractures. A transverse fracture is a linear fracture that is bicortical and is perpendicular to the long axis of the bone. A segmental fracture is two transverse fractures that do not communicate with each other. A short oblique fracture is a bicortical fracture that is angled, but is shorter than twice the width of the bone. A long oblique fracture is longer than twice the width of the bone. A spiral fracture is a long oblique fracture that extends around the cortex of the bone. Finally, a comminuted fracture is when multiple fracture lines are present that communicate with each other to create multiple fragments.

The location of the fracture helps to determine the possible pathology. Generally, long oblique fractures are low-impact, twisting fractures. These usually occur due to getting a limb caught in a fence and subsequently pulling and breaking the bone. When a long oblique fracture occurs in a thick bone like the femur or humerus, a pathologic fracture should be considered highly likely. If periosteal reaction is present, this is pathognomonic for a pathologic fracture since it will take 3-5 days in puppies to form periosteal new bone and can take 2-3 weeks in adult dogs. Therefore, if at initial presentation a periosteal reaction is present, then microfractures have likely occurred previously.

With fracture healing the type of repair and the age of the patient are two important factors for bone healing. With primary, ridged fixation, such as bone plates, there is generally little motion of the fracture so healing is generally primary with little callus formation. When external fixation is used or a bone plate with minimal screws, micromotion is present. This motion causes a mild instability of the fracture and a small amount of callus formation. The degree of callus will relate to the degree of motion. If infection occurs, then the fracture gap generally widens. This usually occurs within 3-5 days post surgery and therefore, radiographs in 2-4 weeks should be done to avoid mis-diagnosing the remodeling phase of bone healing with infection. If infection of the surgery site is a concern, soft tissue swelling and pain are usually more useful findings then radiographic change. This is because radiographs usually lag behind clinical signs by a week or two.

In young animals, bones tend to heal quite rapidly. The table is provided to give you rough guide of the time for healing based on the age of the animal. Note that the less stable the repair, the faster the healing due to the larger amount of callus that is formed.

Age of Animal	Pins (External or internal)	Plates orType II Ex Fix
< 3 mo	2-3 wks	4 wks
3-6 mo	4-6 wks	8-12 wks
6-12 mo	5-8 wks	12-16 wks
> 1 yr	7-12 wks	20-32 wks

In animals with an open growth plate, Salter-Harris fractures are classified. These fractures indicate a growth plate is involved in the fracture. Although there are 14 classifications, veterinary medicine generally recognizes 5. The types increase with severity with Salter I extending through the physis, Salter II through the physis and metaphysis, Salter III through the epiphysis and physis. Salter IV fractures extend through the epiphysis, physis and metaphysis and Salter V is a crushing injury to the physis.

Mal-union and non-union fractures can look like cancer, but the smooth periosteal reaction and lack of progression are key features to the fact that these are fractures that are healing in an abnormal way. Periosteal reaction is useful to determine if infection is present as exuberant periosteal reaction is usually secondary to cellulitis and inflammation rather than stabilization of the fracture.

Radiography is a fast and easy way to assess fracture healing and complications; however, time is needed for bone remodeling to be severe enough to see on radiographs. Sequential radiographic examinations and interpretation based on clinical findings such as disuse of the limb, swelling, pain or a draining track can help characterize aggressive lesions like neoplasia and osteomyelitis from normal healing.

Radiography's Role in the Acute Abdomen Case

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Abdominal radiographs are a rapid, readily available method to give an overview of the abdomen. Though most people believe ultrasound is the new modality of choice for abdominal evaluation, the limitations of ultrasound not being able to penetrate gas as well as the technical ability and time to acquire images still make abdominal radiographs a great first modality in the patient with acute abdominal pain.

Ultimately, the question for the clinician with an abdominal patient is whether surgery is indicated or if medical management is the best course of action. With radiographs providing an overview of the entire abdomen, and the use of the gas within the bowel to provide contrast, abdominal radiographs can be useful as a triage tool that can be augmented and finding further characterized using abdominal ultrasound.

When evaluating the stomach, generally most abdominal radiographs include a right lateral and ventrodorsal projection. The question always arises on why this is performed. These two views have become the standard since a right lateral projection places gas in the fundus of the stomach and fluid in the pyloric antrum. To evaluate the pylorus, a ventrodorsal projection is used to put fluid in the fundus and gas in the pyloric antrum. At Michigan State University, we take 3 view radiographs of all abdomens to include a right lateral to seen the fundus, a left lateral to evaluate the pylorus and look for pyloric outflow obstructions and a ventrodorsal to provide more information about the pylorus and to better evaluate the colon.

With the availability of ultrasound, the use of contrast medium for upper gastrointestinal contrast medium procedures is not routinely performed. However, in clinics without the benefits of ultrasound, barium or iodinated contrast medium procedures still provide some use to evaluate if a luminal obstruction exists, if the bowel wall is think or infiltrated, look at overall motility or assess for a rupture. The main drawback to this procedure is that if any of those differential diagnoses are suspected, an exploratory laparotomy is indicated rather than a contrast procedure that could delay surgery by 3-6 hours.

Barium contrast medium is the most universally used for gastrointestinal imaging. It is safe, the dose is 6-10 milliters per pound and generally is administered through a gastric tube. If aspirated, barium causes physical obstruction of the airways with no inflammatory component, but may cause granulomas if it leaks into the peritoneal or pleural cavity. For this reason, barium is contra-indicated if a ruptured bowel or ruptured esophagus is suspected. Iodinated contrast medium is generally used intravenously but can be administered orally. The main limitation is that it has a bad taste, is hypertonic so it will draw fluid into the bowel and since it is hypertonic, will cause an inflammatory reaction if aspirated into the lungs.

Positional radiography can also be used to evaluate for free gas in the abdomen. Since an air/fluid interface is needed to help to see gas within the peritoneal space, a horizontal beam projection with the dog on its left side and obtaining a ventrodorsal projection will put the gas in the right lateral abdomen near the pyloric antrum. Since the pylorus is small, the gas accumulation will be identified caudal to the diaphragm.

For gastric dilation with volvulus, the main feature is to obtain a right lateral radiograph. No other projection is needed. If the pylorus is seen in the craniodorsal abdomen, a GDV is confirmed. Numerous times people have been fooled by the normal appearance of the ventrodorsal projection and decided the case was just gastric dilation. Nothing else can put the pylorus in the craniodorsal abdomen except for a GDV.

Small intestinal wall thickness is also something frequently evaluated on survey radiographs. This cannot be done. Since soft tissue and fluid are the same opacity, it is impossible to know if the structure observed is a thick wall or just a combination of fluid summating with the small intestinal wall.

The abdomen is divided into two spaces, peritoneal and retroperitoneal. The retroperitoneal space contains the adrenal glands, kidneys and sublumbar lymph nodes and the peritoneal space contains the remaining organs. This determination is important since it will aid in the differential diagnoses of a mass that is present or the cause for gas within the abdomen. The retroperitoneal space is dorsal to the colon. Therefore if a soft tissue mass displaces the colon ventrally, then the mass is likely retroperitoneal indicating it is either arising from the kidney or adrenal glands. If gas is present in the retroperitoneum, this is likely secondary to a pneumomediastinum rather than a rupture of the gastrointestinal tract.

Radiographs are useful to determine if a surgical obstruction or mass is present or at least provides a general overview of the abdomen. Though barium contrast medium can be used, this has largely been replaced with ultrasound or exploratory surgery. By the end of this lecture, the audience will seen numerous examples of radiographs for surgical and non-surgical lesions and how a better understanding of the limitations and benefits of abdominal radiography.

Ultrasound Cases: What Can I Really See With Some Practice and How to Communicate Value to Pet Owners

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

The use of radiography to examine the abdomen is full of complications. Radiographs are very good at determining the difference between bone and gas, but soft tissue and fluid are the same opacity. When dealing with intra-abdominal lesions, the main goal is to differentiate one soft tissue mass from a normal soft tissue structure from abdominal fluid. Ultrasound uses high frequency sound waves to accomplish what radiographs cannot. With ultrasound, fluid and soft tissue can be clearly distinguished from one another, where bone and gas cannot. The purpose of this proceeding is to describe the benefits and uses of abdominal ultrasound to the general practitioner.

Abdominal ultrasound is a unique diagnostic test in veterinary imaging. Unlike blood work, radiographs, computed tomography or magnetic resonance imaging, ultrasound requires the sonographer to both acquire images as well as interpret them. This unique combination is why physicians have allowed technicians to acquire the ultrasound images and that leaves radiologists free to perform other studies and interpret the images acquired. This model has not been accepted in veterinary medicine as yet.

So the first stage to abdominal ultrasound is gaining the technical skill to acquire images. This requires patience and time, but is relatively easy with practice. Where ultrasound skill comes into play is with adaptation for disease processes. It is necessary to know that if you suspect portal hypertension, you need to look behind the left kidney for acquired portosystemic shunts. If you see a thrombus in the splenic vein, you need to evaluate the portal vein for thrombosis as well. This is the degree of medicine that keeps the ultrasound probe in the hands of the veterinarian.

Ultrasound examinations have nearly replaced abdominal radiographs at Michigan State University. As an example, on a given day, we performed up to 20 ultrasound examinations and only 3-5 abdominal radiographic series, generally performed during emergency hours. This replacement has occurred because ultrasound provides better detail and more information about the abdomen compared to plain radiographs. Although we have virtually replaced radiography, radiography is more rapid and gives a better overview of the abdomen compared to ultrasound. For example, a gastric dilation with volvulus can be diagnosed with ultrasound, but it would be easier and more accurate to use radiography to identify the gas filled pylorus displaced dorsally and to the right.

Once the images have been acquired, the next step is interpretation. When ultrasound was first used, it was the first non-invasive, cross-sectional imaging modality. This means that rather than just seeing the outline of an organ, you can now see the portal vein within the liver and the medulla within the kidney. Ultrasound images were compared to gross necropsy examination, but done in a much less invasive manner. Since the image generated can see into the organ, it is very sensitive to find morphologic changes such as masses, cysts, abscesses and tumors. However, unlike gross pathology, you no longer have color and smell to aid in your diagnosis. For this reason, an abscess can look just like a tumor, which can look just like a blood clot. This is why we considered ultrasound very sensitive for disease, but not very specific. The benefit of ultrasound is the ability to identify a lesion in an organ of interest as well as aid in obtaining a sample, either with fine needle aspiration or with a biopsy to help determine the true nature of the lesion.

Common lesions identified using ultrasound include: foreign body obstruction, mucocele formation, splenic hemangiosarcoma and urinary tract disease. Previously, a foreign body obstruction could only be identified if it was completely obstructive, was radiopaque or radiolucent and if there was marked dilation orad from the lesion. With the superimposition of other organ structures, sometimes barium was used to evaluate wall thickness and motility. Ultrasound has virtually eliminated the need for barium studies and allows the evaluation and identification of foreign material, whether completely or partially obstructed, within the gastrointestinal tract. This is because that any foreign material, whether it is made from wood, cloth or metal, will absorb sound and cast a dark shadow deep to the lesion. That coupled with the increased ability to identify small intestinal distension and wall layering, makes the determination between a foreign body obstruction and a neoplastic mass easily distinguished.

A mucocele is a chronic form of cholecystitis. Generally, a patient presents with a chronic history of intermittent vomiting followed by an acute onset of collapse or severe, unrelenting vomiting. Ultrasound is the only method available to non-invasively examine the gallbladder and bile duct for evidence of obstruction or mucocele formation. A mucocele has the unique appearance of linear striations that radiate from the center of the lumen. These radiations are thought to be bile salts trapped within a thick, hypoechoic (dark) mucosal wall. At this stage, the gallbladder is considered a nidis for infection and a surgical emergency since it has a high risk of rupture if left in place.

Large splenic masses are generally easily identified on radiographs or ultrasound (as well as physical examination). The difference is in the dog that presents with acute collapse and a hemoabdomen. It is true that with a hemoabdomen and no history of trauma, you can perform an exploratory surgery to find the source of the bleeding, but this is usually difficult to do. Instead, ultrasound evaluation of the abdomen to look for a mass as well as metastatic disease is considered the non-invasive method of choice to help with the surgical planning.

Lastly, urinary tract abnormalities such as hydronephrosis, perinephric pseudocysts, transitional cell carcinoma and cystitis can all be evaluated without the use for contrast medium or general anesthesia in a rapid non-invasive way using ultrasound. Examination of the kidneys will show if the renal pelvis is dilated or the kidney is surrounded by fluid. With radiographs, since fluid and soft tissue are the same opacity, it is not possible to make this determination without contrast medium, which is considered nephrotoxic. Instead, ultrasound can show the architecture of the kidney as well as help find a distended ureter if one is present. The wall of the urinary bladder is also a dilemma with ultrasound since the urine will obscure the luminal margin. With ultrasound, small areas of mineralization within the mass as well as proliferation of the wall seen with cystitis can be quickly and accurately identified, though differentiating tumor versus inflammation is difficult without obtaining a sample with traumatic catheterization.

Abdominal ultrasound in the general practice has the potential to provide a practitioner with rapid information to help facilitate referral or further diagnostic tests especially in the vague, chronically ill patient. With practice, guidance and perseverance, it is possible to use this modality as a triage tool as well as method to determine the progression and regression of disease.

Upper *vs* Lower Motor Neuron: Never Miss Again after this Videocase Presentation

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

The ability to examine a patient and determine where in the body the disease is located is critical to determining the cause, best therapy and prognosis. Weakness is a common presenting complaint and can result from spinal cord (upper motor neuron - UMN) or nerve and muscle disease (lower motor neuron-LMN). Understanding the function of the UMN and LMN system will enhance the accuracy of lesion localization and therefore determination of the diagnostic testing and prognosis. This talk will discuss the function of the UMN and LMN system and then how to assess these systems via examination of a patient's gait, postural responses, and reflex testing. Secondly we will discuss assessing the cutaneous trunci reflex and for focal pain to assist in lesion localization and honing the list of possible the spinal cord diseases. Lastly we will discuss evaluating the palpebral response and laryngeal / pharyngeal / esophageal function in LMN disease.

Tonic gamma loop mechanism

Muscle tone refers to the intrinsic tension of the muscle when supporting the body against gravity while standing, shifting weight from limb to limb, jumping or performing stairs – but how does this occur? The tonic gamma loop mechanism (TGLM) is intrinsic to the LMN system and understanding TGLM physiology offers insight into how gait is generated and why UMN or LMN disease cause alterations in muscle tone and reflex. When we jump down from a height and our knees start to bend or buckle there is a sudden stretch of the quadriceps muscles and stimulation of stretch receptors (neuromuscular spindle) within these muscles. These receptors then stimulate the sensory portion of the femoral nerve which then directly synapse and stimulates the motor portion (alpha motor neuron) of the femoral nerve. This causes the quadriceps muscle (which is innervated by the femoral nerve) to contract and prevent your knees from buckling. When the patella tendon is artificially simulated with a reflex hammer it fools the body into thinking there is a sudden heavy load on the quadriceps muscle (like jumping down), the TGLM is stimulated and the knee jerks.

Gait generation

As mentioned above, when information from the neuromuscular spindle of the TGLM returns to the spinal cord it directly synapses on the alpha motor neuron or motor portion of the same muscle in which the spindle is located. However, the information also stimulates inhibitory interneurons that then reduce activity or tone in the antagonistic muscle group. Therefore when there is contraction of the quadriceps there will be reduced tone in the hamstring or flexor group. The modulation of flexion is performed by the phasic gamma loop or flexor gammas loop. The UMN system acts on the tonic and then phasic gamma loop mechanisms to generate extension and then flexion of the leg by activating this intrinsic reflex mechanisms and therefore generate gait.

UMN lesions influence the TGLM

In our example above, gravity lengthen the quadriceps muscle and stretches the neuromuscular spindle, which then via a direct synaptic connection, stimulates the femoral nerve. This causes contraction of the quadriceps muscle which then causes more stretching of the neuromuscular spindle and more contraction of the quadriceps muscle. This system, if not modulated would lead to dramatic increases in muscle tone and reflex. The UMN system modulates or controls the TGLM and therefore controls muscle tone and reflex. Disease of the UMN lesion can cause increased tone and reflex. Examination of dogs with UMN spinal cord disease often reveals increased tone because there is resistance to flexion of the stifle. This stiffness can also manifest in the protraction phase of the gait and appear as swinging out of the limb (circumduction) or a long-strided gait. Furthermore, brainstem lesion (where the UMN tracts start) can lead to opisthotonus also known as decerebrate rigidity where the head, neck and limbs are held in rigid extension.

Reflex testing

A reflex is something that occurs automatically or spontaneously without influence from the cerebrum whereas a reaction or response requires the unconscious participation of the cerebrum. In reflex testing there is a sensory stimulus that runs into the spinal cord or brainstem and then an immediate spinal cord or brainstem mediated response. For example, stretching the patella tendon with a pleximeter (reflex hammer) causes a sudden, intense stimulation of the stretch receptors within the femoral nerve, in essence simulating what would happen if we jumped down from a large height. Immediately the muscles innervated by the femoral nerve contact and the knee jerks. An absence of reflex often means there is a lesion of the motor or sensory portion of the femoral nerve or severe disease of the quadriceps muscle. If there is an increase in reflex (exaggerated, clonus) then there is a failure of UMN system to control this reflex.

Upper motor neuron system
The UMN system primarily starts in the brainstem. The axons from this collection of neurons run within the white matter of the spinal cord and synapses in the ventral horn of the spinal cord to activate the peripheral nerve (LMN). This system activates the LMN to generate gait and modulates or controls tone and reflex by influencing the tonic gamma loop mechanism. A lesion of the descending or motor component of the UMN system results in paresis (weakness), paralysis, increased reflex and increased muscle tone. A lesion of the ascending or sensory system causes a disordered gait and postural deficits (see below).

Lower motor neuron system
The LMN system starts within the spinal cord where the cell bodies are grouped in the grey matter of the spinal cord within the ventral horn at the intumescence (swelling) located at spinal cord segments C6-T2 and L3-S3. The numbered nerves then run to the brachial or lumbar plexus and then exit as named nerves that will then innervate specific muscles. The LMN generates muscle tone and with a lesion there is weakness, paralysis and loss of muscle tone and reflex. The LMN system also carries sensory information from receptors in the joints and skin into to the dorsal horn of the spinal cord and this is eventually relayed via the UMN system to the cerebellum and somatosensory cortex via the spinocerebellar and spinothalamic tract, respectively.

Spinal cord ataxia and postural reactions
A complete lesion of the UMN system causes no movement or paralysis and an increase in muscle tone (spastic paralysis). A partial lesion will cause only weakness or paresis but the movement will be ataxic. Ataxia means disorder. The absence of ascending information reaching the brain can result in a loss of self- reception (proprioception) and consequently spinal cord or proprioceptive ataxia and slow postural reactions. Spinal cord ataxia can take the form of a long-strided gait, the limbs can circumduct, cross midline, and interfere with each other - occasionally causing the patient to trip or fall. In addition the patient might stand on the dorsal surface of the paw or stand with limbs too close, too far apart or with limbs crossed. Besides observation of the gait, testing of the postural reactions (paw flip test, hopping, tactile placing) also assesses the function of the UMN system. The postural reactions will be delayed to absent with an UMN lesion.

LMN lesions
A complete lesion of the LMN system causes paralysis with an absence of muscle tone (flaccid paralysis). An incomplete lesion causes weakness and the patient will have a short-strided or choppy gait as though they are walking on egg shells. Importantly, incomplete LMN lesions do not cause significant disruption of the sensory system. Therefore LMN lesions do not cause ataxia. Furthermore, if the patient's weight is properly supported the postural reactions will be normal. Please see Table 1.

C6-T2 spinal cord
A lesion that involves the white matter of the spinal cord at C6-T2 will cause UMN signs to the pelvic limbs. The pelvic limbs will have increased tone and reflex, reduced postural reactions, weakness and ataxia. A lesion of the grey matter in this area will generate LMN signs to the thoracic limbs manifested as a short-strided gait, preserved postural reactions and no ataxia, reduced reflex, and neurogenic muscle atrophy. The long-strided, stiff and ataxic gait in the pelvic limbs is much different than the short-strided gait of the thoracic limbs and sometimes referred to as a two engine gait.

T3-L3 spinal cord and the cutaneous trunci reflex
Disease between the two intumescences is called T3-L3 spinal cord disease and results in upper motor neuron disease to the pelvic limbs. The presence of a cut-off or cessation of the cutaneous trunci reflex can indicate the level of the spinal cord lesion. The input for the reflex is stimulation of dorsolateral cutaneous receptors. Once a stimulus is registered the information then ascends in the spinal cord where it synapses motor neurons at the level of spinal cord segment C8 -T2. These nerves form the lateral thoracic nerve that causes contraction of the cutaneous trunci muscle. Functionally a pinch of the skin with hemostats should stimulate contraction of the entire cutaneous trunci muscle along the entire flank of the patient. With a thoracolumbar spinal cord lesion, pinching of the skin behind the lesion will not result in twitching of the skin and thus there appears to be a cut-off of this reflex. A cut-off in the cutaneous trunci reflex indicates the lesion is about 2 vertebral bodies cranial to the cut-off. Furthermore, following surgery movement of the cut-off caudally predicts recovery while movement cranially predicts myelomalacia.

Lumbar intumescence and nerve root disease (lumbosacral syndrome)
Disease of the spinal column or spinal cord/nerve roots from the L5 to S1vertebrae can generate LMN signs to the pelvic limbs, fecal and urinary incontinence as well as paralysis of the tail. These signs can overlap and be mistaken for osteoarthritis of the hip or stifle. A sciatic lesion can be the cause of an increased patella reflex as a consequence of losing strength and tone to the antagonist of stifle extension, this is called a pseudo-hyperpatella reflex and should not be mistaken for an UMN reflex. A reduction of the patella reflex can help localize lesion to L3-L4 vertebral bodies and would not be expected with disease from L5 – S1 vertebrae. The patella reflex

can be absent in otherwise healthy middle-age and older dogs, presumably from degeneration of the sensory portion of the femoral nerve.

Pain assessment

Diseases of the nerve and muscle (LMN disease) are typically not painful, however many spinal cord diseases are associated with pain. Determining the patient is painful at a specific location can direct diagnostic testing and also hone the list of possible causes of disease – for instance intervertebral disk disease, neoplasia, and diskospondylitis are typically painful whereas ischemic myelopathy (fibrocartilaginous emboli) and acute, non-compressive nucleus pulposus extrusions are often non-painful, especially after the first 24 hours. Neck pain is often suspected when patient spontaneously yelps out but there is no gait or posture deficits, intermittent thoracic limb lameness (root signature), or stiff neck or decreased range of motion is noted. Palpating muscle spasm laterally at level of transverse process, pain with manipulation or ventral process of C6, or resistance to range of motion can also indicate neck pain. Mid-back pain is often suspected with kyphosis, stiffness and when slow to sit or rise. Palpating and applying pressure to dorsal processes while putting pressure / palpating the ventrum and palpating muscle / rib heads at level of transverse process often allow for detection of back pain. Lumbosacral pain is suspected with abnormal tail carriage and when patient is slow to sit and rise. Pain can often be detected with rectal palpation of the lumbosacral junction (or spondylosis at L7-S1), tail extension or by applying pressure to muscle between dorsal process of L7 and S1. Hip extension will not differentiate back from hip pain. However, hip pain can be discerned by slowly elevating the femoral head about 3-5 mm from acetabulum by lifting up on the medial surface of the femur while the patient is in lateral recumbency.

Cranial nerve exam in LMN disease

LMN disease can affect cranial nerves when there is a polymyositis, polyneuropathy, or disease of the neuromuscular junction (Myasthenia gravis). When LMN disease is suspected then a few physical examination maneuvers can be helpful. Firstly listen to the patient's breathing – a respiratory stridor can indicate weakness of neuromuscular system that abducts the vocal folds. Gagging can indicate pharyngeal weakness or incoordination and misdirection of saliva into the airway. Pneumonia may be present from laryngeal or pharyngeal dysfunction or from megesophagus – listen for a soft, moist cough and carefully auscultation the lungs. Thoracic radiographs are indicated in dogs with suspected LMN disease to assess for megesophagus, aspiration pneumonia and other pathology. Secondly, assess temporalis muscle mass because marked atrophy can indicate a lesion of the mandibular nerve. Lastly, repeated stimulation of the medical canthus of the eye should provoke a prompt and complete blink response – incomplete blinking or an absent blink indicates there is neuromuscular disease.

Table 1. Distinguishing characteristics of UMN and LMN disease

	UMN	**LMN**
Gait Characteristic	Long strides	Short strides
Ataxia	Yes	No
Postural Deficit	Yes	No
Tone & Reflex	Increased	Decreased
Atrophy	No	Yes
Spinal Pain	Often	Seldom

References

Braund KG. Clinical Syndromes in Veterinary Neurology. 2ed. St. Louis, MO, Mosby, 1994

De Lahunta A. Veterinary Neuroanatomy and Clinical Neurology. 2nd Edit, W.B. Saunders, Philadelphia, 1983

De Lahunta AD, Glass E. Veterinary Neuroanatomy and Clinical Neurology. St. Louis: Saunders Elsevier, 2009

Gutierrez-Quintana R, et al. The cutaneous trunci reflex for localizing and grading thoracolumbar spinal cord injuries in dogs. *J Small Anim Pract.* 2012;53(8):470-5.

Muguet-Chanoit AC, et al. The cutaneous trunci muscle reflex: a predictor of recovery in dogs with acute thoracolumbar myelopathies caused by intervertebral disc extrusions. *Vet Surg.* 2012; 41(2):200-6.

Sharp NJ, Wheeler SJ: Small Animal Spinal Disorders. 2ed. Philadelphia, PA, Elsevier

Mosby, 2005

Central *vs* Peripheral Vestibular Disease: A Matter of Life or Death

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

The vestibular system provides information to the brainstem and somatosensory cortex regarding head position, acceleration, and deceleration and provides us with our sense of balance. Clinical signs of dysfunction include side-stepping as though drunk, abnormal head or eye position and spontaneous eye movement. Examination of the patient will allow an assessment of whether the dysfunction is from the nerve and therefore peripheral to the brain or from the brainstem or central. This distinction is critical because central diseases are often life-threatening unless identified and treated, whereas peripheral disease often improves on its own or with minor intervention. There are many causes of peripheral and central vestibular disease but special attention should be given to meningoencephalitis of unknown etiology (MUE) because it is common and often lethal if not treated promptly. This talk will discuss common and distinguishing features of central and peripheral vestibular disease, common causes for diseases in each location and available treatments and prognosis for MUE.

Vestibular anatomy and function

Movement of endolymph over the hair cells of the receptors of the inner ear (semicircular canal, saccule, and utriculus) provides input to the vestibular nerve. The cell bodies for the vestibular nerve are located in 4 paired nuclei located within the brainstem nestled around the fourth ventricle and choroid plexus. The receptor apparatus the detects acceleration, deceleration as well as the static position of the head. There are many outputs from the vestibular nuclei:

1. Vestibular system controls eye position and coordinated movement by synapsing on cranial nerve 3, 4, and 6 via the medial longitudinal fasiculus (MLF). The generation of physiological nystagmus by moving the head left and right is called the vestibulo-ocular reflex. This reflex relies on structures deep within the brainstem and when abnormal and not related to drug therapy, there is an indication of severe brainstem dysfunction.
2. The vestibulospinal tract connects the vestibular nuclei with the nerve and muscle and will increase extensor tone to support the body against gravity during movement
3. Vestibular system has projections via the caudal cerebellar peduncle to the cerebellum which functions to coordinate movement of the eyes, neck, trunk, and limbs in relation to movement of the head as well as static head position.
4. Vestibular influences on the vomiting center in the reticular formation of the brainstem account for the motion sickness often noted in people and possibly in dogs with vestibular dysfunction.
5. There is a conscious awareness or perception of balance and equilibrium and although the pathway is not currently well defined, there is a thalamic relay of information to the somatosensory cortex.

Besides the receptors of the inner ear there are visual and proprioceptive inputs into the vestibular system. Blindfolding a vestibular patient and then lifting them off the floor often increase the sense of poor balance. Also, congenitally blind patients often have spontaneous nystagmus.

Central vs. peripheral vestibular disease

Peripheral vestibular disease has a fairly consistent clinical presentation. A useful tool to think about central disease is that dogs whose clinical signs do not look like they peripheral likely have central disease. Please see Table 1.

Peripheral vestibular disease

Peripheral vestibular disease typically has a sudden onset and can be associated with vomiting at its onset. Patients have rotary or horizontal nystagmus at a rate of 60 beats per minute or greater and a head tilt of about 20 degrees from midline. The nystagmus can change from rotary to horizontal but its fast phase should remain opposite the direction of the head tilt. Persistent weakness and postural deficit are not noted and after a few hours of acclimating these dogs are bright and responsive and able to ambulate. These patients may lean, side-step or rarely roll in the same direction as the head tilt.

The three most common causes of peripheral vestibular disease are infection of the middle ear extending into the inner ear's bony labyrinth that contains the vestibular receptors (OTMI), the old dog peripheral vestibular or idiopathic vestibular syndrome (dogs typically older than 5, cats of any age), and the low thyroid state, especially when the cholesterol is elevated.

Central vestibular disease

One specific example of central disease is called paradoxical vestibular disease because the signs are different or opposite of what would be expected for peripheral disease. In this syndrome, the lesion is within the brain in the caudal cerebellar peduncle or floculonodular lobe of the cerebellum and the head tilt is opposite the side of the lesion. Some clinical signs of non-peripheral or

central vestibular disease include dull mentation, side- stepping/leaning towards head tilt, sway back and forth, hypermetria, tremors, weakness, non-ambulation, postural deficit, nystagmus at a rate under 60 beats per minute, extreme head tilt, cranial nerve deficits besides those associated with Facial nerve and Horner's tract (commonly seen with OTMI). Common causes of central vestibular disease include neoplasia like meningioma (larger breeds), meningoencephaltiis of unknown etiology (MUE), and infarcts of the cerebellum (larger breeds). Please see Table 2.

Meningoencephalitis of unknown etiology (MUE)

MUE is a group of diseases all thought to be immune mediated. Necrotizing disease of the grey matter (NME) and white matter (NLE) and Granulomatous meningoencephalitis (GME) are all examples of MUE. GME has a predisposition for the brainstem and often presents with central vestibular signs and is thought to account for up to 25% of all cases of canine CNS disease. Female, small breed dogs 4-8 years of age are predisposed and the diagnosis is made by a combination of clinical suspicion, MRI, CSF and infectious test results. A recent prospective prospective study of 39 MUE dogs treated with prednisone and then 4 weeks later Cytosine arabinoside provides insight into the prognosis with MUE. 13/39 (33%) died in the first 72 hours and 22/39 (56%) died within the first 52 days and the study had an overall mean survival time of 26 days (range 0-2250 days). In progressive MUE, prompt recognition and treatment with Prednisone 0.5 -1 mg/kg, BID, plus a chemotherapy (Cytosine arabinoside, Lomustine, Procarbazine) and/or immune modulation with (Cyclosporine and less commonly Leflunomide, Azathioprine, or Mycophenolate) is thought to provide best chance of a return to normal. In that same study, 12/39 (31%) of dogs returned to normal.

Conclusion

Vestibular disease is a common presenting complaint and assessing the disease to be central or peripheral provides the owner with the best sense of the appropriate diagnostic plan, treatment and prognosis. Having the image of a typical peripheral case in your mind and comparing all cases against this image can allow for best determination of the likelihood of central disease. Prompt treatment of the diseases that cause central vestibular signs is essential for a good outcome.

Table 1. Clinical signs of disease in the central or peripheral vestibular system

Observation	**Central Disease**	**Peripheral Disease**
Mentation	Dull	Normal
Gait	Side step opposite head tilt Hypermetria Weakness	Side-steps towards side of lesion
Postural Reactions	Delayed or absent	Normal
Head Tilt	Absent or extreme	20 Degrees
Cranial Nerve Deficits	Any	+/- Facial, +/- Horner's tract
Nystagmus	Vertical or positional (chronic) Fast phase towards lesion Fewer than 10 beats/second	Rotary or horizontal Fast phase away from lesion Greater than 60 beats/minute
Positional Strabismus	Ventral on side of head tilt Dorsal opposite head tilt	Ventral on side of head tilt
Neck Pain	Yes	No

Table 2. Categories of disease that cause central or peripheral vestibular disease

Category	Central Diseases	Peripheral Diseases
Malformation	Rostrocerebellar fluid accumulation Caudal occipital malformation syndrome (COMS) Hydrocephalus	Congenital vestibular disease
Metabolic	Hypothyroidism (± infarction)	Hypothyroidism
Neoplastic	Primary intracranial neoplasms Metastatic neoplasms	Primary aural neoplasia Vestibular neurofibroma
Infectious & Inflammatory	Viral: Canine distemper virus, Feline infectious peritonitis Bacterial: Abscess, Rocky mountain spotted fever, Ehrlichiosis, Bartonellosis, Anaplasmosis Protozoal: Toxoplasmosis, Neosporosis Mycotic: Cryptococcosis, Blastomycosis, others Non-infectious (MUE)	Otitis media interna (OMI) Nasal- and otopharyngeal polyps Idiopathic vestibular disease (vestibular neuronitis)
Trauma	Brainstem trauma	Inner ear trauma
Toxic	Metronidazole	Ototoxic drugs (systemic and topical)
Vascular	Cerebrovascular disease	

References

De Lahunta A. Veterinary Neuroanatomy and Clinical Neurology. 2nd Edit, W.B. Saunders, Philadelphia, 1983

De Lahunta AD, Glass E. Veterinary Neuroanatomy and Clinical Neurology. St. Louis: Saunders Elsevier, 2009

Rossmeisl JH, Vestibular Disease in Dogs and Cats. *Vet Clin Small Anim* 40 (2010) 81-100

Troxel MT, et al. Signs of neurologic dysfunction in dogs with central versus peripheral vestibular disease. *J Am Vet Med Assoc* 2005; 227 (4): 570-4

Common and Deadly: Recognizing and Treating Inflammatory Disease of the Brain, Spinal Cord, and Meninges

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

When there are inflammatory cells within the brain, spinal cord or meninges then the terms encephalitis, myelitis, and meningitis are used, respectively. When inflammation is in more than one area the terms are combined like with meningoencephalomyelitis. The inflammation in these cases if most often from a non-infectious, unknown etiology and therefore called meningoencephalomyelitis of unknown etiology (MUE). The signs of the disease are specific to the location of the inflammation and most cases respond well to aggressive immune suppression. This talk discusses the terminology, definition / histopathology, common presentations, treatment and prognosis for different manifestations of non-infectious inflammatory disease within the nervous system

Terminology

MUE is an umbrella term for necrotizing encephalitis (NE) and granulomatous meningoencephalomyelitis (GME). Necrotizing encephalitis implies death of neurons within the brain from inflammation and is further subdivided into Pug dog encephalitis or necrotizing meningoencephalitis (NME) and Yorkshire terrier encephalitis or necrotizing leukoencephalitis (NLE). MUE has replaced these terms since multiple breeds have been identified with these disease and the prognosis, testing and treatment protocols are similar. Steroid responsive meningitis-arteritis (SRMA) is another non-infectious inflammatory disease that typically involves only the meninges – this disease will be discussed separately at end of this talk.

Definitions and signalments

NLE was first described in the Yorkshire terrier. NLE is a progressive disease with an acute or chronic onset where there is necrosis of the white matter that with time, can coalesce into cavities or holes in the brain. The grey matter and spinal cord are spared in this disease. The other form of NE, NME first described in the Pug dog has since been noted in many other small breeds like the Maltese, Brussels Griffon, Colon du Tulear, Shih Tzu, and Papillion. NME is typically an acute onset and rapidly progressive disease of the both the grey and white matter of the cerebrum, with only 25 % of cases showing any multifocal or brainstem signs. Because the cerebrum is so commonly affected, seizure is common clinical sign - 94% of Pugs with this disease have seizure. GME is common and may account for up to 25% of canine CNS disease – it is an acute onset, progressive and potentially fatal disease. Unlike NE, the disease can manifest in the cerebrum, brainstem and spinal cord – 8 % of all cases present with only spinal cord signs. Histopathologically GME is noted most often in the white matter as perivascular infiltrates of rounds cells (plasma cells, lymphocytes and occasionally lymphoblasts) - these can coalesce to form tumors (unlike NE where the lesions coalesce to form cavities within the brain) (SJSR). Female, small breed dogs like the Miniature poodle, Maltese, Dachshund, Westie, and Chihuahua are commonly affected. Most dogs with GME are 4-8 years of age, whereas with NE most dogs are under 4 years of age. The take home point is that MUE should be suspected in small breed under 8 years of age with acute onset of brain and less commonly spinal cord signs.

Signs of disease with MUE

The signs of disease are specific to the region of the brain that is involved. Most cases of MUE presents with multifocal clinical representing a mixture of forebrain and brainstem signs which can include altered mentation, visual deficits, central vestibular signs, proprioceptive placing and hopping deficits and seizures. In one report, 8% of cases has only spinal cord signs (weakness, paralysis, ataxia).

What is the cause of MUE?

The causes of MUE is thought to be from a genetic predisposition coupled with environmental exposures leading to a pathologic immune response. For instance, the histopathological differences in NE may result from minor differences among breeds, modifying genes, or variations in antigenic exposure. Breed predispositions indicate there is a heritable component to development of MUE. In the Pug, heritability has been proven and a strong association demonstrated between affected dogs with single nucleotide polymorphism within the dog's leucocyte antigen (DLA) complex II region located on chromosome 12. The authors point out that this same association is made in human multiple sclerosis (MS) patients and that NME in the Pug dog maybe a good model for the less common acute variant forms of MS. Recent work in Maltese with NME show risk loci on chromosome 4 and 15.

MUE has been associated with viral diseases like Borna virus, West Nile, Canine parainfluenza, and Encephalomyocarditis virus, Canine herpes virus-1, Parvovirus, Porcine herpes virus-1, Bunya- and Polyomaviruses. Additionally, DNA from *E. Coli*, *Mycoplasma canis.* and *Bartonella vinsonii subsp berkhoffii* have been identified in sporadic cases of MUE and a recent report shows DNA from *Anaplama phagocytephilum* in 4/23 cases SRMA. These pathogens are not thought to be direct cause of the disease but according to

the “Hit-and-Run Hypothesis” work in tandem with genetic and other environmental factors (vaccination?) to generate an autoimmune response, perhaps through molecular mimicry.

Autoimmune disease is likely in MUE because the CSF and serum of dogs with MUE contain an anti-astrocyte autoantibodies against glial fibrillary acidic protein (GFAP) which is an intermediate filament protein important in astrocyte function. Recent work has shown that the active cellular proliferation is thought to occur within the CNS lesion (and not from a migration from outside the CNS) and is assisted by matrix metalloprotineases (MMPs). MMPs are enzymes necessary for migration of leukocytes into the CNS or CSF and MMP-9 is elevated in some dogs with MUE. Other work by Dr. Mariani has also shown elevations in many interleukins necessary for lymphocyte proliferation and trafficking into tissue. However, to date there is no useful serum or CSF biomarker to assist in the diagnosis or treatment of MUE.

Lastly, since some cases of MUE lesions contain small amount of lymphoblasts and some are truly shown to be lymphoma at the time of histopathology, it is theorized that MUE is a lymphoproliferative disorder with features of both inflammation and neoplasia. Further support for this claim is the marked clinical responses of certain cases to chemotherapy.

MUE diagnosis

An MUE diagnosis is based on clinical suspicion from the signalment and disease progression, and then MRI, CSF and infectious disease testing. It can be difficult ruling-out infection because of inaccurate test results and the fact that there are not tests for all known pathogens. For example, we had a suspected MUE whose necropsy revealed a high burden of an unknown protozoal agent. Complicating things further is not all cases will have an abnormal MRI and between 12-25% of MUE cases will have normal CSF analysis. In cervical spinal cord MUE, MRI of the paraspinal cervical muscles with STIR sequence in MUE is often abnormal (78% sensitivity) and rarely abnormal in normal controls (92% specificity) – because CSF results can be normal in cases of spinal cord MUE about 10% of the time, this sequence is important in suspected cases of cervical and maybe intracranial MUE.

Pursing infectious etiology

When the CSF is abnormal in a MUE cases, less than 10% of cases will have a predominantly neutrophilic CSF analysis. Therefore a neutrophilic pleocytosis should alert clinician to a possible infection rather than MUE. Typical testing when searching for infection could include PCR, serology and rarely cultures for protozoal, rickettsial, fungal, bacterial, and viral diseases. In the Mid-Atlantic region of the USA, we typically test the CSF via PCR for distemper virus, serology for *Toxoplasmosis gondi*, *Neospora caninum* and potentially *Sarcocystis neurona*, and antigen testing for *Cryptoccocus* sp. as well as whole blood PCR testing for vector borne disease. Failure to improve while on antibiotics or a relapse of signs when prednisone is reduced while on antibiotic therapy is often the last step in ruling-out infection and committing to multimodal immune suppressive therapy (see below). Brain biopsy has been reported and occasionally performed in our clinic however, the procedure has risks, costs, may yield false negative or positive results and may not change the course of treatment. A recent paper describing needle guided brain biopsy had 82% of cases achieved a specific diagnosis with a 6% indirect mortality rate and 29% incidence of transient side effects (stupor, seizure, weakness and loss of proprioception).

MUE treatment

Initial testing often reveals inflammation but does not clearly delineate between non-infectious and infectious inflammation. To address a possible infection antimicrobial therapy (clindamycin 15 mg/kg, BID, minocycline 10 mg/kg, BID +/- Fluconazole 10 mg/kg, BID) if often started while waiting for infectious disease test results. Prednisone 0.5 mg/kg, BID is also started and if signs are progressive and severe additional immune suppression could be considered with chemotherapy (Cytosine arabinoside, Lomustine, Procarbazine) and/or immune modulation with (Cyclosporine and less commonly Leflunomide, Azathioprine, or Mycophenolate). Radiation therapy has also been reported to have a positive influence of the disease course with MUE. There are many important and unanswered clinical questions revolving around what is best immunosuppressive protocol and when it is advised to stop therapy.

Steroid alone are insufficient

In a meta-analysis of MUE cases the median survival for dogs treated with corticosteroid plus any other immune suppressant protocol ranged from 240 to 590 days (n=96) compared with corticosteroid alone where range of median survival was 28 to 357 days (n= 43). A recent retrospective study evaluating different glucocorticoid protocols (no other immune therapy) showed survival times ranging from 2 to 2065 days – and the authors concluded that an 18 week schedule of sole prednisone therapy can be used to treat MUE. However, multiple other authors conclude that treating with immune suppressants other than prednisone will improve control of the immune condition, improve survival times, and improve quality of life for the patient by reducing steroid associated side-effects (polydipsia, polyuria, polyphagia, muscle loss, urinary tract infection, hepatotoxicity, etc.). However, which immune suppressive protocol is best in not known and there is a desperate need for randomized, blinded, controlled, prospective study of MUE to assess current and future therapies that could include (intravenous immunoglobulin, plasma exchange and even anti-viral therapy).

Once remission or improvement is achieved it can be difficult to know when to taper steroid and other immune suppressive therapy. In our experience, tapering medication can lead to relapses with poor outcomes in dogs that had a normal neurological exam. A recent paper showed that follow-up CSF analysis at 3 months can predict relapse and that tapering medication in dogs with an abnormal MRI always lead to relapse. Repeating these tests when they were previously abnormal is advised prior to the tapering or elimination of immune suppressive therapy.

Prognosis

Comparing studies is difficult due to different inclusion criteria, therapy, treatment endpoints, and lack of a prospective, controlled study. There is a recent prospective study of 39 MUE dogs treated with prednisone and then Cytosine arabinoside that provides insight into the prognosis with MUE. 13/39 (33%) died in the first 72 hours and 22/39 (56%) died within the first 52 days and the study had an overall mean survival time of 26 days (range 0-2250 days). The remaining 17 dogs that lived beyond 52 days had survivals that ranged from 562 to 2241 days (median 1616 days). Overall 12/39 (31%) dogs returned to normal and 7/39 (18%) were normal without treatment. These results can best be summarized by saying MUE can have an acute and fatal presentation up to 33% of the time and if alive at 8 weeks then survival time jumps to a median of 4 and ½ years. Among the dogs that survive more than 8 weeks, most return to normal and some can be off medication altogether.

Prognostic indicators

One paper demonstrated that signs of high intracranial pressure (foramen magnum herniation, loss of cerebral sulci) was associated with a higher mortality. Multifocal disease and seizure have been inconsistently reported as negative prognostic indicators in MUE. A recent abstract suggested that focal brainstem disease carried best prognosis in MUE.

Seizure and the role of electroencephalography (EEG) in MUE

Non-convulsive seizure and non-convulsive status epilepticus (NCSE) can be present and only detectable by using EEG. In pediatrics, continuous EEG is used in patients with encephalitis, seizure and altered mentation to identify non-convulsive seizure and non-convulsive status epilepticus. Children with non-convulsive seizure have a poor outcome compared to those with the same diseases without non-convulsive seizure. We have also documented NCSE in MUE and believe that identifying and treating NCSE would improve outcome in MUE cases. NCSE should be highly suspected in MUE patients with seizure as part of the presenting complaint plus altered mentation, twitching of the ears or eyelids, sudden changes in temperature or respiratory rate, or unexplained coma. If referral for EEG is not possible, I recommend treating with Levetiracetam 60 mg/kg, IV and then potentially phenobarbital at doses of 20-40 mg/kg, divided into 6-8 mg/kg boluses until there are no abnormal movements or paroxysmal changes in vital parameters.

Steroid responsive meningitis-arteritis (SRMA)

SRMA is a systemic immune disorder characterized by inflammatory lesions of the meninges and associated arteries. This disease can occur in any breed but the Bernese Mountain Dog, Boxer, Beagle, German Short and Wire Haired pointers, Weimaraner are over-represented. Clinical signs typically start at 10 months of age with a range of 6-18 months, however it has been reported in dogs as old as 7 years of age. Although histopathological changes have been noted in the heart, mediastinum, thyroid and there is an association with immune mediated polyarthritis - the clinical signs are from the meningitis (Webb). Clinical sign include neck pain and lethargy, not eating, and fever. Typical exam findings include stiff neck, short- strided gait, neck and back pain on palpation and spontaneous yelping-out or with movement. Misdiagnosis can occur because this is a sporadic disease, with non-specific, waving and waning signs that are often initially responsive to antibiotics and NSAID therapy. The diagnosis is made when inflammation is noted on CSF analysis, with most cases having a severe neurotrophilic pleocytosis. The major differential diagnosis for these clinical signs is diskospondylitis which would be best identified with MRI.

A peripheral neutrophilia and elevated globulin count are inconsistently findings whereas serum C reactive protein (CRP) is elevated in all cases. CRP is an excellent biomarker for this disease because it drops to normal with resolution of disease and increases with relapse. Serum and CSF IgA concentration are increased indicating this is an immune disease, however IgA is a poor biomarker because it remains elevated, even in remission. Treatment involves high dose steroid therapy and when there is an incomplete response, relapse, or intolerable corticosteroid side effects then other immune modulators can be added-on (Azathioprine, Cyclosporine, Mycophenolate). A chronic form of the disease has been reported where there is weakness and ataxia in all 4 limbs and a mononuclear CSF analysis - it has been suggested this develops from late recognition of the disease or inadequate treatment (premature taper of therapy, too little immune suppression). Most cases return to normal. Relapse can occur in 20-60% of the cases – a higher CRP at 4 weeks is associated with multiple relapses. Although treatment durations of up to 20 months have been reported – most cases require about 6-10 months of therapy.

Conclusion

MUE is common and should be expected in any small breed dog with acute and/or progressive brain or spinal cord signs. Once diagnosed with MUE the prognosis is guarded but might be able to be improved by treating with multiple immune suppressive medications as well as anti-epileptic drugs. A return to normal is certainly possible as well as clinical remission. More study is desperately needed to determine the benefit of different treatment protocols, especially ones where multiple immune suppressive medication are given early in the course of the disease. SRMA is another example of immune mediated disease observed in medium to large breeds at about 10 months of age – if recognized early in the disease course the prognosis is excellent.

References

Cizinauskas S, et al. Long-term treatment with SRMA: clinical, lab, and therapeutic results. Journ Small Anim Pract 2000; 41: 295-301

Flegel T, et al. Diagnostic yield and adverse effects of MRI-guided free-hand brain biopsy through a mini-burr hole in dogs with encephalitis. *J Vet Intern Med* 2012; 26: 969

Granger N, et al. Clinical findings and treatment in non-infectous meningoencephalomyelitis in dogs: a systemic review of 457 published cases from 1962-2008. *The Veterinary Journal* 2010; 184: 290-297

Higginbotham MJ, et al. Noninfectious CNS disease in dogs. Compendium 2007 : 488

Lowrie M, et al. MUO investigations of prognostic factors and outcome using a standard treatment protocol. *Veterinary Record* 2013

Lowrie M, et al. SRMA: a prospective study of potential disease markers, prednisone treatment and long-term outcome in 20 dogs (2006-2008). *J Vet Intern Med* 2009; 23: 862-870

Mariani C. Canine meningoencephalitis: what do we know?. *ACVIM Proceedings* 2014

Schatzberg SJ. Idiopathic and granulomatous and necrotizing inflammatory disorders of the CNS. *Vet Clin Small Anim* 2010; 40: 101-120

Tipold A, et al. An update on steroid responsive meningitis-arteritis. *Journ Small Anim Pract* 2010; 51: 150-154

Nonconvulsive Seizure: Clandestine, Common, and Important

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

A seizure is defined as a transient occurrence of signs, symptoms or both due to abnormal excessive or synchronous neuronal activity. In veterinary medicine seizure is diagnosed via observations about the patient's level of awareness, spontaneous muscle movements in the limbs and head as well as autonomic changes. However, a seizure is fundamentally an aberrant electrical event in the brain and therefore best diagnosed using electroencephalography (EEG). In human medicine the primary use of EEG is to distinguish epileptic seizure from psychogenic seizure, metabolic events or movement disorders. Equally important, EEG is used in seizure patients with altered mentation to detect electrical seizure and assess response to pharmacologic therapy. At our clinic, we have worked with a physician expert in the interpretation of human and animal EEG for over a decade and use EEG for these same purposes. The talk will discuss the characteristics, diagnosis, treatment and prognosis with electrical seizure and non-convulsive status epilepticus in both human and veterinary medicine.

Seizure terminology

An electrical seizure is defined as ictal discharges consisting of a rhythmic pattern with definitive evolution in frequency, amplitude and/or morphology persisting for at least 10 seconds. Electrical seizure can occasionally manifest as convulsions (generalized tonic-clonic) with patient flailing on its side, paddling all 4 limbs or holding the limbs, head and neck in rigid extension. A non-convulsive seizure (NCS) is defined as a seizure where there is no overt convulsive movements. Another term used for non-convulsive seizure is complex partial seizure where there is only an acute alteration in consciousness. NCS is more common than convulsive seizure in people and cats, and potentially dogs as well. When an electrical seizure lasts for more than 30 minutes it is almost always non-convulsive and termed non-convulsive status epilepticus (NCSE).

Seizure frequency and status epilepticus

Terms to describe seizure frequency from best to worst prognosis include: sporadic seizure, cluster seizure, acute repetitive seizure, convulsive status epilepticus (CSE), non-convulsive status epilepticus (NCSE), refractory status epilepticus (RSE), super-refractory status epilepticus, or malignant status epilepticus. A cluster seizure is 2 or more seizure within 24 hours and acute repetitive seizure is 2 or more seizure within 5-12 hours. When seizures are prolonged and without a return to baseline, they are referred to as status epilepticus (SE) with the best studied form being CSE. The original definition of SE was a 30 minute or longer continuous seizure because animal models show neuronal damage and seizure become self-sustaining after 30 minutes. However the current definition of a SE is a seizure lasting 5 minutes or longer, 2 seizures where the patient is unable to respond to commands or walk between seizures, or when patient is still seizing. This definition has evolved because clinicians no longer want to delay a patient's entry into a protocol for SE since prompt therapy is required for a good outcome. In human medicine, about 150,000 people are thought to develop CSE per year in the USA. In dogs with idiopathic epilepsy (genetic or unknown cause) the rate of cluster seizure is reported at 41-94% and for CSE 53-69%. These conditions are common and important problems in both veterinary and human medicine.

Progression from convulsive to non-convulsive status epilepticus

During CSE treatment with benzodiazepines (BDZ) can be ineffective due to endocytosis and changes to the GABA receptor. In this same period of time the convulsions often stop and the electrical seizure can persist despite no obvious convulsions, which is called non-convulsive status epilepticus (NCSE) (Foreman). Refractory status epilepticus (RSE) is diagnosed when electrical seizure activity persists despite treatment with 2 anti-epileptic drugs (AEDs) at appropriate doses – refractory SE is typically non-convulsive. When RSE persists for greater than 24 hours it is super-refractory SE and when SE returns within 5 days of tapering anesthetic medications used to treat SE, then it is called malignant SE.

NCSE is clandestine

As our video cases will demonstrate many of our patients with NCSE appeared to be asleep or comatose. This is common too in people. A paper concludes that many people with NCSE appeared to be sleeping and that "clinical detection of NCSE would not have been possible with routine neurologic evaluations without use of EEG monitoring". The signs of NCSE can range from mild confusion or disorientation to coma. NCSE should be suspected following a convulsive seizure when there is no improvement in 20 minutes or failure to return to baseline in 60 minutes. Distinguishing NCSE from conditions that mimic seizure can be difficult and about 25% of human patients can have subtle movements that are not from seizure. In human medicine studies have demonstrated some positive symptoms indicative of NCS/NCSE and negative symptoms indicating clinical signs are not from seizure. No such

published criteria exist in veterinary medicine. However, in our population of patients with NCSE we noted subtle twitching of ears or facial muscles, confusion, transient hyperthermia, episodic and unexplained changes in respiratory rates, mydriasis, or coma.

NCSE frequency in seizure patients

In veterinary medicine there are a few reports describing electrical seizure or NCSE following treatment of convulsive SE with diazepam and phenobarbital. In one report of ten patients (7 dogs, 3 cats) treated for CSE with anesthetic doses phenobarbital or propofol anesthesia, 100% of the patients had electrical seizure. In 164 human patients at Virginia Commonwealth University treated with their hospital's typical protocol for CSE, EEG recording after the CSE stopped showed that 48% of the patients had persistent electrical seizure and 14% had NCSE. Another human study showed that about 33% of patients in convulsive status continue to have electrographic seizure after the convulsive seizure had stopped Generally in human medicine, NCSE is thought to be underdiagnosed and to account for about 30-40% of all SE cases. In an effort to diagnose electrical seizure and NCSE in seizure patient with seizure and an altered mentation we record the routine EEG for about 20-30 minutes, whereas in humans recordings are often done for 1-2 days via continuous monitoring. Using routine EEG we noted 4/11 (36%) of cats and 5/55 (9%) dogs were diagnosed with NCSE and 4/55 (7%) had electrical seizure.

Pathophysiology with NCSE

Pathology with CSE is due to both systemic effects from the muscle movement and hyperthermia and the intracranial effects of continuous neuronal firing in the brain with mortality rates of 25- 40% reported in canine patients. NCSE could be thought of as more benign than CSE since there are no obvious muscle movements or systemic effects but, on the other hand, NCSE is typically noted after CSE and represents prolonged and continuous neuronal firing in the brain. Human studies have shown that NCSE E is a statistically significant independent predictor of mortality and reduced functional independence separate from age and underlying diagnosis. In other words, when comparing age and diagnoses matched cases, those with NCSE did far worse indicating that NCSE is a pathologic and lethal process.

NCSE cause brain necrosis and facilitates more seizure. The excessive neuronal firing in NCSE generates excess glutamate mediated stimulation of the NMDA receptor, calcium influx and then neuronal cell death. A reduced seizure threshold from the kindling and mirroring phenomenon, structural and cellular reorganization of the hippocampus, selective neurodegeneration and altered cellular expression, and distribution of neurotransmitter and receptor channels can self-sustain the seizure and promote future seizure. This latter phenomenon in people is well known as one study showed 33% of refractory SE will have recurrent seizure within 5 days of tapering an anesthetic medication, a condition referred to as malignant SE (Foreman). In this talk the speaker will describe a 7 year-old Swiss Mountain dog with seizure of unknown cause that had two episodes of NCSE, 30 days apart, where necropsy showed neuronal necrosis. This case demonstrates that NCSE can cause neuronal necrosis and reduce the seizure threshold.

Mortality with NCSE

Human studies show that NCSE is an independent predictor of mortality, especially when there is a delay in diagnosis, or longer episodes of NCSE. Mortality rates with CSE in humans is about 30% whereas 50% is a stated mortality rate for NCSE. There are no published veterinary reports regarding the incidence or mortality rates with NCSE, however in our study 2/4 cats and 3/5 dogs or 5/9 (55%) had died within 3 months of their NCSE.

Treatment of status epilepticus

The endpoint for treating CSE is cessation of all motor activity, but as noted above, many of these cases will continue to have electrical seizure or NCSE. In human medicine, refractory CSE is treated with anesthetic doses of midazolam, propofol or pentobarbital. There is no clear advantage to any of these agents but surveys of physicians show a preference for barbiturate. EEG defines the endpoint of treatment which includes the reduction or elimination of epileptiform discharges (ED) and/or to establish a burst suppression pattern. Burst suppression is thought to be neuroprotective in NCSE because it hyperpolarizes at least 95% of cortical neurons and conserves on ATP. The necessary duration of burst suppression or whether it is as good or better of an endpoint that eliminating ED is debated in human medicine.

After a benzodiazepine, second line seizure treatment in humans can include Levetiracetam, Valproate and Phenytoin. Levetiracetam had variable response rates (30-79%) as a second line treatment in human NCSE. Levetiracetam has been studied for acute repetitive seizure and SE in veterinary medicine and demonstrated to be more effective than placebo. Furthermore, Levetiracetam is thought to be synergistic with benzodiazepines. Fosphenytoin has also been studied in veterinary medicine in a similar patient population also shown to be much more effective than placebo, however this drug is currently not available and also cost prohibitive. A clinical trial is being proposed in veterinary medicine to study injectable valproate compared to placebo in CSE.

Recommended seizure treatment

In our clinic we give 1 mg/kg to 2 mg/kg of valium, IV and 60 mg/kg of Levetiracetam, IV and if patient does not improve in 10-15 minutes then a routine EEG is performed. If epileptiform discharges are noted then boluses of 10 mg/kg of phenobarbital are given until ED abate or burst suppression pattern is noted. We have noted that between 45 mg/kg and 100 mg/kg of phenobarbital is typically required to achieve these endpoints. In a veterinary report of 10 patients with electrical seizure following CSE, burst suppression and/or elimination of ED was a goal and the report concluded this treatment strategy was safe as mechanical ventilation was not required and only treatable hypotension noted as side effects. Without the benefit of EEG, the end point of therapy should be the absence of any subtle twitching of ears or facial muscles, confusion, transient hyperthermia, episodic and unexplained changes in respiratory rates, or mydriasis.

Conclusion

Patients presenting after a convulsive seizure or status epilepticus that also exhibit behavioral changes or altered mentation are candidates for having continued electrical seizure and NCSE. EEG is required to prove the diagnosis and ideally to guide therapy. Practically speaking, in seizure patients that remains twitchy or confused following seizure and can't be referred for EEG, administer 60 mg/kg Levetiracetam and then phenobarbital 8-10 mg/kg boluses every 20-30 minutes to a total dose of 40 mg/kg and blood pressure support if needed. Hopefully the use of veterinary EEG will become more common so patients with CSE can be referred for prompt detection and treatment of NCSE.

References

DeLorenzo RJ, et al. Persistent NCSE after control of CSE. *Epilepsia* 1998; 39(8): 833-840

Foreman B, et al. Epilepsy Emergencies: Diagnosis and Management. *Neurol Clin* 2012; 30: 11-41

Patterson N. New and old drugs for CSE. *ACVIM Proceedings 2014*

Raith K, et al. Continuous EEG monitoring of SE in dogs and cats: 10 patients (2004 -2005). *J Vet Emerg Crit Care*. 2010; 20(4): 446 -455

Rueegg SJ, et al. Diagnosis and treatment of NCSE in ICU setting. *Current Treatment Options in Neurology* 2003; 5: 93-110

Schreiber JM, et al. Continuous Video EEG for patients with acute encephalopathy in pediatric ICU. *Neuro Crit Care* 2012; 17: 31-38

Idiopathic *vs* Structural Epilepsy: Clinical Guidelines for Making this Vital Distinction

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

Some studies show more than 1 in 20 dogs will suffer from recurrent seizure in their lifetime. When a client presents a recent onset seizure patient they are keenly interested in the diagnosis and prognosis along with best course of action. Some cases will be of unknown or genetic cause (idiopathic) and others will have a specific (structural) cause for the seizure. The diagnostic plan, prognosis and treatment plan can be very different between dogs with an unknown cause for their seizure and dogs with a structural problem (brain tumor, encephalitis, stroke, malformation). Considering the age of onset, breed, weight, historical and neurological exam findings are crucial in estimating the likelihood that there is a structural cause for the seizure. This talk will discuss the current terminology and rational for grouping seizure by their underlying cause and frequency and then discuss how to make the distinction between structural versus idiopathic epilepsy.

Epilepsy vs. reactive seizure

Epilepsy generally means recurrent seizure, however in humans after just one seizure you can be considered epileptic if the seizure is associated with an enduring alteration of the brain that increases the likelihood of seizure. Reactive seizures occur when the brain is normal but reacting to an extra-cranial toxic or metabolic insult.

Epilepsy terminology

In 1989 the International League Against Epilepsy (ILAE) distinguished 3 etiologies of epilepsy which were then adopted in veterinary medicine. Idiopathic or primary epilepsy is diagnosed if no underlying cause can be determined other than a possible hereditary predisposition. Symptomatic epilepsy is a consequence of an identifiable brain disorder. Cryptogenic (probable symptomatic) epilepsy a heritable cause is not likely and an underlying pathologic change in the brain suspected but not proven. In 2005 these terms for epilepsy were changed by the ILAE to genetic, structural and unknown cause and now these are the terms used in published veterinary literature.

Genetic epilepsy can be diagnosed when the prevalence in a breed exceeds that of the general population. Making this distinction is important because certain breeds may have a particularly severe form of genetic epilepsy. For example in the Border Collie survival from seizure onset is 2 years with a 94% rate of cluster seizure and 53% rate of status epilepticus. Conversely genetic epilepsy in the Lagotto Ramagnolo starts at 6 weeks of age and resolves by 16 weeks of age. Structural epilepsy is diagnosed when there is a physical disruption of the brain from a malformation, infection, inflammation, stroke or brain tumor. Epilepsy of unknown cause is diagnosed when a cause for the seizure has not been determined.

Classification by seizure frequency

Progression of disease and a worse prognosis is often indicated when seizure becomes more frequent. Therefore applying other terms for more frequent or longer seizures is valuable. A **cluster seizure** is noted there are 2 or more seizure within 24 hours and **acute repetitive seizure** is 2 or more seizure within 5-12 hours. **Status epilepticus** (SE) is present when the seizure lasts 5 minutes or longer, 2 seizures where the patient is unable to respond to commands or walk between seizure, or patient having a seizure at presentation. SE may not respond to initial treatment with Benzodiazepine, Phenobarbital and/or Levetiracetam at which time it is called **refractory status epilepticus** (RSE). In these cases electroencephalography (EEG) often shows continued seizure activity despite few to no physical manifestation of the seizure, a condition called **non-convulsive status epilepticus** (NCSE). SE and NCSE have an associated 25 and 50% mortality rate in human and veterinary medicine.

Age of onset

A recent study of dogs 7 or older at time of first seizure that had a MRI determined that 79% of dogs had structural epilepsy and 21% had cryptogenic epilepsy (now called seizure of unknown origin). Furthermore when the dogs were 10 or older at seizure onset there was an 87% chance of an abnormal MRI showing a structural cause for the seizure. In the dogs with structural epilepsy, 72% had a brain tumor with stroke and encephalitis being the next most common causes of seizure. At other end of spectrum, dogs younger than 6 months of age are very likely to have a genetic or seizure of unknown cause.

Breed

Genetic epilepsy and epilepsy of unknown cause is the most prevalent diagnosis in dogs between 6 months and 7 years of age. However, within this age group encephalitis in young dogs and prevalent in many small breeds (Pug, Chihuahua, Yorkshire terrier, Maltese, Westie, Dachshund, Minature poodle, Shih Tzu, others). Therefore in young, small breed dogs encephalitis should be highly

suspected as the cause of seizure, especially when seizure are clustered, progressive over a few weeks to a few months or there are examination or behavioral changes. A recent study showed a statistically higher incidence of brain tumors in the breeds Golden Retriever, Boxers, French Bulldog, Rat Terrier and Boston Terriers. Increasing age and weight were also correlated with higher rates of brain tumor. Therefore in these breeds and dogs > 15 kg, a recent onset seizure when 5 or older should raise a high suspicion for brain tumor.

Behavior

In dogs with seizure from structural brain disease the seizure can be the only symptom, however there are often subtle behavioral changes. When these behavioral changes are noted in a seizure patient then this should raise suspicion for a structural brain problem. These include inappropriate defecation, inappropriate urination, not greeting the owners, restless at night, sleeping more in the day, irritability, not playing, and aggression.

Exam findings

Seizure is generated from lesions in the forebrain or thalamus. Lesions in this area can cause patients to circle towards the side of the lesion and have contralateral menace and postural deficits. Since strength and gait are generated from the brainstem, a focal forebrain lesion would not be expected to cause weakness or ataxia. If a patient has a unilateral menace deficit with normal pupillary light responses and normal palpebral response then a contralateral forebrain mass lesion should be suspected. Similarly if the gait is normal but there is a unilateral postural deficit (paw flip test, tactile placing, hopping) then a contralateral forebrain lesion should be suspected. Lastly, while in the exam room if a patient circles to only one side then a forebrain lesion is very likely and will be located on the side towards which they are circling. In a recent study of dogs and cats where only neck pain was noted almost 10% had only a focal brain tumor. The presence of neck pain in a seizure patient should suggest there is a structural cause of the seizure. However an abnormal exam is not always noted and about 30% of patients with a mass lesion will have a normal neurological exam.

Conclusion

Your client expects a sense of the diagnosis, treatment plan and prognosis when they present with a pet with recent onset seizure. Prior to starting AED or/and referral for MRI and neurological consultation, you can make an accurate guess as to the diagnosis by considering age, breed, weight, historical findings and then performing a 5 minute neurological examination.

Selected references

De Lahunta AD, Glass E, eds. *Veterinary Neuroanatomy and Clinical Neurology*. 3rdedit, Saunders Elseveir, St. Loius, 2009

Monteiro R, et al. Canine idiopathic epilepsy: prevalence, risk factors and outcome associated with CS and SE. *Journ Small Anim Pract* 2012; 53: 526-530

Schwartz M, et al. Assessment of the prevalence and clinical features of cryptogenic epilepsy in dogs: 45 cases (2003-2011). *JAVMA* 2013; 242 (5): 651

Song RB, et al. Postmortem evaluation of 435 cases of intracranial neoplasia in dogs and relationship with breed, age and body weight. *J Vet Intern Med* 2013; 27: 1143-1152

When and How to Treat Acute and Chronic Seizures, Optimizing New-Generation Antiepileptics

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

Optimal management of seizure disorders is important because seizures are common, potentially life threatening, and very upsetting to the other family members. There are several important questions that a veterinarian must ask during every seizure evaluation. One, is the described or perhaps videotaped event actually seizure. Two, is there an underlying genetic, structural or metabolic cause that can be diagnosed and treated more specifically than just treating the symptom of seizure. Three, when and how should I start treatment an antiepileptic drug (AED).

Treatment challenges

About 30% of epileptic dogs will be refractory or drug resistant. There are variable definitions for this but many dogs continue to have seizure despite having been on more than one AED with trough serum concentrations in the reference range. Cluster seizure (CS) is defined as more than 1 seizure within 24 hours, and status epilepticus (SE) is defined as a 5 minute or longer seizure, 2 seizures without becoming normal in between or seizing at presentation. These are common problems in dogs with idiopathic epilepsy (genetic, unknown cause) with reported rates of CS at 41-94% and SE at 53-59%. Furthermore, in the Border Collie the average life expectancy after the first seizure is 2 years with cluster seizure and status epilepticus being significant risk factors for euthanasia. Therefore the veterinarian often needs to develop a treatment plan for maintenance AED therapy, switching / transitioning AED therapy, and at home and in hospital treatments for cluster seizure (CS) and status epilepticus (CS).

Defining the event as a seizure

There are many disease processes that can mimic a true seizure (Table 1). The identification of an event as a seizure is most often achieved by comparing the observed event to what is considered a typical epileptic seizure. In our clinic, we utilize electroencephalography (EEG) to record electrical activity from the scalp during a candidate seizure event to distinguish true nature of the episode.

Intracranial and extracranial activity during seizure

The first step in seizure generation is that a group of neurons synchronizes and depolarizes / repolarizes autonomously and spreads within that hemisphere of the brain due to failure of spatial containment. This hypersynchronous electrical activity then crosses to the other hemisphere capturing the entire brain before eventually being contained, usually within 2 minutes. During the seizure there is excess glutamate release that can lead to temporary neuronal dysfunction.

In the pre-ictal state, as the focus is developing and spreading the patient may experience abnormal visual, auditory, physical, or autonomic nervous system abnormalities manifested as staring off into space, searching a room, restlessness, clingy behavior, fly biting, circling, odd vocalization, a limb becoming stiff or rhythmically moving, elevated heart rate, dilated pupils, salivation, vomiting.

In the ictus or seizure, the focus has captured both cerebral hemispheres and the patient may experience loss of consciousness, collapses, rigidly extend the neck and all 4 limbs. The hypersynchronous or rhythmic nature of the electrical focus can be noted as paddling or all 4 limbs. A failure to control and regulate the breathing can manifest as apnea and paradoxical breathing where the diaphragm and intercostal muscles are not working together. Perturbations in the autonomic nervous system can lead to bradycardia or tachycardia, profuse salivation, urination, defecation, miosis or mydriasis, and piloerection. The post-ictal period results from excitotoxicity and typically lasts 30-30 minutes where the patient emerges from being confused, blind, weak, and side-stepping. If the seizure is not recognized (non-convulsive) or difficult to treat neuronal necrosis and death can result from seizure.

Practical criteria for distinguishing seizure

In a recent paper the inclusion criteria for seizure was when 3 of the 4 of the following were noted.

1. Salivation, urination or defecation
2. Tonic or tonic-clonic posture or movements or rhythmic contractions of facial or appendicular muscles
3. Decreased responsiveness intra-ictally
4. Postictal phase in which abnormal behavior or mental state was noted

Generally episodes that do not have 3 of the 4 criteria are classified as seizure-like and may or may not be manifestation of abnormal electrical activity of the brain (seizure). There are many episodic expressions of disease or events that are seizure-like but not seizure (Table 1).

Role of electroencephalography (EEG)
EEG records electrical activity from the cerebral cortex with subdermal scalp electrodes and is used to discern, detect and treat seizure. In human medicine EEG is very commonly used to discern true epileptic seizure from movement disorder, metabolic encephalopathy, and psychogenic seizure. Several videocase examples will be provided of events that were misdiagnosed by myself and others as seizure. Conversely, patients can have electrical seizure with subtle or no outward manifestation known as non-convulsive seizure and non-convulsive status epilepticus (NCSE). There will be a few brief examples of where EEG was used in our clinic to detect and treat NCSE (see lecture notes on non-convulsive seizure).

Determining the cause for the seizure
Structural epilepsy can be discerned from genetic and seizure of unknown cause by firstly considering the patient's age, breed, weight, history, and exam findings and then advanced testing with MRI and cerebrospinal fluid analysis if indicated (see lecture notes on distinguishing structural vs idiopathic epilepsy). Defining a structural cause is important because this allows treatment of the cause in addition to the symptom of seizure and often has bearing on prognosis. Additionally certain breed of dog like the Border Collie and Australian Shepherd have severe forms of genetic epilepsy and their treatment plan should reflect the high incidence of CS, SE and euthanasia for seizure.

When to start an AED
AED should be initiated when there is a structural cause for the seizure, severe first seizure or post-ictal period or owner's preference is to reduce the chance of another seizure. When the seizures are sporadic and likely from genetic or unknown causes then I would recommend starting an AED after 1 or 2 seizures in 6 to 12 months. The rationale is four-fold. One, AED likely reduces the chance of a life-threatening seizure or SE. Secondly, there is very good experimental and some clinical evidence in people to suggest that having a seizure sets-up or facilitates connections in the brain that reduce the seizure threshold. In other words, every seizure can make it a little easier to have another seizure. We know that about 1/3 of veterinary patients with primary epilepsy are difficult to control and delayed treatment may allow a particular patient to be in this category. Thirdly, a recent study surveying owners of dogs with seizure revealed, not surprisingly, that the most acceptable seizure frequency was not once per month, but no seizure. Another study of dogs on bromide or/and phenobarbital found owners reasonably satisfied with seizures less often than every 3 months. Owners have come to the veterinarian not to be told seizures are harmless and that 1 seizure per a month is acceptable, but to have the seizure disorder treated with the goal being no more seizure. Lastly, the balance between side-effect, risk of organ failure, ease of administration and cost vs. efficacy will determine when an AED is applied. Recent, popular AEDs like Zonisamide and Levetiracetam have few side-effects, little risk, low cost in generic form and can be given twice a day. These medications have been shown to be effective as add-on medications and clinical experience in human and veterinary patients suggest they are effective for monotherapy as well.

Prophylactic AED therapy
In our clinic patients with lesions from tumor or encephalitis in the cerebrum and sometimes thalamus are often placed on one of the newer AED to try to prevent a first seizure. The perception of benefit in reducing the chance of a seizure is thought to outweigh risks, cost, side-effect and inconvenience of giving AED.

Maintenance therapy
Maintenance therapy is the application of an AED on a daily basis to reduce or eliminate seizures.

There are no placebo controlled or even crossover studies done in veterinary medicine to determine the effectiveness or side-effects of a sole AED (monotherapy) for this purpose.. There have been studies to compare efficacy and side-effect of the traditional AEDs: phenobarbital and bromide, but not with a cross-over design. Multiple studies have been conducted where a newer generation AED (Pregabalin, Levetiracetam, Zonisamide, Topirimate) have been added-on to traditional AED phenobarbital therapy resulting in at least a 50% reduction in seizure frequency. However, when Levetiracetam was studied as an add-on to phenobarbital and bromide in a placebo controlled, randomized, crossover design, a significant reduction in seizure frequency was not observed but the quality of life was thought better on Levetiracetam relative to placebo. Regardless, when and what AED to apply in the clinical setting remains uncertain or controversial. Some reasonable guidelines for seizure management are to use one medication at a time, determine serum concentrations prior to adding-on or abandoning an AED and pick medications with best efficacy to side-effect ratio. Table 2 is a summary of the AED that are used in our clinic.

Placebo effect
When there was a meta-analysis of three prospective, placebo controlled AED studies it was noted that among the 28 total dogs that 79% had fewer seizure and 29% had fewer than 50% while being treated with placebo. For the 3 trials evaluated, the average reduction in seizures during placebo administration relative to baseline was 26%. The authors concluded their findings were important

because open label studies in dogs that aim to assess efficacy of antiepileptic drugs might inadvertently overstate their results and that there is a need for more placebo-controlled trials in veterinary medicine.

When to change AED

Side effects and lack of efficacy can prompt the need to change AEDs. Studies show that only about 70% of dogs are well controlled on an AED and fewer than half of the dogs on phenobarbital and/or bromide are seizure-free without adverse medication related side-effects. Treating with multiple AED may be beneficial because of broader range of mechanisms and synergy, however side-effects can be additive and determining which AED is effective if difficult when using multiple AED. Therefore AEDs often need to be switched instead of added.

Transitioning AED

Abrupt cessation or missed doses of AED is a common cause of seizure and SE in humans. This maybe less of a concern in dogs – only 6% of SE cases in one study resulted from low AED. Regardless, tapering the dose prior to stopping is recommended and the risk of seizure can be further reduced if at least one AED is maintained in the therapeutic range during transition. Generally I recommend adding on the new AED for 1 week then in the following 5 days reduce the dose of the old AED by 50%, then in the following 5 days reduce the frequency of old AED to once a day and then stop old AED. If marked sedation, ataxia or weakness ensue in the first week then the taper of the old AED or just the stopping is recommended. If there is a marked increase in seizure frequency or severity on the new AED then a return to the former AED and/or substitution / addition of a new, different AED is recommended.

Rescue or pulse AED therapy – oral therapy

Additional or different, oral or parental AED therapy to control cluster seizure or status epilepticus is called rescue therapy. Oral rescue therapy is appropriate if time to next seizure is an hour or greater which will give time for AED to start to reach a useful serum concentration, for example Levetiracetam takes about 81 minutes to reach maximal serum concentration. A recent double-blind, placebo controlled, crossover pilot study of 6 outpatient dogs with idiopathic epilepsy and cluster seizure being treated with maintenance doses of bromide and phenobarbital was performed with Levetiracetam 30 mg/kg, PO, Q8 h (or placebo) given after first seizure and for 24 hours after last seizure. There were statistically fewer cluster seizure in the study group and the authors concluded Levetiracetam pulse therapy for cluster seizure is probably effective. Because most patients are already on Levetiracetam or Zonisamide, the author often uses Gabapentin (10-30 mg/kg, Q8 H, and/or Clorazepate (1/2 to 2 mg/kg, Q 8 h) for pulse therapy – given after the first seizure and continued for 24 hours after the last seizure. Phenobarbital is used commonly for CS and SE and is given until seizure stop and then stopped – the dose is 6-10 mg/kg after every seizure up to total dose of 40 mg/kg.

Acepromazine at 0.5 to 1 mg/kg, PO, up to every 6 hours, can be useful to reduce post-ictal confusion and prevent stress-induced seizure. Bromide is avoided for pulse therapy due to side-effects and long elimination half-life. Lastly, Recent EEG evidence suggests from dogs suggest that seizure are not random events and that forecasting seizure is possible. Therefore while therapy can be initiated after a seizure, it can potentially be administered before a seizure, as many owners think they can predict when a seizure will occur. To discern the side-effects of an AED used for pulse therapy separate from the influence of the post-ictal state or additional maintenance medication, I advise owners to try the novel AED between seizures and before it is used in the rescue scenario.

Parenteral rescue therapy

Intranasal, subcutaneous, intramuscular and rectal AED administration have been advocated when patient unable to swallow and/or when rapid cessation of seizure activity is required and intravenous route not available (at home or ambulance therapy). Subcutaneous Levetiracetam 60 mg/kg will reach therapeutic concentrations in 15 minutes or less and last for 7 hours and currently authors at home therapy of choice. The same dose, undiluted can be given as intravenous bolus to rapidly achieve useful serum concentrations without causing any sedation. Diazepam solution at 2 mg/kg per rectum is also advised, however an intranasal injection of 0.5 mg/kg reaches more rapid, more consistent and longer lasting serum concentrations. Midazolam 0.2 mg/kg intramuscular or intranasal can also be recommended. Phenobarbital is commonly used by the author for CS and SE at 8-10 mg/kg doses up to total doses of 60-70 mg/kg, provided the systolic blood pressure is greater than 90 mmHg. Rectal valium suppository formulations have unfavorable absorption and are not recommended for emergency treatment of seizure.

AED monitoring

Serum drug concentrations can be monitored for many of the AED – see Table 2. The author will assess serum concentrations when starting a new AED in a difficult to control patient, when toxicity is suspected at a relatively low dose, or before abandoning an AED because there is poor seizure control. Another important consideration is that phenobarbital will increase metabolism of both Levetiracetam and Zonisamide such that the serum concentrations maybe 50% lower than expected. Therefore serum concentrations of these AEDs are recommended whenever they are added-on to phenobarbital. Lastly, since liver, kidney, bone marrow, immune, and

urinary calculi problems are possible as a consequence of AED therapy, biochemistry, complete blood cell count, urinalysis and physical examination are recommended at minimum every 6 to 12 months based on AED therapy and patient's needs.

Table 1. Disease processes with seizure-like appearance

▪ Atlantoaxial subluxation
▪ Breed and drug induced dyskinesia / movement disorders
▪ Cataplexy, narcolepsy, rapid eye movement (REM) sleep disorders
▪ Cervical muscle spasm
▪ Chiari-like malformation / syringomyelia
▪ Encephalitis
▪ Exercise induced collapse
▪ Extreme agitation / psychogenic seizure
▪ Feline hyperesthesia syndrome
▪ Head bobbing / Tremor syndromes
▪ Intermittent decerebrate/decerebellate rigidity
▪ Jaw chomping / fly biting / lip smacking
▪ Metabolic encephalopathy
▪ Myoclonus
▪ Neuromuscular disease
▪ Syncope

Table 2. Maintenance AED therapy in dogs

Drug	**Dose**	**Side Effect Scale**	**Primary Side Effect**	**Reported Toxicity / Dysfunction**
Levetiracetam*	**25-50 mg/kg** PO, Q8 h (or Q 12 for extended release	1	Ataxia, sedation	None
Zonisamide*	**5-10 mg/kg** PO Q 12 h	2	Decreased eating, ataxia, sedation	Liver, Kidney
Gabapentin	**10-30 mg/kg** PO Q 8 h	2	Sedation	None
Pregabalin	**2-4 mg/kg** PO Q 12 H	2	Sedation	None
Phenobarbital*	**2-6 mg/kg** PO Q 12 H	4	Ataxia, polydipsia, polyphagia, weight gain, polyuria, sedation, weakness	Liver, bone marrow, skin, endocrine
Bromide *	**25-50 mg/kg** PO Q 24	5	Ataxia, diarrhea, polydipsia, polyphagia, weight gain, sedation, vomiting, weakness	Esophagus, pancreas, stomach, panniculus
Felbamate	**10-60 mg/kg** PO Q8	1	Tremors (rare)	Liver, bone marrow, lacrimal gland (KCS)
Topiramate	**5-10 Mg/kg** PO Q 8-12 H	1	Sedation	Urinary calculi
Clorazepate	**½ to 2 mg/kg** PO Q 12 H	3	Ataxia, sedation, weakness, polyphagia	None

*Indicates serum drug monitoring recommended

References

Boothe DM, et al. Comparison of phenobarbital with bromide as a first-choice antiepileptic drug for treatment of epilepsy in dogs.*J Am Vet Med Assoc.* 2012;240(9):1073-83.

Chang Y, et al. Idiopathic epilepsy in dogs: owners' perspectives on management with phenobarbitone and/or potassium bromide. *J Small Anim Pract*. 2006;47(10):574-81

Cook AK, et al. Renal tubular acidosis associated with zonisamide therapy in a dog. *J Vet Intern Med.* 2011;(6):1454-7

Dewey CW, et al. Pregabalin as an adjunct to phenobarbital, potassium bromide, or a combination of phenobarbital and potassium bromide for treatment of dogs with suspected idiopathic epilepsy. *J Am Vet Med Assoc.* 2009;235(12):1442-9.

Dewey CW. Anticonvulsant therapy in dogs and cats. *Vet Clin North Am Small Anim Pract*. 2006 ;36(5):1107-27

Gaskill CL, et al. Pancreatitis associated with potassium bromide/phenobarbital combination therapy in epileptic dogs.*Can Vet J.* 2000 Jul;41(7):555-8.

Govendir M, et al. Improving seizure control in dogs with refractory epilepsy using gabapentin as an adjunctive agent. *Aust Vet J*. 2005;83(10):602-8.

Hulsmeyer V, et al. Epilepsy in Border Collie: clinical manifesations, outcome, and mode of inheritace. J Vet Intern Med 2010; 24: 171-178
Hardy BT, et al. Double-masked, placebo-controlled study of intravenous levetiracetam for the treatment of status epilepticus and acute repetitive seizures in dogs. *J Vet Intern Med*. 2012;26(2):334-40.
Kluger EK, et al. Serum triglyceride concentration in dogs with epilepsy treated with phenobarbital or with phenobarbital and bromide. *J Am Vet Med Assoc*. 2008;233(8):1270-7.
Kube SA, et al.Dyskinesia associated with oral phenobarbital administration in a dog. *J Vet Intern Med.* 2006;20(5):1238-40.
Miller ML, et al. Apparent acute idiosyncratic hepatic necrosis associated with zonisamide administration in a dog. J Vet Intern Med. 201;25(5):1156-60.
Müller PB, et al. Effects of long-term phenobarbital treatment on the thyroid and adrenal axis and adrenal function tests in dogs.*J Vet Intern Med.* 2000;14(2):157-64.
Muñana KR,et al. Placebo effect in canine epilepsy trials. *J Vet Intern Med.* 2010 Jan-Feb;24(1):166-70.
Muñana KR,et al. Evaluation of levetiracetam as adjunctive treatment for refractory canine epilepsy: a randomized, placebo-controlled, crossover trial. *J Vet Intern Med.* 2012;26(2):341-8
Nichols ES, et al. Bromide toxicosis secondary to renal insufficiency in an epileptic dog. *J Am Vet Med Assoc.* 1996 Jan 15;208(2):231-3.
Platt SR, et al. Treatment with gabapentin of 11 dogs with refractory idiopathic epilepsy. *Vet Rec.* 2006;23-30;159(26):881-4.
Rossmeisl JH, et al. Clinical signs, risk factors, and outcomes associated with bromide toxicosis (bromism) in dogs with idiopathic epilepsy.*J Am Vet Med Assoc*. 2009;234(11):1425-31
Ruehlmann D, et al. Treatment of partial seizures and seizure-like activity with felbamate in six dogs. *J Small Anim Pract.* 2001;42(8):403-8.
Schwartz M, et al. Possible drug-induced hepatopathy in a dog receiving zonisamide monotherapy for treatment of cryptogenic epilepsy. *J Vet Med Sci*. 2011;73(11):1505-8.
Schwartz M et al. Assessment of the prevalence and clinical features of cryptogenic epilepsy in dogs: 45 cases (2003-2011) J Am Vet Med Assoc. 2013 Mar 1;242(5):651-7
Streeter AJ, et al. Pharmacokinetics and bioavailability of topiramate in the beagle dog. *Drug Metab Dispos.* 1995;23(1):90-3
Tobias KM, et al. A retrospective study on the use of acepromazine maleate in dogs with seizures. *J Am Anim Hosp Assoc.* 2006;42(4):283-9.
von Klopmann T, et al. Prospective study of zonisamide therapy for refractory idiopathic epilepsy in dogs. *J Small Anim Pract.* 2007;48(3):134-8.
Yohn SE, et al. Bromide toxicosis (bromism) in a dog treated with potassium bromide for refractory seizures. *J Am Vet Med Assoc.* 1992;201(3):468-70.

Why Dog is Man's Best Friend: Exciting Results of Neurologic Clinical Trials

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

Despite many significant bench-top findings in laboratory animals there has been little progress in improving clinical outcomes for brain tumors and Status Epilepticus (SE). Veterinary clinical researchers working in tandem with the human research community are making significant progress in fostering a mechanistic understanding of human disease - this effort is called translational medicine. Due to the contributions of dog and their owners we are likely on the brink of significantly better clinical outcomes in both humans and dogs.

Brain tumor

The two most common brain tumor types in canines and people are meningioma and glioma. Each are a serious problem for each species and very similar. Brain tumors in canine have disease courses, clinical manifestations, imaging characteristics, molecular and histopathology and genetic changes that are very similar. The translational value of canine brain tumor research is well recognized resulting in some impressive results from NIH funded clinical trials in the dog.

Glioma

Glioma is a brain tumor arising from the support cells of the brain or glia. Malignant glioma and glioblastoma multiforme in particular represent some of the most biologically aggressive and treatment refractory malignancies in humans and dogs. For humans treated with surgery, radiation and chemotherapy (temozolamide) average survival is 14 months, 2 year survival is seen in 26% and 5 year survival in just 4 %. These abysmal results have not really changed since 1959 despite intensive research. For canine intraxial tumors (all grades of glioma and other tumors) the median survival following radiation, corticosteroids +/- surgery is about 10 months. Dogs are about 3 more times as likely as a human to develop a brain tumor and in each species glioma make up about 1/3 of all brain tumors. Impediments to treating glioma in humans remain failure of the therapy to cross the blood brain barrier, infiltration of disease into the normal brain such that it is hard to know true borders of the tumor, and cellular resistance and heterogeneity.

Meningioma

Meningioma is a brain tumor arising from the arachnoid lining of the brain. They are the most common brain tumor of humans and canine and comprise about 45% of primary canine brain tumors. In people, meningioma are predominantly of a lower grade and surgery is the primary treatment. However about 6000 people per year will have recurrence often due to invasive or malignant (higher grade) disease. Reoperation is often performed but even in low grade disease there is a recurrence rate of 50% by 3 years. Radiation therapy can be effective in lower grade meningioma but has been associated with cognitive deficits, secondary malignancy, and transformation of the tumor to a higher grade neoplasm. More than 40% of canine meningioma are atypical or malignant and tumors in dogs in general 5 to 7 times faster than in people. Surgery for canine meningioma is reported to have a median survival of about 10 months for canine meningioma.

Convection enhanced delivery (CED)

CED is a low-pressure continuous infusion process that occurs over hours to days that can achieve substantial tissue concentrations of macromolecules over a large area of the brain without producing serious injury, increasing intracranial pressure or decreasing blood flow. This technique can be followed with real-time MRI and gadolinium loaded liposomes. Dr. Peter Dickinson at UC Davis' pioneering research showed CED to be effective and suggested that the canine spontaneous glioma can be a model system for the validation and development of novel therapeutic strategies for human brain tumors. Dr. Simon Platt at UGA is enrolling patients into a funded, canine glioma trial studying the CED of the epidermal growth factor inhibitor Cetuximab. Another proposed clinical trial involves the CED of an Pseudomonal exotoxin coupled to the IL-13 and agonist for the tyrosine kinase receptor Eph2A. Each receptor is overexpressed in high grade glioma in humans and canines but not normal canine brain tissue. A funded study using CED with carboplatin is being performed at UMINN.

Electroporation

Electroporation is performed using electrical pulses in order to reversibly or irreversibly permeabilize the cell membrane. Reversible electroporation safely delivers things like plasmid DNA and viruses through nanopores while irreversible electroporation (IRP) simply leads to cell death. Electroporation can generate heat leading to cell death over a relatively large area, so non-thermal methods are used in the brain. Electrochemotherapy (ECT) occurs when electroporation is combined with chemotherapy to promote delivery across the blood brain barrier. In the rodent glioma model, ECT with bleomycin doubled survival time AND in vitro investigations show that IRP alone has cytotoxic effects on canine, rodent and human glioma cell lines. Dr. John Rossmeisl at Virginia Tech has run a funded clinical trial where canine glioma patients received either stereotactic IRP and placebo or sterotactic IRP and bleomycin. One

patient from our clinic was enrolled and remains disease free two years later. Dr. Rossmeisl has also reported non-thermal irreversible electroporation (N-TIRE) by itself to have reduced the tumor volume in a boxer with a malignant glioma by 75% in 48 hours.

Brain tumor vaccine

Surgical biopsies from canine brain tumors can be shipped to the Ohlfest laboratory at UMINN for the production of a vaccine that is then administered intradermally to the patient every 2 weeks for 12 weeks. Funded trials have been performed for both glioma and meningioma. Interim results for surgery plus vaccine +/- IFN gamma for various glioma have shown mean survival for about 8 months. Meningioma vaccine results show a mean survival well over 2 years compared to controls of about 8 months. We have used the UMINN laboratory to prepare vaccine for meningioma and nasal carcinoma with favorable results.

Human status epilepticus

Convulsive human status epilepticus (HSE) affects an estimated 152,000 people causing death in 42,000 and leaving the survivors with a lower IQ, lower quality of life and socioeconomic status. Lorazepam and phenytoin have marginal success rates in treating HSE, 67% and 44% respectively, but remain the mainstay of therapy in people. These treatments have potential for respiratory depression and severe sedation (benzodiazepines) and cardiac complications (phenytoin). These drugs are intended for the treatment of chronic epilepsy and are based on clinical studies that are at least 20 years old that were based on research 30 to 80 years old or older. The mechanisms driving HSE are different than chronic epilepsy and therefore adapting drugs designed for chronic epilepsy simply because there is an intravenous formulation seems inadequate. There are many drugs demonstrated in rodents to be highly effective against a broad spectrum of different induced seizures. These drugs are not being developed for HSE because of the relatively smaller market (the drugs will only be used for a short time) and there is not enough safety and preclinical data to warrant a human clinical trial. If there was a more relevant clinical model of SE in the dog then drug companies might develop some of the very promising, ‘rodent proven’ drugs for treatment of the HSE.

Canine status epilepticus

Canine status epilepticus (CSE) has many striking similarities to that of HSE. The different seizure types noted in people (simple partial, complex partial, and tonic-clonic) are recognized in dogs. Electroencephalographic (EEG) studies in dogs, including those from our own clinic, have identified interictal and ictal patterns are similar in dogs and people. CSE is a common emergency condition treated in veterinary hospital with 53-59% of dogs with idiopathic or genetic epilepsy experiencing at least one episode of CSE and some experiencing more than 10 episodes. The mean life span of dogs with SE is shorter many veterinary studies and there is a mortality rate of 25% despite being treated with valium and phenobarbital infusions.

Advantages of canine for the study of HSE

The similarities between HSE and CSE have provoked researchers to develop the canine as a platform for study of novel drugs for HSE and translating this information into valuable information for researchers and drug companies. Unlike induced disease in rodents, epilepsy in dogs is a natural model and the same mechanism of HSE and drug resistance likely exist in the dog. Separate from generating important preclinical information for people, the other valuable aspect of the canine model is their body size. A dog is about 25% the size of a human but a rodent is 0.025%, this makes it much easier to generate an accurate formula for picking the correct human dose. Furthermore, results of safety and efficacy in the dog are more easily assessed than in a rodent. In particular rodent models fail to predict cognitive, behavioral and neurological side effects like irritability, insomnia, poor balance and cardiac effects like arrhythmia and hypotension. Being able to assess drug side-effect, safety, and efficacy in a clinical trial will make it much easier to generate appropriate approval and interest in human clinical trials.

CSE clinical trials

One of the goals of CSE trials was to develop the canine as a platform for study of HSE and to generate a network similar to the Neurological Emergency Treatment Trails (NETT) program in people. The NETT program is funded by NIH and recently reported it’s results “Rapid Anticonvulsant Medications Prior to Arrival Trail (RAMPART) Using Midazolam” ahead of schedule and under budget. Canine trials with Levetiracetam (LEV) and then Fosphenytoin (FOS) have showed that the canine is a useful platform for the study of CSE. This then allowed for the formation of the Canine Neurology Treatment Trail (CNETT) consortium whose focus is to study novel drugs for SE.

In the first trial LEV was used to treat CSE in a randomized, placebo-controlled, double masked study. Dogs were enrolled in the study after having CSE and then if there was further seizure they were given 0.5 mg/kg diazepam and a placebo or LEV (30 mg/kg or 60 mg/kg over 5 minutes). The responder rate defined as dogs with no additional seizure after the study drug was 56% in the LEV group compared to 10% in the placebo group ($p=0.057$). Furthermore dogs in the placebo group required significantly more boluses of diazepam than the LEV group.

The second study examined FOS in 31 clinical patients (22 in FOS group, 9 in placebo) were enrolled from both university and private specialty practice. There was a significant difference in the 12 hour responder rate with 63% in the FOS group versus 22% in the placebo group having no further seizures after receiving study treatment. This response rate is nearly identical to that seen in HSE with FOS and the authors conclude that this is proof that naturally occurring CSE can be utilized as a translational platform for future studies of novel SE compounds that could economically bridge the laboratory studies in rodent models with human SE trials.

Conclusion

Thus far clinical trials in people have failed to produce meaningful progress for the most serious neurological conditions. Utilizing the canine as a clinical model for studying brain tumors and SE should provide vital insight and meaningful advancements in therapy for humans, proving the adage that the dog is man's best friend.

Brain tumors references

Andersen BM, et al. Vaccination for invasive canine meningioma induces in situ production of antibodies capable of antibody-dependent cell-mediated cytotoxicity. Cancer Res. 2013 May 15;73(10):2987-97

Dickinson PJ, et al.Canine spontaneous glioma: a translational model system for convection-enhanced delivery. *Neuro Oncol.* 2010;9:928-40

Freeman AC, et al. CED of Cetuximab conjugated with Iron Oxide Nanoparticles for Canine Intracranial Gliomas: A pilot Study, *ACVIM Proceedings*, 2014

Garcia PA, et la. Non-thermal irreversible electroporation (N-TIRE) and adjuvant fractionated radiotherapeutic multimodal therapy for intracranial malignant glioma in a canine patient. *Technol Cancer Res Treat.* 2011;10(1):73-83.

Rossmeisl JR. Molecularily Targeted Cytotoxic and Elecroporation-Based Therapies for Canine Intracranial glioma. *ACVIM Proceedings*, 2011

Pluhar GE. Canine Brain Tumor Clinical Trials at the University of Minnesota. *ACVIM Proceedings*, 2011

Status epilepticus references

Hardy BT, et al Double-masked, placebo-controlled study of intravenous levetiracetam for the treatment of status epilepticus and acute repetitive seizures in dogs. *J Vet Intern Med*. 2012 Mar-Apr;26(2):334-40.

Leppik IE, et al. Canine status epilepticus: a translational platform for human therapeutic trials. *Epilepsia*. 2011 Oct;52 Suppl 8:31-4.

Patterson, E. et al. The canine translational platform: proof of concept study of fosphenytoin for status epilepticus in canine clinical patients. Abstract, American Epilepsy Meeting, Washington, D.C. 2013

Potschka H, et al. Canine epilepsy as a translational model? Epilepsia. 2013 Apr;54(4):571-9.

Ouch! Recognizing and Treating Neck or Back Pain

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

Recognition of pain is perhaps the biggest limitation to treating pain in veterinary practice. The degree and location of the pain can be determined with careful consideration of owner observations in conjunction with the physical examination. Once pain is localized a diagnostic efforts should be made to determine the cause of the pain such that it can be treated as specifically. Acute pain is generally easier to manage than chronic pain and in particular neuropathic pain. This talk will discuss the behavioral observations and physical exam techniques to assess the location and degree of pain. Differential diagnoses for spinal pain will be discussed along with tips on diagnoses and treatment. Next we will discuss inflammatory pain (physiologic, nociceptive or acute) and neuropathic pain and implications for pharmacologic and non-pharmacologic treatments.

Pain categories

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. Acute pain (physiologic, nociceptive, and inflammatory) has a sudden onset, dissipates with healing, and is localized and transient – it serves as a protective mechanism to spare an individual tissue damage. Chronic pain however is unrelenting, intense, purposeless and persists long after the recovery from the inciting injury and if often refractory to common analgesic agents. The most severe form of chronic pain is neuropathic pain which occurs when the primary lesion is within the nervous system. Neuropathic pain results from plasticity in the nervous system and is associated with lower quality of life scores and is described in people as burning, lancinating, shooting, tingling, crawling or electrical sensations. Breakthrough pain is an abrupt, short-lived, and intense pain that "breaks through" the around-the-clock analgesics used to controls persistent pain. It is common in people and subdivided into incident, idiopathic and incident related.

Pain assessment

Lord Kelvin in 1883 stated the ability to effectively treat pain is dependent on how well pain can be detected and measured. Dogs and cats hide their pain as a protective mechanism such that a dog may still experience pain and wag its tail. Despite this challenge, pain can be localized, characterized and diagnosed with a physical exam and behavioral history. Many of the current pain assessment tools (PATs) in veterinary medicine are adapted from humans and involve questionnaires that determine client-specific outcome measures (CSOM). These have been shown to be a sensitive method for use in the pain management of dogs. Looking at these questionnaires offers insight into what things dogs or cats might do when they are in pain. Please see Table 1.

Physical exam techniques to detect and localize pain

Pain from the cervical vertebral column or neck pain is often suspected when patient spontaneously yelps out and there is no gait or posture deficits, intermittent thoracic limb lameness (root signature), or a stiff neck with decreased range of motion. Palpating muscle spasm laterally at level of transverse process, pain with manipulation or ventral process of C6, or resistance to range of motion can also indicate neck pain. Dog with Caudal Occipital Malformation Syndrome (see below) will often vocalize with firm palpation of dorsal or lateral muscle at level of dorsal process of C2. Pain from thoracic, ribs and lumbar spinal column or mid-back is often suspected with kyphosis, stiffness or when patient is slow to sit or rise. Detection of mid-back pain involves applying pressure to dorsal processes while putting pressure / palpating the ventrum and/or palpating muscle / rib heads at level of transverse process. Lumbosacral or low back pain is suspected with abnormal tail carriage, fecal or urinary incontinence, and when patient is slow to sit and rise. Low back pain can be detected with rectal palpation of the lumbosacral junction (or spondylosis at L7-S1), tail extension and lateral movement, or by applying pressure to muscle between dorsal process of L7 and S1 or muscle just cranial and lateral to ilium. Hip extension will not differentiate back from hip pain. However, hip pain can be discerned by slowly elevating the femoral head about 3-5 mm from acetabulum by lifting up on the medial surface of the femur while the patient is in laterally recumbent. In a patient with mid-back pain testing the cutaneous trunci cut-off can be very useful in determining the level of the lesion (see notes from UMN vs LMN talk).

Neck pain localization and differential diagnoses

Neck pain can come from another location about 25% of the time. When a patient's pain localizes to the neck it is important to consider the cause of the pain could be only within the head or even the thorax. A recent retrospective of 169 dogs and 9 cats presenting with neck pain showed pathology in only the neck 73% of the time, only the head 9% of the time, head and neck in 17%, and thorax in 1%. We have also diagnosed neck pain with involvement of only the high thoracic spine as well. In this same neck pain retrospective about 50% of the cases suffered from intervertebral disk disease, 20% from neoplasia, 15% from inflammatory disease, 9% from trauma, 3% vascular and 3% malformations. Important points are that if you assume spinal pain is from disk disease then you will be incorrect 50% of the time and that about 10% of the cases of neck pain in this study had a brain tumor.

Differential diagnoses for spinal pain in small dogs

The following diseases are diagnosed in *mostly but not exclusively* small breed dogs. The intervertebral disk (IVD) is located between the vertebral endplates and serves to cushion the vertebrae. In health it consists of a well hydrated nucleus pulposus which is surrounded by concentric rings of collagen called the annulus fibrosis (AF). Type I IVD occurs when the AF completely tears and the dehydrated and often calcified NP extrudes into the spinal canal or intervertebral foramen causing compression and inflammation of the meninges, spinal cord and nerve root. Type II IVD occurs when there is a bulging with microtears of the AF without NP extrusion. Together they are no doubt the most common causes of spinal pain in companion animals. When intractable pain is the only sign of disk disease success rates with surgery are about 98%. Management with pain medication, restricted activity and rehab therapy can also be highly successful. However, as mentioned above, disk disease only accounts for about 50% of the cases of spinal pain. Meningoencephalomyelitis of Unknown Etiology (MUE) is a non-infectious inflammatory condition of the brain, spinal cord and meninges – this disease is common and can present with just spinal cord signs about 10% of the time. MUE is most common in small breed dogs under 8 years of age and responsive to glucocorticoid therapy. The diagnosis is easily confused with IVD without advanced diagnostic testing. MUE can progress to life-threatening intracranial disease especially when not treated with immune suppressive therapy – therefore the veterinarian should be vigilant for progression of signs to include head tilt, depression, and seizure. Glucocorticoids should be avoided for treating spinal pain because it can mask MUE and when compared to NSAIDs is associated with more side-effects, lower quality of life scores and higher recurrence rates of IVD. Caudal Occipital Malformation Syndrome (COMS) or Chiari-Like Malformation occurs when a malformed or hypoplastic occipital bone allows the cerebellum to protrude into the brainstem and high cervical spinal cord often causing fluid build-up within the spinal cord (syringomyelia). The disease is often progressive and best treated with pain modulators +/- surgery. A specific characteristic of this disease is scratching at the side of the head without making contact (phantom scratching). Atlanto-Axial subluxation secondary to an absent or hypoplastic dens and/or associated ligaments can also be seen in young small breed dogs, present as intermittent neck pain and progress to paresis, paralysis, head tilt and death. In our clinic it is not uncommon to find more than of these abnormalities in patients with neck or back pain.

Differential diagnosis for spinal pain in large breed dogs

The following diseases are diagnosed in *mostly but not exclusively* large to medium breed dogs. Diskospondylitis is an infection of the intervertebral disk, vertebral endplates and adjacent soft tissues which can enter the spinal canal causing empyema and meningitis. The pain can be from inflammation as well as disk extrusion and pathologic fracture. Male dogs, older dogs and being a Boxer, Great Dane, and Labrador are risk factors for this disease. An intermittent fever, neutrophilia, elevated globulin and radiographic changes are inconsistently present with this disease. MRI and potentially a C reactive protein are most valuable diagnostic aids. Some dogs require anti-microbial therapy for up to a year. The prognosis is fair but improved with early diagnosis. Steroid Responsive Meningitis – Arteritis is an immune disease seen in mostly large dogs (Bernese Mountain Dog, Boxer, Pointer but also the beagle) at about 10 months of age. The signs and biochemical profile closely overlap with diskospondylitis and can include not eating, lethargy, intermittent pain, neck stiffness, and a short-strided gait. Acute Non-Compressive Nucleus Pulposus Extrusion (ANNPE) occurs when during exercise or activity a small amount of NP extrudes at a high velocity through a tear in the AF. Fibrocartilaginous Embolism (FCE) occurs when NP ruptures into the vascular supply and arterial blood flow to the spinal cord. These two disease present very similar clinically in that patients suddenly yelp out and suffer a sudden onset, non-progressive and often asymmetric weakness along with dysuria. Nerve sheath tumors can present as pain alone with muscle atrophy and lameness being noted later in the course of the disease. Vertebral fracture can occur in any size dog and are often suspect based on the history.

Neuropathic pain

Neuropathic pain (NP) develops when there is a lesion within the somatosensory system. NP develops when there is physical disruption of the pain pathway which starts with the receptors in the peripheral nerve and ends with the somatosensory cortex. NP results from persistent and exuberant firing of the peripheral pain fibers which then leads to recruitment of silent nociceptors in the periphery (peripheral sensitization), enhanced reactivity or disruption of neurons in the CNS (central sensitization) or imbalance of the endogenous facilitator systems and descending inhibitory systems. Over activity of the spinal cord NMDA receptor is thought to be the key process in generating NP.

In humans, NP results from inadequate recognition and treatment of pain. Furthermore, in humans with NP, the lesion within the nervous system is not always observed (despite having NP) and clinical signs can take more than a year to develop. The abnormal sensations are described as dysaesthesia (spontaneous or evoked unpleasant abnormal sensation like burning or pins and needles), allodynia (pain from stimulus that is normally not painful – light touch might be experienced as an electrical shock), or hyperaesthesia (increased pain response from a normally painful).

Companion animal examples of neuropathic pain

One model of NP is thought to occur in the Cavalier King Charles Spaniel where syringomyelia physically disrupts the dorsal horn of the spinal cord leading to increased levels of Substance P and abnormal sensory processing or NP. Affected dogs might be

hypersensitive to touch, scratch an area on the shoulder, ear or neck without making physical contact (phantom scratching), rub their face or head and spontaneously yelp out. Like in people, recently NP in this breed has been shown to correlate with an anxiety behaviors, increased fear and reduced owner-perceived quality of life.

Feline hyperaesthesia syndrome is likely another good example of NP. These cats often suffer severe pain despite no cause being determined for their clinical signs. Affected cats stare at their flank and attack or excessively groom these areas. They can have episodes of mydriasis, hallucinate and run around the house frantically, vocalize and act irritable. Cats often respond to treatments recommended in people for NP like gabapentin, amitriptyline and anti-epileptics drugs.

Therapy for pain in companion animals with neurological lesions

A subset of human or veterinary patients with acute pain from a neurological lesion will go on to develop chronic, severe pain called NP. NP pain occur from excessive neuronal firing and is thought to occur from inadequate pain treatment. Therefore when there is pain from a lesion within the nervous system it is important to diagnose and eliminate the painful stimuli (treat the cause) and promptly start aggressive, multimodal pain medications.

Anti-inflammatory therapy

NSAIDs are the typical first choice pain medication based on perception of efficacy and side-effect profile. For dogs, meloxicam available as a 7.5 mg generic tablet and is dosed at 0.1 mg/kg, once a day. Carprofen at 2 mg/kg, Q12 or 4 mg/kg, Q24 is also used about as commonly as Meloxicam at 0.1 mg/kg, Q24. There are many other NSAID choices and if one NSAID is not effective changing NSAID is often recommended. NSAIDS work by blocking inflammatory prostaglandins by inhibiting cyclooxygenase isoform 2 (COX-2). Importantly, NSAIDS also combat central sensitization by blocking the hyperalgesia induced by activation of spinal glutamate and substance P receptors. Lastly, COX2 inhibition has been shown to benefit recovery in the brain and spinal cord of laboratory animals. A urine specific gravity, chemistry and CBC are advised prior to anti-inflammatory therapy as the rare dog will develop renal tubule disease, hepatotoxicity and dysfunction, and gastrointestinal bleeding.

Prednisone is not typically used for pain control unless inflammation or brain swelling is suspected as a primary cause of the pain, 0.5 mg/kg of prednisone or 0.1-0.2 mg/kg of dexamethasone, twice a day will be the highest dose used to try to achieve pain control.

Ketamine & amantidine

Ketamine binds the NMDA receptor which prevents central sensitization or wind-up. In humans and veterinary medicine ketamine has been demonstrated to improve analgesia and outcome and reduce requirement for opiates. Ketamine does NOT increase intracranial pressure and has no effect on cerebral blood vessels size when CO2 is controlled. In our neurology clinic all surgical patients are managed peri-operatively with ketamine to improve analgesia and prevent wind-up. A loading dose of 0.5 mg/kg and then a CRI achieved by placing 60 mg of ketamine in a 1 liter bag in a 10 kg dog – this will achieve a dose of about 10 ug/kg/min when the fluids are run at 10 ml/kg/hr. Some authors suggest doses should be 2-3 times higher than this dose and would likely be very safe. Amantadine is also a NMDA receptor antagonist and has been shown to be of benefit in a randomized, blind, placebo controlled study as an adjunct to Meloxicam in osteoarthritis. The dose is 3-5 mg/kg once a day and the medication comes in a 10 mg/ml oral syrup or 100 mg tablet.

Lidocaine

Systemically administered lidocaine is a sodium channel blocker effective for treating neuropathic pain at doses that do not produce anesthesia or slow cardiac conduction. Lidocaine blocks ectopic afferent neural activity at the NMDA receptor within the dorsal horn and several veterinary studies have shown benefit to lidocaine infusions during anesthesia. A loading dose of 2 mg/kg and then a CRI of 4 mg/kg/hr can be achieved in a 10 kg patient by placing 400 mg in a 1 liter bag 10 ml/kg/hr (surgical fluid rate).

Amitriptyline

Tricyclic antidepressants are a recommended first line treatment of neuropathic pain in people. The descending inhibitory system is activated by incoming nociceptive firing and serves to reduce the perception of pain. This system is deficient in neuropathic pain. By blocking the reuptake of serotonin and catecholamine they enhance the activity of the descending inhibitory system. Furthermore, amitriptyline is an NMDA receptor antagonist. The recommended dose of amitriptyline is 1-2 mg/kg, once to twice a day in the dog and 2.5 to 12.5 mg per cat, once a day. The medication is bitter.

Tramadol

Although structurally similar to codeine, tramadol is a weak mu opiate agonist and works by inhibiting the reuptake of serotonin and norepinephrine. Therefore it works similar to amitriptyline in that it increases the descending inhibition of pain. Bioavailability in the dog is variable and one study showed that 5 mg/kg, every 6 hours was needed to provide similar serum concentrations to those in people associated with analgesia. However, we use a dose of tramadol of 2-5 mg/kg, 2 to 3 times a day. There is a theoretical concern for serotonin sickness (vomiting, diarrhea, seizures, hyperthermia, hyperesthesia, depression) when tramadol is combined with other therapies that increase serotonin, however we have yet to recognize this condition in our clinic. We have noted mild to moderate sedation with this medication.

Gabapentin

Although an antiepileptic drug, Gabapentin works via several mechanisms to provide pain control and is cornerstone of therapy in our neurology clinic. Gabapentin blocks calcium channels which is important because central sensitization or wind-up is facilitated by the influx of calcium. Gabapentin activates descending noradrenergic systems facilitating the release of NE in the dorsal horn which then binds the alpha-2 receptor and provides analgesia. Gabapentin causes a mild sedation and rarely severe sedation which resolves when drug is stopped. We use 10 mg/kg, 3 times a day in a dag and if sedation is absent and pain present then the dose can be increased at 10 mg/kg intervals up to 50 mg/kg per dose. In cats we usually start with 5 mg/kg, twice a day. Gabapentin should be tapered because of the concern for rebound hyperalgesia. When possible, Gabapentin is used prior to spinal surgery and continued beyond when other treatments have been eliminated.

Opiates

Opiates bind receptors both centrally and peripherally to provide analgesia and control anxiety. Peripherally they prevent nociceptive sensitization and prevent neurotransmitter release. Centrally they act in the dorsal horn to modulate input from C- fibers (which mediate secondary pain or the throbbing you feel with ongoing tissue damage) and in the cerebral cortex they blunt the perception of pain. In our clinic we use the mu agonists – fentanyl 2-5 ug/kg/hr as CRI and hydromorphone 0.1 mg/kg, IV or IM. Butorphanol and burenoprhine are partial opioid receptor agonist and used only when there are intolerable side-effects from fentanyl or hydromorphone. We will also use the opiate receptor antagonist, naloxone, to reverse the effects of a mu agonist. For chronic or oral therapy we prescribe codeine, which get metabolized to morphine or much less commonly the fentanyl patch.

Opiates are useful for controlling pain but have several downsides to consider. One, side effects include dysphoria, panting, nausea, not eating, sedation, weakness, and dysuria. This can confound examination and if the clinician assumes changes in exam are from opiate and not from progression of spinal cord or brain disease, then important interventions like surgery and drugs for brain swelling might not be applied. Alternatively a patient might be delivered an inappropriately poor prognosis if the signs of disease are not from the neurological lesion but from the opiate side effects. Secondly, opiates may not be effective for all forms of neuropathic pain because they do not modulate incoming signals from the tactile / proprioceptive fibers that mediate tactile allodynia and opioid receptors in the descending pathway are down-regulated in neuropathic pain. Lastly, although uncommon opiates can generate a hyperalgesic or paradoxical response, physical dependence can develop with chronic use, and individual receptor type difference might mean more than one opiate may need to be used to achieve desired response.

In our clinic we are frequently left to wonder if a patient on opiates is still painful or dysphoric. If we consider it likely that the patient is still painful then we treat dysphoria by adding a CRI of acepromazine 0.01-.01 mg/kg/hr, or dexmedetomidine 1-3 ug/kg/hr . If we suspect dysphoria then we partially or completely reverse opiate with butorphanol 0.3 mg/kg, IV or low dose naloxone 0.01 mg/kg. Another strategy would be to switch opiates – in the patient recovering from surgery we often substitute Tylenol #4 (acetaminophen 325 mg / codeine 60 mg) at a dose of 15 mg/kg acetaminophen and 1-2 mg/kg codeine, 2 to 3 times a day.

Dexmedetomidine

Alpha-2 agonists work in the brainstem to activate the descending inhibitory system by binding a brainstem nucleus called the locus ceruleus. In the spinal cord alpha-2 agonists inhibit incoming peripheral pain signals. Spinally administered alpha-2 agents reverse allodynic and dysesthetic pain in peripheral nerve injury in both rats and people. Dexmedetomidine is use commonly in the control of perioperative pain at doses of 1-3 ug/kg/hr. Pain control is synergistic when used with opiates. Dexmedetomidine is excellent in perioperative setting where a patient on opiate may be either dysphoric from opiate or painful – it has an anxiolytic effect and also reduces or eliminates the dose of opiate needed to control pain.

Anxiolytics

Pain is a conscious or cerebrally recognized phenomenon. The cerebral anticipation of pain causing anxiety or anxiety itself appears to amplify the recognition or experience of pain. Sedation and/or anxiety medication can have a synergistic or useful role in controlling pain. Acepromazine at 1 mg/kg, PO, up to every 6 hours or at bedtime is advised in addition to multimodal pain protocols, especially in beagles with severe neck pain secondary to disk disease. Acepromazine can also be used as a CRI at 0.01 to 0.1 mg/kg/hr for anxiety and dysphoria in the hospital. Trazodone is very popular in our clinic for sedation and anxiety associated with cage confinement or hospitalization and is used at 2.5-5 mg/kg, 2-3 times a day. We have combined trazodone with tramadol without any evidence of serotonin sickness. At these doses seizures have not been noted with either medication. Alprazolam 0.1 mg/kg, PO up to 2 mg, twice a day can also be used for anxiety, however it seems to be less effective than trazodone or acepromazine.

Muscle relaxants

Muscle spasm can be painful and is often associated with processes of the spinal column which are painful, treatment with methocarbamol at 30 mg/kg, 3 times a day and or valium 0.3 -0.5 mg/kg, 3 times a day can be useful for attenuating muscle spasm.

Tylenol and codeine

Acetaminophen is safe and effective when combined with an NSAID or corticosteroid at doses of about 10 mg/kg, twice a day. When needed, as an add-on medication, acetaminophen 300 -325 mg plus codeine 30 mg or codeine 60 mg are administered as Tylenol #3 and Tylenol #4, respectively. The dose of codeine typically starts at 1 mg/kg and can be increased to 2-3 mg/kg. In dogs that are restless at night and potentially painful, the Tylenol #3 or #4 and acepromazine 1 mg/kg combination is effective.

Acupuncture

Acupuncture is the stimulating of specific anatomic points in the body to provide a therapeutic or analgesic effect. Placement of needles releases endorphins, serotonin, and NE which can affect the processing of sensory input and amplify the descending inhibitory system. Acupuncture is highly recommended for both acute pain and the treatment of neuropathic pain.

Rehab therapy / nursing care

Passive range of motion, hydrotherapy and then controlled exercise plus bladder management are important for optimizing the comfort of neurological patients. These therapies reduce pain from contracture, anxiety, and the discomfort of bladder distension and infection.

Recommendations

Whenever a patient presents with pain from a neurological lesion then I advise an anti-inflammatory, gabapentin, and tramadol. If this is insufficient then change the NSAID, add on an opiate and/or acetaminophen. If the patient is suspected of having neuropathic pain or another chronic painful condition then owner is counseled that break through pain is likely and can be treated with hospitalization and a CRI of an opiate plus dexmedetomidine in addition to oral maintenance medications. Prior to surgery these same medications (gabapentin, NSAID, tramadol) are recommended plus ketamine and lidocaine are added to all fluid bags. A fentanyl CRI at 5-10 ug/kg/hr is used for anesthesia and then tapered over the next 2-24 hours post-surgery. Dexmedetomidine is commonly used to reduce the need and side-effects noted with opiates.

Conclusion

Veterinarian's primary responsibility is to recognize and treat pain. Therefore, in every patient and similar to humans, pain should be considered the fifth sign. It should be remembered that nervous system lesions cause severe pain and can transform into a chronic pain syndrome called neuropathic pain. Neuropathic pain is an especially debilitating condition in people and thought to result from inadequate treatment of the initial pain focus. Recognizing, diagnosing, and specifically treating a painful condition plus the use of multi-modal pain protocols are essential to a achieving a good outcome.

Table 1. Behaviors associated with pain in companion animals

Unwilling to jump, slow to more, rise or sit, exercise intolerant, lame, stiff, arched back
Lethargic, dull, irritable, anxious, fearful, aggressive, aloof, confused, not greeting owner
Not eating well
Requires being hand fed to eat well (neck pain)
Yelping out with movement or spontaneously, crying, groan, scream, quiet
Squinting
Panting
Shaking or trembling,
Chewing, licking, looking, rubbing at specific location or surgical incision
Crying, flinch, snap, growl, guard or bite in response to touch / being pet

References

Grubb T. Chronic neuropathic pain in veterinary patients. *Topics in Companion Animal Medicine* 2010: 45-51

Mathews K. Neuropathic pain in dogs and cats: if only they could tell us if they hurt. *Vet Clin Small Anim* 2008; 38:1365-1414

Rutherford L, et al. Questionnaire-based behavior analysis of the CKCS with neuropathic pain due to Chiari-like malformation and syringomyelia. *The Veterinary Journal* 2012; 194: 294-298

Sharkey M. The challenge of assessing osteoarthritic and postoperative pain in dogs. *AAPS* Journal 2013; 15 (2): 503

Diagnosing and Treating the Five Disk Diseases: Why is MRI so Important?

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

The spinal cord connects the brain to the neuromuscular system which is responsible for locomotion and respiration. The spinal cord is protected by a long bony box that is segmented to allow for improved axial movements. The segments of the bony box (vertebrae) are cushioned by the intervertebral disk. The intervertebral disk (IVD) contains a jello-like substance called nucleus pulposus (embryonic notochord) that is wrapped by concentric layers of ligamentous material (annulus fibrosus). The IVD is located below and adjacent to the spinal cord and pathology of the IVD puts the spinal cord at risk for infection, infarction, and compression all of which can lead weakness, paralysis, ataxia, pain, and incontinence.

Role of magnetic resonance imaging (MRI)

MRI characteristics are based on the proton or water content of different tissue allowing for detection of even mild pathology in the soft tissue and to a lesser extent bone. Because MRI directly images the spinal cord it is superior to X-ray based technology like radiography, myelography and CT scanning. MRI consistently demonstrates superior accuracy in the diagnosis of spinal cord disease. Additionally, MRI is better at predicting outcome than assessment of neurological function at presentation. MRI is currently essential to the practice of high quality veterinary neurology.

Hansen type I disk disease

Hansen Type I disease occurs when the degenerated annulus fibrosus loses tensile strength and tears allowing the degenerated, dehydrated nucleus pulposus to extrude or herniate and co-occupy the spinal canal with the spinal cord. The stretching of the meninges, nerve root and annulus fibrosus tear generating pain and the spinal cord compression can cause weakness, paralysis and incontinence. Prognosis and the choice of medical vs. surgical management is made by combining information about the neurological grade and MRI findings. This disease is prevalent in 3-6 year-old dachshunds and many other small breed dogs and 6-9 year-old large breed dogs like the German Shepherd, Rottweiler, Dalmatians and mixed-breeds. Type I disk disease has a very good to excellent prognosis but surgery is often required when there is persistent pain and/or weakness with significant spinal cord compression. Remarkably, in paraplegic dogs with Type I disease that have hemilaminectomy, MRI is a greater predictor of outcome than nociceptive or deep pain status.

Hansen type II disease

Hansen Type II disease is present when there are micro-tears and bulging of the annulus fibrosus and compression of the spinal cord, meninges and nerve roots. The disease is most common in larger breed dogs in the low cervical spine and lumbosacral junction. In the low cervical spine, Type II disk extrusion is an important factor in cervical spondylomyelopathy and is also known by disk associated wobbler's syndrome (DAWS). In DAWS the outcome with surgery is better than with medical management although there is no significant difference in life expectancy with these 2 treatments. Lumbosacral disk disease can mimic hip or stifle disease but unlike these other conditions, it can lead to urinary or fecal incontinence. Success rates with surgery are generally with LS surgery unless incontinence is already present. Therefore the distinction between lumbosacral Type II disk extrusion and orthopedic disease is an important. Nerve pain (and not orthopedic disease) can be distinguished from orthopedic disease via palpation of lateral muscles just cranial and lateral to the wings of the ilium, between the L7 and S1 dorsal spinous process, ventral surface of L7 and S1 via rectal, or with elevation of the tail. Pain with hip extension can indicate nerve compression or joint pain. However, hip pain can be discerned by slowly elevating the femoral head about 3-5 mm from acetabulum by lifting up on the medial surface of the femur while the patient is laterally recumbent

Acute non-compressive nucleus pulposus extrusion (ANNPE)

ANNPE is sometimes referred to as Type III disk disease or low volume high velocity disk extrusion. In this disease a small amount of nucleus pulposus (NP) ruptures at a high velocity through a small tear in the dorsal annulus fibrosus leading to edema, malacia, and/or hemorrhage of the spinal cord and epidural fat but minimal to no compression of the spinal cord. ANNPE has a peracute onset and associated with activity or a traumatic event and seen more commonly in medium to large breed, male dogs, especially Labrador retrievers and mixed breeds. About 2/3 of the patients in one study returned to walking and when the T2 weighted cross sectional MRI showed less than 90% of the spinal cord to be affected, 93% of the dogs regained function. Similar to Type I disk disease, the prognosis is more strongly correlated to MRI findings than admission neurological grade or nociceptive status. Many patients have difficulty urinating over the short-term and are treated with phenoxybenzamine or prazosin and diazepam to reduce smooth and skeletal muscle tone, respectively. Urinary catheterization can be a useful way of managing these patients in the first 2-3 days while

the disease improves and the phenoxybenzamine has time to take maximal effect. Monitoring the urinalysis and bacterial culture and sensitivity are advised because the resulting urethral inflammation can frustrate useful urination. Exercise restriction, rehab therapy and pain medication as indicated are hallmarks of therapy. Pain medication in the short term and rehab therapy may improve outcome.

Fibrocartilaginous emboli (FCE)

FCE or ischemic myelopathy occur when the NP obstructs blood flow within a spinal cord arteriole leading to necrosis of the spinal cord from loss of blood flow (infarct). The onset and progression of clinical signs are very similar to ANNPE although dogs with FCE are rarely painful. The middle aged Miniature Schnauzer, Shetland sheepdog and Labrador are at higher risk for FCE. The overall recovery rate is about 84% but 100% of dogs will improve if the T2 weighted MRI cross sectional lesion is less than 67% and the length of the lesion is less than 2 vertebral bodies. Despite the fact that the MRI can be normal about 20% of the time, MRI is the most accurate test and the strongest predictor of outcome in dogs with FCE. The same concerns exist for micturition with ANNPE and FCE. Rehab therapy instituted early in disease process may improve recovery rate.

Diskospondylitis

Diskospondylitis is an uncommon infectious and therefore inflammatory condition of the intervertebral disk and surrounding bony endplate, soft tissue, and meninges. Increasing age, male, large breed dogs are at higher risk and the Great Dane, Boxer and Labrador are thought to be predisposed to this disease. Pain, lethargy, not eating well and low grade fever are often noted. This can progress to weakness, paralysis and incontinence if there is spinal cord compression from empyema, disk extrusion, fracture or subluxation. Diagnostic evaluation can be frustrating as neutrophilia, monocytosis and hyperglobulinemia are inconsistently elevated – a C reactive protein maybe a sensitive indicator of inflammation from diskospondylitis. Radiographic are often initially normal in this disease, MRI far more sensitive and can help determine degree of spinal cord compression and requirement for surgery. The typical bacteria implicated are *Staphylococcus*, *Streptococcus*, *E.Coli* and less commonly the zoonotic agent *Brucella canis* or fungal agents. Antimicrobial therapy is ideally based on a culture from the urine, blood, and/or affected interspace or spinal canal. However, even this combination of testing does not always produce a specific pathogen and sensitivity profile. Empiric therapy often recommended with cephalosporin, fluroquinolone or/and clindamycin. Pain management is often with NSAIDs, however, despite the concern for immune suppression, the author prefers a tapering course of anti-inflammatory doses of glucocorticoids plus pain modulators. Surgery to decompress the affected spinal cord and nerve roots is often very useful in improving outcome, perhaps by enhancing the delivery of antibiotic to the nervous tissue and surrounding structures. The overall prognosis for this disease is thought to be fair to good with mortality rates of about 30%. Early detection, absence of systemic disease, a better neurological grade, non-fungal and non-*Brucella* cases, and a good response to initial therapy are positive indicators for surviving this disease.

Conclusion

Pain, weakness and ataxia are common presenting complaints in veterinary medicine. IVD pathology is commonly implicated as the cause of the clinical signs. A presumptive diagnosis can often be established by considering breed, age of onset, progression but MRI is best test for establishing definitive diagnosis, prognosis and the requirement for surgery.

Table 1. Clinical features of 5 disk diseases

	Type I	Type II	ANNPE	FCE	Diskospondylitis
Definition	Annulus tear, nucleus pulposus in spinal canal	Annulus bulge, microtears	Small annulus tear, low volume, high velocity	Spinal cord stroke	Infection vertebral endplate, disk, soft tissue
Signalment	3-6, Chondrodystrophic 6-8, Large Breeds	>6 yrs Large Breeds	6 yrs, medium to large, Lab, Border collie	6 yrs, Sheltie, Schnauzer, Lab	Male, Great Dane, Boxer, Labrador, risk up with age
Onset Progress	Sudden, progressive with periods of rapid progression	Slowly progressive	Peracute, can progress in first 24 hours	Peracute, can progress in first 24 hours	Progressive, wax and wane
Painful	Yes, episodically very painful, muscle spasm	Mild pain, limits mobility	Moderate pain, improves in 24 hours	No	Painful to episodically very painful

Preferred Location	Neck, TL junction	low neck, low back	Over disk space	Intumescence	C6-7, Mid-thoracic, LS
Signs	Paresis to paralysis	Weak, incontinent, tail down (LS)	Paresis to paralysis, often one side worse	Paresis to paralysis, often one side worse	Painful, sick, weak
Diagnosis	MRI especially in deep pain negative	MRI	MRI required	MRI required	MRI most sensitive, CRP
Treating	Surgery often required, exercise restrictions, NSAIDs	Exercise restrictions, surgery, NSAIDs	No surgery, NSAIDs, exercise restrictions	No surgery, NSAIDs, exercise restrictions	Long term antibiotics, surgery, pain meds, NSAID >Steroid
Prognosis	Dependent on neurological grade and MRI findings but generally good to excellent				

References

Type I Disk Disease

Aikawa T, et al. Long-term neurologic outcome of hemilaminectomy and disk fenestration for treatment of dogs with thoracolumbar intervertebral disk herniation: 831 cases (2000-2007). *J Am Vet Med Assoc*. 2012;241(12):1617-26.

Bos AS. Clinical usefulness of MRI and myelography in the diagnosis of intervertebral disc extrusion in dogs. University of Guelph. 2008: 113-49.

Bray JP, Burbidge HM. The canine intervertebral disk: part one: structure and function. *J Am Anim Hosp Assoc* 1998; 34: 55-63.

Brisson, B. Intervertebral disc disease in dogs. *Vet Clin Small Anim*. 2010; 40:829-858.

Ito D, et al. Prognostic value of magnetic resonance imaging in dogs with paraplegia caused by thoracolumbar intervertebral disc extrusion: 77 cases (2000-2003). *J Am Vet Med Assoc.* 2005; 227: 1454-60.

Levine JM, et al. Evaluation of the success of medical management for presumptive thoracolumbar intervertebral disk herniation in dogs. *Vet Surg*.2007; 36: 482-91.

Naude SH, et. al. Association of preoperative magnetic resonance imaging findings with surgical features in dachshunds with thoracolumbar intervertebral disc extrusion. *J Am Vet Med Assoc*. 2008; 232: 702-8.

Okada M, et. al. Magentic resonance imaging features and clinical signs associated with presumptive and confirmed progressive myelomalacia in dogs: 12 cases (1997-2008). *J Am Vet Med Assoc*. 2010; 237: 1160-1165.

Type II IVD

De Lahunta AD, Glass E. Small animal spinal cord disease. In: De Lahunta AD, Glass E, eds. *Veterinary Neuroanatomy and Clinical Neurology*. St. Louis: Saunders Elsevier, 2009; 243-284.

Levine GJ, Levine JM, Walker MA, et al. Evaluation of the association between spondylosis deformans and clinical signs of intervertebral disk disease in dogs: 172 cases (1999-2000): *J Am Vet Med Assoc* 2006;228(1):96-100.

De Risio L, Sharp NJ, Olby NJ, et al. Predictors of outcome after dorsal decompressive laminectomy for degenerative lumbosacral stenosis in dogs: 69 cases (1987-1997): *J Am Vet Med Assoc* 2001;219(5):624-628.

Danielsson F, Sjostrom L. Surgical treatment of degenerative lumbosacral stenosis in dogs. *Vet Surg 1999;28(2):91-98.*

ANNPE / FCE

De Risio L, et al. Fibrocartilaginous Embolic Myelopathy in Small Animals. *Vet Clin Small Anim* 40 (2010) 859-869

De Risio L, et al. Association of clinical and magnetic resonance imaging findings with outcome in dogs suspected to have ischemic myelopathy: 50 cases (2000-2006) *J Am Vet Med Assoc.*2008 233 (1) 2008

Cauzinille L, et al. FCE in 75 dogs: clinical findings and factors influencing outcome. *Journ Small Anim Pract* 2003; (44): 76

De Risio L, et al. Association of clinical and magnetic resonance imaging findings with outcome in dogs with presumptive ANNPE: 42 cases (2000-2007). *J Am Vet Med Assoc*. 2008; (4): 234

Diskospondylitis

Bathen-Noethen, et al. Concentrations of acute-phase proteins in dogs with steroid responsive meningitis-arteritis. *J Vet Intern Med*. 2008;22(5):1149-56.

Burkert BA, et al. Signalment and clinical features of diskospondylitis in dogs: 513 cases (1980-2001). J *J Am Vet Med Assoc* 2005;227 (2): 268-75

Gorgi A, et al. Diskospondylitis in Dogs. Standards of Care: *Emergency and Critical Care Medicine* 2007 (95):11-15

Harris JM, et al. Clinical features and magnetic resonance imaging characteristics of diskospondylitis in dogs: 23 cases (1997-2010). *J Am Vet Med Assoc* 2013;242 (3): 359-65

Tipold A, et al. Inflammatory disease of the spine in small animals. *Vet Clin Small Anim* 2010; 40 871-879

Feeding the Food-Allergic Patient Successfully

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

Few nutritional diseases can respond so profoundly to appropriate therapy. The challenge is determining the best approach for a particular patient. The importance of diet history in the selection of foods along with common challenges and their commercially prepared & homemade solutions will be discussed.

A. Diet History
    a. Collecting
        i. Recognizing all potential antigen sources
    b. Handling Incomplete or Potentially Inaccurate History
        i. Hydrolysates vs. Uncommon Antigens
B. Blood & Saliva Testing
C. Cross-reactivity
    a. Effect on Novelty
D. Concurrent therapy
    a. Immunosuppressives
    b. Flavored Drugs/Treatments
E. Reduced n-6 to long-chain n-3 fatty acid ratio
    a. Dosing Marine Oils/Fat Based on n-6 Intake
F. Stool Quality "Effectors"
    a. Sudden Diet Changes
    b. Moisture
    c. Fat
    d. Fiber
        i. Type
            1. Soluble vs. insoluble
        ii. Amount
G. Elimination Trial Length
    a. GI Signs vs. Skin Signs
H. Development of New Reactions
    a. Timing
    b. "Feeding to Failure"
I. Recognizing Reactions
    a. Intolerances vs. Reactions
    b. Other disease mimicry
        i. Fat intolerance
        ii. Fiber-responsive
    c. Concurrent GI and Skin Signs
    d. Inappetance and Its Role
        i. Aversions
J. Commercial Solutions
    a. Hydrolysates
        i. Molecular weight averages
        ii. Species
        iii. Intact protein from carbohydrates
    b. Uncommon Antigen
        i. Limited ingredient
            1. Addressing hypoallergenic perceptions
        ii. Less limited ingredient
            1. OTC options
    c. Homemade
        i. When to use
            1. Concurrent conditions
            2. Commercially prepared novelty exhausted
        ii. Uncommon protein sources
            1. Effect on cost
        iii. Uncommon carbohydrate sources
            1. Effect on ease of preparation
        iv. When to fortify

Be the Biggest Winner with Weight Loss

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

Small animals in North America are supplied with an abundance of highly nutritious and palatable food. Concurrently, small animals live increasingly more sedentary lives, and clients provide treats and food as a basis for enhancing the human-animal bond. The result is frequently the consumption of excessive calories and the accumulation of adipose tissue. The development of obesity can have numerous adverse effects on a patient's health, thus, weight reduction in obese patients or weight stability in patients with an ideal body condition should be a focus of every veterinarian. The veterinarian's focus can be aimed by the consistent use of a body condition scoring system. Patients who are overweight or obese should be entered into a weight loss program. Successful weight loss programs should focus on three main areas that often are neglected. Area number one is increased **awareness** both by the veterinarian and by the client. Area number two is **accurate accounting** of the patient's food intake. Area three is **assessment** of the plan's ability to meet the patient's and the client's needs. The following lecture will detail the application of these three A's in clinical practice.

Since animals do not wear clothes and there is no social stigma with having an obese small animal pet, clients are frequently unaware of the presence and/or magnitude of their pet's obesity. Thus, the first step of any weight loss plan must be identifying the patient that is in need of weight reduction or is at risk of weight gain.

Veterinarians regularly perform procedures that will increase the risk of a patient becoming obese. Ovariohysterectomy and castration have been shown to lead to increased food intake (Kanchuk et al. 2003). Discharge instructions following orthopedic procedures frequently prescribe exercise restriction initially. Certain common drug therapies such as prednisone are known to cause polyphagia. Thus, iatrogenic energy imbalances should be identified and preventative adjustments in feeding strategies should be recommended. In addition, certain breeds appear to be more commonly obese, thus, in those breeds more aggressive intervention may be indicated. Finally, certain clients may be more prone to having a series of obese pets. Thus, "at-risk" client identification may be a valuable strategy to identify "at-risk" patients.

Some veterinarians feel uncomfortable addressing a patient's overweightedness or obesity if the client is themselves overweight or obese. It should be remembered that, as veterinarians, we constantly discuss diseases in a patient that may also be afflicting the client. If kept on medical terms and discussed as a medical condition as opposed to a character weakness, clients usually respond quite well to the topic of obesity. If overweight clients raise any concern, it should be that they may have preconceived beliefs about what are effective methods for weight reduction based on personal experience, and these may need to be addressed. Since fads are frequently introduced into the human weight loss marketplace, and clients take their cues from these highly marketed and publicized fads, awareness of these strategies can be useful in refuting their claims or in assisting with any contrasting proposed plans.

A patient is overweight, using a human definition, when they are up to 20% over their ideal body weight, and a patient is obese when they are 20-25% over their ideal body weight due to adiposity. There are numerous methods of quantifying a patient's body condition. The least accurate and potentially most subjective method is using a patient's body weight. Tables listing the "normal" weight range for dogs based on breed and sex do not account for the potential individual variation that can exist within breeds nor are similar tables fine enough to be useful in cats. Thus, the usefulness of body weight alone is quite minimal. More sensitive methods such as bioelectrical impedance, stable isotope dilution, bromide dilution, DEXA and MR imaging are available, but their widespread use is inherently limited by cost and/or availability. A more readily available technique is the use of a body condition scoring system (Laflamme et al. 1994). Body condition scoring utilizes both visual and tactile cues to assign a numeric value to a patient's degree of adiposity. The body condition score (BCS) has been validated to correlate with more complex measures of body condition such as DEXA. It should be noted that a BCS is not designed to determine a patient's degree of sarcopenia, but most patients are concurrently sarcopenic and "fat wasted" when underweight. Exceptions to this occur in disease states such as hyperadrenocorticism where there is a disconnect between the patient's degree of lean and fat mass. (Further discussion regarding underweight patients is beyond the scope of this/these presentation/notes.) Since body condition scoring can be readily explained to clients, it is an effective tool to increase a client's awareness of a patient's degree of adiposity. Many of the therapeutic pet food companies have created posters and handouts which illustrate the appearance of patients at the different body condition scores. Some companies even have charts on their packaging. Most of these systems are based on either a 5- or 9-point system. 5-point systems usually consider a 3 out of 5 as ideal. Each subsequent point on the 5 point scale represents an increase or decrease depending on direction of 20-30% in body fat above or below ideal (i.e., 1 = very thin and 5 = obese). 9-point systems usually consider a 4 or 5 out of 9 as ideal. Each subsequent point on the 9-point scale represents an increase or decrease depending on direction of 10-15% in body fat above or below ideal (i.e., 1 = emaciated and 9 = grossly obese). Clients should be given a handout (readily available from many pet food companies) and informed of where their pet falls on the chart.

There is a constant search on the part of the medical community and the public to identify interventions that will improve the quality and quantity of life. To date, the only intervention proven scientifically to improve quality of life and concurrently extend

lifespan in a pet species is caloric restriction and maintenance of a lean body condition score (Kealy et al. 2002). This argument may be the best motivator to prevent at risk patients from becoming obese. In any given patient, there may be a more specific benefit to weight reduction. For example, an obese dog with tracheal collapse clearly will benefit from weight reduction, thus, the client's focus should be placed on weight reduction as a treatment for the tracheal collapse. Similarly, an obese dog with a lameness refractory to further NSAID therapy and/or surgery may benefit greatly from weight reduction. Clients should be focused on improvement of the clinical sign that is worsened by overweightedness/obesity. Although it would be nice if patient's achieved an ideal body weight as an endpoint for any weight loss plan, it may not be practical and may misplace the client's focus. Since significant improvements can be made in certain diseases with weight reduction, the improvements themselves serve as the best and most effective means of maintaining interest and focus on continued weight loss.

The goal of any plan should be the improved health of the patient. For some patients this may not be the return to an ideal body weight, but instead the reduction in clinical signs associated with some disease process or a reduction in risk for the development of disease (please see table below). It must be remembered that a weight loss plan that achieves any weight reduction has inherently been successful. Weight loss can be quite difficult to achieve in some patients and/or be very slow, thus, even slight weight reductions should be celebrated.

Once a client recognizes that their pet is overweight and may benefit from weight loss, there is a potential for the development of guilt and concern that the veterinarian will blame them for their pet's weight. It must be remembered that for most clients the development of guilt can result in a desire to consciously or subconsciously deflect blame. The main effect of this defensive posture is a lack of accurate accounting of a patient's complete daily/weekly diet. Unfortunately, patients vary greatly with regard to energy requirement for weight stability (presented in Lewis et al. 1987); thus, if one receives an inaccurate or incomplete diet history from the client, there is an increased risk that recommendations for amounts to feed will result in weight gain, weight stability or weight loss at too rapid a rate. This is due to the inherent variability in energy requirement for the individual patient. Although the following equations, to calculate weight loss in a patient, can be used, the best measurement is to use the patient's current caloric intake to make recommendations.

In dogs, feed resting energy requirement (RER; seventy times the current body weight in kilograms raised to the 3/4 power (**70 x** (**$BW_{kg}^{3/4}$**))) OR **80% of current caloric intake whichever is less**. Please note if the calculation results in a value below 50% of RER, a careful review of the patient's health status (blood work, physical, etc.) and the accuracy of the diet history should be undertaken. Severe caloric restriction can result in both metabolic rate and activity changes that may prevent weight loss without concurrently making a patient extremely lethargic. Most patients undergoing weight reduction should be at least as active as they were prior to the initiation of the plan or more often they will be more active.

In cats, feed 80% of resting energy requirement (RER; 80% of seventy times the current body weight in kilograms raised to the 3/4 power (**56 x** (**$BW_{kg}^{3/4}$**))) OR **80% of current caloric intake whichever is less**. Please note if the calculation results in a value below 50% of RER, a careful review of the patient's health status (blood work, physical, etc.) and the accuracy of the diet history should be undertaken. Severe caloric restriction can result in both metabolic rate and activity changes that may prevent weight loss without concurrently making a patient extremely lethargic. Most patients undergoing weight reduction should be at least as active as they were prior to the initiation of the plan or more often they will be more active. *In addition, special care must be made in cats to ensure that weight loss is not so rapid as to increase the risk of developing **hepatic lipidosis**. An obese cat should never be allowed to become anorexic under the pretext that it will be beneficial for weight loss. Anorexia in an obese cat should be closely monitored for, and the risk of developing hepatic lipidosis should be discussed with the client at the start of any weight loss plan.*

The rate of loss (**usually 1-2% of body weight per week**) is based on traditional clinical recommendations that were designed to maintain lean body mass and preferentially burn fat mass. In addition, it appears that the slower the rate of weight loss, the less the body responds by slowing the metabolic rate and the less hungry the patient seems. Thus, a slower rate of weight loss potentially decreases the likelihood of weight rebound and increases the likelihood of client compliance. Often patients with the most compliant of clients will not lose greater than 0.5% of their body weight per week. If the patient is doing well and the client is not impatient, this level of loss should be accepted and further caloric restriction is not necessary. It must be remembered that there can be a great deal of variation in the energy requirement of a patient. Thus, even with the most accurate diet history and most compliant client, there will be times when the patient's response to the weight loss plan will be poor. Thus, an assessment of a patient's response must be made with corresponding adjustments based on the response.

Since patients may respond to the weight loss plan in unpredictable ways, reassessing the patient's response is vital to any successful plan. It is not uncommon for patients to be identified as needing weight loss and placed on weight loss diets indefinitely without adjustment. Prescription diets are just that -- prescriptions. Veterinary therapeutic diets are sold through veterinarians due to the concern that they may be used inappropriately. This includes using a diet that is proving ineffective in treating the desired disease process. Veterinarians have become increasingly aware of the need to check the efficacy of a particular antibiotic for say a bacterial UTI, and thus perform repeat urinalyses with C&S. If ineffective in clearing the UTI a different antibiotic will be selected and prescribed. The same philosophy should be adopted for commercial therapeutic diets. Thus, in the case of a diet designed for weight

loss, adjustments in the quantity of diet being fed needs to be adjusted based on response. There is often a temptation to starve the animal to achieve "guaranteed" weight loss, but this is not in the best medical interest of the patient nor is it likely to lead to long-term successful weight loss and/or compliance.

Reweighing patients serves two main functions. First, it allows adjustments to be made in the weight loss plan based on response. Second, it allows for more frequent success. Since the majority of patients will not show any visible signs of weight loss for several months, the client may become disenchanted and less resolved to continue. However, if the client can see quantifiable changes in the patient's weight, it can help reinforce their commitment to the weight loss plan. It also can serve as a clear indicator to the client whether the restriction is appropriate or not. For example, if the client initially felt the restriction was too severe, but is then faced with the reality that the patient is losing weight at an appropriate rate or isn't losing weight, their acceptance of the plan or adjustments to the plan should increase. Weigh-ins also provide the best method to adjust the level of restriction for a particular patient. Without weigh-ins, weight loss plans are often doomed to failure due to inaccurate initial recommendations.

Some practitioners have set up weight loss support groups for clients with patients undergoing weight loss. This allows for grouped weigh-ins, encouragement and peer advice. Patients further along in the program can be used as examples, which in turn strengthen the resolve of all involved. A display of before and after photographs of patients that have completed plans can help as both an incentive and a recruiting tool. This certainly could be a practice builder and enable a more consolidated approach to obesity management of the practice's patients.

Numerous dietary strategies have been employed in the design of therapeutic diets. With the exception of a few low carbohydrate weight loss diets, all diets have a decreased energy density (i.e., kcal per unit volume) than most "light" or maintenance diets. The basis of this strategy is the concept that gastric/bowel distention leads to satiety. The use of fiber to achieve satiety is hotly debated (unpublished data by Hill's; Butterwick et al. 1997). Other strategies have been employed to achieve decreased energy density other than fiber. For example, one company achieves decreased energy density by increasing the degree of kibble expansion following extrusion, thus, creating a kibble that is more puffed up with air. Probably the most important formulation difference between weight loss diets and regular foods is **an increase in the essential nutrients per kilocalorie**. Ideally, the only nutrient being limited during weight loss would be energy. A patient's requirement for protein, fat, minerals and vitamins is not known to decrease during weight loss. Thus, limiting intake of essential nutrients would be inappropriate. One must remember that a pet eats to their caloric need typically. For example, dogs and cats do not have a drive for calcium when in a state of calcium deficiency. Nutritionists are aware of this fact, thus, commercial diets provide a set amount of a particular nutrient per kilocalorie of diet to ensure that an appropriate amount of the nutrient is consumed. If a patient's caloric intake is intentionally restricted for an extended period, as it is during weight loss plans, there is a potential for the patient to develop a nutrient deficiency unless a diet designed with enhanced levels of nutrients per kilocalorie is fed. To illustrate this point let's take the example of protein. Let's say that an adult obese dog needs to consume 16% of dry matter as protein (assuming a particular level of protein digestibility and amino acid composition) to avoid an amino acid deficiency at a caloric intake that maintains the dog's current weight. Let's also say the clients are currently feeding a diet with 20% of dry matter as protein and decide on their own to use this same diet for weight loss. They then gradually decrease the amount of diet fed to achieve weight loss until they are feeding 60% of the amount they were originally feeding. Unfortunately, the dog is now being fed the same amount of protein as if the diet contained 12% protein on dry matter and is at definite risk for developing an amino acid deficiency. This concern extends to all nutrients, thus, the selection of a weight loss diet is not solely for decreased energy density and potential satiety, but also for deficiency prevention.

Increasing the frequency of meals may assist with decreasing the problem of begging. This may be due to a satiety effect or more likely will provide the client with an allowed and accounted for meal during times of begging. Increasing the frequency of meals may also lead to better compliance because although the volume for any given meal is less, the client feels the pet is fed more due to the increased meal frequency. There may also be an increase in energy expenditure with increased meal frequency due to the "thermal effect of food".

Providing clients with treats is important for compliance to weight loss plans. If treats are not included in the plan, they most likely will still be provided but not accounted for, making appropriate adjustments in caloric intake more difficult. Incomplete and unbalanced treats should be limited to 10% of caloric intake to prevent deficiencies from developing. Excellent low calorie human foods that can be used as treats are baby carrots (assuming that calcium oxalate urolithiasis is not a concern as carrots are higher in oxalate), air-popped popcorn and unflavored rice cakes. Even high fat treats can be used, but careful instructions on the limited amount that can be fed must be given to the client (this also allows one to educate the client on energy density differences between foodstuffs).

Exclusively relying on calorie restriction may not be the best means of achieving weight loss. Caloric restriction coupled with exercise has the benefit of increasing the patient's metabolic rate and assisting with lean body mass maintenance. In addition, exercise provides an alternative method of reinforcing the human-animal bond that does not rely on treats or meal feeding. Exercise can be instituted by simply increasing/creating play time(s) or taking the pet on walks.

It is important that once a patient successfully completes a weight loss plan that they also successfully maintain their new weight. Thus, care should be taken when the patient is weaned onto a new diet and a new caloric intake. Numerous weight management diets are available over-the-counter (OTC). These diets fall into two categories, “light”, “lite” or “low calorie” AND “less calorie”, “reduced calorie”, “lean”, “low fat”, “less fat” or “reduced fat”. Only the first group of terms gives information on energy density. By definition, these “light” diets must contain no more than specific amounts of calories such as 3100 kcal ME/kg for dry dog diets and no more than 900 kcal ME/kg for canned dog diets. The other group of terms do not provide any insight on the energy density of the diet. Thus, a diet that is labeled “reduced calorie” could be very energy dense (e.g., 500 kcal/cup) if being compared to an even more energy dense diet (e.g., 600 kcal/cup) and, thus, potentially be very inappropriate for weight loss or an obese prone dog. The selection of a weight maintenance diet is further complicated by the common lack of energy density information on diet packaging. Therefore, creating a list of “light” diets that you are familiar with and that is readily available to the client may prove quite useful. Armed with such a list, the client can select a diet that meets their personal preferences (e.g., diet ingredients, brand/company, price). As the veterinarian, you can then give a starting recommendation on the amount of the new diet to feed. Initially, feeding should start with a slow transition to the new diet over 5-7 days at the same number of calories that the patient was on at the end of the weight loss plan. The patient should then be weighed. Then the caloric intake should be increased by ~10%, and the patient should be reweighed in two weeks. If the patient is losing weight then an additional increase of ~10% can be implemented and the patient reweighed in two weeks. If the patient is weight stable, then continue at current caloric intake and reweigh in one month. If gaining weight, reduce by ~10% and review that the client is complying with the dietary recommendations still. Overall, this process of weaning the patient onto the new amount of diet is performed based on weigh-ins to achieve weight stability.

References available upon request

So Many Foods, So Little Time, Money, and Space-Help!

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

With the ever expanding selection of commercially prepared foods to meet practice, client and patient needs, how does one determine what to offer as a solution and carry? This lecture will provide strategies to optimize and prioritize recommendations and inventory.

Outline

A. Average Revenue From Food Sales and The Potential
   a. Economic Rationale for Nutrition In Clinical Practice
      i. 4% of total veterinary practice revenue
      ii. Large compliance gap indicates significant additional potential
      iii. Above is important given "opportunity cost" of spending resources/time on nutrition
B. Strategies to Increase Product Sales
   a. Recommending an Effective Therapeutic Nutritional Plan
      i. Matching plan to client and patient needs
         Please see lecture entitled "Increasing Compliance With Nutritional Recommendations" for more on this topic.
   b. Establishing Expectations
      i. Client education outlining nutritional goals
         1. Contrast therapeutic solutions/recommendations with perceived alternatives/OTC products
   c. Monitoring Patient Response
      i. Measure to see if goals are met and adjust as needed
         1. Proactively schedule recheck calls and appointments
   d. Providing a Variety of Viable Options
      i. Maximize with inventory management
C. Inventory Management
   a. Selecting What to Carry
      i. Practice type based
         1. Client demographics
      ii. Veterinary exclusivity
         1. Understanding FDA guidelines on therapeutic food sales
      iii. Product performance/support for use
      iv. Company technical resources/delivery practices
      v. Margins and carrying cost of inventory
   b. Determining How Much to Stock
      i. Sizing
      ii. Number
      iii. Adjusting orders based on historical data
   c. Handling Returns
      i. Manufacturer policies
      ii. Tracking reasons
         1. Improving offerings
   d. Storage
      i. "First in, first out" stacking or shelving
      ii. Visibility/proximity to waiting area/discharge
      iii. Security
   e. Point of Sale Procedures
      i. Cross checking product matches recommendation
      ii. Expiration date check
      iii. Overall product condition check
      iv. Service
         1. Carrying out
         2. Schedule reorder reminders
   f. Handling Perishables and Product Recalls
      i. Temperature, moisture, and pest controls
      ii. Recall notification procedures
         1. Liability insurance coverage
D. Recommending Nutraceuticals and Dietary Supplements
   a. Method for Assessing Safety and Efficacy
      i. Confirming that form or carriers are appropriate

1. Probiotic
    a. Viability
    b. Species specificity
2. Nutritive carriers

ii. Matching recommended dose to reported efficacious dose

iii. Understanding if safe upper limits exist

E. Creating or Increasing Revenue From Nutritional Recommendations

a. Nutritional Recommendations for Healthy Patients

i. Importance

1. For maintenance
2. During growth
    a. Large breeds
    b. Form (variety in kittens)
    c. Energetics and individual energy needs

b. Nutritional Recommendations for Unhealthy Patients

i. Importance

1. End of life decisions

Recommended additional reading

S. J. Delaney, A. J. Fascetti, and P. Brentson, *Applied Veterinary Clinical Nutrition*, Ch. 1, "Integration of Nutrition into Clinical Practice", John Wiley & Sons, Inc. West Sussex, 2012. pp. 3-7.

S. J. Delaney and A. J. Fascetti, *Encyclopedia of Canine Clinical Nutrition*, Ch. 16, "Integration of nutrition into clinical practice", Aniwa SAS. Aimargues, 2006. pp. 462-473.

S. J. Delaney, *Blackwell's Five Minute Veterinary Practice Management Consult*, Ch. 8.12, "Inventory Management: Nutritional Products", 2nd Ed., John Wiley & Sons, Inc. West Sussex, 2014. pp. 408-409.

What I Have I Learned from 20,000+ Therapeutic Homemade Diets

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

With the insight gained from having generated 10,000s of homemade recipes, this lecture will discuss the common reasons for, the challenges with, and the successful approach to homemade feeding.

Outline

A. Reasons for Feeding Homemade Food
    a. Medical Need
        i. Most common conditions
            1. Adverse reactions
            2. Diseases with reduced appetite/learned aversions
            3. Concurrent condition
            4. Unintentional
    b. Human Animal Bond
        i. Client enjoys cooking for pet
    c. Anthropormorphism
        i. Children should have healthy fresh meals
            1. Doesn't predict dietary approach
        ii. Pets should be fed like humans
            1. Often predicts dietary approach
    d. Fear
        i. Toxins
        ii. Diseased/unhealthful livestock
        iii. Unknown/Indeterminate
        iv. Establishment
    e. Client Philosophy(ies)
        i. No preservatives
        ii. Whole/fresh foods
        iii. Agricultural practices
        iv. Vegan/vegetarian
        v. Religious
    f. Regionalism
        i. Coastal

B. Challenges with Homemade Food
    a. Pathogens/Zoonoses
        i. Asymptomatic shedding
        ii. Associated liability
    b. Nutrient incompleteness/imbalances
        i. Whole prey vs. whole food
        ii. Perception that variety over time solves constant deficiencies
    c. Appropriateness:
        i. Long-term feeding
            1. Good intention, short-term recipes
        ii. Species
            1. Vegetarianism for a carnivore
        iii. Pet Risk Factors/Conditions/Diseases
            1. Lack of awareness of caloric distribution
            2. Requirements in growth and sickness
    d. Potential Use of Toxic or Inappropriate Ingredients
        i. Garlic and onion
        ii. Oxalate rich foods
        iii. Mineral and protein rich carbohydrates
    e. Cost
        i. Perception of cost vs. reality
    f. Convenience
    g. "Diet Drift"
        i. Tendency to change recipe over time
    h. Energy Balance
        i. Increased digestibility and palatability effect on caloric intake and body condition

C. Assessing Recipes
    a. Completeness
        i. Sources of essential nutrients checklist
        ii. Specificity needed to assess
    b. Balance
        i. Formulation software
        ii. Individualized consultations with DACVN
    c. Preparation Methods
        i. Pathogens
        ii. Vitamin degradation
        iii. Batching

When Dietary Fat is Just Too Much Fat

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

Achieving needed dietary fat restriction although a simple concept can be challenging to implement. Determining the level of fat restriction a patient needs and the amount of dietary fat in a potential food along with identifying palatable options can be difficult. The importance of a diet history evaluation, caloric distribution and its calculation, and commercially prepared & homemade solutions will be discussed.

Outline

- A. Pathogenesis
  - a. CCK stimulation of pancreatic digestive enzymes release
  - b. Effect of macronutrients on CCK
    - i. Fatty acids - significant
    - ii. Amino acids - moderate
    - iii. Carbohydrate - minimal
- B. Level of needed fat restriction dictated by patient
  - a. Higher levels of fat may be tolerated, if potentially inducing level of dietary fat very high
  - b. Important to determine as moderate or severe fat restriction can be very limiting and negatively affect palatability
- C. Caloric Distribution
  - a. Best method to compare foods' macronutrient levels
  - b. Units are percentage of calories
    - i. Not same percent as that found on packaging in guaranteed analysis section
    - ii. Crude fat % value on labels are often much lower than the % of calories from fat
      1. Commonly leads to confusion and client believing they have found a "fat restricted" diet over-the-counter (OTC) that "works" when in fact it is too high in fat
  - c. Method to calculate from guarantees
    - i. Calculate the % carbohydrate by adding up crude protein, crude fat, moisture, crude fiber, and ash percentages with 3% assumed for ash when unavailable and subtracting the total or sum from 100% to get % carbohydrate by difference
    - ii. Multiple % crude protein value by 3.5, % crude fat by 8.5, and % carbohydrate (calculated by difference) by 3.5 and adding the products of all three. Then divide the individual products by the total and multiply by 100 to get the percentage of calories from each macronutrient
- D. Commercial Foods
  - a. OTC
  - b. Therapeutic foods
    - i. Low fat
    - ii. Other but happen to be lower fat
  - c. Homemade
    - i. Indications
      1. Palatability issues with commercial
      2. Fat restriction beyond even therapeutic options needed
      3. Concurrent conditions
         - a. Calcium oxalate urolithiasis
         - b. Adverse reactions to food
         - c. Renal disease
    - ii. Solutions
      1. Free at vet.balance.it
         - a. Note that ground meat are typically too fatty to be used
         - b. Using low linoleic acid fatty acid containing oils difficult
           - i. Avoid olive oil, coconut oil
           - ii. Use corn oil or walnut oil
         - c. Human supplement options available for free
           - i. Conflict: speaker is an owner of Balance IT that sells all-in-one supplements at this site
      2. For a fee via Diplomates listed at acvn.org
         - a. Advantage can get help with level of dietary fat restriction needed based on diet history evaluation
         - b. Requires medical record and completed diet history form typically
         - c. May or may not interact directly with client

Urolithiasis:
Is Nutritional Management Written in Stone?

Sean Delaney, DVM, MS, DACVN
DVM Consulting Inc.
Davis, CA

The nutritional management of urolithiasis is ever evolving. Changes over the last couple of decades include not focusing on urine pH in calcium oxalate urolithiasis, treating with antibiotics and/or surgery for struvite urolithiasis prevention in canine patients, a decreased focus with urate urolithiasis in some female canine patients and pushing dietary protein when concurrent hepatic encephalopathy exists with urate urolithiasis, and avoiding the development of taurine deficiency in cystine urolithiasis.

Outline

- A. Diagnosis
  - a. Crucial to ensure right therapy is applied
    - i. If stone analysis not undertaken closer monitoring of treatment needed
      1. Concern of struvite shell over other stone type (compound urolith)
  - b. Challenge of culturing infection in dogs with struvite
    - i. Presume infection
- B. Calcium oxalate (CaOx) urolithiasis
  - a. Water
    - i. Higher moisture (85%)
      1. Soup or stew like
         a. How to calculate
      2. Slow introduction needed to improve acceptance and to avoid loose stool and accidents
    - ii. Goal: Urine specific gravity of 1.020 or less for dogs and 1.025 or less for cats
    - iii. Goal: No crystalluria
  - b. Controlled calcium levels to enable CaOx crystals to pass in feces
  - c. Avoidance of higher oxalate foods
    - i. Example: carrots but many other vegetables, grains, and starch rich foods
  - d. Potassium citrate
    - i. As a citrate source versus minimal to no impact on urinary pH
  - e. Commercial foods
  - f. Homemade foods
    - i. Indications
- C. Struvite urolithiasis
  - a. Decreasing urinary pH while avoiding high protein intake that increase ammonia and phosphorus intake
    - i. Sulfur amino acid supplementation - methionine
  - b. Increasing water intake
    - i. Concern of higher sodium intake with cats especially
  - c. Controlling magnesium intake not just ash
  - d. Canine management
    - i. UTI cause, no apparent cases of sterile struvite urolithiasis
      1. Prevention focused on antibiotics and/or correction of anatomical issues leading to increased risk of UTI
    - ii. Dissolution can still be accomplished with diet
      1. Close monitoring needed to ensure progress is made especially if urolith was compound with different core like calcium oxalate
  - e. Commercial foods
  - f. Homemade foods
    - i. Indications
- D. Urate urolithiasis
  - a. Breed genetic defect versus hepatic shunt
    - i. If shunt and surgical correction possible, pursue as method of prevention
  - b. Avoidance of high purine intake
    - i. Lower protein
      1. Titrate lower intake to any liver failure and hepatic encephalopathy (HE)
         a. Risk of protein malnourishment
            i. Risk of sulfur amino acid deficiency in dogs on legume based diet
  - c. Lower purine rich foods
  - d. Increase water intake
  - e. Commercial foods

f. Homemade foods
i. Indications

E. Cystine urolithiasis
a. Avoidance of high cystine intake
i. Lower protein
1. Avoid taurine deficiency
2. Alkalinizing effect
b. Increase water intake
c. Medical therapy (e.g., 2-MPG)
d. Commercial foods
e. Homemade foods
i. Indications

F. Other rare stone types
a. Not to be covered

Nuts and Bolts of Canine Osteosarcoma

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Osteosarcoma (OS) is the most common primary bone tumor of dogs, accounting for approximately 85% of malignancies arising in the skeleton. It is a high grade, biologically aggressive neoplasm of mesenchymal origin that closely parallels human OS. It is estimated that 10,000 dogs per year develop OS in the United States. The peak incidence of canine OS occurs primarily in middle-aged to older animals, with a median age of 7 years; although, a bimodal age distribution is reported with a second small peak at 18 to 24 months. Approximately 75% of OS occurs in the appendicular skeleton. Analogous to humans, the metaphysis of long bones is the most common primary location, with the forelimbs affected twice as commonly as the rear limbs. The most frequent anatomical sites are the distal radius (35%) and proximal humerus (18%) followed by the distal femur, proximal tibia, and distal tibia. Osteosarcoma is typically a cancer of large and giant breed dogs with only 5% of tumors occurring in dogs weighing less than 15 kilograms, the majority of which originate in the axial skeleton. The precise etiology of canine OS is unknown; however, likely include genetic predispositions, exposure to ionizing radiation and sustained microtrauma (*ex*. repetitive weight bearing stresses, metallic implants) as possible risk factors in dogs for OS development.

Current local therapies

The local effects of OS which result in excessive and pathologic bone resorption have a significant impact on patient mobility and quality of life, and thus, addressing the primary tumor is one of the major goals of OS therapy. Effective local therapy for canine OS necessitates the removal or killing of malignant osteoblasts and various treatment modalities have been employed to this end. The following discussion will focus on the benefits and limitations of current local therapies for canine OS.

Surgery

Surgical resection of the primary tumor followed by either a platinum- or doxorubicin-based chemotherapy protocol generally results in the longest median survival times, with a median survival time approximately 275-300 days. For appendicular OS, surgical options include amputation or limb-sparing procedures. High amputation of the affected limb is the standard local treatment, and most dogs function well after this procedure, retaining good mobility and quality of life. An advantage of amputation is that it usually ensures complete local tumor removal. However, in cases where severe preexisting conditions exist, such as obesity, orthopedic or neurological disease, limb amputation may not be a viable option.

In select cases, a limb-sparing surgery may be an alternative to amputation, in which the affected bone is resected and replaced by a normal bone allograft, metal endoprosthesis, or other less common methods. Overall, outcome has been acceptable following limb salvage, with approximately 80% of dogs experiencing good to excellent limb function; however, even in the hands of the most experienced surgeons, there remains a risk for relatively high rates of local complications including recurrent disease, construct failure, and post-operative infection.

Local palliative strategies

Standard-of-care therapy, defined as the treatment option that results in the longest median survival times, is surgical resection of the primary tumor followed by 3 to 6 cycles of either a platinum- or doxorubicin-based chemotherapy protocol. Unfortunately, not all dogs with OS are considered good candidates for amputation, and alternative palliative treatment options for controlling bone pain should be considered. Reported survival times for canine patients treated with palliative intent therapy ranges from 3 to 10 months. With the commercial boom of pharmacologic pain medications approved for use in dogs and cats, the general practitioner is now offered a plethora of novel analgesics that may provide some moderate relief for chronic osteolytic pain associated with appendicular OS. In addition to the administration of conventional nonsteroidal anti-inflammatory drugs (NSAIDs) or the application of transdermal opioids, newer analgesics such as tramadol and gabapentin may also alleviate cancer-related pain.

Palliative radiation therapy (RT)

Palliative RT is effective for the management of malignant bone pain, and typically involves administering coarse fractions of 8 to 10 Gy of megavoltage irradiation, in 3 treatments at 0, 7 and 21 days. Palliative RT reportedly improves limb function and quality of life in about 75% of patients, and for a median of 2-3 months duration. The concurrent administration of systemic chemotherapy along with palliative RT appears to enhance analgesic response rates and durations, and should be highly recommended.

Radiopharmaceuticals

The use of a therapeutic radionuclide called ^{153}Samarium-EDTMP has been described for both appendicular and axial OS in dogs, and provided pain relief in many treated patients. By means of delivery concentrated radiation doses to the site of active bone remodeling,

^{153}Samarium-EDTMP administration is capable of providing significant and meaningful palliation of bone pain in dogs suffering from appendicular OS. ^{153}Samarium-EDTMP therapy is well tolerated and alleviates osteolytic bone pain in the majority of dogs treated. Side effects associated with treatment include transient decreases in platelet and white blood cell counts.

Stereotactic radiosurgery (SRS)

Radiosurgery involves the precise delivery of a single large dose of radiation to a designated tumor target, and has been used for the treatment of brain tumors, as well as, appendicular OS. The use of SRS in dogs with OS can provide pain alleviation, long-term local tumor control and improvement in limb function. Similar to palliative radiation therapy, combining systemic chemotherapy with SRS appears to enhance response rates and durations.

Aminobisphosphonates

The pharmaceutical use of aminobisphosphonates is accepted for the treatment of neoplastic bone disorders in human cancer patients. At low concentrations aminobisphosphonates inhibit bone resorption without inhibiting the process of bone mineralization. This results in stabilization and even enhancement of bone mineral density. Bisphosphonates directly inhibit bone resorption by binding to hydroxyapatite crystals, as well as inducing osteoclast apoptosis. In part, pain associated with bone cancers is a direct consequence of malignant bone resorption. Therefore, inhibiting pathologic bone resorption with aminobisphosphonates would theoretically decrease the likelihood of pathologic fracture, as well as alleviate intense bone pain.

Aminobisphosphonates are synthetic analogs of inorganic pyrophosphate (PP_i) that were initially utilized in the detergent industry as demineralizing agents, and then for diagnostic purposes in bone scanning, based on their ability to adsorb to bone mineral. The pharmaceutical use of aminobisphosphonates has now gained wide acceptance in human non-neoplastic bone disorders such as osteoporosis and Paget's disease. In the last decade, aminobisphosphonates have been intensely investigated as novel antineoplastic agents. Currently, several aminobisphosphonates have demonstrated efficacy for treatment of tumor-induced hypercalcemia, multiple myeloma, and metastatic bone diseases.

The effective treatment of bone disorders by aminobisphosphonates is attributed to their differential effect on bone resorption and bone mineralization. At low concentrations aminobisphosphonates inhibit bone resorption without inhibiting the process of bone mineralization. This results in stabilization and even enhancement of bone mineral density. Aminobisphosphonates directly inhibit bone resorption by binding to hydroxyapatite crystals. Once incorporated into the hydroxyapatite matrix of bone, aminobisphosphonates inhibit further calcium and phosphorous mineral dissolution. Perhaps more importantly, aminobisphosphonates impede osteoclast activity and induce osteoclast apoptosis; both mechanisms result in inhibition of bone resorption.

Systemic therapies

Chemotherapy agents that have demonstrated efficacy in the treatment of OS include the platinum agents and doxorubicin. While chemotherapy is primarily used in the management of canine OS for the purpose of delaying onset of metastasis, it may also be employed in local therapy as a pretreatment to amputation or limb salvage. In veterinary medicine, studies that evaluated dogs receiving intra-arterial (IA) cisplatin prior to limb spare surgery found that cisplatin IA with or without radiation therapy induced a significantly greater percent tumor necrosis when compared with dogs receiving no pretreatment, and that percent tumor necrosis was strongly predictive of local tumor control.

Canine Lymphoma: What's on the Horizon?

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Lymphoma is one of the most commonly diagnosed cancers in dogs, cats and people. Canine lymphoma bears similarity to the non-Hodgkin's lymphomas (NHL) in humans and both exhibit similar responses to treatment with chemotherapy. Lymphoma is very difficult to cure and a leading cause of cancer death in dogs and people. Despite many efforts over the last 20-30 years, outcomes in canine patients have not significantly improved over those achieved with CHOP-based chemotherapy protocols (cyclophosphamide, doxorubicin, vincristine, and prednisone). These chemotherapy protocols have extended both the longevity and quality of life in dogs with lymphoma but novel strategies are needed to increase survival times. This presentation will cover a general review of lymphoma and recent advances that hold promise for the future.

Diagnostic advances

Lymphomas are a diverse group of cancers arising from lymphoid cells. There are greater than 30 types of canine lymphoma described that differ in anatomic, histologic and immunophenotypic (T vs. B cell) classification. These different types of lymphoma can vary in their biologic behavior and prognosis; however, further studies are currently needed to correlate the various categories of disease with clinical outcome. The majority of canine lymphomas are intermediate or high grade and are generally characterized as being biologically aggressive and rapidly progressing. Indolent lymphomas may progress more slowly and dogs may experience long-term survival with limited or no therapy; however, indolent lymphomas represent a small percentage of lymphoma in dogs. Diagnosis of lymphoma is achieved via cytology or biopsy. While not performed in every case, the following diagnostics may be helpful to establish a diagnosis of lymphoma or to further characterize the tumor.

Immunophenotyping (cytology, histopathology, or flow cytometry): Using antibodies against specific cell surface markers (ex. B cell CD 79a/CD20, T cell CD3/CD4/CD8), this test is primarily used to determine if the lymphoma is B or T cell in origin. However, it can also be helpful to support a diagnosis of lymphoma by documenting a homogenous population of the same immunophenotype within a tissue.

Flow cytometry

This test allows immunophenotyping of cells in suspension (blood, effusions, and aspirates of LNs or organs). Flow cytometry can also provide information regarding cell size and expression of other CD molecules that may correlate with prognostic information.

PARR (PCR for antigen receptor rearrangement)

Theoretically, a malignant cell population should be derived from expansion of a single clone. PARR amplifies the variable regions of the T cell receptor or Immunoglobulin (Ig) receptor gene to detect the presence of clonal lymphocyte populations. When it is not possible to differentiate between malignant and benign lymphocytes based on cytology or histopathology alone, PARR may be helpful to confirm a diagnosis (especially useful when the lymphocyte population is heterogeneous). PARR can be used to detect minimal residual disease but investigations are ongoing to determine if this is a useful clinical marker of early recurrence.

Proteomics (ex. PetScreen)

Proteomics analyzes the protein components of a cell, which may be used to identify cancer specific markers. Preliminary studies have been performed in canine lymphoma but clinical application is limited at this time.

Clinical staging advances

Lymphoma is considered a systemic disease and most dogs are presented in advanced stages (III to IV). Ideally, the extent of disease is determined after diagnosis as a baseline for treatment monitoring. However, the degree of staging necessary is controversial. The completeness of staging in any given case is often dictated by 1) how a diagnostic test affects treatment plan, 2) how it affects client's decision making and 3) how it affects patient prognosis. A thorough physical exam, CBC, serum chemistry profile, and urinalysis are indicated for every patient to obtain vital information regarding organ and bone marrow function before starting treatment with chemotherapy. Additionally, information regarding prognostic factors (hypercalcemia, anemia) may be obtained. Further diagnostics to consider include thoracic radiographs and abdominal radiographs/ ultrasound. These imaging studies are non-invasive and may provide information regarding areas of significant disease burden (such as mediastinal or sublumbar lymph nodes). This can be important information when monitoring for lymphoma relapse. In the author's practice, abdominal ultrasound is also highly recommended for any dog with clinical signs attributable to the GI tract in order to rule out involvement, and thoracic radiographs/

echocardiogram are recommended for any dog predisposed to heart disease. The value of a bone marrow aspirate in the face of a normal CBC is questionable and rarely pursued in the author's practice.

PET/CT (positron emission tomography/ computed tomography)

PET/CT combines functional and anatomical imaging to allow detection of metabolic or proliferative activity throughout the body. PET/CT is currently the standard of care for monitoring and predicting response to therapy in people with lymphoma. PET/CT has also shown promise for evaluating response to chemotherapy and predicting relapse in dogs with lymphoma.

Standard treatment options

Multi-agent chemotherapy is the mainstay of treatment for lymphoma. For intermediate to high grade lymphomas, CHOP-based protocols are typically advised as first line therapy and provide the best response rates (80-95%) and treatment outcomes. At this time, long term maintenance chemotherapy does not appear to improve remission times. Additionally, dogs that do not receive maintenance therapy appear to be more likely to achieve a second remission following relapse. Several studies suggest that inclusion of L-asparaginase in the protocol does not significantly improve outcome (remission rates or duration of remission). In the author's practice, the decision to use L-asparaginase is made on a case-by-case basis and typically reserved for particular situations (ex. sick patient, cytopenic, rescue, etc.). Individual response and remission durations vary depending on prognostic factors. Overall median survival times are 12-14 months with approximately 20-25% of dogs alive at 2 years. Alternative protocols are offered if clients need less costly or more convenient options.

Rescue chemotherapy is associated with lower response rates and shorter remission times. Chemotherapy agents that are commonly used in the rescue setting include lomustine (CCNU), doxorubicin, mitoxantrone, MOPP (mustargen, vincristine, procarbazine and prednisone), actinomycin-D, and dacarbazine (DTIC).

Novel treatment options

Monoclonal antibodies (Mab)

Outcome improvements in people with non-Hodgkin's lymphoma have been due in large part to Mab therapies such as rituximab (anti-CD20 antibody used to treat B-cell lymphomas). However, rituximab is not effective in dogs. Currently, clinical studies are ongoing to evaluate two conditionally approved monoclonal antibodies (Aratana Therapeutics) for use in the treatment of canine lymphoma. These promising canine-specific antibodies are directed against CD20 (AT-004) for B-cell lymphoma and CD52 (AT-005) for T-cell lymphoma.

Bone marrow/ stem cell transplantation

Ablative total body irradiation and/or chemotherapy combined with bone marrow or stem cell transplantation is available for dogs with lymphoma. However, these treatments are not widely accessible, are costly, and are associated with increased morbidity in dogs undergoing treatment. While these treatments present a potential for increased cure rates, results of a large number of treated cases have yet to be reported.

Adoptive T cell therapy

Expanded autologous T cells infused after CHOP chemotherapy has been shown to significantly improve overall and disease free survival in a small number of dogs with B cell lymphoma. While quite promising, this therapy is currently available to client-owned dogs only through clinical trials.

Prognostic marker advances

Widely accepted negative prognostic factors include T cell immunophenotype (for multicentric lymphoma), substage b (sick), prior treatment with prednisone, and certain anatomic sites (cranial mediastinal involvement, primary diffuse cutaneous, GI, hepatosplenic, and primary CNS). Recently, it has been shown that B-cell lymphomas expressing low levels of class II MHC or lower than normal levels of B5 antigen also had a poorer prognosis. Presence of anemia is also associated with a worse prognosis. Alternatively, it appears that dogs with indolent lymphoma experience prolonged survival times.

Canine Hemangiosarcoma: Rational Future Targets

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Hemangiosarcoma (HSA) is a malignant neoplasm which originates from vascular endothelium and accounts for 0.3-2% of all canine cancers. Large breed dogs such as German Shepherd Dogs, Golden Retrievers, and Labrador Retrievers are over represented with a median age at diagnosis of 9-10 years. Most frequently affected primary sites of HSA in these patients include the spleen, skin, and heart (right atrium and auricle). Other less common sites include the liver, lungs, kidney, muscle, oral cavity, bone, and the urinary bladder. Clinical signs can be nonspecific or consist of acute weakness or collapse with corresponding abdominal distension, tachycardia, tachypnea, pale mucus membranes, and weak pulses. These clinical signs are often secondary to acute blood loss into the peritoneal or pericardial cavity.

Standard of care treatment for HSA depends primarily on tumor location but in large part consists of surgery followed by chemotherapy. The chemotherapeutic agent of choice for HSA is Doxorubicin. For strictly dermal HSA, chemotherapy is not necessary following complete surgical removal with adequate margins. However, for the remaining HSA locations surgery alone affords the patient with a median survival time of less than 2 months. Even with the addition of chemotherapy, the majority of patients will succumb to their disease within 4-8 months. Death is usually secondary to metastatic disease via hematogenous spread to the pulmonary parenchyma and intraabdominal dissemination primarily, but also to the skin, bones, and brain.

Pathology and natural behavior

Malignant endothelium serves as the underlying pathology of HSA, and hence HSA can involve any organ requiring nutrition and oxygen via blood circulation. Often dogs presenting for visceral organ HSA will present with signs associated with acute tumor rupture and resultant hemorrhage and hypovolemic shock. Symptomology reflects the hemodynamic instability of these acutely bleeding patients and include lethargy, weakness, collapse, anorexia, mucous membrane pallor, delayed capillary refill time, tachycardia, tachypnea, cardiac arrhythmias, and poor pulse quality. In circumstances where the patient does not experience a life-threatening hemorrhage event, clinical symptoms might recur and take on an episodic pattern. With primary splenic or hepatic HSA, tumor rupture results in abdominal distention and a noticeable fluid wave secondary to hemorrhagic effusion. With primary cardiac HSA, muffled heart sounds, venous congestion, and signs compatible with cardiac tamponade may be noted. Primary subcutaneous and intramuscular HSA, typically occur as large, firm or fluctuant masses. Overlying skin may be ecchymotic and ulcerated.

Diagnosis and staging

Presumptive diagnosis of HSA can be made based upon multiple clinical and physical findings, as well as patient signalment. However, baseline diagnostics which should be considered in any patient with presumed HSA might include the following:

- Complete blood count
    - Anemia: secondary to hemorrhage
    - Schistocytes: red blood cell morphology
    - Thrombocytopenia: immune mediated destruction, splenic sequestration, severe hemorrhage, and/or disseminated intravascular coagulopathy (DIC)
    - Neutrophilic leukocytosis
- Serum chemistry panel
    - Hypoproteinemia: secondary to blood loss
    - Liver enzyme elevations: involvement of hepatic parenchyma
    - Hypoglycemia: rare paraneoplastic syndrome
- Coagulation panel
    - Elevations in clotting times: disseminated intravascular coagulation
    - Defects in both primary and secondary coagulation cascades
- Thoracic radiography
    - Evaluation of overt lung metastases
    - Cardiac involvement with globoid cardiac silhouette
        - Pericardial effusion

- Echocardiography
    - Evaluation of right auricle or atrial mass effects
    - ECG might demonstrate ventricular arrhythmias and electrical alternans
- Abdominal ultrasound
    - Evaluate primary abdominal tumor involvement, as well as regional metastases within the visceral organs residing within the peritoneal cavity
- Cytology
    - Considered insensitive for diagnosis given poorly exfoliative nature of sarcomas
- Biopsy
    - Required for definitive diagnosis
    - Diagnostic and therapeutic

Canine hemangiosarcoma treatment options

Due to the devastating prognosis for HSA, multiple new therapies outside the realm of surgery and standard doxorubicin administration have been devised and evaluated. These include various alternative chemotherapeutic protocols, intracavitary chemotherapy administration, immune modulation, matrix metalloproteinase inhibitors, antiangiogenic therapy, and tumor vaccines.

Combination chemotherapy protocols with doxorubicin, cyclophosphamide and vincristine (VAC) or doxorubicin and cyclophosphamide (AC) have been evaluated. Unfortunately, the addition of these chemotherapeutic agents to standard treatment with doxorubicin afforded no significant increase in survival times with median survival times of 172 and 179 days respectively. A dose intensified doxorubicin protocol has also been evaluated with doxorubicin being administered every 2 weeks instead of every 3 weeks, however median survival time was not statistically different from that of standard treatment methods. Intraperiotoneal administration of liposome encapsulated doxorubicin has been evaluated as the abdomen is a main site of progression of disease and thus it is logical to treat them with a drug that due to its liposome encapsulation and pegylated nature should have a longer half-life in the plasma. Unfortunately, again survival times did not vary significantly from those previously reported.

Tumors require angiogenesis for growth and thus anti-angiogenic drugs have been and are currently being heavily investigated for the use in a multitude of tumors. Minocycline, an antiangiogenic metalloproteinase agent with anticollagenase activity, was evaluated in combination with doxorubicin and cyclophosphamide for treatment of dogs with hemangiosarcoma. Regrettably, the addition of this drug revealed no significant survival advantage with an all too familiar median survival time of 170 days. Additionally continuous low dose chemotherapy with the combination of etoposide, cyclophosphamide, and piroxicam was evaluated in 9 dogs diagnosed with stage II splenic HSA. The goal of this study was to see if this combination of drugs, which targets the tumor neovasculature itself, would improve survival times in contrast to traditional therapy. Survival times of the dogs in this study were comparable to other previously established studies and known survival times.

Immune modulation via administration of a liposome-encapsulated muramyl tripeptide-phosphatidylethanolamine (L-MTP-PE), a synthetic derivative of a component of bacterial cell walls, in combination with chemotherapy afforded the longest survival times of all above novel treatment options. L-MTP-PE activates macrophages and monocytes leading to increased tumoricidal activity. While the survival time of dogs treated with this therapy (277 days) is the longest seen in the literature, there were an equivalent number of dogs with stage I as compared with stage II and this likely biased the results. Further study with a larger sample size of stage II HSA would be interesting but, studies have not been pursued further due to the lack of availability of this product to the veterinary community at this time, due to high cost and limited supply.

As immune modulation seems to be one of limited treatment options which may improve overall survival times in dogs with hemangiosarcoma, a vaccine prepared from lysates of allogenic canine HSA cell lines was evaluated in 28 dogs. Vaccines were given intraperitoneally once per week for 5 weeks then once monthly for three additional treatments. The vaccine was often given in combination with standard doxorubicin doses. Of the 6 dogs evaluated for antibody production, all 6 mounted a strong response to the vaccine and side effects were minimal. No statistically significant improval in survival time was seen.

Mast Cell Tumors:
The Good, the Bad, and the Ugly

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Mast cell tumors are one of the most common cutaneous tumors in the dog. Biologic behavior is variable and clinical outcome is best predicted by histologic grade. Grade I tumors are usually well differentiated, rarely metastasize and are associated with an excellent outcome. Grade II tumors are locally invasive, may spread to local lymph nodes, and uncommonly spread throughout the body. A population of intermediate grade (Patnaik grade II) MCTs appear to follow a more malignant course, spreading locally and to distant sites. Additional factors are often considered in attempt to predict the behavior of grade II tumors. Grade III tumors are usually anaplastic and locally aggressive, with a high rate of metastasis. These tumors are not cured typically, but many dogs can have extended remissions if tumors are caught early and treated aggressively. In practice, deciphering which MCTs will behave aggressively can be difficult, making prognosis and optimal treatment challenging to predict. Consideration of a number of clinical (tumor size, clinical signs, etc.) and histologic factors (mitotic index, c-kit, etc.) can be used to help the clinician best present to and guide clients through a wide range of diagnostic and treatment options.

Diagnosis and staging

In most cases, MCTs can be easily diagnosed via fine needle aspirate and cytology with the rapid hematologic-type stains used in most practices. A small percentage of MCTs may have poorly staining granules, in which case a Wright-Giemsa or toluidine blue stain may be necessary. If histopathology is required for diagnosis, careful consideration of tumor location, size, and clinical factors is needed to plan for biopsy. When possible, wide excisional biopsy is preferred and incisional biopsy is uncommonly pursued in the author's practice.

Staging is important in the clinical evaluation of canine MCT patients; however, what constitutes adequate staging is controversial. In select cases, an extensive work-up may not be necessary. Generally speaking, a minimum database (complete blood count serum biochemistry profile) and regional lymph node cytology are recommended for all dogs with MCT. These diagnostics are typically inexpensive and quick to perform and are likely sufficient for cases where the tumor is amenable to wide surgical excision and no negative prognostic factors are present. Histologic assessment of a regional lymph node may be required for definitive diagnosis of regional metastasis if cytology is suspicious but not definitive for metastatic disease. If the tumor is in an undesirable surgical location or if negative prognostic factors exist, further staging with abdominal ultrasound is advised. Abdominal ultrasound is non-invasive and allows evaluation of spleen, liver, and intra-abdominal lymph nodes for metastatic disease. Fine needle aspirate of the spleen and liver are always advised if the organs look abnormal. Several studies have suggested that FNA of the spleen and liver is warranted in the case of clinically or histopathologically aggressive disease even if they appear normal on ultrasound. In the author's practice, splenic aspirate is strongly advised for any high grade II or III tumor or in the case of concerning clinical behavior (see prognostic factors). Thoracic radiographs rarely reveal metastasis. However, it is reasonable to pursue this as a pre-anesthetic screening and to rule out other unrelated disease processes prior to a surgical procedure. Bone marrow aspirate is rarely indicated.

Prognostic factors

Grade

Histologic grade is considered the most consistent prognostic factor available for canine MCT but should be interpreted in light of other prognostic factors when making treatment decisions. Histopathologic grading is complicated by inter-observer variation among pathologists. Currently, two forms of grading are reported in clinical practice. The most commonly utilized grading system is the Patnaik grading system (low- grade I, intermediate- grade II, high- grade III). More recently, a 2-tier histologic grading system (low, high) has been introduced for canine MCTs. The second system was developed in an attempt to compensate for some of the weaknesses of the Patnaik system. However, further validation is needed to determine if this is truly better at predicting behavior and clinical outcome.

Proliferation indices

Mitotic index (MI) is a strong predictor of overall survival in dogs. Using a cutoff of 5/10 high powered fields, dogs with a low MI (<5) had a median survival time of 80 months compared to 3 months for dogs with a high MI (>5). It is advisable that any tumor with a high MI is staged and treated as an aggressive MCT in practice.

Other markers of proliferation that have been evaluated include Ki67 (a protein in the nucleus that correlates with cell proliferation), AGNORs (argyrophilic nucleolar organizer regions), and PCNA. These require the use of special stains and are often included in the MCT prognostic panel. Interpretation of this panel can often be confusing for clinicians. At this point, it appears that Ki67 is most useful clinically as a prognostic factor for intermediate grade tumors to help predict expected survival times when the clinical picture remains confusing based on other factors.

C-Kit

KIT (a receptor tyrosine kinase) dysregulation has been implicated in the pathogenesis of MCT development and evaluated as a prognostic factor. While KIT staining patterns (cytoplasmic localization) may be associated with dysregulation and prognosis, clinical application of this as a prognostic factor remains challenging. Alternatively, the presence of c-kit activating mutations is strongly associated with a higher rate of local recurrence, metastasis, and death from disease and should be considered a poor prognostic indicator.

Tumor location

Some tumor locations may differ in behavior and prognosis. Subcutaneous tumors may have a better prognosis. Mucous membrane sites, subungual, and visceral tumors are associated with a worse prognosis. Conjunctival tumors and those of the eyelid margin may be an exception with studies showing prolonged survival after surgery alone. Perioral and muzzle MCTs have an increased risk of locoregional metastasis yet prolonged median survival times despite the higher rate of lymph node metastasis. Scrotal and preputial tumors may be associated with a worse prognosis but this remains controversial.

Clinical stage

Higher stage disease is associated with a worse prognosis. The effect of lymph node metastasis on outcome may be dependent on grade of the primary tumor and how the lymph node is treated. Thus, clinical judgment is important. Multiple tumors may not negatively affect prognosis.

Other factors

Local recurrence, systemic and local clinical signs, growth rate, and tumor size have all been correlated with prognosis and should be considered in the overall evaluation of a patient's tumor.

Treatment options

Primary therapy

Wide surgical excision is the primary treatment of choice for tumors localized to the skin and subcutaneous tissues. Adequate tissue margins may be related to grade; however, grade is often unknown prior to therapy. At least 2-3 cm lateral margins and one tissue plane deep is generally recommended; 2 cm margins are likely adequate for grade I and II tumors. One study found no local recurrence at 2 years for primarily low to intermediate grade tumors removed with a lateral histologic margin of >10 mm and a deep histologic margin of >4 mm. However, histologic margin size may not accurately reflect margin size at surgery. Histopathology is advised for every tumor to determine grade and evaluate margins. The majority of low and intermediate grade tumors are cured with adequate surgical excision. Occasionally, external beam radiation therapy (RT) may be used as a primary treatment in cases of non-resectable tumors. Approaching the dog with multiple mast cell tumors can be challenging and primary therapy should be considered on a case by case basis.

Adjuvant local therapy

Adjuvant local therapy should be discussed with pet owners when adequate margins cannot be achieved due to location or histologic assessment reveals incomplete or narrow excision. Unfortunately, confusion exists regarding which tumors require additional treatment due to varied reports of local recurrence rate in incompletely and narrowly resected tumors (ranging anywhere from about 12-60%). When local therapy is being considered, grade, proliferation indices and c-kit status may be helpful in determining which cases would benefit. The implication of regrowth based on location may also play a factor in discussion with owners regarding the importance of adjuvant therapy. Standard of care options include primary re-excision and radiation therapy, both of which have been found to reduce local recurrence rates and increase survival times. MCTs are radiosensitive and 75-96% of dogs will have a local cure with adjuvant radiation therapy. An alternative option is electrochemotherapy (when available) which shows initial promise in improving local control for incompletely removed tumors.

Systemic therapy

Chemotherapy or tyrosine kinase inhibitors (TKIs) should be offered following excision of tumors in dogs with poor prognostic indicators (grade III, high mitotic index, metastasis, poor location, etc.). High grade and metastatic mast cell tumors are unlikely to be cured, but adjuvant therapy may improve disease free intervals and survival times. Vinblastine and lomustine are commonly used traditional chemotherapy agents. Response rates range from 11-64% when used against bulky disease; however, chemotherapy is more successful against microscopic disease. A variety of chemotherapy protocols exist. A combination vinblastine/prednisone protocol is preferred as a first-line protocol for adjuvant therapy in the author's practice (weekly therapy for 4 treatments and then biweekly therapy for 4 treatments). If the initial vinblastine dose is well tolerated (2 mg/m2), dose escalations (increases of 0.25 mg/m2 at a time up to 3.5 mg/m2) should be considered in an attempt to improve efficacy. Lomustine (CCNU) is typically dosed every 2-3 weeks

and requires close monitoring due to potential for myelosuppression and hepatotoxicity. Denamarin is recommended as supportive therapy for any dog treated with lomustine. Paclitaxel (Paccal Vet) has also recently been evaluated and appears to be safe and clinically effective for gross disease (complete or partial response 59%). However, the role of this agent in the adjuvant setting has not yet been defined. Metronomic chlorambucil may also be a consideration in cases where dogs have failed other therapies or a lower cost alternative is desired.

Toceranib phosphate (Palladia) and masitinib (Kinavet) are orally administered TKIs that have efficacy against gross disease. While these drugs can be considered as adjuvant treatment, there is no data currently to define the efficacy of TKIs alone in the adjuvant setting. In the author's practice, toceranib is discussed as an option for primary adjuvant therapy in cases when an owner declines intravenous treatment for their pet or subsequent to traditional chemotherapy when the presence of a c-kit mutation is known. In the treatment of bulky disease, Toceranib has a response rate of about 40% (~60% if stable disease is included). While dogs with KIT mutations were more likely to have a response than those without (69% vs. 37%), routine testing prior to toceranib therapy is probably not indicated for bulky disease as tumor response will guide therapy. Adverse effects include GI toxicity, mild to moderate leukopenia, and occasional muscle pain or mild PLN. Tolerability of toceranib improves when doses lower than the label dosage are used (2.5-2.75 mg/kg EOD or M,W,F). Combination of toceranib with vinblastine chemotherapy and palliative radiation therapy has also been studied.

Masitinib is conditionally approved for the treatment of nonresectable grade II or III cutaneous MCTs as a first-line therapy. Treatment with masitinib (12.5 mg/kg daily) has been shown to improve time to progression and survival rates at 12 and 24 months for dogs harboring activating c-kit mutations. Thus, this drug can provide the potential for long-term disease stabilization in some dogs. Adverse effects include mild GI toxicity, mild myelosuppression, occasionally PLN, and rarely hemolytic anemia. An appropriate monitoring schedule is important when treatment with oral TKIs is employed. When significant adverse effects are noted, treatment is typically discontinued for a period of time. In the author's experience, it can often be restarted at a lower dose.

Ancillary therapy

Histamine blockers (H1 and H2) are indicated for cases when gross disease is present, either preoperatively or in the palliative setting for nonresectable masses/ metastatic disease. Diphenhydramine (2 mg/kg BID-TID) and famotidine (0.5 mg/kg QD-BID) are common choices.

Clinical management of mast cell tumors can be challenging due to the wide range of biologic behavior. Although many cases are cured with adequate local therapy, the use of prognostic indicators discussed can help guide the clinician in determining which tumors are more likely to behave aggressively, and thus, become life-threatening for the dog. When clear poor prognostic factors exist, complete staging and adjuvant therapy is strongly advised. However, uncertainty regarding prognosis may remain in some cases despite our best efforts to define tumor behavior. This highlights the importance of owner education and clinical judgment in selecting appropriate diagnostic and therapeutic options.

Transitional Cell and Prostate Carcinomas: Best Therapeutic Options

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

Transitional cell and prostate carcinoma continue to be problematic diseases in our canine patients. Tumors are often locally advanced at diagnosis and the location of disease frequently limits surgical options and results in dysuria or obstruction of the urinary tract. Additionally, as advancements in primary tumor control are made, the rate and impact of distant metastases becomes greater. Despite these challenges, treatment options are available that may afford dogs improved quality of life and extended survival time.

Transitional cell carcinoma (TCC) is the most common tumor of the urinary bladder and affects tens of thousands of dogs each year. Risk factors for development of TCC include both heritable genetic factors and environmental exposures. Breeds at an increased risk of developing TCC include Scottish Terriers Eskimo dogs, Shetland Sheepdogs, West Highland White Terriers, Keeshonds, Samoyeds, and Beagles. Owners of such breeds should be educated on the risk of TCC and informed of concerning clinical signs related to the urinary tract.

Prostatic cancer may be either TCC or prostatic carcinoma (PC). Prostatic carcinomas are less common, representing less than 1% of canine tumors. The etiology of prostatic carcinoma is unknown although high grade prostatic intraepithelial neoplasia (PIN) has been detected in dogs with and without prostatic carcinoma. Breeds at an increased risk include Bouvier des Flandres, Doberman pinscher, Shetland sheepdog, Scottish terrier, beagle, miniature poodle, German shorthaired pointer, Airedale, and Norwegian elkhound. The risk of both TCC and prostatic adenocarcinoma may be increased in neutered dogs. Both TCC and prostatic carcinoma are of particular interest due to similarities between dogs and humans and the potential for translation of research between species.

Presentation and diagnosis

Dogs with both TCC and prostate carcinoma commonly present with hematuria, stranguria and pollakyuria. In addition, tenesmus and dyschezia may occur secondary to prostate tumors or enlarged regional lymph nodes. Since these tumors predispose dogs to bacterial infections of the urinary tract, temporary improvement or resolution of clinical signs may occur with antibiotic therapy. When evaluating dogs with signs related to the urinary tract, neoplasia should be considered and further investigation pursued if no bacterial infection is present, response to therapy is transient or incomplete, or if the breed is at high risk for TCC or prostatic carcinoma. Clinical signs of local invasion and distant metastatic disease may also be present.

Evaluation of dogs with suspected TCC or prostate carcinoma often begins with a thorough physical examination including a rectal exam, urinalysis, and imaging of the abdomen. Thickening and/or a mass of the bladder wall or urinary tract or an enlarged, irregular prostate increases suspicion for TCC or prostatic carcinoma, respectively. Finding abnormal epithelial cells in urine also increases suspicion. Cytology may be able to provide a diagnosis of carcinoma. However, histopathology is ultimately needed for definitive diagnosis. Samples may be obtained via surgical routes, cystoscopy, traumatic catheterization, FNA or prostatic wash depending on tumor type. Tumor seeding is a risk of percutaneous biopsy/FNA. Samples may be obtained from the primary tumor or metastatic lesions. The value of urine antigen testing for TCC has limited value due to false-positive results.

Staging

Canine TCC is most commonly located in the trigone region of the urinary bladder. Urethral involvement occurs in 56% of dogs and prostatic involvement occurs in 29% of male dogs. Almost 80% are invading the bladder wall (T2) and 20% invade nearby organs (T3). Metastasis is present in about 20% of patients at diagnosis but more than half of dogs at death. Canine prostatic tumors are both locally invasive and have a high rate of regional and distant metastasis (~80%). Lymph node and lungs are the most common sites but skeletal metastasis (especially lumbar vertebrae and pelvis) occurs in 22-42% of patients. Staging should include CBC, serum chemistry profile, urinalysis and culture, thoracic radiographs, abdominal radiographs and/or abdominal ultrasound, +/- urinary tract imaging. Abdominal ultrasound is most often employed to monitor tumor response; however, a standardized protocol is often necessary for this to be accurate.

Treatment

Systemic medical therapy

The mainstay of TCC and prostate carcinoma treatment is sytemic medical therapy with chemotherapy, COX inhibitors, and a combination of these. The goal of therapy is remission or disease stabilization and improvement in clinical signs. The typical chemotherapy drugs employed are generally well tolerated and include mitoxantrone, vinblastine, gemcitabine, and platinum agents.

Doxorubicin and metronomic chlorambucil have also been investigated for TCC. The best outcomes are seen when COX inhibitors (such as piroxicam) are combined with chemotherapy agents. Mitoxantrone is most commonly used as a first line agent in the author's practice; vinblastine is also commonly used for TCC. However, many drugs are often employed sequentially throughout the disease course guided by tumor and clinical response as well as tolerability of therapy. With combination therapy for TCC, survival times can extend beyond a year with good quality of life. When chemotherapy is declined piroxicam used as a sole agent can provide palliation of clinical signs and a median survival time of about 6-8 months. In cases where piroxicam is not well tolerated, evidence supports deracoxib as a reasonable alternative. For prostate carcinoma, evidence supports a survival benefit with piroxicam or carprofen (~7 vs. 1 month) whereas the benefit of systemic chemotherapy is less clear.

Treatment of secondary urinary tract infections should be guided by culture and sensitivity results to minimize antibacterial resistance.

Surgery

Curative intent surgery has a limited role in dogs with TCC due to the typical trigonal location, extensive bladder wall invasion, multifocal lesions, or the presence of metastatic disease. It may be indicated for cytoreduction when small tumors are located away from the trigone; however, it is unclear if cytoreductive surgery augments the benefit of adjuvant therapy. Transurethral approaches (tumor removal via cystoscopy) including laser ablation are possible but less beneficial in canine patients compared to humans since disease is rarely superficial. The benefit of including this type of therapy in a multi-modal approach is unknown but may be considered in select cases when owners are highly motivated. Surgery is also generally palliative for prostatic carcinoma and prostatectomy or electrosurgical transurethral resection is generally recommended only for dogs with early stage disease. Importantly, complications are common and survival benefit is limited; careful case selection is necessary.

Palliative surgical procedures to maintain urine flow are possible for both tumors and include prepubic cystotomy catheters and placement of urethral stents. Placement of urethral stents is preferred since there are no external components or owner maintenance. Complications can occur and the median survival time after stent placement is limited (about 1-2 months) but owners are generally satisfied with the outcome.

Radiation therapy

The use of radiation therapy (RT) to treat TCC and prostate carcinoma is challenging due to change in bladder location and shape. Because of this, large fields are needed and complications in surrounding normal tissues are common. Advances in RT technology (IM-IGRT/ SRT) may allow more targeted and controlled delivery to local disease and preliminary information shows promise for increased survival times when combined with chemotherapy and NSAIDs. Currently, the benefit of adding coarse-fraction external beam RT to systemic therapy is questionable but there may be a place for palliation of urinary tract obstruction or clinical signs relating to local disease or skeletal metastases in select cases.

Intravesicular therapy for TCC

Partial remission and stable disease have been documented in dogs treated with chemotherapy delivered directly into the bladder. Significant systemic absorption occurred in some dogs and response was not superior to systemic therapy. However, this treatment may be considered for select cases or dogs that have failed other therapies.

Emerging therapies

New strategies currently under investigation include folate targeted therapy; a bladder cancer specific peptide (PLZ4) targeted therapy, and demethylating agents.

Plasma Cell Tumors: The Interesting Cancer

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

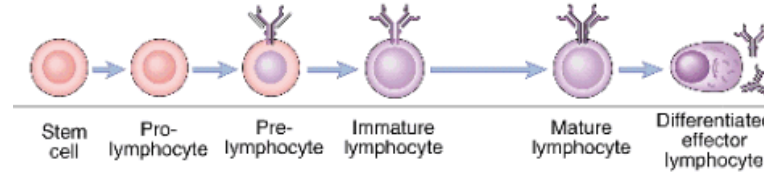
Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

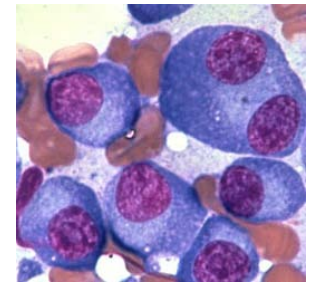
The plasma cell is of lymphoid lineage and specifically a terminally differentiated B-lymphocyte. Based upon its origin, plasma cells have the capacity to produce immunoglobulins, which under physiologic conditions preserve immune competence and protect the host organism from extracellular pathogens. Like any normal cell, malignant transformation can occur and give rise to a cancerous population of plasma cells. There are a number of disease conditions comprised of malignant plasma cells and include multiple myeloma (MM), solitary osseous plasmacytoma (SOP), extramedullary plasmacytoma, and in felines a syndrome known as myeloma-related disorder in which cancerous plasma cells infiltrate visceral organs.

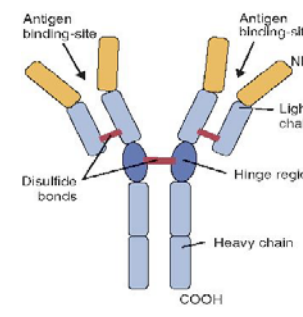
In dogs and cats, the cause of plasma cell cancers is largely undetermined; however, given the role of plasma cells in mucosal immunity, there has been some speculation that chronic antigen stimulation might promote the development of these malignancies. Anecdotal and clinical support for this speculation would be the common anatomic regions affected by plasma cell tumors including the interdigital regions, oral cavity, and gastrointestinal tract, which are systems commonly in contact with environmental antigens. Multiple myeloma is the most common plasma cell malignancies to cause systemic signs of illness, and will be the focus of this review.

Pathology and natural behavior

Clonal origin plasma cell proliferating systemically (usually within multiple bone marrow sites) producing immunoglobulin. Neoplastic cell of origin is the terminally differentiated B-lymphocyte (plasma cell), which normal function is to produce specific immunoglobulin to recognize pathogenic antigens (neutralization, agglutination, and opsonization).



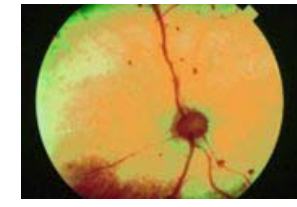




Physical appearance of the cells varies markedly between patients (can be very bizarre). Immunoglobulin produced in excess (a.k.a. M component or paraprotein), usually complete immunoglobulin but sometimes just a portion of the molecule (light chains only = Bence Jones protein, heavy chains only = heavy chain disease). Remember that fully function immunoglobulin is a heterodimer (2 light chains binding with 2 heavy chains).

The M component is usually IgG or IgA. If the M component is IgM, it is called macroglobulinemia or Waldenstrom's macroglobulinemia. Cryoglobulins are paraproteins that precipitate at temperatures <37º C, causing cutaneous lesions in extremities (colder areas). The M component can cause multiple problems for the patient. Infection is a major problem, and arises because excessive production of the paraprotein inhibits production of normal immunoglobulin, patients are considered to be 'immunologic cripples'. Hyperviscosity syndrome arises secondary to the massive amounts of paraprotein present. The severity of the serum hyperviscosity is related to the type, size, shape and concentration of the M component. Hyperviscosity necessitates increased perfusion pressure to maintain vascular flow and also causes hypervolemia both of which increase the cardiac workload and can cause cardiomegaly. Combine this with myocardial hypoxia secondary to poor vascular perfusion and heart failure may result. Neurologic abnormalities including lethargy, ataxia and seizures occur because of poor perfusion. Bleeding problems (hemorrhagic diathesis) occur in about 1/3 of dogs with myeloma.

Bleeding may be caused by M-components 1) inhibiting platelet aggregation and release of activating factors 2) adsorbing minor clotting proteins 3) generating abnormal fibrin polymerization 4) producing a functional decrease in calcium. Thrombocytopenia will play a role in bleeding also. Renal failure can be caused by the high protein content in the glomerular filtrate, as a consequence of tubular obstruction by proteinaceous casts, amyloidosis, ascending pyelonephritis, tumor

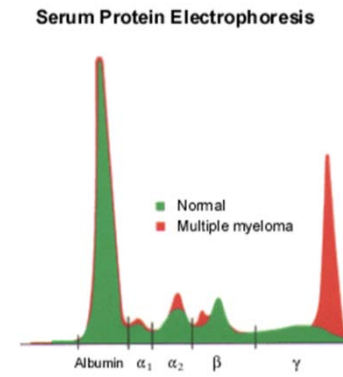


infiltration, and decreased perfusion secondary to hyperviscosity. Retinal lesions are another sequelae of hyperviscosity. Changes include dilated and tortuous retinal vessels and retinal hemorrhages.

History and physical examination

Animals may present with nonspecific signs of weakness, PU/PD, pain, lethargy, or inappetance. More specific signs include epistaxis and gingival bleeding or signs due to a compressive lesion or fracture. Rarely, dogs will present with neurologic signs. PE is often nonspecific, try to localize pain if possible (palpate along limbs and spine).

- CBC may reveal anemia (secondary to either anemia of chronic disease, blood loss, or red blood cell destruction secondary to high serum viscosity, or myelophthisis).
    - Neutropenia and thrombocytopenia will be seen first if myelophthisis is present.
    - Thrombocytopenia may also be immune-mediated.
- Serum chemistry will show hyperglobulinemia (> 90%) and hypercalcemia (15 - 20%). Renal failure is seen in 33-50% of dogs (secondary to poor perfusion).
- Serum electrophoresis should be performed to characterize the globulinemia as monoclonal or polyclonal.
- Urine can be evaluated for Bence-Jones proteins. This requires heat precipitation or electrophoresis, as commercial urine dipstick methods will not detect these proteins.
- Bone marrow aspirate reveals > 10% infiltration of plasma cells.
- Survey skeletal radiographs evaluating specifically for osteolytic (punched out) lesions. Sites most commonly affected include the vertebral bodies, ribs, pelvis, skull and proximal long bones.
    - Biopsy or fine needle aspirate of osteolytic lesions may be needed for diagnosis.
- Demonstration of two or more of the following strongly supports the diagnosis:
    1. Bone marrow plasmacytosis
    2. Presence of osteolytic bone lesions (No osteoproliferation)
    3. Hyperglobulinemia with monoclonal gammopathy
    4. Bence-Jones proteinuria



Prognostic factors

Negative prognostic factors are somewhat intuitive and include:

- Hypercalcemia
- Bence-Jones proteinuria
- Extensive osteolytic bone lesions
- Renal Failure
- Severe hyperviscosity

Treatments options and long term prognosis

- Fluid therapy
    - Intravenous fluid therapy is often needed initially to correct dehydration, improve cardiovascular status, and manage hypercalcemia and azotemia. Treatment with isotonic saline solution is preferred over other fluids in the initial management of hypercalcemic patients.
- Antibiotics
    - Antibiotic therapy may be needed to treat concurrent infections, such as urinary tract infection or bacterial pyoderma, as these can progress to life-threatening infections if left untreated.
- Palliative radiation
    - Neoplastic plasma cells are sensitive to irradiation, and radiation therapy is a highly effective palliative treatment for MM since it can relieve discomfort and quickly decrease the tumor burden. Indications for radiation therapy include painful bone lesions, spinal cord compression, pathologic fracture (after fracture stabilization), or a large soft tissue mass.
- Bisphosphonates
    - Bisphosphonates, such as pamidronate, may be useful in managing hypercalcemia as well as decreasing osteoclastic bone resorption and bone pain. The recommended dose of pamidronate is 1 to 2 mg/kg given intravenously in dogs and, anecdotally, 1 mg/kg given intravenously in cats every 21 to 28 days. Prior to administration, evaluate renal function; dilute the pamidronate in saline solution (amount based on the size of

the patient) and administer as a slow infusion over two hours to minimize renal toxicities. Aminobisphosphonates are an essential component of therapy for MM in people, and their use is associated with significantly reduced skeletal-related events and improved survival in some studies.

- Analgesics
    - Dogs and cats with MM may experience moderate to severe pain; treating for this pain is a priority. Pain may be relieved by treating the underlying cancer and providing various analgesic therapies and supportive care.
- Chemotherapy
    - Although a cure is unlikely, MM can be a rewarding disease to treat since chemotherapy can greatly extend the quality and duration of life. The chemotherapy drugs most often used are alkylating agents, usually melphalan, combined with corticosteroids. However, eventual relapse during therapy is anticipated.
    - The overall response rate for dogs treated with melphalan and prednisone chemotherapy is 92%, with 43% of dogs achieving a complete response and 49% achieving a partial response. The median survival time of dogs treated with this drug combination is 540 days, which is significantly longer than the survival time of 220 days in dogs treated with prednisone alone.

Nasal Tumors:
Differentials and Treatment Options

Timothy Fan, DVM, PhD, DACVIM
University of Illinois
Urbana, IL

Kathryn Wycislo, DVM, DACVP
University of Illinois
Urbana, IL

The nasal cavity is comprised of various cell types which provide secretory and structural functions. As such, the malignant transformation of cells within the nasal passage often gives rise to tumors of epithelial or mesenchymal origin. Primary tumors of the nasal cavity account for approximately 1-2% of all neoplasms in dogs. In the majority of cases, nasal neoplasms are histologically malignant and are capable of regionally invasive and expansive growth patterns which invade into the nasal passages, frontal sinuses, and cranial vault cavity. With lower frequency, nasal tumors can eventually spread to regional and distant sites, which include the draining lymph nodes and lungs, respectively. Histologically, carcinomas are more common than sarcomas, and account for 60% to 78% of all nasal tumors. In the majority of descriptive studies, adenocarcinoma was most common (45%) histologic subtype, followed by squamous cell carcinoma (20%), chondrosarcoma (14%), undifferentiated or anaplastic carcinoma (11%), and unspecified carcinoma (10%). Nasal tumors are less commonly diagnosed in felines than dogs, but nonetheless are malignant in greater than 90% of affected cats. Lymphoma and carcinoma are the most common types of nasal tumor diagnosed in cats.

Pathology and clinical symptoms

Nasal tumors are characterized by rapid and progressive local tissue invasion, but a low metastatic rate. Humane euthanasia of dogs diagnosed with nasal tumors is the result of local tumor progression rather than development of metastatic disease. Although the incidence of regional and distant metastases for nasal tumors is relatively low (less than 30%), the histologic subtype may influence both localized and metastatic behaviors. Carcinomas may be subcategorized as being less or more aggressive. In general, highly undifferentiated and anaplastic carcinomas, as well as squamous cell carcinomas, prove more difficult to treat in dogs. Consequently, dogs suffering from anaplastic carcinoma or squamous cell carcinoma generally survive for shorter periods of time in comparison with dogs diagnosed with nasal adenocarcinoma. Median survival time of dogs with aggressive carcinomas and less aggressive carcinomas has been reported to be 7.2 and 11.9 months, respectively. Nasal tumors arising from mesenchymal origin, in particular chondrosarcoma appear to be less aggressive, with dogs achieving median survival durations approaching 2 years.

Given their growth within the nasal passage, many dogs remain asymptomatic for many months until tumor burden is substantial and occludes airflow or erodes through bone and blood vessels. The most common clinical signs seen in animals with nasal tumors include epistaxis, facial asymmetry, non-hemorrhagic nasal discharge, and sneezing. Physical examination findings may include stertorous breathing, enlarged mandibular lymph nodes, neurologic signs, decreased retropulsion of the eye(s), exophthalmus, ocular discharge resulting from nasolacrimal duct obstruction, and overt facial bone deformation. Although the presence of facial deformity is highly suggestive of a cancerous process, other differential diagnoses should include fungal or bacterial rhinitis, foreign body, trauma, developmental abnormalities, and dental pathology. Epistaxis is a common clinical sign in dogs and cats diagnosed with nasal tumors. The majority of dogs (~85%) with nasal neoplasia will manifest with frank hemorrhagic or serosanguinous nasal discharge, which correlates with a poorer prognosis.

Diagnosis and staging

Presumptive diagnosis of nasal passage cancer can be made based upon multiple clinical and physical findings, as well as patient signalment. However, baseline diagnostics which should be considered in any patient with presumed nasal tumor might include the following:

- Complete blood count
    - Anemia: secondary to hemorrhage
        - Uncommon to have severe blood loss
- Serum chemistry panel
    - Usually unremarkable
- Coagulation panel and buccal mucosal bleeding time
    - Rule out systemic coagulopathy for epistaxis
- Systemic blood pressure and fundoscopic examination
    - Rule out systemic hypertension for epistaxis
- Regional lymph node aspiration and cytology

    - Determine if malignant population of cells have regionally spread to dependent lymph node (uncommon)
- Thoracic radiography
    - Determine if malignant population of cells have distantly metastases to the pulmonary parenchyma (uncommon)
- Skull radiography
    - Evaluate for asymmetry
        - Filling defect on affected side, contrary to findings with fungal rhinitis (lysis)
        - Insensitive measure for identifying nasal pathology
- Computed tomography
    - Identification of mass effect
    - Identification of associated bony lysis and proliferation
    - Highly sensitive imaging modality for detecting nasal pathology
- Cytology
    - Feasibility is dependent upon location of primary tumor and ability to sample with needle
- Biopsy
    - Preferred method of definitive diagnosis
    - Several different methodologies for sample retrieval
        - Blind intranasal sample collection with forceps or curette
        - Rhinoscopic assisted biopsy (space and visual constraints)
        - Otoscopic transilluminator guided biopsy for rostral lesions
        - Open rhinotomy biopsy (not generally performed, high morbidity)
        - Hydropulsion with nasal flushing and dislodgment of tissue fragments

Nasal tumor treatment options

Radiation Therapy

The delivery of ionizing radiation with megavoltage therapy machines have been used for curative intent and palliative therapy for nasal tumors. Radiation therapy has the advantage of treating the entire nasal cavity, including bone, and its use has been associated with the greatest improvement in survival when compared to non-radiation treatment options. Despite the inability to cure the majority of dogs treated with radiation therapy, many patients enjoy relatively long durations of local disease control, improved clinical symptoms, and increased quality of life scores.

Definitive Treatment

Radiation therapy with curative intent has been previously described as a sole treatment option of nasal tumors in dogs. Conventional protocols require the administration of small fractions (3-4.2 Gy) repeatedly (10-19 treatments) on a daily or every other day basis for a total radiation dosage of 40 to 57 Gy. With the advancement in radiation technologies, it has become possible to "sculp" the radiation field to the contours of tumors within the nasal passages, thereby minimizing adverse effects to surrounding normal tissues. Advanced radiation units which allow for conformal targeting of tumor tissues include stereotactic radiosurgery and intensity-modulated radiation therapy. The use of stereotactic radiosurgery and intensity-modulated radiation therapy have not definitively proven improvements in survival time for treated patients, however, their remarkable precision with depositing radiation lessens undesirable acute and late radiation side effects, thereby attenuating unnecessary patient treatment-related morbidity.

Radiation therapy with surgery

Some debate exists over the utility of combining radiation therapy with surgical resection for the management of canine nasal tumors. For the majority of patients diagnosed with nasal cancer, cytoreductive surgery is not deemed possible or favorable for improved outcome, given the highly invasive properties of nasal tumors and the confined anatomic region of involvement.

The vast majority of studies do not demonstrate any added benefit when surgery is combined with radiation therapy for the localized management of nasal tumors. However, in patients with small and ventrally confined nasal tumors which can be surgically approached through the soft palate, the combination of radiation therapy with surgery might be an option which improves overall disease control durations without and unacceptable increase in patient morbidity.

Radiation therapy with chemotherapy

Systemic chemotherapy has been classically indicated for the treatment of disseminated metastatic disease. However, the achievement of high local concentrations within the primary tumor microenvironment may allow for systemic chemotherapy to exert direct anticancer activities, which may contribute to the localized control of various cancers, including nasal tumors. However, given the paramount role of ionizing radiation for the management of nasal tumors, the inclusion of systemic chemotherapy for the treatment of nasal cancer has been as a radiosensitizer, rather than a direct cytotoxic agent. Various small descriptive studies have been conducted in veterinary medicine to support the potential benefit of combining radiation therapy with a radiosensitizing chemotherapeutic agent such as cisplatin or carboplatin. Collectively, the anecdotal evidence would suggest the feasibility of combining platinum agents with

radiation therapy, without unacceptable toxicity; however, historical studies have been inadequately designed to determine if any therapeutic benefit is achieved with this rational combination approach.

Palliative radiation therapy

The goal of palliative radiation therapy is to reduce tumor burden and improve quality of life. Most commonly, palliative radiation protocols deliver large fractions of radiation (6-8 Gy fractions) once to twice weekly for a total of 4-6 treatments. This palliative dosing strategy typically ameliorates clinical symptoms associated with disease, however is insufficient to dramatically reduce tumor burden for prolonged periods of time.

Ocular Emergencies

Emily Moeller, DVM, DACVO
Eye Care for Animals
Tucson, AZ

Diagnosis and management of ophthalmic emergencies can be challenging, however diagnosing the source of a red or painful eye, ocular clouding or vision loss can be simplified with an organized, strategic approach and a few basic diagnostic tests. Some common ocular emergencies and treatment options will be outlined below.

Ocular proptosis

Ocular proptosis is often the result of blunt periocular trauma or increased pressure applied to the posterior periocular tissues. It occurs most commonly in brachycephalic breeds as a result of their shallow orbits and lagophthalmos. Unfortunately, the prognosis for vision in any proptosed eye is guarded. In a 1995 retrospective study of 84 cases of proptosis, only 27% of eyes were visual at follow-up evaluation. Positive prognostic indicators for vision noted in that study included a brachycephalic conformation, intact direct pupillary light reflex (PLR) or consensual PLR to the contralateral eye at presentation, intact vision at presentation, and normal funduscopic exam findings. Negative prognostic indicators for vision included hyphema, a non-brachycephalic facial conformation, absent vision and PLR, facial fractures and visible optic nerve damage on fundoscopy. Interestingly, pupil size was not related to outcome in the study. The recommended treatment for proptosis almost always involves either reduction of the proptosis with placement of temporary tarsorrhaphy sutures or enucleation. Prior to surgery, owners should be counseled that proptosed globes are at risk of lateral strabismus, keratoconjunctivitis sicca, reduced corneal sensation/neurotrophic keratitis and vision loss. The decision to attempt to save a proptosed eye should be made with the above considerations in mind. Proptosed globes with 3 or more avulsed extraocular muscles should be enucleated. Proptosis in the cat is almost universally blinding and enucleation is recommended in this species. Reduction of the proptosis is usually performed under general anesthesia. The eyelids are retracted away from the posterior aspect of the globe, either with the use of atraumatic forceps or pre-placed sutures, and gentle pressure is applied to the globe to reposition the globe into the orbit. Once the proptosis is reduced, non-absorbable suture (generally 4-0) is used to place tarsorrhaphies. Horizontal mattress and simple interrupted patterns are commonly used. Stents may be placed per surgeon's preference. Usually a small opening is left adjacent to the nasal canthus to allow for application of topical medication. The patient should be discharged with systemic anti-inflammatories, topical lubricating agents and generally, systemic antibiotics. The tarsorrhaphies should stay in place for 2 weeks, or until the periorbital swelling has resolved. Tear production should be evaluated periodically.

Exophthalmos-inflammatory orbital disease/orbital cellulitis

Retrobulbar disease is generally either inflammatory, infectious or neoplastic in nature. The most common sign of retrobulbar disease is exophthalmos, which may be combined with third eyelid elevation, globe deviation, reduced/absent retropulsion and corneal exposure. Orbital cellulitis is a general term for retrobulbar inflammatory disease and is generally acute in onset, is often associated with pain on manipulation of the mandible, may be associated with pyrexia, and is often unilateral. Close evaluation of the soft tissue caudal to the ipsilateral second maxillary molar may reveal a notable swelling in the case of an associated abscess. The underlying cause is often unidentified, though an underlying penetrating trauma or foreign body, dental disease, infection of the zygomatic salivary gland, and hematogenous seeding of bacteria have been proposed. *Staphylococcus* spp, *E. coli, Pasteurella multocida, Bacteroides* spp and *Clostridium* spp have all been identified on culture of orbital abscesses, although bacterial cultures are occasionally negative. A tentative diagnosis can be reached through clinical examination and confirmed with orbital ultrasound, CT or MR. Treatment includes transoral lancing (+/- antibiotic lavage), broad spectrum systemic antibiotics, systemic anti-inflammatories and topical lubrication. In a 2009 retrospective study evaluating aerobic culture and sensitivity results of material isolated form orbital abscesses, mixed infections were common. In dogs, antibiotic sensitivity to amikacin, ceftiofur, gentamicin, imipenem, ticarcillin and trimethoprim–sulfamethoxazole was high, while sensitivity to ampicillin, clindamycin, erythromycin and penicillin was low. Bacteria isolated form the orbit of cats did not exhibit a high degree of antibacterial resistance (Wang, et al, 2009). A temporary tarsorrhaphy is often recommended to prevent exposure keratitis while the swelling resolves. Inflammation caused by an unidentified tooth root abscess or foreign body is likely to recur. The prognosis is generally good, although vision loss can result from optic nerve damage caused by severe exophthalmos. Exophthalmos related to neoplasia is often slowly progressive and non-painful. Advanced imaging is often necessary to evaluate the retrobulbar space in these patients.

Deep corneal ulcer/malacia/laceration

Deep or penetrating ulcers or corneal lacerations generally require surgical intervention and should be referred to a veterinary ophthalmologist. Topical and oral broad spectrum antibiotics, systemic analgesics and use of an Elizabethan collar are recommended in the interim. Systemic anti-inflammatories are also often of benefit to treat secondary uveitis. Administration of a topical mydriatic

agent (atropine or tropicamide) may prevent iris prolapse in an impending rupture. In general, topical solutions (rather than ointments) are recommended in ruptured corneas as ointments can be toxic to the corneal endothelium. Malacic ulcers should be treated temporarily with broad spectrum oral and topical antibiotics and serum/plasma q2-6 hours depending on the severity of stromal loss and associated malacia.

Glaucoma

Common clinical signs of acute glaucoma include blepharospasm, third eyelid elevation, episcleral congestion, corneal edema, mydriasis and vision loss. Acute glaucoma generally presents as a unilateral disease but may be bilateral, especially if secondary to other intraocular disease. A breed predisposition for primary glaucoma has been described in a number of breeds, including the Cocker Spaniel, Basset Hound, Chow, Beagle, Boston Terrier and many more. Emergency management of acute glaucoma can involve intravenous, oral and/or topical treatment.

Osmotic agents such as mannitol and glycerin are commonly used in emergency management of glaucoma due to rapid efficacy. **Mannitol** is administered IV at doses ranging from 1-2 g/kg over 30 minutes. The reduction in IOP generally begins within 30 minutes-1 hour with effects lasting from 6-10 hours. Mannitol is not metabolized and therefore can be administered to diabetic patients. It should be administered through a filter given its propensity to form crystals. **Glycerin** is easy to administer, inexpensive and does not require intravenous access or special storage. It is administered orally at a dose of 1-2 g/kg (for a 99% mannitol solution I generally administer 0.75mL/pound). A reduction in IOP should be observed within an hour of administration and can last as long as 10 hours. Administration may result in vomiting. Use of hyperosmotic agents is contraindicated in uveitic eyes due to increased blood-ocular-barrier permeability of inflamed eyes. They should not be administered with fluids (and water should be withheld for ~2 hours post-administration). Due to the expected increase in intravascular volume associated with these agents, hyperosmotics should not be administered in patients with significant cardiovascular disease.

Carbonic anhydrase inhibitors inhibitors inhibit formation of bicarbonate in the ciliary body that is necessary for production of aqueous humor. Commonly used topical agents include **dorzolamide** (Trusopt®) and **brinzolamide** (Azopt®). Oral CAIs include **methazolamide** and **acetazolamide**. Dorzolamide is available as a generic and is fairly cost effective. Topical CAIs can be administered 2-3 times daily. Maximum efficacy may take 4-5 days to achieve but decreased aqueous humor production occurs within 30 minutes – a few hours of dosing. The topical CAIs can be used in dogs and cats and are effective in both species. They can be used in all types of glaucoma, have no effect on pupil size, and do not contribute to intraocular inflammation. These drugs have a slower, less dramatic effect on IOP and therefore should not be used alone as management for high pressure acute glaucoma.

Prostaglandin analogs appear to be the most effective drugs in the treatment of canine glaucoma. These drugs increase aqueous ouflow (with no effect on aqueous production). The mechanism of action is mediated through binding to prostanoid FP receptors. The most commonly prescribed prostaglandin analog in veterinary medicine is **latanoprost** (Xalatan®), which is now available as a generic. Other available PG analogs include **bimatoprost** and **travaprost**. In the cat, latanoprost and other PG analogs are ineffective because activation of prostanoid **EP** receptors is required for similar effects in this species. The prostaglandin analogs are generally administered q12h in dogs (once daily in humans). In the dog, PG analogs result in maked miosis and because they work through activation of inflammatory mediators, should not be used in cases of secondary glaucoma caused by anterior lens luxation or chronic uveitis.

Uveitis

Clinical signs of dogs and cats with uveitis include blepharospasm, corneal edema and miosis. Intraocular pressure may be decreased or elevated, depending on the chronicity of the inflammation. Uveitis can present as either unilateral or bilateral disease. In cats and blue-eyed dogs, a change in iris color may be appreciated due to vascular congestion of the iridal blood vessels. Causes of uveitis are numerous, and include idiopathic, inflammatory/auto-immune, infectious, neoplastic and traumatic etiologies. Baseline bloodwork (CBC/Chem) and infectious disease screening for tick-borne, fungal, bacterial and, in cats, viral diseases endemic to your area are recommended. Treatment involves topical (ie pred acetate q6h) and oral (steroids or NSAIDs, depending on your index of suspicion for infectious disease, the overall health of the animal and the severity of the inflammation) anti-inflammatories until the patient can present to an ophthalmologist. Additional screening may include thoracic radiographs, abdominal ultrasound, and in cases of suspected ocular trauma, radiographs of the head. Clients should be counseled that the workup and treatment of uveitis can be protracted, especially if rapid response to medications does not occur.

Hyphema

Like uveitis, hyphema can be the result of local (ie intraocular) or systemic disease. Causes of intraocular disease include intraocular neoplasia, retinal detachment, blunt or sharp trauma, and underlying intraocular vascular anomalies (more likely in a young animal). Systemic causes include hypertension, coagulopathies, and causes of severe uveitis including neoplastic or infectious diseases. Baseline diagnostics include a CBC/Chemistry and systolic blood pressure. An ocular ultrasound may be performed to evaluate for the presence of intraocular neoplasia and determine the status of the retina. The intraocular pressure should be evaluated as hyphema

can result in both short- and long-term elevations in IOP. Treatment is dependent on the underlying cause, however topical anti-inflammatories (ie pred acetate/neo-poly-dex/dex SP q6h) and, if the intraocular pressure is acceptable, use of a short-acting mydriatic agent (ie tropicamide q12h), may be of benefit in preventing secondary glaucoma.

Acute-onset blindness

Determining the source of acute bilateral vision loss can be complicated, but in a basic sense vision loss occurs from dysfunction of one of three structures: the eye, the optic nerve or the brain. Ocular sources of acute vision loss include glaucoma, cataract development, retinal detachment/retinal hemorrhage, or sudden acquired retinal degeneration syndrome (SARDs). Primary glaucoma does not generally develop in both eyes simultaneously but can present as bilateral vision loss if the 'first' eye has gone undiagnosed. Although glaucoma itself is a complex disease, its diagnosis generally is not (ie it can be ruled in or out via estimation of intraocular pressures). Cataracts, retinal detachment and retinal hemorrhage should be visible on ophthalmic exam. If the ophthalmic evaluation is unremarkable the primarily differential for an ocular source of vision loss is SARDs. Patients with SARDs generally have resting mydriasis with slow PLRs. The diagnosis of SARDs is confirmed with an electroretinogram, which evaluates the electrical activity of the retina. Patients with SARDs exhibit flat line retinal function, while non-retinal sources of vision loss should have a normally appearing ERG waveform. Unfortunately, no consistently effective, safe treatment for SARDs is available, and the cause remains unknown. Referral to an ophthalmologist should still be recommended so that the disease can be confirmed. Non-ocular causes of acute vision loss include optic nerve disease (ie optic neuritis), or central nervous system disease (infectious, inflammatory, neoplastic, etc). If the ERG findings are within normal limits, referral to a neurologist will be recommended.

References

Gilger BD, Hamilton HL, Wilkie DA, van der Woerdt A, McLaughlin SA, Whitley RD (1995) Traumatic ocular proptosis in dogs and cats: 84 cases. *JAVMA*, **206**(8). 1186-90.

Plummer, C.E., Regnier, A. & Gelatt, K.N. (2013) The Canine Glaucomas. In: *Veterinary Ophthalmology* (ed. Gelatt, K.N.), 5th ed., Vol.2, pp.1050-1145. Ames: Wiley-Blackwell.

Spiess, B.M. & Pot, S.A. (2013) Diseases and Surgery of the Canine Orbit. In: *Veterinary Ophthalmology* (ed. Gelatt, K.N.), 5th ed., Vol.2, pp.793-831. Ames: Wiley-Blackwell.

Wang, A.L., Ledbetter, E.C. & Kern, T.J. (2009) Orbital abscess bacterial isolates and *in vitro* antimicrobial susceptibility patterns in dogs and cats. *Veterinary Ophthalmology*, **12**(2), 91-96.

Funduscopic Exam

Emily Moeller, DVM, DACVO
Eye Care for Animals
Tucson, AZ

Fundic examination is an integral part of the complete ophthalmic evaluation and can be considered an important component of any physical exam. Direct ophthalmoscopy is the most common method for evaluation of the fundus, namely because the equipment is readily available in most practices. Indirect ophthalmoscopy requires minimal equipment, namely a light source and a focusing lens. The panoptic ophthalmoscope is a newer device that is becoming more commonly used and in many ways combines the advantages of the other two. For best visualization of the fundus, pupillary dilation and a dark environment are recommended.

Direct ophthalmoscopy- The direct ophthalmoscope provides a highly magnified view of the fundus and can be used for assessing the depth or length of depressed or raised fundic lesions, respectively. The image is real and upright. Disadvantages include the required close proximity to the patient and the high degree of magnification, which can make generalized evaluation of the fundus more difficult.

Indirect ophthalmoscopy- When compared with direct ophthalmoscopy, indirect ophthalmoscopy has the advantages of a longer working distance and larger field of view. Using a light source (penlight or transilluminator) and a converging lens, indirect ophthalmoscopy provides an inverted, reversed view of the fundus (ie a lesion that appears ventrolateral through the indirect lens is actually dorsonasal). The degree of magnification of the converging lens is inversely related to the dioptric power of the lens (ie a 28D lens provides a less magnified view than a 20D lens, and will therefore also provide a larger field of view). Another thing to keep in mind is that the larger the eye, the less magnification any given lens will provide, which is why an indirect lens that is appropriate for a dog or cat (ie 22-28D) may be too ‘zoomed out’ for a horse, for whom a 14-20D lens is more appropriate.

Panoptic ophthalmoscope (Welch Allyn)- The Panoptic provides a real, upright view of the fundus with a magnification strength somewhere between the direct and indirect methods. It provides an intermediate working distance from the patient as well.

Anterior Uveitis

Emily Moeller, DVM, DACVO
Eye Care for Animals
Tucson, AZ

Uveitis in its basic sense represents a breakdown of the blood-ocular barrier. In a healthy eye, the blood ocular barrier acts as a protective mechanism that regulates the constitution of intraocular contents. The blood-ocular barrier consists of a set of anterior chamber (blood-aqueous barrier) and posterior segment (blood-retinal barrier) vascular endothelial and epithelial tight junctions in the iris and ciliary body blood vessels, retinal capillaries and retinal pigment epithelium. Tissue injury, either of immune-mediated, infectious, neoplastic, etc etiology, results in release of inflammatory mediators (histamine, prostaglandins, kinins, plasmin, complement, peptide growth factors) that causes breakdown of these barriers. The breakdown of intracellular tight junctions allows for protein and inflammatory cell leakage and migration into the globe. This results in the classic clinical sign of anterior uveitis, known as 'flare'. The aqueous humor in health is clear, such that a slit beam of light crossing the anterior chamber will reflect off of the cornea and lens capsule, with no evidence of light transit through the anterior chamber. With flare, the beam of light reflects off of the proteins and cells that have accumulated in the anterior chamber, resulting in a visible light beam within the chamber. This effect is known as the 'Tyndall' effect. The classic example of the Tyndall effect is the light of an old movie projector bouncing off of dust in a theater. Breakdown of the blood-retinal barrier results in similar protein, fluid and cell accumulation posterior to the retina, resulting in subretinal fluid accumulation and possibly retinal detachment.

Common clinical signs of anterior uveitis include blepharospasm, epiphora, episcleral congestion, corneal edema, keratic precipitates and miosis. In blue eyed dogs and most cats, the iris may also appear discolored as result of iridal vascular congestion. The anterior chamber can exhibit flare, hyphema, hypopion, fibrin or all of the above. Adhesions may be present between the iris and anterior lens capsule ('posterior synechiae'). The intraocular pressure may be either low or high, depending on the chronicity of the inflammation. Uveitis can be either unilateral or bilateral regardless of the underlying cause. Unfortunately, the cause of the uveitis is only rarely evident based on the appearance of the eye. The majority of cases of uveitis are idiopathic and many will respond nicely to appropriate treatment. Unfortunately, however, uveitis can also be caused by almost any infectious, inflammatory or neoplastic systemic disease.

Infectious (taken from Gelatt, see references)

Canine- algal (Prototheca), fungal (Histo, Blasto, Cocci, Crypto, Aspergillus, Candida), bacterial (Brucella, Borrelia, Leptospira), rickettsial (Ehrlichia, Rickettsia), parasitic (opthalmomyiasis/Dipteria sp, Dirofilaria, Angiostrongylus, Toxocara, Balisascaris) protozoal (Leishmania, Toxoplasma, Neospora, Trypanosoma), viral (Adenovirus, Herpesvirus)

Feline- viral (FeLV, FIV, FIP), fungal (Cryptococcus, Cocci, Blasto, Candida, Histo), bacterial (Bartonella), protozoal (Toxoplasma), parasitic (Diptera)

Neoplastic

Any primary or secondary neoplasm (lymphosarcoma most common), histiocytic disease, feline diffuse iris melanoma in cats

Immune mediated

Idiopathic, Uveodermatologic syndrome (canine only), immune-mediated vasculitis, immune-mediated thrombocytopenia, lens-induced, secondary to scleritis, traumatic, reflexive, radiation-induced, general toxemia or sepsis

The diagnostic workup for any patient with uveitis should include a complete physical exam with evaluation of peripheral lymph nodes, etc. Baseline bloodwork (CBC/Chemistry) and infectious disease screens should be submitted based on current location and recent travel history. Thoracic radiographs and abdominal ultrasound may also be recommended based on the index of suspicion for systemic disease.

With the exception of reflexive uveitis caused by ulcerative keratitis, treatment should consist of topical anti-inflammatories (generally corticosteroids q4-6h), plus or minus oral anti-inflammatories based on the systemic health of the patient, index of suspicion of systemic infectious disease and degree of inflammation. Posterior segment inflammation (ie chorioretinitis) requires systemic treatment in all cases. If an underlying cause is identified, specific treatment should be initiated in conjunction with anti-inflammatories. In general these cases should be referred to an ophthalmologist and rechecked within the first week of treatment. Long term sequelae including secondary glaucoma, cataract development, corneal degeneration and/or retinal degeneration from retinal detachment can be vision threatening. Treatment for the uveitis can be protracted depending on response to treatment and anti-inflammatories should, as a rule, be tapered slowly over weeks to months to prevent recurrence once the inflammation is controlled.

References

Hendrix, Diane. (2013) Diseases and Surgery of the Canine Anterior Uvea. In: *Veterinary Ophthalmology* (ed. Gelatt, K.N.), 5th ed., Vol.2, pp. 812-849. Ames: Wiley-Blackwell.

Stiles, Jean and Wendy Townsend. (2013) Feline Ophthalmology. In: *Veterinary Ophthalmology* (ed. Gelatt, K.N.), 5th ed., Vol.2, pp. 1117-1127. Ames: Wiley-Blackwell.

Evidence-Based Approach to Cranial Cruciate Repair Surgery

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Current research and literature will be reviewed to encourage the audience to update and make their own decisions regarding this multi-million dollar problem in our small animal patients. This lecture gets to the heart of which procedures are the best in skilled surgeons' hands for our canine patients.

Cranial cruciate ligament rupture is a common cause of hindlimb lameness in dogs and is seen in cats as well. Patients can be managed without surgery with exercise restrictions, body weight management and pain medications. However, a better prognosis is achieved when the patients are less than 15 kg. Also, the presence of a meniscal tear or concurrent patellar luxation makes medical management less successful.

When surgical stabilization is opted for, the veterinarian is faced with a plethora of options. The key is to find the balance of what the surgeon is comfortable with and what the best option is for the patient. If the best possible option is chosen by the veterinarian but they do not have the training or experience to perform the procedure correctly, the potential complications can be disastrous. The fact that several options are available to address the same surgical problem indicates that no one procedure is perfect for all cases and all situations. Being current on the options and the data published is necessary to make the most educated decisions for your patients.

There are innumerable intraarticular repair methods in the literature and the theory behind these is the basis for human ACL repair. However, due to the degenerative nature of CCLR in dogs, these techniques have fallen out of favor. Intracapsular techniques are degraded by the inflammatory mediators seen in stifles with osteoarthritis (OA). The result is an unstable surgical repair and a lower level of function due to lameness with progressive OA. Long term outcomes with intracapsular repair are not as good as extracapsular techniques. However, if this is the procedure you are most comfortable with, and the owner will not accept referral to a surgeon, than this may be the "best" option for that patient.

The original extracapsular prosthetic stabilization has gone through many revisions and adjustments since its inception in 1966. The current technique is usually a lateral circumfabellar-tibial suture. Bone anchors can be used on the femur instead of around the fabella if preferred. The tibial suture is typically passed through a tibial bone tunnel located at the level of the long digital extensor tendon groove. Sutures can be tied or crimped. Nylon leader, monofilament or braided sutures are currently used, while stainless steel is no longer recommended due to cycling failure. The type of knot thrown can affect structural strength of some suture materials. For instance a surgeon's throw may weaken knot security, but a square knot where the first throw is clamped to maintain tension while the rest of the knot is tied has not shown to weaken a number of suture materials. Crimps are available for use with specific prosthetic materials but are not interchangeable with sizes or types of sutures. Crimp placement requires addition equipment and slippage is found to occur in 8% of cases. However crimp placement has less elongation and more stiffness than a clamped square knot. The loop configuration of the prosthetic material has also been shown to influence performance. But in most cases, the tension of the suture is not conserved for longer than six to eight weeks after surgery. Most commonly the strength is lost through elongation or rupture. Despite positive clinical results, these techniques do not achieve normalization of stifle biomechanics to the cruciate deficient stifle and may not be the best option especially for large or overweight dogs.

Isometry and a stiffer prosthesis are the potential benefits of the TightRope CCL®. The FiberTape (Arthrex Vet Systems) used in the system has shown significantly greater stiffness and ultimate load to failure forces. However this puts the joint at risk if the prosthesis is over-tightened or if poor isometry is created with inaccurate bone tunnels. In a recent study the TightRope CCL® resulted in outcomes similar to that of the TPLO (Tibial Plateau Leveling Osteotomy). A multicenter study has shown 94% of dogs having good to excellent outcomes with a 9% major complication rate including implant failure, infection, and meniscal tear.

The TPLO surgery has historically been promoted for use in active large breed dogs or dogs with excessive tibial plateau slope. Several studies have found similar results six months postoperatively when comparing the extracapsular suture and the TPLO. However, the extracapsular dogs tended to be lighter and begin physical rehabilitation earlier than the TPLO group. It is possible that larger dogs treated with a lateral suture may have had a worse outcome. Clinically the TPLO dogs are believed to bear more weight sooner while the extracapsular dogs hold the leg up for 1-2 weeks. The TPLO surgery involves specialized equipment and is described as having a steep learning curve. Utilizing arthroscopy or a mini-arthrotomy is proposed to minimize patient discomfort over the arthrotomy used with the lateral suture technique. Complication rates with the TPLO are lower with unilateral or staged procedures ranging from 12-21%. A less specialized version of the TPLO is the Cranial Closing Wedge (CCW) which also lessons the tibial slope to negate tibial thrust, but also alters the mechanical axis of the tibia with a forward shift. This changes the biomechanics of the tibia and may change weight distribution on the menisci. The technique utilizes a saw but does not require a specialized bone plate. It can be combined with the TPLO in cases with excessive (greater than 30°) tibial slope.

The Tibial Tuberosity Advancement (TTA) is a newer procedure that eliminates cranial tibial thrust. The mechanics place the patellar tendon force perpendicular to the weight-bearing force through the stifle. A bone graft appears to be beneficial for speeding

the healing of the boney defect created. Specialized equipment is required but the procedure is technically less challenging and perhaps faster than the TPLO. Long term studies show similarities between the TPLO and TTA, although the TTA appears to take longer to heal the osteotomy and cannot be used in cases with excessive tibial slope. Implant designs are still changing with regards to fork design and available cage sizes for advancement. The overall complication rate for TTA ranges from 25-59%, including minor complications.

All of the osteotomy techniques require strict confinement while the bone heals. This may be a deciding factor between techniques in ill mannered dogs or outdoor-only animals. While physical rehabilitation is started early in all dogs, the postoperative care for the osteotomy dogs can be weeks to month longer than the lateral suture technique. However, early return to function is vital for joint health, and to rebuild muscle mass and regain lost bone density. Service or therapy dogs who are kept in a controlled manner will likely benefit from the quick return to weight bearing of the osteotomy procedures, with their daily activities being as controlled and calm as most rehabilitation programs.

The existence of so many variations on the same surgical problem has shown no concrete superior method for treating our veterinary patients exists to date. Research is ongoing to illustrate the pros and cons of the newer techniques to determine the best options. Kinematic and objective controlled multi-center prospective trials are needed. But patient needs and variation in fibrosis, activity level, meniscal damage and age along with owner financial constraints will all play into the decision of the “right” treatment modality.

Surgical Options for Repairing Luxating Patellas

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Soft tissue and orthopedic procedures are both needed to correct luxating patellas. The intricate details of both will be discussed with focus on anatomy and accuracy. Postoperative care and physical rehabilitation will also be discussed.

Patellar luxation can be congenital or traumatic. Congenital is typically the presentation for small and toy breed dogs. Although some large breed dogs can have it as well. It is typically bilateral, with medial being the most common side of the luxation. Often times one side may be more severe than the other side. Traumatic patellar luxation is typically unilateral in nature and tends to be laterally luxated.

The patella is a sesamoid bone in quadriceps mechanism and uses the straight patellar tendon to insert on the tibial tuberosity. Although the true pathogenesis is unknown, it may results from abnormal hip conformation, angle of inclination, or coxa vara. Any of these components that cause a malalignment of the quadriceps mechanism, can lead to patella luxation. After the patella has been luxated is leads to secondary changes to the limb including medial displacement of the quadriceps, lateral bowing of the femur, torsion of the distal femur, shallow trochlear groove, stifle instability and medial displacement of the tibial tuberosity.

Clinical signs are very suggestive of the disease with an intermittent lameness or “hopping”. Animals may also have a crouched stance or “bowlegged” appearance. Lameness often increases as degenerative joint disease develops. Diagnosis is based on clinical signs and physical examination. However, radiographs are needed of the entre hindlimb to assess for torsional deformity, hip conformation and other orthopedic issues as well. Radiographs will show the displacement of the patella on the craniocaudal view. Shyline views can also be used to assess the trochlear groove. Documentation of secondary arthritis is also important for prognostic goals following surgery.

The patella luxation grading system is currently used to help elicit when surgery is needed and judge the level of surgery needed to correct the limb abnormality.

Grade 1

- Intermittent luxation
- Patella can be manually luxated, but reduces spontaneously
- Rarely lame, occasionally skip
- Minimal medial tibial rotation

Grade 2

- Frequent luxation
- Patella luxates with stifle manipulation, reduces spontaneously with rotation of the tibia
- Lameness varies- occasional skip to weight bearing lameness
- Medial tibial rotation- up to 30°

Grade 3

- Patella is luxated but it can be reduced, reluxates
- Chronic lameness of varying severity
- Medial tibial rotation of 30° to 60°
- Moderate angular and torsional deformities

Grade 4

- Patella is luxated continually and cannot be manually reduced
- Limb is carried or the animal moves in a crouched stance
- Medial tibial rotation of 60° to 90°
- Marked angular and torsional deformities

Surgical repair goals are to realign the extensor apparatus, normalize the forces acting on the physes/cartilage and stabilize the patella in the trochlear groove. Soft tissue reconstruction is helpful, but not a surgical solution to this orthopedic condition by itself. More commonly used soft tissue procedures include; Imbrication of the lateral retinacular fascia, Patellar and tibial anti-rotational sutures, Medial release (desmotomy). Bone reconstruction is far more successful and should be the cornerstone of any patellar luxation surgery. Orthopedic corrections can include; Tibial tuberosity transposition, Trochleoplasty techniques, Corrective osteotomies of femur / tibia. The goal os surgery is to improve limb function in dogs with lameness. Surgery does not prevent the progression of OA.

Reluxation is common with up to 48% reluxation in one study. However relaxation is usually mild (grade 1), and clinical signs may be minimal, negating the need for further surgery.

Managing Hip Dysplasia in Young Dogs

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

At birth most hips are normal. The femoral head and neck are cartilaginous and begin forming bone by endochondral ossification. Joint congruence and stability are dependent on periarticular soft tissues. This congruency and stability is critical for normal joint development. Disparity in the development can happen with any boney part of the joint or soft tissue including muscles, ligaments and the joint capsule. The skeleton develops rapidly and small problems can rapidly lead to a chain reaction of disease. If the hip joint is lax or unstable it leads to poor joint congruence which causes subluxation and further abnormal hip development. A dog may have normal hips at birth but through genetics, nutritional or environmental factors, develops hip dysplasia (HD).

Nutritional influences such as a high plane of nutrition or imbalance can lead to HD. A high plane of nutrition affects growth rate and can lead to rapid bone growth and weight gain. This can over-load the soft tissue support and has been shown to increase the frequency and severity of HD. Studies have shown a faster than average weight gain may lead to HD, even with exercise restriction. A dietary electrolyte imbalance may affect the synovial fluid. A low dietary anion gap (sodium + potassium –chloride) results in less subluxation while excess may increase synovial fluid amount and joint laxity. This may be due to surface tension and hydrostatic pressure.

Paying special attention to "at risk" puppies during initial examination is a key component to managing these patients. Asking pertinent questions about their normal activity, keeping them lean and on a balanced diet to avoid adverse nutritional influences are key. In puppies that are large or giant breeds, or have known familial histories perform an Ortolani and Barden exam. Also consider switching off puppy formulas at 6 months to slow the rate of growth. You may also want to consider prophylactic management.

A radiographic diagnosis of HD is more difficult in younger dogs but can be performed with various techniques. The hip extended view is used by the Orthopedic Foundation for Animals (OFA), and the Norberg Angle. Distraction radiography is used in the Penn HIP Program and Dorsolateral subluxation techniques. The OFA scale does not require special equipment but identifies OA and is not a sensitive method to detect early or mild laxity. You can also not certify with OFA until they are 2 years of age making it a difficult screening test for puppies unless they are severely affected. PennHIP requires certification to submit films as well as sedation or anesthesia of the patients. You need three mandatory radiographs. The distraction index is calculated off the percent of the femoral head that is luxated out of the acetabulum. A distraction index of greater than 0.3 is considered disease susceptible, but breed variation of measurements exist. This modality has been shown to be statistically predictable at 16 weeks of age.

Once you have a diagnosis or have decided for early prevention, time is one your side since you caught it early. Medical management is 80% successful and is clinically more helpful the earlier you begin. Weight control or reduction is the cornerstone to minimize the stress of the growing active joints. A regulated exercise program should be utilized but not overdone. OA disease modifying agents or nutraceuticals can be started early. Physical rehabilitation can be tailored for a puppy and includes homework for owners that promote not only joint health but obedience and training. NSAIDs can safely be used in puppies after 2 months if pain is an issue. The key to conservative treatment or prevention of HD is the multimodal approach. Controlled exercise programs should be designed for the active playful puppy. Consider postponing strict training until they are at least 6 months of age. Excessive force even on normal joints can cause OA. Agility, flyball, sporting and rescue training should be "walk through" training to get the idea and the motions without the force. Exercise is good in moderation and will help reduce obesity as well as maintain a good range of motion. Low impact exercise can be used liberally including swimming, walking, obedience class and leash training. Studies have shown that even with radiographic evidence at a young age of HD, weight control and leash walking can dramatically increase the range of motion, exercise tolerance and long-term function for years.

Nutraceuticals have been shown to be the most beneficial in offsetting OA when given before the inflammation starts, meaning preemptively when we suspect disease. Since they have minimal if any side effects and the potential for a large impact, it is easy to prescribe them to owners who are willing. Nutraceuticals have been called disease modifying agents, disease modifying osteoarthritic drugs, supplements, additive and vitamins. The key to understanding the options are to realize the FDA does not regulate these products for efficacy or quality. It is vital you find a company you like, believe in and has research to support their products and claims. If you are using a product and not seeing results, then try a new source. Some options work better for certain cases, but generally speaking when added to a well balanced multimodal approach can make a big difference with regards to patient comfort and cartilage health. Most contain glucosamine and chondroitin sulfate in various forms. It is reported that they are absorbed by the GI tract, become incorporated into joint tissues, and provide the necessary precursors to maintain cartilage health and decrease inflammation. Anecdotal reports, *in vitro* studies, and published clinical trials indicate that these agents are effective in treating OA.

Glucosamine is an amino-monosaccharide nutrient that has exhibited no toxicity even at high oral doses. It is a precursor to the disaccharide unit of glycosaminoglycans, which comprise the proteoglycan ground substance of articular cartilage. Studies using radiolabeled compounds in man and animals have shown that 87% of orally administered glucosamine is absorbed. Glucosamine acts

by providing the regulatory stimulus and raw materials for synthesis of glycosaminoglycans. Since chondrocytes obtain preformed glucosamine from the circulation (or synthesize it from glucose and amino acids), adequate glucosamine levels in the body are essential for synthesis of glycosaminoglycans in cartilage. Glucosamine is also used directly for the production of hyaluronic acid by synoviocytes.

In vitro biochemical and pharmacological studies indicate that the administration of glucosamine normalizes cartilage metabolism and stimulates the synthesis of proteoglycans. In one study, glucosamine stimulated synthesis of glycosaminoglycans, proteoglycan and collagen, suggesting it not only provides raw material for their production, but may actually up-regulate synthesis. The effects of glucosamine sulfate on human chondrocyte gene expression was also evaluated, assessing its effects on type II collagen, fibronectin and proteoglycans in normal adult chondrocytes. Glucosamine modulated the expression of cartilage proteoglycans, decreased stromelysin mRNA levels in osteoarthritic chondrocytes, and preserved the constitutive expression of type II collagen and fibronectin in both normal and osteoarthritic chondrocytes.

Chondroitin Sulfate (CS) is a long chain polymer of a repeating disaccharide unit. It is the predominant glycosaminoglycan found in articular cartilage and can be purified from bovine, whale, and shark cartilage sources. Bioavailability studies in rats, dogs and humans have shown 70% absorption of CS following oral administration. Studies in rats and humans using radiolabeled CS have shown that CS does reach synovial fluid and articular cartilage.

When human articular chondrocytes were cultivated in clusters in the presence of CS, proteoglycan levels were significantly increased and collagenolytic activity was decreased. A similar study indicated that CS competitively inhibited degradative enzymes of proteoglycans in cartilage and synovium. In a study of rabbits with chymopapain-induced stifle arthritis, proteoglycan depletion was reduced by the administration of CS.

Clinical trials in humans have also found CS to be effective in reducing the symptoms of OA. In a placebo-controlled, double-blinded study of 120 patients with OA of the knees and hips, treatment with CS resulted in significant improvements in pain-scale scores and pain-function index. In another study of 42 patients with knee OA, CS treatment significantly reduced pain and increased joint mobility. Bone and joint metabolism (as assessed by various biochemical markers) also stabilized in the patients treated with CS while remaining abnormal in patients receiving a placebo. Hyaluronate concentrations and viscosity were increased, and collagenolytic activity was decreased, in the synovial fluid of OA patients treated with CS for 10 days. These clinical trials indicate that CS has a positive effect in controlling the symptoms associated with OA. Combinations of glucosamine and chondroitin sulfate are commonly used and it has been reported that these agents work synergistically.

Dasuquin® (Nutramax Laboratories, Inc.) is a joint nutraceutical marketed for management of OA in dogs and cats. It is a combination of glucosamine, chondroitin sulfate, decaffeinated tea polyphenols, and avocado/soybean unsaponifiables (ASU). Tea polyphenols may have a positive effect on cartilage health and provide oxidative balance in the body. ASU, which are biologically active lipids, have been shown to be more effective than chondroitin sulfate in inhibiting the expression of certain OA mediators responsible for cartilage breakdown. In *in vitro* studies, ASU has been shown to decrease the expression of COX-2 enzyme, TNF-α, IL-1β, and PGE_2 in chondrocytes. It was also shown to stimulate synthesis of cartilage matrix by increasing levels of TGF-ß. A 2007 study found that dogs given ASU for 3 months had elevated levels of TGF-ß in their synovial fluid compared to control dogs. The combination of ASU with glucosamine and chondroitin sulfate decreased the expression of numerous pro-inflammatory mediators, including TNF-α, IL-1β, and iNOS. This decrease in pro-inflammatory mediators seen with Dasuquin® (Cosequin® with ASU) is greater than that seen with Cosequin® alone**.** In an *in vivo* study of the effects of Cosequin® on cartilage metabolism in dogs, serum samples were collected after treatment with Cosequin® and tested for circulating glycosaminoglycan content. Median serum glycosaminoglycan levels were significantly increased in treated dogs. When normal calf cartilage segments were exposed to the serum from the treated dogs, the biosynthetic activity of chondrocytes was significantly increased and proteolytic degradation of the cartilage segments cultured in serum was reduced. In vitro studies at the Nutramax laboratories also demonstrated the beneficial effect of Dasuquin® on chondrocytes from different species incluing equine, camelid, canine, feline and bovine. Dasuquin®I inhibited the production of inflammatory mediators and signaling molecules in the inflammatory cascade.

Omega acid supplementation was discovered when dermatologic patients were experiencing relief from their OA. Maintaining a high content of the long chain omega-3 fatty acids EPA, and DHA is the key with this nutraceutical. Short chain omega-3s compete with omega-6s for conversion to long chain fatty acids and then for uptake into cell membranes. Omega-3s and omega-6s have different effects on the inflammatory response. Omega-6 arachidonic acid is the precursor to more pro-inflammatory mediators. While omega-3 EPA is a precursor to less potent inflammatory mediators. Omega-3s are readily available from several companies for veterinary as well as human products. Pet foods that contain them must be kept in a sealed bag for less than 30 days or they dry out. Fish oils will also help lubricate the skin and shine the coat. For large breed dogs I follow the human label recommendation for full grown dogs or half the dose for puppies. If you overdose the oils, they can have soft stool or diarrhea and should decrease the dose.

Some other options that are developing for easy oral administration include green-lipped mussel, methyl-sulfonyl-methane, duralactin and S-adenyl-L-methionine. Less research or anecdotal evidence exists for these but is continually being developed.

The use of joint nutraceuticals in dogs prior to the development of OA is controversial. No controlled studies have been reported that document the efficacy of nutraceuticals in preventing the development of OA. However, because of their reported effects on improving cartilage matrix and reducing levels of inflammatory mediators within the joint, many clinicians have advocated the prophylactic use of joint nutraceuticals, particularly in athletic and large dogs that might be susceptible to joint injury. Additional research is needed to confirm the value of prophylactic use of joint nutraceuticals.

There are also surgical options to diminish the signs of OA in puppies that have HD. The two surgical options are Juvenile Pubic Symphysiodesis (JPS) and Triple Pelvic Osteotomy (TPO). JPS is a simple procedure performed on puppies 12 to 20 weeks of age. But the optimal results are achieved on puppies less than 16 weeks old. Please note that this age is before the PennHIP certification age. The procedure fuses the pubic symphysis with electrocautery via a ventral midline incision. There are no implants and, with proper protection of the urethra and depth to avoid the colon, very few potential side effects. Electrocautery is used every 2-3 mm along the symphysis to cause thermal necrosis and premature closure. The pelvis continues to grow in all other planes while being static at the pubis, resulting in ventroversion of the acetabulum. This procedure is not readily detectable on OFA and PennHIP films and should therefore only be performed on animals that will be sterilized to avoid certifying or breeding falsely represented hip conformation. The TPO is typically performed on dogs less than 10-12 months of age without radiographic signs of OA. It is used to correct hip laxity. Three osteotomies are made on the pubis, ischium and ilium to allow reorientation of the acetabulum. Then an angled plate is placed on the ilium to secure the weight bearing axis for boney healing. The forced manual ventroversion increases dorsal coverage of the femoral head and reduces the formation of OA by improving joint stability and congruence. However bilateral surgery is not performed due to high complication rates and surgeries should be staged at least 4 weeks apart. Potential complications include a narrowed pelvic canal, sciatic neuropraxia, implant failure and an abnormal gait. Lameness improves in 92% of dogs and the progression of OA appears to be slowed with this procedure. The JPS and TPO procedures have similar effects on hip conformation, although neither eliminate laxity or completely cure HD. They can arrest or limit the progression of HD in mild to moderate cases. Both of these preventative surgeries require early puppy screening and counseling of owners about potential benefits and expected outcomes.

Managing Hip Dysplasia in Old Dogs

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

At birth the hips are normal. The femoral head and neck are cartilaginous and begin forming bone by endochondral ossification. Joint congruence and stability are dependent on periarticular soft tissues. This congruence and stability is critical for normal joint development. Disparity in the development can happen with any boney part of the joint or soft tissue including muscles, ligaments and the joint capsule. The skeleton develops rapidly and small problems can rapidly lead to a chain reaction of disease. If the hip joint is lax or unstable it leads to poor joint congruence which causes subluxation and further abnormal hip development. A dog may have normal hips at birth but through genetics, nutritional or environmental factors, develops hip dysplasia (HD).

A presumptive diagnosis of HD can often be made based on clinical signs or physical examination. Palpating for crepitus, a luxated hip or performing the Ortolani and Barden maneuvers can all help make a correct diagnosis of HD. A radiographic diagnosis of HD is more easily made in older dogs. The hip extended view is used by the Orthopedic Foundation for Animals (OFA), and the Norberg Angle. Distraction radiography is used in the Penn HIP Program and Dorsolateral subluxation techniques. The OFA scale does not require special equipment but identifies OA yet is not a sensitive method to detect early or mild laxity.

Medical management is 80% successful and is clinically more helpful the earlier you begin. Weight control or reduction is the cornerstone to minimize the stress diseased joints. A regulated exercise program should be utilized but not overdone. OA disease modifying agents or nutraceuticals can be started early. The key to conservative treatment of HD is the multimodal approach. Excessive force even on normal joints can cause OA. Exercise is good in moderation and will help reduce obesity as well as maintain a good range of motion and comfort.

Weight loss is the easiest and perhaps most beneficial part of a multimodal approach to OA. Minimizing the work the diseased joints have to contend with should be paramount to any regime. Dogs with OA should be kept on the thin side of normal. With proper weight management, many dogs are able to stop taking pain medications until much later in the disease process. Commercially available diets are geared towards weight loss as well as joint comfort. Diets should be low calorie and low in protein while providing an otherwise balanced nutritional plane. Having truthful conversations about treats and table scraps should be geared to reveal honest habits. Caloric responsibility should be encouraged and adjustments made to account for the dogs' favorite treats or foods. Exercise is also important to maintain a good range of motion and weight level. Minimizing concussive forces like stairs, jumping, climbing, running, and horse play should be minimized while still maintaining a good quality of life. Encourage leash walks, swimming and pay close attention to what activities make them sorer afterwards. While we don't want to lock our patients in a box or take away their quality of life, easing their burden is important for their joints. If they love to play fetch on the weekends, make their owners aware that that will be a painful time and they should premedicate or otherwise adjust the protocol for their pet. Having thick warm bedding should also be encouraged to help aching joints. If an overweight animal prefers the hard, cold floor, suggest placing a fan near the orthopedic bed to encourage usage.

NSAIDs are readily available and widely used for OA in dogs. The important thing is to find a drug that works well for each patient and to make the owners aware of potential side effects. If one stops working for a patient, try switching to a different one. When switching NSAIDs, a wash out period of at least two half-lives is recommended. NSAIDs can be used for painful flair ups, around times of increased activity, or later in the disease, for daily maintenance pain relief. For patients with NSAID sensitivities or for patients needing additional pain medication there are other options as well. Tramadol is a synthetic mu opiod with a wide safety margin. It can be given several times a day which make it ideal for use around exercise or physical rehabilitation periods. I typically use 5 mg/kg up to 4 times daily. Gabapentin is a GABA analogue design to treat epilepsy but is widely used for neuropathic pain and OA in people. The most common side effect appears to be sedation. An accepted canine dose is 5-10 mg/kg 2-3 times daily. Acetaminophen with codeine is an additional option for OA management. Due to the limited pill size it is often times easier to dose than tramadol in larger patients. Since it is not considered a COX1 or COX2 drug, side effects should be minimal when used concurrently with NSAIDs, but should still be considered. This drug is dosed off the codeine at 1-2 mg/kg three times daily.

Nutraceuticals have been shown to be the most beneficial in offsetting OA when given before the inflammation starts, meaning preemptively when we suspect disease. Since they have minimal if any side effects and the potential for a large impact, it is easy to prescribe them to owners who are willing. Nutraceuticals have been called disease modifying agents, disease modifying osteoarthritic drugs, supplements, additives and vitamins. The key to understanding the options are to realize the FDA does not regulate these products for efficacy or quality. It is vital you find a company you like, believe in and has research to support their products and claims. If you are using a product and not seeing results, then try a new source. Some options work better for certain cases, but generally speaking when added to a well balanced multimodal approach can make a big difference with regards to patient comfort and cartilage health. Most contain glucosamine and chondroitin sulfate in various forms. It is reported that they are absorbed by the GI

tract, become incorporated into joint tissues, and provide the necessary precursors to maintain cartilage health and decrease inflammation. Anecdotal reports, *in vitro* studies, and published clinical trials indicate that these agents are effective in treating OA.

Physical rehabilitation for muscle mass, range of motion and comfort are a huge component to managing an older dog with arthritis. Passive range of motion with stretching and massage can help aid in comfort while bathing the articular cartilage with nutrients from the synovial fluid. Increasing awareness with bedding, stairs, and household routines will help minimize concussive activities. While implementing therapeutic exercises during regular walks can increase muscle mass and range of motion, especially extension. Focus on increasing comfort while optimizing rear weight distribution through regular, motivated exercise.

If medical management is not an option or is not working for your patient, there are two salvage procedures; Total Hip Arthroplasty (THA) and Femoral head and neck ostectomy (FHO). THA is indicated for large and giant breed dogs but is available in sizes for small dogs and cats. Unilateral replacement is adequate for 80% of dogs. The procedure is technically challenging and expensive. There are cemented and cementless systems with templates and modular designs for a custom fit. The prognosis for a pain-free function is 95% having a good to excellent outcome. Potential complications include infection, luxation, fracture, sciatic neuropraxia or implant loosening. FHO is used to preserve limb function in severe OA when medical management is ineffective or when a THA has unrepairable complications. It is typically performed in small dogs and cats but can be used for larger dogs when THA is not feasible. It is less expensive and easier to perform than a THA. The prognosis is good in smaller patients but much better if muscle atrophy is not severe. Postoperative physical therapy is important to achieve a flexible pseudoarthrosis.

Cats Get Arthritis, Too

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Identifying painful cats with arthritis will be discussed in-depth. Potential changes to the home environment, diet and surgical options will be discussed. Specific cat medical conditions dealing with arthritic joints will be focused on.

Feline osteoarthritis (OA) is a growing problem in our veterinary patients. We are discovering that it has been around and under diagnosed for years. While we tend to think of cats as just a small dog, they are very different from their canine counterparts. Cats come with a unique set or behaviors, personalities and diseases of their own. And OA in cats is very different from OA in dogs.

Knowing when a cat has OA is probably the hardest part of the disease. Typically dog owners report lameness or a decline in exercise tolerance or endurance. They have a specific leg they hold up or skip on. Or perhaps they are sore in the morning but once they begin running they appear comfortable. Owners are very savvy on OA in dogs and most have heard of hip dysplasia. But cat owners and veterinarians are only now learning about what an arthritic cat looks like. Cats can have a lameness or altered gait, but it is much less common than dogs to present for this complaint. Cats may also exhibit stiffness when rising, which may be hard to discern from the normal cat nap stretch, which may be normal. If a cat presents with overt or obvious pain or single leg lameness, the diagnosis may be easy. But more commonly the signs will be much more subtle.

Personality changes are one of the most common observations in a cat with OA. A normally affectionate cat may become nervous around new people or bustling activity around the house. A happy playful cat may become depressed or withdrawn. And a fun loving energetic cat may turn into an aggressive animal, biting family members or hissing at people when they are trying to pet or love on the family pet. These personality changes may have previously been dismissed as a normal aging cat mood change. But these character changes are not normal and should be addressed with the client to maintain a loving home environment and a good quality of life. These may all be signs of OA and pain in cats.

Behavioral changes are also important indicators for feline OA and discomfort. If the family cat changes from years of house training to disuse of the litter box, perhaps the box it too hard to climb into or located too far away to reach in comfort. Litter boxes should be shallow and more numerable for cats with OA. Normally you would want one extra litter box above the number of cats in a household, but with OA you will need more to be easily accessible without a long trek. If the cat normally climbs onto a sunny windowsill but has stopped sunbathing due to its height, this could be another sign of OA. It may be too hard to jump up onto, or too painful when they jump down off of the high ledge. The same can be seen for getting onto kitchen countertops or the family coach they used to love sharpening their claws on. Owners may think their pet has outgrown these less desirable habits, when in reality they may have stopped due to discomfort from these activities. Stairs also pose concussive forces on painful arthritic joints. Cats with OA are less likely to travel upstairs to family bedrooms where they used to sleep and snuggle. If litter boxes are only located downstairs, cats are more apt to eliminate upstairs due to the effort required for an OA patient to travel to the normal laundry room or bathroom downstairs. Another common behavioral change is a cat that would normally dominate the house has stopped chasing the younger cats or dogs. If they normally torment housemates but have stopped doing so, the effort may be too much with arthritic joints and may not be an indication of a mellowing older feline, but a painful one.

Feline OA is much more prevalent than we previously thought. One study of randomly selected cats showed 73% had evidence of OA. Another study showed that elbow and hip joints are the most commonly affected in cats. It also appears that most cats have at least four joints involved when they have OA. There are several other studies looking at “asymptomatic” cats and the prevalence of OA. The prevalence was 64% in older cats but still 16-22% of asymptomatic cats having radiographic signs of OA. This body of knowledge supports that we are under diagnosing and under appreciating the discomfort in our elusive feline patients.

Treatment of feline OA is similar to canine once the suspicion or diagnosis has been made. Weight loss is a large component to minimizing the work the diseased joints are battling. Keeping cats on the thin side of normal as well as a balanced nutritional plane is important. Proper exercise should be encouraged for a good range of motion and joint comfort. Their beds should warm and thick. Beds should also be lowered from windowsills and be available on all floors in the house to minimize traversing stairs. Massaging the cat and encouraging range of motion or stretching can be a bonding experience as well as helping to lubricate joints by circulating synovial fluid. “Lazy” cats should be encouraged to walk by baiting with toys, treats or other positive reinforcement. Commercial diets are now also available for cats and focus on weight loss with joint additives.

Nutraceuticals including chondroitin sulfate, glucosamine HCL, and omega acids are also available in feline friendly sizes and formulations. Many come in feline friendly flavors or sprinkle formulas you can place on their food for ease in administration. Pain medication are difficult in cats but there are options as well. NSAIDs are available for short term use but not approved for long term management of OA in cats in the United States. Tramadol and Gabapentin are used in cats with success. Cats tend to be more excitable with tramadol and when this side effect is encountered, lowering the dose not help. Also, splitting tramadol tablets to dose the smaller patients creates a very bitter taste, so it should not be added to food.

OFA will certify cats and currently has 7 breeds with significant numbers including the Main Coon, which shows 18% affected. PennHIP is currently only for dogs. Surgical options are similar for cats and include Total Hip Arthroplasty (THA) and Femoral head and neck ostectomy (FHO). THA is available in sizes for small dogs and cats. Unilateral replacement is adequate for 80% of dogs. The procedure is technically challenging and expensive. There are cemented and cementless systems with templates and modular designs for a custom fit. The prognosis for a pain-free function is 95% having a good to excellent outcome. Potential complications include infection, luxation, fracture, sciatic neuropraxia or implant loosening. FHO is used to preserve limb function in severe OA when medical management is ineffective or when a THA has unrepairable complications. It is typically performed in small dogs and cats but can be used when THA is not feasible. It is less expensive and easier to perform than a THA. The prognosis is good in smaller patients but much better is muscle atrophy is not severe. Postoperative physical therapy is important to achieve a flexible pseudoarthrosis.

Cats may also have OA in their stifle due to cranial cruciate ligament rupture. The degree of lameness and age are used to guide whether surgical correction should be performed. If the cat is non-weight bearing despite medical management, surgery should be considered. If the cat is young and over 15 pounds surgery may be the better option for a quicker return to function and to minimize the progression of OA. Cruciate repair techniques available in the cat include the extracapsular repair, cranial closing wedge and tibial plateau leveling osteotomy. Medial patellar luxation may also be present in cats with stifle OA. The Devon Rex and Abyssinian are particular prone to this condition. It is also usually bilateral. If the cat has a grade II or more, recurrent or continued lameness or also has a cruciate rupture, surgery should be considered.

Bad Hips and Bad Knees, Now What?

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

A fairly recent study* showed that 32% of dogs referred to a surgeon for hip dysplasia treatment had, in fact, a torn ACL.

Indeed, differentiating between a torn cruciate ligament and hip dysplasia can be tricky if not frustrating. Let's review the differences between the two conditions.

Cranial cruciate ligament tear

Severity of lameness depends on the severity of ligament disruption.

In stable partial tears, lameness can be subtle and noted only after periods of strenuous activity.

In complete tears, lameness will initially be severe and non weight-bearing. Then, moderate to severe weight-bearing lameness will occur.

In obvious cases, of course, a positive cranial drawer and a tibial thrust are the keys to diagnosing a cranial cruciate rupture. But what to do in less obvious cases?

Examination reveals various degrees of stifle pain with flexion and extension, variable crepitus, and possibly clicking associated with a meniscal tear.

In partial tears, a pain response is elicited when the joint is in full extension. In chronic cases, muscle atrophy is notable and peri-articular fibrosis (medial buttress) is evident on the medial side of the stifle. Medial buttress is almost pathognomonic for a cranial cruciate rupture. The only other condition that can present with medial buttress is a medial collateral ligament tear, which is usually seen with a deranged stifle, not a simple lameness.

Joint effusion is also a key finding: it can be palpated on the medial and lateral aspect of the patellar tendon.

Affected dogs have an abnormal "sit test," i.e. they sit with the affected leg extending out to the side, rather than sitting squarely (which they will do even with hip dysplasia). This is critical step in the evaluation. See below how this Lab does not want to flex his left knee.

In a partial tear, the cranial drawer may or may not be present. A sedated exam is needed to confirm the findings. MANY patients who don't seem to have a drawer while awake, suddenly have one once they are sedated and relaxed.

Radiographs are warranted in all cases to document stifle arthritis, to confirm pathology in challenging cases of partial tears, and to rule out other disorders (occasionally, we find a tumor).

The earliest and most consistent finding is the loss of infra-patellar fat pad shadow by a soft tissue opacity in the lateral view. This is consistent with effusion.

Caudal displacement of fat density located caudal to the joint capsule by a soft tissue opacity is also consistent with synovial distention.

In many cases, you can "see" the cranial tibial thrust on an X-ray. See below how subluxated the knee is.

Another consistent finding is osteophyte and/or enthesiophyte formation in the region of femoral trochlear ridges, tibial plateau, and at the base and apex of the patella.

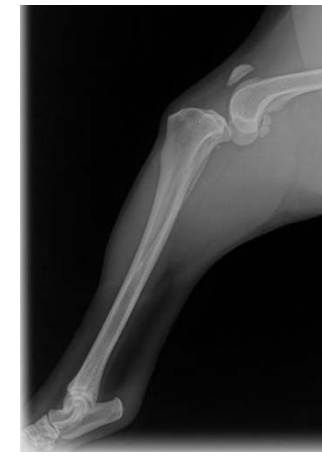
Rupture of the contralateral cruciate ligament occurs in 37%-48% of dogs within 6-17 months of the initial diagnosis. However, rupture can be bilateral on presentation, often times giving them a “neurologic” crouched walk.

Hip dysplasia

Hip dysplasia causes joint inflammation and secondary osteoarthritis, which lead to variable degrees of pain. Clinical signs can vary from slight discomfort to severe acute or chronic pain. Although the disease onset has a linear progression over time, it can be divided into two forms.

The juvenile form typically affects dogs between 5 and 12 months of age. They present with unilateral or bilateral hind limb lameness, bunny hopping, and difficulty rising after rest, reluctance to walk, run, jump, or climb stairs, exercise intolerance, and pain on hip extension.

These clinical signs are the result of joint laxity.



The chronic form of hip dysplasia has a highly variable onset of clinical signs in old dogs. Pain is most often related to DJD and has a more chronic presentation. Clinical signs are similar to the juvenile form. Pain is elicited most notably during hip extension.

As the disease progresses, crepitus can be palpated with range of motion. A sedated exam followed by orthogonal radiographs will further support the diagnosis.

Hip dysplasia dogs have a normal "sit test," i.e. they sit with both legs flexed symmetrically.

Hip and knee

Of course, both conditions can be present at the same time. In the study mentioned above, 32% of dogs referred to a surgeon for hip dysplasia treatment had, in fact, a torn cranial cruciate ligament. Interestingly, 94% of those dogs with a cruciate tear had concurrent radiographic signs of hip dysplasia.

It is imperative to do a thorough orthopedic and neurologic exam to accurately localize the clinical signs to avoid inappropriate diagnosis and treatment.

My absolute best advice? If in doubt, repeat your entire exam under sedation. Let's go over the 7 magic benefits of sedation:

1. Sedation allows you to check for cranial drawer, tibial thrust, Barden and Ortolani sign.
2. Under light sedation, you may still notice a pain response: increased respiratory rate or pulling on the leg.
3. Under heavy sedation, total relaxation allows you much better joint evaluation.
4. Sedation allows you to tap the knee (arthrocentesis), which is an invaluable test.

Crudely, normal fluid = clear, tiny amount and viscous. Abnormal fluid = yellowish, large amount and watery.

1. Sedation allows you to "block" a joint, with lidocaine and/or steroids.
2. Sedation enables you to take X-rays in a perfect position (knee = TPLO position, with a quarter in the picture; hip = OFA style) without fighting or causing pain.
3. Sedation allows you to focus and take your time without fighting with your patient and alienating your technicians.

Reference

M.Y. Powers et al. "Prevalence of cranial cruciate ligament rupture in a population of dogs with lameness previously attributed to hip dysplasia: 369 cases (1994-2003)." JAVMA 2005, Vol. 227, N 7, 1109-1111.

Developmental Orthopedic Disease

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Panosteitis is an acquired self-limiting condition of undetermined cause that affects the diaphyseal and metaphyseal regions of the long bones of young, large breed dogs. German Shepherd, Dobermans, Goldens, Saint Bernards, Bassetts and Labs are overrepresented. Dogs are typically 5-18 months of age at presentation. Males are more frequently affected than females. While the etiology is unknown, histopathology reveals an increased osteoblastic and fibroblastic activity replacing the medullary cavity with connective tissue. There are no inflammatory cells or necrosis, but instead a haphazard intramembranous ossification. Clinical signs may include lethargy, anorexia and a shifting leg lameness which can be acute or chronic, but is often intermittent. Pain can be elicited on palpation of the diaphysis of affected long bones. The humerus, femur and proximal radius/ulnar are the most common sites. The pain can be cyclic and recurrent. Radiographically you can visualize an increased density within the medullary cavity blurring the trabecular pattern, often near the nutrient foramen. However, lameness is not always associated with radiographic lesions and early in the disease, radiographic signs may not be apparent. This self-limiting disease often resolves in 1-2 weeks but can recur up to 18 months of age. Conservative therapy may include NSAIDs, exercise restriction, weight reduction and dietary correction to avoid oversupplementation. The prognosis is excellent with some dogs experiencing a shifting lameness until maturity. Rarely, clinical signs persist after maturity.

Osteochondrosis (OC) is a disturbance in the process of endochondral ossification in a focal area of developing articular surface. Cartilage fails to undergo calcification and replacement by bone and therefore becomes degenerative. Cartilage retention results in thickening of the articular epiphyseal cartilage and degrades because cartilage cannot handle high shearing forces. The etiology may involve genetics, rapid growth, calcium supplementation, hormonal influences, ischemia and trauma as potential factors. OC is seen in large breed, fast growing dogs from 4 to 7 months of age. It is most commonly seen in the shoulder, stifle, elbow and tarsus. The thickened articular-epiphyseal cartilage has poor diffusion of nutrients from the synovial fluid. This leads to necrosis at the deep portion of the thickened cartilage. The consequence is an abnormal arrangement of cells, metabolism and function of these chondrocytes. When a separation occurs between the noncalcified and calcified layers at this weakened site a cartilage flap is formed and called osteochondritis dessicans (OCD). The flap may reattach or have a vertical fracture of the articular cartilage. The vertical fracture has minimal motion during weight bearing but causes synovitis, irritation and lameness leading to osteoarthritis (OA). When synovial fluid enters the vertical fracture it prevents it from healing. The cartilage flap can also detach and become a joint mouse, which causes irritation. The free floating flap can resorb or may enlarge due to nutrition from synovial fluid. Clinical signs usually begin with an intermittent lameness that is worse after exercise. Joint effusion and pain may also be present. Muscle atrophy and OA will develop over time. Radiographic findings will show a filling “defect” or “flattening” of the subchondral bone, which is the thickened area of cartilage that is not radiopaque. A joint mouse may also be visible if the flap is mineralized. You may see radiographic signs of OA. A positive contract arthrogram may aid in identifying a cartilaginous flap or joint mouse. Ultrasound, MRI and CT have also been shown to be very sensitive and specific for OCD. Conservative therapy can be utilized if there is no clinical pain or joint mouse present and in dogs less than 7 months of age with a small lesion. Rest and a restricted diet are implemented for 6 weeks. NSAIDs and chondroprotectants, with physical rehabilitation should also be used. This may allow the cartilage defect to heal. Surgical treatment is indicated for the presence of a non-healing flap, lameness of more than 6 weeks, a dog older than 8 months or a visible joint mouse on radiographs. The surgical objectives are to excise the cartilage flap and unadhered cartilage and well as encourage healing of the defect. Healing of the defect occurs by production of fibrocartilage which requires bleeding from subchondral vessels to allow invasion of mesenchymal stem cells. After surgery, the animal must be on restricted exercise for 4 to 6 weeks to allow the scar cartilage to form. Shoulder OCD has a good to excellent prognosis with other joints being guarded due to OA.

Elbow dysplasia is an inclusive term used to describe all developmental conditions resulting in elbow arthrosis. The growth discrepancy within the antebrachial growth plates, genetics, conformation and oversupplementation are all proposed etiologies for elbow dysplasia. Elbow incongruency can occur with the trochlear notch, radial head and humeral condyle. An elliptical trochlear notch will change the contact points of the elbow joint. Ununited anconeal process is when the anconeal process fails to unite with the proximal ulna before 20 weeks of age. It is common in large dogs including the German Shepherds, Bassett hounds and Saint Bernard’s. While the etiology is undetermined it may be OCD-related, trauma or genetics. Lameness, stiffness, pain and creptius are commonly seen and usually bilateral. Radiographically a cleavage line can be seen along with sclerosis and OA of the elbow. Conservative therapy is described but rarely efficacious. In young dogs there are variable techniques to attach the fragment, but these are technically challenging. In dogs over 6 months of age excision of the ununited fragment is recommended. The prognosis is generally fair due to the inevitable OA and early surgical intervention may help limit OA. Fragmented medial coronoid process (FCP) is the third component of elbow dysplasia. It may be a result of excessive loading of the coronoid process during abnormal development or joint incongruency, direct trauma or OCD-complex. Lameness usually begins at 4 to 9 months of age and occurs in

large breed dogs as well, with males being over represented. Elbow pain and lameness are similar with signs of OCD, and the two may occur together. Elbows may also be abducted when standing or have joint effusion localized to the medial aspect of the elbow joint. The best radiographic view is a 25 degree craniocaudal-lateromedial oblique view flexed 30 degrees. However, CT scans are much more sensitive for diagnosing FCP. Often signs on plain films are non-specific and include periarticular osteophytes, sclerosis and rarely soft tissue swelling. Conservative therapy with restricted exercise and weight control can be tried or surgical therapy with excision of the fragment via arthrotomy or arthroscopy can be used to remove the coronoid and evaluate for "kissing lesions" on the humerus. FCP carries a fair to guarded prognosis with inevitable OA. The choice between medical and surgical management for FCP remains controversial but surgery is generally recommended in dogs under a year.

Hypertrophic osteodystrophy is an idiopathic disease that affects rapidly growing large breed dogs and involves the long bone metaphysis. Dogs generally present between 2 to 8 months of age with males being overrepresented. German Shepherds, Irish Setter, Weimeraners, Great Danes and Chesies are more commonly affected. Clinical signs may include lameness with a reluctance to walk and warm painful swelling of the metaphysis of the distal radius/ulna, and tibia bilaterally. Patients can be anorexic, run a high fever, and exhibit depression or lethargy. Radiographs show a radiolucent region in the metaphysis with neighboring sclerosis called the "double physeal line". There may also be irregular widening of the physis and extraperiosteal cuffing. The etiology remains unknown but theories have been proposed for vitamin-C deficiency, oversupplementation of vitamins and minerals, *E. coli*, canine distemper, genetics, vascular abnormalities, and vaccine induced. Treatment is aimed at supportive care to maintain hydration, nutrition support, NSAIDs for pain and to correct any dietary imbalances. The prognosis is good with most patients recovering in 7 to 10 days with this self-limiting disease. Possible sequela may include growth disturbances of affected limbs, systemic illness, or death.

Legg-Calve-Perthes Disease (LCPD) is avascular necrosis of the femoral head. It has also been called ischemic necrosis, or coxa plana. LCPD typically occurs in small and miniature breeds between 4 to 11 months of age with no apparent sex predilection. Etiology may be traumatic, vascular, autosomal recessive, infectious or hormonal. But an ischemic event occurs that results in the death of the affected bone. Bone necrosis occurs and subsequent remolding of the femoral epiphysis occurs. Hip pain and lameness with crepitus are the most common clinical signs. Muscle atrophy can be seen, especially in bilateral cases which compromise 15-18% of LCPD cases. Radiographically you can see a flattening or irregular surface of the femoral head with a moth eaten appearance. Occasionally femoral neck fractures can also be seen. Conservative therapy may be tried unless a fracture is present indicating an FHO. Overall prognosis is good to excellent.

Capital Physeal Dysplasia is an uncommon disorder of the proximal femoral metaphysis seen in overweight male neutered cats as well as Shelties. It classically appears as an atraumatic Salter Harris Type I or II. It is often called a slipped epiphysis. While the pathophysiology is unknown the disease appears to be a combination of delayed physeal closure, decreased gonadal hormones, dysplastic chondrocytes and obesity. Typically cats are young, presenting from 5 months to 2 years. OA is already present at the time of diagnosis. The treatment of choice is FHO.

Laser Use in Physical Rehabilitation and Adding it to Your Practice

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

Laser therapy is Light Amplification by the Stimulated Emission of Radiation (LASER). Lasers are classified into four levels depending on their potential to harm tissue. Class 1 is a laser pointer used in lectures or at a grocery store while an example of a Class 4 laser would be a surgical cutting laser. Class 3 and 4s are used for low level laser therapy or physical rehabilitation. They are advocated for many things but used mostly for wound healing and pain relief.

Laser therapy cause cellular oxygen production by photons being absorbed into the mitochondria. This in turn causes a proton gradient across the cell and mitochondrial membrane. The gradients result in increased cell permeability. Laser therapy also stimulates the production of ATP, thereby stimulating DNA production. Also laser therapy increases cellular metabolism and growth. This accelerates tissue repair and cell growth in tendons, ligaments and muscles.

There are also indications in human and rodent models that laser therapy may block pain transmission through conduction latencies and selectively inhibit nociceptive neuronal activities. It may also increase endorphins. For this reason laser therapy is being used for muscle trigger points and acupuncture, called acupressure.

Laser therapy is advocated in wound healing due to its ability to stimulate fibroblasts and speed collagen production to repair tissues. It appears to accelerate angiogenesis and neovascularization. Laser is used on edema because it causes vasodilation and improves lymphatic drainage. It appears laser therapy may help with surgical incisions, open wounds and burns. The goal of wound laser therapy is to increase blood circulation, stimulate the reduction of hemoglobin, then stimulate both the reduction and immediate re-oxygenation of cytochrome c oxidase. This is the normal metabolic, wound healing process, just trying to speed it up with laser therapy.

Lasers emit energy, or joules, at a certain wavelength. This wavelength determines how deep the laser will penetrate into the tissue. The power, or watts, of a laser is the rate or speed at which it can deliver the desired energy to the tissues. There are many different lasers with different penetrating wavelengths, but the energy density or dose for square of centimeter of tissue is the critical data point. Not only does the laser light need to fully penetrate the area we want, but it needs to bring the right level of energy to the tissue. Based on the size of the tissue or area we are treating (cm2) is how we determine the total dosage (J/cm2). The power of your laser will determine if that takes you 10 seconds or 10 minutes to accomplish that treatment dose. Research is still ongoing for determining whether continuous wave, or pulsed wave lasers are better, if daily or every other day protocols are superior and what the ideal dosage is for a condition. So given all the variables in laser company styles, format and protocols, it is of paramount importance that we discuss energy density and dosages in the same concise language so we can communicate appropriately; Joules per centimeter squared.

We do know that the minimum dosage in humans to achieve a photochemical response to laser therapy is 5 J/cm2. We also know there are contraindications to laser therapy; active hemorrhage, local steroids, pregnancy, cancer, heart disease, photosensitive medications.

There are limited studies looking at laser therapy, but many are in progress. Once human study should an improvement in pain relief for 2 months and up to 1 year after a two week protocol. A canine study showed similar results with weekly sessions for four to six weeks showing 70% of patients showing some improvement in arthritic pain and gait abnormalities.

The difference between commercially available laser unties lie solely in the wavelength, power density, pulse modulation and aesthetics. The goal is to stimulate the cell, and ultimately the body, to perform its natural functions, but at an enhanced rate.

Osteoarthritis in Dogs and Cats: Why is it so Important to Know What's Going on in There?

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

Osteoarthritis is the most common chronic musculoskeletal disease in dogs and cats. It is estimated approximately 60% of all dogs and close to 90% of aged adult cats are affected by this disease. [3] Osteoarthritis (OA) is not a single disease entity but rather a disease process. It is a common final pathway for a failing synarthroidal or diarthroidal joint. It must be remembered the joint is an organ therefore OA affects not only cartilage but also involves the synovium, synovial fluid, ligament, fat and underlying bone. The condition may be confined to the joint but the entire patient is affected due to the pain and disability of OA. Patients with OA have decreased activity and performance, decreased ROM, muscle atrophy (often generalized sarcopenia), pain, decreased flexibility, loss of strength and increased joint stiffness.

OA in dogs is always a secondary problem caused either by abnormal stress on a normal joint (such as may happen with trauma) or normal forces on a joint that has an underlying abnormality (e.g.. joint laxity, or instability from hip dysplasia, or cruciate disease). Either scenario will result in a gradual loss of articular cartilage (the morphological marker for OA) and joint impairment. OA in cats can be secondary to genetic disease or trauma but often no initiating cause can be identified.[2]

Tissues in the synovial joint

To truly understand OA requires a working knowledge of the metabolism of the tissues of the synovial joint. It is important to remember that all the components of a joint adapt their composition and appearance to match functional demands. The demands are usually mechanical but can change with immobilization, injury, training or inactivity.

The tissues have a certain form and characteristic but change due to demands on the tissue. Stress and strain can change the type of collagen, and amounts, cross linking, PG types and architecture of the joint Wolff's law tells us about changes in bone due to demand—there are similar changes in tendons and ligaments.

What makes up a joint?

- Bone
- Articular Cartilage
- Synovium
- Tendon
- Ligament
- Menisci
- Labra
- Fat Pads
- Bursae
- Synovial Fluid

Most of these structures are made up of connective tissue. Connective tissues are made up of widely dispersed cells in a large volume of extracellular matrix (ECM). The function of the connective tissue is determined by its ECM not the cells in the tissue. Tendons and ligaments are considered dense connective tissues with tendons being more elastic than ligaments. Important cell types found in joints are fibroblasts in tendons, ligaments, menisci, and labra, chrondoblasts in articular cartilage and osteoclasts and osteoblasts in bone. [2]

Extracellular matrix

The ECM is mostly protein and water and has both interfibrillar (ground substance) and fibrillar components. The fibrillar component is composed of mostly collagen and elastin. Collagen is the most abundant protein in the body, has a tensile strength similar to steel, is responsible for the integrity of the tissues and their resistance to tensile force.

Interfibrillar component

This is mostly glycoproteins and proteoglycans (PGs).

PG characteristics

- Distinguished by protein core and attached glycosaminoglycans (GAGs)
- Attract water through attached GAGs
- Regulate collagen fibril size
- Attach to Hyaluronan to form large aggregates called aggrecans

- Are increased in tissues subjected to alternating cycles of compression.

Glycosaminoglycans (GAGs) exist mostly in 2 classes[2]

- Glucosaminoglycans—Heparan sulfate and keratin sulfate—contain D-glucosamine
- Galactosaminoglycans—Chondroitin sulfate and dermatin sulfate—contain D-galactosamine.
- Exception is Hyaluronic acid (hyaluronan) which is non sulfated D-glucosamine and D-glucuronic acid and does not attach to a core protein. In synovial fluid, hyaluronan is produced by type B synoviocytes but in the ECM it is produced by chondrocytes. Synovial hyaluronan acts as a lubricant and molecular barrier.

PG aggregates (aggrecans) are a number of PGs linked together by link proteins and attached to Hyaluron. Along with collagen they are the major weight bearing macromolecule in the articular cartilage. During metabolism PGs are broken down by enzymes matrix metalloproteinases (MMPs) and aggrecanase. In acute inflammation MMPs increase in number and disrupt the balance of production and destruction in the joint.

Etiology of osteoarthritis

1. Genetic predisposition—Hip dysplasia,elbow dysplasia
2. Aging—Chondrocytes synthesize smaller aggrecans, less functional protein and there is an accumulation of advanced glycation end products in the Type II collagen network. Decreased amounts of chondroitin sulfate are produced and increased amounts of keratin sulfate are produced. Keratin sulfate has less ability to imbibe water and therefore cartilage is stiffer and less resistant to deformation.
3. Obesity—increased load on joint mechanically. Adipose tissues is pro-inflammatory and produces increased levels of tumor necrosis factor (TNF), IL-6 and leptin. Obesity causes osteoarthritis through action of adipokines.
4. Early neutering—this appears to be the case for some joints.
5. Exercise, diet, housing— Over exercising at a young age can damage joints. There are no studies validating home made diets vs commercial diets to prevent the development of arthritis.

Pathogenesis of Osteoarthritis

The formation of OA involves all the tissues of the synovial joint. Changes include alterations of the metabolism and morphology of the articular cartilage, and subchondral bone, osteophyte and enthesophyte formation and synovial inflammation and fibrosis. Changes also occur in the soft tissue structures and the ipsilateral musculature due to disuse and inhibition. Changes in the central nervous system occur due to chronic pain leading to pain sensitization.

A normal healthy cartilage looks like the figure below.

Orientation of the cells and relatively little PG in Zone 1, the Tangential Zone, allows the surface of the joint to withstand high tensile stresses resisting deformation and distributing the load across the joint. Loss of this layer as happens in early OA changes the biochemistry within the cartilage. Zone 2 and 3 contain more PG and this allows them to withstand more compressive loads. PGs have a high affinity for water and when the cartilage is loaded slowly this weeps out onto the articular surface to lubricate the joint. In areas of high stress the cartilage is stiffer. In areas of low stress the cartilage is softer. If excess force is put on softer cartilage, OA can result. The subchondral bone has a large area that meshes with the cancellous bone and is very deformable. This allows it to distribute the load . When OA occurs the subchondral bone becomes stiff. The most profound changes are in the major weight bearing areas.

Three stages of OA

Stage one

- Imbalance in the anabolic and catabolic processes in the the cartilage
- ECM degrades and water content increases
- Size of aggrecan molecules in matrix decreases
- Structure of collagen network is damaged which leads to increased stiffness of cartilage.
- Macrophages in the synovium produce TNF alpha, IL-1Beta, IL-17,IL-18—all pro inflammatory . These affect the chondrocytes and activate the MMPs and aggrecanase which break down the matrix.

Stage two

- Chondrocytes proliferate and increase metabolic activity—produce more MMPs to try repair damage—decreased TIMP. Chondrocytes express COX-2 and produce Prostaglandin E2. This enhances the degradation of aggrecan and Type II collagen
- Cell clusters form to try and repair damage but catabolism eventually takes over.

Stage three

- Repair can not keep up with damage and cartilage is lost. Chondrocytes produces nitric oxide (NO) synthase which cause progressive cartilage loss. NO inhibits matrix sythesis, activates MMPs and apoptosis.

Degradation of the ECM of the articular cartilage and cell death are key processes in osteoarthritis.

Pain in OA

Our understanding of joint pain is poor—much comes from human models.

Joint nerves are A beta, A Delta and C fibers. Only cartilage has no nerve endings so stimulation does not produce pain. Silent nociceptors only respond when there is inflammation in the joint.

Synovium—key tissue in the origin of pain of OA. Cytokines and growth factors are produced by the synovial lining cells and inflammatory mediators which sensitize the silent nociceptors. Synovial inflammation, once established, can alter the metabolism of resident synoviocytes, the major biosynthetic source of hyaluronan (HY) in synovial fluid . Inflammatory mediators released from local synovial cells and infiltrating leukocytes can promote increased vascular permeability and the accumulation of plasma in synovial fluid, thereby decreasing HY concentration. This dilution of HY and reduction in its molecular weight due to abnormal synthesis by synoviocytes results in a decrease in the viscoelasticity of synovial fluid and thus its ability to lubricate and protect articular cartilage. This sets up a vicious cycle of cartilage degradation and pain.

Joint pain results in central sensitization which causes increased pain. COX enzymes play a role in central sensitization and COX inhibitors such as NSAIDs prevent establishment of central sensitization. Central sensitization can increase joint pathology while suppressing it can decrease joint pathology.

** A direct effect of NSAIDs at the level of the joint can result in a reduction in disease progression..NO induces cell death. NO is produced by chondrocytes when they are stimulated by pro inflammatory cytokines. COX-2 inhibitors block this by blocking the pro inflammatory cytokines. NSAIDs are still the most important treatment in OA***

References

Levangie, PK, and Norkin, CC. 2011. Joint Structure and Function: A Comprehensive Analysis, 5th Ed. F.A Davis, Philadelphia. p. 64-107.
Tobias, KM, and Johnston, SA. 2012. Veterinary Surgery, Small Animal. Elsevier, Philadelphia. p.553-556, 1078-1112, 125-134.
Millis, DL and Levine, D. 2014. Canine Rehabilitation and Physical Therapy. Elsevier, Philadelphia. p79-92.

Managing the Pain of Osteoarthritis in Dogs and Cats

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

Osteoarthritis (OA) is one of the most common chronic musculoskeletal diseases and causes of lameness in the dogs. The osteoarthritic disease process involves the entire synovial joint, encompassing the synovium, cartilage and underlying bone. Joint failure results from an abnormal mechanical strain causing damage to normal tissue or failure of pathologically impaired articular cartilage and bone under the influence of normal physiological strain or a combination of both. In both cases, the end point is cartilage loss and joint impairment. Osteoarthritic chondrocytes show an altered phenotype characterized by an excess production of catabolic factors, including metalloproteinases and reactive oxygen species(NO). These factors constitute potential therapeutic targets and some new drugs and nutraceuticals have been proposed to promote the return to homeostasis.

It is important to remember that the pain of OA is not felt in the articular surfaces, instead the peri-articular structures such as the inflamed synovium, fibrotic joint capsule, or weak tendons, ligaments or muscle. OA is a disease of the entire joint involving synovitis, atrophy and fibrosis causing pain and progressive degenerative disease.

In recent years the human literature has identified OA pain as maladaptive pain that resembles true neuropathic pain. Maladaptive pain is pain as a disease and involves the creation of peripheral and/or central sensitization.

Pharmacological pain relief

The first line drugs for treatment of osteoarthritis are the Non Steroidal Anti-Inflammatory Drugs (NSAIDs). A number of NSAIDs have been approved for use in dogs and fewer in cats. Generally NSAIDs inhibit one or more steps in the metabolism of arachidonic acid. This class of drugs ameliorates the symptoms of osteoarthritis but also has a role in preventing central sensitization through COX inhibition.

Actions of NSAIDs

Stresses on the joint lead to production of inflammatory cytokines released by synovial cells, chondrocytes, macrophages and fibroblasts. These proinflammatory cytokines, including certain interleukins and TNF-alpha, lead to upregulation of COX-2 enzymes and production of eicosanoids such as PGE2,and the upregulation of matrix metalloproteinases. Normally during metabolism PGs are broken down by enzymes matrix metalloproteinases (MMPs) and aggrecanase. In acute inflammation MMPs increase in number and disrupt the balance of production and destruction in the joint.There is shift toward breakdown of articular cartilage resulting from an imbalance between MMPs and their TIMP inhibitors, leading to thinning and destruction of the cartilage tissue and perpetuation of the inflammatory cascade with PGE2 production and subsequent pain.

NSAIDs block PG synthesis by binding to and inhibiting COX. The major therapeutic and toxic effects of NSAIDs result from this action. The major " safe" NSAIDs are said to be COX2 selective although these do have some COX 1 effects.

Adverse events

Adverse side effects of NSAIDs can include gastric upset, vomiting, diarrhea, inappetence, gastric bleeding, platelet inhibition, analgesic nephropathy, liver and cardiac problems. Inappetence is the most common side effect in cats.

Most adverse events occur within 2 to 4 weeks of commencement of the NSAID and stop soon after drug is discontinued. NSAIDs can cause gastric erosions but unlikely that these would occur without clinical signs. Perforations are most likely caused by concurrent use of steroids and NSAIDs or by using high doses of NSAIDs.

Nephrotoxicity can be seen in patients with pre-existing renal disease, hypotension, hypovolemia, congestive heart failure or diuretic administration. Hepatic necrosis appears to be due to an inherited sensitivity to the molecule used and not a true toxicosis.

Common NSAIDs

Drug	Trade name	Dose	Species
Carprofen	Rimadyl—Zoetis	4.4mg/kg q 24 hours or 2.2 mg/kg q 12 hours	Dogs only
Deracoxib	Deramaxx- Elanco	1-2 mg/kg q 24 hours	Dogs only
Firocoxib	Previcox—Merial	5 mg/kg q 24 hours	Dogs only

Drug	Trade name	Dose	Species
Meloxicam	Metacam, Orocam, Meloxyn—	0.1mg/kg q 24 hrs-dogs 0.05 mg/kg q 24 hrs -cats	Dogs and cats
Robenacoxib	Onsior-Elanco		Dogs and cats

Long term use and safety in OA patients

- Use a veterinary approved drug at label dose—can be used long term and may show improvement in disease from 6 months to 1 year
- Meloxicam and Robenacoxib are metabolized in cats by oxidation not glucuronidation. Long term oral use has been safely demonstrated.
- No one veterinary approved NSAID has been proven to be safer than another.
- Veterinary approved products are safer than non veterinary approved products.

Nutraceuticals that work as well as drugs (and are proven winners)

Omega 3 fatty acids

There are a number of Randomized Controlled Clinical Trials (RCCT) proving the efficacy of Omega 3 fatty acids—fish oil or Marine Oil (Algael Oil) but not flaxseed oil.

Arachidonic acid is the primary substrate for the lipooxygenase (LOX) and cyclooxygenase (COX) enzymes. This fatty acid is derived dietary sources and stored in phospholipids of the cell membrane until needed. AA is a member of the omega-6 fatty acid family. AA can be partly replaced in cell membranes by the omega-3 fatty acid EICOSAPENTANOIC acid (EPA). EPA can be used by the LOX and COX enzymes to produce eicosanoids. When EPA is used by the COX and LOX enzymes, they produce the eicosanoids PGE3, thromboxane (TX) A3 and LTB5, which are less active and relatively anti-inflammatory compared to their counterparts produced from AA.

Omega 3 Fatty Acids can be supplied by supplemented diets (HIll's J/D, Purina JM and RC Mobility Support) or directly supplemented from fish oil capsules or liquid. Dose for supplementation varies but most accepted is:

Injectables

Polysulfated glycosaminoglycans

Adequan (PSGAG) and Cartrophen (Sodium pentosan polysufate) are the 2 products that are available.

Polysulfated glycosaminoglycans (PSGAGs) are a semisynthetic product (derived from bovine trachea) structurally similar to the GAGs found in articular hyaline cartilage. PSGAGs stimulate collagen synthesis and inhibit collagen breakdown as well as decrease pain and inflammation. Several studies have documented positive effects when administering PSGAGs (Adequan) to dogs with hip dysplasia and osteoarthritis. One study found decreased hip laxity in dogs treated with Adequan twice weekly from 6 weeks to 8 months of age compared to age-matched controls. It is recommended to begin treatment as early in the disease process as possible in order to slow the progression of cartilage damage. The strength of evidence for PSGAGs used at the labeled dose is considered high. Dose: 5mg/kg once weekly x 4 to 6 weeks then once monthly in dogs, cats first 4 weeks is the same but 2nd month every other week then once monthly

Cartrophen

Pentosan polysulphate—this product is used in Canada, Europe and Australia. Similar actions to Adequate. Dose is 1ml/33kg once weekly for 4 weeks then once monthly.

Other drugs for chronic/ maladaptive pain

Tramadol

In humans tramadol is known to exert its pain modifying effect through two metabolites; one enhances inhibitory neurotransmitters (serotonin, norepinephrine), and the other (0-desmethyltramadol, or "M1") metabolite is a weak opioid (1/100th the mu-receptor affinity of morphine.) Tramadol has a very short half-life (1.7 hours) in the dog, and it appears that dogs produce very little of the M1 opioid metabolite. Evidence for a pain-modifying effect of oral tramadol remains unknown at this time. Plasma levels in dogs are much lower following oral administration than in humans. One study of oral tramadol reports a statistically significant increase of mechanical threshold levels, but only at the 5- and 6- hour time point. One study does find oral tramadol effective as part of a multi-modal analgesic protocol to control cancer pain, but others have found it (not unsurprisingly) inferior as a solo agent to multi-modal pain management.

Gabapentin

Gabapentin is said to be effective in neuropathic pain states such as post- herpetic neuralgia (shingles) in people. Gabapentin binds to the alpha 2 delta subunit of the voltage-gated calcium channel resulting in the decreased release of excitatory neurotransmitters such as glutamate. It also increases brain concentrations of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter. It has also been used in people for fibromyalgia and diabetic neuropathy pain, and restless leg syndrome, and in acute pain states it may reduce the opioid need of some patients.

Gabapentin is used in dogs with neuropathic pain or in dogs who pheotypically appear as if they have neuropathic pain i.e. osteoarthritis. Dosage of this drug is usually 10 mg / kg BI but geriatric dogs may need a decreased dose of 5,g /kg.

Amantadine

Amantadine is an antiviral drug but it also increases concentrations of dopamine in the CNS as well as being an antagonist at the NMDA receptor. It affects central pain sensitization via NMDA receptor and appears to enhance the analgesic effects produce by opioids, NSAIDs and gabapentin. In dogs, one clinical study using 3 to 5 mg/kg once daily in combination with meloxicam showed significant improvement using client-specific outcome measures for activity on day 42 of administration but not on day 7 or 21. This may be a function of dosage frequency as pharmacological data indicate twice daily dosing is more appropriate.

In cats, there is very good oral bioavailability but a short half suggests twice daily dosing in the similar range to dogs. Central sensitization must be present for efficacy to be demonstrated.

Dosage is usually 10 mg .KG BID or in cats 3 to 5 mg /Kg BID to start

Amitriptylline

Amitriptyline and other TCAs are commonly used in neuropathic pain in people. They produce serotonin and norepinephrine reuptake inhibition, some NMDA antagonism, sodium channel blockade and are anti- inflammatory. In the dog suggested dosage is 3-5 mg/kg every 12 hours**.**

Acetaminophen

Contraindicated in cats! It has been used in dogs for a washout period if switching NSAIDs and may be combined with codeine or tramadol. May be beneficial for dogs with renal dysfunction but should not be used immediately postoperative. Even at recommended doses there is some potential for toxicity. Dose: 10 – 15 mg/kg PO q8h; if using long-term (>5 days) consider giving q12h at the lower end of dosing range.

Oral opioids

Maladaptive pain secondary to peripheral nerve damage shows decreased sensitivity to opioids. Oral opioids have a very low bioavailability due to metabolism in the liver. Codeine has the highest bioavailability and is often combined with acetaminophen **in dogs only.**

Dose: 1-2 mg/kg q 4 hours

If combined with acetaminophen dose on the acetaminophen fraction and do not exceed 2mg/kg of codeine.

Cortisone

Corticosteroids are usually the last drug used and are not analgesic but do reduce inflammation. Intra articular injections are common in humans and becoming more common in dogs. Intra articular steroids have been shown to protect articular cartilage in experimental canine OA; however, repeated use may also have deleterious effects on joint tissue from suppression of cartilage matrix synthesis. Benefits usually outweigh risks. Strict aseptic techniques are needed for these injections.

On the horizon

A new EP4 receptor blocking drug, grapiprant, will soon be coming to market. It is rumoured to replace NSAIDs in dogs and will have applications in cats as well. The company producing this drug is Aratana. It should be to market in 2016.

References

Epstein, M., Rodan, I, et al. 2015 AAHA/AAFP Pain Management Guidelines for Dogs and Cats. JAAHA 2015; 51:67-84.

Epstein, Mark. The Prevention and Management of Pain in Dogs in *Canine Sports Medicine and Rehabilitation .2013,* Van Dyke, JB and Zink, CM (eds), Wiley- Blackwell, Ames, IA

Nonpharmaceutical Treatment of Osteoarthritis: Rehabilitation, Acupuncture, and More

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

For many years OA was managed with a single pharmaceutical agent if and when the clinician determined the animal was suffering. Recently it has been realized that pain is a very complex process and involves signalling molecules, pathways, substances, receptors and transmitters with different modes of action. It is unrealistic to think only one pharmaceutical could be effective in eliminating chronic pain. It is equally unrealistic to think that drugs alone can manage OA effectively for the life of the animal. A multimodal approach to the treatment of OA is necessary and the best approach.

Weight loss and diet[1]

Prevalence of OA is likely close to 60 % of all dogs and over 50 % of all dogs are overweight. Excess weight causes an excess load on an abnormal joint, creating more pain. In addition the adipose tissue secretes adipokines which are pro-inflammatory and these increase the overall inflammation in the joints and elsewhere in the body.

Purina Longevity study determined that dogs who are normal weight live on average 2 years longer than their obese siblings. Musculoskeletal problems, especially OA were the leading cause of death or euthanasia and doubled the need for pain medications.

To have success with weight loss, you need to be able to calculate the Resting Energy Requirement (RER) and determine calories needed for weight loss. Generally for weight loss the pet needs 60 to 80 % of RER. A weight loss diet that is higher in protein (minimum 1 g/lb of body weight) tends to maintain lean body mass. Just having the client cut down the number of calories with their existing diet can promote muscle loss instead of fat loss, so true weight reduction diets are needed. Here is an example of how to calculate amount of food needed.

Determine RER from Body Condition Score on a 9 scale. For every point that the dog or cat is overweight over the ideal 5/9 body condition score, the pet is 10 % obese. For example a 10 kg cat with a body condition score of 7/9 is 2 x 10% or 20% over ideal weight. To determine Lean body weight in kilograms 10/1.20 = 8.3kg. Take this lean body mass of 8.3 and raise it to the 0.75 power. Multiply this result by 70 to give the RER. In this case a cat with a lean body mass of 8.3 kg has a RER of 342 kcal. Multiply this by 0.8 = 272 kcal. This is the number needed for weight loss. Had the example been for a dog I would have used 7. Use this formula and this calculation rather than amount on bag or can for weight loss. If supplementing with Omega 3 fatty acids be sure to take those calories into account. Consider using 1/2 joint diet and 1/2 weight loss diet and then adding additional Omega 3s for cats or using one of the new combination weight loss and joint health diets (Hill's).

Environmental modification and assistive devices

Simple environmental modifications can have a positive effect on old painful patients. Raising food and water dishes, putting down area rugs or carpet to reduce slipping, installing ramps and using baby gates to limit dangerous areas are all good ideas for household modifications. A foam bed or other soft area to lie on can cushion old joints. Harnesses, slings, booties, power socks, braces and orthotics are all examples of assistive devices that can be used. Sometimes carts and wheel chairs are also necessary.

Acupuncture[2]

Acupuncture can be used to relieve pain, cause an autonomic nerve response, increase the rate of nerve regeneration, and cause surgical analgesia. Studies have found that acupuncture and non-acupuncture points were differentiated by their connection to different pathways in the central nervous system. They found that the pathway connected to the acupuncture point is different from the pathway connected to the non-acupuncture point. In addition, the pathway connected to the non-acupuncture point is inhibited within the lateral periaqueductal gray when the analgesia inhibitory system (AIS) is activated. They also found that analgesia caused by stimulation of the acupuncture point is naloxone reversible, while that caused by stimulation of the non-acupuncture point after a lesion in the AIS is dexamethasone reversible. Stress-induced analgesia caused by low frequency electrical shock was naloxone as well as dexamethasone reversible.

There are multiple theories as to how acupuncture works in humans and animals alike. It is important to understand that no one theory explains all the different effects of acupuncture. Just as research is continuously being done to further develop western medicine, additional research is being done with both human and animal acupuncture to further our understanding of this ancient healing art. The most current theories are: 1) The Gate Theory; 2) Endogenous Opioid Theory; 3) Autonomic Nervous System Input Theory; 4) Humoral Theory; 5) Bioelectric Theory; and 6) Traditional Oriental Medicine Theory.

1.The gate theory

A beta sensory neurons close the gate to larger pain fiber sensations.

2. Endogenous opioid theory

Studies have found that acupuncture analgesia could be reversed by naloxone. It was also determined that a cross-tolerance can develop between acupuncture and morphine. Levels of the opiate peptide NAGA and beta-endorphins were shown to increase in the brain and cerebrospinal fluid (CSF) after acupuncture. It has also been shown that levels of met- and leu- enkephalins significantly increase in the brain after electrical acupuncture. Opiates are also known to have systemic effects that can be produced by acupuncture. For example, opiate receptors in the gut are responsible for decreasing peristalsis and increasing segmental contractions, thus effectively controlling diarrhea.

3. Autonomic nervous system input theory

Type A-delta visceral and somatic fibers have a similar distribution in the dorsal gray matter and tract of Lissauer. Inputs from both converge in the spinothalamic tract. Visceral A-delta fibers form reflex arcs with propriospinal afferents, and can cause muscle cramping secondary to visceral inflammation. Conditions of somatic pain can also cause visceral manifestations of disease. These interactions account for the phenomenon of “referred pain.” Stimulation of acupuncture points can cause a reflex arc, resulting in sympathetically induced segmental superficial and visceral vasodilation. This explains how acupuncture can be effective in the treatment of internal organ dysfunction.

4. Humoral theory

This theory was first postulated after studies showed that a transfer of blood, CSF, or brain tissue from an animal under acupuncture analgesia to an animal not receiving acupuncture resulted in analgesia of the recipient. This analgesia was generalized and reversed by naloxone. The analgesia level required for surgery took twenty to thirty minutes of stimulation to reach its peak and lasted hours after stimulation of the points had ceased. Acupuncture has also been shown to cause systemic increases in growth hormone, prolactin, oxytocin, luteinizing hormone, white blood cells, immunoglobulins, antibodies, and interferons depending on which points are stimulated(66).

5 . Bio-electric theory

Becker and Reichmanis[3], in 1976, proposed a theory that the healing and analgesic properties of acupuncture are based on a DC current system. In this system, electric signals are generated and propagated by Schwann cells, satellite cells, and glial cells. Acupuncture points, like amplifiers, would boost the DC signal along the nerve pathways. Insertion of a metal acupuncture needle would, in effect, short-circuit the system and block pain perception.

6. TCM theory

According to TCM theory, Qi, also known as Chi, energy, or life force, circulates through each of the meridians or channels every twenty-four hours. Each channel is connected energetically to a TCM organ. The channels derive their names from the organ upon which they have the greatest influence. A blockage of Qi circulation manifests as dysfunction or disease. By stimulating or sedating energy levels at acupuncture points, the body is brought into balance and healing is facilitated.

Physical rehabilitation[4]

The goals of rehabilitation include the restoration, maintenance and promotion of optimal function and quality of life as they relate to movement disorders. The majority of rehabilitation therapeutics involves manual therapies including joint mobilizations, and therapeutic exercises. Equipment used on a regular basis in veterinary rehabilitation includes physioballs, therapy bands, rocker/wobble boards, cavaletti poles and land treadmills. Hydrotherapy equipment can include pools, resistance pools and underwater treadmills. Modalities such as hot and cold therapy, laser, electrical stimulation, shock wave therapy and therapeutic ultrasound can also be used. Regenerative medicine with platelet rich plasma and stem cells is now also a part of rehabilitation and pain management.

Manual therapies[5]

Joint mobilizations—a manual technique used to assess a joint and improve its movement (arthrokinematics). Joint mobilizations improve joint lubrication, modulate mechanoreceptors, and decrease sensory input thus relieving pain. Therapeutic glides are ranked Grade I to V using the Maitland Mobilization Scale.

Massage is soft tissue massage and soft tissue mobilization. Massage can decrease excessive tissue tension by aiding in removal of chemical substances in soft tissue that activate chemical nociceptors. Soft tissue massage can also, by the Gate Theory, reduce pain by stimulating large rapidly conduction fibers, selectively closing the gate against smaller pain fiber input.

Thermal therapy[5]

The effects of thermotherapy are vasodilation with secondary increased local circulation, decreased pain, relaxed muscle tone, reduced muscle spasm, increased tissue extensibility, increased cellular metabolism, and increased local tissue oxygenation. Heat is generally used to reduce pain from arthritis, trigger points and muscle spasms, and to prepare tissues for exercise or stretching. Precautions of using heat therapy include impaired thermal sensation, recent hemorrhage, malignancy, and acute inflammation. Heat can be applied by gel packs, hot towels, or therapeutic ultrasound.

Cryotherapy can be applied via ice bath, ice massage, ice pack, vapocoolant gel, or circulating ice compression units. The beneficial effects of cryotherapy include vasoconstriction; reduced cellular metabolism; decreased nerve conduction velocity, and decreased production of pain mediators, leading to analgesia; reduction of edema and decreased muscle spasm. Metabolism may be decreased by more than 50%, which facilitates oxygen diffusion into the injured tissues. Joint range of motion is improved through suppression of excitatory muscle spindle afferents. Intermittent pneumatic compression, when combined with cryotherapy has been shown to prevent edema formation, increasing blood flow, and stimulation of tissue healing. Although static compression is effective in edema reduction, intermittent compression optimizes lymphatic drainage. Game ready is commonly used for pain reduction post surgery.

Laser[4]

LASER" is Light Amplification by Stimulated Emission of Radiation. By definition, a laser must be collimated and monochromatic. Penetration of laser energy is determined by the wavelength, and many wavelengths are patented. The physiological effects of laser stimulation include accelerated cell division via mitochondrial stimulation, increased leukocyte phagocytosis, stimulation of fibroblast production, enhanced synthesis of ATP, and angiogenesis. Treatment with laser is indicated for pain management, control of inflammation, and tissue healing.

Electrical therapy[5]

Electrical stimulation (ES) can affect the sensory and the motor nerves. Indications for ES include wound healing, pain control/relief, reduction of inflammation, muscle re-education, reversal of atrophy, and strengthening. Electrotherapy works at the cellular level to cause excitation of nerve cells, changes in cell membrane permeability, and stimulation of protein synthesis, osteosynthesis and fibroblast formation. On the tissue level, electrotherapy causes skeletal muscle and smooth muscle contraction. On the segmental level, electrotherapy facilitates muscle-pumping action, which improves joint mobility and circulatory and lymphatic drainage. ES can be TENS or NMES.

Sound therapy[5]

ESWT has been applied to painful OA lesions in veterinary practice, including hip and elbow dysplasia and Supraspinatus tendinopathy with excellent pain relief results being reported. ESWT works by releasing a sudden high-powered shock wave resulting in tissue modulation in a very focused depth of tissue. This modality does require deep sedation or anesthesia as the treatment is uncomfortable for the patient, however the patient experiences pain relief immediately post treatment, which can last for days to weeks. The mechanism behind the pain-relieving function of ESWT is thought to be due to increased serotonin activity in the dorsal horn, and descending inhibition of pain signals.

Therapeutic exerises[5]

Therapeutic exercise contributes to pain management in through Exercise Induced Hypoalgesia (EIH) which results from activation of the opioid system with beta-endorphin release from the pituitary. It is also believed that exercise can activate large afferents and that mechanical hypoalgesia is induced by repeated low load exercises regardless of exercise mode.

Exercises are used for stretching, strengthening, balance, proprioception, flexibility, endurance and muscle re-education

Exercises for stretching, front and hind limb and balance and proprioception 4

PROM, High 5s, Ball Work, Wheelbarrow, Step ups, Sit to Stand, Backwards Walking, Side stepping, Rhythmic Stabilization, Cross legged standing, Crawling, Sit to Be

Regenerative medicine

Stem cell and PRP (Platelet Rich Plasma) can be used for pain management. Progenitor cells present in almost every tissue that are self- renewing, able to become different tissue types and signal other cells to come in and repair tissue. Adipose derived and bone marrow derived mesenchymal stem cells are used. Benefits are more like due to growth factors. PRP contains growth factors as well. This is a wide topic and only gets a brief mention here.

References

1. Marshall, W. G.et al.: A review of osteoarthritis and obesity.Vet Comp Orthop Traumatol 2009; 22: 339–345
2. Medina, Carolina. The Role of Acupuncture in Canine Rehabilitation in *Canine Sports Medicine and Rehabilitation.* VanDyke, J.B. and Zink, M.C. (eds) Wiley-Blackwell, Ames, IA, 2013.
3. Becker, Robert O., et al. "Electrophysiological correlates of acupuncture points and meridians." Psychoenergetic Systems 1.106 (1976): 195-212.
4. Mc Cauley, L. and Van Dyke, J. Therapeutic Exercise in Canine Rehabilitation in Canine Sports Medicine and Rehabilitation. VanDyke, J.B. and Zink, M.C. (eds) Wiley-Blackwell, Ames,IA, 2013.
5. Millis, D and Levine, D. 2014. Canine Rehabilitation and Physical Therapy, 2nd Ed. Elsevier, Philadelphia . pp-, 312-381, 447-506.

Emerging Modalities in the Treatment of Pain

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

What exists for painful veterinary patients beyond rest and NSAIDs? What can I do for those really painful patients? Where can I find help and answers for my pain questions? What are the standards of care for pain? Are there any non pharmalogical modalities that really work for pain?

These are all very common questions for veterinary practitioners to ask in this changing world. We will deal with what's new and what is on the horizon for pain in veterinary practice.

Standards of care for pain in dogs and cats is now outlined in the new AAHA/AAFP pain guidelines. Here is an excerpt summarizing the guidelines:

The 2015 guidelines summarize and offer a discriminating review of much of this new knowledge. Pain management is central to veterinary practice, alleviating pain, improving patient outcomes, and enhancing both quality of life and the veterinarian-client-patient relationship. The management of pain requires a continuum of care that includes anticipation, early intervention, and evaluation of response on an individual-patient basis. The guidelines include both pharmacologic and nonpharmacologic modalities to manage pain; they are evidence-based insofar as possible and otherwise represent a consensus of expert opinion. Behavioral changes are currently the principal indicator of pain and its course of improvement or progression, and the basis for recently validated pain scores. A team-oriented approach, including the owner, is essential for maximizing the recognition, prevention, and treatment of pain in animals. Postsurgical pain is eminently predictable but a strong body of evidence exists supporting strategies to mitigate adaptive as well as maladaptive forms. Degenerative joint disease is one of the most significant and under-diagnosed diseases of cats and dogs. Degenerative joint disease is ubiquitous, found in pets of all ages, and inevitably progresses over time; evidence based strategies for management are established in dogs, and emerging in cats. These guidelines support veterinarians in incorporating pain management into practice, improving patient care.

Pain scoring is important and veterinarians need to use pain scales

Although the Glasgow Composite Pain Scale is the only validated Acute pain scale, the Colorado State Acute Pain scales for post surgical pain are easier to use. They rely on pictures and should be scored by the same person as the inter rater scores could vary.

Chronic pain scales include the Helsinki Chronic Pain Scale, the Canine Brief Pain Inventory, the Cincinatti Orthopaedic Disability Index and others. The important thing is to familiarize yourself with one of these scales and use it consistently.

New or new to you techniques to consider

Local anesthetics with every surgery—Line blocks, Ring blocks, testicular and ovarian blocks.

For chronic orthopedic disability regional anesthesia with bupivicaine can be used to relieve pain so muscles can be strengthened—consider blocking femoral or sciatic nerves—may need to use a nerve finder to do this.

Epidurals—not really new for orthopaedic surgery but consider these for blocked cats (sacral epidural). For dogs with painful lumbosacral disease consider epidurals with methyprednisilone—it will not improve neurological function but will relieve pain.

- Ketamine—Subanesthetic doses as CRIs for painful surgeries—things that are likely to trigger maladaptive pain syndrome.
- Use of Amitriptyline for Chronic pain—much lower doses than needed for anxiety.
- Joint injections with HA and corticosteroids

New information

- Pruritis receptors are a subset of nociceptors that also respond to pain.
- Substance P and Glutamate can cause pain and itch.
- Itch can be inhibited by pain--mild scratching inhibits itch. In order to inhibit the itch signalling pathway you need to have both itch and pain as these overlap, so consider this when dealing with chronically itchy animals—this may be why amitriptyline works for pain.

Glial cell dysregulation

Originally thought that non neuronal cells (glia) had no input into the nervous system. However research has shown that microglia and astrocytes have an effect on the nervous system and how it handles opiates. Glial cells are key in the development of pathologic pain.

In every clinically relevant model of enhanced pain, the glial cells are activated, so if you block the glia cells you block pain. Glial cells monitor the CNS--they are very active cells--when they find danger they actively attack it--they release all kinds of substances.

The important thing to know is they amplify the pain transmission to brain, they up regulate the NMDA receptor numbers and down regulate GABA and glia glutamate transporters.

Glial cells enhance pain and PREVENT opiates from working.

What activates glia cells?—lots of stuff--Opioids, endogenous danger signals (leakage of blood—anything that should not be in the nervous system that causes cell stress and damage).

Most common endogenous danger signals are peripheral nerve injury , overuse of medication, s diabetic neuropathy, spinal cord injury, bone cancer, arthritis, and pancreatitis. These conditions cause pro inflammatory cytokines to be released.

Opioids activate the glial cells so this can actually block the pain control from the glial cells--if you block the spinal IL-1 the analgesia comes back. Opioid effects are different on neurons vs glial cells. The glial cell receptor is TLR4 (not me not right no ok receptor) --it is a major player in identifying endogenous danger signal and recognizes all lipids.Glial TLR4 is a driver of neuropathic pain. If the glial cells are blocked by + naloxone then it might be a stand alone treatment for neuropathic pain.Other cells involved are in blood vessels and these produce IL-1 (pro inflammatory cytokines) and these can be blocked by naloxone.

When glial cells are active and you give opioid for pain it makes pain worse because the glial cells are induced to produce more IL 1 and block the opioid receptors. Primed state can occur for a period of time after prior activation--the glial cells are not activated they are waiting and the reaction comes back with a vengeance. Primed glial cells can be activated by aging, opioids , stress, trauma and inflammation

Clinical relevance--prior surgery changes pain to chronic pain --this can be prevented by glial activation inhibitor..

Another interesting point--morphine can worsen post surgical pain. This is mediated by TLR4--so to control this you need to give a TLR4 blocker when you give morphine.

IL-10—anti inflammatory interleukin—this is being developed for inter thecal injection.

Grapiprant—EP4 blocker that works in inflammatory cascade with no NSAID side effects

Theracurmin—biologically active curcumin—water soluble

Non pharmacological

- Acupuncture—more common and more accepted.
- PT modalities easily added to general practice—Laser, exercise therapy, hot and cold therapy, TENS
- Myofascial pain—this is something new to veterinary medicine. It is a myalgic condition in which muscle and tendon are the primary cause of pain. The syndrome is centered around the myofascial trigger point (MTrP). A myofascial trigger point is an extended contraction of a few muscle fibers that results in a painful knot. Dry needling is what is done to eliminate them. If you are interested there is an entire lecture on this topic.
- Regenerative Medicine—PRP and Stem cell

Pain in Cats:
An Integrative Approach

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

Pain is a multidimensional sensory experience that is intrinsically unpleasant and associated with hurting and soreness. It may vary in intensity (mild, moderate, or severe), quality (sharp, burning, or dull), duration (transient, intermittent, or persistent), and referral (superficial or deep, localized or diffuse).

Pain is divided into 2 categories: Adaptive and Maladaptive Pain. Adaptive pain is that which serves a purpose—to protect the body from harmful substances or protect the body while healing occurs. Adaptive pain can be either nociceptive or inflammatory. Nociceptive pain is pain that is transient from noxious stimuli. Inflammatory pain is spontaneous in response to tissue inflammation or injury. Both of these could be considered acute pain and will occur naturally post injury or inflammation and are limited in their scope and time frame. These types of pain are pain with a purpose—to protect and allow rest for healing.

Maladaptive pain is pain as a disease and it serves no useful purpose.Such pain may occur in response to damage to the nervous system (neuropathic pain) or result from abnormal operation of the nervous system (functional pain). Maladaptive pain is the expression of abnormal sensory processing and usually is persistent or recurrent. Maladaptive pain can result from peripheral or central sensitization. In peripheral sensitization inflammation and tissue damage produce a variety of nociceptor-sensitizing substances, including prostaglandins, histamine, serotonin, bradykinin, proteases, cytokines (tumor necrosis factor α), and nerve growth factor. This "sensitizing soup" lowers the nociceptor threshold to painful stimuli and activates "silent" or "sleeping" nociceptors, resulting in hyperalgesia(exaggerated response to noxious stimuli) and allodynia (painful response to normal stimuli).

Central sensitization occurs when severe (high-intensity) or chronic painful stimuli activate C fibers, causing the release of glutamate, substance P (Sub P), and brain-derived neurotrophic factor (BDNF) at central nerve terminals; this results in the activation of number of receptors producing acute and long-lasting dull, aching, burning pain sensations. Collectively, the activation of these receptors increases the activity of a host of signaling molecules that alter gene expression and change the responsiveness (sensitize) of the central nervous system to subsequent input. Chronic painful stimulation may result in neurochemical changes (neuroplasticity) in the spinal cord such that all stimuli produce pain.(Gaynor 37)

Pain assessment in cats

Currently the only validated acute pain scale for cats is the UNESP-Botucatu Multidimensional Composite Pain Scale .A shorter and easier to use pain scale is the Colorado State University Feline Acute Pain Scale. It involves a simple numeric scale with pictures outlining behavioural and psychological indicators of pain and includes response to palpation. This scale is not currently validated.

For chronic pain, specifically related to degenerative joint disease (DJD) in cats, the only validated system is the NCSU Comparative Pain Research Lab's Feline Musculoskeletal Pain Index. Behaviors evaluated include litterbox use, grooming, fluidity of gait, temperament, appetite, allowing petting and general activity. Use of activity monitors is another possibility to determine a cat's pain. These have been used in scientific research and will have a place in feline pain determination in the future.

No matter which system is used, results are best if the same person scores the cat's pain each time to minimizer inter rater variability.

Pain management in cats

Nonsteroidal anti-inflammatory drugs

NSAIDs are one of the most common drug classes used to treat pain, and there is a robust body of information indicating that NSAIDs are effective in treating acute pain in cats.They have antipyretic, analgesic, and anti-inflammatory properties, which make them appealing therapeutic options; however, remember that there is not, and never will be, a completely safe NSAID for use in cats. (lascelles)

NSAIDs work to block the cyclooxygenase (COX) enzyme pathway to prevent production of eicosanoids and also work to inhibit central perception of pain. Eicosanoids are metabolically active compounds derived from 20-carbon fatty acids, usually arachidonic acid . The lipooxygenase (5-LOX) and cyclooxygenase (COX) enzymes are the rate-limiting steps in the production of leukotriene B4, thromboxane A2 and prostaglandin E2.

The ideal NSAID should:

- Spare COX-1 as much as possible (to prevent GI erosion and renal tubular necrosis)
- Inhibit COX-2 sufficiently for efficacy against pain and inflammation
- Spare enough COX-2 to allow it to function in normal everyday processes

***Robenacoxib* (Onsior- Elanco)**

Robenacoxib is a targeted tissue selective and a unique COX-2 selective NSAID. It has a very short half-life (3 hours) in the blood, yet persists, and is active, for at least 24 hours in inflamed tissue in cats which demonstrates "tissue selectivity." It is available in injectable and tablet form. Dosage: 1mg/kg q 24 hours

***Meloxicam* (Metacam—Boehringer Ingleheim)**

Meloxicam is a an example of a preferential COX-2 inhibitor that has greater inhibition of COX-2 than COX-1. It is also tissue selective but has a longer tissue half life than robenacoxib.

Used for years in Canada, Europe and Japan. Has a black box label in the US because labelled dose is 0.3mg/kg once post surgery—too high a dose.

Canada has a specific Metacam for Cats with a reduced dose—this dose seems to be the safest.Dose is Injectable 0.1mg/kg—once post surgery followed by oral dose of 0.05 mg/kg q 24 hrs for 5 to 11 days. Dose may be further reduced for long term therapy..we find 0.02mg/kg once daily as a good oral dose for cats with chronic pain—this is study supported although the study was not blinded.

Opiates

Buprenorphine

A partial mu-agonist that is used to manage chronic pain in cats and is classified by the Drug Enforcement Administration (DEA) as a Schedule III controlled substance. Buprenorphine is not approved by the Food & Drug Administration (FDA) for use in cats. The drug may be administered SC, IM, IV, or buccally; buccal administration is the preferred route for chronic pain management. Dosage: 0.01–0.02 mg/ kg SC, IM, IV, or transmucosal.

In July 2014, a new veterinary formulation of buprenorphine was FDA-approved and introduced into the marketplace (Simbadol, Abbott). At 1.8 mg/mL it is 6X more concentrated than the human commercial product Buprenex (0.3 mg/mL). It is labeled for post-surgical pain in cats, with a 24-hour duration with one injection at 0.24 mcg/kg subcutaneously (SC); it can be given daily for up to 3 days. The labeled dose is 0.24 mg/kg, approximately 10X the dose previously recommended. Shelf life 21 months unopened and 28 days opened.

Tramadol—can be used but not approved, variable results in dogs but cats do make the M1 metabolite so better results in cats. In cats it is a mu agonist and serotonin–norepinephrine reuptake inhibitor. Cats are sensitive to the side effects of this drug and the bitter taste makes it difficult for cats to accept.

Dose: 1-4 mg/kg q 8 to 12 hours

Fentanyl—patch forms—variable efficacy

Analgesic adjuvants

These are used in combination with NSAIDs or Opiates to treat chronic pain

Amantadine

Amantadine is an antiviral compound used in humans that is reported to exert an analgesic effect through NMDA receptor antagonism. Toxicity and kinetic studies have not been performed in cats. It is often effective however but can cause diarrhea in cats. Caution in cats with liver and kidney disease or seizures.Dosage: 3-5 mg/kg q 24 hours

Gabapentin

Gabapentin is an anticonvulsant that is used in cats for chronic pain particularly neuropathic pain. It is often used with amantadine and NSAIDs. It has been used to treat allodynia and hyperesthesia. Caution in cats with kidney disease—can be used at a reduced dose.

Dosage: 5 to 10 mg/kg q 12 hours

Amitriptyline

Amitriptyline, a tricyclic antidepressant, is usually administered in combination with an NSAID for feline chronic pain of neuropathic origin.Avoid in seizuring animals or with liver disorders. Do not give along with Tramadol as you may cause serotonin syndrome. Dosage: 1-2 mg/kg q 12 to 24 hours

Nutraceuticals

Adequan (Polyglycoaminoglycan) and Cartrophen (Pentosan polysulphate)

These injectables have been used in dogs and are also used in cats. The bioavailability and distribution of PSGAGs to inflamed joints in cats has been demonstrated with extralabel subcutaneous administration.

Dosage: Cartrophen 1 ml per 33kg SQ once weekly for 4 weeks then once monthly

Adequan: 5mg/kg once weekly x 4-6 weeks then q14d then once monthly (SQ)

Omega 3 fatty acids

The primary source of omega 3 fatty acids is fish oil. A recent placebo controlled trial done with Royal Canin's Feline Mobility support diet found significant improvement in indicators of pain and quality of life when comparing the base-line outcome measures to those collected at the end of the 16-week trial. (Lascelles et al). Dose of combined EPA + DHA is maximum 100 mg/kg if using capsules or adding fish oil to the diet (generally 1 tsp of fish oil is the maximum). There is a concern that this level of

supplementation may cause clotting problems in this species. However, research shows that at this level of supplementation, no cats experienced any clotting problems (Joe Wakshlag, Cornell University, Personal communication)

Green lipped perna mussel (GLM)

Perna canaliculus is found in the waters around Australia and New Zealand. It contains EPA, DHA, and ETA. It is also a source of glycoproteins and GAGs. The anti-inflammatory effects of GLM may be derived from its omega-3 fatty acids content or the GAGs or the glycoproteins. Suggested dose is 50-70mg/kg/d

Herbals

Flexadin Plus (Vetoquinol) contains Devil's Claw, Omega 3 and Glucosamine/chondroitin—seems to get a good rating but RCCT lacking.

Avocado soybean unsaponifiables

Avocado soybean unsaponifiables (ASU) are residues of avocado and soy oils combined in a 1:2 ratio to produce a product that has demonstrated anti-arthritic properties. Theoretically, ASU decrease the production of pro-inflammatory cytokines such as PGE-2 and TNF alpha. There are no published controlled trials in clinical cats with OA examining ASU alone or in combination products although in vitro studies have been conducted on feline chondrocytes.

Pain management beyond drugs

Weight reduction

Many cats with OA are overweight. As the OA worsens and becomes more painful the cats become less active contributing to an increase in weight. Excess weight causes an excess load on an abnormal joint, creating more pain. In addition the adipose tissue secretes adipokines which are pro-inflammatory and these increase the overall inflammation in the joint of the cat. Secret to weight loss in the cat is canned weight loss diet amount calculated by RER and exercise.

Determine RER from Body Condition Score on a 9 scale. For every point that the cat is overweight over the ideal 5/9 body condition score, the cat is 10 % obese. For example a 10 kg cat with a body condition score of 7/9 is 2 x 10% or 20% over ideal weight. To determine Lean body weight in kilograms 10/1.20 = 8.3kg. Take this lean body mass of 8.3 and raise it to the 0.75 power. Multiply this result by 70 to give the RER. In this case a cat with a lean body mass of 8.3 kg has a RER of 342 kcal. Multiply this by 0.8 = 272 kcal..This is the number needed for weight loss. Use this formula and this calculation rather than amount on bag or can for weight loss.

Exercise therapy can involve an obstacle course, playing with a feather, chasing a laser pointer, climbing a tower etc. A hockey rink with cat toys on a smooth surface can help with weight loss. Moving the food bowl during feeding and making the cat move around is helpful. Food balls can work for cats as well. Designing a cat tree so the cat has vertical and horizontal space is helpful. Indoor outdoor cats are thinner—cat gazebo is a possibility. Treadmill exercise can also be used for cats. Cat nip treats may entice cats to exercise.

Acupuncture

Acupuncture is a safe and often enjoyable method of pain relief for cats and should be considered as part of a multi modal pain management plan. It is minimally invasive and can be used with other modalities and medications as well. This author has used it in cat with back pain, osteoarthritis, stifle pain, post surgery, persistent pain post declaw, for excess grooming (that was related to back pain) for interstitial cystitis and other conditions. There is a growing body of evidence for its use in veterinary medicine.

Physical rehabilitation

Physical rehabilitation is now considered a mainstay for pain relief post surgery and for geriatric animals. Cats are very amenable to all forms of physical therapies. Physical therapy should be considered part of a long term strategy for pain management in the cat. The goals of physical therapy are to restore muscular and joint strength and function, to restore balance and proprioception, to relieve pain, to improve mobility, endurance and flexibility.

Physical rehabilitation can involve manual therapies, massage, laser therapy, hot and cold therapy, exercise therapy, joint mobilizations, ultrasound, electrical stimulation, myofascial release and hydrotherapy. Exercise therapies using balls, treadmills and other devices can be used with cats and often are simply limited by imagination. Passive range of motion (PROM) is a technique easily taught to clients to help relieve pain for stiff cats and one that should be employed for every geriatric cat.

References

Bennett,D, Zainal -Ariffin, S and Johnson, P. Osteoarthritis in the Cat, Journal of Feline Medicine and Surgery (2012) 14, 76–84.

KuKanich B. analgesia and pain assessment in veterinary research and clinical trials. Vet J 2011; 188 (1):1-2

Lascelles Bd, Robertson Sa, Taylor PM, et al. Comparison of the pharmacokinetics and thermal antinociceptive pharmacodynamics of 20 mcg/ kg buprenorphine administered sublingually or intravenously in cats. Vet Anaes Analges 2003; 30:109 (abstr).

Lascelles BD, Henderson A, Hackett I. Evaluation of the clinical efficacy of meloxicam in cats with painful locomotor disorders. J Small Anim Pract 2001; 42:587-593.

Pypendop B, Je i. Pharmacokinetics of tramadol, and its metabolite o-desmethyl-tramadol in cats. J Vet Pharmacol Ther 2007; 31:52-59.

Sparkes AH, Heiene R, Lascelles BD, et al. isFM and aaFP Consensus guidelines, long-term use of Nsaids in Cats. J Feline Med Surg 2010; 12:521-538.
Tranquilli W, Grimm K, Lamont l. Pain Management for the Small Animal Practitioner, 2nd ed. Jackson, Wyoming: Teton New Media, 2004.

Myofascial Pain:
What's All the Buzz?

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

Myofascial Pain Syndrome(MPS) was brought to the attention of modern human medicine by Dr. Janet Travell in 1952 although it has been described in literature as long ago as the 16th century. Despite this, it has failed to enter mainstream medicine, especially in veterinary medicine. Many veterinarians do not even know of its existence! However, within the past decade this aspect of pain medicine along with many others has been steadily gaining a foothold in the general veterinary practice.

What is myofascial pain?

The pathophysiology of myofascial pain is a complex syndrome involving in part, motor, sensory and autonomic nerve components. It is a myalgic condition in which muscle and tendon are the primary cause of pain. The syndrome is centered around the myofascial trigger point (MTrP). A myofascial trigger point is an extended contraction of a few muscle fibers that results in a painful knot. Simons, Travell and Simons define it as

" a hyper irritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band. The spot is tender when pressed and can give rise to characteristic referred pain, motor dysfunction and autonomic phenomena."[1]

Therefore all MTrPs have a sensory component, a motor component and an autonomic component. When the motor end plate is overstretched which can happen when only a few muscle fibers are activated then myofascial tension is increased in that fiber. An increase of tension of only 1% will evoke a 10 % increase in ACh release. With excessive release of ACh there is excessive motor activity. The local muscle contraction compresses local sensory nerves and blood vessels and reduces the supply of oxygen to the area. Decreased oxygen and increased metabolic demands of the contracted muscle fibers result in a depletion of the local ATP. This cause pre and post synaptic changes in the Calcium pump and leads to muscle spasms. Trigger points are formed which are painful and either excite or inhibit activity on motor activity in the muscle or its functionally related group. This inhibition causes poor co-ordination and muscle imbalances. There are also autonomic phenomena associated with MTrPs.[2]

Etiology of MTrPs

Mechanical issues

Acute trauma may activate MTrPs but does not perpetuate them. Sudden activation can occur with direct trauma, muscle strain, joint sprain or excessive or unusual exercise. Mostly commonly are formed with chronic muscle overload such as occurs with orthopedic injury, neuropathy, joint dysfunction or osteoarthritic pain. It is thought that low level muscle contractions, unaccustomed eccentric contractions or eccentric contractions isn unconditioned muscle as well as maximal or sub maximal concentric contractions may lead to MTrP formation.

In OA the joint dysfuntion and postural changes can activate and perpetuate MTrPs. With coxofemoral arthritis the muscles that frequently develop trigger points are the sartorius, tensor fascia lata, pectineus, rectus femoris and iliopsoas (hip flexors). Due to the forward weight shift , they also develop in the triceps, infraspinatus and deltoid muscles. Because pelvic movement is compromised, and more lateral flexion of the spine occurs, the iliocostalis lumborum and lateral multifidi are also effected. If a dog is hopping on one back leg, trigger points can develop in the contralateral limb and hopping causes excessive eccentric contraction of the stifle extensors. In this leg we see MTrPs in the sartorius, tensor fascia latae, rectus femoris and vastus group. The lumbar paraspinals are also involved as they assist in ambulation.[4]

Nutritional deficiencies and metabolic issues[3]

It is unknown if nutritional deficiencies or metabolic problems perpetuate trigger points in dogs but in humans they have been linked with certain deficiencies such as cobalamin, folate, iron deficiency, Vitamin D and B12 deficiency and metabolic diseases such as hypothyroidism and diabetes.

Examination techniques[3]

MTrPs are diagnosed by palpation. 3 types of palpation are used: Flat palpation, Pincer Palpation and Snapping palpation. With flat palpation the finger pressure is applied at right angles to the muscle fiber compressing against the bone—this is used for the infraspinatus, supraspinatus and psoas muscle. With Pincer Palpation the muscle bands are pinched and rolled between thumb and fingers to detect taut bands. This works for the triceps, sartorial and tensor fascia latae. Snapping palpation is similar to pincer but the fibers are rolled under the finger similar to plucking a guitar string. Taut bands are palpated and usually animal is painful so jumps (Jump sign)

Clinical cases

Brooklyn the Rottweiler

F/S 5 year old Rottweiler BCS 6/9, had TPLO LH 1 year ago and still not using leg well. Current pain medications included Meloxicam and Tramadol. On examination she had a large number of MTrPs in her iliopsoas, sartorial, TFL on the left side and Triceps bilaterally. All of her hip flexors were sore to the point she resent extension of her stifle and was vocal and aggressive with the iliopsoas test. Because Brooklyn had spent a lot of time with her leg contracted she had slight muscle contractions of the hip flexors due. The front leg MTrPs were due to compensation from weight shifting. Brooklyn was uncomfortable and her owners were frustrated.

Treatment: Sedation and dry needling

After one session Brooklyn was more comfortable and would allow her muscles to be touched. A rehabilitation program including acupuncture, UWTM, stretching, leg and core strengthening was able to proceed. Within 1 month Brooklyn was back to her normal self and was fully weight bearing.

Regi the wirehaired fox terrier

Regi, 11 yr old F/S BCS 6/9 former agility dog, pain in sacral area, elbow arthritis, lagging in walks and not wanting to go many places. Owner felt she was depressed. She noticed Regi was walking "funny" in the front end and base wide in the hind end. She had had several rehabilitation sessions for strengthening and gait retraining as well as medication—Gabapentin, Amantadine, Chinese herbs, acupuncture—nothing seemed to be helping. My examination revealed myofascial pain in her iliopsoas, quadriceps, and sartorial and in the triceps and infraspinatus muscles of both front legs.

Treatment: Sedation and dry needling

Result: Regi continued rehab therapy but this time there was a big improvement. She went back to walking well and was no longer depressed.

Dry needling is the preferred method of treatment in myofascial pain syndrome in dogs. Dry needling involves the act of placing an acupuncture needle directly into the painful trigger point resulting in a complex cascade of events involving in part spinal reflexes, increased blood flow and an increase in the amount of energy available to the muscle. This causes the taut band of muscle containing the trigger point to relax and the pain relief is immediate. When Brooklyn's owner picked up her dog after the first session, she was misty-eyed with relief when she saw Brooklyn walking normally as she came out to greet her. Dry needling imparts an immediate benefit but it generally requires several sessions to give complete relief. And unless the underlying cause can be found and completely treated, it eventually returns needing additional treatments, especially in the case of chronic conditions like osteoarthritis.

Dry needling is not taught in university settings. The only regular classes that a veterinarian can take is through the Canine Trigger Point Therapy Program given through Myopain Seminars and taught by Drs. Jan Dommerholt and Rick Wall.[4]

References

1. Travell JG, Rinzler SH. The myofascial genesis of pain. Postgrad Med 1952;11:452-434.

2. Treaster D, Marras WS, Burr D, Sheedy JE, Hart D. Myofascial trigger point development from visual and postural stressors during computer work. J Electromyogr Kinesiol 2006;16:115-124.

3.Dommerholt, J, and Huijbregts, P. Myofascial Trigger Points: Pathophysiology and Evidence-Informed Diagnosis and Management. Sudbury, MA. Jones and Bartlett, 2011

4.Wall, Rick. Myopain Seminar Course Notes, Canine Trigger Point Course, www.myopainseminars.com

Nutraceuticals for Pain

Janice Huntingford, DVM, DACVSMR, CVA, CCRT, CVPP, CAVCA
Essex Animal Hospital
Essex, Ontario

What is a nutraceutical?
A food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease.

What is a dietary supplement?
Product taken by mouth that contains a dietary ingredient intended to supplement the diet or a substance produced in purified or extracted form which, when administered orally to patients, aims to provide them the necessary elements for their structure and normal function to better their health and wellbeing.

Nutraceuticals are used by a large number of veterinary clients for osteoarthritis and are one of the fastest growing areas of supplementation for pets.

Normal joint structure and function
The ECM of articular cartilage is mostly protein and water and has both interfibrillar (ground substance) and fibrillar components. The fibrillar component is composed of mostly collagen and elastin. Collagen is the most abundant protein in the body, has a tensile strength similar to steel, is responsible for the integrity of the tissues and their resistance to tensile forces. The interfibrillar component is mostly glycoproteins and proteoglycans (PGs)

Proteoglycans provide the articular cartilage with selective permeability properties and compressive stiffness, while the collagen fibers provide tensile strength.

Proteoglycans have a negative charge & great affinity for water and have the potential to absorb 50 times their weight in water. However, the collagen framework in normal cartilage constrains the proteoglycans and limits their ability to expand to about 20% of their potential. This swelling pressure keeps the cartilage turgid, helping to resist deformation when a compressive load is applied. This dynamic tissue is able to tolerate both compressive and shearing forces without damage, transmitting and distributing the forces to the underlying subchondral bone, which aids in shock absorption.

The proteoglycans in articular cartilage are large aggregates of protein, hyaluronic acid and glycosaminoglycans, predominantly chondroitin 4-sulfate, chondroitin 6-sulfate, and keratan sulfate.

Glycosaminoglycans (GAGs) are long unbranched polysaccharides consisting of a repeating disaccharide unit. This unit consists of an N-acetyl-hexosamine and a hexose or hexuronic acid, either or both of which may be sulfated. The combination of the sulfate group and the carboxylate groups of the uronic acid residues gives them a very high density of negative charge. Members of the glycosaminoglycan family vary in the type of hexosamine, hexose or hexuronic acid unit they contain (e.g. glucuronic acid, iduronic acid, galactose, galactosamine, glucosamine). They also vary in the geometry of the glycosidic linkage (N or O linkage) GAG chains covalently linked to a protein to form proteoglycans.

Extensive notes on the pathogenesis of osteoarthritis have been provided for a previous lecture but to review the pathogenesis of osteoarthritits on a cellular level, stresses on the joint lead to production of inflammatory cytokines released by synovial cells, chondrocytes, macrophages and fibroblasts. These proinflammatory cytokines, including certain interleukins and TNF-alpha, lead to upregulation of COX-2 enzymes and production of eicosanoids such as PGE2,and the upregulation of matrix metalloproteinases. Normally during metabolism PGs are broken down by enzymes matrix metalloproteinases (MMPs) and aggrecanase. In acute inflammation MMPs increase in number and disrupt the balance of production and destruction in the joint. There is shift toward breakdown of articular cartilage resulting from an imbalance between MMPs and their TIMP inhibitors, leading to thinning and destruction of the cartilage tissue and perpetuation of the inflammatory cascade with PGE2 production and subsequent pain. On a gross level, the thinning or loss of cartilage leads to joint space narrowing, remodelling of subchondral bone with sclerosis and osteophyte formation, joint effusion, periarticular swelling and pain which may lead to decreased use of the joint and secondary atrophy of musculature.

Goals for a nutraceutical to relieve OA pain

1. Decrease in inflammatory prostaglandin (PGE2).
2. Decrease the production of Pro MMP 2 & 9 and active MMP 2 and 9 (the enzymes responsible for degradation of cartilage.
3. Increase the inhibitor of MMP (TIMP-2) to help restore proper balance between these enzymes.

Evidence based nutraceutical use

Fish oil--Omega 3 DHA and EPA[1,2,3,4]

Arachidonic acid (AA) is the primary substrate for the lipooxygenase and cyclooxygenase enzymes. This fatty acid is derived from dietary sources and stored in phospholipids of the cell membrane until needed. AA is a member of the omega-6 fatty acid family. AA can be partly replaced in cell membranes by the omega-3 fatty acid Eicosapentanoic Acid.

The difference between omega-6 and omega-3 fatty acids centers on the location of the first double bond in the carbon chain, occurring either at the 3rd or 6th carbon from the methyl end. While mammalian cells can elongate and desaturate fatty acids, they are not able to form double-bonds beyond these defining bonds, so are unable to synthesize these fatty acids nor interconvert between these families. Thus, the presence of these fatty acids within cell membranes reflects dietary intake. And this can be important because the physiologic function of the 2 fatty acid families differ.

Eicosanoids are metabolically active compounds derived from 20-carbon fatty acids, usually arachidonic acid . The lipooxygenase (5-LOX) and cyclooxygenase (COX) enzymes are the rate-limiting steps in the production of leukotriene B4, thromboxane A2 and prostaglandin E2. In health, these eicosanoids serve important functions. However, in inflammatory conditions such as arthritis, their production can be increased and their effects can be detrimental. For example, PGE2 can be increased up to 50 fold in arthritic joints. Leukotriene B4 has a potent chemotactic effect and promotes further inflammation. PGE2 and TXA2 both promote the release of tumor necrosis factor alpha and Interleukin 1beta, both which promote further inflammation and, in joints, stimulate the production of matrix metalloproteinases or MMPs. MMPs are the collagen-destroying enzymes that break down articular cartilage in arthritic joints. Further, PGE2 is a potent stimulator of pain receptors, and contributes to the pain of arthritis.

Eicospentaenoic acid (EPA) also can be used by the LOX and COX enzymes to produce eicosanoids. However, when EPA is used by the COX and LOX enzymes, they produce the eicosanoids PGE3, thromboxane (TX) A3 and LTB5, which are less active and relatively anti-inflammatory compared to their counterparts produced from AA.

It has been demonstrated that therapeutic diets containing approximately 3.5% omega 3 fatty acids can decrease pain and lameness, improve weight bearing, and decrease the need for NSAIDs in dogs with OA. The primary source of omega 3 fatty acids is fish oil. Approximately 480 mg/kg of fish oil (50–100 mg/kg EPA) would be required as a supplement to match the amounts available in the therapeutic food discussed above. A recent placebo-controlled clinical trial in dogs with OA investigated the effects of a fish oil supplement added to a non-fish based food, dosed at 90 mg/kg EPA and 20 mg/kg DHA. These researchers found significant improvement in indicators of pain and quality of life when comparing the base-line outcome measures to those collected at the end of the 16-week trial. There is a high level of support for supplementation of omega 3 fatty acids.

Mobility diets

All mobility diets are not created equal! Research shows that 7.5 g EPA +DHA/1000kcal diet significantly reduced symptoms of arthritis. This amount is quite unwieldy as well as likely to cause diarrhea. Other studies have shown as little as 1 to 3 g/1000kcal has clinical effect. Ideally for most dogs you would like to get up to the 100mg/kg of Omega 3 for arthritis. Here is an example:

For a 20kg dog you would like it to receive 2 g of Omega 3 total/day for arthritis. This dog would eat around 700 kcal so if feeding a 1.5 g Omega 3/1000kcal diet it would provide approximately 1 gram of Omega 3. To make up the additional gram, you would have to supplement with 2 capsules that contain 500mg of EPA and DHA combined. This is quite feasible.

Green-lipped mussel

Perna canaliculus is found in the waters around Australia and New Zealand. It contains EPA, DHA, and ETA. It is also a source of glycoproteins and GAGs. A randomized, double- blind, placebo controlled clinical trial in dogs with chronic pain attributed to OA found significant improvement in mobility and pain in those dogs treated with GLM compared to placebo. The dose used was 50 mg/kg. The anti-inflammatory effects of GLM may be derived from its omega-3 fatty acids content or the GAGs or the glycoproteins. This has yet to be determined but it does prove to be at least mildly effective.[6],[7]

Avocado/soybean unsaponifiables

Avocado soybean unsaponifiables (ASU) are residues of avocado and soy oils combined in a 1:2 ratio to produce a product that has demonstrated anti-arthritic properties. Theoretically, ASU decrease the production of pro-inflammatory cytokines such as PGE-2 and TNF alpha. In a canine cruciate ligament transection model, ASU administration decreased osteophytes, improved cartilage thickness and produced more normal chondrocytes. [11] Additional in vitro studies have shown that the combination of ASU with chondroitin is more effective in decreasing inflammatory cytokines than either product alone. There are no published controlled trials in clinical dogs with OA examining ASU alone or in combination products. However research on induced arthritis shows a positive result. Dasuquin (Nutramaxx) is the product generally used.

Chondroprotectants

Glucosamine/chondroitin[5]

Glucosamine is a precursor of glycosaminoglycan (GAG). When administered orally, glucosamine is 90% absorbed and undergoes biotransformation in the liver. It is then distributed to tissues and has been shown to have a tropism for articular cartilage. Glucosamine sulfate is absorbed better than glucosamine hydrochloride and may be more effective.

The mechanism of action of glucosamine has not been fully elucidated. In vitro studies have shown that when exogenous glucosamine is administered, it is utilized in the synthesis of GAGs. It has also been demonstrated that supplementation with glucosamine inhibits enzymes that are responsible for the degradation of cartilage, and the production of inflammatory mediators is decreased.

Chondroitin sulfate is a much larger molecule than glucosamine, and its oral bioavailability has been questioned. Low-molecular weight chondroitin sulfate is more effectively absorbed by the gastrointestinal tract than larger molecules. Metabolites of chondroitin sulfate are concentrated in articular cartilage.The mechanisms of action of chondroitin are: to stimulate GAG production; inhibit degradative enzymes; enhances the production of hyaluronic acid and prevent the degeneration of type II collagen within articular cartilage. Glucosamine and chondroitin sulfate are often combined in commercially available products. It appears that there is a synergistic effect when the two products are used together.

Studies demonstrating efficacious use of glucosamine/ chondroitin are few. McCarthy et al showed glucosamine/ chondroitin improved pain, weight bearing and disease severity scores (3/5 measures) but the onset of response was slower for glucosamine/chondroitin compared to NSAIDs. 5Moreau et al showed no change with the supplement so evidence is conflicting.12 In a systematic review only 13 studies were controlled and evidence was positive for Glucosamine/chondroitin but this is a human study.The level of evidence supporting the use of glucosamine/chondroitin for pain management in dogs is low.

Dosage: Dose at 15mg/kg on the Chondroitin fraction.

Adequan

Polysulfated glycosaminoglycans (PSGAGs) are a semisynthetic product (derived from bovine trachea) structurally similar to the GAGs found in articular hyaline cartilage. PSGAGs stimulate collagen synthesis and inhibit collagen breakdown as well as decrease pain and inflammation. Several studies have documented positive effects when administering PSGAGs (Adequan) to dogs with hip dysplasia and osteoarthritis. One study found decreased hip laxity in dogs treated with Adequan twice weekly from 6 weeks to 8 months of age compared to age-matched controls. It is recommended to begin treatment as early in the disease process as possible in order to slow the progression of cartilage damage. The strength of evidence for PSGAGs used at the labeled dose is considered high. Dose: 5mg/kg once weekly x 4 to 6 weeks then once monthly in dogs, cats first 4 weeks is the same but 2nd month every other week then once monthly[10]

Cartrophen

Pentosan polysulphate—this product is used in Canada, Europe and Australia. Similar actions to Adequate. Dose is 1ml/33kg once weekly for 4 weeks then once monthly.

Herbals and natural supplements

Flex-RX

This product is a bioflavanoid that contains Baicailin and Catechin and has balanced COX and 5-LOX enzyme inhibition activity. In studies by Burnett et al it showed statistically significant improvement in pain scores when compared to Cosequin using veterinarian and owner VAS.

Elk velvet antler

Quality Elk Velvet comes from the antler at the velvet stage and contains Chondroitin Sulphate, collagen, glycosaminoglycan and pilose antler peptide. Study by Morneau showed improvement in dogs with clinical OA on force plate and by subjective analysis.[12]

Boswellia

This is also know as Indian Frankincense in Ayurvedic Medicine. 4 compounds isolated have been isolated and purified. These have been found to have anti-LOX activity.

This herb is found in human products Flexamine as Aflapin and Osteo-biflex as 5-Loxin.

2 Placebo controlled clinical trials in humans suggest efficacy for joint pain. In an unblinded open label Austrian study it was found to have 71 percent positive response in clinically lame dogs.[9,8]

Theracurmin

Curcumin is found in veterinary nutraceuticals marketed for arthritis. Its utility as a natural NF- kB (nuclear factor kappa-light-chain-enhancer of activated B cells) and cyclooxygenase-2 inhibitor is documented in humans but not in dogs. However, its gastrointestinal absorption in most species appears to be poor. An extract of turmeric, the spice from which curcumin is derived, produced subjective, but not objective, improvements in dogs with arthritis. Theracurmin is a new water soluble curcumin that has shown to have advantages and may have promise in the future in dogs.

References

1. Fritsch D, Allen TA, Dodd CE, et al. Dose-titration effects of fish oil in osteoarthritic dogs. J Vet Intern Med 2010; 24:1020-1026.
2. Fritsch DA, Allen TA, Dodd CE, et al. A multicenter study of the effect of dietary supplementation with fish oil omega-3 fatty acids on carprofen dosage in dogs with osteoarthritis. JAVMA 2010; 236:535-539.
3. Roush JK, Cross AR, Renberg WC, et al. Evaluation of the effects of dietary supplementation with fish oil omega-3 fatty acids on weight bearing in dogs with osteoarthritis. JAVMA 2010; 236:67- 73.

4. Hannah SS, Laflamme DP. Increased dietary protein spares lean body mass during weight loss in dogs. J Vet Intern Med 1998; 12:224.
5. Vandeweerd JM, Coisnon C, Clegg P, et al. Systematic review of efficacy of nutraceuticals to alleviate clinical signs of osteoarthritis. J Vet Intern Med 2012; 26:448-456
6. Rialland P, Bichot S, Lussier B, et al. Effect of a diet enriched with green-lipped mussel on pain behavior and functioning in dogs with clinical osteoarthritis. Can J Vet Res 2013; 77:66-74.
7. Pollard B, Guilford WG, Ankenbauer-Perkins KL, et al. Clinical efficacy and tolerance of an extract of green-lipped mussel (Perna canaliculus) in dogs presumptively diagnosed with degenerative joint disease. N Z Vet J 2006; 54:114-118.
8. Hamidpour R, Hamidpour S, Hamidpour M, et al. Frankincense (Ru Xiang; species): From the selection of traditional applications to the novel phytotherapy for the prevention and treatment of serious diseases. J Trad Complement Med 2013; 3:221-226.
9. Reichling J, Schmokel H, Fitzi J, et al. Dietary support with Boswellia resin in canine inflammatory joint and spinal disease. Schweiz Arch Tierheilkd 2004; 146:71-79.
10. Oke SL. Indications and contraindications for the use of orally administered joint health products in dogs and cats. JAVMA 2009; 234(11):1393-1397.
11. Boileau C, Martel-Pelletier J, Caron J, et al. Protective effects of total fraction of avocado/soybean unsaponifiables on the structural changes in experimental dog osteoarthritis: Inhibition of nitric oxide synthase and matrix metalloproteinase-13. Arth Res Ther 2009; 11:R41.
12. Moreau M, Dupuis J, Bonneau NH, Lecuyer M. Clinical evaluation of a powder of quality elk velvet antler for the treatment of osteoarthrosis in dogs. Can Vet J 2004; 45(2):133-139.

Poop in the Coop:
What it Tells You about Backyard Chicken Parasites

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Avian parasites consist of multiple species including helminthes, protozoa and arthropods. Included are some of the important parasites that may be found in various avian species. The likely hood of infection will depend if the birds are pet birds, captive collection, or backyard species. The listed parasites in this paper are not inclusive but give the major pathogenic producing parasites that may be encounter in veterinary medicine.

Toxoplasma gondii causes toxoplasmosis which is infectious for all birds. Cats are the definitive host and shed oocysts in their feces. Clinical signs in affected birds include incoordination, listlessness, seizures, and convulsions. Lesions can range from encephalitis, myocarditis, pneumonia, and splenomegaly. Infected birds can be diagnosed using the modified agglutination test Necropsy findings include histopath examination and PCR on affected tissues can identify *T. gondii* as well. Limiting cat access to yard is the most effective prevention and owners should be strongly encouraged to keep cats indoors.

Baylisascaris procyonis is a roundworm of raccoons and birds are infected by ingesting larvated eggs in the environment. Dogs can also serve as the definite host for *B. procyonis* and can shed eggs. The distribution of *B. procyonis* has been increasing recently. Larval migrans of *B. procyonis* can result in numerous neurological impairment clinical signs including encephalitis, circling, seizures, and death. Necropsy diagnostics include histopath examination and PCR. Limiting raccoon access to yard and making the areas unattractive to raccoons is the main way to prevent this disease.

Oxyspirura sp. roundworms which lead to eye worm infection have been reported in avian families. Affected birds generally have swollen conjunctiva and birds are observed scratching their eyes. The globe can be rendered non function from chronic inflammation. Infection in birds occurs by eating infected cockroaches so limiting arthropod ingestion is important. Ivermectin has been useful in treatment of eyeworms.

Avian trichomonosis is caused by *Trichomonas gallinae* which is a protozoal parasite that primarily affects columbids, birds of prey, turkeys and passerines. Clinical signs include swollen crop, listlessness, ruffled feathers, and often open mouthed breathing. Variable lesions can consist of caseous necrosis within the oral cavity and esophagus and less frequently the liver. The presence of the parasite does not indicate disease given the wide spectrum of virulence. Transmission of the parasite occurs by direct avian contact or via contaminated food and water. Gross lesions of trichomonosis are not pathognomonic. Other diseases including avian pox, candidiasis, aspergillosis, oral *Capillaria* spp. infection, and vitamin A deficiency can have similar gross findings. Testing to confirm infection is conducted by examining the oral swabs via wet mount by light microscopy to observe the undulating swimming motion. PCR testing is available as well. Successful treatments in early infections include metronidazole and carnidazole.

The thread-like nematode, *Capillaria contorta* can be found in the oral cavity and esophagus of numerous various avian species. The parasites are slender and long and may be difficult to see grossly. Lesions are similar to *T. gallinae* infection. Birds are infected by ingesting extremely environmentally resistant eggs and as such, treatment without prevention will not stop infection in a flock. Other capillarid spp. can be found in the gastrointestinal tract leading to weight loss.

Syngamus trachea often referred to as the gape worm often leads to open mouth breathing due to parasite infection of trachea. The parasites are red color and form a "Y" shape in the trachea. Variable clinical signs can include gaping and gasping, listlessness, and lethargy. Infected birds can be treated with benzimidazole antihelmentics.

Coccidiosis is an important disease in captive birds. Oocysts are shed in the host's feces and following ingestion by another host, lead to cellular infection. Anticoccidial compounds fall into two categories including polyether ionophores and enzymatic reaction compounds. Ionophore compounds allow limited cycling of the coccidia in the bird which aids in producing immunity. Variable compounds are available and depending on previous compound use on a particular farm, experimentation may be needed to determine useable compound. Maxiban (narasin/nicarbazin) is toxic in turkeys. Live vaccines are available for use in the poultry industry; immunity develops rapidly after exposure, but needs reinfection to reinforce the developing protection.

The protozoa *Histomonas meleagridis* is the cause of blackhead and is considered the most important parasitic disease for wild turkeys and is an important cause of mortality for numerous game birds and domestic turkeys. Recently mortality has been seen in backyard chickens. Clinical signs include yellow diarrhea, weight loss, and ruffled feathers. Lesions include target shaped necrotic areas in the liver and ceca are markedly thickened with necrotic material. On fresh carcasses, histomonads can be observed via wet mounts of swabs from affected organs. Ring-neck pheasants are the natural host for *H. meleagridis* however chickens can serve as unapparent carrier for the parasites including the *Heterakis* nematode that is a vector for *Histomonas*. For this reason, turkeys, quail, grouse, or chukars cannot be raised in the same areas as chickens or pheasants. Nitrasone (Histostat7 Alpharma Inc. Clifton, New Jersey) has been used to prevent outbreaks; however, this drug is now banned,

Ascardia spp are frequently reported in birds and can interfere with intestinal passage of food. Ascarids are relatively large and range from 3-6 cm in length in comparison to *Heterakis* spp. ranging from 0.5-1.0 cm.

Worm in the Brain: Update on Meningeal Worm Infection in Goats, Sheep, and Camelids

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Meningeal worm or brain worm infection in camelids, elk, moose, and sheep and goats is caused by the roundworm parasite, *Parelaphostrongylus tenuis*. Meningeal worm infection is one of the most common causes of neurological illness and death in camelids and treatment of chronic cases are often difficult and expensive. Infected animals present with a head tilt, arching of the neck, incoordination, difficulty getting up, and/or gradual weight loss. The parasite causes disease by migration of the worm through the brain or spinal cord of affected animals leading to internal trauma and inflammation. Currently, no live animal test is available and post-mortem testing is performed by microscopic examination of brain sections for evidence of the worm migration pathways. Aberrant migration of meningeal worm larvae through the neuropil and spinal cord of camelids, especially alpacas and llamas, causes severe clinical neurological disorders. Camelids are exposed to the intermediate larval stages of *P. tenuis* via the accidental ingestion of infected terrestrial slugs and snails. Many other domesticated species have also been proven to be susceptible to *P. tenuis* infection including sheep, horses, cattle, and bison. Infected animals present with a head tilt, arching of the neck, incoordination, difficulty getting up, and/or gradual weight loss. Treatment for camelids and ungulates with moderate to severe clinical disease is often expensive, but unrewarding, despite use of numerous anthelmintics and supportive. *Parelaphostrongylus tenuis* infection also has a huge impact on wildlife conservation.

The natural host of the metastrongylid parasite is the white-tailed deer, *Odocoileus viginianus*, which are unapparent carriers of the parasite. However, in other species of ungulates, like those listed above, the response to infection is quite different. The larvae emerge from accidentally ingested slugs and snails, and penetrate the host's gastrointestinal track. From there, they migrate to and develop within the spinal cord for up to 1 month. The migrating *P. tenuis* larvae cause extensive central nervous system (CNS) damage and disabling neurologic disease. Lesions caused by *P. tenuis* migration are often difficult to identify, due to the fact that their histologic appearance varies so greatly. Currently, there is no commercially available antemortem test to confirm *Parelaphostrongylus* spp. infection in any species. Suspect cases of *P. tenuis* is often made in camelids following detection of cerebrospinal fluid (CSF) eosinophilic inflammation, combined with the clinical signs of head tilt, arching of the neck, incoordination, difficulty getting up, and/or gradual weight loss. A nested PCR can be used to detect *P. tenuis* from formalin fixed tissue which was successfully used for detection of *Parelaphostrongylus* spp. DNA in a Sika deer, horse, cattle, and guinea pig.

Prevention of parasite infection include minimizing deer populations through hunting, high fences to exclude deer, the use of livestock guardian dogs, and use of rock lined area on the outside of the fence. The use of molluscicides on the outer fence rocks can impede the entry of infected gastropods into pastures and minimize infection of *P. tenuis* into camelids and other animals. The use of injectable ivermectin has been used to prevent infection in *P. tenuis* infection; however, unintentional side effects could be selection of ivermectin-resistant *Haemonchus contortus* and other gastrointestinal nematodes.

Treatment for cases of meningeal worm include febendazole and anti-inflammatory drugs, particularly in early stage infections. As disease progresses, prognosis is less favorable and treatment may require a sling or further assistance given at a referral clinic.

How to Identify and Treat Toxoplasma, Isopora, and Other Coccidial Infections

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Eimeria spp. have a direct life cycle and ingested sporulated oocyst reproduce in respective organs including liver, kidney, and mainly intestines. Through the process of multiple rounds of asexual reproduction will produce large number of merozoites. Following the last round of merizoite replication, the merizoites will differentiate into male and female stages to begin sexual reproduction. Once fertilization occurs feces. The processes of both asexual and sexual reproduction result in rupture of the infected cells and associated disease as a result of epithelial destruction.

The life cycle of *Atoxoplasma*, a coccidian parasite that infects birds, also has a direct life cycle with both asexual and sexual life stages. The asexual reproduction occurs in the intestines of infected birds and also in mononuclear phagocytes of the gut mucosa, resulting in infected mononuclear cells containing the merozoite that may stay in the gut or enter the blood to disseminate the parasite to other extraintestinal tissues such as the liver. Sexual reproduction occurs in the intestines and results in the excretion of oocysts in the feces.

Toxoplasma gondii and *Isospora* are different in that they have a direct life cycle but can utilize a paratenic host. The only definitive host for *Toxoplasma* is the cat. Thus, sexual reproduction (the formation of micro and macrogamonts) and shedding of oocysts occurs only the gastrointestinal tract of felids. Oocysts that are shed in the feces of cats will sporulate to become infective to nearly any warm-blooded vertebrate host. Any warm-blooded animal that consumes the oocyst may act as a paratenic host – i.e., the parasite can live in the tissues of the paratenic host but the parasite does not require growth or multiplication in the paratenic host in order to complete its life cycle. When the cat or paratenic host ingests the infective oocyst, the sporozoites are released and undergo massive asexual reproduction in the cells of the intestines and lymph nodes producing tachyzoites. These tachyzoites continue to multiply in other cells of the body (extraintestinal phase); destruction of infected cells is what results in disease and signs of disease will depend upon the organ infected (i.e., pneumonia if damage occurs in lungs, neurologic signs if damage occurs in brain). After the fast replicating tachyzoite stage, a slow replicating bradyzoite stage will begin in which the parasite forms cysts, containing the bradyzoites, in various tissues that can include the brain. The cysts will persist for the life of the animal. If a cat ingests a parentic host that has the encysted bradyzoites, the bradyzoites will enter the small intestinal epitheial cells and first undergo asexual reproduction and then the sexual reproductive life stage, shedding oocysts 3-10 days later. If the life cycle is direct, and the cat ingests sporulated oocysts (rather than the encysted bradyzoites of a paratenic host), it take 19-48 days to shed oocysts which suggests that the parasite can accomplish much of the required asexual reproductive stages in the process of forming bradyzoites in the paratenic host.

Isospora may undergo direct transmission or indirect transmission by use of a paratenic host. A rodent or bird may act as a paratenic host by ingesting the sporulated oocyst. In the paratenic host, the sporozoite is released from the oocyst and migrates to lymph nodes where it will encyst (monozoic cyst) and be infective to the carnivore that consumes the rodent. The host may consume the infected paratenic host or ingest the sporulated oocysts from the environment. There is no extraintestinal life cycle for this coccidian and both asexual and sexual reproduction occurs in the villar epithelium and nonsporulated oocysts are excreted in the feces. However, extraintestinal migration of the parasite may occur in the host after ingestion of the sporozoites in the host. Some sporozoites may enter the mesenteric lymph node (as also seen in the paratenic hosts) or may enter other extraintestinal tissues (spleen, liver) where they form cysts. Thus, monozoic cysts may form in both the definitive and paratenic hosts and remain for the life of the animal. In definitive hosts, the cyst may rupture and release sporozoites to reinfect the intestine.

The advantage of having an asexual life stage for these coccidian parasites is the ability for the parasite to rapidly and markedly increase the number of parasites from the ingestion of only a single sporozoite. Asexual reproduction allows the parasite to quickly and exponentially increase in a non-immune host. In theory one ingested oocyst can produce close to a 1million new oocysts in feces of naïve animal depending on age and available intestinal cells to infect.

Most (although not all) coccidian parasites undergo sexual reproduction in the gut. This is an important strategy for transmission because oocysts are therefore shed in the feces for a feco-oral transmission. Infection can result in clinical signs as a result of cellular destruction (the severity of disease seen is related to the degree of infection and cellular destruction). Diarrhea will increase the environmental contamination, which can aid in transmission especially in a captive environment. Although coccidiosis may cause morbidity and/or mortality, it would not be advantageous to the parasite to cause high degree of mortality thus the asexual reproduction ceases after a genetically predetermined number of cycles (which may vary per coccidian species).

Parasitic encystment (either as encysted bradyzoites in *Toxoplasma* or as monozoic cysts in the paratenic or definitive hosts for *Isospora*) is another strategy for the parasite for transmission or reinfection. The use of a paratenic host by *Isospora* and *Toxoplasma* is an advantageous because it increases the chance of exposure to the definitive host by "presenting" the parasite back to the definitive host. By infecting prey species (and affecting the prey species such that it is more susceptible to predation as is seen in *Toxoplasma*

infection of rodents) the parasite increases its chances of returning to the felid host to complete the sexual stage of the life cycle. For wild felids with large home-ranges and solitary behavior, the ingestion of a paratenic host may be more likely than ingestion of infective oocysts directly.

Many, if not all, animals have been reported with one or more coccidian parasites, but infection does not typically cause disease in free-ranging wild animals in natural conditions. Clinical coccidiosis is seen in captive animals because transmission is enhanced by captive conditions. Because there is no requirement for an intermediate host, these parasites with a direct life cycle are easily transmitted in captive environments. Environmental contamination in a closed/confined space is much greater than over a natural habitat and the controlled temperature and humidity of captive animal holding can promote sporulation of the oocyst to its infective form. The oocysts can be destroyed by desiccation and direct sunlight but many commonly used disinfectants are not effective and thus a captive environment can be easily contaminated. Captive animals are also typically found at much higher density than wild animals, increasing the chance for shedding and exposure. In breeding or production facilities there are young animals that have not yet developed immunity to the parasite and are susceptible to infection clinical disease and likely to shed the parasite. Coccidian oocysts may be shed from asymptomatic animals as well (there have been reports of 30-50% prevalence in apparently healthy animals of a range of species) thus environmental contamination and risk for reinfection is high in a captive environment. Lastly, stress is a known factor in the development of clinical coccidiosis. "Winter coccidiosis" in cattle occurs likely due to the stress of extreme temperatures in combination with infection, while outbreaks of clinical coccidiosis have been seen after shipping (another stressful event) in other species. Sources of stress in captive animals can include high stocking density, poor nutrition, competition, and handling that could contribute to the development of clinical coccidiosis. While wild animals also have stressors, they do not have the added combination of high levels of environmental contamination, high stocking density, and intensive breeding or production.

The most pathogenic lesions in enteric coccidiosis occur as a result of the host cell rupture during the asexual propagation. Most coccidia develop in villus enterocytes but others may develop in crypt enterocytes or lamina propria. Rupture of the host cell at the end of merogony is associated with the release of schizonts (containing merozoites). Cell rupture also occurs when the oocyst is released after the sexual reproduction stage. Destruction of enterocytes or lamina propria results in diarrhea, dehydration, weight loss, and severe hemorrhage.

Antiprotozoal vaccines for animals include vaccines against coccidiosis for poultry, many of which are actually nonattenuated oocysts from various coccidian species. Anticoccidial treatment is often used at the time of vaccine administration. Interestingly, use of live coccidia vaccines in poultry houses can restore a drug-sensitive population of parasites to populations in which drug-resistant coccidia become prevalent. Live coccidiosis vaccines that incorporate attenuated oocysts and a nonliving subunit vaccine are also available.

Anticoccidial compounds generally fall into one of two categories. The first are polyether ionophores which disrupt the proper intra and extracellular concentrations of the various cations and leads to cellular dysfunction. The second group includes compounds that cause an enzymatic reaction. The various classes of anticoccidial compounds and their mechanism of action are listed below.

Polyether Ionophores fall into one of five categories including monovalent, monovalent glycosides, divalent, divalent glycosides, and divalent pyrole ethers. Their mode of actions is to form lipophilic complexes with alkali metal cations and to transport these ions across biological membranes. The end result is that the cell is unable to maintain the proper intra and extracellular concentrations of the various cations and leads to cellular dysfunction. A main way this occurs is by the Ionophores interfering with the K+/Na+ pump osmolarity. Ionophore drugs also allow some cycling of the coccidia in the bird which aids in producing immunity. Ionophores generally have lower rate of resistance development compared to the enzyme reaction drugs listed above and often allow some low level cycling of the coccidia in the host leading to host immunity. Anticoccidial drugs belonging to the polyether Ionophores include lasalocid, salinomycin, maduramicin, monensin, narasin, lonomycin, and semduramicin. Maxiban is toxic in turkeys and should not be used in this species, but is a safe drug for quail, pheasants and chickens

Enzyme or metabolic blocking anticoccidial compounds include sulfonamides are folate antagonists and their mechanism of action (MOA) occurs by competitive inhibitors of PABA in the dihydropteroate synethetase reaction to make folate. Normally, folate is reduced to tetrahydrofolate, using NADPH as a co-factor, and is used to create and methylate DNA. 2,4-diaminopyrimidines act in a similar fashion and block the reduction of folate to tetrahydrofolate. The combination of sulfonamides and 2,4-diaminopyrimidines is synergistic and is active on first and second generation schizonts and perhaps sexual stages as well. Amprolium is a thiamine antagonist and acts by competitively inhibiting the active transport of thiamine. Care must be taken not overdose animals on amprolium or secondary complications including *polioencephalomalacia* may develop due to lack of thiamine.

Coccidia are generally immunogenic and a single infection in an immunocompenent host will induce immunity to reinfection to some degree. However, exceptions to this generality have been noted. Immunity in coccidia occurs primarily as a result of the asexual replication, with the sexual stages contributing little additional protection. Immunity to a challenge inoculum is manifested as a reduction in clinical signs and reduced multiplication of the parasite. Circulating antibodies are effective at opsonization and cytopathological and enhancing the uptake of parasites of macrophages. The role of cell-mediated immunity has been shown to be the most important factor in host protection. Adoptive transfer of lymphocytes from *Eimeria* immunized animals to naïve animals leads

to protection when challenged. It is assumed that the importance of cell mediated immunity is the same in all vertebrate hosts of coccidia.

Ticks and Diseases They Cause in Pets- Ehrlichiosis, Anaplasmosis, Cytauxzoonosis, and More

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Tick-borne diseases are extremely important and emerging diseases in the United States. The area in which you live will influence the diseases that are circulating in the environment. Although diseases such as Lyme disease has received a great deal of attention, other important diseases including ehrlichiosis, Rocky Mountain spotted fever, anaplasmosis and cytauxzoonosis have been emerging in various areas. A good travel history is imperative given various species of ticks and tick-borne diseases are more common in certain geographical areas. More information on tick-borne disease distribution can be found at http://www.capcvet.org/parasite-prevalence-maps/

Diagnosis of tick-borne diseases: Serology vs PCR

Testing is warranted on animals with the aforementioned clinical signs. PCR testing (detection of pathogen DNA) is more sensitive than serology for detection of Rocky Mountain spotted fever and *Anaplasma*/*Ehrlichia* species during the acute phase of the disease, prior to the development of an antibody response. Therefore, if an animal presents with acute signs suggestive of tick-borne disease (i.e. fever, lethargy, thrombocytopenia, leukopenia, arthropathy, neurologic dysfunction), the best test for diagnosis is the PCR. Whole blood (EDTA) should be obtained for the test, prior to antibiotic administration.

Serology is useful for detection of chronic/persistent infections, during which the numbers of pathogens are lower or absent from circulation and cannot be detected as easily by PCR. This is particularly true for Lyme disease. This organism localizes in the tissues and is difficult to detect in the blood. It is important to note that antibodies to these tick-borne agents may persist for several months to years (especially for *E. canis)*, so detection of antibodies does not distinguish current infection from previous exposure. Also, high seroprevalence to these agents has been documented in healthy dogs in endemic areas, such as the Southern USA, and most dogs exposed to *Anaplasma* or *Ehrlichia* species will not develop overt clinical disease. Therefore, PCR of skin or other tissues (not blood) and/or complete blood count is useful to determine if seropositive animals are currently infected and have clinical disease.

Identification of ticks

Tick bodies are divided into two primary sections including fused head and thorax and abdomen. All adult and nymphal forms have 4 pairs legs and no antennae and all larval forms have 3 pairs of legs. The importance of determining larvae vs other stages include to determine the likelihood of tick being infected with various pathogens. Unless transovarial transmission occurs, larvae are unlikely to be infected with pathogens, while nymphs and adults have higher likelihood include with pathogens in transstadial transmission. Whereas hard ticks have scutum, soft ticks do not have scutum. Ticks are great vectors due to their ability to be persistent blood-suckers which attach firmly & feed slowly, long life spans, may be geographically widespread, resistant to environmental conditions, high reproductive potential, and can pass infective agents through egg to next generation and/or through successive stages. Ticks bites in themselves can lead to wounds and Inflammation from salivary proteins. Secondary infection and disease can be due to toxicosis, local necrosis, and tick paralysis. Tick bites predispose animals to secondary attacks by myiasis-producing flies.

Soft tick have no scutum are soft, tough, leathery body, do not stay attached—instead take multiple small volumes of blood, and often feed at night.

Soft ticks include Otobius megnini (Spinose Ear Tick) transmits relapsing fever caused by a Borrelia spp. (different than Borrelia burgdorferi which causes Lyme Disease). Spinose ear ticks are more common in western states that are west of 100th meridian

Hard Ticks is largest family of ticks has a scutum (dorsal, hardened plate) that covers entire dorsum of males and forms an anterior shield in females. Hard ticks remain attached until engorged and then fall off to molt or lay eggs. General life cycle include:

- Egg → 6-legged larva → 8-legged nymph → 8-legged adult
- Oviposition (egg laying) occurs off of the host
- Nymphs and adults can be identified based on visual exam but often unable to distinguish larvae without microscopic exam

Nymphs and adults are more likely to harbor pathogens than larvae—this is why you need to be able to distinguish larvae (6 legs) from nymphs/adults (8 legs).

Tick species

All dermacentor spp.

- Ornate ticks with eyes
- *Basis capitulum* (mouth part) is rectangular if viewed from above and has stubby palps
- Resembles *Rhipicephalus* (both have11 festoons, small rectangular patterns on posterior abdomen)

Dermacentor variabilis (American dog tick)

- Eastern half of U.S. and west coast, but rare in Central US
- Dogs, cats, humans, horses, cattle, fox, rodents, and other mammals
- Can cause tick paralysis in humans, dogs, etc.
- May take as little as 3 months, with favorable conditions, or up to 2 years
- Principal vector of Rickettsia rickettsia - Rocky Mountain Spotted Fever (RMSF) and others in Spotted Fever Group
- Infrequent vectors of tularemia, anaplasmosis, *Babesia canis*, *Cytauxzoon felis*

Rhipicephalus sanguineus (brown dog tick)

- Wide distribution
- Rhipicephalus ticks are similar in appearance to Dermacentor, except they have a hexagonal basis capitulum. All stages parasitize on dogs and will attach to other animals, but usually not humans
- Can survive indoors for months to possibly years without a blood meal
- Domestic & kennel problem due to tropical nature of tick and because it cannot survival outdoors in North America
- Vectors Babesi*a canis voglei*, tularemia, *Ehrlichia canis*, RMSF

Rhipicephalus (boophilus) annulatus (cattle fever tick)

- Southern U.S. & Mexico—spreading North into lower Texas
- Parasitize mainly on cattle; also deer, horses, donkeys, sheep, etc. in other countries, not U.S. and Mexico
- 1-host tick in U.S. and Mexico—re-emerging cases on US/Mexican border—large concern for USDA
- First demonstrated tick-borne disease
- *Babesia bigemina* (Texas cattle fever) VERY important disease to cattle industry—causes severe anemia and death in cattle and is a reportable tick species!

All amblyomma spp.

- Ornate ticks
- Long mouth parts & commonly 11 festoons—allows one to differentiate from Ixodes spp which lack festoons

Amblyomma americanum (Lone Star Tick)

- Wide distribution, but mainly in southern U.S.
- Large silver spot at apex of scutum on females – hence name "lone star"
- All stages feed on wild & domestic animals, birds, & humans and is significant pest for humans & animals
- Can transmit *Coxiella burnetii* (Q-fever), tularemia, *Ehrlichia chaffeensis*, *Ehrlichia ewingii*, RMSF, *Cytauxzoon felis* (cats)
- Vectors agent of Southern Tick Associated Rash Infection (STARI) in humans
- Cause of STARI is currently unknown—may actually be the host reaction to tick saliva—leads to swelling and pain at bite region

Amblyomma maculatum (Gulf Coast Tick)

- Southeastern US in Gulf coast region, but has expanded range recently
- Ornate scutum – often confused with *Dermacentor*—examine mouth parts to differentiae
- Adults attack nearly all animals & humans and can transmit *Hepatozoon americanum* Hepatozoonosis—dog must eat tick to be infected with *Hepatozoon*

All *Ixodes* spp.

- Inornate ticks and No festoons, has distinct anal groove anterolateral to anal orifice
- Used for identification in NON-ENGORGED tick but can't see groove in engorged ticks—use mouth parts instead

***Ixodes scapularis* (Black-Legged Tick)**

- Wide distribution, in East, South, and Midwest U.S. Highest populations in upper Midwest and New England/midatlantic states
- Primary Lyme disease (*Borrelia burgdorferi*) vector in Eastern US and Midwest
- Vectors *Babesia microti*, *Anaplasma phagocytophila*

***Ixodes pacificus* (California Black-Legged Tick)**

Primary Lyme disease vector in the West Coast

Tick-borne diseases

Tick paralysis

- Potentially fatal reaction to a paralyzing neuromuscular toxin secreted in the saliva of a female tick late in her feeding. Cattle, sheep, horses, dogs, and humans seem to be most affected.
- Clinical signs include: headache, vomiting, general malaise, loss of motor function and reflexes, followed by paralysis that starts in the lower body and spreads to the rest of the body

- Respiratory failure and death can result. Signs disappear rapidly when tick is removed, suggesting that the toxin is rapidly excreted or destroyed

Lyme borreliosis

- Agent: Borrelia burgdorferi
- Vector: Ixodes scapularis (Eastern and Midwestern US), Ixodes pacificus (Western US)
- Geographical distribution: New England and mid-Atlantic states, upper Mid-west, and Pacific coast.
- Animal health: Major cause of canine and equine disease, including endocarditis and joint pain. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Human health: Acute and chronic diseases including joint pain, heart disease, and neurological disorders. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Diagnoses: Lyme disease is diagnosed using serology tests, bacterial cultures, and/or PCR of tissue (NOT BLOOD). Blood may be used for PCR in very acute cases, otherwise tissue biopsy is needed. Predictive value influences serological test interpretations—only treat animals with clinical signs suggestive of disease!!!

Rocky Mountain Spotted Fever

- Agent: Rickettsia rickettsia
- Sometimes placed in "Spotted Fever" disease group
- Vector: Dermacentor variabilis

Geographical distribution: Eastern US mainly. Most frequently reported tick borne disease in the eastern US. Animal health: Recent evidence has shown that untreated RMSF may lead to death of the affected animal. Clinical signs include whole body pain and are painful on palpation.

Cytauxzoon felis

Piroplasm of cats. Bobcats are reservoir host that is transmitted by Amblyomma americanum. Clinical signs: fever, dehydration, icterus, lymphadenomegaly, and hepatosplenomegaly. Treatment with atovaquone plus azithromycin. Diagnosis: PCR, blood smear (negative blood smear does not rule out infection) since early stage only see schizonts in macrophages. Prevention: Keep cats indoors!! Use preventative for tick infestation

Anaplasma phagocytophilum

- Intracellular rickettsia that causes human granulocytic anaplasmosis
- Infects granulocytes and leads to bleeding, fever, leukopenia,
- Clinical signs/symptoms may be worse with co-infection with Lyme or *Babesia*
- Vectored by *Ixodes scapularis* so same geographical distribution as Lyme Disease. Can be transmitted by blood transfusion.
- Diagnosis: clinical signs, PCR (acute cases), serology (chronic), CBC to look for leukopenia, Blood smear to look for morulae in granulocytes.
- Don't treat animals that are clinically normal but are only seropositive—potential false positive due to positive predictive value.
- Treatment with doxycycline or minocycline

Anaplasma platys

- Intracellular rickettsia that causes infectious cyclic thrombocytopenia in dogs
- Common clinical signs include bleeding, due to cyclic thrombocytopenia…may be worse with co-infection with *Ehrlichia canis*, which is transmitted by same tick.
- Transmitted by *Rhipicephalus sanguineus* –worldwide distribution
- Diagnosis: clinical signs, PCR (acute cases), serology (chronic). Don't treat animals that are clinically normal but are only seropositive—potential false positive due to positive predictive value.
- Treatment with doxycycline or minocycline

Ehrlichia canis

- Intracellular rickettsia that causes canine ehrlichosis
- Infects monocytes and leads to fever, anorexia, lethargy, thrombocytopenia, lymphadenopathy, edema, bone marrow suppression.
- The acute stage is mainly due to a vasculitis. *E. canis* replicates in monocytes. The infected monocytes bind to vascular endothelial cells and leads to a vasculitis
- Transmitted by *Rhipicephalus sanguineus* –worldwide distribution
- Diagnosis: clinical signs, PCR (acute cases), serology (chronic), CBC to look for leukopenia, Blood smear to look for morulae in monocytes
- Don't treat animals that are clinically normal but are only seropositive—potential false positive due to positive predictive value. Treatment with doxycycline or minocycline

Ticks and the Diseases they Cause in Pets and People: Lyme Borreliosis, Tick Paralysis, Rocky Mountain Spotted Fever

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Tick-borne diseases are extremely important and emerging diseases in the United States. The area in which you live will influence the diseases that are circulating in the environment. Although diseases such as Lyme disease has received a great deal of attention, other important diseases including ehrlichiosis, Rocky Mountain spotted fever, anaplasmosis and cytauxzoonosis have been emerging in various areas. A good travel history is imperative given various species of ticks and tick-borne diseases are more common in certain geographical areas. More information on tick-borne disease distribution can be found at http://www.capcvet.org/parasite-prevalence-maps/

Diagnosis of tick-borne diseases: Serology vs PCR

Testing is warranted on animals with the aforementioned clinical signs. PCR testing (detection of pathogen DNA) is more sensitive than serology for detection of Rocky Mountain spotted fever and Anaplasma/Ehrlichia species during the acute phase of the disease, prior to the development of an antibody response. Therefore, if an animal presents with acute signs suggestive of tick-borne disease (i.e. fever, lethargy, thrombocytopenia, leukopenia, arthropathy, neurologic dysfunction), the best test for diagnosis is the PCR. Whole blood (EDTA) should be obtained for the test, prior to antibiotic administration.

Serology is useful for detection of chronic/persistent infections, during which the numbers of pathogens are lower or absent from circulation and cannot be detected as easily by PCR. This is particularly true for Lyme disease. This organism localizes in the tissues and is difficult to detect in the blood. It is important to note that antibodies to these tick-borne agents may persist for several months to years (especially for E. canis), so detection of antibodies does not distinguish current infection from previous exposure. Also, high seroprevalence to these agents has been documented in healthy dogs in endemic areas, such as the Southern USA, and most dogs exposed to Anaplasma or Ehrlichia species will not develop overt clinical disease. Therefore, PCR of skin or other tissues (not blood) and/or complete blood count is useful to determine if seropositive animals are currently infected and have clinical disease.

Identification of ticks

Tick bodies are divided into two primary sections including fused head and thorax and abdomen. All adult and nymphal forms have 4 pairs legs and no antennae and all larval forms have 3 pairs of legs. The importance of determining larvae vs other stages include to determine the likelihood of tick being infected with various pathogens. Unless transovarial transmission occurs, larvae are unlikely to be infected with pathogens, while nymphs and adults have higher likelihood include with pathogens in transstadial transmission. Whereas hard ticks have scutum, soft ticks do not have scutum. Ticks are great vectors due to their ability to be persistent blood-suckers which attach firmly & feed slowly, long life spans, may be geographically widespread, resistant to environmental conditions, high reproductive potential, and can pass infective agents through egg to next generation and/or through successive stages. Ticks bites in themselves can lead to wounds and Inflammation from salivary proteins. Secondary infection and disease can be due to toxicosis, local necrosis, and tick paralysis. Tick bites predispose animals to secondary attacks by myiasis-producing flies.

Soft tick have no scutum are soft, tough, leathery body, do not stay attached—instead take multiple small volumes of blood, and often feed at night.

Soft ticks include Otobius megnini (Spinose Ear Tick) transmits relapsing fever caused by a Borrelia spp. (different than Borrelia burgdorferi which causes Lyme Disease). Spinose ear ticks are more common in western states that are west of 100th meridian

Hard Ticks is largest family of ticks has a scutum (dorsal, hardened plate) that covers entire dorsum of males and forms an anterior shield in females. Hard ticks remain attached until engorged and then fall off to molt or lay eggs. General life cycle include:

- Egg $\rightarrow$ 6-legged larva $\rightarrow$ 8-legged nymph $\rightarrow$ 8-legged adult
- Oviposition (egg laying) occurs off of the host
- Nymphs and adults can be identified based on visual exam but often unable to distinguish larvae without microscopic exam

Nymphs and adults are more likely to harbor pathogens than larvae—this is why you need to be able to distinguish larvae (6 legs) from nymphs/adults (8 legs).

Tick species

All dermacentor spp.

- Ornate ticks with eyes
- Basis capitulum (mouth part) is rectangular if viewed from above and has stubby palps
- Resembles Rhipicephalus (both have11 festoons, small rectangular patterns on posterior abdomen)

Dermacentor variabilis (American dog tick)

- Eastern half of U.S. and west coast, but rare in Central US
- Dogs, cats, humans, horses, cattle, fox, rodents, and other mammals
- Can cause tick paralysis in humans, dogs, etc.
- May take as little as 3 months, with favorable conditions, or up to 2 years
- Principal vector of *Rickettsia rickettsia* - Rocky Mountain Spotted Fever (RMSF) and others in Spotted Fever Group
- Infrequent vectors of tularemia, anaplasmosis, *Babesia canis*, *Cytauxzoon felis*

Rhipicephalus sanguineus (brown dog tick)

- Wide distribution
- Rhipicephalus ticks are similar in appearance to Dermacentor, except they have a hexagonal basis capitulum. All stages parasitize on dogs and will attach to other animals, but usually not humans
- Can survive indoors for months to possibly years without a blood meal
- Domestic & kennel problem due to tropical nature of tick and because it cannot survival outdoors in North America
- Vectors Babesia canis voglei, tularemia, Ehrlichia canis, RMSF

Rhipicephalus (boophilus) annulatus (Cattle Fever Tick)

- Southern U.S. & Mexico—spreading North into lower Texas
- Parasitize mainly on cattle; also deer, horses, donkeys, sheep, etc. in other countries, not U.S. and Mexico
- 1-host tick in U.S. and Mexico—re-emerging cases on US/Mexican border—large concern for USDA
- First demonstrated tick-borne disease
- *Babesia bigemina* (Texas cattle fever) VERY important disease to cattle industry—causes severe anemia and death in cattle and is a reportable tick species!

All Amblyomma spp.

- Ornate ticks
- Long mouth parts & commonly 11 festoons—allows one to differentiate from *Ixodes* spp which lack festoons

Amblyomma americanum (Lone Star Tick)

- Wide distribution, but mainly in southern U.S.
- Large silver spot at apex of scutum on females – hence name "lone star"
- All stages feed on wild & domestic animals, birds, & humans and is significant pest for humans & animals
- Can transmit *Coxiella burnetii* (Q-fever), tularemia, *Ehrlichia chaffeensis*, *Ehrlichia ewingii*, RMSF, *Cytauxzoon felis* (cats)
- Vectors agent of Southern Tick Associated Rash Infection (STARI) in humans
- Cause of STARI is currently unknown—may actually be the host reaction to tick saliva—leads to swelling and pain at bite region

Amblyomma maculatum (Gulf Coast Tick)

- Southeastern US in Gulf coast region, but has expanded range recently
- Ornate scutum – often confused with *Dermacentor*—examine mouth parts to differentiae
- Adults attack nearly all animals & humans and can transmit *Hepatozoon americanum* Hepatozoonosis—dog must eat tick to be infected with *Hepatozoon*

All *Ixodes* spp.

- Inornate ticks and No festoons, has distinct anal groove anterolateral to anal orifice
- Used for identification in NON-ENGORGED tick but can't see groove in engorged ticks—use mouth parts instead

***Ixodes scapularis* (Black-Legged Tick)**

- Wide distribution, in East, South, and Midwest U.S. Highest populations in upper Midwest and New England/midatlantic states
- Primary Lyme disease (*Borrelia burgdorferi*) vector in Eastern US and Midwest
- Vectors *Babesia microti*, *Anaplasma phagocytophila*

***Ixodes pacificus* (California Black-Legged Tick)**

Primary Lyme disease vector in the West Coast

Tick-borne diseases

Tick paralysis

Potentially fatal reaction to a paralyzing neuromuscular toxin secreted in the saliva of a female tick late in her feeding. Cattle, sheep, horses, dogs, and humans seem to be most affected.

Clinical signs include: headache, vomiting, general malaise, loss of motor function and reflexes, followed by paralysis that starts in the lower body and spreads to the rest of the body

Respiratory failure and death can result. Signs disappear rapidly when tick is removed, suggesting that the toxin is rapidly excreted or destroyed

Lyme Borreliosis

- Agent: Borrelia burgdorferi
- Vector: *Ixodes scapularis* (Eastern and Midwestern US), *Ixodes pacificus* (Western US)
- Geographical distribution: New England and mid-Atlantic states, upper Mid-west, and Pacific coast.
- Animal health: Major cause of canine and equine disease, including endocarditis and joint pain. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Human health: Acute and chronic diseases including joint pain, heart disease, and neurological disorders. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Diagnoses: Lyme disease is diagnosed using serology tests, bacterial cultures, and/or PCR of tissue (NOT BLOOD). Blood may be used for PCR in very acute cases, otherwise tissue biopsy is needed. Predictive value influences serological test interpretations—only treat animals with clinical signs suggestive of disease!!!

Rocky Mountain Spotted Fever

- Agent: Rickettsia rickettsia
- Sometimes placed in "Spotted Fever" disease group
- Vector: Dermacentor variabilis
- Geographical distribution: Eastern US mainly. Most frequently reported tick borne disease in the eastern US. Animal health: Recent evidence has shown that untreated RMSF may lead to death of the affected animal. Clinical signs include whole body pain and are painful on palpation.

Anaplasma phagocytophilum

- Intracellular rickettsia that causes human granulocytic anaplasmosis
- Infects granulocytes and leads to bleeding, fever, leukopenia,
- Clinical signs/symptoms may be worse with co-infection with Lyme or *Babesia*
- Vectored by *Ixodes scapularis* so same geographical distribution as Lyme Disease. Can be transmitted by blood transfusion.
- Diagnosis: clinical signs, PCR (acute cases), serology (chronic), CBC to look for leukopenia, Blood smear to look for morulae in granulocytes.
- Don't treat animals that are clinically normal but are only seropositive—potential false positive due to positive predictive value.
- Treatment with doxycycline or minocycline

Non Tick-Borne Diseases: Avian and Swice Influenza, Bartonellosis, Leptospirosis, Rabies, and More

Richard Gerhold, DVM, MS, PhD
University of Tennessee
Knoxville, TN

Anthrax

- Bacillus anthracis
- Ruminant reservoir
- Human:
- Reportable disease

Animals

- Sudden death
- Bloody discharge from orifices that DOES NOT CLOT
- Do not necropsy; burn carcass, send ear only to lab for confirmation of disease

Human

- 95% cutaneous
- Small, painless, red pruritic papules on skin that ulcerate; Tx w/ AB's
- Inhalation → FATAL URI with fever, shock and respiratory distress; death in 24h

Avian chlamydiosis

- "Ornithosis/Psittacosis"
- *Chlamydophila psittaci*
- Bird reservoir
- Humans have flu like symptoms
    - Fever, chills, headache, muscle aches, URI & LRI symptoms
- Reportable disease
- Birds are often subclinical
    - Yellow-green diarrhea, conjunctivitis, nasal discharge, respiratory difficulty
    - Bacteria can persist in dander/heating/air ducts
- Responds to antibiotics

Avian and swine influenza

- Normally not infective to humans
- Mutations/variations can occur that can lead to efficient transmission and binding to human cell receptors
- Wear PPE when dealing with avian and swine that are suffering from respiratory disease

Brucellosis

- Brucella abortus, B. melitensis, B. suis, B. canis
- Ruminants, horses, swine, dogs
- Human
- Reportable disease

Animal-to-animal or –to-human transmission

- Ingestion of materials contaminated with infected birth fluids.
- Coitus (pigs & dogs)
- HUMAN: Farmers moving placentas, etc. OR… Inoculation with the Strain 19 vaccine…OR…Consumption of infected milk, or cleaning or eating infected feral swine

Animals

- Abortion
- Orchitis,
- Infertility

Cat scratch fever

- Bartonella henselae
- Cats
    - Cats have bacteria, asymptomatic

    - Fleas ingest, shed in flea feces
- Human
    - Flea feces contaminate human wound
    - Lymphadenopathy
- Self-limiting disease (2-3wks) or chronic malaise that can mimic Lyme disease
- Humans: Infection worse in immunocompromised people
    - Local skin rxn & enlarged l.n. in area of bite
    - 1/3 of people will have fever, headache & malaise
- PREVENTION = Flea control!
- Problem in nursing homes if animals are not well cared for

Gastointestinal disease

- Campylobacter jejuni & C. coli
    - Birds & mammals (Chickens, cattle, pets)
- Cryptosporidium sp.
    - Mammals, esp. cattle
- Enteric Bacteria
    - Salmonella, E. coli
- Wash hands! Keep things out of mouth!
- Most self- limiting diarrhea in humans if immunocompetent
- Food ingestion is common means of infection; direct contact possible

Leptospirosis

- Leptospirosis is a zoonotic disease with a worldwide distribution and can potentially infect all mammals.
- Leptospirosis is an aerobic, gram negative spirochete bacterial infection caused by members of the genus *Leptospira*, which contain around 220 distinct pathogenic serovars.
    - Common maintenance hosts of certain pathogenic *Leptospiral* serovars:
        - Dogs – Canicola
        - Pigs, cattle, oppossums, and skunks – Pomona
        - Raccoons and muskrats – Grippotyphosa
        - Cattle – Hardjo
        - Rats – Icterohaemorrhagiae
        - Pigs and possibly mice and horses – Bratislava
- Leptospirosis is typically transmitted by direct contact with the urine or other body fluids of infected animals or indirectly through contact with water or soil that has been contaminated with infected urine/body fluids.
- An array of clinical effects have been reported, ranging from mild, subclinical infection to multiple organ failure and death.
- Clinical signs of leptospirosis in wildlife have not been thoroughly documented, but it is believed that most infected wildlife are asymptomatic and serve as maintenance hosts for transmission of the organism to domestic animals and humans.
- Clinical signs of leptospirosis in domestic animals and humans is species dependent but generally includes alterations in liver and kidney function. Infections in these incidental hosts can be asymptomatic or may result in kidney and/or liver failure, fever, jaundice, and death

Plague

- Yersinia pestis
- Two forms Bubonic and pneumonic
- Bubonic
    - Rodents, lagomorphs
    - Spread through flea bites
- Pneumonic
    - Cats, man
    - Spread through aerosol

- Dogs are resistant but can carry the fleas
- Reportable disease in US

- Tx systemic abs

Clinical signs in cats

Clinical signs vary depending on what form of plague is present. Plague should be suspected in any cat exhibiting a fever in an endemic region. Cats with **bubonic plague** typically have fever, dehydration, lethargy, weight loss, hyperesthesia, and lymphadenopathy. The submandibular, cervical, and retropharyngeal lymph nodes are usually involved if the cat acquires infection by ingestion of infected prey. Lymph nodes will enlarge, form abscesses, and may spontaneously drain.

Toxoplasmosis

Domestic and wild felids are the definitive host for the protozoan *Toxoplasma gondii*. The oocysts of *Toxoplasma* are extremely environmentally resistant and human and animal infections can occur months or possibly even years after the cat has excreted the oocysts. As such, cat feces-contaminated gardens, sandboxes, and other outdoor recreational areas may serve as a source of infection for humans and animals. In toxoplasmosis, infection occurs primarily by ingestion of sporulated oocyst in cat feces- contaminated soil or water or tissue cysts in undercooked or raw meat. Upon ingestion of tissue or environmental cysts, the parasites are released, penetrate the intestinal bilayer, and replicate rapidly inside host cells. Currently, toxoplasmosis is considered the third most frequently diagnosed food borne disease in the US and approximately 60 million US citizens are infected with the parasite. Higher frequency of *T. gondii* seroprevalence has been disclosed in free-roaming cats compared to pet cats, with the lowest seroprevalence in cats kept indoors.

Although the risk of infection of human infection through ingestion of oocysts has been less common than infection from ingestion of undercooked or raw meat, recent research suggests otherwise. A recently developed sporozoite specific antibody has been developed which allows for serological distinction between oocyst and tissue cyst infection given that sporozoites are only present in oocysts. Of 163 individuals in acute stage of toxoplasmosis infection 103 (63%) were positive for sporozoite-specific antibody indicating that the majority of human infection was due to oocyst infection from cat-feces contaminated environments. Clinically, *Toxoplasma* infections appear as abortions, and birth defects, as ocular diseases, neurological impairment leading to blindness, particularly hydrocephalus, in humans. Furthermore, toxoplasmosis is also a significant risk in individuals undergoing immuosuppressive therapy including transplant recipients. Toxoplasmosis is also a major cause of systemic infection and death for immunosuppressed (e.g., HIV/AIDS) patients. An increased of risk of neuro-inflammatory diseases including schizophrenia, autism, Alzheimers, and other has been suggested with *T. gondii*; more research is warranted to elucidate the neurological impacts of *T. gondii*.

Tick-borne diseases

Tick paralysis

Potentially fatal reaction to a paralyzing neuromuscular toxin secreted in the saliva of a female tick late in her feeding. Cattle, sheep, horses, dogs, and humans seem to be most effected.

Clinical signs include: headache, vomiting, general malaise, loss of motor function and reflexes, followed by paralysis that starts in the lower body and spreads to the rest of the body

Respiratory failure and death can result. Signs disappear rapidly when tick is removed, suggesting that the toxin is rapidly excreted or destroyed

Lyme borreliosis

- Agent: Borrelia burgdorferi
- Vector: Ixodes scapularis (Eastern and Midwestern US), Ixodes pacificus (Western US)
- Geographical distribution: New England and mid-Atlantic states, upper Mid-west, and Pacific coast.
- Animal health: Major cause of canine and equine disease, including endocarditis and joint pain. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Human health: Acute and chronic diseases including joint pain, heart disease, and neurological disorders. Most cases occur in the spring and summer, during nymphal emergence, and in late fall and winter, during adult emergence.
- Diagnoses: Lyme disease is diagnosed using serology tests, bacterial cultures, and/or PCR of tissue (NOT BLOOD). Blood may be used for PCR in very acute cases, otherwise tissue biopsy is needed. Predictive value influences serological test interpretations—only treat animals with clinical signs suggestive of disease!!!

Rocky Mountain Spotted Fever

- Agent: Rickettsia rickettsia
- Sometimes placed in “Spotted Fever” disease group
- Vector: Dermacentor variabilis

- Geographical distribution: Eastern US mainly. Most frequently reported tick borne disease in the eastern US. Animal health: Recent evidence has shown that untreated RMSF may lead to death of the affected animal. Clinical signs include whole body pain and are painful on palpation. May see petechial and ecchymotic hemorrhages

Rabies

Although rabies is detected most frequently in various wildlife populations in the U.S., multiple recent studies have disclosed that human exposure to rabies is primarily associated with domestic cats due to people being more likely to come in contact with cats. Rabies virus is transmitted via saliva from one host to another primarily via a bite from a rabid animal. Following a bite of a rabid animal and virus inoculation, the virus replicates in neurons and disseminates via the nervous system. Later in the infection the virus can be found in highly innervated organs including cornea, skin, and salivary glands Rabies leads to various neurological impairment symptoms and the disease is invariably fatal. 92% of actual human rabies infection has been associated with bat-associated rabies virus mainly due to bat bites not being noticed by humans. Only 1% of healthy bats and 11% of sick bats are found to be rabid. Effort should be made to make houses and areas unattractive to raccoons, skunks, and other rabies hosts.

Visceral larval migrans

Baylisascaris procyonis is a roundworm of raccoons and birds are infected by ingesting larvated eggs in the environment. Dogs, kinkajous, ringtailed coatis can also serve as the definite host for *B. procyonis* and can shed eggs. The distribution of *B. procyonis* has been increasing recently. Larval migrans of *B. procyonis* can result in numerous neurological impairment clinical signs including encephalitis, circling, seizures, and death. Necropsy diagnostics include histopath examination and PCR. Limiting raccoon access to yard and making the areas unattractive to raccoons is the main way to prevent this disease.

Introduction to Laparoscopy: Achieving Big Things Through Small Holes

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Laparoscopic and thoracoscopic techniques provide minimally invasive access to the abdominal and thoracic cavities, respectively. They allow both diagnostic evaluation of various organs and tissues as well as allowing an ever growing armamentarium of therapeutic interventions to be carried out through small port incisions.

Performing successful minimally invasive surgery relies heavily on patient selection and adequate training, but equally important is having good quality equipment. Attempting these procedures without the correct equipment might not only compromise the safety of the patient but can be very frustrating for the surgeon.

Prior to performing a minimally invasive procedure it is important that owners are informed of the possible need to convert to an open approach if the need arises. It is therefore vital to have regular instrumentation for open surgery available on the operating room table should conversion to open surgery be necessary.

Instrumentation

Imaging - rigid telescopes

The telescope allows transmission of the visual image from the surgical site to the camera. Quality of telescopes has risen rapidly in recent years especially with the introduction of the rod lens system. These telescopes employ a series of glass lenses arranged in a narrow tube to transmit light. The important variables to consider when choosing a telescope are the diameter, the length and the angulation at the tip. Probably the most versatile telescope for laparoscopy and thoracoscopy in small animals is the 5 mm diameter telescope. This is adequate for most dogs and cats. A smaller 3 mm diameter 14 cm long telescope (Karl Storz Veterinary Endoscopy) or a traditional 2.7 mm arthroscope can be used for smaller dogs and cats. Angulation of the tip of the telescope dictates the direction of the field of view. The 0º telescope will provide an image of what lies directly in front of the tip of the scope which is adequate for most abdominal procedures. The 30º telescope provides a view that is offset by 30º. Although somewhat more difficult to manipulate initially, they are helpful as by rotation of the light post (and therefore the telescope), a greater field of view is obtained.

Imaging – cameras

The image that is transmitted through the lenses of the telescope is captured by the camera and turned into a video image. The camera attaches to the head of the telescope and has a cord that feeds into the camera control box housed on the tower. The quality of the endoscopic video camera depends on the camera control unit or "chip". One-chip cameras use a single computer chip to process the colors the camera sees whereas in a 3-chip camera each chip processes a separate primary color, namely red, green or blue. One-chip cameras are satisfactory for most applications but three-chip cameras have superior optical clarity and color reproduction and provide images that are of photographic or broadcast quality. Alterations of the focus and field of vision size are usually controlled by rings located on the camera head with more modern cameras allowing the operator control of multiple functions such as white balance, other menu alterations, and image and video recording via buttons also located on the camera head.

Imaging - tower components

The light source

Modern light sources are usually powered by either halogen or xenon. Xenon is preferable as it emits a high intensity light that reproduces the color of natural light closely. Light sources between 150-300 watts are recommended to ensure good picture quality. Care of the fiberoptic light cable is also essential for optimal performance as if the fibers break or the tips are not regularly cleaned image quality will suffer. Care should always be taken to know where the tip of the telescope or light cable (when not attached to the telescope) is while the light source is fully powered. When resting on the table adjacent to drapes or in body cavities, or when resting against tissues, thermal burns can occur rapidly. When not directly in use, the power to the light source should always be turned down.

The insufflator

During laparoscopy a mechanical insufflator regulates the flow of gas (usually CO_2) into the abdomen during creation of a pneumoperitoneum. Pneumoperitoneum allows the working space necessary to manipulate instruments and organs during laparoscopic procedures. Modern insufflators allow monitoring of the pressure within the abdominal cavity and prevent pressure rises above preset levels. In dogs, intra-abdominal pressure of 15 mm Hg is considered to result in physiologically acceptable levels of cardiorespiratory depression while providing more than adequate working space in most patients.[1] Intra-abdominal pressures of 8-10 mm Hg generally provide adequate working space in most dogs and cats.

The Monitor

Usually located at the top of the "tower", a high quality medical grade cathode ray tube or flat panel monitor is essential to be able to view structures clearly and should be large enough so that the surgeon can see images from across the surgical table. It is very

important to consider optimal tower location for any given procedure during preoperative planning. This will minimize the need for cumbersome intra-operative relocation of the tower while maximizing the ability to maintain the straight line viewing axis from the surgeon to the lesion being operated and on to the monitor.

Data recording devices

Providing a record of images or video of the procedure is very helpful for patient medical records as well as client and veterinarian education and publication purposes. The simplest device for image capture is the video printer that will print single images in surgery. Video recorders can be used to record whole procedures that can then later be edited. Digital capture devices are now commonplace which provide perhaps the most versatile storage and distribution medium. Still images and videos can be captured, stored on the units' hard drive or be easily downloaded to CD, DVD or connected via USB ports to external storage devices such as flash drives or portable hard drives (e.g. AIDA -vet device, Karl Storz Veterinary Endoscopy).

Trocars and cannulas

Establishing access ports using cannulas is essential for laparoscopic procedures to allow atraumatic repeated instrument exchanges. For laparoscopy where insufflation is used, maintenance of an airtight seal to prevent leakage of insufflation gas during laparoscopy is also accomplished using cannulae.

A large variety of sizes and designs of trocars and cannulae are available. Choices to be considered include the use of single-use disposable versus resterilized non-disposable cannulae, blunt versus sharp trocars and trocar-cannula assemblies versus trocar-less cannulae. Single-use disposable cannulae are generally made of lightweight plastics and are less likely to slide out of port incisions; a common occurrence in small dogs and cats. Blunt trocars should always be used during establishment of the first (camera) port to avoid iatrogenic damage to underlying organs prior to the establishment of a pneumoperitoneum or pneumothorax. Instrument ports can then safely be established using sharp-tipped trocars that can be placed under direct visualization from within the body cavity. Trocar-less threaded cannulae (Endotip™, Karl Storz Endoscopy) are also popular for use in small animals. These blunt-tipped threaded cannulae are screwed into position and are well retained by the body wall due to the threads present on the cannula shaft. They also allow the laparoscope to be inserted into the cannulae during placement to visualize penetration of the body cavity during entry.

Surgical instruments

Almost all of the instruments used for open surgical procedures are available in laparoscopic versions including scissors, various grasping forceps and cup biopsy forceps. The 5 mm sized instruments are usually used for small animal procedures although 2, 3 and 10 mm are also available. A simple blunt probe is one of the most useful instruments for carefully moving organs in a non-traumatic fashion. Other components of a basic instrument set required for most laparoscopic and thoracoscopic interventions include a Metzenbaum and hook (suture-cutting) scissors, Kelley hemostats, Babcock forceps (5 and 10 mm versions), and cup biopsy forceps. For procedures requiring more intricate dissection various sizes of right-angle forceps (5 and 10 mm) are useful. A knot-pusher is an instrument required when extra-corporeal knot tying is used. Knots tied outside the body cavity are pushed into position through the cannula and around the vessel or other structure being ligated. Various forms of laparoscopic retractors are also available including fan retractors, and various forms of inflatable retractors that are necessary when performing certain procedures where visualization is obscured by certain other organs or by the movement of the organ being operated. Laparoscopic needle holders are necessary for intracorporeal suturing. These are generally used in pairs and are available with various styles of tip, one of the most popular of which is the parrot-jaw.

Anesthetic considerations

The most important anesthetic considerations for laparoscopic surgery are related to abdominal insufflation. Respiratory and cardiovascular depression can occur secondary to excessive pressure exerted on the diaphragm and vascular structures of the peritoneal cavity. Intra-abdominal pressures should be maintained at ~10-12 mmHg and certainly below 15 mmHg to prevent potential cardiovascular and respiratory depression. Carbon dioxide (CO_2) is the gas of choice to achieve a pneumoperitoneum. Insufflation with air may result in fatal air embolism and the use of nitrous oxide (N_2O) is discouraged due to the potential for combustion when electrocautery devices are used. Hypercarbia can occur during pneumoperitoneum for two main reasons: increased pressure on the diaphragm causing a reduction in tidal volume, thus compromising ventilation, and rapid absorption of CO_2 through the peritoneal lining. It is therefore recommended that monitoring of CO_2 via either capnography or blood gas analysis be performed and ventilation adjusted accordingly.

Principles of abdominal access

Veress needle technique

A Veress needle is a specialized instrument used for creation of pneumoperitoneum or pneumothorax . It consists of a sharp-tipped needle component that houses within it a blunt-tipped obturator loaded on a spring-like mechanism. The sharp component of the needle will penetrate the body wall whose resistance will force the blunt obturator to retract into the shaft. Upon penetration of the

body wall, however, resistance is lost, allowing the blunt-tipped obturator to spring forward thereby shielding the abdominal viscera from injury.

Modified Hasson technique

The modified Hasson technique avoids the blind introduction of a sharp needle and cannula into the peritoneal cavity. It is performed by making a 1 cm skin incision just caudal to the umbilicus which is followed by blunt dissection to the linea alba. A 3-4 mm incision is made through the linea alba and a trocar-cannula assembly is introduced into the peritoneal cavity. A blunt-tipped trocar should be used to prevent injury to the abdominal organs. Penetration into the peritoneal cavity can be confirmed by observation of falciform fat through the incision prior to inserting the trocar. The insufflator line is attached to the cannula and the abdomen is insufflated. Upon establishing a pneumoperitoneum, the abdominal cavity should become tympanic.

Placement of instrument portals

Once the camera portal has been established as many instrument portals as are necessary for a given procedure can be placed. Instrument portals are usually placed using direct visualization from inside the body cavity now that access for the telescope has been achieved. A stab incision with a scalpel blade is made over the proposed site of the portal and a trocar-cannula assembly or trocarless cannula is inserted through the deeper layers of the body wall. The surgeon can then observe from within the body cavity as the cannula enters thereby avoiding any iatrogenic damage to organs.

Achieving hemostasis

A variety of methods for achieving hemostasis within body cavities during laparoscopic and thoracoscopic procedures are available.

Hemostatic agents

Topical hemostatic agents such as gelatin sponges (Gelfoam©) and oxidized regenerated cellulose (Surgicel©) can be passed down laparoscopic ports and applied as in open surgery but they can be tedious to manipulate into position. Newer fibrin "glue" sealants are also becoming available for laparoscopic applications in human medicine and may be used for veterinary applications in the future.

Laparoscopic hemostatic clips

A variety of disposable or non-disposable laparoscopic hemoclip appliers are available. Reusable sterilized clip appliers (M/L-10 reusable multi-fire hemoclip applier, Microline Pentax) are loaded with clip cartridges and are more cost effective than disposable devices. Multi-fire clip appliers that allow several clips to be applied without withdrawal of the device minimize instrument exchanges and surgical time. The use of laparoscopic hemoclips in veterinary patients has been evaluated in a laparoscopic ovariohysterectomy model and was shown to be safe and effective for ovarian pedicle ligation; however, hemoclip application was shown to be more time-consuming than the use of a vessel-sealing device for this application.[2]

Monopolar and bipolar electrosurgery

Both monopolar and bipolar electrosurgery can be used in minimally invasive surgery. Monopolar electrosurgery should however be used with great caution in MIS as several potentially hazardous problems can occur. A defect in the insulation of the instrument shaft can result in the passage of current to tissues that are not in the visual field resulting in iatrogenic injury. Direct coupling injuries can occur when the instrument through which the electric current is passed comes into contact with the telescope, or other instrument, resulting in iatrogenic damage to tissues that may lie outside the visual field. Bipolar electrosurgery is safer as it is usually of lower voltage current and the electrical current is only passed between the tips of the bipolar instrument used.

Vessel-sealing devices

A more recent development in MIS is the increasing use of vessel-sealing devices. Vessel-sealing devices are very helpful for hemostasis and simultaneously sealing and cutting a variety of tissues. They work by a combination of pressure exerted on tissue when the tissue is crushed in the tips of the device, followed by the application of bipolar or ultrasonic energy applied to the tissue. This process allows the elastin and collagen in the vessel wall to be sealed together permanently. A variety of units are currently available. Two bipolar electrocautery devices are the Ligasure™ (Valleylab, Tyco Healthcare Group) and the Enseal™ (SurgRX Inc.). Both devices have tips that are indicated to seal arteries and veins up to 7 mm in diameter. The Ligasure has the advantage of sensing the tissue impedance within the jaws of the tip that then adjusts the energy output from the generator accordingly to ensure a safe and effective seal. A second-generation Ligasure device known as the Force Triad™ is now available that provides a much more rapid seal cycle. The Harmonic Scalpel® (Ethicon Endo-surgery) is a device that uses ultrasonic energy to cut and coagulate tissue. The Harmonic Ace® tip is indicated to seal vessels up to 5 mm in diameter.

Several reports have compared these devices with respect to the degree of lateral thermal spread, bursting pressures and sealing time although the results of these studies are often conflicting.[3,4] Overall, however, all produce supra-physiological bursting pressures of at least three times systolic blood pressure.[3] For the Ligasure lateral thermal spread ranged from 1.5-3.2 mm in one study with a greater degree of thermal spread seen as vessel size increased.[5] Although generally very safe, care must nevertheless be taken when these devices are used adjacent to neurovascular or other vital structures. They are also not indicated for sealing of non-vascular luminal organs such as bile duct or lung tissue. Other vessel-sealing technologies are emerging onto the market constantly.

References

1. Duke T, Steinacher SL, Remedios RM. Cardiopulmonary effects of using carbon dioxide for laparoscopic surgery in dogs. Vet Surg 1996;25:77-82

2. Mayhew, P.D. and Brown, D.C. Comparison of three techniques for ovarian pedicle hemostasis during laparoscopic-assisted ovariohysterectomy. Vet Surg 2007; 36:541-547.

3. Person B, Vivas DA, Ruiz D et al. Comparison of four energy-based vascular sealing and cutting instruments: a porcine model. Surg Endosc 2008;22:534-538

4. Lambertson GR, Hsi RS, Jin DH et al. Prospective comparison for four laparoscopic vessel ligation devices. J Endourol 2008;22:2307-2312

5. Carbonell AM, Joels CS, Krecher KW et al. A comparison of laparoscopic bipolar vessel sealing devices in the hemostasis of small, medium and large-sized arteries. J Laparoendosc Adv Surg Tech 2003;13:377-380

Ear Surgery:
Pick the Right Technique and Avoid Complications

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Surgery of the ear is commonly indicated in small animal practice for a variety of causes including otitis externa, otitis media as well as traumatic and neoplastic conditions of the bulla, ear canal and pinna. The complexity of these interventions can range from very basic to highly complex and ear surgery remains an area of soft tissue surgery that is associated with significant morbidity.

In order to perform some of the more advanced surgeries an in depth knowledge of regional anatomy is vital. The cartilaginous ear canal is made up of the pinna, which is supported by the auricular cartilage. The pinna is continuous with the vertical canal, which then becomes more perpendicular to the skull base and continues as the horizontal canal. The annular cartilage fuses with the auricular cartilage but during dissection of the ear canal an obvious step can be appreciated between these two cartilages. The annular cartilage attaches to the skull at the external acoustic meatus, which forms the entrance to the tympanic bulla and is the insertion site of the tympanic membrane.

The arterial supply to the external ear comes from a branch of the external carotid artery and venous blood drains to the maxillary vein. The retroarticular vein lies just rostral to the external auditory meatus and can easily be damaged during dissection. When this occurs it can be challenging to grasp and cauterize or ligate the vessel due to limited accessibility. Sustained packing of the area in combination with placement of a topical hemostatic agent such as an absorbable gelatin sponge is usually successful in stopping the hemorrhage.

Several important neurological structures lie within the surgical field especially when total ear canal ablation is performed and neurological complications are the most common group of complications associated with ear surgery. Axons from postganglionic sympathetic neurons course close to the wall of the middle ear in dogs and cats and are particularly exposed in cats during curettage of the tympanic bulla during TECA-BO surgery. Damage to these fibers can result in Horners syndrome. The facial nerve exits the stylomastoid foramen immediately caudal to the external auditory meatus and then travels ventrally and cranially around the aspect of the tympanic bulla. The entrance to the inner ear at the epitympanic recess lies on the dorsomedial aspect of the tympanic bulla. Signs of vestibular disease can result in damage to the structures of the inner ear if over-exuberant curretage occurs in this area or if a fracture is propagated into the this area during bulla osteotomy. It is important to remember that unlike dogs who in general have one compartment to the bulla, the feline tympanic cavity consists of two compartments, a larger ventromedial and a smaller craniolateral compartment which are separated by a bony septum. It is imperative to penetrate both cavities of the bulla in cats as disease is usually not limited to one cavity.

Surgery of the pinna

Occasionally traumatic lesions may require resection of a portion of the pinna if devascularization and necrosis of a portion of the pinna has occurred. However, more commonly pinnal surgery is indicated for treatment of neoplastic lesions. The most common neoplasm involving the pinna is squamous cell carcinoma. These lesions are particularly common in cats that lack pigment in their pinnae. These cats have been shown to have a 13.4x greater risk of developing SCC compared to those cats with pigmented pinnae.[1] In cases where SCC is present a complete pinnectomy is often required to achieve a clean surgical margin. Pinnectomy is a simple procedure that involves a full-thickness incision medially and laterally that penetrates through the auricular cartilage. The skin margins which have a tendency to retract away from the cartilage are primarily sutured and healing in most cases is uneventful as long as the patient is prevented from self-traumatizing the area. The prognosis for cats with SCC of the pinna is good with one study documenting a disease free interval and median survival time of 681 and 799 days respectively.[2]

Surgical management of otitis externa

Cases that have become refractory to medical management or animals that have such severe canal stenosis or obstruction that medical management can no longer be administered are surgical candidates. A variety of surgical procedures have been described over the years for otitis externa including lateral wall resection (Zepp procedure), vertical canal ablation, subtotal ear canal ablation with bulla osteotomy (STECA-BO) and total canal ablation with bulla osteotomy (TECA-BO).

Lateral wall resection is the simplest of these procedures but has become seemingly less popular in recent years and is only indicated in patients that lack significant disease in their horizontal canals. After an initial skin incision is made over the lateral aspect of the vertical canal, dissection down to the cartilage is performed. The cranial and caudal margins of the lateral vertical ear canal are incised in order to create a cartilaginous flap. The flap is turned ventrally and sutured to the ventral margin of the skin incision in order to create a cartilaginous drainage board. The procedure does not remove any of the diseased cartilaginous canal but merely has the potential to improve access for administration of medications and can change the microenvironment of the ear canal by improving ventilation, and reducing humidity thus discouraging bacterial growth. However, results of this surgery have been disappointing with

one study reporting an unacceptable surgical outcome in 55% of cases overall and in 86.5% of the cocker spaniels in which it was performed mainly due to progression of disease.[3] Lateral wall resection may be used successfully for resection of small well-circumscribed non-malignant masses of the lateral aspect of the vertical canal although these lesions rare.

Vertical canal resection is another procedure that has fallen out of favor for management of otitis externa. In this procedure the vertical canal is isolated by resecting in a circumferential fashion around the proximal aspect of the ear canal as is done in a total ear canal resection. Dissection is continued as close as possible to the cartilage of the vertical canal until the point where the horizontal canal starts. At this point the vertical canal is amputated and the margin of the epithelium of the ear canal is sutured to the skin to create a new external ear orifice that is located in a more ventral location. The remainder of the skin incision is closed routinely. Similarly to the lateral wall resection vertical canal ablation may be a useful technique for resection of small well-circumscribed benign masses emanating from the wall of the vertical canal. Stenosis of the small orifice that is created can occur and clipping of the hair around the orifice may be necessary to prevent obstruction of air flow. Stenosis can be minimized by creation of a small drainage board as is performed with the Zepp procedure.

While both the lateral wall and vertical canal resection have the advantage of minimizing the risk of damage to the neurovascular structures located closer to the base of the ear canal and the tympanic bulla they have lost favor in the management of otitis due to their inability to remove all of the diseased tissue.

TECA-BO and a recently reported modification termed the STECA-BO[4] are generally more appropriate for most dogs with moderate to severe signs of otitis externa and media but do carry a higher risk of neurovascular complications. For many years it has been known that an ear canal ablation without bulla osteotomy would result in a high incidence of fistula formation after surgery.[5] The importance of performing the osteotomy therefore cannot be overemphasized. The STECA-BO was recently described in 18 dogs as a potentially less invasive alternative to TECA-BO that also allows preservation of the proximal vertical canal with potentially better ear carriage.[4] In a traditional TECA-BO surgery dissection of the entire vertical and horizontal canal is performed staying as close to the cartilaginous canal as possible. Facial nerve paralysis occurs in 13-36% of dogs depending on which study is quoted and is usually the result of excessive retraction of the nerve during the dissection.[6] Transection of the nerve is also possible and usually occurs when tissue around the horizontal canal that remains attached to the perineural tissues is being removed with some force causing the nerve to be withdrawn in a traumatic manner. In most cases, however, where transection has not occurred, facial nerve paralysis is temporary. If function does not return the third eyelid commonly functions as a surrogate for lubrication of the eye during globe retraction although this does not occur in all cases and severe corneal ulceration with the loss of function can occur in extreme cases. In cats facial nerve paralysis has been described in 56% of TECA-BO cases post-operatively and was permanent in 28% of cases in one study.[7] Horners syndrome is principally seen in cats and has been reported to occur in 42% of cats of which it was permanent in 14 percent.[7] Although animals with Horners syndrome have obvious cosmetic changes that are readily visible to owners it generally does not appear to be associated with significant detriment to quality of life in the post-operative period. Vestibular dysfunction is thankfully the least common (3-8% incidence in dogs) of the neurological disorders seen in small animals after TECA-BO but has the most profound affect on quality of life in the post-operative period.[6] Damage to the inner ear may occur due to overzealous curettage of the dorsomedial aspect of the bulla. The author has also seen this complication after fracturing of the bulla during the osteotomy procedure. When performing the bulla osteotomy it is advised that small pieces of bone be removed or that a burr be used. Significant pressure applied to rongeurs on larger pieces of bone can propagate fractures in the area of the petrous temporal bone that can result in vestibular dysfunction. Recovery from vestibular signs can be incomplete and can take several months.

Fistula formation after TECA-BO is another potentially serious complication that can arise if any infected epithelium or canal tissue is not removed. The incidence of this complication is between 2-10% and treatment is usually limited to re-exploration of the surgical site as antibiotics are not usually successful in managing these infections.[6] Re-exploration can be performed using either a ventral or lateral approach, the latter being chosen if remaining cartilage is detected on pre-operative advanced imaging studies which are recommended. However, owners should be aware that even after re-exploration recurrence of signs is possible.[8]

Surgical treatment of ear canal neoplasia

Tumors of the ear canal are predominantly malignant in origin especially in cats. Ceruminous gland adenocarcinoma (CGA) is the most common tumor in cats and dogs with squamous cell carcinoma being almost as common as CGA in cats. Metastasis is uncommon, however, with spread to lymph nodes and lungs documented in less than 10% of cases.[9] Total ear canal ablation is firmly established as the procedure of choice for malignant ear canal tumors to provide the best long-term control of local disease. In dogs with malignant ear canal tumors median survival time has been documented to be 58 months.[9] Cats with CGA have a median survival time of 49 months. However, survival time for those cats with SCC was only 3.8 months in one study.[9]

References

1) Dorn CR, Taylor DON, Schneider R. Sunlight exposure and risk of developing cutaneous and oral squamous cell carcinoma in white cats. J. Nat Cancer Inst 1971;46:1073-1078

2) Lana SE, Ogilvie GK, Withrow SJ et al. Feline cutaneous squamous cell carcinoma of the nasal planum and the pinnae: 61 cases. J Am Anim Hosp Assoc 1997;33:329-32.

3) Sylvester AM. Potential factors affecting dogs with a resection of the lateral wall of the vertical ear canal. Can Vet J 1998;39:157-160

4) Matthews KG, Hardie EM, Marcia Murphy K. Subtotal ear canal ablation in 18 dogs and one cat with minimal distal ear canal pathology. J Am Anim Hosp Assoc. 2006;42:371-380

5) Smeak DD, DeHoff William D. Total ear canal ablation. Clinical results in the dog and cat. Vet Surg 1986;15:161-170

6) Smeak DD. Management of complications associated with total ear canal ablation and bulla osteotomy in dogs and cats. Vet Clin Small Anim 2011;41:981-994

7) Bacon NJ, Gilbert RL, Bostock DE et al. Total ear canal ablation in the cat: indications, morbidity and long-term survival. J Small Anim Pract. 2003;44:430-434.

8) Holt D, Brockman DJ, Sylvestre AM et al. Lateral exploration of fistulas developing after total ear canal ablations: 10 cases (1989-1993). J Am Anim Hosp Assoc 1996;32:527-30

9) London CA, Dubilzeig RR, Vail DM et al. Evaluation of dogs and cats with tumors of the ear canal: 145 cases (1978-1992). J Am Vet Med Assoc 1996;208:1413-1418

Gall Bladder Mucoceles: The Kiwi Inside

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Gall bladder mucocele (GBM) may currently represent the most common indication for surgical management of extra-hepatic biliary tract disease in dogs. It has not yet been convincingly described in cats. The underlying lesion has been described as cystic mucosal hyperplasia.[1] Hypersecretion of mucus progressively leads to an accumulation of gelatinous bile within the gall bladder lumen. Increased viscosity over a period of weeks or months leads to thick gelatinous material eventually occupying the entire lumen of the gall bladder and in some cases also being present in the common bile duct. This can in some cases lead to clinico-pathological signs consistent with extra-hepatic biliary obstruction. In other cases eventual gall bladder rupture may occur possibly secondary to increases in intracholic pressure and/or gall bladder wall infarction. This will lead to an initial localized and progressively more generalized bile peritonitis.

Etiopathogenesis

The cause of GBM remains largely unknown but recent reports have shown associations (although not a causative link) between GBM and certain intercurrent disease processes with a focus on endocrinopathies and other metabolic abnormalities. Certain genetic predispositions may play a role as Shetland Sheepdogs were recently shown to be predisposed to gall bladder disease albeit not specifically to GBM formation.[2] Several previous studies have commented anecdotally on the relatively high incidence of endocrinopathies that are present in dogs with GBM.[2-4] In a recent report evaluating a possible association between GBM and hyperadrenocorticism (HAC) and hypothyroidism (HT) both conditions were found to have an association with GBM.[5] Dogs diagnosed with HT were 3.0 times more likely to have GBM than dogs without HT and the odds of having a mucocele in dogs with HAC was 29.0 times greater than dogs without HAC. In all 21% of dogs with GBM had HAC compared to 2% in the control group. In the case of HT 14% of GBM dogs had the condition compared to 5% in the control group. Certain limitations were present in this study and no causal relationship can be proven from this data.[5]

Diagnosis

A combination of clinical signs, laboratory parameters and imaging studies are used in the diagnosis of GBM. The most frequent laboratory abnormalities include elevations of alanine aminotransferase (ALT), alkaline phosphatase (ALKP), and aspartate aminotransferase (AST). Serum bilirubin is elevated in most cases but is often normal in early cases. A leukocytosis is present in half of the cases. Abdominal radiographs can be helpful but are often non-specific. Hepatomegaly may be evident and gall bladder enlargement with partial mineralization of contents is an occasional finding. Abdominal ultrasonography is the most useful imaging study for this condition. The gall bladder usually contains echogenic material with a typical stellate or finely striated bile pattern (kiwi fruit) which differs from biliary sludge by the absence of gravity dependant bile movement.[6] Gall bladder rupture is suggested by gall bladder wall discontinuity, the presence of pericholecystic hyperechoic fat or an accumulation of fluid in the abdomen. The sensitivity of ultrasound for gall bladder rupture is 85.7%, so in most cases a suspicion of biliary peritonitis should be ruled out by abdominocentesis or diagnostic peritoneal lavage.[7]

Management

Appropriate management of gall bladder mucoceles depends on clinical presentation. The successful medical management of two dogs with GBM that were followed ultrasonographically has been reported.[8] Medications administered included ursodiol, S-adenosyl methionine and famotidine although the relative role of these drugs in the resolution of the GBM can only be hypothesized.[8] The belief that most mucoceles should be treated surgically is probably justified by the high levels of morbidity and mortality seen in cases that develop EHBO or bile peritonitis secondary to gall bladder rupture.[4,7] However, medical management can be considered in early cases that have significant co-morbidities and are poor anesthetic candidates. Further research into the medical management of GBM seems warranted by this report. In most other cases the procedure of choice for GBM is cholecystectomy although one report includes a description of a significant percentage of dogs that underwent biliary rerouting procedures.[4] Most dogs with GBM do not have gall bladders that remain healthy enough to allow a viable cholecystoduodenostomy to be performed and progressive gall bladder wall necrosis has been reported.[4] It is generally considered that the gall bladder wall is the source of excessive mucus production and so the underlying cause appears to be removed when a cholecystectomy is performed. The gall bladder should always be submitted for histopathological analysis and a sample of the bile and a portion of the gall bladder wall should be submitted for bacterial culture and sensitivity testing. Evidence is somewhat conflicting as to whether infection is common in cases of biliary mucoceles with positive cultures for aerobes and anaerobes being reported in 9-75% and 0-25% respectively.[4,6,7] Enterococcus and E.Coli isolates are the most frequently cultured bacteria.

Gall bladder rupture with subsequent bile peritonitis is encountered in 23-60% of cases and surgeons should be prepared for this eventuality.[3,4,6] Some form of ongoing drainage is helpful in many cases and can consist of closed suction drainage using Jackson-Pratt drains or open abdominal drainage post-operatively. In dogs with GBM and concurrent evidence of partial or complete EHBO, such as ultrasonographic common bile duct distension or hyperbilirubinemia it is important to ensure that the common bile duct is free of congealed gall bladder mucus post-operatively. Concurrent EHBO has been documented in up to 30% of cases and based on laboratory data alone functional obstruction may be present in an even higher percentage of cases.[4,7] Ensuring bile duct patency intraoperatively by catheterization and flushing as outlined above is critical especially in patients that have laboratory or imaging evidence of EHBO as persistent obstruction post-operatively may result if this is not performed.

The treatment of incidentally discovered or asymptomatic mucoceles is controversial. Care must be taken to avoid confusing early mucocele formation with the presence of biliary sludge ultrasonographically, a common incidental finding in dogs and cats. A careful history should also be taken in these cases as some apparently asymptomatic dogs will have mild to moderate clinical signs attributable to the presence of GBM, which can resolve after cholecystectomy.[9] No controlled studies exist to compare surgical and conservative management of incidentally discovered mucoceles and so each case must be considered on its own merit. Recently the development of a laparoscopic cholecystectomy technique in dogs and its application to the treatment of gall bladder mucoceles has been described and may be a good option for dogs with incidentally diagnosed mucoceles.[9]

Prognosis

The prognosis for GBM is generally favorable especially if treated early and no bile leakage or trauma to the biliary tract is present. Post-operative complications consist of further leakage of bile from the surgery site, pancreatitis and re-obstruction of the common bile duct with gelatinous bile post-operatively. Most dogs that survive the perioperative period will not have long-term recurrence or complications. Overall perioperative mortality in the veterinary literature ranges from 22-32%.[4,7]

References

1. Kovath RM, Hildebrandt PK, Marcus LC: Cystic mucinous hypertrophy of the mucosa of the gall bladder in the dog. Vet Pathol 2:574-584, 1965.
2. Aguirre AL, Center SA, Randolph JF, et al: Gallbladder disease in Shetland sheepdogs: 38 cases (1995–2005). J Am Vet Med Assoc 231:79-88, 2007.
3. Mehler SJ, Mayhew PD, Drobatz KJ, et al: Variables associated with outcome in dogs undergoing extrahepatic biliary surgery: 60 cases (1988–2002). Vet Surg 33:644-649, 2004.
4. Worley DR, Hottinger HA, Lawrence HJ: Surgical management of gallbladder mucoceles in dogs: 22 cases (1999–2003). J Am Vet Med Assoc 225:1418-1422, 2004.
5. Mesich ML, Mayhew PD, Paek M, et al: Gallbladder mucoceles and their association with endocrinopathies in dogs: a case control study. J Sm Anim Pract 50:630-635, 2009.
6. Besso JG, Wrigley RH, Gliatto JM, et al: Ultrasonographic appearance and clinical findings in 14 dogs with gall bladder mucocele. Vet Radiol Ultrasound 41:261-271, 2000.
7. Pike FS, Berg J, King NW, et al: Gall bladder mucocele in dogs: 30 cases (2000–2002). J Am Vet Med Assoc 224:1615-1622, 2004.
8. Walter R, Dunn ME, d'Anjou MA, et al: Nonsurgical resolution of gallbladder mucocele in two dogs. J Am Vet Med Assoc 232:1688-1693, 2008.
9. Mayhew PD, Mehler SJ, Radhakrishnan A: Laparoscopic cholecystectomy for management of uncomplicated gall bladder mucocele in six dogs. Vet Surg 37:625-630, 2008.

Thyroid and Parathyroid Surgeries

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Therapeutic strategies for management of thyroid and parathyroid tumors have evolved significantly over the last decade in some areas and are little changed in others. To obtain the best outcomes in surgical diseases of the thyroid and parathyroid glands a thorough knowledge of the biological behavior of the different tumors is required as well as an appreciation of the regional anatomy.

Regional anatomy

The thyroid glands lie in the proximal neck region on either side of the trachea and in close association with several structures that must be protected during therapeutic procedures. The glands lie medial and ventral to the carotid sheath which contains the carotid artery, internal jugular vein and vagosympathetic trunk. The recurrent laryngeal nerve lies on the dorso-lateral aspect of the trachea and is therefore dorsomedial to the thyroid glands. The recurrent laryngeal nerve is a very fine structure, which in smaller animals can be challenging to visualize. The blood supply to both thyroid and parathyroid glands comes principally from the cranial thyroid artery, which is a branch of the carotid artery. A caudal thyroid artery contributes blood supply to the glands in dogs but is lacking in most cats. Venous drainage occurs through the cranial and caudal thyroid veins which drain to the internal jugular vein. There are four parathyroid glands, two of which are extracapsular and two of which are intracapsular. The exact location can be quite variable but generally the extracapsular glands lie within the fascia at the cranial pole of the thyroid gland and are usually easier to visualize as small tan spherical bodies. The intracapsular glands lie approximately half way down the thyroid gland deep to the capsule and on the medial aspect of the thyroid. Ectopic thyroid and parathyroid tissue can be present in both dogs and cats and is an important consideration when considering therapeutic strategies. In dogs the incidence of ectopic thyroid tissue is less well documented but neoplastic transformation of ectopic thyroid tissue has been documented in both dogs and cats. Predilection sites for ectopic thyroid neoplasia in dogs appear to be at the base of the tongue or hyoid apparatus1 or in the cranial mediastinum.2 In cats hyperfunctional ectopic adenomatous hyperplasia occurs in up to 20% of hyperthyroid cats although malignant transformation has not been as well described.3 Ectopic parathyroid tissue is rare in dogs occurring in only 3-6% of dogs and is usually associated with the thymus. In cats, ectopic parathyroid tissue is much more common occurring in approximately 35-50% of cats.

Thyroid gland – Comparative oncology

Dogs and cats both suffer from benign as well as malignant disease of the thyroid gland with benign disease predominating in cats and malignant disease predominating in dogs. Approximately 90% of dogs with a palpably enlarged thyroid gland will have a thyroid carcinoma and in most cases these will be surgically resectable. Only about 10% of these tumors are functional creating a hyperthyroid state similar to that seen in cats with hyperthyroidism. Metastasis at the time of surgery has occurred in 35-45% of cases at the time of diagnosis with the lungs and local lymph nodes being the most common sites affected. Retropharyngeal lymph nodes are one of the primary drainage nodes for the thyroid glands. Tumor size is predictive of metastatic rate with larger tumors having higher metastatic rates at diagnosis.

The prospective thyroid surgeon should be aware that substantial thyroid neovascularization is the norm in thyroid carcinomas and that profuse hemorrhage is very possible during surgery. Patients should ideally be cross-matched and typed prior to surgery. Due to the proximity of important neural structures we always use bipolar electrosurgery close to the gland and the primary goal of therapy is removal of the entire tumor without penetration of the capsule. The ability to preserve parathyroid gland function is preferable but not usually possible. In unilateral cases this is generally not important due to the ability of the contralateral gland to maintain the euthyroid state. However in bilateral cases post-operative hypoparathyroidism is a greater concern and occurred in 11/15 dogs in one study of dogs undergoing bilateral simultaneous thyroidectomy.[4] Laryngeal paralysis has also been seen as a complication after thyroid carcinoma resection although is also more likely to be a clinically relevant problem in bilateral cases. Despite the high propensity for metastatic spread at the time of diagnosis canine thyroid carcinomas have a good prognosis even without chemotherapy in some cases. Prognosis for dogs with thyroid carcinoma is generally quite good with median survival times reported of around 3 years for mobile tumors and 6-12 months for invasive masses. Invasive tumors that are immobile or invading underlying structures are uncommon and may necessitate other non-surgical treatment strategies. External beam irradiation of invasive thyroid carcinoma has been associated with very reasonable outcomes in one study demonstrating progression-free survival rates of 80% and 72% at 1 and 3 years respectively.[5] I^{131} therapy may also be used for treatment of dogs with non-resectable tumors with success.[6] The use of adjuvant chemotherapy has never been shown to be highly effective in thyroid carcinoma. One recent study suggested that the addition of chemotherapy did not have a beneficial effect on survival (median survival of dogs undergoing surgery and chemotherapy was 518 days compared to 510 days for surgery alone) although this was a study of only 44 dogs.[7]

Ectopic thyroid carcinomas have been described in several studies with two main predilection sites emerging, the cranial mediastinum and the ventral laryngeal area. A series of nine dogs with cranial mediastinal carcinomas has been described of which

five were thyroid in origin.[2] Despite being amenable to surgical resection in many cases these tumors can be locally invasive and perioperative morbidity can be high when surgical resection is considered. A recent report describes the imaging findings associated with 8 dogs that presented with invasive ectopic thyroid carcinomas centered around and invasive into the basihyoid bones.[1] While these often highly vascular masses may be amenable to surgical debulking their invasiveness may preclude a clean margin of resection being attainable and treatment with radiation therapy may be preferable.

The vast majority of thyroid lesions in cats are associated with adenomatous hyperplasia and are detected due to their propensity to overproduce thyroid hormone with the resulting symptoms of weight loss, polyphagia and polydispsia amongst others. In the authors practice these cats are almost exclusively treated using I^{131} therapy although surgical thyroidectomy using a modified extracapular technique has been reported to have excellent results in experienced hands.[8] In 1-3% of hyperthyroid cats, however, a thyroid carcinoma is present and this should be suspected in cases where the mass is larger than expected, if the T4 concentration is very high, if there has been a poor response to therapy or if distant metastasis is present.[9,10] The scintigraphic pattern of radionuclide uptake has been evaluated in cats but is not a reliable indicator of malignancy.[10] Feline thyroid carcinoma has been treated with surgical thyroidectomy and I^{131} therapy. I^{131} therapy has been shown to be associated with very prolonged survival (median 814 days, range 181-2381) in one small case series in which no cats suffered a recurrence of hyperthyroidism during the follow-up period.[10] I^{131} has the advantage of treating all thyroid tissue including ectopic deposits although 3-10 fold increases in I^{131} dose are required to treat thyroid carcinoma compared to benign disease which can cause problems with radiation safety protocols.[10]

Parathyroid gland – Comparative oncology

Both benign and malignant disease of the parathyroid glands have been reported in both dogs and cats and are a common entity in small animal practice. Functional parathyroid adenomas that lead to hypocalcemia are especially common and in 90% of dogs are solitary lesions with the remainder usually having two lesions. Adenomas can reside in any one of the four glands and careful inspection at the time of surgery is necessary to diagnose these often small (most commonly 3-10 mm) masses. They present as small raised nodules that upon digital palpation appear firmer than the surrounding thyroid tissue. The clinical picture can sometimes be confused by the presence of non-neoplastic chronic change within adjacent thyroid glands in some dogs. Fine dissection is used along with bipolar electrosurgical units to delicately resect the offending mass. Several surgical options can be considered intraoperatively for adenoma resection. An enucleation of the mass with the aim of not penetrating the parathyroid capsule (with the consequent risk of leaving behind neoplastic cells) can be successful when resecting the extracapsular glands. The internal gland is usually removed using a parathyroidectomy with partial thyroidectomy approach. This author usually performs the thyroid transection with bipolar electrosurgery being careful to preserve the blood supply to the cranial pole of the thyroid where the external parathyroid gland resides. In cases where multiple masses are present on one side or if a malignancy is suspected a complete thyroid/parathyroidectomy is recommended with ligation of both cranial and caudal thyroid arteries and veins. Assuming the contralateral glands are unaffected post-operative hypocalcemia should not be a long-term problem. Intraoperative monitoring of PTH has been described to aid in confirmation of excision of all adenomatous tissue.[11,12] In one study of nine clinical cases significant drops in PTH occurred in all dogs after excision of the mass. However, in another study significant drops occurred in PTH level after resection of only one of two affected masses suggesting that this test may lack specificity.[11]

Parathyroid ablative techniques are also frequently performed in the author's institution for treatment of benign parathyroid adenomas. Ethanol ablation was performed initially but was associated with a higher level of recurrence of hypercalcemia. More recently radiofrequency ablation has been used with results very similar to those of surgical parathyroidectomy and long-term control of hypercalcaemia in dogs of approximately 90%.[13,14]

Post-operative hypocalcemia is the principal post-operative complication of parathyroidectomy or parathyroid ablation. Dogs with prolonged pre-operative hypercalcemia and those with very high pre-operative ionized calcium levels have traditionally been considered at high risk for this complication, which is clinically significant in approximately 33% of post-operative patients although two recent studies were unable to confirm these risk factors for post-operative hypocalcemia.[15,16]

Primary hyperparathyroidism is very rare in cats with only approximately 20 cases reported. In this species post-operative hypocalcemia appears to be less of a problem with symptoms of hypocalcemia not seen in any cat despite hypocalcemia being reported on the biochemical screen. Some cats with primary hyperparathyroidism have been reported with parathyroid carcinoma although resection appeared to be associated with excellent long-term control of hypercalcemia also.

Malignant disease of the parathyroid glands can also be a cause of hypercalcemia in dogs and it is estimated to account for 4-7% of parathyroid nodules in this species. A recent study reported that parathyroidectomy alone can provide excellent control of parathyroid carcinomas with no recurrence of hypercalcemia documented in this cases series of dogs that were treated by parathyroidectomy with or without ipsilateral thyroidectomy.[17]

References

1) Rossi F, Caleri E, Bacci B et al. Computed tomographic features of basihyoid ectopic thyroid carcinoma in dogs. *Vet Radiol Ultrasound* 2013;54:575-581

2) Liptak JM, Kamstock DA, Dernell WS et al. Cranial mediastinal carcinomas in nine dogs. *Vet Comp Oncol* 2008;6;19-30

3) Harvey AM, Hibbert A, Barrett EL et al. Scintigraphic findings in 120 hyperthyroid cats. *J Fel Med Surg* 2009;11:96-106

4) Tuohy JL, Worley DR, Withrow SJ. Outcome following simultaneous bilateral thyroid lobectomy for treatment of thyroid gland carcinoma in dogs: 15 cases (1994-2010). *J Am Vet Med Assoc* 2012;241:95-103

5) Theon AP, Marks SL, Feldman ES et al. Prognostic factors and patterns of treatment failure in dogs with unresectable differentiated thyroid carcinomas treated with megavoltage irradiation. *J Am Vet Med Assoc* 2000;216:1775-1779

6) Turrell JM, McEntee MC, Burke BP et al. Sodium iodine I131 treatment of dogs with nonresectable thyroid tumors: 39 cases(1990-2003). *J Am Vet Med Assoc* 2006;229:542-548

7) Nadeau ME, Kitchell BE. Evaluation of the use of chemotherapy and other prognostic variables for surgically excised canine thyroid carcinoma with and without metastasis. *Can Vet J* 2011;52:994-998

8) Naan EC, Kirpensteijn J, Kooistra HS et al. Results of thyroidectomy in 101 cats with hyperthyroidism. *Vet Surg* 2006;35:287-293

9) Turrel JM, Feldman EC, Nelson RW et al. Thyroid carcinoma causing hyperthyroidism in cats: 14 cases (1981-1986). *J Am Vet Med Assoc* 1988;193:359-364

10) Hibbert A, Gruffydd-Jones T, Barrett EL et al. Feline thyroid carcinoma: diagnosis and response to high-dose radioactive iodine treatment. *J Fel Med Surg* 2009;11:116-124

11) Ham K, Greenfield CL Barger A et al. Validation of a rapid parathyroid hormone assay and intraoperative measurement of parathyroid hormone in dogs with benign naturally occurring primary hyperparathyroidism. *Vet Surg* 2009;38:122-132

12) Graham KJ, Wilkinson M, Culvenor J et al. Intraoperative parathyroid hormone concentration to confirm removal of hypersecretory parathyroid tissue and time to post-operative normocalcemia in nine dogs with primary hyperparathyroidism *Aust Vet J* 2012;90:203-209

13) Pollard RE, Long CD, Nelson RW et al. Percutaneous ultrasonographically guided radiofrequency heat ablation for treatment of primary hyperparathyroidism in dogs. *J Am Vet Med Assoc* 2001;218:1106-1110

14) Rasor L, Pollard R, Feldman EC. Retrospective evaluation of three treatment methods for primary hyperparathyroidism in dogs. *J Am Anim Hosp Assoc* 2007;43:70-77

15) Arbaugh M, Smeak D, Monnet E. Evaluation of preoperative serum concentrations of ionized calcium and parathyroid hormone as predictors of hypcalcemia following parathyroidectomy in dogs with primary hyperparathyroidectomy: 17 cases (2001-2009). *J Am Vet Med Assoc* 2012;241:233-236

16) Milovancev M, Schmiedt CW. Preoperative factors associated with postoperative hypocalcemia in dogs with primary hyperparathyroidism that underwent parathyroidectomy: 62 cases (2004-2009). *J Am Vet Med Assoc* 2013;242:507-515

17) Swayer ES, Northrup NC, Schmiedt CW et al. Outcome of 19 dogs with parathyroid carcinoma after surgical excision *Vet Comp Onc* 2011, 10: 57-64

Gastric Dilation and Volvulus

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Pathophysiology and risk factors

Gastric dilation and volvulus (GDV) syndrome has always represented the quintessential surgical emergency faced by veterinarians. Attempts at elucidation of the pathophysiology of the condition remain challenging but a variety of predisposing factors have been documented including increased thoracic depth-to-width ratio, history of GDV in a first degree relative, eating one meal per day, small food particle size and eating rapidly. Breeds at high risk include Great Danes, Gordon and Irish Setters, Weimeraners, St Bernards, and Standard Poodles.

Preoperative management

Preoperative management of GDV is a well-studied science now and the importance placed on adequate hemodynamic stablization preoperatively cannot be overstated. Generally fluid resuscitation is performed with a combination of crystalloid and colloids with the overall aims to rapidly increase intravscular volume and then maintain intravascular volume by increasing oncotic pressure. Sodium chloride or lactated ringers solution can be administered at rates up to 90mls/kg in dogs although these fluid rates should be chosen based on an individual patients clinical parameters. Hydroxyethyl starch is usually used as a colloid at rates of 10-20 ml/kg.

Decompression should be performed as soon as possible after admission and can be achieved using either orogastric intubation or percutaneous placement of an over-the-needle catheter. If orogastric tube placement is chosen the dog may be lightly sedated (this may not be necessary in cooperative dogs or those that are very sick) and a 2 inch roll of white tape placed between the incisiors. A large-bore orogastric tube is then placed through the roll of tape and passed down into the stomach (mark on the tube prior to use the length required to reach the last rib). Care should be taken as the tube passes into the stomach not to cause further compromise to the distal esophagus or stomach. Stomach contents will usually rapidly be evident draining in the tube which is then held over a bucket until no further stomach contents are obtained. If the use of an orogastric tube fails or cannot be passed into the stomach then a large-bore catheter can be passed into the stomach over the site of greatest gastric tympany after aseptic preparation of the skin.

Surgical treatment

Once in the operating room a standard ventral midline celiotomy is performed. Immediately upon entry into the peritoneal cavity inspection of the surface of the stomach will reveal whether a volvulus is currently present. If the superficial leaf of the greater omentum is draped over the stomach it generally means that a volvulus has occurred as when the greater curvature of the stomach is twisted ventrally and over to the left side it drags with it the greater omentum confirming the presence of volvulus. The stomach at this stage may have been well-decompressed pre-operatively in which case derotation can be performed or it may have refilled with a substantial amount of gas between the time of decompression and the time it took to begin the celiotomy. Derotation is facilitated by decompression and so needle decompression performed by inserting an 18-gauge needle into a healthy area of gas-distended stomach wall and attaching wall suction to the needle is generally an efficient way to perform rapid intraoperative decompression.

Once the stomach has been decompressed derotation can be performed. Generally this is a simple maneuver that is facilitated by passing a surgeons hand down the left body wall lateral to the stomach and grasping the lesser curvature. This palpable “crease” in the stomach can be used as a handle as the stomach is rotated ventrally towards the right side to reposition the antrum on the right side and the fundus over to the left. Derotation might be facilitated by simultaneously pushing the fundus in a dorsal direction and over to the left side with the surgeons other hand as the antrum is being rotated ventrally. If there is ever confusion regarding the position of the stomach after derotation the surgeon should go back to basic anatomical principles by assessing the hiatal region and cardia to ensure that no twisting exists, ensuring that the fundus is located on the left hand side and confirming that the pylorus and descending duodenum are now correctly positioned along the right side of the body wall.

The next step in intraoperative management is to assess the stomach for viability. It is imperative that the decision regarding stomach viability is made after decompression and derotation have been completed and this author will often delay the decision as to whether gastric resection is necessary until after a full exploratory celiotomy has been completed. The reason for this is that until the ingastric pressure has been relieved it can be challenging to assess the margins of necrosis and a highly distended stomach may appear more ischemic than it really is once that pressure has been relieved.

The decision to resect stomach still largely relies on some very basic factors that include the color, consistency and perfusion of the stomach wall. Despite techniques such as laser doppler flowmetry[1] and intravenous fluorescein[2] having been used to assess wall viability these techniques are not generally practical in the clinical setting and so have never been widely adopted. Having said that the use of the factors mentioned, in the authors experience, provides a very good assessment of viability and this improves with experience. Areas of stomach that are black, green or very dark red are generally ischemic and need to be resected. Areas that are an intense red or have patchy areas of darker red are more challenging to interpret. In general color should be interpreted in conjunction with consistency. Any areas that are judged to be thin-walled are usually unhealthy and need to be resected. Thickened areas of

stomach wall are often edematous which usually means that blood supply to these areas remains and they may be salvageable. Once the surgeon has decided that gastric resection is necessary and the extent to which he/she will resect the stomach a decision must be made as to whether to use a hand-sewn technique or one involving surgical staplers if they are available. Firstly the entire area around the stomach should be packed off liberally with moistened sponges to avoid contamination in the event of spillage of gastric contents. The use of surgical staplers in experienced hands is probably quicker but increases costs associated with the technique. If using the gastrointestinal stapler (GIA), the appropriate staple size should be chosen which is usually the 4.8mm leg length staples. In many cases the use of two cartridges might be necessary to bridge the entire length of the portion of stomach to be resected.[3] The GIA stapler has the advantage of having 4 lines of staples and a blade that cuts between them thus sealing both sides of the stomach and minimizing spillage of gastric contents. However, many surgeons advocate oversewing of the staple line after gastric stapling possibly diminishing the time advantage of the use of surgical staplers for this indication. The thoracoabdominal stapler (TA) can also be used for gastric resection with the one disadvantage that the TA stapler does not seal both sides of the stomach and so contamination from the resected portion of the stomach can occur. While stapled gastric resection has some advantages most surgeons probably still use a hand-sewn approach, which is perfectly acceptable for this purpose. When using a hand-sewn approach the area is again packed off with moistened sponges and stay sutures are placed circumferentially approximately 1cm from the planned margin of resection. With assistants providing constant upward tension on the stay sutures to avoid gastric spillage the surgeon starts to incise the stomach. At this point bleeding from the mucosal and seromuscular layers of the stomach can be assessed and if deemed adequate the apposing margins of gastric mucosa are closed in a simple continuous pattern using a monofilament absorbable suture material (usually polydioxanone). This author usually progresses by incising a few centimeters and then suturing a few centimeters and repeating that pattern until the entire ischemic section of the stomach has been excised and the mucosal layer has been closed. At that point a second layer of sutures are placed in the seromuscular layer of the stomach in a continuous cushings or lembert pattern to over sew that layer. Upon incising of the stomach in some dogs with GDV the surgeon will note that despite a seromuscular layer that appears pink/red and is bleeding readily the mucosa may be ischemic or even black in color. The gastric mucosa has a much higher metabolic rate and is more sensitive to perfusion impairment caused by the increased wall tension that occurs in these cases and so differential ischemia of gastric wall layers can occur. If mucosal ischemic is only slightly more extensive that seromuscular ischemia the non-viable mucosal section can be included in the resection. However, the author has seen cases where mucosal ischemia was very extensive and in these cases it may be necessary to leave the ischemic mucosa in and rely on a healthy seromuscular wall to heal the stomach with an assumption that mucosal sloughing and subsequent regeneration will occur in time. To date our experience with these cases has been positive and leaving the ischemic mucosa in place appears to be tolerated.

The technique of gastric invagination was reported several years ago as an alternative to gastric resection with the purported advantage that it may reduce surgical time in patients with gastric necrosis secondary to GDV. Clinical reports of significant case numbers managed with this technique have not emerged but the literature includes a case where the site of gastric inversion sloughed to become a large linear bleeding ulcer post-operatively resulting in severe lethargy, anemia and melena.[4] This technique is not performed by this author because of this concern and skepticism over whether this technique really provides a significant time saving.

Once gastric resection, if necessary, has been completed the surgeon should turn their attention to ensuring that the remainder of the peritoneal cavity contains no further abnormalities as dogs with GDV not infrequently may exhibit comorbid conditions. When exploratory celiotomy has been completed a prophylactic gastropexy must be performed to minimize risk of recurrence. Risk of recurrence in the absence of prophylactic gastropexy is greater than 50% but is reduced to <5% if a gastropexy is performed.[5] It is therefore likely that failure to perform a prophylactic gastropexy in GDV patients could expose the surgeon to legal liability. Many types of open surgical gastropexy have been described in dogs but in dogs with concurrent GDV the author only performs the very simple and rapid incisional gastropexy. This technique simply involves suturing the margins of two incisions created through the transversus abdominis of the stomach wall in the right cranial abdominal quadrant and a seromuscular incision created in the antrum of the stomach midway between the greater and lesser curvature. It is a highly reliable gastropexy that should almost guarantee that volvulus will not recur in the future (gastric dilation is still a life-long risk in these dogs).

Post-operative management

Post-operatively close attention needs to be paid to patient oxygenation, perfusion, cardiac rhythms and analgesia. Post-operative complications including aspiration pneumonia, disseminated intravascular coagulation, peritonitis, pancreatitis and ileus.

Prophylaxis

Prophylactic gastropexy in dogs at high risk of GDV is often performed and can be performed using open surgical techniques or laparoscopically. These include both laparoscopic-assisted techniques but are increasingly being performed using total laparoscopic techniques allowing the procedure to be performed in an ever more minimally-invasive way.

References

1) Monnet E, Pelsue D, MacPhail C: Evaluation of laser Doppler flowmetry for measurement of capillary blood flow in the stomach wall of dogs during gastric dilatation-volvulus. Vet Surg 35:198, 2006.

2) Wheaton L, Thacker H, Caldwell S: Intravenous fluorescein as an indicator of gastric viability in gastric dilatation-volvulus. J Am Anim Hosp Assoc 22:197, 1986.
3) Clark GN, Pavletic MM. Partial gastrectomy with an automatic stapling instrument for treatment of gastric necrosis secondary to gastric dilation-volvulus. Vet Surg 1991;20:61-68
4) Parton AT, Volk SW, Weisse C. Gastric ulceration subsequent to partial invagination of the stomach in a dog with gastric dilatation-volvulus. J Am Vet Med Assoc 2006;228:1895-900
5) Glickman LT, Lantz GC, Schellenberg DB *et al.* A prospective study of survival and recurrence following the acute gastric dilation-volvulus syndrome in 136 dogs. *J Am Anim Hosp Assoc* 1998;**34**:253-9

Rectal Tumors:
The Good, the Bad, and the Ugly

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Colorectal tumors are frequently encountered in small animal practice and can vary from simple to highly complex depending on their type, location and extent. In dogs the most frequently encountered lesions are adenomatous polyps followed by adenocarcinomas, Much less commonly plasma cell tumors, lymphoma, mast cell tumors and hemangiosarcomas can be seen. In cats the most common tumors are lymphoma and adenocarcinoma. Adenomatous polyps in dogs are well known to be pre-cancerous lesions that have the potential to undergo malignant transformation. Benign neglect of these tumors is therefore not recommended. Once invasion into the lamina propria and submucosa has occurred they are generally termed carcinoma in situ and once the basement membrane has been penetrated they are termed adenocarcinoma and at that stage are much more likely to metastasize.

Most rectal tumors are either diagnosed due to the detection of hematochezia or fecal tenesmus or after a rectal examination has been performed. Less commonly, rectal masses may be evident after prolapsing out of the rectum. Other clinical signs seen in these patients can include dyschezia and weight loss. On rectal examination a palpable mass will be obvious in up to 60% of canine cases. Many epithelial tumors will ulcerate easily and so blood may be evident on rectal examination. Some cases with annular lesions may have a stricture-like area palpable.

Diagnostic evaluation usually includes sampling of the mass by fine needle aspirate or biopsy as well as staging of the patient. Obtaining a sample for biopsy is very simple in those tumors that are located close to the anorectal junction. In these cases mucosal eversion will often yield sufficient access for aspiration, tru-cut biopsy or incisional biopsy. In cases where the lesion is located in the mid to proximal rectum, proctoscopy or colonoscopy may be required to secure a biopsy sample. It should be noted that in up to 30% of cases the results of endoscopic samples collected from colorectal masses do not agree with the histopathological results of definitive resections in one study.[1] Staging of colorectal neoplasia should involve abdominal ultrasound and proctoscopy or colonoscopy to detect further lesions located more cranially within the colon. Ultrasound should detect metastatic spread to colic, hypogastric and medial iliac lymph nodes, liver or other organs. Thoracic radiographs should be performed to look for evidence of metastatic spread to the lungs.

A knowledge of the regional anatomy and physiology is important to maximize success in management of colorectal tumors. In dogs blood supply to the rectum comes mainly from the cranial rectal artery, which is a branch of the caudal mesenteric artery. Every effort should be made to preserve this vessel although this is impossible during resections that involve the mid to cranial aspect of the rectum and very distal colon. In cats there is a greater contribution from the middle and caudal rectal arteries. One of the major potential complications of colorectal resections is the potential for fecal incontinence post-operatively. Two principal mechanisms can lead to fecal incontinence. Extensive damage to the external anal sphincter or the terminal 1.5cm of the rectum can lead to loss of voluntary continence. Loss of reservoir continence is also described and occurs due to loss of fecal storage ability. In a study using mixed breed dogs weighing 19-35kg when 6cm of rectum was resected using a dorsal approach all dogs were fecally incontinent post-operatively.[2] This was not the case when either 0 or 4cm resections were performed.[2] The authors hypothesized that this may be a reservoir issue or possibly a result of damage to the peritoneal reflection within which passes the important reflex arc to the pelvic plexus that provides the innervation to the rectum. It does seem vital that in any rectal resection the terminal 1-1.5cm of distal rectum be preserved in order to preserve continence. This has particular importance with regard to rectal pull-through where preservation of that segment may have a beneficial effect in preserving continence.[3]

The surgical approach to rectal lesions is largely dependant on the location and extent of the mass. A variety of surgical approaches have been used for management of colorectal tumors including the mucosal eversion technique,[4] transanal endoscopic approach,[5] the dorsal perineal approach,[6] the rectal pull-through,[3] combined abdominal-transanal pullthrough,[3] and pelvic osteotomy techniques.[7,8]

Mucosal eversion is the simplest technique and is appropriate for small to moderate lesions (especially those that are pedunculated) in the distal rectum.[4] A series of stay sutures can be used to evert the section of rectum that is of interest. Resection is followed by primary suturing of the defect in the rectal wall. The dorsal perineal approach has been used to gain access to the distal to mid-rectum for resections of modestly-sized lesions.[5] An inverted U-shaped incision is made over the proximal aspect of the rectum. Dissection down onto the rectal wall is followed by resection and anastomosis. Rectal pull-through is classically indicated for lesions of the mid- to distal rectum although lesions more cranial can be resected with this technique if necessary.[3,7] The technically challenging component of this technique is to find the dissection plane between the rectal wall and the external anal sphincter so that the sphincter is preserved as much as possible. The key, as mentioned, is to preserve the most distal 1-1.5cm of the rectum as this appears to decrease the likelihood of post-operative incontinence. A variation of the rectal pull-through for lesions that extend into the distal colon is to perform a combined abdominal-transanal pull-through.[3] This advanced procedure is complex and involves mobilization of the intra-abdominal component prior to its exteriorization through a perineal approach. Finally the pelvic osteotomy techniques are

potentially the most invasive and reserved for the most extensive lesions or lesions that are located within the cranial rectum/distal colon that would be difficult to approach from any of the perineal approaches.[7,8] Two options exist here including a pubic symphysiotomy or a pubic-ischial osteotomy flap. Pubic symphysiotomy is technically less challenging but due to the limited ability to spread the pelvis apart, visualization is often less than ideal. The pubic-ischial osteotomy flap is more technically challenging but may provide much better surgical access to the pelvic rectum. The bone flap elevated using this technique is replaced after the rectal resection is completed and is either sutured or wired back into place.[8]

Complications after resection of colorectal tumors are commonplace especially with the more extensive lesions and more complex surgical procedures. The rectal pull-through is a relatively high morbidity surgery with complications including rectal bleeding, stricture formation, incisional dehiscence and wound infection as well as incontinence being reported with significant frequency.[3]

References

1. Valerius KD, Powers BE, Hutchison JM, et al: Adenomatous polyps and carcinoma in situ of the canine colon and rectum: 34 cases (1982–1994). J Am Anim Hosp Assoc 1997;33:156–160

2. Anderson GI, McKeown DB, Partlow GD et al. Rectal resection in the dog. A new surgical approach and the evaluation of its effect on fecal continence. Vet Surg 1987;16:119-125

3. Morello E, Martano M, Squassino C et al. Transanal pull-through rectal amputation for treatment of colorectal carcinoma in the in 11 dogs. Vet Surg 2008;37:420-426

4. Danova NA, Robles-Emanuelli JC, Bjorling DE. Surgical excision of primary canine rectal tumors by an anal approach in twenty-three dogs. Vet Surg 2006;35:337-340

5. Holt PE. Evaluation of transanal endoscopic treatment of benign canine rectal neoplasia. J Small Anim Pract 2007;48:17-25

6. Holt DE, Johnston DE, Orsher R et al. Clinical use of a dorsal surgical approach to the rectum. Comp Contin Educ Vet 1991;13:1519-1528

7. Aronson LR. Rectum, Anus and Perineum. In: Veterinary Surgery Small Animal (eds Tobias KM & Johnston SA), Elsevier Saunders, St Louis, MO, 2012, pp 1564-1600.

8. Yoon HY, Mann FA. Bilateral pubic and ischial osteotomy for surgical management of caudal colonic and rectal masses in six dogs and a cat. J Am Vet Med Assoc 2008;232:1016-1020

Hernias of the Diaphragm: Traumatic, Pericardioiperitoneal, and Hiatal

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

Diaphragmatic hernias

It is thought that up to 85% of diaphragmatic hernias (DH) are traumatic in origin and a significant proportion of dogs and cats that sustain major trauma can sustain DH. The theorized mechanism by which these injuries arise is by major blunt trauma to the abdomen with the glottis open causing a sudden increase in the pressure gradient between the chest and abdomen. Rupture of the diaphragmatic costal muscle is the most common consequence due to the inherent weakness of these tissues in comparison to the stronger central tendon. When costal muscles are involved tearing most commonly occurs parallel to the orientation of the costal muscle fibers and these are usually termed radial tears. Another common defect configuration is circumferential where the diaphragm is avulsed from its attachment to the body wall. Circumferential tears occur commonly in both dogs and cats but proportionally occur with greater frequency in cats.[1,2] Almost any non-fixed organ within the abdominal cavity can become herniated in a DH but the most common include stomach, small intestine, liver, spleen.

Of great importance prior to surgical intervention in DH cases is global assessment of the patient. Many cases of DH present with concurrent musculoskeletal or other organ system injuries. Recognition and treatment of comorbidities is essential in these cases and can in some cases distract the clinician from recognizing DH as well as other internal injuries. In one study only 57% of DHs were diagnosed within 30 days of trauma.[3] Animals with DH should be carefully evaluated. In some cases no or few clinical signs referable to the respiratory system will be detected. In other cases mild to severe respiratory distress may be evident. Diagnostic assessment usually starts with thoracic radiography which should be performed with the least amount of physical restraint necessary. Classical signs consistent with DH include loss of a clear diaphragmatic outline and cranial displacement of abdominal organs or the presence of abdominal viscera within the thoracic cavity. Pleural effusion is evident in approximately 20% of cases.[2,3] Ultrasonography has also been assessed as a diagnostic modality in these cases and was shown to have 93% accuracy in one report.[4]

Currently, the recommendation is that surgical intervention is warranted without delay after hemodynamic stabilization and treatment of other life-threatening injuries has been performed. Chronic diaphragmatic hernias are diagnosed frequently due to the sometimes delayed diagnosis in these cases.[5,6] Despite concerns over these cases having a greater incidence of adhesion formation and re-expansion pulmonary injury, survival in chronic DH cases has not been shown to be different compared to those diagnosed shortly after injury. In one large study of 1674 cases mortality rates in dogs with acute and chronic DH were 27.8 and 26.2% whereas in cats those figures were 20% and 11.8% respectively.[5]

The surgical approach of choice for DH repair is a ventral celiotomy. Despite this, the possibility of having to perform a caudal sternotomy if significant adhesions exist in the chest should always be anticipated and so a wide clip and aseptic preparation of the entire thoracic area should be performed. Upon inspection of the diaphragmatic area, the defect is usually obvious. Herniated organs should be very gently grasped and caudal traction applied. In many cases organs will move easily out of the thoracic cavity back into the abdomen. In others, adhesions within the thorax or to the edges of the diaphragmatic defect may exist and can be broken down digitally or using electrocautery. In cases where traction does not result in abdominal organs retreating back into the abdomen two choices can be made. In some cases enlargement of the hernial defect may allow the hernial contents to become more mobile or may allow greater access to the adhesions. The other option is to perform a caudal sternotomy to provide the necessary visualization of intra-thoracic structures to allow hernial content reduction. Sternotomy was necessary in 28% of dogs and cats with chronic DH in one study.[6] Once all hernial contents have been replaced in their correct anatomical location, closure of the defect is performed. In simple radial or circumferential tears where apposition of the edges can be performed without undue tension, primary apposition with either a simple interrupted or continuous line of 2-0 to 3-0 absorbable or non-absorbable suture is reasonable. The author favors not trimming the edges of the defect to minimize hemorrhage and maximize the suture holding power on tissue, which might be improved by anchorage around the scar tissue at the edge of the defect. In rare cases the defect in the diaphragm cannot be easily apposed in a tension-free manner and a reconstructive technique is required. This has been done using a large variety of different materials. The author usually favors an omentalized polypropylene mesh closure that is simple to perform and usually quite reliable. The peripheral 0.5cm of the mesh is turned over on itself and sutured to the muscular rim at the periphery of the defect using simple interrupted 3-0 non-absorbable monofilament sutures that pass through the double thickness of the mesh that has been turned over. The free cut end of the mesh is oriented towards the abdominal side to avoid the potentially sharp cut ends of the mesh damaging lung parenchyma. The abdominal component can then be covered with omentum to cushion the sharp edges as well as to cover the defect. Another elegant method of defect closure in chronic DHs with large defects is the use of a pedicled abdominal wall muscle flap from the tranversus abdominis.[7] Just prior to final defect closure a catheter or red rubber tube can be inserted into the thoracic cavity and an acute drainage of air from the thorax can be performed making placement of an indwelling thoracic tube unnecessary in most cases. In cases where

significant hemorrhage occurred during dissection or lung injury occurred or is suspected to have occurred, placement of an indwelling thoracic drain may be warranted. Some authors like to re-expand the lungs very slowly after DH repair to minimize the risk of re-expansion pulmonary edema. Placement of a thoracic drain that allows slow sequential thoracic drainage over time may be advantageous if this is of great concern. Re-expansion pulmonary edema appears to occur relatively rarely in these cases with few credible reports in the literature. However, if it occurs it can be life-threatening and so should be monitored for carefully in the post-operative period.

Pericardio-peritoneal diaphragmatic hernias

PPDH results from the embryological failure of fusion within the most ventral aspects of the diaphragm. Communication between the pericardial sac and abdomen results although there is no communication into the thoracic cavity in these cases. Decision-making in PPDH management is controversial as many cases are asymptomatic and only detected on work-up of other conditions. In one study 41% of feline cases were detected incidentally and the abnormality occurs much more frequently in cats than dogs.[8] Clinical signs that have been attributed to PPDH include signs of gastrointestinal and respiratory dysfunction as well as non-specific signs such as weight loss, anorexia and lethargy.[8-10] Similarly to DH, organs most commonly herniated into the pericardial sac in PPDH cases include small intestine, liver and gall bladder.[9] Thoracic radiography is sufficient for establishing the diagnosis in the vast majority of cats with classical signs including enlargement of the cardiac silhouette and visible abdominal viscera within the peritoneal sac. Cats with PPDH should always be evaluated for other congenital abnormalities such as pectus excavatum and other cardiac abnormalities which can be present in a proportion of cases.

Decision making on surgical management has been controversial as many cats can experience long-term survival with medical management. Post-operative mortality in larger studies ranges from 5.1-14% of cases.[8-10] However, left untreated progression of clinical signs or acute death have been documented. In one large study outcomes of the surgical versus conservative management appeared to be similar.[10] However it is very likely that selection bias may affect outcomes in retrospective studies of this nature as the more clinically affected cases may be more likely to be treated surgically.[10]

Surgical treatment of PPDH involves reduction of the hernial contents back into the abdomen with subsequent closure of the diaphragmatic hernial defect. Adhesions of the liver and/or omentum to the epicardium can be encountered and these need to be very carefully broken down. The necessity for liver lobectomy to be performed needs to be considered if there is significant damage to liver lobes during reduction. Primary suturing of PPDH defects is possible in most cases.

Hiatal herniation

In many cases the clinical signs of hiatal herniation are both vague and non-specific and diagnostic tests are plagued with the difficulties of imaging what is a dynamic and intermittent pathology. Hiatal herniation can occur in a number of different forms with four common types being recognized in veterinary patients. Type 1 is the sliding hiatal hernia and is the classical form seen in most patients who present just with intermittent regurgitation. It is associated with cranial movement of the gastroesophageal junction (GEJ) into the thoracic cavity and affects patients to varying degrees. Type 2 is much less common and is a paraesophageal hernia where part of the stomach moves into the thorax adjacent to the normal GEJ. Type 3 is a combination of the abnormalities seen in Type 1 and 2. Gastroesophageal intussusception is another abnormality that is not a true hiatal hernia but needs to be considered as a differential diagnosis in animals where these defects are suspected.

In dogs it is known that the LES is a naturally lax structure compared to humans and that some gastro-esophageal reflux is normal in this species. What is not known is the relative contributions of muscular tone within the esophageal wall at the LES and the support afforded to the GEJ by the gastroesophageal ligament and crural muscles. It is known that in dogs with congenital or acquired sliding hiatal hernia the GEJ moves cranially and that in some normal dogs there may actually be no intra-abdominal component to the esophagus at all, meaning that the GEJ is located cranial to the diaphragm in those cases.[11] Because of this inherent variation of normal in dogs as well as the lack of a complete understanding of the pathophysiology, diagnosis of the condition and interpretation of normal from abnormal can be challenging. The most common diagnostic test for HH used in clinical practice today is the positive contrast esophagram. Because of the dynamic nature of the disease these studies are best performed with the aid of fluoroscopy and even then there is probably a high rate of false-negative results. In our institution it is common practice to perform a second positive contrast esophagram if the first study is negative and the index of suspicion remains high for a diagnosis of HH based on signalment and clinical signs.

Treatment of hiatal herniation is controversial as medical and surgical options exist. One study has suggested that 30 days of medical management may alleviate signs in many patients and should be pursued prior to surgical management. Surgical management using a combination of hiatal plication, esophagopexy and left fundic gastropexy is the classical combination of techniques used to treat HH but has never been extensively and objectively evaluated.[12] Response rates in the range of 80% have been reported for this surgical regimen in the small numbers of cases reported.[12,13]

References

1. Sullivan M, Reid J. Management of 60 cases of diaphragmatic rupture. J Small Anim Pract 1990;31:425-430
2. Garson HL, Dodman NH, Baker GJ: Diaphragmatic hernia: analysis of fifty-six cases in dogs and cats. J Small Anim Pract 1980;21:469
3. Wilson GP, Newton CD, Burt JK. A review of 116 diaphragmatic hernias in dogs and cats. J Am Vet Med Assoc 1971;159:1142-1145
4. Spattini G, Rossi F, Vignoli M et al. Use of ultrasound to diagnose diaphragmatic rupture in dogs and cats. Vet Radiol Ultrasound 2003;44:226-230
5. Downs DC, Bjorling DE. Traumatic diaphragmatic hernias: A review of 1674 cases. Vet Surg 1987;16:87
6. Minihan AC, Berg J, Evans KL. Chronic diaphragmatic hernia in 34 dogs and 16 cats. J Am Anim Hosp Assoc 2004;40:51-63
7. Helphrey ML: Abdominal flap graft for repair of chronic diaphragmatic hernia in the dog. J Am Vet Med Assoc 1982;181:791
8. Reimer SB, Kyles AE, Filipowicz DE et al. Long-term outcome of cats treated conservatively or surgically for peritoneopericardial diaphragmatic hernia: 66 cases (1987-2002) J Am Vet Med Assoc 2004;224:728-732
9. Banz AC, Gottfried SD. Peritoneopericardial diaphragmatic hernia: A retrospective study of 31 cats and eight dogs. J Am Anim Hosp Assoc 2010;46:398-404
10. Burns CG, Bergh MS, McLoughlin MA. Surgical and nonsurgical treatment of peritoneopericardial diaphragmatic hernia in dogs and cats: 58 cases (1999-2008) J Am Vet Med Assoc 2013;242:643-650
11. Pratschke KM, Fitzpatrick E, Campion D, et al: Topography of the gastro-oesophageal junction in the dog revisited: possible clinical implications. Res Vet Sci 76:171, 2004
12. Lorinson D, Bright RM. Long-term outcome of medical and surgical treatment of hiatal hernias in dogs and cats: 27 cases (1978-1996). J Am Vet Med Assoc 1998;213:381-384
13. Prymak C, Saunders HM, Washabau RJ. Hiatal hernia repair by restoration and stabilization of normal anatomy. An evaluation in four dogs and one cat. Vet Surg 1989;18:386-391

Hemostasis and Electrosurgery: When to Use and What Where

Philipp Mayhew, BVM&S, DACVS
University of California
Davis, CA

The use of electrosurgery (ES) in modern medicine dates back many years and a plethora of devices are in common usage today to aid in cutting and coagulating a variety of tissues. The technology behind ES remains to this day very poorly understood by most surgeons. Given the potentially harmful side effects of inappropriate use, it is prudent for at least a basic understanding of these technologies to be acquired. Currently many new options exist in ES that have revolutionized human surgery in recent years and are beginning to have the same effect in veterinary medicine.

Electrosurgery is the use of radiofrequency alternating current to create heat in order to achieve dessication and protein coagulation. Wall outlets in North America create a 50-60Hz waveform, which is the frequency at which polarity changes per second in an alternating current. An ES generator will take this current and convert it into a higher voltage output in the range around 500kHz which is similar to that produced by an AM radio, hence the name radiofrequency. These higher frequencies are necessary as the lower frequencies can stimulate muscle and nerve cells to depolarize whereas the higher frequencies do not cause neuromuscular stimulation. Modern ES generators can also produce a variety of other different waveforms that will produce variations in the effect on tissues when they are applied. These changes include effects that promote "cutting" of tissue that are created using continuous relatively low-voltage waveforms. This waveform creates very high temperatures, vaporization, but little hemostasis. To create a "coagulation" effect an intermittent waveform is produced using high current density, which promotes hemostasis. There are also "blended" waveforms that create a combination of coagulation and cutting effects. The general principle is that a current released into tissues encounters impedance as it is passes through the tissue, which results in the generation of heat. Different tissues react differently to current and this is a function of impedance. Well-hydrated tissue such as muscle has the lowest impedance while dehydrated tissues such as scar tissue and fat will have higher impedance. The higher the impedance of the tissue, the higher the resistance to flow of current and the greater the temperature that is produced.

Electrocautery, a term that is often used erroneously in place of ES, is the direct application of heat to tissues through direct tissue contact and results in denaturation of the tissue. However, electrocautery does not involve the creation of an electrical circuit and is rarely used in modern veterinary medicine.

For current to pass through tissue an electrical circuit has to be created which must contain a positive and a negative pole so that ions and/or electrons can move between the two poles. Therefore all ES is really "bipolar" despite the common usage in medicine of the terms monopolar ES and bipolar ES. The difference between these two modalities lies in the location of the electrodes. In bipolar devices both electrodes are on the device tip resulting in current passing only a very short distance across the tips and exerting very precise effects on the small amount of tissue that is placed between the tips. In monopolar ES the device tip is one electrode and the second electrode is the grounding plate that is usually placed under the animals back.

Monopolar electrosurgery

This form of ES is very efficient, allows tissue to be cut or coagulated very rapidly and decreases surgical time and blood loss. The main disadvantage in open surgery is the possibility of grounding pad burns. A large grounding pad is needed to disperse the current over a large area to avoid the temperature rising in the tissue over the area where it is placed. Therefore, if the base plate is incorrectly positioned or is only in contact with a relatively small area of the patient current concentration can result in thermal burns in these locations. There are now some grounding pads that incorporate a sensing system that alerts the user if grounding is inadequate. Vessels up to 2mm are effectively coagulated but dispersion of the current can cause burns up to 2cm away from the site of application.[1] Monopolar ES can be used in minimally invasive surgery but it is potentially hazardous and so great care needs to be taken. A defect in the insulation of the instrument shaft can result in the passage of current to tissues that are not in the visual field resulting in iatrogenic injury. Direct coupling injuries can also occur when the instrument through which the electric current is passed comes into contact with the telescope, or other instrument, resulting in iatrogenic damage to tissues that may lie outside the visual field.

Bipolar electrosurgery

Bipolar is generally considered somewhat safer than monopolar as the current only travels between the tips of the instrument and operates at lower power settings and voltage. It is therefore used preferentially when working in proximity to delicate structures such as large neurovascular bundles or spinal cord and brain tissue. Vessels up to 3mm can be effectively coagulated but must be carefully positioned between the tips of the device.

Vessel-sealing devices

Vessel-sealing devices are very helpful for hemostasis and simultaneously sealing and cutting a variety of tissues. They work by a combination of pressure exerted on tissue when the tissue is crushed in the tips of the device, followed by the application of bipolar or ultrasonic energy applied to the tissue. This process allows the elastin and collagen in the vessel wall to be sealed together permanently. They have been used for a variety of applications in veterinary medicine including open splenectomy as well as laparoscopic ovariohysterectomy, ovariectomy, cholecystectomy, adrenalectomy, thoracoscopic pericardectomy, and thymoma resection. It has been shown that the use of vessel sealing devices can significantly decrease surgical time for certain applications such as canine ovariohysterectomy when compared to laparoscopic hemoclip application and extracorporeal suture placement.[2] A variety of units are currently available. Two bipolar electrocautery devices are the Ligasure™ (Valleylab, Tyco Healthcare Group) and the Enseal™ (SurgRX Inc.). Both devices have tips that are indicated to seal arteries and veins up to 7 mm in diameter. The Ligasure has the advantage of sensing the tissue impedance within the jaws of the tip that then adjusts the energy output from the generator accordingly to ensure a safe and effective seal. The Harmonic Scalpel® (Ethicon Endo-surgery) is a device that uses ultrasonic energy to cut and coagulate tissue. The Harmonic Ace® tip is indicated to seal vessels up to 5 mm in diameter.

Several reports have compared these devices with respect to the degree of lateral thermal spread, bursting pressures and sealing time although the results of these studies are often conflicting.[3,4] Overall, however, all produce supra-physiological bursting pressures of at least three times systolic blood pressure.[3] For the Ligasure lateral thermal spread ranged from 1.5-3.2 mm in one study with a greater degree of thermal spread seen as vessel size increased.[5] Although generally very safe, care must nevertheless be taken when these devices are used adjacent to neurovascular or other vital structures. Other vessel-sealing technologies are emerging onto the market constantly.

References

1. Dubiel B, Shires PK, Korvick et al. Electromagnetic energy sources in surgery. Vet Surg 2010;39:909-924

2. Mayhew PD, Brown DC. Comparison of three techniques for ovarian pedicle hemostasis during laparoscopic-assisted ovariohysterectomy. Vet Surg 2007;36:541-547

3. Person B, Vivas DA, Ruiz D, Talcott M, Coad JE, Wexner SD. Comparison of four energy-based vascular sealing and cutting instruments: a porcine model. Surg Endosc 2008 22:534-538

4. Lambertson GR, Hsi RS, Jin DH, Lindler TU, Jellison FC, Baldwin DD. Prospective comparison for four laparoscopic vessel ligation devices. J Endourol 2008 22:2307-2312

5. Carbonell AM, Joels CS, Krecher KW, Matthews BD, Sing RF, Heniford BT. A comparison of laparoscopic bipolar vessel sealing devices in the hemostasis of small, medium and large-sized arteries. J Laparoendosc Adv Surg Tech 13:377-380; 2003

Managing the Mystery Poisoning Patient

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

The practitioner is occasionally presented with a situation where it is suspected, either by the owner or the veterinarian, that an unidentified "poison" has intoxicated the patient. Although identification of the agent involved is often extremely helpful in determining proper treatment and prognosis, it is important to remember that the majority of these types of cases are managed without the offending agent ever being identified. Just because the identity of the toxicant remains a mystery does not mean that the veterinarian cannot deliver appropriate and effective treatment. Whether the toxic agent is known or not, it should always be remembered that the goal of the practitioner is to **"treat the patient, not the poison."**

Assess the patient

Upon initial examination, evaluation of the animal for immediate life-threatening problems such as seizures, apnea/dyspnea, hemorrhage, cardiac arrhythmias, and hyperthermia is essential. A brief history may be obtained from the client while the examination is taking place—more detailed history may be obtained after the animal is stabilized. Additional important information that should be obtained includes duration of signs, age and prior health status of the animal, and any initial signs that are no longer apparent.

Stabilize the patient

Stabilization is a priority in animals presenting with severe clinical signs. Animals should be intubated and/or provided with supplemental oxygen as needed. If possible, obtain venous access and draw blood for laboratory profile and potential diagnostic testing (3 cc EDTA tube, 2 serum tubes are ideal), prior to administration of other medications. Standard anticonvulsants such as diazepam or barbiturates may be used to control seizures. Anticonvulsants, particularly benzodiazepines, should be administered slowly IV, as rapid administration may induce a dysphoric effect and temporarily exacerbate the situation. If the standard anticonvulsant therapy does not have any effect, consider inhalant anesthesia or a propofol CRI to allow for initial management of the patient.

Life-threatening cardiac arrhythmias should be treated as needed (atropine, propranolol, or lidocaine prn); arrhythmias not deemed immediately life-threatening can be treated after a better history has been obtained. Intravenous fluids and blood or blood replacement agents should be administered as needed. Body temperature should be normalized as needed, however aggressive cooling measures should be undertaken with care. Any electrolyte or acid/base abnormalities should be corrected. Once the patient has been fully stabilized, a more comprehensive physical examination may be performed.

Obtain history

Once the animal is stable, further questioning of the owner should be performed in an attempt to narrow down the possible causes for the animal's signs. Questions to consider include how long since the last time the animal appeared normal to the owner, whether the onset of signs was gradual or sudden, the location of the animal in the last few hours prior to the development of clinical signs, and any history of administration of medications/herbal products/flea or tick control products to this animal or other animals in the household in the past 24 hours. The type of environment in which the animal lives (e.g. indoor only vs. indoor/outdoor vs. fenced yard vs. roaming) will help to determine the next lines of questions to ask.

For indoor animals, information that may be useful includes the areas to which the animal has access, the types of medications/herbal products (human and veterinary, prescription, illicit and OTC) available, whether there have been recent visitors who may have dropped medication, the types of houseplants in the home, whether there are children or teenagers in the household, presence of rodenticides or insecticides, and whether other pets in the house appear normal. In cases where illicit drugs are involved, or where owners have inappropriately administered medications or other products to their pets, the veterinarian may notice some reluctance on the part of the owner to provide the requested information. Tactful questioning may aid in obtaining the desired information. In other cases, it may be helpful to mention that without knowledge of the agent involved, more intensive (and expensive) diagnostics and treatments may be necessary.

For outdoor animals confined by fences or other means, identification of potentially toxic agents in outbuildings, garages or sheds to which the pet may have access is important. Other potential hazards found in yards include compost piles, plants, mushrooms, and yard treatments (especially some systemic insecticides and crabgrass killers). For free roaming animals, the challenge is much greater as the number of potentially toxic agents available is quite large. Determining whether the animal is in an urban, suburban, or rural environment and identifying the nature of the animal's immediate surroundings (e.g. wooded areas vs. parks and lawns) may help in narrowing down the agents to which the roaming animal may have been exposed. The presence of livestock in the pet's environment should stimulate questioning to determine the pet's access to the barns or feed bins, whether medicated feeds, fly baits or feeds with

growth promotants in them are present, whether the livestock have recently been medicated or dewormed, and if any livestock have recently been euthanized and buried on the property.

Formulate rule-out list

Armed with a thorough physical examination and as much history as is obtainable, the clinician should then formulate a list of differential diagnoses. It is important not to become so caught up in the certainty that the causative agent is a poison that one loses sight of potential etiologies of infectious, metabolic or other "non-toxic" origin. For instance, although a variety of toxicants may cause acute onset of seizures, other potential etiologies to consider include encephalitis, idiopathic epilepsy, hypoglycemia, head trauma, hypoxia, hepatic failure, acid/base abnormalities, etc.

Ancillary support

General supportive care includes maintaining hydration, ensuring adequate urine output, monitoring of respiratory, cardiac and neurologic status, and managing clinical signs as they develop. Recumbent or comatose animals require careful monitoring and thermoregulation. Gastrointestinal protectants or anti-emetics may be required (e.g. NSAID overdosages). Management of secondary hepatic or renal injury is imperative.

Prevent toxicant absorption

Decontamination should be instituted only after the animal has been fully stabilized. In clinically normal animals with suspected oral exposure to toxicants, emesis may be induced. Contraindications to emesis would include cases where animals have already vomited, are at risk of aspiration (e.g. CNS depression or other severe clinical signs), or have ingested corrosive agents, acids, alkalis, or hydrocarbons. In cases where animals are sedated or anesthetized (e.g. seizure control), gastric lavage may be considered; lavage is contraindicated if it is suspected that corrosive agents have been ingested. The gastric contents from spontaneous or induced emesis or gastric lavage should be kept in case analytical testing is desired in the future. Contents should be placed in a clean glass jar with a tight lid and kept refrigerated or frozen. If there could be possible legal action, seal with tape and initial/date sample. It is important to maintain records of chain of custody of samples (vomitus, carcass, etc.).

Administration of activated charcoal is recommended for most cases of ingested poisons, although it is contraindicated in cases where oral exposure to potentially corrosive agents is suspected. For dermal exposures, animals should be bathed in liquid dish soap such as Dawn or Palmolive and rinsed copiously with warm water. Use of aprons, gloves and goggles by the veterinary staff during dermal decontamination will minimize human exposure to the toxicant.

"The antidote"

If, after stabilizing the animal and obtaining an adequate history, the toxic agent has been identified, specific antagonists may be indicated (e.g. Vitamin K for rodenticides). It is important to remember that the vast majority of toxic agents have no specific antidote, so the treatment will be, by necessity, symptomatic and supportive. Even in cases where antidotes do exist for the specific toxicant, there are often barriers to their use in veterinary medicine, including high cost and lack of availability (e.g. pamidronate for cholecalciferol or calcipotriene toxicosis).

Analytic testing

Unfortunately, there is no one test that will "screen" for all known toxicants, and multiple tests for specific agents can become costly. In general, one needs to have an idea of the general type of agent that may be involved before analytical testing is attempted. For suspected human medication ingestion, human hospitals may be willing to run tests for illicit drugs, antidepressants, cardiac drugs, acetaminophen, etc. on a STAT basis. Alternatively, there are now available in many human pharmacies, OTC home drug testing kits that might be considered; these bench-top tests, though technically not validated for non-humans, are quick, easy and cost-effective in cases of suspected exposure to certain human medications. For suspected rodenticide, insecticide, or heavy metal exposure, most veterinary diagnostic laboratories offer basic screens. Some diagnostic laboratories offer specialty screenings, such as "convulsant" screens that might detect agents such as bromethalin, tremorgenic mycotoxins, strychnine, etc. In many cases, the results from these tests may not be obtained for days, at which point the patient may be either recovered or dead. Therefore, the veterinarian should still be prepared to manage the case using appropriate symptomatic and supportive care.

Mood-Altering Drugs and Serotonin Syndrome

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

With the large number of people and animals that are on antidepressant medications it is not surprising that the number of accidental ingestions of these drugs has also increased. Advances in medicine have lead to the development of medications capable of targeting specific biochemical mechanisms thought to be responsible for a variety of mental health disturbances. The increase in the number of drugs that affect serotonin metabolism reflects the discovery of the role of serotonin in maintenance of mental health. Serotonin has been determined to be involved with regulation of personality, sleep, temperature, sexual function, aggression, motor control, pain perception and cardiorespiratory function. Serotonin acts peripherally to stimulate smooth muscle and centrally as an inhibitor of excitatory neurotransmission. When overdosage of serotonergic drugs occurs, the result may be serotonin syndrome, a potentially life threatening multi-systemic disorder caused by over stimulation of serotonin receptors within the CNS and other systems.

Formation of serotonin

Serotonin is formed from tryptophan, an essential amino acid. Tryptophan, in competition with other amino acids, crosses the blood-brain barrier via a non-selective transporter mechanism. Within the CNS, tryptophan readily enters neurons and is subsequently converted to 5-hydroxytryptophan (HTP) by the enzyme tryptophan hydroxylase. This conversion is saturable and is the rate-limiting step in the formation of serotonin. The 5-hydroxytryptophan is then rapidly converted to serotonin (hydroxytryptamine). Serotonin is packaged in vesicles and released at the synapse during depolarization of the presynaptic neuron. Serotonin subsequently binds to receptors on the postsynaptic neuron, stimulating its depolarization or binds to receptors on the presynaptic neuron where it inhibits further release of serotonin. Its work accomplished, serotonin is pumped back into the presynaptic neuron, where it is either recycled into vesicles for future release or broken down to metabolites (primarily hydroxyindoleacetic acid) through the action of the enzyme monoamine oxidase.

Mechanism of action

With evidence that increasing brain serotonin levels may have antidepressant and anxiolytic effects in humans (and possibly other animals), many serotonergic drugs have been investigated. The drugs can be classified by how they effect serotonin (see Figure 1):

- Drugs that enhance serotonin synthesis (L-tryptophan, L-5-hydroxytryptophan)
- Drugs that increase presynaptic serotonin release (amphetamines, amphetamine derivatives, monoamine oxidase inhibitors [MAOIs], cocaine)
- Drugs that inhibit serotonin uptake into the presynaptic neuron (selective serotonin reuptake inhibitors [SSRIs], tricyclic antidepressants [TCAs], amphetamines, cocaine, dextromethorphan, meperidine)
- Drugs that inhibit serotonin metabolism (MAOIs)
- Drugs that act as serotonin agonists (buspirone, sumatriptin, LSD).

When these drugs do their jobs too well, or when overdoses occur, serotonin syndrome can result. The syndrome most commonly occurs in human when two or more serotonergic agents with different mechanisms of action are administered either concurrently or in close succession, leading to excessive levels of serotonin in the CNS. (see Table 1) Serotonin syndrome most commonly occurs in dogs secondary to inappropriate ingestion of the owner's medications.

Clinical signs

Serotonin syndrome was originally classified in humans and defined as a constellation of symptoms that included at least three of the following: myoclonus, mental aberration (dementia, disorientation, etc.), agitation, hyperreflexia, tremors, diarrhea, ataxia and hyperthermia. This "classic" definition of serotonin syndrome has recently become controversial although a majority of cases of serotonin syndrome in humans and animals will fulfill these criteria.

In addition to the CNS and GI tract (where serotonin is a modulator of gastrointestinal smooth muscle contractility), respiratory and cardiovascular function may be altered in serotonin syndrome due to the importance of serotonin in maintaining vascular tone, stimulating bronchial smooth muscle, and stimulating cardiac stroke rate and volume. In general, these effects are not as clinically relevant as the GI and CNS signs. Alteration in platelet function or coagulation, both areas in which serotonin plays important role, has not been described in cases of serotonin syndrome in humans or animals.

In dogs the most common clinical signs include (in descending order): vomiting, diarrhea, seizures, hyperthermia, hyperesthesia, depression, mydriasis, vocalization, death, blindness, hypersalivation, dyspnea, ataxia/paresis, disorientation, hyperreflexia, and coma. Signs are similar, but vary in severity, whether 5-HTP or other serotonergic drugs such as SSRIs or MAOIs are ingested.

History of serotonin syndrome

The earliest account of serotonin syndrome in people was published in 1955, but the term serotonin syndrome was not used until 1982.

Diagnosis

There are no diagnostic tests to confirm serotonin syndrome, and the diagnosis will need to be based on history of ingestion of serotonergic drugs and presence of compatible clinical signs.

Decontamination

Emesis should only be attempted in asymptomatic animals. Gastric lavage may be used in cases of large ingestions. Most of the medications that can cause serotonin syndrome bind well to activated charcoal (lithium is the exception) and many times this is the only decontamination procedure needed. Repeated doses of activated charcoal may need to be used with ingestions of TCAs or other medications that undergo enterohepatic recirculation. A cathartic should be used along with the first dose of activated charcoal. Do not use magnesium salts as a cathartic in TCA ingestions as the decreased peristalsis caused by TCAs can result in increased magnesium absorption. An enema may also be given if sustained release products are consumed.

Treatment

Treatment of serotonin syndrome is largely symptomatic and supportive. Inducing vomiting is not recommended if clinical signs are present because of the increased risk of aspiration. Seizures and agitation generally respond to diazepam or phenothiazines (the drug of choice in humans), and barbiturates can be used in refractory cases. Because hyperthermia is a significant concern, cooling measures should be instituted. Diuresis does not enhance excretion, but intravenous fluids should be administered to support the cardiovascular system, aid in thermoregulation, and maintain renal blood flow. The use of cyproheptadine, a nonselective serotonin antagonist, has shown to be a helpful adjunct in managing serotonin syndrome in animals. Cyproheptadine may be administered at a dose of 1.1 mg/kg PO (dogs) or 2-4 mg PO (cats). In cases where the oral route is not feasible (e.g. severe vomiting), cyproheptadine may be crushed and mixed with saline to be instilled rectally. Doses of cyproheptadine may be repeated every 4-6 hours as needed until signs have resolved. Propranolol also has some serotonin blocking effect, and may be of benefit if animals are tachycardic. Administration of activated charcoal is important, but only once the animal has been reasonably stabilized. Metabolic acidosis may occur and can be corrected with sodium bicarbonate as indicated by blood gas analysis. Symptomatic care to control vomiting, abdominal pain, or other signs can be instituted as needed.

Prognosis

In most cases, signs will subside over 12 to 24 hours and full recovery is expected within 48 hours in uncomplicated cases. The outcome depends on dose, treatment, and exposure to other highly protein bound medications. The prognosis also depends on the overall health of the dog, especially if there is a history of liver and/or renal disease. Liver disease can inhibit metabolism of these drugs and renal disease can delay excretion. Potential sequelae include rhabdomyolysis, disseminated intravascular coagulation, and renal failure secondary to myoglobinuria. Prognosis is generally good with rapid and aggressive therapy.

Table 1. Serotonergic potential of various drugs

High	Medium	Low
Amitriptyline (Elavil®) Clomipramine (Clomicalm®, Anafranil®) Dexfenfluramine (Redux®) Dextromethorphan Fenfluramine (Ponderal®) Fluoxetine (Prozac®) Fluvoxamine (Luvox®) Imipramine Isocarboxazid (Marplan®) Lithium MDMA (methylenedioxymethamphetamine) Meperidine Moclobemide (Manerix®) Paroxetine (Paxil®) Phenelzine (Nardil®) Selegiline (Anipryl®, Eldepryl®) Sertraline (Zoloft®) Tranylcypromine (Parnate®) Venlafaxine (Effexor®)	Buspirone (BuSpar®) Cocaine Desipramine (Norpramin®) Doxepin (Adapin®, Sinequan®) L-Dopa LSD (lysergic acid diethylamide) Nortriptyline (Pamelor®) Trazodone (Desyrel®)	Amantadine Bromocriptine (Parlodel®) Bupropion (Wellbutrin®, Zyban®) Carbamazepine (Tegretol®) Codeine Melatonin Mirtazapine (Remeron®) Nefazodone (Serzone®) Pentazocine (Talwin®) Pergolide (Permax®) Tramadol (Ultram®)

Hot Topics in Clinical Toxicology

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

The good

Silica gel packs

Desiccant packs are included as moisture absorbents. Most ingestions will not cause clinical signs, although a mild gastrointestinal upset may occur.

Ant and roach baits

Ant and roach baits are common objects found in households. The insecticides used most commonly in these baits are fipronil, avermectin, sulfluramid, boric acid, indoxacarb and hydramethylnon, all of which are of low mammalian toxicity and present in very low concentrations within the baits. The baits also contain inert ingredients such as peanut butter, breadcrumbs, fats and sugar to attract the insects; these agents are also sometimes attractive to pets.

Birth control pills

Birth control pills generally contain estrogen and progestins. Estrogen doses of less than 1 mg/kg are not of concern. At higher doses, bone marrow suppression may be seen.

Glow-in-the-dark sticks and jewelry

The primary luminescent agent in these types of products is dibutyl phthalate (n-butyl phthalate), an oily liquid that is also used as a plasticizer and insect repellent. Dibutyl phthalate is of low toxicity (LD_{50} >8000 mg/kg in rats) but has an extremely unpleasant taste. Taste reactions are commonly seen.

Toilet water (tank drop-ins)

Tank "drop in" products typically contain anionic/nonionic detergents, cationic detergents, bleach, and/or acids. However, when a tank "drop in" cleaning product is used in a toilet, dilution occurs and the cleaning agent is just a gastric irritant.

Cyanoacrylate glues

Cyanoacrylates (Super Glue®) solidify when they contact saliva, so minimal absorption occurs.

Fertilizers

Fertilizers are made up of nitrogen, phosphorus, and potassium (NPK) in various ratios. Fertilizers generally have a wide margin of safety and only mild GI signs are expected after ingestion. Additives to fertilizers may include herbicides, insecticides, fungicides, iron, copper, and zinc. These additions increase the likelihood of GI and systemic signs.

The bad

Anticoagulants

Anticoagulants in use as rodenticides today are almost all second-generation derivatives. They inhibit the activity of vitamin K epoxide reductase, which converts vitamin K epoxide to the active reduced form. This reduced vitamin K is crucial to activation of clotting factors II, VII, IX, and X.

Any exposure > 0.02 mg/kg of a second generation anticoagulant requires treatment and evaluation. Emesis can be induced if ingestion has occurred within the last 4 hours. If little or no bait is recovered, administration of activated charcoal is next. Another option is to institute Vitamin K1 therapy (2.5-5 mg/kg/day) or monitor PT tests. Because the body has several day's worth of active Vitamin K stored in the liver (the site of the re-activation activity), there is a delayed onset of effect on blood clotting after ingestion of an anticoagulant. Factor VII has the shortest half-life, so we can get the earliest valid estimate of effect by checking the prothrombin time (PT). The PT is expected to elevate within 24-48 hours post ingestion.

Early signs of anticoagulant toxicosis are vague, and depend on the site of a bleed. Lethargy, non-productive cough, intermittent lameness, mild anemia, or even sudden collapse can be seen. Petechiae and echymoses are more often seen later in the course of illness, after the platelet numbers have been depleted in smaller bleeds. Diagnosis is based on signs, history of possible exposure, and coagulation studies.

If the animal is actively bleeding, start vitamin K1 and give clotting factors via a whole blood transfusion, fresh frozen plasma, or fresh plasma. Minimize physical activity throughout therapy.

Bromethalin

Bromethalin is a neurotoxin that uncouples oxidative phosphorylation in CNS mitochondria. This results in lack of adequate ATP concentration and insufficient energy for maintaining Na^+-K^+ ion channel pumps. Loss of pump activity results in cerebral and spinal cord edema and a demyelination injury to long nerves.

Bromethalin is rapidly absorbed from GI tract. Cats are far more sensitive to this agent than are dogs. Dogs seem to have both a low-dose and a high-dose syndrome. With lower doses signs may not appear for 72-96 hours, and include hind limb ataxia and paresis, decreased proprioception, loss of deep pain response, vocalizations, patella hyper-reflexia, CNS depression progressing to coma,

vomiting, and fine muscle tremors. At or above the mean lethal dose, signs can begin within 12-24 hours and include severe tremors, hyperthermia, extreme hyperexcitability, running fits, hyperesthesia and seizures.

Treatment of clinical signs is directed to controlling cerebral edema, and is mostly frustrating and non-productive. Mannitol, corticosteroids and diazepam may be used. Animals with sub-lethal doses will require good nursing care.

Cholecalciferol

Cholecalciferol is a Vitamin D_3 analog. It alters calcium metabolism in the body, increasing intestinal absorption and renal tubular reabsorption of calcium and stimulating bone resorption. Clinical signs of intoxication usually develop within 12-36 hours. Early signs include lethargy, weakness, anorexia, polydipsia, polyuria, and vomiting, often with blood. Biochemical alterations include hyperphosphatemia within 12 hours and hypercalcemia within 24 hours of exposure and azotemia (both renal and pre-renal). The elevated calcium levels result in calcification of many tissues, notable renal tubules and walls of blood vessels. The elevated calcium also has a direct effect on kidney function, sometimes causing acute renal failure even without mineralizations.

Diagnosis of toxicosis is based on history of exposure, clinical signs, serum chemistries and urinalysis. Run baseline chemistries as soon as possible after a known exposure. Pursue GI decontamination if within several hours of ingestion, or if there is evidence of ingestion (chewed box) at unknown time but a still asymptomatic animal. Multiple doses of activated charcoal and cholestyramine can help decrease absorption.

Treatment is aimed at lowering the serum calcium and phosphorus levels, preventing a rise in these values if still normal, and stopping further calcium mobilization from the bones. IV normal saline at twice maintenance, prednisone and furosemide all enhance calciuria. Monitor serum calcium, phosphorus, BUN and creatinine daily to judge effectiveness of therapy. If calcium levels are rising despite calciuresis, best choice is pamidronate (Aredia™). Unlike salmon calcitonin, it needs to be given only once, with a repeat dose possibly at about 5-7 days. It acts at the level of the osteoclast and is deposited in the bone itself. Once the pamidronate has been administered, it is important to taper the initial treatments (prednisone, furosemide) and decrease the rate of fluid administration. Continue to monitor calcium, phosphorus, and kidney values during this time. End of therapy will be marked by a return to normal of kidney values and the decrease of calcium x phosphorus levels (in mg/dl).

Zinc phosphide

Zinc phosphide is an old rodenticide posing as a new one. The phosphide salts are unstable in an acid environment. At gastric pH they degrade rapidly to form phosphine gas. Phosphine gas, when inhaled, results in acute non-cardiogenic pulmonary edema. When absorbed systemically, it is thought to block cytochrome C oxidase, leading to formation of highly reactive oxygen compounds. It is these reactive compounds which cause most of the tissue injury, most severe damage is in tissues with the highest oxygen demand – brain, lungs, liver and kidney.

Lethal doses for cattle, sheep, pigs, goats, dogs, and cats range between 20-50 mg/kg. For a 55 pound (25 kg) dog, that would be between 10 grams (0.35 ounce) and 25 grams (just under an ounce) of 5% bait. Severely poisoned animals may die in 3-5 hours. Those who survive longer than 48 hours have a pretty good chance.

Initial signs may vary by species, as well as by the dose. Onset of signs is normally between 15 minutes to 4 hours post ingestion. Vomiting, often with blood, is common. Dogs may show lateral recumbency with whole body tremors and salivation. Other signs may include anorexia and lethargy. Rapid deep breathing may signal the onset of the pulmonary changes. Abdominal pain, ataxia, and weakness leading to recumbency may follow. Hyperesthesia and seizures may develop that resemble the signs of strychnine toxocosis.

Metabolic acidemia ensues. Other biochemical changes may include depressed serum calcium and magnesium. If there is survival beyond 48 hours an elevated blood urea is common. Hepatic and renal damage often may be detected 5-14 days later.

Initial decontamination is tempered by the wish to keep the stomach pH as high as possible to prevent the formation of phosphine gas. If there has been no spontaneous vomiting, it may be better to induce emesis with apomorphine rather than hydrogen peroxide. Giving food, commonly done in order to improve gastric emptying and the response to peroxide, will trigger release of gastric acid and increase the rate of production of phosphine. If you are going to perform gastric lavage, add an alkalizing component like a magnesium and aluminum hydroxide gel to your lavage liquid. Also consider mixing into your activated charcoal preparation.

Supportive care includes IV fluids to maintain blood pressure renal perfusion, and gastroprotectants. Seizures may respond to diazepam, or may require barbiturates or full anesthesia. Since the most severe injury is probably due to action of the oxygen radicals, use of an antioxidant may be useful – consider vitamin C or n-acetylcysteine.

Caution: Phosphine gas released from vomitus or stomach washings can cause significant illness in veterinary personnel assisting animal. Phosphine has been describes as having a spoiled fish or garlic odor. It is detectable at 1-3 ppm in air; maximum allowed in air in occupational situations is 0.3 ppm, so if you can smell it, you are being exposed to a concentration that can be harmful.

Corrosives: Acids, alkalis, cationic detergents

Products containing acids, alkalis or cationic detergents can cause local corrosive damage. Clinical signs occur almost immediately upon exposure with acids, but can be delayed up to 12 hours with alkalis or cationics. Oral exposure results in pain, vocalization, dysphagia, vomiting (+/- blood), and irritation or ulceration of oral and/or esophageal mucosa. Significant hyperthermia (>104° F) may accompany oral inflammation.

Batteries

When batteries are chewed and the alkaline gel is released, liquifactive necrosis results (see Alkali section). Foreign body obstruction may occur when casings are swallowed and disc batteries may be inhaled, resulting in acute dyspnea and cyanosis.

Pennies

Ingestion of pennies can result is zinc toxicosis. In the stomach, gastric acids leach the zinc from its source, and the ionized zinc is readily absorbed into the circulation, where it causes intravascular hemolysis.

Polyurethane adhesives

Isocyanate glues (Gorilla Glue®, Elmer's ProBond Polyurethane Adhesive®) are expanding wood glues that have been associated with gastric foreign bodies.

The tasty

Bread dough (yeast)

Rising yeast bread dough produces carbon dioxide and ethanol. This can result in bloated drunk dogs.

Chocolate

The active (toxic) agents in chocolate are methylxanthines, specifically theobromine and caffeine. Methylxanthines stimulate the CNS, act on the kidney to stimulate diuresis, and increase the contractility of cardiac and skeletal muscle. The relative amounts of theobromine and caffeine will vary with the form of the chocolate (see Table 1).

Macadamia nuts

Macadamia nut ingestion in dogs can cause weakness, depression, vomiting, ataxia, tremors, transient paresis, and hyperthermia. Most animals return to normal within 48 hours.

Avocados

Species sensitivity among animals varies. In dogs and cats, avocados are likely of low toxicity. In other species, sterile mastitis and myocardial necrosis can occur.

Moldy food (tremorgenic mycotoxins)

Tremorgenic mycotoxins produced by molds on foods are a relatively common, and possibly under-diagnosed, cause of tremors and seizures in pet animals. These molds grow on practically any food, including dairy products, grains, nuts, and legumes; compost piles may also provide a source of tremorgens. Clinical signs include fine muscle tremors that may rapidly progress to more severe tremors and seizures.

Table 1. Methylxanthine levels of various chocolates

Compound	Milligrams per ounce Theobromine	Caffeine
White Chocolate	0.25	0.85
Milk Chocolate	58	6
Semi-sweet Chocolate chips	138	22
Baker's Chocolate (unsweetened)	393	47
Dry cocoa powder	737	70

New Antidotal Therapies

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

Antidotes can be divided into three broad categories: chemical antidotes, pharmacologic antidotes, and functional antidotes. Chemical antidotes act directly on the toxicant to make it less toxic and/or more readily excreted. Pharmacologic antidotes antagonize toxic agents at their receptor sites or through other macromolecules. Functional antidotes are agents that act on the symptoms of poisoning. In many cases, these antidotes have no real effect on the toxicant itself, but they lessen the severity of the clinical picture of the intoxicated patient.

Chemical antidotes: chelators

Deferoxamine

Deferoxamine (Desferal®, Ciba) is a chelating agent approved for use in humans for the treatment of acute iron poisoning, chronic iron overload and treatment of chronic aluminum overload in patients on chronic dialysis. It has been used off label to treat iron toxicosis in animals. Deferoxamine forms a chelate complex with free iron, which is then excreted in the urine and bile. Deferoxamine is most effective within the first 24 hours, before the iron has been distributed to the tissues. The extrapolated animal dose for iron toxicosis is 40 mg/kg, IM, every 4-8 hours. The IM route is preferred, as too rapid IV administration can cause hypotension and pulmonary edema. The efficacy of deferoxamine can be increased by giving ascorbic acid after the gut has been cleared of iron. The deferoxamine-iron complex gives a salmon pink color to the urine ("vin rose"). Continue to chelate until urine clears or until serum iron levels return to normal.

DMSA (2,3-dimercaptosucinic acid, succimer)

Succimer (Chemet®, McNeil Consumer Products) is approved for the treatment of childhood lead poisoning. It has also been used to treat arsenic and mercury poisoning and does not bind iron, calcium or magnesium. Succimer is available as 100 milligram capsules. It is a structural analog to BAL (British Anti-Lewisite, dimercaprol) but has less potential to cause nephrotoxicity. Succimer is preferred over Ca-EDTA and penicillamine, as succimer can be given while lead is still in the GI tract (the other 2 increase lead absorption), it comes in an oral form, it has a lower incidence of causing GI upset and it is also less likely than the others to induce Zn deficiency. Succimer, however, is more expensive than the other options (capsules are approximately $4 apiece).

Although not approved for animal use, there are published doses for treating lead toxicosis. The dose for dogs and cats is 10 mg/kg PO TID for 10 days (administer on empty stomach; per rectum if animal is vomiting). Dosing for caged birds is 25-35 mg/kg PO BID 5 days a week for 3-5 weeks. Higher doses (80 mg/kg) have caused death in cockatiels. It is not uncommon for there to be a post-chelation rebound (or elevation) of blood lead levels. Most of the time, this is due to redistribution of the lead from bone and tissue stores in animals chronically exposed to lead. If lead levels are still increased and the animal is still symptomatic, a repeated round of therapy can be pursued. If the animal is asymptomatic, there is no need to retreat.

Chemical antidotes: immunotoxicotherapy

Crotalidae polyvalent immune FAB (Ovine)

Crotalidae polyvalent immune Fab (ovine) (CroFab®, Fougera) is approved for the management of patients with North American crotalid snake envenomation. The antivenin has been show to cross react with 10 North American crotalid species (see Table 1). In a recent study, CroFab® was given to 115 dogs presented to several veterinary emergency hospitals in the western US. The CroFab® gave "excellent results" although some dogs did require more than one vial (average dosing was 1.25 vials). This study also reported significantly less reactions to the CroFab® product compared to Ft. Dodge/Wyeth equine antibody antivenin (advantage of Fab over whole IgG).

Early use (within 6 hours of snakebite) is recommended to prevent clinical deterioration and the occurrence of systemic coagulation abnormalities. Crotalid Fab is diluted in 250 mL of saline and infused over 60 minutes, with monitoring for development of an allergic reaction during the first 10 minutes. Recurrence of local symptoms of crotalinae envenomation following CroFab® treatment has been reported in people, probably due to the short half-life of the antivenin. Cost is approximately $1400/2 vials.

Digoxin immune Fab

Digoxin immune Fab (Digibind®, Burroughs Wellcome) is produced from specific digoxin antibodies from sheep and will bind directly to digoxin or digitoxin and inactivate it.

Antidigitoxin Fab fragments have an affinity for digoxin that is much higher than the affinity of digoxin for its sodium-potassium ATPase target. Digibind® has sufficient cross reactivity and can also be effective against bufotoxins (*Bufo* toads) and plants containing cardiac glycosides (see Table 2).

Treatment with Fab fragments should be considered in those patients who fail to respond to conventional therapy. Signs of severe toxicity might include severe ventricular arrhythmias (ventricular tachycardia, ventricular fibrillation), progressive bradyarrhythmias

(severe sinus bradycardia), or second or third degree heart block not responsive to atropine. The dosage varies based on the amount of digoxin to be neutralized. The best situation is to have a human hospital run digoxin levels and then dosing is based on those results. The dose of Digibind® is calculated: Digibind® dose (number vials) = [Serum Digoxin Concentration (ng/mL) x Patient's weight (kg)] / 100. The next best method is to estimate the body load of digoxin ingested (almost impossible with toads or plants). Body load is estimated as dose ingested x 0.8. The formula is then: Digibind® dose (number vials) = [Body load (mg) / 0.5 (mg/vial)]. If either of these methods are not feasible then it is suggested that 1-2 vials be administered and the effects observed. Each vial of Digibind® contains 38 mg which will bind approximately 0.6 mg of digoxin or digitoxin. Reconstitute each vial with 4 mL of sterile water or isotonic saline. Administer slow IV over 30 minutes, infused through a 0.22 micron filter (if possible). Digibind® can be a life saving treatment however, it is expensive ($2200/5 vials).

Chemical antidotes: enzyme inhibitors

Fomepizole (4-MP, 4-methylpyrazole)

Fomepizole (Antizol-Vet®) is a competitive inhibitor of alcohol dehydrogenase. It was approved for use in dogs to treat ethylene glycol (EG) toxicosis in 1997. Each vial contains 1.5 g of fomepizole and the reconstituted solution is 50 mg/ml. Shelf life is 72 hours once reconstituted. The advantages of fomepizole are that is does not induce hyperosmolality, CNS depression, and diuresis (vs. ethanol). Dogs may be treated as late as 8 hrs post ingestion and still have a favorable prognosis. Fomepizole may still be effective as late as 36 hrs post-ingestion of EG. The recommended dosing regime for dogs is an initial IV injection of 20 mg/kg (give over 15-30 minutes), followed by 15 mg/kg slow IV at 12 hours and again at 24 hours. A last dose of 5 mg/kg IV is given at 36 hours after the first injection. Since fomepizole slows down the metabolization of EG, serum levels may still be detectable at 72 hours after ingestion. If the EG test is still positive after the last dose continue treatment at 5 mg/kg IV every 12 hours until test is negative.

Fomepizole is not labeled for cats but preliminary clinical trial results suggest that high doses of fomepizole in the cat (125mg/kg slow IV infusion loading, then 31.25 mg/kg at 12, 24, 36 hrs post EG ingestion) are safe and effective when therapy is initiated within 3 hours following EG ingestion. [Note: at 3 hrs post lethal dose EG administration, 100% recovery with fomepizole, 25% recovery with ethanol. At 4 hrs post EG, 100% mortality with fomepizole and ethanol was noted in these studies]. Other than calcium oxalate crystals in the urine, no biochemical evidence of renal impairment was noted out to 2 weeks post EG exposure and fomepizole.

Pharmacologic antidotes: receptor antagonists

Flumazenil

Flumazenil (Romazicon®, Roche) is an imidazobenzodiazepine derivative, which antagonizes the CNS actions of benzodiazepines. Flumazenil binds to and rapidly displaces benzodiazepines from the benzodiazepine receptor, thereby reversing their sedative and anxiolytic effects within 1-2 minutes. It is indicated in people for diagnosis of benzodiazepine overdose and reversal of benzodiazepine sedation and respiratory depression. Use in animals is usually limited to those at risk of respiratory depression. The dose is 0.01 mg/kg, IV, for both dogs and cats and can be repeated if severe depression returns. The half-life for flumazenil is about 1 hour, so repeated injections may be needed. Flumazenil may also be given intratracheally in an emergency situation. Flumazenil is contraindicated in patients suspected of tricyclic antidepressant overdoses as it can cause seizures.

Atipamezole

Atipamezole (Antisedan®, Pfizer) is an α2-adrenergic antagonist labeled for use as a reversal agent for medetomidine, but it can also be used to treat several toxicoses. Atipamezole can be used to reverse other α2-adrenergic agonists (amitraz, xylazine, bromonidine, clonidine and tizanidine). Atipamezole quickly reverses the hypotension and bradycardia seen in these toxicoses. After IM administration in the dog, peak plasma levels occur in about 10 minutes. Atipamezole has an average plasma elimination half life of about 2-3 hours (vs. yohimbine half life of 1.5-2 hr in dogs) and may need to be repeated.

Functional antidotes

Bisphosphonates

Bisphosphonates are synthetic analogs of pyrophosphate that bind to the hydroxyapatite found in bone. Pamidronate (Aredia®, Novartis) inhibits osteoclastic bone resorption and was developed to treat hypercalcemia of malignancy in people. Pamidronate can be used in dogs for treating hypercalcemia secondary to cholecalciferol toxicosis. The recommended dose of pamidronate for dogs is 1.3 - 2.0 mg/kg as a slow IV infusion in 0.9% sodium chloride over 2-4 hours. The advantage of pamidronate over salmon calcitonin is that it has long lasting effects (may need to repeat once in 5-7 days). Do not use in combination with calcitonin. The downside of pamidronate is that it is expensive ($275-400/vial), however, when compared to length of hospitalization and the labor involved in the repeated doses of calcitonin, the cost is comparable.

New antidotal uses for other drugs (teaching old dogs new tricks)

Intralipids

Intralipids are lipid emulsions. Lipid emulsions are commonly used as a fat component for parenteral nutrition. While more studies are needed, lipid therapy is very exciting new treatment for lipid soluble toxicoses. Lipid use is based on human research investigating bupivacaine overdoses. The possible mechanism for lipid rescue is that the lipids bind to the fat soluble toxin ("lipid sink") and bound toxin is inactive.

Liposyn, or any other 20% lipid solution, can be given through a peripheral catheter and is relatively inexpensive. A bolus of 1.5 ml/kg is given (over 1 minute if cardiac arrest, slower otherwise), followed by 0.25 ml/kg/min for 30-60 minutes. This is repeated in four hours if the serum is clear. Lipid therapy can hasten recovery time in some cases.

There are possible complications to lipid therapy: significant lipemia, pancreatitis, transiently increased liver enzymes, volume overload and lipids can also remove antidotes and other therapies.

Cholestyramine

Cholestyramine is an anion exchange resin available by prescription only. It is used to lower cholesterol in patients who have not responded to normal therapies. Cholestyramine has been used in human medicine to aid in the treatment of toxicoses (amiodarone, digitoxin, chlordane, methotrexate, piroxicam, vitamin D, warfarin, blue-green algae, indomethacin). It binds with bile acids in the intestine, preventing their reabsorption. This stops enterohepatic recirculation. Cholestyramine is not absorbed out of the digestive tract, so it has no systemic effects, but constipation and mild liver enzyme elevation may be seen. The dose is 0.3 – 1 g/kg TID for several days (depends on toxin ingested). For our patients, the powder should be given or mixed with canned food. Cholestyramine is cost effective with a price around $50-80 for 240g.

Cyproheptadine

Cyproheptadine(Periactin®, Merck) is an antihistamine (H1 blocker) that also has serotonin antagonistic activity. Cyproheptadine has been used in veterinary medicine for its antihistaminic and appetite-stimulant effects (cats) and is now being used to help treat serotonin syndrome. Serotonin syndrome is a condition caused by serotonin excess within the CNS and is characterized in dogs by tremors, seizures, hyperthermia, ataxia, vomiting, diarrhea, abdominal pain, excitation or depression, and hyperesthesia. Serotonin syndrome has been associated with the use of drugs that increase brain serotonin levels (e.g. selective serotonin reuptake inhibitors, amphetamines) in humans and after accidental ingestion of 5-hydroxytryptophan (serotonin precursor) in dogs. The recommended dose for dogs is 1.1 mg/kg PO or per rectum every 1-4 hours until signs subside.

N-acetylcysteine

N-acetylcysteine (NAC, mucomyst) is the N-acetyl derivative of L-cysteine, a naturally occurring amino acid. Although originally used as a mucolytic agent in people, NAC has become an important part of managing acetaminophen overdoses in people and animals. Because of NAC's ability to minimize oxidative damage to the liver from acetaminophen, NAC had been investigated for its ability to prevent damage from other hepatotoxins. A recent study on *Amanita phalloides* (death cap mushroom) poisoned people showed that the use of a protocol similar to that used for acetaminophen toxicosis (high dose) was effective in preventing permanent hepatic injury in 10 of 11 people.

Dantrolene

Dantrolene (Dantrium®, Procter & Gamble Pharm.) has been mostly used in veterinary medicine for the prevention and treatment of malignant hyperthermia syndrome. Dantrolene may also be used to treat the malignant hyperthermia-like reaction seen in dogs after the ingestion of hops (*Humulus lupulus*). Hops are used in the brewing of beer. Recommended dose of dantrolene is 2-3 mg/kg, IV, or 3.5 mg/kg, PO, as soon as possible after ingestion.

Table 1. Cross reactivity of Crotalidae polyvalent immune Fab

Scientific name	Common name
Agkistrodon picivorus	Cottonmouth, water moccasin
Agkistrodon contortrix contortrix	Copperhead
Crotalus adamanteus	Eastern diamondback rattlesnake
Crotalus atrox	Western diamondback rattlesnake
Crotalus horridus atricaudatus	Canebrake rattlesnake
Crotalus horridus horridus	Timber rattlesnake
Crotalus molossus molossus	Northern blacktail rattlesnake
Crotalus scutulatus	Mojave rattlesnake
Crotalus viridis helleri	Southern Pacific rattlesnake
Sistrurus malarius barbouri	Pygmy rattlesnake

Table 2. Cross-reactivity of antidigoxin Fab fragment with plant cardiac glycosides

Scientific name	Common name
Acokanthera oblongifolia	
Adonis microcarpa	Pheasant's eye
Asclepias physocarpa	Balloon cotton bush
Byrophyllum tubiflorum	Mother of millions
Calotropis procera	King's crown
Carissa laxiflora	
Cerbera manghas	Sea mango
Convallaria majalis	Lily of the valley
Crytostegia grandioflora	Rubber vine
Helleboros sp	
Nerium oleander	Oleander
Thevetia neriifolia, T. peruviana	Yellow oleander
Urginea maritima	Squill

Toxicology of Herbal Medications

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

Herbal preparations are increasing dramatically in usage. A recent survey (2007) discovered that 38% of adults and 12% of children in the US have used at least one alternative therapy over the preceding 12 months. Many people not only use alternative therapies themselves, but also give various therapies to their pets, with or without advice from a veterinarian. The odds are that at least some clients in an average practice will have an interest in, or ask about the use of alternative medicine. The regulation of herbs and other dietary supplements differs from most pharmaceutical drugs. In 1994, the Dietary Supplement and Health Education Act (DSHEA) was created. This act includes vitamins, minerals, neutraceuticals, and herbs. Under the DSHEA, supplement manufacturers are not required to prove efficacy, safety, and there are no mandated quality controls. The FDA can intervene if enough adverse reactions to a specific product occur, but the burden of proof is on the FDA to prove a particular product is harmful. Manufacturers are allowed to state what effect a product is expected to produce (such as the antidepressant effects produced by St. John's Wort) but the manufacturer can not claim a product specifically cures a stated effect. The label must include the statement that the claims have not been evaluated by the FDA.

Ma Huang, *Sida cordifolia,* and *Citrus aurantium*

Ma Huang is produced from *Ephedra sinica*, as well as other *Ephedra* species and herbs such as *Sida cordifolia*. Other common names of ma huang include yellow horse and sea grape. *S. cordifolia* is often known as Indian common mallow. Bitter orange, *Citrus aurantium*, contains synephrine. Historically, ma huang has been used to treat asthma, colds and flu, fevers, congestion and coughs. Today, ma huang is frequently used as a weight-loss aid because of its stimulant properties and as a decongestant because it is vasoconstrictive. Ma Huang is also abused, like an illicit drug, because of its hallucinogenic and stimulant properties. When used as a weight-loss aid, frequently caffeine-containing plants are included in the formulation, which can increase toxicity. Some formulations will list the quantity of ephedrine per unit of drug. The active components of *Ephedra sinica* and *Sida cordifolia* are alkaloids, including ephedrine and pseudoephedrine. The FDA has banned *Ephedra* containing substances, but did not specifically list the active constituents. Products containing *S. cordifolia* and bitter orange cause the same clinical syndrome as those containing *Ephdedra*.

Pharmacologically, ephedrine is a sympathomimetic alkaloid. The alkaloids stimulate alpha- and beta-adrenergic receptors, causing the release of endogenous catecholamines at synapses in the brain and heart. This stimulation results in peripheral vasoconstriction and cardiac stimulation. This results in increased blood pressure, tachycardia, ataxia, restlessness, tremors, and seizures.

Guarana

Guarana is the common name of *Paullinia cupana*, a plant containing high levels of caffeine. Guarana may contain 3% to 5% caffeine by dry weight compared to coffee beans (1-2 % caffeine) and tea (1-4 % caffeine). Common names include Brazilian cocoa and Zoom. Theobromine and theophylline have also been found in the plant. Historically, guarana was used to provide energy during fasting, as an aphrodisiac, and to prevent malaria and dysentery. Guarana is frequently found in herbal weight loss aids (with or without ma huang) and in products promising increased energy. Because guarana contains methylxanthines, it produces a clinical syndrome similar to chocolate, coffee, or over the counter stimulant products which contain caffeine.

Caffeine is a methylated xanthine. It increases cyclic AMP, releases catecholamines, and increases muscular contractility. The net effect is a positive inotropic and chronotropic effect on the heart, cerebral vasoconstriction, renal vasorelaxation, and smooth muscle relaxation in the gastrointestinal tract. Clinical signs include vomiting, restlessness and hyperactivity, polydipsia and polyuria. Tachycardia and other cardiac arrhythmias such as premature ventricular contractions (PVCs), are possible. Clinical signs progress to muscle tremors and seizures, and finally death.

Griffonia simplicifolia

Griffonia simplicifolia seeds are used as a source of 5-hydroxytryptophan (5-HTP). This extract is generally used to treat depression, headaches, obesity and insomnia in humans. 5-HTP is reported to increase serotonin in the CNS. Label information may list 5-HTP, 5-hydroxytryptophan, or griffonia seed extract as an ingredient. Drug interactions with MAO inhibitors, antidepressants, and herbs such as St. John's Wort can occur. 5-HTP is rapidly and well absorbed from the gastrointestinal tract. 5-HTP readily crossed the blood-brain barrier. Once target cells are reached, 5-HTP is converted to serotonin (5-hydroxytryptamine). Serotonin is important in the regulation of sleep, cognition, behavior, temperature regulation, and other functions. Clinical signs resemble serotonin syndrome in humans. Signs include seizures and tremors, depression, ataxia, and hyperesthesia. Gastrointestinal effects including vomiting, diarrhea, and drooling are common. Severe hyperthermia and blindness have been reported.

Yohimbine

Yohimbine is derived from the bark of *Pausinystalia yohimbe.* It has long been considered an aphrodisiac, and the bark was smoked as a hallucinogen. In traditional medicine, angina and hypertension were treated with yohimbine. Today, it is mostly used as a sexual stimulant, and is frequently marketed as herbal Viagra. Pharmacologically, yohimbine is classed as an alpha 2-adrenergic blocking agent. A first pass effect can be seen, and the drug is metabolized in the liver. Metabolites are eliminated in the urine. The T1/2 in dogs is 1.5-2 hours. In large doses, severe and life threatening clinical signs can be seen. Clinical effects are related to the alpha 2 blockade and subsequent CNS and cardiovascular stimulation. Clinical signs include hyperactivity, agitation, tremors, seizures, vomiting, diarrhea, abdominal pain, hypertension initially followed by a profound hypotension.

Alpha lipoic acid

Alpha lipoic acid is a fat-soluble, sulfur-containing antioxidant. A variety of synonyms exist including lipoic acid, thioctic acid, acetate replacing factor, biletan, lipoicin, thioctaid and thioctan. Alpha lipoic acid is found in a variety of foods, especially yeast and liver. Spinach, broccoli, potatoes, skeletal muscle and organ meats like the heart and kidney are also good sources. In toxicology, alpha lipoic acid is useful in treating amanita mushroom poisoning. In veterinary medicine, it is used to treat diabetic polyneuropathy, cataracts, glaucoma, and ischemia-reperfusion injury. Alpha lipoic acid is synergistic with insulin, causing decreased blood sugar and increasing liver glycogenesis, and facilitates glucose uptake into cells. Clinical signs of toxicity include vomiting, ataxia, hypersalivation, tremors and hypoglycemia. Seizures can occur and symptomatic animals should be monitored for acute renal failure. Clinical signs can occur 30 minutes to several hours post-ingestion.

Chamomile

Chamomile refers to both German chamomile (*Matricaria recutita*) and Roman chamomile (*Chamaemelum nobile*). Common names for German chamomile include wild chamomile and pin heads. Common names for Roman chamomile include garden chamomile, sweet chamomile, ground apple and whig plant. The plant is indigenous to Europe and northwest Asia and naturalized in America. German chamomile is an annual and Roman chamomile is a slow growing perennial. The plant is erect and grows to about 20-40 cm. Flowers are white with yellow centers. Chamomile has been used since the Roman empire. It was used as an anti-spasmodic and sedative. In folk medicine, chamomile is used for rheumatism and intestinal parasitism. Chamomile has also been used as a hair tint and cigarette flavoring. In veterinary medicine, the most common uses are as a natural wormer, sedative, and as a treatment for aggression.

Chamomile contains essential oils, flavanoids, and hydroxycoumarins. Bisabolol, which accounts for 50% of the essential oils found in chamomile, has an acute LD_{50} of 15 ml/kg in rats and mice. Chronic ingestion in cats can cause epistaxis and hematomas due to the hydroxycoumarin content.

St. John's Wort

St. John's wort (*Hypericum perforatum*) is also known as goatweed, rosin rose, and Klamath weed. Traditionally, this herb is used as an antidepressant, to treat diarrhea and gastritis. It was also used to treat insomnia and cancer. In veterinary medicine, this plant is well known for causing photosensitization in livestock and horses. St. John's wort has been responsible for devastating economic losses. The major active constituents are anthraquinone derivatives, hypericin and pseudohypericin, as well as flavanoids.

Valarian root

Valerian root (*Valeriana officianalis*) is one of the most popular herbs on the market. Common names include all-heal, heliotrope, Vandal root, and Capon's tale. It is an herbaceous perennial found widely over the United States. The primary active ingredients are volatile oils, alkaloids, and most importantly, valepotriates. The root is the only part of the plant that is used. Valerian is classed as generally recognized as safe (GRAS) for food use. The volatile oils are used as flavoring in some food products. Valerian is used primarily as a sedative, and as a sleeping aid. It has also been used in epilepsy, headaches, colic, and numerous other minor ailments. Valerian is frequently taken as a tea, or as an extract. Valerian increases the length of sedation induced by pentobarbital and length of anesthesia produced by thiopental. Valerian has helped ease the effects of withdrawal from benzodiazepines due to similar receptor sites but increases the effects of sedatives if taken concomitantly. Most reports of adverse effects of valerian in human literature occur after chronic use. These effects include headache, cardiac arrhthymias, and agitation. In one case report, 200 mg in a human caused fatigue, tremors, abdominal pain, and mydriasis. Animal studies included injections of 50 mg/kg intravenous in cats which caused a drop in heart rate and blood pressure. Another study found no pharmacological effect in cats at 250 mg/kg. Mice given up to 4600 mg/kg orally produced mild clinical effects. Signs of toxicity included ataxia, hypothermia, and muscle relaxation. The ASPCA Animal Poison Control Center has had only a few calls on valerian ingestion. Most produced no clinical effects, although lethargy and sedation was seen in a cat.

Garlic

Garlic (*Allium sativum*) is most often used in cooking. Other common names include stinking rose, treacle, nectar of the gods, and camphor of the poor. The fresh bulb, dried bulb, and liquid extract of the bulb are all used. Historically, garlic has been used to treat diseases ranging from leprosy to clotting disorders in horses. Garlic powder used to be a standard tuberculosis treatment. The volatile oils in garlic contain the active ingredients, a sulfur containing compound and allicin. The majority of pharmaceutical activity is believed to be found in these substances. Garlic has been used to treat high cholesterol, hypertension, as well as the common cold and diabetes. Garlic is contraindicated if gastrointestinal ulcers or inflammation is present. Patients with hypothyroidism should also avoid garlic. It is theorized that consumption of high levels of purified active constituents may cause reduced iodine uptake by the thyroid. Due to increased clotting times, garlic should be avoided prior to surgery. Since garlic can have a hypoglycemic effect, insulin dosages should be monitored carefully. Anticoagulant effects of warfarin may be enhanced by garlic use and clotting times require additional monitoring. Garlic is in the same family as onions and a similar toxic effect would be expected. Onion toxicity results in weakness, tachypnea and tachycardia. Hematological changes including hemolysis, Heinz bodies, and possibly methemoglobinemia may occur.

Essential oils

Essential oils are produced by a large number of plants. The oils are a mixture of terpenes and other chemicals. Essential oils are used from food flavorings to perfumes to medications. The most commonly used essential oils in veterinary medicine include Melaleuca or tea tree oil (*Melaleuca alternifolia*), pennyroyal oil (*Mentha pulegium*), D-limonene and linalool (*Citrus spp*.), Citronella (*Cymbopgum nardus*), Thuja (*Thuja occidentalis*), and wormwood or absinthe (*Artemisia absinthium*). In veterinary medicine, essential oils are most commonly used to treat flea infestations, hot spots or other dermatological conditions, or as wormers. Oils may be found in shampoos, dips, liniments, teas, tinctures, syrups, or other formulations. Cats appear to be more sensitive to essential oils than dogs. The most common clinical signs after dermal exposures include ataxia, muscle weakness, depression, and behavioral abnormalities. Severe hypothermia and collapse have occurred in cats. A transient paresis can occur in small breed dogs when melaleuca oil is applied down the spine as a topical flea treatment. Cats have developed scrotal dermatitis after exposure to D-limonene or linalool. Liver failure is associated with essential oils, especially pennyroyal and melaleuca. Oral ingestions cause vomiting and diarrhea. Central nervous system depression may occur, and seizures are possible with large doses. Aspiration pneumonia can occur when essential oils are inhaled. Death can occur with sufficient doses. Signs usually develop from almost immediately up to eight hours post exposure.

Grapefruit seed extract

Grapefruit seed extract (GSE) is being touted as a disinfectant, to cure fungal disease, external parasites, and many other conditions. GSE is made from the pulp and seeds of grapefruit. The final product is acidic, and contains quaternary compounds similar to cationic detergents. Severity of injury typically depends on the concentration of the product and the duration of the contact. Primary clinical signs include hypersalivation, vomiting with possible hematemesis, muscular weakness. Fasciculations and CNS depression may occur. Diarrhea, dermal necrosis or dermatitis, pulmonary edema, and hypotension are possible. Corrosive burns can occur in the mouth, especially on the tip and sides of the tongue, pharynx and the esophagus. Hyperthermia is common in cats.

Summary

When a decision has been made to use an alternative therapy, quality assurance is critical. Herbal medications should be treated as medications, with appropriate precautions. Veterinarians should encourage clients to discuss alternative therapies with them. Choice of therapies, diagnoses, and clients expectations should be discussed. Encourage clients to learn the facts behind CAM (complementary and alternative medicine) therapies. When discussing information obtained from web sites, suggest clients use the C.R.E.D.I.B.L.E. evaluation criteria developed by Dr. Gunther Eysenbach.:

Current and frequent updates
References cited
Explicit purpose and intentions of the site
Disclosure of sponsors
Interests declared and not influencing objectivity (eg financial interests)
Balanced content, listing advantages and disadvantages
Labeled with metadata
Evidence level indicated.

Managing Toxicosis in Exotic Species

Tina Wismer, DVM, DABT, DABVT
ASPCA Animal Poison Control Center
Urbana, IL

Our exotic animal pets can present a challenge with some of their differences in physiology. However, the same adage remains…treat the patient, not the poison. Take a complete history while the patient is being stabilized in the incubator with oxygen. The history should include information such as whether the animal has been exposed to infectious disease or toxins; the animal's environment, diet, reproductive status, and previous illness; husbandry practices should be discussed. Environmental history includes information about caging, flight capabilities (in birds), and exposure to toxins.

Most decontamination techniques transfer easily from one species to another. Stress is a big killer of our exotic animal patients. Taking it slow and allowing down time can help reduce stress. Sedatives and anesthesia can make managing decontamination much easier for you and the animal. Always check cheek pouches as they can hold large amounts of toxic substances. Clean out with a cotton swab until empty.

Emesis

Do not induce vomiting in species that cannot vomit (rabbits, rodents, marsupials, birds, ruminants). It is OK to induce vomiting in pot bellied pigs and ferrets.

Adsorbents

When administering charcoal by gastric tube to rabbits go slowly as their stomach is thin walled and could easily be ruptured. When giving activated charcoal to the avian patient, take into consideration the crop volume.

Species	Crop Volume (ml)
Finch	0.1-0.5
Canary	0.25-0.5
Budgie	1
Lovebird	1-4
Cockatiel	2-4
Small Parrot	3-6
Medium parrot	10-15
Large Parrot	20-30

Cathartics

Magnesium sulfate should not be used in reptiles as their slow GI transit time can allow large amounts of magnesium to be absorbed.

Glue traps

Use oily substance (mineral oil, cooking oil, etc.) to break down glue. Remove oil with liquid dish washing detergent.

Toxic vapors

Carbon monoxide (CO)

Carbon monoxide (CO) is produced by inefficient combustion of carbon based fuels (wood, coal, petroleum, natural gas) and is toxic to all species of domestic animals, birds, and humans. CO will accumulate in garages, homes, closed trailers, and livestock housing units. It has a similar density to air, so it does not segregate or stratify readily. CO competes with oxygen for binding to hemoglobin. CO has 240 times the affinity of oxygen for hemoglobin. This higher affinity results in production of carboxyhemoglobin (COHb) over time. Acute CO poisoning results when COHb concentration in blood exceeds 30%. For dogs, 3700 ppm of CO for 1-2 hours produces 70% COHb with apnea and death. Birds (with high respiratory and metabolic rates) are generally more susceptible than mammals. Carboxyhemoglobin is readily detected in blood, and the test is available at many clinical laboratories, in hospitals and some veterinary diagnostic laboratories. Acute CO toxicosis causes rapid depression, coma, respiratory paralysis and death. The blood is bright red due to the inherent color of carboxyhemoglobin. The skin and mucous membranes may be pink. Anoxia causes necrosis of the cerebral cortex and white matter, globus pallidus and brain stem. Recovered animals can have permanent brain damage and locomotor impairment. COHb is very stable and this may prevent spontaneous recovery to oxyhemoglobin when CO exposure ceases. Hyperbaric oxygen is used in human medicine to drive CO from hemoglobin binding sites. If hyperbaric oxygen is available, it is the treatment of choice for our patients. If not available, place the animal in an oxygen rich environment until able to intubate and ventilate as needed with 100% oxygen. Carbon monoxide prognosis is guarded unless hyperbaric oxygen is available. Poisonings can be prevented in homes and animal confinement units with alarmed CO detectors.

Polytetrafluoroethylene (PTFE, Teflon®)

Although polytetrafluoroethylene (PTFE, Teflon®) is inert under ordinary circumstances, when the polymer is heated under conditions of inadequate ventilation, PTFE fumes may result. Small pet birds are extremely sensitive to chloroflourocarbon fumes, which sensitize the myocardium causing arrhythmias, pulmonary congestion and cardiac failure. With PTFE toxicosis, birds will show respiratory signs immediately. Most die quickly, but some may survive and die later. Environmental conditions and ventilation can be vastly different between rooms and homes. Birds that die may not be in the closest rooms to the PTFE source.

Temperature (F)	Common Cooking Temperatures
325	Birds died from preheated oven (Stewart, 2003)
350	Common baking temperature
396	Temperature of PTFE-coated light bulbs under which Missouri birds died (Boucher, 2000)
500	Searing temp for meat in oven or grill
536	Birds killed in DuPont lab experiments
700	Preheated grill
750	Surface of PTFE-coated pan after heating for 8 minutes on conventional stove (Wells, 1982)
1000	Drip pans (gas range)
1500	Broiling temperature for high-end ovens

Smoke

Smoke can be generated by the burning of many different substances. With smoke inhalation, dyspnea may be delayed several hours. Treatment is oxygen, bronchodilators and possibly diuretics.

Other vapors

Substance	Where Found	Clinical Signs
Acetone	Paints, solvents, cleaning agents	CNS depression, narcosis, respiratory irritation. Excreted in expired air. Possible inhalation pneumonia.
Benzene	Paint and varnish removers	Respiratory and dermal irritation; CNS depression; prolonged exposure may cause blood dyscrasia
Heptane	Waterproofing agents	Dyspnea, pulmonary edema
Mineral spirits	Painting and refinishing solvents	Dermal and GI irritation. Less volatile than toluene, xylene or naphtha
Painter's naphtha	Solvent for lacquers and fast drying paints	CNS depression, ataxia.
Toluene	Anthelmintics, inks, dyes, varnishes, paints, adhesives	Ataxia, depression; cerebellar, liver and renal damage.
Xylene	Thinners, rubber solvents, adhesives, lacquers	Ocular and dermal irritation, impaired vision, tremors, salivation, coma.

Other household items with strong fragrances or odors can all cause respiratory irritation in our small mammal and avian patients. Treatment for most of the animals is insuring good ventilation. Remove to fresh air and supply oxygen if needed. Remind owners to remove animals before using such products.

Heavy metals

Lead

Lead toxicosis, termed "plumbism," has been recognized in both humans and domestic animals for thousands of years. All species of animals are susceptible to lead toxicosis, but it has been most commonly associated with waterfowl. Wildlife may still be exposed to lead from lead shot deposited prior to the ban or used to hunt upland game, from ingestion of lead sinkers or jigs lost by fishermen, from environmental contamination from lead smelters or sewage sludge, or from ingestion of tissue from prey containing lead shot or bullets. Captive wildlife and household pets may ingest lead from leaded paints or caulking in old facilities or on old machinery/equipment, from some galvanized containers, or from linoleum, any of which may unknowingly be present in their enclosures. Lead interferes with a variety of metabolic activities within the body, including red blood cell production, bone formation, nerve transmission, and immune function. Anemia and immunosuppression are common features of chronic lead toxicosis in humans and animals. Competition with calcium in the body results in lead being stored in the bone and also leads to alterations of nerve and muscle function. Interference with cell membrane-associated pumps results in cellular damage in the kidney, liver and myocardium. Lead may also cause reproductive dysfunction in a variety of species.

The clinical signs of lead toxicosis will vary depending on whether the exposure is acute or chronic, and death may occur within a few days to several months depending on the degree of exposure (e.g. number of shot ingested). Acute lead toxicosis in mammals generally produces signs of gastrointestinal and CNS dysfunction. Affected mammals may develop anorexia, vomiting, diarrhea, lethargy, behavior disorders, hyperesthesia, ataxia, blindness, seizures, paralysis, coma and death. Avians develop an impacted crop.

Treatment of lead toxicosis includes eliminating the metal from the gastrointestinal tract, chelation therapy to reduce blood lead levels, and general supportive care. Animals showing severe clinical signs should be stabilized as needed prior to institution of other therapies. Removal of lead objects from the gastrointestinal tract is necessary prior to attempts at chelation, as most chelators will

enhance lead absorption from the gastrointestinal tract and thereby increase blood lead levels if there is lead in the gut. Calcium EDTA, penicillamine and succimer (DSMA) can be used a chelators.

Zinc

Zinc is an essential mineral. Most commonly, animals are exposed through ingestion of zinc from objects such as carpentry hardware (e.g. nuts and bolts), US pennies, and galvanized containers. Zinc-containing objects in the stomach or gizzard are slowly corroded by the low pH, releasing zinc that is readily absorbed into the bloodstream. Zinc is directly damaging to red blood cells, resulting in hemolysis. Renal failure secondary to the hemolysis may develop. Because zinc is irritating to the gastrointestinal tract, vomiting may be noted for a few days prior to the onset of more severe signs. Animals may subsequently present with weakness, lethargy, pallor, ataxia and collapse. Radiographic identification of metallic foreign bodies in the stomach or gizzard may help in determining if zinc toxicity is possible. Bloodwork should be evaluated for evidence of anemia, hemoglobinemia, hemoglobinuria, and/or icterus. Serum zinc levels can aid in diagnosis, but turnaround times may be too long. Zinc levels over 200 ug/dl are considered diagnostic. Treatment of zinc toxicosis entails stabilizing the patient (blood transfusions, etc.) and removal of any metal from the gastrointestinal tract.

Pesticides

Anticoagulant rodenticides

The injectable Vitamin K1 can be given orally in our patients too small for the oral capsules/tablets.

Pyrethrins

Pyrethrin based sprays can cause seizures in snakes. Fish are also very sensitive to pyrethrins and they should not be used around fish tanks or ponds where run off could be a problem.

OP/carbamates

Reptile exposure to OPs or carbamates can cause signs similar to mammals: salivation, ataxia, muscle fasciculation, inability to right themselves, coma, respiratory arrest, seizures and death. Birds are also very sensitive to organophosphates. Treatment of OP/carbamate toxicity as also similar to mammals.

Ivermectin

Ivermectin cannot be used by injection in any of the chelonian species. The use of this medication will result in flaccid paresis or paralysis. Some lizards and snakes (ball pythons) may also show mild neurologic signs when treated. Prognosis for turtles/tortoises is poor.

Fipronil (Frontline®)

Seizures have been seen in rabbits a few hours up to 4-5 days post fipronil exposure. The mechanism of action is unknown. Once seizures begin prognosis is guarded.

D-limonene

D-limonene is found in citrus oil flea dips and is toxic to male rats. D-limonene causes renal failure in these animals by binding to α2u-globulins leading to protein accumulation in the renal tubules.

Medications

NSAIDs

Ferrets are the most likely exotic species to get into human medications. An acute ibuprofen overdose in ferrets is associated with GI, renal, and CNS (coma). Treatment is the same as for other species.

Acetaminophen

Ferrets have low levels of acetaminophen UDP-glucuronosyltransferase activity; only the cat has lower levels. Due to the ferret's inability to detoxify acetaminophen, they should be decontaminated at the same doses as cats and treated the same.

Venlafaxine

Venlafaxine (Effexor®) is an antidepressant. Ferrets are attracted to the taste of this medication. Mydriasis, vomiting, tachypnea, tachycardia, ataxia and agitation are the most common signs. Acepromazine may be used for the agitation, and cyproheptadine may be useful in antagonizing the serotonin effects.

Plants

Cardiac glycosides

Oleander *(Nerium oleander)*, foxglove *(Digitalis purpura)*, Lilly of the valley *(Convallaria majalis)*, dogbane (*Apocynum sp.)* and squill (*Scilla [Urginea] maritima)* all contain cardiac glycosides. The cardiac glycosides act like digoxin. The general symptoms of cardiac glycoside poisoning include diarrhea, abdominal pain, irregular pulse, tremors, and convulsions. In severe cases, death occurs. Some of our exotic patients do not have the same progression of signs. Rabbits, rodents (except the prairie dog), and reptiles did not have any GI signs, they went straight into heart failure. Treatment is supportive care, and Digibind® (Digoxin specific FAB fragments) may be used if arrhythmias are non-responsive to traditional medications.

Avocado

Avocados have been associated with toxicity. They cause sterile mastitis in mice, goats and other livestock and myocardial necrosis in birds and horses. Death occurs 24-47 hours post exposure.

Insoluble calcium oxalate plants

Plants of the Araceae family are a common cause of plant poisoning. They include dumbcane (*Dieffenbachia* sp), philodendron, elephant ear (*Alocacia antiquorum*), caladium, and Jack-in-the-pulpit (*Arisaema* sp). The plants contain calcium oxalate crystals which irritate mucous membranes and cause histamine release. Clinical signs may include oral pain and irritation, hypersalivation, head shaking, dyspnea, nausea, vomiting, and diarrhea. Treatment includes rinsing the mouth with milk to help precipitate the oxalates.

Mycotoxins

Aflatoxins

Avians are more sensitive to aflatoxins than other domesticated species. However, all mammals are susceptible. Aflatoxins are usually associated with cereal grains, corn and peanuts. Clinical signs include lethargy, weight loss, anorexia, ataxia, regurgitation and polydipsia. Long term ingestion can lead to liver cancer.

Other

Lucibufagins (fireflies)

Lizard deaths have been reported as happening after consumption of fireflies. Researchers have identified chemicals in fireflies that are related to their luminescence. Some of these chemicals are similar to digitalis.

Avian botulism

Avian botulism is a paralytic, often fatal, disease of birds resulting from ingestion of toxin produced by *Clostridium botulinum.* There are seven types of toxins (A-through G). Waterfowl die-off is usually from type C; sporadic die off among fish-eating birds (common loons, gulls) from type E toxin, and domestic chickens can be affected by type A. *C. botulinum* spores persist in the soil for years. Toxin production occurs during multiplication of the vegetative form when conditions are favorable (dead organic matter, lack of oxygen, temperature 75 F, pH 5.7-6.2, water depth). The toxin production takes place in decaying animal carcasses. Maggots concentrate toxin and the waterfowl eats the now poisonous maggots. Death of the waterfowl then perpetuates the cycle. The toxin affects peripheral nerves and results in paralysis of voluntary muscles and inability to fly and paralysis of leg muscles (early sign). Paralysis of the nictitating membranes and neck muscles follow. Death is from drowning or from respiratory failure. Prompt removal and proper disposal of carcasses is key in controlling the disease. Providing supportive care and antitoxin injections may provide 75-90% recovery rate (high cost).

Chlorine

The use of chlorinated tap water without pretreatment with dechlorinating agents can create lethal chlorine levels which can kill all fish in the tank/pond within hours. Dechlorinator placed after the fact and water changes may help decrease mortality.

Urine Pain:
UTI

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Etiopathogenesis

- Urinary tract is in contact with external environment and bacteria normally reside in distal urogenital tract
- Urinary tract has many **defense mechanisms** to prevent bacterial urinary tract infection
    - Anatomically
        - Length of urethra
        - Presence of high pressure zones in urethra
        - Urethral and ureteral peristalsis
        - Vesicoureteral flaps
        - Extensive renal blood supply and flow
    - Mucosal defense barriers
        - Glycosaminoglycan layer
        - Antibody production
        - Intrinsic mucosal antimicrobial properties
        - Exfoliation of cells
        - Commensal non-pathogenic microbes in distal urogenital tract
    - Composition of urine
        - Concentration/osmolality
        - High urea nitrogen concentration
        - Organic salts
        - Low molecular weight carbohydrates
        - Tamm-Horsfall mucoprotein
    - Cell-mediated and humoral-mediated immunity
    - Frequent and complete voiding
- A UTI also requires a **pathogenic bacterial organism**
    - Not all bacteria are pathogenic
    - For UTI, bacteria must possess 1 or more urovirulence factors for motility, adherence, invasion, production of enzymes, and production of toxins
- Uropathogenic bacteria invade primarily from ascension from the lower urogenital tract

Physical examination findings and clinical signs

- May be symptomatic or asymptomatic
- Bacterial infection of the lower urinary tract is often associated with signs similar to other lower urinary tract diseases including hematuria, pollakiuria, dysuria, stranguria, and inappropriate urination
- Bacterial of the upper urinary tract may be associated with hematuria
    - If septicemia develops, systemic illness may occur
    - May be associated with recurrent lower urinary tract infection and clinical signs
- Bacterial urinary tract infections occur in 2-3% of dogs and in female dogs more often than male dogs
    - It is more common in older dogs
- **Bacterial urinary tract infections occur in <1% of cats**
    - It is very rare in cats <10 years of age
    - It occurs in >40% of cats >10 years of age

Diagnosis

- Urinalysis and urine culture
- **IT'S GOLD FOR A REASON !**
    - Urine should be collected by **cystocentesis**
        - Urine in the bladder is normally sterile or contains very low numbers of bacteria
        - The more distal in the urogenital tract, the larger the numbers of bacteria

        - Even if a single organism is cultured from a voided sample, it does not mean that a UTI is present or that is the offending organism
    - Always examine urine sediment
        - **Pyuria** (>5 WBC/hpf) is often present, unless animals are immunosuppressed
        - Identification of bacteria is helpful, but not accurate
            - Staining urine sediment improves predictive value

	Unstained	Stained
Sensitivity	82 %	93 %
Specificity	76 %	99 %
Positive Predictive Value	**40 %**	**95 %**
Negative Predictive Value	**96 %**	**99 %**

- Urine specific gravity should be normal; however, dilute urine may be a risk factor for development of bacterial urinary tract infection or may indicate infection of the upper urinary tract
- Urine sediment examination may reveal struvite crystalluria associated with UTI
    - Struvite crystalluria, however, can be normal
    - We will discuss further with urolithiasis
- Cylindruria may be present with upper urinary tract UTI
    - Cellular casts are always abnormal

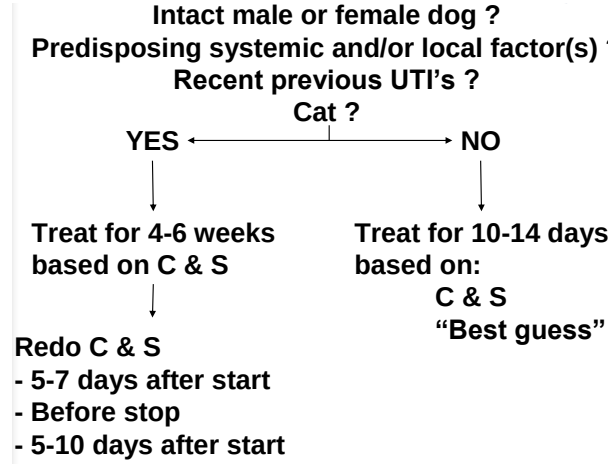
- **Urine culture** is most definitive means of diagnosing a bacterial urinary tract infection
    - Urine should be collected by cystocentesis
    - Urine should be transported in a sealed container and processed as soon as possible
    - If processing is delayed, refrigerate the sample
    - Alternatively, a blood agar plate can be streaked and later submitted for identification and antimicrobial susceptibility pattern if bacteria grow
    - Antimicrobial susceptibility testing
        - Kirby-Bauer agar diffusion test
            - After an organism is isolated and identified, it is transferred to an agar plate
            - Antimicrobial discs are placed on the plate
            - Zone of inhibition around the antimicrobial discs are measured to determine susceptibility of the bacterium
            - This is an inexpensive and readily available technique
            - However, concentration of antimicrobial on most discs are not similar to concentration of antimicrobial achieved in urine
        - Minimum inhibitory concentration
            - More sensitive and specific than Kirby-Bauer method
            - More expensive and more time consuming technique and not widely available
            - Lowest concentration required to inhibit bacterial growth
            - Performed using a series of dilutions of each antimicrobial in a multi-well plate to which a standard number of bacteria are added
            - Kirby-Bauer technique is acceptable for most bacterial urinary tract infections

Common bacterial isolates

- Escherichia coli is most common in dogs and cats accounting for $^1/_3$ to ½ of infections
- Gram positive organisms are second most common cause
    - Staphylococci and streptococci account for ¼ to $1/_3$of infections
- Bacteria accounting for remaining ¼ to $^1/_3$ of infections
    - Proteus spp., Klebsiella spp., Pasteurella spp., Enterobacter spp., Pseudomonas spp., Corynebacterium spp., and Mycoplasma spp.
- Laboratory evaluation
    - Should be normal unless associated with septicemia, azotemia due to renal failure or dehydration, or predisposing metabolic disease (e.g. hyperadrenocorticism, diabetes mellitus, hyperthyroidism, etc)
- Radiography, ultrasonography, endoscopy
    - Usually normal unless bacterial infection is associated with a predisposing cause
    - Struvite stones may form secondary to a urease-producing bacterial urinary tract infection
    - Renal pelvic and proximal ureteral dilation may be present with pyelonephritis

Treatment

- Treatment of bacterial urinary tract infection is dependent on whether the breech in host defenses is temporary or persistent
  - Antimicrobial agents
  - Supportive care, if necessary
  - Correct or control identifiable predisposing cause(s)
- Bacterial urinary tract infections can be classified as simple/uncomplicated, or complicated
- Simple/uncomplicated bacterial urinary tract infection
  - Bacterial urinary tract infection with no underlying structural, neurologic, or functional abnormality
  - Occurs in most dogs
  - Usually successfully treated with a 10-14 day course of the proper antimicrobial administered at appropriate dose and frequency
    - Recent study demonstrated effectiveness of a 3-day course of once-a-day, high dose, enrofloxacin
  - Clinical signs should resolve and urinalysis results should improve within 2 days



- Complicated bacterial urinary tract infection
  - Bacterial urinary tract infection associated with a structural, neurologic, or functional abnormality
  - Reproductively intact dogs, all cats, and animals with predisposing causes for bacterial urinary tract infections (e.g. renal failure, hyperadrenocorticism, diabetes mellitus, etc)
  - In addition, animals that have bacterial urinary tract infections that are relapses, reinfections, or superinfections
  - Pyelonephritis and prostatitis are examples of complicated bacterial urinary tract infections
  - Complicated infections should be treated for 3-6 weeks
    - Urine should be evaluated in the first week of treatment
    - Towards the end of therapy
    - 5-7 days after discontinuing antimicrobial treatment
  - Relapse
    - Recurrence of a bacterial urinary tract infection with the same organism
    - Usually occur within days to weeks of discontinuing antimicrobial treatment
    - Possible causes include
      - Choice of inappropriate antimicrobial agent
      - Antimicrobial agent given at inappropriate dosage, frequency, or duration
      - Complicating factors
    - A urine culture should be evaluated prior to instituting antimicrobial treatment and further diagnostic testing is indicated
  - Reinfection
    - Recurrence of a bacterial urinary tract infection with a different organism than what was initially present
    - Usually occur weeks to months after cessation of antimicrobial treatment
    - Although predisposing factors may be present, many animals that become reinfected do not have identifiable risk factors
    - If reinfections are infrequent (<3 per year), then each episode may be treated as an uncomplicated bacterial urinary tract infection unless a predisposing cause is identified
    - If reinfections occur with greater frequency (>3 per year), then the animal should be considered as having a complicated bacterial urinary tract infection and treated accordingly
      - Diagnostic testing for predisposing cause(s) should be done if not performed previously
      - Prophylactic antimicrobial treatment may be warranted in these animals
  - Complicating factors for recurrent UTIs
    - Breaks in host defenses
      - Local defenses
        - Recessed vulva
        - Deep-seated infection: 18.5% of cases had positive bladder wall or urolith culture with a negative urine culture
          - In our experience, 4% of bladder wall cultures are positive in dogs with negative urine culture who do not have uroliths
        - Anatomic defects (e.g. ectopic ureter)

- Indwelling urinary catheter
    - Concomitant antimicrobial administration decreases incidence of UTI
    - However, when UTI develops, it is highly resistant
    - We do not administer antimicrobial agents with an indwelling urinary catheter unless there is another reason
- Systemic host defenses
    - Associated complicating disease (e.g. diabetes mellitus, hyperadrenocorticism, hyperthyroidism, renal failure)
- Bacterial factors
    - Multi-drug resistance
    - Unusual organism (e.g. Corynebacterium, methicillin-resistant Staphylococcus)

Prevention

- Minimize bacterial contamination of the urinary tract and avoid or minimize conditions that impair host defenses
- Catheterization and endoscopy of the urinary tract always carries a risk of inducing a bacterial urinary tract infection
    - Magnitude of risk increases with degree of pre-existing urinary tract disease, amount of any additional injury caused by the procedure, and duration of the procedure
    - Risks can be decreased by being careful to perform invasive procedures only when necessary, by performing the procedure as atraumatically as possible, and by removing the catheter or endoscope as soon as possible
    - Catheter-induced bacterial urinary tract infection
    - Bacteria migrate along outside of catheter
    - Risk of bacterial urinary tract infection increases with pre-existing urinary tract disease
    - Risk is greater in animals with indwelling urinary catheters than in those that are intermittently catheterized
    - Despite the low risk, one study documented bacterial urinary tract infections in 7 or 35 dogs that were catheterized one time
    - Bacterial urinary tract infection occurs in>50% of animals after 4 days with an indwelling urinary catheter
    - Antibiotic treatment while an indwelling catheter is in place decreases the frequency of bacterial urinary tract infection; however, when infection occurs, the organisms exhibit a greater degree of antimicrobial resistance.
        - Therefore, do not give antimicrobials to animals with indwelling urinary catheters unless indicated for some other reason
        - Catheter-induced bacterial urinary tract infection may be minimized by
        - Using intermittent catheterization when possible
        - Removing indwelling urinary catheters as soon as possible
        - Using a closed collection system
        - Avoiding antimicrobial agent administration while catheters are inserted
- Cats with perineal urethrostomies are at high risk for developing bacterial urinary tract infections
- Resistant urinary tract infections

***Resistant E coli UTI* – Several options may exist depending on results of culture and sensitivity**

- Flouroquinolones (e.g. Enrofloxacin: 5-20 mg/kg PO q24h): May be effective when used at high
- Aminoglycosides: Are often an effective antimicrobial agent. Amikacin (cats: 10-15 mg/kg IV, IM, SQ q24h; dogs: 15-30 mg/kg IV, IM, SQ q24h) appears to be less associated with nephrotoxicity than gentamycin, but should not be given to animals with azotemia. It can be administered by owners at home
- Potentiated beta-lactams: may be tried if intermediate susceptibility is present. I usually use amoxicillin-clavulanic acid at a higher dosage (22 mg/kg PO q12h). Ampicillin-sulbactam may also be used (cats - 20-30 mg/kg PO q8-12h x 3-7 days; 5-11 mg/kg IM, SQ q8-12h; has been given 20-40 mg/kg IV q6-8h; dogs - 12.5 – 30 mg/kg PO q8-12h x 7 days; 6.6 -40 mg/kg IM, SQ q16-2h x 3-7 days; has been given 20-40 mg/kg IVq6-8h)
- Penems: Meropenem may be useful for highly resistant (8 mg/kg SQ q12h)
- 3rd generation cephalosporins: May be useful. Cefpodoxime (Simplicef) does not have as much activity as parenteral forms and may not be effective even with a favorable sensitivity pattern (5-10 mg/kg PO q24h)
- Cefovecin: A newer parternal long-acting cephalosporin has been shown to be effective against E coli in dogs and cats; however, effectiveness with resistant organisms is unknown (8 mg/kg SQ q14d)
- *Staphylococcus UTI (methicillin resistant)* – These appear to be more difficult to treat. With resistance to methicillin, beta lactam antibiotics even potentiated ones will not be effective. Staphylococci are inherently resistant to fluoroquinolones (as are most Gram positive cocci) even with a favorable sensitivity pattern.
- Chloramphenicol: monitor liver enzymes as can be hepatotoxic, GI side effects occur commonly (50 mg/kg PO q8h)
- Linezolid: An oxazolidinone antibiotic with activity against Gram + organisms. It is often effective against methicillin-resistant Staphylococci, but is expensive (10 mg/kg PO q12h)
- Vancomycin: Standard for treating methicillin-resistant Staphylococci, it is discouraged from being use because of potential for inducing resistance that may spread to human medicine (15 mg/kg IV q8h)

Enterococcus

Oftentimes Enterococcus UTI is not associated with clinical signs and there is suggestion that not treating may be better than treating. In some animals without clinical signs or urinalysis changes (pyuria, hematuria), no treatment with re-culture in 2 weeks may reveal eradication of the organism. Treatment should be considered for animals with active clinical infection or that are immunocompromised.

- Penicillins: may be sensitive to amoxicillin/ampicillin especially potentiated ones at higher dosages
- Inherently resistant to cephalosporins, flouroquinolones, trimethoprim-sulfa, erythromycin even if favorable sensitivity results
- Can combine amikacin with a penicillin
- Penems may be effective for E faecalis, but not E faecium infections
- Linezolid and vancomycin may be effective
- There is evidence that if a resistant UTI is not associated with clinical signs, that it may be better to not treat.

Prophylactic antimicrobial treatment may be indicated in animals with relapses or frequent reinfections

- Antimicrobial agent should be chosen based on urine culture and susceptibility pattern
- The agent is administered at ½ to $^1/_3$ of daily therapeutic dose and is usually given at night
- Urine should be re-cultured every 4-6 weeks
- If a "break through" infection does not occur during a 6 month period, then antimicrobial treatment can usually be discontinued
- Disadvantages of this approach include development of resistant bacteria and side effects of the antimicrobial agent

Methenamine is an effective preventative in select cases

- It is a cyclic hydrocarbon that is hydrolyzed to formaldehyde at pH < 6.5
- It is combined with an acidifying salt either hippurate (D: 500 mg PO q12-24h); C: 250 mg PO q12-24h) or mendelate (D, C: 10 mg/kg PO q6-12h) but additional acidification may be required
- It is effective against many organisms, but may cause systemic acidosis because it has acidifying properties
- It should not be used with renal failure

Nitrofurantoin (4 mg/kg PO q6-8h; prophylaxis: 3-4 mg/kg PO q24h)

- Has activity against many organisms
- Is not used much in veterinary medicine; therefore, susceptibility is high
- Complications include GI upset, hepatopathy, peripheral neuropathy

Estrogens

- May be helpful in female dogs with recurrent vaginocystitis
- May increase epithelial turnover keeping bacterial counts down
- No data
- Dose as with incontinence
    - Estriol: Start at a dose of 1 mg/dog PO q24h. If treatment is successful reduce the dose to 0.5 mg/dog PO. q24h. If treatment is unsuccessful increase to 2 mg/dog PO q24h. Alternate-day dosing can be considered once a response has been seen. The minimum effective dose is 0.5 mg/dog PO q24-48h. The maximum dose is 2 mg/dog PO q24h
    - Premarin: 20 ug/kg/d x 7 days; then q2-3d PO
    - DES: 0.1-1 mg/day x 5 days; then q3-7d PO
- Complications are uncommon

Urinary acidifiers do NOT work for prevention of bacterial UTI in dogs and cats

- Bacteria can live in pH values of 4.0 to 9.0
- Dogs and cats cannot achieve urine pH values of < 5.5 or > 9.0
- Therefore, it is not physically possible to acidify urine enough to prevent UTI's

Ecotherapeutics

- Ecotherapeutics include probiotics (live bacteria) and probiotics (fiber sources that select for certain strains of bacteria)
- The idea is to populate the GI tract with non-pathogenic "healthy" bacteria such as Bifidobacteria spp or non-pathogenic enteric bacteria
- Since bacterial UTI originate from distal urogenital tract bacteria and since these bacteria are primarily enteric bacteria, the premise is that changing the intestinal flora will result in changing of the distal urogenital tract bacteria
- These bacteria are not as "hearty" as the pre-existing normal bacteria; therefore, it is necessary to continue probiotics once you start
- There is minimal evidence that this aids in preventing UTI's; however, it does seem to help some dogs
- There are several veterinary probiotics (Forti-Flora, Prostora Maxx, ProViable); however, there are many more human probiotics.

- There is really no such thing as a “dog” or “cat” specific probiotic
- Usually want large numbers and multiple organisms
- VSL #3 contains most organisms and multiple organisms (450 billion per packet; 1/10 packet per 4.5kg)

Cranberries and cranberry extract

- The active ingredient in cranberries are proanthocyanidins
- Proanthocyanidins are found in cranberries, blueberries, and chocolate; however, only the proanthocyanidins found in cranberries are useful with bacterial UTI
- Proanthocyanidins bind to adhesins, primarily PapG pili, that are virulent factors involved with binding of the bacteria to uroepithelial cells
- PapG pilli are found on 25-50% of canine E coli, but not with other bacteria
- Therefore, proanthocyanidins might be helpful in preventing certain strains of E coli from binding to uroepithelia, but not all E coli and not all bacteria
- There is evidence in human medicine (nearly 2 dozen positive randomized, controlled clinical trials), but one study in dogs failed to show benefit; nonetheless, some dogs may benefit from proanthocyanidins found in cranberry extract

D-mannose is a sugar that may prevent bacterial adherence. It is also incorporated into the GAG layer and may prevent bacterial invasion into uroepithelial cells. We use Pure Encapsulation d-mannose at 1/8 (1/16 tspn) scoop for small dogs and cats, 1/4 scoop (1/8 tspn) for medium dogs, and 1/2 scoop (1/4 tspn) for large dogs q8h.

Urine Agony: Urolithiasis

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

- Urolithiasis is common in dogs and cats
- 99% of uroliths occur in the lower urinary tract
- Urolith formation is not a specific disease, but the sequelae to a group of underlying disorders
- Urolith formation occurs with sustained alterations in urine composition that promotes supersaturation of one or more substances in urine resulting in precipitation and subsequent organization and growth into uroliths
- Urolith formation is erratic and unpredictable emphasizing that several interrelated physiologic and pathologic factors are often involved
- Mere presence of uroliths, however, does not necessitate their removal
- Approximately 98% of uroliths occur in the lower urinary tract
- Composition of uroliths
- Approximately 80% of canine uroliths and 90% of feline uroliths are either struvite or calcium oxalate
- Calcium oxalate and struvite occur at approximately even frequency although struvite occurs more commonly now (slightly)
- The third most common type of mineral is urate
- Other types – including compound uroliths (uroliths composed of more than 2 minerals) occur less frequently
- Urolith formation is dependent on a combination of many factors
- Urine pH
- State of saturation – related to concentrations of minerals in urine
- Inhibitors and promoters of urolith formation
- Complexors
- Macrocrystalline matrix

Struvite urolithiasis

- Infection-induced struvite are the most common form occurring in dogs; whereas sterile struvite is the most common form occurring in cats
    - However, any animal that develops a bacterial urinary tract infection with a urease-producing micro-organism can develop infection-induced struvite uroliths
    - Sterile struvite uroliths have been documented to occur in dogs, but it is very rare

Dogs

- Struvite uroliths typically, but not always, form in female dogs (because of their higher risk for development of a bacterial urinary tract infection), and in dogs with immunosuppressive diseases or receiving immunosuppressive therapy because of their increased risk for bacterial urinary tract infections.
- They can occur at any age, but are more common in young adult dogs.
- They are the most common type of urolith in puppies (dogs < 1 year of age)

Cats

- Sterile struvite is the most common type of struvite urolith occurring in cats.
    - It typically occurs in young adult cats.
    - In older cats (>10 years) and in kittens (<1 year), infection-induced struvite urolith formation is more common than formation of sterile struvite uroliths because of their increased risk for development of a bacterial urinary tract infection
- Remember, crystalluria is not synonymous with urolithiasis.
    - In healthy dogs, more than 50% of urine samples will contain struvite crystals without a bacterial urinary tract infection and without subsequent urolith formation
    - Likewise, some animals with active stone disease will not have crystals; however, most animals with active struvite stone disease will be crystalluric

"Guesstimation" that is consistent with struvite uroliths

- Urine pH: alkaline
- Crystals: struvite
- Bacterial urinary tract infection:

    - Yes, if infection-induced struvite uroliths
    - Should be a urease-producing micro-organism
        - Typically Staphylococci spp
        - Occasionally Proteus spp
        - Rarely other bacteria such as Klebsiella and Streptococcus
        - Rarely Mycoplasma/Ureaplasma
        - Never Escherichia coli
    - No, if sterile struvite
        - Unless a secondary bacterial urinary tract infection has occurred
- Radiographic appearance
    - Density: radiodense
    - Size:
        - Infection-induced: typically variable sized including some fairly large stones
        - Sterile: typically small (<5-10 mm)
    - Surface contour: typically smooth
    - Shape:
        - Infection-induced: often pyramidal shaped, similar to river rocks
        - Sterile: usually round, but can be wafer-like
    - Number:
        - Infection-induced: usually many dozen
        - Sterile: usually small number (perhaps 1-a dozen or so)
- Serum and urine biochemical analysis
    - Often normal, especially in cats
    - In animals with infection-induced struvite, predisposing metabolic causes for bacterial urinary tract infection may be present
        - Cushing's disease
        - Diabetes mellitus
        - FeLV/FIV
- Signalment
    - Infection-induced:
        - Young to middle-aged adult female dogs
        - Pediatric or geriatric dogs and cats (due to predisposition to bacterial urinary tract infection
        - More common in females than males
    - Sterile:
        - Usually young adult cats (same is true in the few reported cases of dogs)
        - No gender or breed predisposition

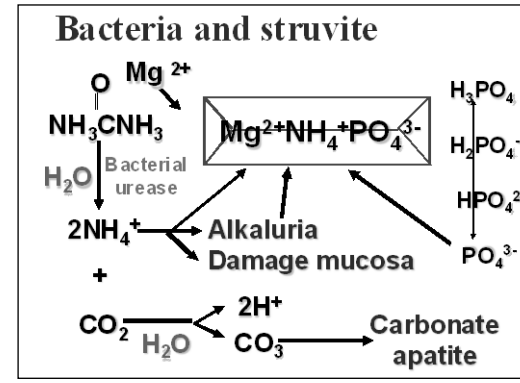
Etiologic and pathophysiologic points

Infection-induced struvite

- A urinary tract infection with urease-producing bacteria (usually Staphylococci and Proteus spp; rarely other bacteria and Ureaplasma/Mycoplasma) occurs
    - Results in urease-mediated metabolism of urea to ammonium and carbonate
- Ammonium comes from the ammonia liberated from urea buffering hydrogen ion in urine
    - Results in an alkaline pH
    - Changes ionization state of phosphorous
- Magnesium is typically present in low amounts in urine
- Phosphorous is present in high amounts and is a strong and important buffer (in acid-base metabolism) called "titratable acid"
- These conditions favor formation of uroliths containing struvite ($Mg^{2+}NH_4^+PO_4^{3-}$), with some "contaminant" minerals: calcium apatite and carbonate apatite
- Struvite is less soluble (more likely to precipitate) when the urine pH is > 6.8, and is more soluble (more likely to stay in solution) when the urine pH is < 6.8
- **REMEMBER: these are called infection-induced struvite stones**

Sterile struvite

- Sterile struvite typically forms in cats; however, it has been reported to occur rarely in dogs
- Sterile struvite uroliths are typically composed of 100% struvite and do not contain "contaminant" minerals
- The mechanism(s) for sterile struvite formation is not clear, although an alkaline urine pH is necessary
    - Persistent or recurrent alkaluria is a predisposing risk factor for sterile struvite formation
    - Because of the carnivorous nature of cats, a "post-prandial alkaline tide" occurs and can be profound
        - It is thought that with a high protein intake, a large amount of HCl is produced and excreted into the gastric lumen to begin digestion of protein (acid-mediated proteolysis)
        - This results in a metabolic alkalosis
        - Kidneys respond by excreting less acid and more base
        - This results in alkaluria
        - This is the reason most cat foods are "acidifying" – to minimize the post-prandial alkaline tide and prevent struvite formation



- Other factors have a role
    - Highly concentrated urine resulting in retention of urine and concentration of calculogenic minerals
    - High levels of magnesium and phosphorous in urine

Therapeutic points

- Overview of therapy
    - Eliminate existing uroliths
    - Eradicate or control bacterial urinary tract infection
    - Prevent recurrence of uroliths

Surgical removal – Will be discussed later
Minimally invasive procedures – Will be discussed later
Medical dissolution
Infection-induced struvite

- Can be dissolved medically, or removed physically (surgery or voiding urohydropropulsion) – or combinations
- Protocol:
    - Control and/or eradicate the bacterial urinary tract infection
    - Choose appropriate antibiotic
    - Must be administered during entire time of medical dissolution. Bacteria are trapped in matrix of urolith and released as the stone dissolves from the outer layers inwards (similar to an ice cube melting in a glass of water)
    - The struvite dissolution diet induces a diuresis, which may decrease efficacy of antimicrobial (although rarely are changes in dosage necessary)
    - Calculolytic diet (struvitolytic diet)
    - Currently, only 1 diet has data documenting its efficacy in medical dissolution of struvite – Hill's Prescription Diet s/d
    - Diet is:
        - Lower in protein (source of urea and therefore ammonia)
        - Lower in magnesium
        - Lower in phosphorous
        - Acidifying
        - Diuresis (to stimulate thirst and urine output)
- Although infection-induced struvite stones may dissolve with antibiotic therapy alone, it takes much longer than the combination of antibiotic and struvitolytic diet, and is less successful
- Average time for dissolution is 8 weeks

    - Monitor animal every 4 weeks
    - Urinalysis – should find aciduria, no crystalluria, no inflammation
    - Urine culture, if necessary
    - Survey abdominal radiography (at least a lateral view) to monitor dissolution
- Dissolution therapy should continue for 2-4 weeks beyond radiographic evidence of dissolution of uroliths to ensure all stones are dissolved
- Complications of medical dissolution
    - Recurrent urethral obstruction
    - Continued clinical signs of lower urinary tract disease (although signs typically resolve, except for polyuria/polydipsia, within 3-5 days of starting dissolution therapy)
    - Reaction to antimicrobial
    - Problems with diet
        - A very low protein diet – protein malnutrition may develop
        - Prolonged feeding of diet – it is not intended for long term consumption
        - Use cautiously if at all in pediatric patients, especially those in rapid growth phase
        - Contra-indicated in pregnant animals
        - Usually see an increase in alkaline phosphatase activity and a decrease in blood urea nitrogen concentration because of the low protein content
        - In addition to pregnant animals, contraindicated in:
            - Hypertensive patients or those that cannot tolerate a sodium load
            - Those with renal failure – acidifying, hypokalemia
            - Animals that cannot tolerate a high fat intake – diet is high in fat

An alternative dissolution protocol has been shown to be effective in > 80% of dogs

- In this protocol, the diet is not changed; instead a urinary acidifier (d,l-methionine; D: initial 100 mg/kg PO q12h) is administered in combination with an appropriate antibiotic for the organism responsible for struvite formation (typically Staphylococcus)
- Dissolution occurs in 4-8 weeks
- Advantage is that the diet does not require changing and the acidifier is safe
- Disadvantage is that in the one study, 2 dogs had a shell of calcium phosphate that appeared to impede dissolution – this could be due to "over" acidification

Sterile struvite

- Can be dissolved medically or removed physically
- Protocol:
    - Feed struvitolytic diet
    - Antimicrobials are not necessary unless a secondary infection is present (one that would not be associated with struvite formation)
    - Other aspects are similar to management of infection-induced struvite uroliths
- Sterile struvite uroliths typically dissolve in 2-4 weeks; therefore, at recheck at 4 weeks, uroliths may no longer be visible on survey abdominal radiographs
    - Feed diet for 2 to 4 weeks beyond medical dissolution

Prevention of struvite uroliths

- Successful prevention of struvite uroliths involves modifying risk factors to decrease risk of re-formation

Infection-induced struvite

- Most important component of prevention is preventing the bacterial urinary tract infection
- **REMEMBER: these are called infection-induced struvite**
- If predisposing risks for recurrent bacterial urinary tract infections cannot be modified, then treat the animal as having a complicated bacterial urinary tract infection, and take appropriate prophylactic steps (see notes on urinary tract infections)
- Dietary modification for prevention of infection-induced struvite uroliths is not warranted, and often not successful

Sterile struvite

- Dietary modification is often required to decrease risk of recurrent sterile struvite urolith formation
- Specific struvite preventative diets are modified to decrease risk

Calcium oxalate

Calcium oxalate accounts for 40-50% of all uroliths and > 85% of nephroureteroliths

Risk factors for calcium oxalate formation

- Increased urinary calcium excretion (hypercalciuria)
  - May result from hypercalcemia, GI hyperabsorption (excessive absorption of calcium from the GI tract), resorptive (excessive calcium resorption from bone), or renal leak (decreased calcium reabsorption from the distal tubule)
- Increased urinary oxalate excretion (hyperoxaluria)
  - May result from excessive absorption from the GI tract, excessive absorption from the GI tract due to deficiency of *Oxalobacter formigenes* (an enteric bacterial organism that metabolizes oxalate in the GI tract), and possibly from vitamin B6 deficiency (vitamin B6 is involved with oxalate metabolism)
- In a small study of Miniature schnauzers, GI hyperabsorption appears to be the most likely cause as urinary calcium excretion decreased with fasting
- Net result of risk factors is urinary oversaturation with calcium oxalate

Signalment

- Cats
  - Middle-aged or older
  - Males = females
  - Long-haired cats; Siamese and Ragdolls tend to form at young age
  - Overweight to obese body condition
- Dogs
  - Middle-aged or older
  - Males > females
  - Small breed dogs (e.g. Miniature schnauzers, Lhasa apsos, Yorkshire terriers, Bichons). Bichons tend to form at young age
  - Overweight to obese body condition
- Laboratory evaluation
- **Aciduria**
- **Hypercalcemia**
  - 20-35% of cats – usually idiopathic hypercalcemia
  - 4% of dogs – usually primary hyperparathyroidism
- **Crystalluria – not present in > 50% of cases with active stone disease**
- Renal azotemia – associated with nephroureteroliths

Management

- Medical protocols that will promote dissolution of calcium oxalate uroliths are currently unavailable; therefore, uroliths must be removed physically
- If **urethral obstruction** is present, uroliths should be retropulsed into bladder and removed
  - If necessary urethrotomy or urethrostomy may be performed
- **If no clinical signs, then minimize growth** in size and number and monitor for urethral obstruction and clinical signs
- **Removal of calcium oxalate uroliths**
  - **Surgery – cystotomy and / or urethrotomy / urethrostomy**
  - **Catheter-assisted retrieval**
    - Technique can be used to retrieve "sand" or small uroliths
      - Uroliths must be small enough to pass through the internal diameter of the lumen of the urethral catheter
      - It is important to "jiggle" the urinary bladder to get the sand/uroliths "in motion" in order to facilitate retrieval through the catheter
    - Complications
      - Occur very rarely
      - Iatrogenic bacterial urinary tract infection is most likely complication that might occur
      - Irritation from catheterization resulting in urethral spasm and lower urinary tract signs may also occur, but they occur rarely
  - **Voiding urohydropropulsion**
    - Voiding urohydropropulsion is a non-surgical technique for removing bladder stones from dogs and cats
    - The technique is based on the idea of using gravity to assist an animal in voiding out stones

- Indications
    - The largest diameter stone must be able to pass through the urethra at its narrowest luminal diameter
        - We have retrieved stones with the following sizes:
            - 10 mm - 7.4 kg F / S K9
            - 5 mm - 9 kg M / C K9
            - 5 mm - 4.6 kg F / S Fel
            - 1 mm - 6.6 kg M / C FelIt will not work in animals that present with urethral obstruction
- Contraindications
    - Animals that present with urethral obstruction due to stones
    - Animals that have urethral outflow obstruction such as strictures, tumors
    - Do not perform in animals that have had a cystotomy in the previous 14 days – the bladder incision may not be strong
    - Use caution when applying pressure on the bladder in animals with a bacterial cystitis as this may cause reflux of infected urine up the ureters into the kidneys
    - Animals with other more serious disease should be stabilized or treated
    - Complications
    - Hematuria occurs commonly
        - In dogs, this usually subsides in a couple of hours
        - In cats, this may persist for 12-24 hours
    - Urethral obstruction may occur if one or more stones are larger than the smallest diameter of the urethra
    - Bacterial urinary tract infection occurs uncommonly, but may occur secondary to poor technique and urethral catheterization
    - Bladder and/or urethral rupture could occur, but is very rare
- Voiding urohydropropulsion can be used in combination with other treatment modalities for bladder stone disease
    - Stones amenable to medical dissolution can be dissolved to a size where they can be retrieved using voiding urohydropropulsion
    - Stones that are accidentally left behind at surgery may be retrieved with this technique if they are small enough
    - This technique can be done at time of induction for a cystotomy. If all stones are retrieved then the animal can be recovered. If not, then proceed with cystotomy.

Cystoscopy and retrieval and laser lithotripsy

- Cystoscopy can be performed using rigid cystoscope (in female dogs and cats) or flexible cystoscope (in male dogs)
    - A small "semi-rigid" cystoscope is available for use in male cats; however, due to its size (1 mm) there is no operating channel
        - This permits visualization of the lower urogenital tract
        - Procedures such as biopsy, urolith retrieval, injections, and use of laser can be performed through the operating channel
    - In larger male dogs, a flexible endoscope may be used for visualization
    - In female cats and dogs, a 1.9mm, 2.7mm, or 4.0mm rigid cystoscope is used
    - I perform cystoscopy usually with the patient in dorsal recumbency
        - Requires general anesthesia
        - Fluid for instillation through the scope for distention of the lower urogenital tract and for visualization

Cystoscopic retrieval of uroliths

- Baskets and graspers can be inserted through the operating channel of the cystoscope for removal of uroliths
    - They must be small enough to be extracted through the most narrow portion of the urethra

Laser lithotripsy

- Laser lithotripsy can be used to manage bladder stones
- Cystoscopy is performed and a laser fiber – usually a Ho:YAG laser – is inserted through the operating channel
- The laser energy is used to fragment the stone into small fragments that can be retrieved
- Complications are rare; however, trauma and perforation of the urinary bladder has been reported

Cystoscopic-assisted cystotomy

- A cystoscopic-assisted cystotomy is similar to laparoscopic removal
- A small incision is made on ventral midline
    - In male dogs, the incision is made just cranial to the preputial reflection
- The urinary bladder is grasped and brought to the incision edge of the linea where it is sutured with a continuous pattern of 2-0 or 3-0 Monocryl
- A stab incision is made and a rigid cystoscope is inserted into the urinary bladder

- Stones are retrieved using instruments passed through the cystoscope
- The urinary bladder is closed with a single layer of 2-0 or 3-0 Monocryl, the linea closed with 2-0 or 3-0 PDS, and the skin and SQ closed with 2-0 or 3-0 Monocryl in a continuous intradermal pattern
- Patients go home the same day

Prevention

- Calcium oxalate uroliths are recurrent; therefore, preventative measures are warranted
  - @ 8% recurrence at 6 months
  - @ 35% recurrence at 1 year
  - Recurrence increases with subsequent years
  - "**Pseudorecurrence**" refers to leaving uroliths behind after a procedure is performed
    - Occurs in 15-20% of cystotomies

With hypercalcemia, potential causes should be investigated.

- 4% of dogs with calcium oxalate uroliths have hypercalcemia – usually due to primary hyperparathyroidism
- 20-35% of cats with calcium oxalate uroliths have hypercalcemia – usually idiopathic in nature

Management

The goal of prevention is lower the urinary saturation for calcium oxalate by decreasing urinary levels of calcium and oxalate and by increasing urine volume in order to dilute the minerals

Cats with hypercalcemia

- Feed a high fiber, mineral restricted diet
- Administer an alkalinizing agent (Potassium citrate)
  - Citrate is an inhibitor of calcium oxalate crystallization and formation
  - In cats with idiopathic hypercalcemia, we have had success feeding a higher fiber diet (Hill's Prescription Diet Feline w/d) and administering potassium citrate (see below)

Cats without hypercalcemia

- Feed a diet that induces a diuresis, is mineral restricted, and induces a neutral to alkaline urine pH
- There are several "multiple use" feline diets formulated to prevent struvite and calcium oxalate
  - Prescription Diet c/d Multicare
  - Royal Canin S/O
  - Purina CNM UR st/ox
- S/O and UR are higher in sodium than c/d
- In a study comparing these 3 diets, they each induced a similar degree of urine undersaturation with calcium oxalate albeit by different mechanisms
- Data from clinical studies is lacking, although in one clinical study of 10 cats with naturally-occurring calcium oxalate bladder stones, consumption of Prescription Diet Feline c/d^{oxl} decreased urinary saturation level to the low end of the metastable range
- Data from healthy, non-urolith-forming cats have demonstrated decreased urinary saturation with calcium oxalate when cats consumed c/d^{oxl} or S/O

Dogs

- Feed a diet that is mineral restricted, diuresing, and alkalinizing
  - Prescription Diet U/d
- This is an "ultra-low" protein diet originally formulated for "uremic" dogs
  - It is also low in minerals, has increased vitamin D, has increased B vitamins, and is very alkalinizing
    - Royal Canin S/O
    - Royal Canin s/o has been shown to decrease urine saturation with calcium oxalate but no clinical studies have been done
- These diets are higher in fat than maintenance foods.
- Can feed a higher fiber diet and administer the alkalinizing agent, potassium citrate

Pharmacologic management

Potassium citrate (initial: 75 mg/kg PO q12h)

- Citrate is an inhibitor of calcium oxalate crystal formation because it forms a soluble salt with calcium
- Oral potassium citrate may be beneficial in managing calcium oxalate uroliths because it is a calcium oxalate inhibitor and because it is alkalinizing in nature
- Dosage is titrated to achieve a urine pH of approximately 7.5
- Calcium oxalate preventative diets contain potassium citrate

Vitamin B6 (2-4 mg PO q24h)

- Vitamin B6 increases metabolism of glyoxylate, a precursor of oxalic acid, to glycine
- Whether vitamin B6 deficiency occurs in adult animals, especially cats, with calcium oxalate uroliths is unknown, but unlikely
- One study in adult calcium oxalate forming dogs showed lower plasma B6 levels when compared with non-urolith forming dogs
- Vitamin B6 supplementation is inexpensive and safe and should be considered in pets that have difficult to control uroliths

Thiazide diuretics (hydrochlorothiazide: 1-4 mg/kg PO q12h; chlorothiazide: 20-40 mg/kg PO q12h)

- By inducing a diuresis and decreasing urinary calcium excretion, thiazide diuretic administration may be beneficial in pets with difficult to control calcium oxalate uroliths
- Thiazide diuretics decrease urinary calcium excretion in human beings, dogs, and cats
- In cats, thiazide diuretics have been shown to decrease urinary saturation for calcium oxalate in healthy cats only and they appear safe.
- One 2-week study in calcium oxalate urolith forming dogs demonstrated decreased urinary calcium excretion
- Diuretic administration may also be associated with dehydration and electrolyte imbalances and should be used cautiously in animals with renal failure

Other agents

- **Glucocorticoids** have been recommended to decrease blood calcium concentrations in cats with idiopathic hypercalcemia; however, they do so by increasing urinary excretion
- **Bisphosphonates** have been recommended for cats with idiopathic hypercalcemia; however, no studies have been published.
- **Alendronate** (2 mg/kg PO q7d; most cats respond to 10 mg total dose. Administer at least 6ml of water after administration and butter lips to increase salivation and increase transit as esophagitis and stricture may occur. Beneficial effect usually seen in 3-4 weeks.

Urine a Mess:
Micturition Disorders

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

1. Micturition refers to the process of storing and periodically voiding urine.
    a. Disorders of urine storage usually lead to urinary incontinence, whereas disruption of urine voiding leads to incomplete emptying, dysuria, or urine retention
    b. Micturition is a complex integration of central, sympathetic, parasympathetic, and somatic nervous systems, with resultant muscular activity
    c. The two functional units of the lower urinary tract include the reservoir/pump (urinary bladder) and the continence/conduit (urethra).
    d. The urinary bladder and proximal urethra are composed of smooth muscle and are thus under autonomic nervous system control while the distal urethra is composed of skeletal muscle and thus under somatic nervous system control

BOTTOM LINE:
PARASYMPATHETIC PROMOTES PEEING
SYMPATHETIC STIMULATES STORAGE

2. Disorders of micturition
    a. Several different ways of classifying
        i. Storage vs voiding
        ii. Full bladder vs empty bladder
        iii. Neurogenic vs myogenic
    b. Important to establish status of urinary bladder contractile force and patency of urethral outlet, determine whether disorder is primarily neurogenic or myogenic, and determine underlying etiology or contributing factors
        i. History and signalment
            1. Age
            2. Gender
            3. Reproductive status
            4. Prior neurologic disease
            5. Trauma or surgery to urinary tract or nervous system
            6. Water intake
            7. Urination habit
        ii. Physical examination
            1. Complete examination
            2. Complete neurological examination
                a. Mental status
                b. Gait
                c. Spinal reflexes
                d. Cranial nerve reflexes and responses
            3. Examine external genitalia
            4. Bladder size and tone prior to a voiding urination
            5. Digital rectal exam (all dogs; cats if sedated)
            6. Digital vaginal exam (dogs; cats if sedated)
            7. Observe urination if possible
                a. Does animal sense when bladder is full?
                b. Does it posture appropriately to void?
                c. Is urine stream normal?
                d. Does animal continue to attempt to void after stream has stopped?
                e. How does urinary bladder palpate after voiding?
        iii. Diagnostic testing
            1. Urinalysis and urine culture
            2. +/- CBC, serum biochemical panel
            3. +/- Infectious disease testing (FeLV, FIV, etc)
            4. +/- Imaging
                a. Survey radiographs
                b. Contrast studies
                c. Ultrasound
            5. +/- Cystoscopy or exploratory
            6. +/- Neurologic testing

a. Myelogram
b. MRI or CT

7. +/- Urinary system functional testing
    a. Cystometrogram
    b. Urethral pressure profile

c. Problems with storage
    i. Bladder overactivity
        1. Due to "hyperexcitability" of storage phase -> results in inability to permit adequate bladder filling because of "urgency"
            a. Animals have increased frequency of urination, pollakiuria, inappropriate urination
            b. Often urethral irritation or spasm is present
            c. Examples: cystitis, urocystolithiasis, chemical stimulation (cyclophosphamide)
        2. Treatment: RELAX bladder
            a. Antimuscarinic agents (propantheline, oxybutynin, tolterodine) and antispasmodic agent (oxybutynin, flavoxate, tolterodine)
                i. Decrease detrusor activity and have urethral anti-spasmodic effects
                ii. May help with refractory incontinence by increasing urine storage
            b. Tricyclic antidepressants: imipramine, amitriptyline (?)
                i. May improve bladder storage by several mechanisms including anticholinergic, alpha-adrenergic, and beta-adrenergic effects
    ii. Bladder atony
        1. Due to neurogenic or myogenic causes
            a. "Upper motor neuron bladder"
            b. Bladder overdistention
            c. Animal may or may not posture to urinate with a distended bladder
        2. Treatment: STIMULATE bladder (Should almost always relax urethra at same time)
            a. Manage large over-distended bladder with urinary catheterization
            b. Bethanechol
                i. Parasympathomimetic with direct cholinergic activity
                ii. Stimulates or augments smooth muscle contraction
            c. Metoclopramide?
            d. Cisapride?
            e. When pharmacologically stimulating bladder contraction consider relaxing urethra
            f. Manual expression

d. Problems with voiding
    i. Increased outlet resistance
        1. Functional vs mechanical
            a. "Upper motor neuron" lesion
            b. Urethral spasm
            c. Outlet obstruction (mass, stone, etc)
            d. Animal often postures to urinate but cannot void or voids a small amount
        2. Treatment: RELAX urethra
            a. Manage large over-distended bladder with urinary catheterization
            b. Alpha adrenergic antagonists: phenoxybenzamine, prazosin
                i. Sympatholytics
                ii. Tamsulocin is used in humans and experimentally in dogs at 1-100 ug/kg IV and PO. Dosage of 1-10 ug/kg produced effect – consider 10 ug/kg PO q24h
            c. Skeletal muscle relaxants: diazepam, dantrolene, baclofen
                i. NOTE: external urethral sphincter not as important as internal urethral sphincter
            d. Clean intermittent catheterization
            e. Chronic catheters (urethral or cystostomy)
            f. *Urethral stents
    ii. Decreased outlet resistance (urethral incompetence)
        1. Neurogenic or myogenic
        2. Most common cause is urethral sphincter mechanism incompetency in female dogs
            a. Uncommon in male dogs or cats and male dogs
            b. In these animals, search for other causes
        3. Animal "leaks" urine
        4. Treatment: STIMULATE urethra
            a. Alpha agonists – phenylpropanolamine, pseudoephedrine
                i. Continence in 85-90%

ii. Once a day treatment may be as effective as three times a day administration with fewer side effects

b. Reproductive hormones
    i. Estrogens
        1. Increase alpha adrenergic receptor responsiveness and improve urethral vascularity and other mucosal characteristics
        2. Usually given as loading dose and then lowest maintenance dose
        3. Safe and reasonably effective (40-65%0
        4. Estriol (Incurin) is the only approved estrogen for use in dogs and is reported to have a 93% excellent response rate
    ii. GnRH analogs
        1. Chronically unsuppressed FSH and LH release (due to lack of negative feedback) in ovariectomized dogs may contribute to urinary incontinence
        2. Administration of GnRH analogs paradoxically reduce FSH and LH over time
        3. Was found effective in 12/13 dogs in one study and in another study 9/23 dogs were continent from 70-575 days with another 10/23 having partial response; however, the 23 dogs also responded to PPA

c. Urethral bulking
    i. Involves injection of an agent submucosally in the proximal urethra via cystoscopy
        1. Thought to create artificial urethral cushions improving urethral closure (coaptation)
        2. Also functions as central filler volume increasing length of smooth muscle fibers and closure power of internal urethral sphincter
        3. There are no bulking agents available for use in veterinary medicine. Historically, glutaraldehyde cross-linked collagen was used, but has been withdrawn from market. A study with polydimethylsiloxane has promising results.

d. Artificial sphincters/urethral occluding devices
    i. A urethral occluding device is similar to a blood pressure or vascular cuff
    ii. It is placed surgically around proximal urethra with a loose fit
    iii. A tube connects the device with a subcutaneously implanted injection port, which provides a means to increase pressure within the device and therefore urethral pressure in area of internal urethral sphincter
    iv. Continence rates are high; however, they may require adjustment with time
    v. Urethral obstruction and irritation with clinical signs may occur

e. Surgical techniques: slings, plication, culposuspension

iii. Reflex dyssynergia
    1. Incoordination between bladder contraction and urethral relaxation
    2. Animal usually postures normally, initiates a good stream, but stream stops yet animal continues to posture and attempt to void
        a. Treatment involves relaxing urethra
        b. If bladder does not completely empty despite urethral relaxation, then add bladder stimulant

iv. Paradoxical incontinence
    1. Outflow obstruction resulting in bladder overdistention
    2. Increased bladder pressure results in “leaking” of urine through or around obstruction
    3. Animal dribbles urine with a full bladder and is unable to void
    4. May be due to functional or mechanical outflow obstruction and is often associated with bladder atony

Table. Drugs used to manage dogs and cats with micturition disorders.

Agent	Mechanism of action	Recommended dosage	Adverse effects
Agents used to increase urinary bladder contractility			
Bethanechol	Parasympathomimetic; direct cholinergic activity	D: 5-25 mg PO q8h C: 1.25-7.5 mg PO q8h	Nausea, vomiting, salivation
Metoclopramide	Prokinetic; sensitizes to acetylcholine	D, C: 0.2-0.5 mg/kg PO q8h	Behavior changes
Agents used to decrease urinary bladder contractility			
Propantheline	Parasympatholytic; acetylcholine blockade	D: 7.5-30 mg PO q8h C: 5-7.5 mg PO q8h or 7.5 mg PO q72h	Nausea, vomiting, constipation, sedation, increased ocular pressure
Oxybutynin	Parasympatholytic; antispasmodic; detrusor relaxation	D: 1.25-5 mg PO q8-12h C: 0.5-1.25 mg PO q8-12h	Nausea, vomiting, urine retention, diarrhea, sedation
Flavoxate	Direct smooth-muscle relaxant	D: 100-200 mg PO q6-8h	Weakness
Dicyclomine	Anti-muscarinic	D: 10 mg PO q6-8h	Nausea, vomiting, constipation, sedation, increased ocular pressure
Imipramine	Tricyclic antidepressant with anticholinergic, alpha-and beta-agonist effects, detrusor smooth muscle relaxation and urethral muscle contraction	D: 5-15 mg PO q12h C: 2.5-5 mg PO q12h	Seizures, tremors, tachycardia, hyperexcitability
Amitriptyline	Tricyclic anti-depressant	D: 2.2-4.4 mg/kg PO q12h C: 0.5-1 mg/kg PO q24h	Sedation, anticholinergic effects
Agents used to increase urethral resistance			
Estriol (Incurin)	Reproductive hormone	D: 0.5-2 mg PO q24h initially; followed by 0.5-2 mg PO q2-3d	
DES	Reproductive hormone	D (females): 0.1-1 mg PO q24h for 5 days (approximately 0.2 mg/kg) followed by 0.1-1 mg PO q7d	Signs of estrus, bone marrow suppression
Premarin	Reproductive hormone	D: 20 mcg/kg q24hr x 7-10d; then q1-3d	
Testosterone propionate	Reproductive hormone	D (males): 2.2 mg/kg SQ or IM q2-3d C (males): 5-10 mg IM as needed	Aggression, prostatic disease, perineal hernia
Testosterone cypionate		D (males): 2.2 mg/kg IM q30d or 200 mg IM q30 d	
Phenylpropanolamine	Alpha agonist; urethral smooth muscle contraction	D: 12.5-50 mg PO q8h; 1-2 mg/kg PO q8h C: 1.0-1.5 mg/kg PO q8h	Anxiety, cardiac arrhythmias, anorexia, hypertension
Ephedrine	Alpha agonist; urethral smooth muscle contraction	D: 1.2 mg/kg PO q8h or 5-15 mg PO q8h C: 2-4 mg/kg PO q6-12h or 2-4 mg PO q8h	Anxiety, cardiac arrhythmias, hypertension
Agents used to decrease urethral resistance			
Phenoxybenzamine	Alpha antagonist; urethral smooth muscle relaxation	D: 5-15 mg PO q12h C: 2.5-10 mg PO q24h D, C: 0.25 mg/kg PO q12h	Hypotension, tachycardia, vomiting, diarrhea, increased intraocular pressure
Prazosin	Alpha antagonist; urethral smooth muscle relaxation	D: 1 mg/15kg PO q12-24hr C: 0.25-0.5 mg PO q12-24h	Hypotension
Tamsulocin	Alpha antagonist, urethral smooth muscle relaxation	D: 0.03-0.2 mg/10kg q24h	Hypotension
Doxazosin	Alpha antagonist, urethral smooth muscle relaxation	D: 0.1-1.0 mg/kg PO q24h	Hypotension
Terazosin	Alpha antagonist; urethral smooth muscle relaxation	D, C: 0.5-5 mg PO q12-24hr	Hypotension

Terazosin	Alpha antagonist, urethral smooth muscle relaxation	D: 0.1-1.0 mg/kg PO q24h	Hypotension
Fiduxosin	Alpha antagonist, urethral smooth muscle relaxation	D: 0.1-3.0 mg/kg PO q24h	Hypotension
Diazepam	Striated muscle relaxation; central nervous system depressive effect	D: 0.2 mg/kg PO q8h or 2-10 mg PO q8h C: 2.5-5 mg PO q8h or as needed or 0.5 mg/kg IV	Sedation, paradoxical excitement
Dantrolene	Striated muscle relaxation; direct action	D: 3-15 mg/kg PO q24h divided or 0.5-1 mg/kg PO q8h C: 0.5-1 mg/kg PO q12h	Weakness, hepatotoxicity
Acepromazine	Urethral muscle relaxation by neuroleptic effect; alpha antagonism	D: 0.1-2 mg/kg PO q8-12h C: 0.1 mg/kg IV or 1.1-2.2 mg/kg PO q12h	Sedation, hypotension, seizures
Aminopromazine	Smooth muscle relaxation	D, C: 2.2 mg/kg PO q12h	

Urine a Losing Situation: Proteinuria

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Key clinical diagnostic points

- Glomerulus represents a barrier and functions to filter plasma
  - Components include
    - Fenestrated endothelium of glomerular capillary
    - Glomerular basement membrane
    - Podocytes containing negatively-charged slit diaphragms
    - Filtration is limited to molecules that are >68,000 Daltons
  - Function
    - Size and charge determine the "filterability" of a substance from plasma into Bowman's space
    - Size limit is 68,000 to 70,000 Daltons
      - Albumin is 65,000, but its negative charge precludes filtration
    - From Bowman's space, the filtrate continues through the tubules
    - For solutes to pass freely through the glomerulus, filtration of a solute is a function of GFR and plasma concentration of the solute:
      - GFR = K_f X net filtration pressure
      - K_f is the permeability coefficient, which is a function of surface area and permeability
      - Net filtration pressure is the sum of Starling's forces (hydrostatic and oncotic) between plasma and Bowman's space
        - Hydrostatic pressure in glomerular capillaries has greatest influence on GFR – it is about 60 mmHg
        - Net filtration pressure is typically about 10 mmHg
- Diagnosis
  - Finding of proteinuria should be interpreted in light of other findings on urinalysis
    - Always examine urine sediment to rule-out inflammation, infection, or hemorrhage, which is associated with proteinuria
    - Proteinuria with an inactive sediment may indicate glomerular disease
  - Qualitative methods
    - Dipstick pad
      - Part of most (perhaps all) urine dipsticks
      - Colorimetric method
      - Amino groups of proteins bind to an indicator in filter paper producing a color change
      - Change is graded subjectively to a standard
      - Most sensitive to presence of albumin
      - Range: 30-3,000 mg/dl
        - Graded as negative, trace, and 1+ to 4+ depending on intensity of color change
      - Recent studies suggest this analytical pad is not very good – many false positives and false negatives – and additional testing for proteinuria should be performed when there is a concern
        - False positives
          - Alkaline urine pH (> 7.5)
          - Contamination of urine with quaternary ammonia compounds (eg some cleaners and disinfectants)
          - Prolonged contact with urine
          - Any pigment in urine may absorb into the pad
        - False negatives
          - Very dilute urine
          - Very acidic urine
          - Presence of some abnormal proteins (eg Bence Jones proteins (myeloma proteins))
    - Sulfosalicylic acid
      - 3-5% sulfosalicylic acid solution is mixed with an equal volume of urine
      - Turbidity that results from acid precipitation of protein is evaluated
      - Good for albumin and Bence Jones proteins
      - Range: 5-5,000 mg/dl
      - False positive
        - Radiocontrast agents
        - Certain drugs (eg penicillin, cephalothin, sulfonamide, thymol)

- False negative
    - Very alkaline urine
    - Very dilute urine
- Quantitative methods
  - Microalbuminuria
    - Recently, an "early diagnosis of renal disease" (ERD) test has become available
      - Measures micro-albuminuria – range of 1 to 30 mg/dl
      - Less than detectable by dipstick
      - May be useful in detecting early renal disease
        - 19% of healthy dogs have micro-albuminuria
        - 36% of dogs seeking veterinary care have micro-albuminuria
        - True with congenital or induced glomerular disease
        - No data (yet) concerning spontaneously occurring non-glomerular renal disease
        - Used in human beings for detection of early renal disease due to diabetes mellitus and hypertension (small capillary (glomerular) damage)
      - Despite inherent issues, there are indications for determining microalbuminuria including
        - Not overtly proteinuric, but clinical disease likely to be associated with proteinuria
        - Not overtly proteinuric, middle-aged or older
        - When conventional tests for proteinuria are equivocal or conflict
        - Dogs and cats known to be at risk for developing a glomerulopathy
  - Verification of significant proteinuria
    - Evaluate urine dipstick in light of urine sediment examination (eg "clean" or "dirty" sediment)
      - As little as 10% whole blood (volume/volume) can result in a positive dipstick reaction
      - Inflammation can result in proteinuria even without hematuria
        - If proteinuria is present with a "quiet" sediment and in a dilute urine, consider doing a urine culture
        - A urinary tract infection can result in very large amounts of protein in urine due to exudation
    - Also, evaluate in light of urine specific gravity and urine pH
      - A "trace" amount of protein in a concentrated urine is probably less significant or even an artifact than if it occurs in very dilute urine
      - Likewise, a "trace" amount of protein in a very alkaline urine pH could be an artifact due to the alkalinity of the sample
    - If proteinuria is present with a "clean" sediment and a bacterial urinary tract infection has been ruled-out, then the degree of proteinuria should be verified and quantitated
      - Urine protein-to-urine creatinine ratio (UPC)
        - A spot urine sample can be collected by any method (as long as hemorrhage is not induced)
        - Creatinine concentration (mg/dl) and protein concentration (mg/dl) is determined
        - The result is a unit-less number
          - Normal UPC in dogs is <0.5:1.0 and cats < 0.4:1.0
          - Suspect UPC is 0.4/0.5:1.0 to 1.0:1.0
          - Significant proteinuria occurs when UP:UC is > 1.0:1.0
    - With CKD
      - Relative risk of mortality is 3 times higher when UPC > 1
      - Risk of adverse outcome increased by 1.5-fold for every 1 unit increment of UPC above 1

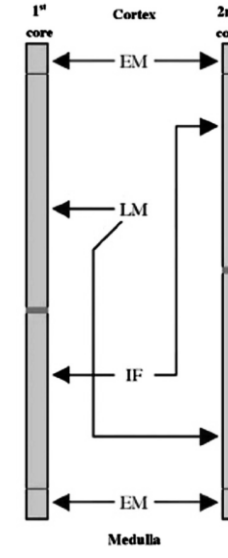
- How is proteinuria investigated?
  - Make sure not artifact
    - False positives: pigment, alkaluria
  - Voided sample?
    - If yes – then check cystocentesis (r/o extra-urinary)
  - Evaluate plasma proteins and color
    - r/o pre-renal (e.g. hyperglobulinemia, hemolysis, etc)
  - Evaluate urine sediment
    - * * * Active vs inactive sediment (post-renal) * * *
      - If active and signs of upper tract dz -> nephritis
      - If inactive -> evaluate further (renal)
  - Renal
    - If minimal: re-evaluate in 2 weeks (functional ?)
    - Persistent -> UPC
      - UPC < 2: glomerular or tubular
      - UPC > 2: glomerular

What is the clinical significance of renal proteinuria?

- Proteinuria ≠ renal proteinuria
  - Pre-renal
    - Physiologic proteinuria (exercise, stress, fever, seizures, venous congestion, etc)
    - Overload proteinuria (hyperproteinemia, myoglobinemia, and hemoglobinemia)
  - Post-renal – Most common cause
    - Inflammation
    - Infection
    - Hemorrhage
- When renal proteinuria = renal disease
  - Will the kidney disease lead to morbidity or mortality
  - Is the kidney disease a sign of some underlying condition
  - Is therapy indicated to prevent additional renal or systemic injury
  - Types
    - Glomerular
    - Tubular
    - Interstitial

Renal biopsy

- Indications
  - Renal biopsy is most useful with
    - Nephrotic syndrome/glomerular disease
    - Mass lesions/neoplasia
    - Acute renal failure (for diagnosis and prognosis)
    - Patients with proteinuria
    - Cats with feline infectious peritonitis (diagnosis)
    - Suspected familial or congenital renal disease
    - Perinephric cysts (fine needle aspiration only)
    - Investigation
  - Renal biopsy may be useful with
    - Infectious renal disease (fine needle aspiration of tissue or pelvic urine)
    - Culture of pelvic urine
    - Slowly progressive tubulointerstitial disease
    - Patients with undiagnosed renal hematuria
  - Renal biopsy is not helpful or should not be performed with
    - Chronic renal failure (unless associated with neoplasia)
    - Polycystic kidney disease
- *When performing a renal biopsy, the core of tissue is divided for histopathology (light microscopy = LM), immunofluorescence (IF), and electron microscopy (EM)*



Texas A&M University
Texas Veterinary Renal Pathology Service
For assistance, contact:
Dr. George E. Lees
Email: glees@cvm.tamu.edu
Telephone (TAMU Small Animal Clinic):
+1-888-778-5523 (toll free), or +1-979-845-2351

Conservative approach

- Serially monitor urinalysis, UPC, and renal function
- Patients with stable or improving mild proteinuria (UPC < 2)
- If severe or progressive proteinuria – investigate further
  - Identify and treat inciting disorder
  - Limit proteinuria
    - Limits albumin loss and consequences of hypoalbuminemia
    - Renoprotective
      - Proteinuria is nephrotoxic
      - Activates fibrosis and inflammatory pathways

General clinical signs of glomerular disease

- Vary with severity of disease and underlying cause, if any
- Azotemia may or may not be present and is unassociated with the degree of proteinuria and hypoalbuminemia
- Mild to moderate proteinuria results in serum albumin concentrations >1.5 g/dl, but < 2.5-3.0 g/dl
  - At this level, clinical signs often include polyuria, weight loss, and lethargy
  - With severe or heavy proteinuria, serum albumin is < 1.5 g/dl, and clinical signs are more severe
- In addition to aforementioned signs
  - Muscle wasting

- Edema/ascites
- Nephrotic syndrome
    - Occurs with severe proteinuria and is characterized by proteinuria, marked hypoalbuminemia, hypercholesterolemia, hyperlipidemia, and edema

Therapy

- Treatment is often frustrating and biologic course is variable
- Goals of therapy are similar to those for CKD with additional goal of increasing serum albumin concentration and minimizing likelihood of nephrotic syndrome
- Treatment includes:

Treat the underlying cause, if it can be identified

- Two major glomerulopathies
    - Glomerulonephritis
        - Glomerulonephritis (GN) is better termed glomerulopathy
            - "-itis" implies inflammation, which typically occurs, but is not always present depending on cause of the glomerular disease (eg congenital renal disease, glomerulosclerosis)
        - *Many causes that have been described, primarily in dogs:*

Familial
Doberman pinscher, Samoyeds (X-linked dominant), Bull terrier (autosomal dominant), soft-coated Wheaton Terrier, Greyhound, Burmese mountain dog, Rottweiler, English Cocker spaniel (autosomal dominant), Norwegian Elkhound, Brittany spaniel (autosomal dominant), Deficiency of C3 results in recurrent bacterial urinary tract infections and membranoproliferative GN
Neoplastic
Lymphosarcoma, mastocytosis, hemangiosarcoma, adenocarcinoma
Infectious
Bacterial endocarditis, infectious canine hepatitis, brucellosis, dirofilariasis, ehrlichiosis, systemic fungal or bacterial infection, feline infectious peritonitis, feline leukemia virus
Inflammatory
Systemic lupus erythematosus, chronic pancreatitis, chronic pyoderma, chronic otitis externa, polyarthritis
Miscellaneous
Hyperadrenocorticism, diabetes mellitus, chronic glucocorticoid treatment, systemic arterial hypertension, idiopathic

- Any process resulting in antigenic stimulation may result in GN
- In most cases, underlying cause(s) is/are not identified; therefore, most are classified as idiopathic
- Glomerulopathies may be immune-mediated or non-immune-mediated:
- Immune-mediated GN:
    - Accounts for @ 48% of renal proteinuria in dogs; amount in cats…?
    - *Etiopathogenesis is related to presence of immune complexes in glomerular capillary walls*
    - Histologically, GN can be classified as:
        - Proliferative:
            - Mesangial and epithelial cell proliferation and infiltration (primarily neutrophils)
            - Cellular proliferation compresses glomerular capillaries resulting in decreased blood flow and GFR
        - Membranous:
            - Thickening of basement membrane due to subepithelial deposition of immune complexes
            - Membranoproliferative:
                - Combination of membranous and proliferative GN
    - Immunofluorescence can be used to document the immune-mediated nature; however, few labs do this technique and even fewer do it well
        - Prognosis is thought to be related to histologic type with membranous having a better prognosis than proliferative or membranoproliferative.
    - Non-immune-mediated:
        - Glomerular disease may occur due to developmental abnormalities in glomerular structure and function
        - Glomerular disease (sclerosis characterized by glomerular thickening and mesangial expansion) has been reported to occur with:
            - Glucocorticoid excess (endogenous or exogenous)
            - Systemic arterial hypertension
            - Diabetes mellitus
            - Renal failure
    - Immunofluorescence studies would be negative

- Amyloidosis
  - Amyloid is a beta-pleated sheet of serum amyloid A protein
  - Deposits in and around glomerulus, usually beginning in the tubulointerstial area
  - Amyloidosis is uniformly progressive in nature and animals invariably develop chronic renal failure
  - It may occur:
    - Primary familial disease
      - Primarily described in Shar pei dogs Abyssinian cats
      - In these animals, amyloid may be deposited primarily in the medulla and not glomerulus
      - Proteinuria, therefore, may not be present
      - Amyloidosis develops typically in animals under 5-6 years of age
      - Shar pei dogs with amyloidosis often develop an arthropathy associated with fever and joint pain (called Shar pei fever, Shar pei swollen hock syndrome, Mediterranean Fever)
      - Has also been described in Siamese cats, Oriental shorthair cats, Walker hound dogs, Beagle dogs, and Collies
    - Secondary to chronic inflammatory diseases (eg infections, inflammatory organ disease, or cancer)
  - Clinical signs of amyloidosis include:
    - Proteinuria
    - Edema (depending on degree of proteinuria and hypoalbuminemia)
    - Chronic renal failure
    - Systemic arterial hypertension (and its related clinical signs – see Chronic Renal Failure lectures)
    - Inappetence and weight loss
    - Fever (depending on cause)
    - Arthropathy (depending on cause) – especially in Shar Pei breed
    - Other signs related to inciting cause of secondary amyloidosis
  - Diagnosis:
    - Differentiated from other glomerulopathies by renal biopsy
    - On light microscopy, amyloid appears as an eosinophilic substance in the mesangium and/or interstitium
    - Congo red stain using polarized light confirms the presence of amyloid (Congo red gives an "apple green" color when viewed under polarized light)
    - Amyloid may occur outside of the glomeruli particularly in the medulla in cats; therefore, it may be missed with a renal cortical biopsy

Feed a protein-restricted diet

- Studies have shown that dietary protein restriction decreases the degree of proteinuria and increases serum creatinine concentration. Supplementing dietary protein actually makes the situation worse.
- Decrease sodium intake. This can usually be accomplished by feeding a low protein, renal failure diet. Dietary salt restriction aids in decreasing fluid retention.

Administer an angiotensin-converting enzyme inhibitor

- Enalapril is the only ACE inhibitor that has been evaluated in dogs with proteinuria although other ACE inhibitors have been evaluated in dogs with induced diabetes mellitus (lisinopril) and in human beings (captopril, ramipril, etc). Benazepril has been shown to reduce proteinuria in cats. Benazepril is excreted more through biliary system than urinary system (although it is renally excreted as well) when compared with enalapril; therefore, it may be safer to use in animals with renal azotemia.
- Enalapril has been shown in a controlled study to decrease proteinuria, increase serum albumin concentration, and prolong survival in dogs with GN

Enalapril in dogs or benazepril may be tried

- There is a potential to worsen azotemia if present; therefore, start with a lower dose in azotemic animals and monitor BUN and creatinine
- Indicated when UPC is > 1-2 in IRIS stage 1 or > 0.4 (cats) and 0.5 (dogs) in IRIS stage 2-4
- Initial dose: 0.25 mg/kg PO q12h

Administer anti-inflammatory drugs to decrease platelet aggregation

- Platelet activation and intraglomerular thrombosis occurs with glomerular disease
- Aspirin is usually administered at 0.25-0.5 mg/kg PO q12-24hr in dogs or ½-1 baby aspirin q3d in cats.
- Efficacy is not proven in dogs, but it is in human beings.

Consider omega-3 fatty acids

- Theoretically, diets containing higher levels of omega-3 fatty acids may decrease inflammation. The omega-3 fatty acid becomes incorporated into plasma lipid membranes instead of arachidonic acid. The prostaglandins, thromboxanes, and leukotrienes produced from metabolism of omega-3 fatty acids tend to promote less inflammation and coagulation.
- In a chronic CKD model, dogs consuming a diet with an omega-6-to-omega-3 fatty acid ratio of 5:1 maintained GFR longer, survived longer, and had less inflammatory prostaglandin excretion than when dogs consumed diets containing higher levels of omega-6 fatty acids. There is no data in dogs with proteinuria. Furthermore, cats with chronic renal failure do not appear to respond to omega-3 fatty acid supplementation.
- Most renal failure diets contain an omega-6-to-omega-3 fatty acid ratio of 5:1. Supplementation of omega-3 fatty acid should be done to achieve a ratio of omega-6-to-omega-3 fatty acids of somewhere between 1:1 to 5:1. Therefore, the amount of omega-3 fatty acid supplementation must be done based on the fat content of the diet and type of fat in the diet
- Omega-3 fatty acids can be supplemented with diet with a starting dose of 300 mg of EPA + DHA per 10 lbs per day. Remember, EPA is the 20-carbon long-chain fatty acid and DHA is the 22-carbon long-chain fatty acid.

Consider immunosuppressive drugs

- Administration of immunosuppressive drugs to dogs with proteinuria is controversial. None have been shown to be effective in controlled studies, although there are sporadic case reports of response. However, biopsies show that 48.7% of glomerular disease in dogs have an immune-mediated basis
- In human beings, glucocorticoids are often administered. Studies in dogs have shown that in most cases of proteinuria, glucocorticoid administration is not beneficial and is often associated with a worsening of the proteinuria. Glucocorticoids appear to promote glomerulosclerosis and intraglomerular hypertension. Therefore, glucocorticoids are not recommended unless the proteinuria is secondary to glucocorticoid-responsive systemic disease.
- Cyclosporine was not found to be effective in dogs with idiopathic GN in a controlled, blinded study. Therefore, it cannot be recommended at this time.
- Other immunosuppressive drugs that may show benefit, but that have not been evaluated in placebo-controlled, blinded studies are **azathioprine** (2 mg/kg PO q24h x 2 weeks, then 1 mg/kg PO q24h, then 1 mg/kg PO q48h), cyclophosphamide (50 mg/m^2 PO q48h), and **chlorambucil** (2-6 mg/m^2 PO q24-48h). The most promising are **mycophenolate** (D: 20 mg/kg PO q12h for 3-4 weeks, then 10 mg/kg PO q12h; C: 10 mg/kg PO q12h) and azathioprine + chlorambucil
- Most immunosuppressive drugs are also cytotoxic; therefore, their administration may be associated with worsening azotemia.
- The decision to use immunosuppressive therapy should be based on the likelihood of an immune-mediated cause of proteinuria, the patient's overall condition, and the ability to monitor the patient.

Consider diuretics to decrease sodium retention and edema/ascites

- In human beings with nephrotic syndrome, diuretics are often used to decrease ascites/edema. Commonly a combination of a loop diuretic (such as furosemide) and a thiazide diuretic (such as chlorothiazide) are used. These diuretics promote natriuresis thereby decreasing sodium and fluid retention.
- **Furosemide** is often used in veterinary medicine to decrease fluid retention and should be considered in dogs or cats that have nephrotic syndrome. Combination diuretic therapy may be considered in animals that are refractory to single agent therapy.

Treatment targets

- Ideal goal: reduce UPC to < 0.5 in dogs and 0.4 in cats
- Realistic goal: reduce UPC by at least 50%

Additional therapies

- If goal is not achieved:
    - Increase dosage of ACE-I and monitor
    - Angiotensin receptor blocking (ARB) agent
        - Some ATII escapes ACE inhibition
        - ARB block ATII interaction at receptor
        - Same tendency for complications as with ACE-I
        - I typically use Losartan (1 mg/kg PO q12h); however, irbesartan has been evaluated in dogs (5 mg/kg PO q12-24h)
    - Immunosuppression, if not done
    - Doxycycline

- Loose information of decreasing proteinuria in humans
- Metalloproteinase inhibitor – anti-inflammatory
- Used with tick-borne disease-associated glomerular disease

Prognosis

- Generally poor
- Most patients dead within 1-2 months of diagnosis
- However, can be stable for long time and may resolve with therapy

Getting the Most out of Liquid God: Urinalysis

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Urinalysis is an important laboratory test that can be readily performed in veterinary practice, and is considered part of a minimum database. Collected urine should be evaluated within 30 min. It may be refrigerated for up to 24 hours or submitted to an outside diagnostic laboratory; however, this may alter results.

Urine appearance

Color

Urine is typically transparent and yellow or amber. The intensity of color is in part related to the volume of urine collected and concentration of urine produced; therefore, it should be interpreted in context of urine specific gravity (USG). Significant disease may exist when urine is normal in color. Abnormal urine color may be caused by presence of endogenous or exogenous pigments, but it does not provide specific information. Interpretation of semi-quantitative, colorimetric reagent strips may yield false-positive results because of pigmenturia.

Clarity

Urine is typically clear.

Odor

Normal urine has a slight odor of ammonia; however, the odor is dependent on urine concentration. Some species, such as cats, have pungent urine odor because of urine composition. Bacterial infection may result in a strong odor due to pyuria; a strong ammonia odor may occur if the bacteria produce urease.

Urine chemistries

Semi-quantitative, colorimetric, chemical test pads are usually done prior to centrifugation; however, if urine is discolored or turbid, it may be beneficial to perform these tests on supernatant.

Specific gravity

The USG is determined using a refractometer designed for veterinary samples, which includes a scale calibrated specifically for cat urine. In healthy animals, USG is highly variable, depending on fluid and electrolyte balance. Interpretation of USG depends on clinical presentation and serum chemistry findings. An animal that has prerenal azotemia will have hypersthenuric urine with USG >1.025-1.080. Dilute urine in an azotemic animal is abnormal.

Semiquantitative, colorimetric reagent strips

Reagent strips can be used to perform semi-quantitative chemical evaluations. They determine urine pH, protein, glucose, ketones, bilirubin/urobilinogen, and occult blood. Some reagent strips include test pads for leukocyte esterase (for detection of WBC), nitrite (for detection of bacteria), and USG; these are not valid in animals and should not be used. Reagent strips are adversely affected by moisture and have a limited shelf life.

Urine pH

Urine pH is typically acidic in dogs and cats, but varies depending on diet, medications, or presence of disease. Reagent strip colorimetric test pads for pH determination are accurate to within ± 0.5 pH units. Urine pH will affect crystalluria.

Protein

The protein test pad uses a color indicator (tetrabromophenol blue), which detects primarily albumin in urine. Results range from 30 mg/dL to 3,000 mg/dL). A positive reaction must be interpreted in light of USG, pH, and urine sediment examination. Proteinuria can be measured using sulfosalicylic acid precipitation, which detects albumin and globulins; however, it is not accurate. If proteinuria is present with inactive urine sediment, its significance can be verified and quantitated by dividing the urine protein concentration by the urine creatinine concentration (urine protein to urine creatinine ratio; UPC). A semi-quantitative microalbuminuria test is available to detect urinary albumin in the range of 1 to 30 mg/dL. It uses ELISA technology specific for canine or feline albumin.

Glucose

Glucose is detected by a glucose oxidase enzymatic reaction that is specific for glucose. Glucosuria is not present normally because the renal threshold for glucose is >180 mg/dL in most species and >240 mg/dL in cats. With euglycemia, the amount of filtered glucose is less than the renal threshold and all of the filtered glucose is reabsorbed in the proximal renal tubules. If glucosuria is present, blood glucose concentration should be determined.

Ketones

Ketones are produced from fatty acid metabolism, and include acetoacetic acid, acetone, and β-hydroxybutyrate. The ketone test pad detects acetone and acetoacetic acid, but not β-hydroxybutyrate.

Bilirubin/urobilinogen

When hemoglobin is degraded, the heme portion is converted to bilirubin, which is conjugated in the liver and excreted in bile. Some conjugated bilirubin is filtered by the glomerulus and excreted in urine. Male dogs have a higher secretory ability compared with female dogs; bilirubinuria in cats is always abnormal. In dogs with concentrated urine, a small amount of bilirubin can be normal. Urobilinogen, formed from bilirubin by intestinal microflora, is absorbed into the portal circulation and is excreted renally. The test is not clinically useful.

Occult blood

The occult blood test pad uses a "pseudoperoxidase" method to detect intact RBC, hemoglobin, and myoglobin. A positive result should be interpreted with microscopic examination of urine sediment.

Urine sediment

Microscopic examination of urine sediment should be part of a routine urinalysis. For centrifugation, 3-5 mL of urine is transferred to a conical centrifuge tube. Urine is centrifuged at 1,000-1,500 rpm for 5 minutes. The supernatant is decanted, leaving 0.5 mL of urine and sediment in the tip of the conical tube. The sediment is resuspended by tapping the tip of the conical tube against the table several times. A few drops of the sediment are transferred to a glass slide, and a cover slip is applied. Examination of unstained urine is recommended for routine samples. Microscopic examination is performed at 100X (for crystals, casts, and cells) and 400X (for cells and bacteria) magnifications. Contrast of the sample is enhanced by closing the iris diaphragm and lowering the condenser of the microscope. Stains can be used to aid in cell identification but may dilute the specimen and introduce artifacts such as stain precipitate and crystals. Use of a modified Wright's stain increases the sensitivity, specificity, and positive and negative predictive values for detection of bacteria.

Red blood cells

RBC's are small, round, have orange tint, and smooth appearance. Normal urine should contain <5 RBC/field at 400X magnification.

White blood cells

WBC's are slightly larger than RBC and have grainy cytoplasm. Normal urine should contain <5 WBC/field at 400X magnification.

Epithelial cells

Transitional epithelial cells resemble WBC but are larger. They have a greater amount of grainy cytoplasm and a round, centrally located nucleus. Occasionally, neoplastic transitional cells may be observed in an animals.

Cylindruria (casts)

Casts are elongated, cylindrical structures formed by mucoprotein congealing within renal tubules. Hyaline casts are mucoprotein precipitates, transparent, and have parallel sides and rounded ends. Epithelial cellular casts form from entrapment of sloughed tubular epithelial cells in the mucoprotein. Granular casts are thought to represent degenerated epithelial cellular casts. Waxy casts have a granular appearance. They typically have sharp borders with broken ends. Other cellular casts include erythrocyte casts and WBC casts, and are always abnormal. Fatty casts are not common, but can be observed with disorders of lipid metabolism. A few hyaline or granular casts are considered normal; however, presence of cellular casts or other casts in high numbers indicates renal damage.

Infectious organisms

Presence of bacteria in urine collected by cystocentesis indicates infection. Small numbers of bacteria from the lower urogenital tract may contaminate voided samples or samples collected by catheterization and do not indicate infection. Bacterial rods are most easily identified. Particles of debris may be mistaken for bacteria. Suspected bacteria can be confirmed by staining urine sediment with modified Wright's stain; however, aerobic culture is best for confirmation. Rarely, yeast and fungal hyphae and parasitic ova may be observed in urine sediment. Their presence is not always associated with clinical disease.

Crystals

Many urine sediments contain crystals. The type of crystal present depends on urine pH, concentration of crystallogenic materials, urine temperature, and length of time between urine collection and examination. Crystalluria is not synonymous with urolithiasis and is not necessarily pathologic; uroliths may form without observed crystalluria. Struvite crystals appear typically as "coffin-lids" or "prisms"; however, they may be amorphous. Struvite crystalluria in dogs is not a problem unless there is a concurrent bacterial urinary tract infection with a urease-producing microbe. Cats do form struvite uroliths without a bacterial urinary tract infection. Calcium oxalate dihydrate crystals appear as squares with an "X" in the middle or "envelope-shaped." Calcium oxalate monohydrate crystals are "dumb-bell" shaped. Calcium oxalate crystalluria occurs less commonly in dogs and cats; if persistent, it may indicate an increased risk for calcium oxalate urolith formation. Ammonium acid urate crystals suggest liver disease (eg, portosystemic shunt). These crystals occur in acidic urine and are yellow-brown spheres with irregular, spiny projections; however, they may also be amorphous. Certain breeds of dogs, e.g. Dalmatians, can normally have ammonium acid urate crystalluria. Cystine crystals are 6-sided and of variable size. They occur in acidic urine. Presence of cystine crystals represents a proximal tubular defect in amino acid reabsorption. Bilirubin crystals occur with bilirubinuria; however, they may be normal in dogs.– Lipid, spermatozoa, and plant material may occasionally be seen.

Bladder tumor antigen test (VBTA)

The VBTA can be used as a screening test for transitional cell carcinoma in dogs. The results are not specific and non-neoplastic disease (e.g. urinary tract infections, hematuria, etc) can give positive results. A negative test; however, is meaningful in that a transitional cell carcinoma is not likely to be present. This test may be useful for routine screening of dogs at higher risk of developing transitional cell carcinoma (e.g. Scottish terriers) that do not have other signs or laboratory findings of lower urinary tract disease.

Point-of-care testing for urinary tract infections

There are several point-of-care tests for evaluating a patient for a urinary tract infection. They suffer from either a low level of sensitivity or specificity or both. As mentioned before, staining the urine sediment with a modified Wright's stain is effective in determining whether a urinary tract infection is present or not, but urine culture is still the most reliable if performed correctly.

References

Bartges, J. W. "Discolored Urine." In Textbook of Small Animal Internal Medicine, edited by S. J. Ettinger and E. C. Feldman, 112-114. Philadelphia: WBSaunders, 2005.

Olin, S. J., J. W. Bartges, R. D. Jones and D. A. Bemis. "Diagnostic Accuracy of a Point-of-Care Urine Bacteriologic Culture Test in Dogs." J Am Vet Med Assoc 243, no. 12 (2013): 1719-25.

Osborne, C. A., J. B. Stevens, J. P. Lulich, L. K. Ulrich, K. A. Bird, L. A. Koehler and L. L. Swanson. "A Clinician's Analysis of Urinalysis." In Canine and Feline Nephrology and Urology, edited by C. A. Osborne and D. R. Finco, 136-205. Baltimore: Williams & Wilkins, 1995.

Swenson, C. L., A. M. Boisvert, J. M. Kruger and S. N. Gibbons-Burgener. "Evaluation of Modified Wright-Staining of Urine Sediment as a Method for Accurate Detection of Bacteriuria in Dogs." J Am Vet Med Assoc 224, no. 8 (2004): 1282-9.

Urine a Quandary:
Feline Idiopathic Cystitis

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Prevalence of lower urinary tract disease is more common in cats between 1 and 10 years of age; whereas in dogs, the prevalence increases with advancing age

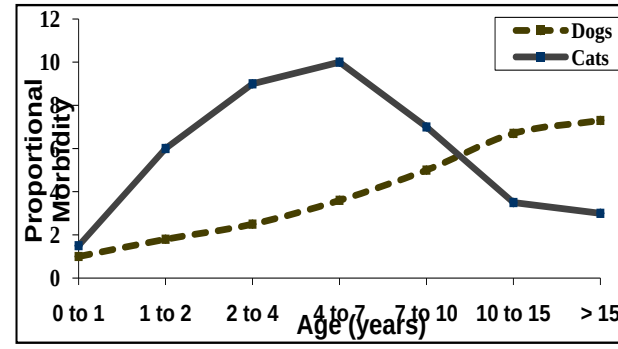
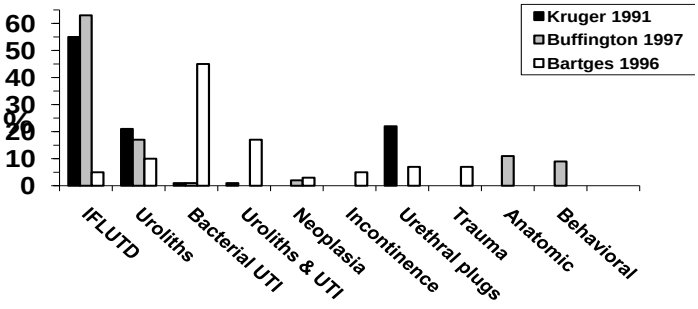


Figure. Prevalence of lower urinary tract disease in dogs (1980-1995) and cats (1980-1990) reported through the Veterinary Medical Database

- In cats >10 years of age, bacterial urinary tract infection is most common
- In young cats, idiopathic lower urinary tract disease occurs most commonly

Figure. Causes of lower urinary tract disease in cats from 3 studies.



What is feline idiopathic cystitis (idiopathic feline lower urinary tract disease)?

Currently, there are 2 hypotheses concerning FIC

Viral hypothesis

- A gamma-herpesvirus, a calicivirus, and a retrovirus have been isolated from urine and tissues from cats with naturally occurring idiopathic lower urinary tract disease
- Reproducible clinical evidence that viruses cause naturally occurring disease is scarce
- Viral particles have been observed in plugs recovered from cats with matrix-crystalline urethral plugs

Neurogenic inflammation hypothesis

- Similar in some respects to hypothesis for interstitial cystitis in women
- Cats with idiopathic lower urinary tract disease have decreased urinary glycosaminoglycan concentration and similar light microscopic changes to interstitial cystitis
- This may represent a central nervous system problem
    - In cats with FIC, there appears to be a dysregulation of the sympathetic nervous system
    - sANS activation w/o activation of hypothalamic-pituitary-adrenal axis for counter-regulation
        - ↑CRF release w/o appropriate ↑ cortisol (adrenocortical hypoplasia)
        - tissue inflammatory response
        - epithelial permeability
            - Fluorescein studies
        - neuron firing ->pain (nitric oxide?)
        - "flare-ups" of signs with stress
    - Developmental disorder (**Pandora Syndrome**)
        - Early age adverse experience (?)
            - Queen stress -> cortisol suppression of adrenal development in kittens

        - Other organ system problems

Clinical signs of feline lower urinary tract disease

- Causes of lower urinary tract disease in cats present with similar clinical signs including, but not limited to:
    - Pollakiuria
    - Hematuria
    - Stranguria
    - Dysuria
    - Inappropriate urination
    - +/- Urethral obstruction

Diagnostic testing for cats with lower urinary tract signs

- CBC and biochemical analysis are normal unless urethral obstruction is present
- **Urinalysis** reveals hematuria
    - Pyuria and possibly bacteriuria present, if UTI
    - Crystalluria may be present with plugs or stones
- **Urine culture** is negative unless a UTI is present
- **Abdominal radiography** and **ultrasonography** may be normal
    - A large bladder may be found with urethral obstruction
    - Uroliths may be observed or "sand"
    - Urinary bladder wall may be thickened on ultrasound
- **Cystoscopically**, small pin-point hemorrhages (glomerulations) are found and occasionally larger mucosal ulceration
    - These can be found with other diseases of the lower urinary tract
- **Bladder biopsy** often reveals submucosal edema, mucosal ulceration, possible submucosal inflammation, possible fibrosis
    - May be observed with other diseases of the lower urinary tract
    - We routinely biopsy the bladder wall for histopathologic examination and aerobic and anaerobic bacterial culture
- **Idiopathic disease is a diagnosis of exclusion**

Treatment of lower urinary tract disease

Urethral obstruction

- Obstruction may occur from uroliths or from matrix-crystalline urethral plugs
    - Matrix-crystalline plugs have been found only in male cats
    - Approximately 84% of matrix-crystalline plugs contain a mineral component
    - Struvite is present in 80% of these
    - Urethral plugs have not been observed to occur in dogs
    - Uroliths occur in both dogs and cats (we will discuss in future lectures)

Consequences of urethral obstruction

- Consequences of urethral obstruction
    - Early in course of urethral obstruction
        - May not be clinically evident
        - Stranguria, pollakiuria, and inability to urinate may be present
        - Patient may appear uncomfortable and/or have behavior changes
    - As obstruction progresses, clinical signs increase in severity
        - Cat may sit in liter box attempting to urinate or dog may attempt urination and pass only few drops; owners often mistake this sign as constipation
        - As urine retention continues, post-renal azotemia and eventually uremia develops
            - Depression, lethargy, moribund state
            - Vomiting due to uremia
            - Bradycardia and collapse due to hyperkalemia
            - Halitosis due to uremia
            - Death will occur in 72-96 hours after complete obstruction
    - If urethral obstruction is relieved, cat is likely to recover
- The most common abnormalities associated with obstructive uropathy include: dehydration, hyperkalemia, metabolic acidosis, and post-renal azotemia

- Dehydration
  - Fluid therapy is very important in obstructive uropathy because of dehydration and for circulatory support
  - Remember the 3 components of fluid therapy
    - Amount for rehydration
      - % dehydrated x BWkg = L for rehydration
    - Maintenance
      - Typically 1 ml/lb/hour (2.2 ml/kg/hour)
    - On-going losses
      - Measure or estimate
      - Some recommend ½ maintenance fluid requirements
  - You should review types of fluid and routes of administration that are acceptable for managing patients with obstructive uropathy
- Hyperkalemia
  - Management of hyperkalemia with obstructive uropathy is similar to management of hyperkalemia occurring with acute renal failure
  - Re-establishing urethral patency and fluid therapy is often all that is required as long as arrhythmias are not present
    - Arrhythmias (bradycardia -> sinoatrial arrest -> ventricular escape beats) typically do not occur until the serum potassium is > 8 mEq/L
    - Death occurs with potassium concentration exceeds 12-13 mEq/L
    - 3 ways to decrease plasma/blood potassium concentration
      - Dilute and excrete – fluid therapy or dialysis
      - Transcellular shift
        - Glucose
        - Insulin
        - Insulin and glucose
        - Bicarbonate
      - Counteract effect of hyperkalemia at sino-atrial node
        - Calcium gluconate

Re-establishing urethral patency

- Male cats
  - Male cats may be obstructed with uroliths or matrix-crystalline urethral plugs
  - In male cats, heavy sedation or anesthesia is required
  - Position male cats in lateral or dorsal recumbency – dorsal is best
  - Massage distal urethra while compressing the urinary bladder may dislodge the plug
  - Perform cystocentesis in order to obtain a diagnostic sample and to decompress the bladder. Do not remove all of the urine so that the bladder can be palpated. A potential complication is urine extravasation, which is uncommon if the procedure is performed correctly.
  - Urethral patency can be re-established by retrograde flushing the urethra

Aftercare once urethral patency is re-established

- Re-establishing urethral patency is not the end point
  - **Remove as much of the urine** as possible once the cat is un-blocked
  - The bladder may need to be "**rinsed**" if there is a lot of particulate matter and/or mucous present in the urine
    - Use sterile crystalloids or water; do not use glucose containing solutions
    - Do not infuse antibiotics, anti-spasmodics, anesthetics, or acidifiers into the bladder
  - Glucocorticoids are not indicated as they increase risk of infection
  - Systemic antibiotics may be administered if an indwelling urinary catheter is not inserted
  - **Anti-spasmodics** (urethral relaxants) may help, but there is little data that they in fact do help
    - In order to relax the urethra, an alpha-antagonist is administered
    - Phenoxybenzamine or prazosin can be used
    - Some people administered a skeletal muscle relaxant; however, diazepam has minimal effect on the urinary tract
  - An **indwelling urethral catheter** may be required

        - Indications for an indwelling urethral catheter include
            - Difficulty in un-obstructing the patient
            - A large amount of particulate matter and/or mucous despite flushing of the urinary bladder
            - When there is a high likelihood of re-obstruction
            - If detrusor atony is present

Management of an indwelling urethral catheter

- An indwelling urethral catheter should be considered on an individual case basis
    - Severely ill patients
    - If difficult to catheterize
    - Poor urine stream post obstruction
    - Detrusor atony (atonic bladder)
- A urethral catheter should be connected to a **closed collection system**
- **Management**
    - **Systemic antibiotics** should not be administered unless given for some other reason
        - The risk of bacterial urinary tract infection decreases with antibiotic administration
        - However, when an infection occurs, the organism has a high degree of resistance
        - Furthermore, the bacterial organism may invade the upper urinary tract resulting in chronic pyelonephritis
    - **Anti-inflammatory agents** – such as an NSAID – may be beneficial as long as renal function is good
    - With an indwelling catheter, a **urethral relaxing agent** (alpha blocker: prazosin: 0.25-0.5 mg PO q12-24h; phenoxybenzamine: 1.25-5 mg PO q12-24h) is administered to minimize catheter-induced urethral trauma and irritation
    - With bladder atony, a drug to stimulate bladder contraction, a parasympathomimetic (bethanechol: 1.25-5 mg PO q8h; metoclopramide: 0.1-0.2 mg/kg PO q8h), is administered
- **Catheter-associated UTI**
    - Occurs in 50-80% of catheterized patients
    - Prophylactic antibiotics decrease incidence, but increase likelihood of resistance or of an unusual organism
    - Prevention:
        - Use as clean to aseptic technique as possible
        - Physically separate patients with indwelling catheters from others
        - Wear gloves and wash hands between patients
        - Replace catheters when damaged or dirty
- Typically, an indwelling urinary catheter is maintained for 2 to 3 days
    - This is not a hard and fast rule, however
    - Decision to remove the catheter should be based on the progress of the patient, appearance of the urine, and likelihood that the tight junctions of the detrusor muscle have re-established
    - Remove if catheter is non-patent, damaged, or contaminated
- **Post-obstructive diuresis** must be addressed
    - Due to back pressure from the obstructive uropathy being transmitted to the upper urinary tract, a heavy diuresis may develop when the obstruction is relieved
    - This may be as much 2.4 L per day (most cats urinate 30-40 ml per day)
    - It is important to adjust fluid intake to match urine output so that dehydration does not occur
- **Cystostomy catheters** may be inserted and used long term
    - These may be mushroom-tipped catheters or low-profile catheters
    - Allows for long term, indefinite use

Non-obstructive idiopathic feline lower urinary tract disease

- There have been dozens of proposed treatments for cats with lower urinary tract disease; very few have undergone evaluation in a randomized controlled clinical trial
- **Antimicrobial agents**
    - Often administered
    - Bacterial urinary tract infection is an uncommon cause of lower urinary tract disease in cats <10 years of age occurring in <1% of such cats
    - If a bacterial infection was present, then the cat would have a diagnosis of bacterial cystitis and not idiopathic lower urinary tract disease

- Their use is not indicated in cats without a proven bacterial urinary tract infection

- **Urinary tract antiseptics**
  - **Methenamine** and **methylene blue** are not indicated in cats with idiopathic lower urinary tract disease
  - They may cause side effects such as metabolic acidosis (methenamine) or Heinz body anemia (methylene blue)
  - Since bacterial urinary tract infections are uncommon in young cats, they are not recommended
- **Urinary tract analgesics**
  - **Phenazopyridine** is an over the counter preparation available for use by women with recurrent vaginitis/cystitis
  - In cats, phenazopyridine causes Heinz body anemia and should not be used
- **Smooth muscle and skeletal muscle relaxants**
  - Many cats with idiopathic lower urinary tract disease have urge incontinence and inappropriate urination
  - **Propantheline**, an anticholinergic agent, minimizes force and frequency of uncontrolled detrusor contractions, but has negligible effect on urethral tone (0.25-0.5 mg/kg PO q12h)
    - It may be beneficial in some cats
    - However, one study could not document a benefit
  - **Phenoxybenzamine** and **prazosin** are sympatholytic agents that decrease urethral tone and spasm
    - Clinical data is lacking as to their efficacy with idiopathic feline lower urinary tract disease
    - I use for a short time in some cats that strain frequently or that had a urethral obstruction especially if an indwelling urinary catheter was inserted prazosin: 0.25-0.5 mg PO q12-24h; phenoxybenzamine: 1.25-5 mg PO q12-24h
  - **Diazepam** and **dantrolene** are skeletal muscle relaxants that may decrease tone and spasm of the distal urethra
    - Diazepam has minimal effect on urethral tone (2-5 mg PO q8h)
    - Dantrolene is more effective (0.15-0.6 mg/kg PO q8h)
    - Clinical studies are lacking as to efficacy of these drugs in cats with idiopathic lower urinary tract disease
    - I do not usually use
- **Anti-inflammatory agents**
  - **Glucocorticoids**
    - Have been used historically to decrease inflammation
    - Several studies have shown no benefit
    - They are contraindicated in cats with urethral obstruction or those that have indwelling urinary catheters
      - Risk of urinary tract infection increases in cats with indwelling urethral catheters that receive glucocorticoids
      - Some cats develop pyelonephritis
  - **Non-steroidal anti-inflammatory agents**
    - There are no clinical studies demonstrating safety or efficacy of use of these drugs in cats with idiopathic lower urinary tract disease
  - **Amitriptyline**
    - A tricyclic antidepressant
    - May have analgesic properties, stabilize mast cells, and decrease inflammation
    - In one uncontrolled study, 9 of 15 cats with idiopathic lower urinary tract disease improved with amitriptyline
    - One controlled study of cats with active lower urinary tract disease showed no benefit and cats receiving amitriptyline had a higher incidence of recurrence of lower urinary tract signs
    - Goal is to find a dose that will have a calming effect on the cat (begin at 5 mg than increase slowly; most cats require 10-12.5 mg)
- **Glycosaminoglycans**
  - Cats with idiopathic lower urinary tract disease have decreased concentrations of glycosaminoglycans in their urine
  - Glycosaminoglycans may have a protectant role at the mucosal-urine interface
  - Two controlled study\ies, failed to show a difference in clinical signs between a glycosaminoglycan and placebo in cats with idiopathic lower urinary tract disease
  - Pentosan polysulfate sodium, however, may still have effect (50 mg PO q12h)

- **Dietary modification**
  - In cats with matrix-crystalline plugs or with struvite crystalluria, feeding a "struvite preventative" diet may have some benefit
  - In one study of cats with idiopathic lower urinary tract disease, cats fed a canned diet had fewer recurrences than those fed a dry diet
    - However, there were more drop-outs in the canned group for unexplained reasons and if added back in – no difference between diet groups
  - In another study, there was a dramatic decrease in recurrence of clinical signs when cats with idiopathic cystitis were fed a diet that contained higher levels of omega 3 fatty acids and anti-oxidants
- **Clomipramine and Fluoxetine**
  - Used for urine spraying / marking behavior
  - Modifies behavior may have some analgesic effects
  - Not studied for FIC
- **Pheromones**
  - Sprays and diffusers
  - May calm a cat down
  - 1 study of cats with FIC – no benefit
- **Multi-modal environmental modification (MEMO)**
  - Cats do not respond to force
  - Cats are territorial and 'in control'
  - Litter boxes and food should be away from noise and distractions
  - Cats like to climb, hide, scratch, and hunt – vertical and horizontal space
  - Cats are clean and self-grooming
  - Cats are active at night
  - 1+1 rule – 1 food dish, 1 water bowl, and 1 litter box per cat plus 1 extra
  - Indoor Cat Initiative: http://www.vet.ohio-state.edu/indoorcat.htm

How do I treat cats with lower urinary tract disease?

First episode, urethral obstruction, young cat

- Unobstruct
- Radiographs, UA (other lab work?)
- Indwelling catheter?
- Torbugesic?
- Diet change (likely)?
- Antibiotics (peri-catheterizationEnvironmental and behavioral modification?
  - If persists or recurs, do additional diagnostics**First episode, no urethral obstruction, young cat**
- Urinalysis (minimum)
- Torbugesic?
- Diet change (likely)? – usually crystal-related disease (either stones or plugs)
- If persists or recurs
  - Do additional diagnostics
  - Consider
    - Diet?
    - Amitriptyline?
    - Pentosan polysulfate?
    - Environmental and behavior treatment

First episode, urethral obstruction, older cat

- Unobstruct
- Radiographs, UA (other lab work?)
- Indwelling catheter?
- Torbugesic?
- Diet change (likely)
- Stones?
  - Struvite: infection vs. non-infection
  - Calcium oxalate

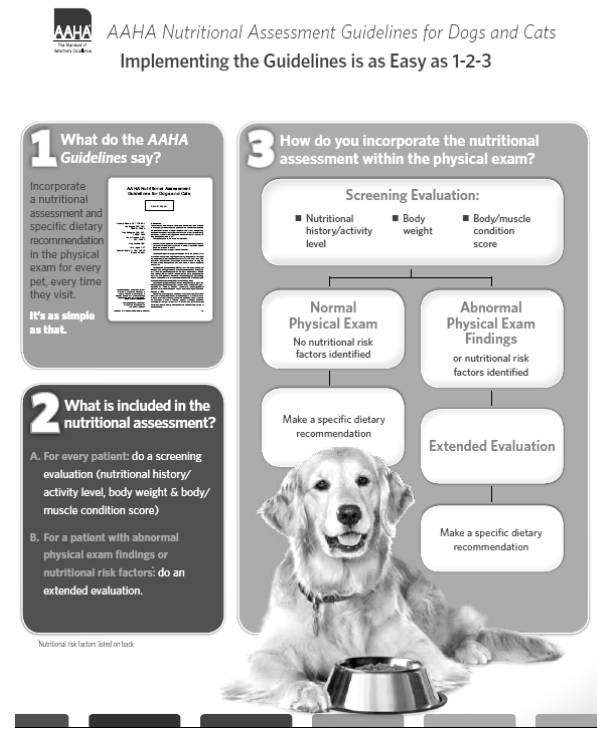
- Matrix-crystalline plug?
- Others?
- Antibiotics (peri-catheterization)**First episode, no urethral obstruction, older cat**
- Diagnostics
- Torbugesic?
- Diet change? Most likely – urolithiasis most likely cause (especially calcium oxalate)
- If persists or recurs
    - Torbugesic as needed
    - Diet?
    - Amitriptyline?
    - Pentosan polysulfate?
    - Environmental and behavior treatment

The Skinny on Fat: Obesity

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Obesity is the most important malnutrition of companion animals. It can be a disabling medical condition when moderate to severe in scope. At prevalence rate estimates of 10-40%, obesity must be considered a significant hazard to dogs and cats. Increased emphasis on pet health and preventative health programs makes obesity prevention an important aspect of health maintenance programs in dogs and cats. Treatment for obesity varies from frustrating to rewarding and evaluating and prescribing for successful, long term weight loss and maintenance usually requires management of multiple, inter-related patient and client factors. Diagnosis of disease secondary to obesity and the major task of client education and motivation is the provenance of the veterinarian.

The American Animal Hospital Association released the Guidelines for Nutritional Assessment (July/August JAAHA 2010). Utilizing the two-step iterative process, a screening assessment is made and if concerns are found, then a more detailed assessment is made. Following assessment, data are analyzed, a plan formulated and initiated, and repeated evaluation and modification of the plan is made. The importance of nutrition is emphasized by it being considered one of the "5VA's" (5 vital assessments): temperature, cardiac function, respiratory health, pain, and nutrition (http://www.everypeteverytime.com/index.html).



The American College of Veterinary Nutrition recommends a two-step process in making nutritional recommendations. The process is iterative in that it should be re-evaluated periodically and changes made as deemed necessary.

The first step is ASSESSMENT. During this step, assess the ANIMAL, the DIET, and the FEEDING factors.

ANIMAL FACTORS assessed include gathering historical information, performing physical examination, body condition scoring, and evaluating laboratory and imaging results if indicated. Gather information on any health or disease-related conditions, medications (including over-the-counter and nutraceuticals/supplements), reason for visit, and other household members. A thorough physical examination is performed and a body condition score assigned. There are 5- and 9- point body condition scoring systems; either can be used. In either scale, the middle number of the scale (3 out of 5 or 5 out of 9) represents ideal body condition and a body fat content of 15-25%; numbers lower than this correspond to lower body condition and less body fat (0-15%) while numbers higher than this correspond to higher body condition and greater body fat (≥ 35%). Assigning a body condition score provides more information than body weight alone and can be used with a muscle condition scoring system where 3 = adequate muscle mass, 2 = decreased muscle mass, and 1 = severe muscle wasting (sarcopenia).

Descriptor	Description	5 point	9 point
CACHECTIC	Ribs are easily palpated with no fat cover; bony structures are prominent and easy to identify; muscle tone and mass often decreased; little to no subcutaneous fat; hair coat often poor; pronounced abdominal tuck	1	1
UNDERWEIGHT	Ribs are easily palpated with little fat cover; abdominal tuck present; bony structures are palpable but not prominent; hair coat may be poor; muscle tone and mass may be good or slightly decreased	2	3
IDEAL	Ribs are easily palpated, but fat cover is present; hourglass shape present and abdominal tuck is present, but not pronounced; bony prominences are palpable but not visible some subcutaneous fat, but no large accumulations; muscle tone and mass good; hair coat quality is good	3	5
OVERWEIGHT	Ribs are difficult to palpate due to overlying fat accumulation; hourglass shape is not prominent and abdominal tuck is absent; subcutaneous fat obvious with some areas of accumulation; muscle tone and mass good; hair coat quality may be decreased; cannot identify bony prominences	4	7

OBESE	Ribs are impossible to palpate due to overlying fat; hourglass shape is absent and animal may have a round appearance; subcutaneous fat is obvious and accumulations are present in the neck, tail-base, and abdominal regions; muscle tone and mass may be decreased; hair coat quality may be decreased	5	9

DIETARY FACTORS include gathering information on dietary intake and inspection of the food, if needed. Take the dietary history from the person that actually feeds the pet(s) asking for type of food, amount fed, frequency of feeding, table food or treats, access to other food (garbage, outside, etc), supplements, and medications (including over-the-counter). If necessary, inspect a sample of the food or send a sample for analysis (i.e. Cornell Animal Health Diagnostic Center, Woodson Tenent Laboratories, EMSL Food and Consumer Products Testing Lab, etc). Pet foods can be purchased in a variety of forms – dry, canned, semi-moist, semi-dry, liquid, and frozen.

Reading the food label is also beneficial. The food label can be roughly divided into a principal display panel and an information panel. The PRINCIPAL DISPLAY PANEL contains information directed towards the consumer including the product name, species for which the food is intended, net weight of product, and descriptive words and/or pictures (e.g. "new and improved", picture of a famous cat, etc). The INFORMATION PANEL contains the important information including ingredient list, guaranteed analysis, feeding guidelines, contact information, and the nutritional adequacy statement. Although often maligned and not as complete as labels for human foods, there is useful information to be found. Ingredients are listed in descending order according to pre-processing weight and names are set by AAFCO (e.g. by-product, etc); this means that ingredients containing moisture that weigh more will be listed first. Unfortunately, this does not give information as to the quality or exact amount of each ingredient; also, different forms of the same type of ingredient are listed separately. Chemical sounding ingredients are typically vitamins, minerals, and preservatives. Feeding guidelines are provided that are suitable for most, but not all, dogs or cats that consume the diet. The manufacturer's or distributer's name and address is required and questions regarding the food should be directed to them; they should be able and willing to provide answers.

When contacting them, several questions should be asked:

1. Do you have a Veterinary Nutritionist or some equivalent on staff in your company? Are they available for consultation or questions?
2. Who formulates your diets and what are their credentials?
3. Which of your diet(s) is AAFCO Feed Trial tested? Which of your diets have been AAFCO Nutritional analyzed?
4. What specific quality control measures do you use to assure the consistency and quality of your product line?
5. Where are your diets produced and manufactured? Can this plant be visited?
6. Can you provide a complete product nutrient analysis of your bestselling canine and feline pet food including digestibility values?
7. Can you give me the caloric value per can or cup of your diets?

The **guaranteed analysis** provides information regarding the 4 major components of a pet food as percentages of the diet as fed including minimum amount of crude protein, minimum amount of crude fat, maximum amount of crude fiber, and maximum amount of moisture. "Crude" refers to the analytical procedure and does not refer to the quality of the ingredient.

The **nutritional adequacy** statement must be included and is designed to ensure that the product, when fed as the sole source of nutrition, is complete and balanced for one or more life stages, including how this adequacy was verified. The four recognized life stages by AAFCO are pregnancy, lactation, growth, and adult maintenance, and nutritional adequacy can be determined by feeding trials or by calculation. The calculation method involves determining the amount of nutrients in the diet and comparing to AAFCO nutrient profiles for that/those life stage(s). Feeding trials are performed by feeding the diet to the animals in that/those life stage(s) following AAFCO protocol. Feeding trials, while not perfect, provide indirectly information on bioavailability of nutrients and is preferred method for validation of nutritional adequacy. Therapeutic diets, supplements, and treats often do not carry a nutritional adequacy statement. Therapeutic diets are formulated for specific non-healthy conditions, which are not recognized by AAFCO and for which no nutrient profiles exist (e.g. renal failure, liver failure, etc); they usually carry a statement such as "intended for intermittent use" or "use only under the supervision or direction of a veterinarian". Snacks and treats are not formulated or intended to be the sole source of nutrition; therefore, they are not required to carry a nutritional adequacy statement.

The label often contains other information, much of which do not have official definitions. According to AAFCO, "natural" is "…only acceptable in reference to the product as a whole when all of the ingredients and components of ingredients meet the definition….the use of 'natural' is false and misleading if any chemically synthesized ingredients are present in the product; however, AAFCO recommends that exceptions be made in the cases when chemically synthesized vitamins, minerals, or other trace nutrients are present as ingredients in the product, provided that the product is not a dietary supplement and that a disclaimer is used to inform the consumer that the vitamins, minerals, or other trace minerals are not natural. For example, 'Natural with added vitamins, minerals, and other trace minerals.'" AAFCO defines "natural" as "a feed or ingredient derived solely from plant, animal, or mixed sources,

either in its unprocessed state or having been subject to physical processing, heat processing, rendering, purification, extraction, hydrolysis, enzymolysis, or fermentation, but not having been produced by or subject to a chemically synthetic process and not containing any additives or processing aids that are chemically synthetic except in amounts as might occur unavoidably in good manufacturing processes." "Organic" does not have a specific AAFCO definition other than in reference to processing, "organic (process): a formula or a specific ingredient within a formula feed that has been produced and handled in compliance with the requirements of the USDA national Organic Program (7 CFR Part 205)." The USDA National Organic Program (NOP) "develops, implements, and administers national production, handling, and labeling standards for organic agricultural products. The NOP also accredits the certifying agents (foreign and domestic) who inspect organic production and handling operations to certify that they meet USDA standards." There is no definition of "human grade" food and many ingredients used in pet foods are suitable for human consumption. "The U.S. Food and Drug Administration (FDA) Center for Veterinary Medicine has taken the position that if every ingredient in a product is edible, meaning that it was processed according to rules of sanitation required of food sold to people, then the product may be labeled "human grade". However, an edible ingredient becomes inedible when you add it to other inedible ingredients." - Dr. William Burkholder, veterinary medical officer for the FDA CVM (January 2009). Other designators such as "premium" and "gourmet" also have no official definitions. Such designators are arbitrary and subject to interpretation.

FEEDING FACTORS to be assessed include how the nutrition is provided and must take into account owner and animal factors. Simply filling a bowl within reach of the animal is not enough; the appropriate diet must be provided in the appropriate amount. Obesity is the most common nutritional disorder of dogs and cats and, in part, is due to overfeeding. "One cup" of food refers to the amount of food contained in one 8-ounce measuring cup. Ask specifically for the size of the cup used and the size of the bowl that is filled up. Many owners feed free choice – "drive-by feeders" - without regard to amount. The amount of energy required by the pet can be determined using one of two formulae:

Linear: $[(30 \times BW_{kg}) + 70]$ Exponential: $70 \times (BW_{kg}^{0.75})$

This provides the RESTING ENERGY REQUIREMENT and this result is multiplied by a life stage or activity factor depending on the individual.

Life Stage	Canine Factor	Feline Factor
Gestation	1.0 – 3.0	1.6 – 2.0
Dogs – first 1/2 - 2/3	1.0 – 2.0	
Dogs – last 1/3	2.0 - 3.0	
Lactation	2.0 – 8.0	1.0 – 2.0
Growth	2.0 – 3.0	2.0 – 5.0
Adult intact	1.8	1.4
Adult neutered	1.6	1.2
Senior	1.4	1.1
Work – light	2.0	
Work – moderate	3.0	
Work – heavy	4.0 – 8.0	
Obese prone	1.4	1.0
Weight loss	1.0	0.8
Weight gain	1.2-1.4 ideal	0.8-1.0 ideal
Critical care (usually)	1.0	1.0

The second step is FORMULATION AND INITIATION OF A FEEDING PLAN. The nutritional plan is formulated based on the assessment phase and initiated. It is important that this plan is re-evaluated periodically (iterative process) and adjustments made based on what is found during assessment. Recommendations for the feeding plan are made based on life stage and physiological or pathological condition of the pet as well as the life style of the owner. Working within the constraints placed by the owner helps to ensure compliance; otherwise, recommendations will not be followed. There is no "one best" diet available for healthy pets or for pets that suffer from a disease. Oftentimes, many options exist including homemade diets.

Today's health care providers, veterinarians and technicians, need to be able to assess a pet, evaluate diets, and make recommendations on diets and feeding. Knowledge of assessment and formulation of a nutritional plan should be part of a patient's health care. Use body condition scoring in addition to weight to assess nutritional status.

Types of diets

There are basically 3 types of diets available for pets: (1) commercial, over-the-counter diets, (2) therapeutic diets, and (3) homemade including raw food diets. These arbitrary designations are becoming somewhat blurred as there are commercial raw food diets and commercially available feed mixes that provide all nutrients except for the protein source, which the pet owner adds a protein source whether cooked or raw. Over-the-counter (OTC) diets are regulated through several different agencies. The Association of American Feed Control Officials (AAFCO) is not a regulatory agency but sets nutritional standards for life stages (of which there are basically two: adults and reproduction (pregnancy, lactation, and growth) and defines ingredients. The FDA specifies and regulates health

claims in addition to ensuring safety. The USDA regulates ingredients and inspects facilities. The State Department of Agriculture enforces animal food regulations. AAFCO sets nutritional standards so that if the food is fed as a sole source of nutrition it meets or exceeds known nutritional requirements.

OTC foods are convenient and can be cost effective and they are easy to feed especially dry foods. There are potential disadvantages, though, including the minimal regulatory requirements, lack of additional AAFCO lifestages (e.g. is a 15 year old Chihuahua the same as a 3 year old Great Dane?), pet food labels provide a minimal amount of information and give no indication of food quality, and there is a wide range of diets available that vary in composition and ingredients.

Therapeutic diets have more defined formulations and are primarily produced by larger companies who maintain better control over formulation, production, and distribution. Therapeutic diets are formulated primarily for non-healthy states (e.g. chronic kidney failure and obesity); however, some can be fed to healthy pets. Larger companies actively pursue and support research. These companies maintain control of the process and so have better quality control and formulations are more defined. Therapeutic diets are available for food elimination, but OTC diets may claim to contain "novel" ingredients. There is one study of 4 OTC venison dry dog food diets that showed that none of the diets would be suitable for an elimination food trial because they contained common pet food proteins some of which were identified on the label while others were not but were detected in the diet. If these diets represent a majority of OTC products then OTC diets should not be used for a diagnostic elimination trial. In another study of "soy free" diets, 4 of 4 OTC diets contained soy while 1 of 7 therapeutic diets contained soy. There are some disadvantages of therapeutic diets including public perception of large pet food companies, some of the therapeutic diets have been recalled (especially the melamine/cyanuric acid recall in 2007 due to specialized formulated diets containing wheat gluten), often pets are transitioned onto therapeutic diets when they are sick and so do not eat, and many therapeutic diets are formulated for specific disease states and so may not be suitable for all pets in the household (e.g a weight reduction diet for an obese pet would not be advisable for a lean healthy pet and an alkalinizing renal diet would not be suitable for a pet during growth). Some joint diets, dermatology diets, and GI diets are suitable for healthy pets including large breed growth (e.g. some joint diets).

Some owners prefer to prepare homemade foods – feel less guilty and have impression of preparing a "real meal" that is "more natural" and "more traditional". Nearly all dogs and cats in the US consume table foods at some time in their lives. Majority of dogs and cats in US receive >90% of calories from commercial foods. When a client wants to prepare pet foods at home, it is important for veterinarians to understand the client's reasons and motivation. In many cases it is possible to address their concerns and to recommend an appropriate commercial food. If they still wish to cook, then proper guidance can be provided.

Some owners wish to cook homemade diets in order to provide a natural or organic food. Remember, there is no legal definition for the terms "natural" and "organic". Pet owners may also want to prepare vegetarian food for their dog or cat because they are vegetarian or vegan. Because cats are true carnivores, vegetarian cooking should be discouraged. Other owners wish to prepare homemade diets including cooked and raw diets in order to avoid additives, preservatives, and contaminants. Pet food labels may be difficult to read and understand and they do not contain as much information as human food labels; therefore, some choose to home cook because they are more comfortable with being in control. Some pets will only eat table foods because it has become a habit. Lastly, homemade diets may be used for dietary elimination trials and for medical situations where a commercial diet is not available (e.g. a dog with chronic kidney disease and pancreatitis). Homemade diets are often very palatable and so may be useful with sick patients.

It is possible to achieve the same nutrient balance with a homemade food as with a commercially prepared food. However, this largely depends on the accuracy and competence of the person formulating the food, and on the compliance and discipline of the owner. Unfortunately, some homemade recipes are flawed even when followed exactly and consistently. IN one survey, 90% of homemade elimination diets prescribed by 116 veterinarians in North America were not nutritionally adequate for adult dog or cat maintenance. Few of the recipes available in books, magazines, and on-line have been tested to document the nutritional adequacy of the diet. Preparing homemade diets take time and some owners cannot afford the time.

There are common nutrient problems in many homemade foods. Many formulations contain excessive protein, but are deficient in calories, calcium, vitamins, and micro-minerals. Commonly used meat and carbohydrate sources contain more phosphorous than calcium resulting in inverse calcium: phosphorous ratio. Foods designed by clients are commonly deficient in fat and energy density or contain an unpalatable fat source (vegetable oil). Homemade foods are rarely balanced for micro-minerals and vitamins because veterinary vitamin-mineral supplements are not complete nor are the nutrients well balanced within the product.

People are taught that eating a variety of foods is nutritionally sound. Clients often extend this principle to their pet's nutrition. Pet owners perceive that feeding a variety of foods is their best defense against malnutrition. Likewise, many owners feed a homemade diet because they can use a variety of ingredients. Some owners choose meat and carbohydrate sources for their pet's food based on their own preferences, product availability, or affordability. Other pets are fed "leftovers" such as fat trimmings, bones, vegetable skins, crusts, and condiments. Some owners feed their pets according to guidelines for humans not realizing that dogs and cats have different requirements. A common problem with homemade diets is that the vitamin-mineral supplement is left out because

of inconvenience, expense, or failure to understand its importance – after all, many humans do not take vitamins. Lastly, some homemade diets use raw ingredients – we will talk more about these in a little bit

Veterinarians encounter a wide variety of pet food recipes from breeders and the popular press. Some owners want an opinion as to whether the recipe is good and others want to alter the recipe. Homemade formulations can be checked for nutritional adequacy and adjusted using the "quick check" guidelines:

1. Do five food groups appear in the recipe?
    a. Carbohydrate/fiber source from a cooked cereal grain
    b. A protein source, preferably of animal origin, or if more than one protein source is used, one source should be of animal origin
    c. Fat source
    d. Source of minerals, particularly calcium
    e. Multivitamin and trace mineral source
2. Is the carbohydrate source a cooked cereal and present in a higher or equal quantity than the meat source?
    a. Carbohydrate to protein ratio should be at least 1:1 to 2:1 for cat foods and 2:1 to 3:1 for dog foods
    b. Sources are cereal such as cooked corn, rice, wheat, potato, or barley
    c. These sources have similar caloric contributions, but some carbohydrates contribute a substantial amount of protein, fiber, and fat
3. What is the type and quantity of the primary protein source?
    a. Overall protein quality of the diet can be improved by substituting an animal-derived protein source for a vegetable protein
    b. Skeletal muscle protein from different species have similar amino acid profiles
    c. Final food should contain 25-30% cooked meat for dogs (1 part meat to 2-3 parts carbohydrate) and 35-50% cooked meat for cats (1 part meat to 1-2 parts carbohydrate)
    d. Providing some liver in the meat portion is recommended once a week or no more than ½ of the meat portion on a regular basis – corrects most potential amino acid deficiencies and contributes fatty acids, cholesterol, energy, vitamins, and microminerals
    e. If owner requests an ovo-lacto-vegetarian food, eggs are best
    f. If vegan food is requested, soybeans are the next best, but incomplete, amino acid profile
4. Is the primary protein source lean or fatty?
    a. Lean protein sources require addition of an animal, vegetable, or fish fat source at 2% of the formula weight for dogs and 5% of the formula weight for cats
    b. If a homemade food lacks sufficient caloric density, addition of cooked beef or chicken fat, poultry skins, vegetable or fish oils can markedly increase caloric density without adding other nutrients
5. Is a source of calcium and other minerals provided?
    a. An absolute calcium deficiency is common
    b. Many owners erroneously assume cottage cheese, cheese or milk added in small quantities provides adequate calcium
    c. Most foods require a specific calcium supplement
        i. When the protein fraction equals or is greater than the carbohydrate fraction, usually only calcium carbonate is added (0.5 g/4.5 kg cat/d and at least 2.0 g/15 kg/dog/d).
        ii. Calcium and phosphorous supplementation may be necessary when the protein fraction is less than the carbohydrate fraction. Steamed bone meal, dicalcium phosphate, and certain proprietary mineral supplements contain @ 27% calcium and 16% phosphorous (about 2:1) and micro-minerals
6. Is a source of vitamins and other nutrients provided?
    a. A human adult over-the-counter vitamin-mineral tablet that contains no more than 20% of the recommended daily allowances for people works well for both dogs and cats at ½ to 1 tablet per day (@ 1 gm/tablet).
    b. One tablet per day of a human adult product will not over-supplement pets with calcium, phosphorous, magnesium, vitamins A, D, and E, iron, copper, zinc, iodine, and selenium according to AAFCO maximum allowances for canine and feline foods.
    c. In general, veterinary supplements provide between 0-300% of vitamin-mineral requirements of dogs and cats

Substitution of ingredients can be done, but should be researched as to the equivalent amounts. One protein source is not the same as another. Other instructions that should be given owners include those for preparation, storage, and feeding. Emphasis should be

made to not eliminate an ingredient or indiscriminately substitute ingredients. Owners that wish to use raw eggs and meats should be informed that there is a risk for infectious diseases. Animal ingredients should be cooked for at least 10 minutes at 180F. Vegetable ingredients should be washed or rinsed and cooked if increased digestibility is desired. Since antioxidants are not usually added to homemade diets, storage in airtight containers at refrigeration temperature can be done for 7 day stretches. Large quantities can be frozen. Owners should check appearance and odor daily to make sure rancidity or contamination has not occurred. Starches should be cooked to increase digestibility; however, they should be cooked separately from the protein source. Carbohydrate sources require a longer cooking time; meat and liver should not be overcooked or protein denaturation will occur

Pets should be evaluated routinely whether they are being fed commercial food or homemade food. Stools should be formed although they may contain more water. Body condition and weight should be maintained. If problems are encountered, then either the homemade diet should be re-evaluated and modified or use of a commercially available diet should be encouraged.

Definition

Obesity is a condition of positive energy balance and excess adipose tissue accumulation with adverse effects on quality and quantity of life. Obesity literally means increased body fatness, but measurement of fat fractions of body composition is difficult in practice. Therefore, obesity can be defined as body weight in excess of 15 to 20 % of ideal, due to the accumulation of body fat. Negative health manifestations often begin at this level of weight excess and are a virtual certainty at a 30% excess over ideal weight.

Pathogenesis of body fat composition

Pathogenesis of obesity is not as simple and direct as uncontrolled gluttony. The idea of human obesity as a syndrome caused by being “weak in will” has yielded to observations and reasoning that obesity is a complex disorder of metabolism and satiety control with significant genetic components. Multiple genetic and environmental factors control regulation of food intake, resting metabolic rate, thermic effect of food, and energy expenditure and efficiency during work. Three causes of initial obesity in pets are overeating, decreased exercise, and lower metabolic rate; however, genetic influence cannot be overlooked.

Risk factors for obesity

Gender is important in the development of adult obesity; females or neutered animals are more frequently affected with obesity than males or intact animals. In addition to gender, certain breeds are predisposed to developing obesity while other breeds appear to be resistant. Pet owner lifestyle is important, as overweight human beings are more likely to own an overweight pet. Apparently overweight owners provide opportunities that override normal internal and external satiety control signals for both themselves and their pets. Ad libitum feeding, improper meal feeding, inappropriate diet selection, supplementation, provision of home cooking, and the conditioning of abnormal feeding behavior all cause excess calorie consumption. Begging, competitive eating with other pets and specific food addictions are problems in some homes and are identifiable risk factors. In addition to these factors, there are metabolic diseases such as hypothyroidism and hyperadrenocorticism that are associated with obesity.

Body fat deposition

Body composition of 1-2% fat at birth increases rapidly to 10-15% by weaning at 4-6 weeks, and is 15-20% in normal dogs during the first year of maturity. Females have increased levels when compared with males. Twenty-five to 30% fat is normal in dogs 8-10 years of age as there is lower lean body mass and increased adiposity with ageing. The initial phase of obesity occurs during chronic, positive energy balance. A phase of static obesity follows when caloric expenditure equilibrates with intake and the animal maintains a stable, but altered body composition of increased adipose tissue. These phases may repeat many times during an animal’s life leading to a gradual step-wise increase in body weight and body composition. Because fat-free mass appears to be an important determinant of resting energy, as more fat mass is acquired and as lean mass is lost, less energy intake is required to maintain the increased body weight (increasing fat mass). This explains why many obese animals do not appear to be eating “too much” or why owners often say “but my dog only eats a half of a cup of food a day”.

Detrimental effects of obesity

Obesity is associated with many diseases and has been shown to decrease life span in dogs and cats. In many respects, obesity-associated conditions could be considered metabolic syndrome. In human medicine, metabolic syndrome is often defined as “a cluster of conditions — increased blood pressure, a high blood sugar level, excess body fat around the waist and abnormal cholesterol levels — that occur together, increasing risk of heart disease, stroke and diabetes.” While these are not necessarily the manifestations observed in human beings, the etiopathogenesis of metabolic syndrome is similar.

Obese pets generally appear less healthy and have a less pleasing appearance. Furthermore, obese animals have less tolerance to heat and environmental changes. With added weight in obesity, physical activity is often decreased. This may not only make for an acceptable pet, but inactivity may also potentiate the weight gain because of decreasing the resting energy requirement. Obesity is associated with increased risk for musculoskeletal disease such as degenerative osteoarthritis, intervertebral disc disease, and anterior

cruciate rupture, and in growing large breed dogs, excessive energy intake and obesity may lead to developmental musculoskeletal disease such as hip dysplasia, osteochondrosis desiccans, and joint laxity and deformity. In dogs, obesity has been shown to be associated with increased blood pressure. Excess thoracic fat and increased liver size may impair ventilation, decrease respiratory efficiency, and result in alveolar hypoventilation. Treatment of collapsing trachea is improved with weight reduction. With increasing adiposity, lipid infiltrates the liver and in cats may result in liver failure due to hepatic lipidosis if a stressful event resulting in anorexia occurs. In breeding animals, obesity causes decreased sperm viability due to decreased testosterone production, and in females, it predisposes them to dystocia. Bacterial infections were also more severe in obese dogs than in dogs of normal weight. Obesity has been associated with increased skin and gastrointestinal disease in dogs and cats. It may represent overall decrease in body condition, decrease in general health, decrease in immunocompetence, and intake of an unbalanced diet. When surgery is necessary in obese animals, a compromised surgical approach, general difficulty in dissection, and increased incidence of intraoperative and postoperative complications can be expected. Obesity predisposes to local infection and some surgeons consider using antibiotic prophylaxis even in clean surgical procedures performed on obese animals. Obese animals are more difficult to achieve an adequate anesthetic state because of decreased hepatic metabolism, compromised respiratory and cardiovascular function, and because of redistribution of drugs into adipose tissue. Obesity not only interferes with surgical procedures, but diagnostic procedures as well such as thoracic auscultation and abdominal palpation. Obesity is associated with an increased risk of certain types of cancer. Obesity is associated with insulin receptor defect(s) and decreasing sensitivity to insulin fat, muscle, and liver. Insulin resistance and hyperglycemia occur concurrently as fatty acids displace glucose as the preferential fuel source. While the obese, type II diabetic animal is not dependent on exogenous insulin for maintaining the non-ketotic state, there is both a fasting hyperglycemia and abnormal glucose tolerance test response. Non-insulin dependent diabetes mellitus caused by obesity may be reversible by weight loss in some cats. Obesity decreases longevity in pets.

Diagnosis of obesity

The diagnosis of obesity is often obvious on clinical inspection and palpation of the patient. The differential diagnosis for obesity includes pregnancy, peripheral edema, intra-abdominal organomegaly, abdominal masses, ascites, hypothyroidism, and hyperadrenocorticism. Quantification of obesity requires the use of objective methods, but the convenient measurement of body composition is not practical in practice settings. Therefore, indirect methods are substituted and their limitations accepted.

Body weight

Body weight can be an indirect measurement of obesity in pets and it is a procedure that is familiar, easily determined, and universally available. The dog's weight at its first birthday or during the first year of maturity probably reflects the "ideal" adult weight if skeletal development and juvenile nutrition are normal. Another useful generalization from weight measurement is that the mature domestic cat weighs 3.5-5.0 kg (8-11 lb) at a normal body composition. The major disadvantage of using body weight as a standard for body composition is that "overweight" may not mean "overfat". This is true in athletic or working animals. Breed weight tables serve as guidelines for diagnosis in individual patients. Normal intra-breed body weight and height variability, determining ancestry in mixed breed animals, and the lack of statistically validated age- and gender-specific adjustment factors to the purebred dog averages are the major limitations in using weight tables too literally.

Body condition score

Subjective clinical observations for obesity assessment are the loss of an "hourglass" shape when viewed from above, protuberant or draped accumulations of fat around the tailhead and neck, and the inguinal "udder" in cats. Different fat accumulation patterns are specific for men versus women and are predictive for cardiovascular disease risks in human beings. Such patterns are of attenuated diagnostic importance in the companion animal. Inability to easily distinguish the individual ribs by palpation means that excess subcutaneous fat is present. This is a practical means of physical diagnosis, but may under-diagnose obesity if there are substantial, localized fat accumulations elsewhere. A 5-point and 9-point scale have been published. The middle of the scale represents optimal condition; lower values represent various degrees of under-conditioning and higher values represent various degrees of 'over-conditioning'. The problem with these scales is that the highest condition score (5/5 or 9/9) equates to an estimated body fat content of 45%; however, morbidly obese pets may have 65-70% fat. Thus, the upper end of the scale underestimates body fat content.

Treatment of obesity

Treatment of obesity requires a team effort and convincing the client to be a part of the solution and not part of the problem. Set a goal for the clients and stick to it. Giving positive feedback even if the success is small is very important and helps to support the client in their effort to not only change habits, perhaps long-standing, in their pets, but in themselves as well. When possible, a combination of dietary therapy and exercise is effective. This is difficult in dogs that have pre-existing orthopedic problems and in cats.

Diet

There are basically five dietary options available for the management of obesity. The first option is feed lesser amounts of the same diet. While this has the advantage of allowing the owner to purchase and feed the same diet, many times the pet will develop habits of

begging or of scavenging for food. It is thought that the pet experiences a feeling of hunger because of this technique. Furthermore, owners often feel guilty because their pet appears to be constantly hunger, and many times their perception is that a “healthy pet is a full pet”. The second option is starvation. Starvation results in rapid weight loss; however, initial losses are often due to changes in water content of the body. This is a very dangerous technique and requires the animal to be hospitalized. As a result, owners are not part of the effort. This is an especially dangerous technique in cats because obese cats that suddenly stop eating are at risk for developing hepatic lipidosis and failure. The third option is to feed a low carbohydrate containing diet. The idea is that by limiting carbohydrate intake and providing protein, vitamins, minerals, and fat, the body begins to mobilize peripheral fat for energy. This strategy works in some cats, but not all, and has not been shown to be effective yet in dogs. The fourth option utilizes a high protein diet. In human beings, this is usually a liquid diet. This type of weight loss diet is not utilized any more because of fatalities associated with electrolyte and mineral imbalances. Lastly, substituting “empty calories” for digestible calories can decrease the caloric content of the diet. A safe and effective formulation must provide for complete nutrition and nutrient balance in relation to dry matter intake. There must be complete bioavailability of all nutrients except energy. Using unbalanced diets in weight reduction programs may produce deficiency states that can be dangerous or lethal. Replacing dietary fat with indigestible fiber creates a hypocaloric diet. Fiber reduces the caloric density of the diet by physically insulating nutrients from digestive enzymes, and reducing food transit time. The reduced total and energy digestibility of a high fiber diet requires offsetting increases in protein and micronutrients to compensate for the diet’s reduced digestibility. Because the patient is treated with a low fat, high fiber diet, it is able to ingest familiar volumes of dry matter and dietary bulk and neuroendocrine responses to mechanical and chemical gastrointestinal fullness are retained as contributory signals to the satiety center. Hyperphagia and begging are less frequent. Whether high fiber diets in fact induce satiety is controversial. There are also “low fiber” diets available for weight management. Although the crude fiber content is perhaps low, the types of fiber that are used in these diets are not analyzed by the crude fiber method; therefore, the un-measured fiber is reported as part of the carbohydrate (NFE) fraction. Dietary fiber is defined as chemically and morphologically diverse plant substances resistant to hydrolysis by digestive enzymes including plant cell wall substances (cellulose, hemicellulose, pectin, and lignin) as well as intracellular polysaccharides (gums and mucilages). Fiber can be classified based on solubility or fermentability, and each imparts different physiological effects. There are several diets that are manufactured and marketed for weight reduction. Usually these diets are higher in fiber.

There are two techniques that are available for weight reduction in pets. The first uses an estimation of the ideal weight, and the second uses a target goal of weight loss per week and monitoring and adjusting dietary intake to meet this goal (iterative approach).

Using ideal weight

Using this technique, an ideal weight for the animal is estimated. The maintenance energy requirements for that animal are estimated using the ideal weight. In order to induce weight reduction, it is necessary to restrict caloric intake further, to approximately 60-75% of the maintenance energy requirement calculated using the ideal body weight. Different pet food companies recommend different percentages, and they range from 40% to 80%. At least 2 studies show that in dogs, using 75% of maintenance energy requirement results in a 1-2% rate of weight loss per week and minimizes rebound weight gain once the target weight is reached and the diet is changed to a maintenance diet.

A weight reduction diet is chosen, typically a high fiber/low fat diet or a low carbohydrate diet if a cat, and the amount to feed to meet this calculated weight loss goal is determined by dividing the MER for weight reduction by the caloric content of the diet. The diet is gradually changed over 5-7 days to avoid inducing gastrointestinal upsets such as vomiting, diarrhea, and inappetence. Following this period, the pet should be weighed every 2 weeks and the body weight charted. This accomplishes several things. First, it provides graphical representation of the weight loss period. Secondly, it provides encouragement for the owner. Once the target weight is reached, the diet can be switched from a weight loss diet to a diet designed for weight maintenance.

Iterative process

Using this technique, the ideal weight is not estimated. Rather, a target rate of weight loss is estimated, and a weight loss diet is fed to achieve this rate. For example, a target rate of 2% loss of body weight per week may be chosen. The amount of a weight loss diet to feed in order to induce this 2% loss of body weight is then calculated, and the diet is slowly switched. The pet is returned every 2 weeks and the food intake is adjusted to continue this controlled rate of weight loss. A computer program developed by Ralston Purina Company is available to facilitate using this technique.

Pharmacologic treatment

Dehydroepiandrosterone (DHEA) is an agent that has been evaluated in dogs, and is not effective. Slentrol (dirlotapide), a selective microsomal triglyceride transfer protein inhibitor that blocks assembly and release of lipoproteins into the bloodstream, has been approved by the FDA to decrease weight in dogs. Its primary mechanism of action is decreasing appetite; however, a slight decrease in fat absorption also occurs. The drug is given to the dog in varying amounts over the course of the treatment. The dog is given an initial dose for the first 14 days. After that, assess the dog's progress at monthly intervals, adjusting the dose depending on the dog's weight loss. After the dog has achieved the goal weight, the drug is continued during a three-month period, while the the optimal level of food intake and physical activity needed to maintain the dog's weight is established. Adverse reactions associated with treatment

with Slentrol include vomiting, loose stools, diarrhea, lethargy and loss of appetite. Unfortunately, while this drug was very effective, it has been removed from market and is no longer available.

There are two groups of approved drugs that can be used to manage weight in obese humans: medications approved for obesity per se and medications that affect body weight for obese patients who have complications from their obesity and are receiving these medications for chronic disease management. For obesity per se, treatment is with one of the three drugs currently approved for long-term treatment of obesity or one of a few others that can be used for short-term treatment. Among these, orlistat partially blocks intestinal digestion of fat and produces weight loss of 5-8 kg but major limitations are associated gastrointestinal symptoms; lorcaserin, a serotonin-2C agonist with few side effects, produces a mean weight loss of 4-7 kg; and the combination of phentermine and topiramate (extended release) produces a mean weight loss of 8-10 kg, but should only be used after verifying a woman is not pregnant. Failure to lose more than 3% of body weight within 3 months with any of these agents should lead to reevaluation of therapy. The short-term drugs for treating obesity per se are sympathomimetics, with phentermine being most widely used. The second group of drugs is for weight-centric prescribing for patients with a chronic disease such as diabetes, depression, or psychiatric disorders. For each disorder, some drugs produce weight gain, others are weight neutral, but the best choice for these patients is the combination of drugs that treat the underlying condition and also produce weight loss

Prevention

In order to prevent obesity, it is necessary to modify risk factors that led to obesity in the first place. This involves altering behaviors of not only the pet, but of the owners as well. In animals that have difficulty in keeping weight off, diets are available that are less calorically dense, contain higher fiber content, and are complete and balanced for maintenance (see table of diets). Animals that are high risk for recurrence of obesity should be evaluated periodically. Examination should involve not only a good physical examination, but also measurement of body weight, and estimation of body condition using a body condition score. This can be accomplished as part of an overall health maintenance plan. This allows the veterinarian to recommend changes that may aid in preventing obesity from recurring. Also, it establishes a good patient-client-doctor relationship. Owners require positive re-enforcement for doing a good job and a gentle “push in the right direction” if their pet is beginning to gain weight back.

Snacks may be an important part of development and maintenance of obesity. Therefore, they should be used sparingly. If used, they should not represent more than 5% of energy intake, and they must be accounted for in estimation of dietary intake necessary to meet maintenance energy requirements. Because “snacking” is a large part of human existence, it is difficult to break owners of this habit. Instead of punishing owners for giving snacks to their pets, in which case they may be dishonest about providing such treats, it is better to counsel them on what treats and what amount is acceptable.

Forget Profit- Here's What Really Adds Value to a Practice

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

Most practice owners don't know what the true fair market value of their practice is; therefore the first step in improving value is to determine what it is now. This baseline appraisal should be performed by someone with business valuation training and experience in veterinary medicine. One of the biggest drivers of practice value is the profitability of the practice. In that sense you can't ignore profits if you want the value of your practice to increase. However, profitability is just the MECHANISM which increases practice value and focusing just on the goal of "increasing profits" can cause long term harm to the practice. For example, in the short run, it can be easy to increase profits by increasing fees or firing team members to reduce costs. In the long run, however, this might cause harm to the practice—clients don't get the value and service they used to, the price of the services has gone up while the value has gone down, there are many other practices in the area and so they flee.

The direct focus instead should be on the specific activities that improve the operations of the practice and the offerings to the clients or bring more clients into the practice. If these things are done successfully, the indirect result is that profits will increase and the value of the practice will increase.

There are many, many things a practice can do to improve its operations, client offerings or marketing programs: A few include:

- Increase or improve marketing efforts—both internal and external
- Increase or improve staff training efforts including that related to client communication
- Increase efficiency of operations—doctor and non-doctor
- Spruce up the look of the practice
- Expand hours
- Improve inventory control and reduce the cost of professional services
- Set up a formal hiring process to improve the quality of people brought into the practice
- Add new services
- Educate clients better about payment alternatives

The specific areas a practice chooses to focus on will depend on the particular challenges it is facing and the issues it is passionate about. Bringing in new clients, however, is one area, in which almost all clients are struggling. An ongoing survey of about 500 practices done by the Veterinary Hospital Managers Association indicates a significant decline in new clients in every month of 2014 with a year-to-date average decline of 9.6%:

Month	Change in new clients
Jan, 2014	-7%
Feb, 2014	-6%
Mar, 2014	-13%
Apr, 2014	-12%
May, 2014	-14%
Jun, 2014	-8%
Jul, 2014	-10%
Aug, 2014	-11%
Sept, 2014	-5%
Oct, 2014	-8%
Year-to-date	-9.6%

Two areas most practices need to focus on are the quality of the overall client experience and measuring the success of marketing efforts.

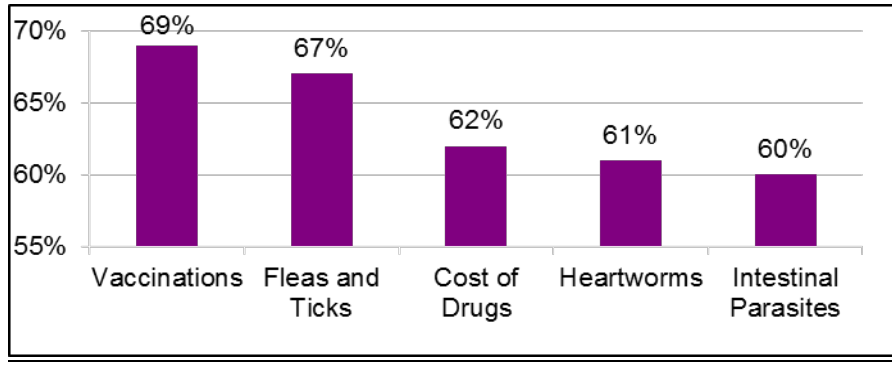
Increase the value of practice offerings

Businesses that are successful focus on what customers want. As W. Edwards Deming, one of the most revered management gurus of our time said: "Profit in business comes from repeat customers, customers that boast about your project or service, and that bring friends with them."

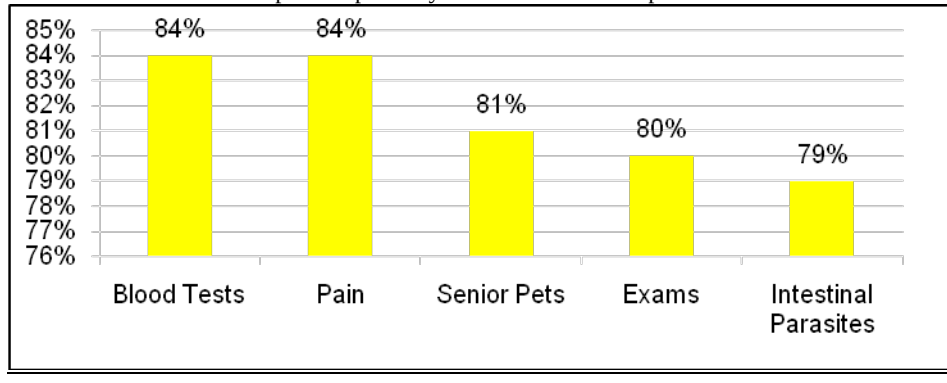
A practice's reputation and its success are built step by step each time a pet owner visits and each time a pet owner talks about that visit to others whether in person or online. The practices with the strongest reputations and those that do best from a business standpoint don't just provide services and sell products to clients; they also focus on building real relationships between clients, veterinarians and team members. Because pet owners generally can't judge the quality of the medicine offered by the practice, they determine the value of their experience based on things they CAN judge and that are important to them. Sometimes what they want is really simple to provide but in the rush of seeing clients, practices don't provide what clients want consistently.

There has been a lot of pet owner and veterinary practice research done in the last couple of years that provides great insights into areas successful practices need to focus on. Communication in its many forms is one of those areas. No matter what research is reviewed, communication ranks high as an area that needs improvement.

For example, in a recent study by Veterinary Economics and Trone Brand Energy, it was determined that the top five topics pet owners want to discuss with their veterinarian are:



Veterinarians were also asked about the top five topics they want to discuss with pet owners:



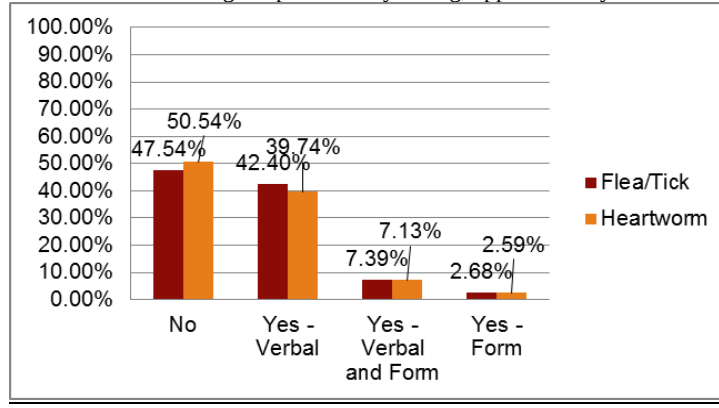
When the two charts are compared, what's wrong with the picture? There is only one topic that appears on both lists! How can veterinarians fulfill the needs of their clients if they don't know what they are?

One simple thing practices can do is ASK clients if they are getting the info they need:

- Is there anything else going on with Fluffy that we haven't covered?
- Did you have any questions about what we have discussed?
- Do you have any other concerns?
- Are there any other questions you have?
- Can I do anything else for you?

And of course, be quiet after the question is asked and let clients think and respond. Anyone in the practice who talks to a client, whether it be a receptionist, technician or veterinarian needs to ask each client if there is more information they need.

Two topics that pet owners in the research above said they wanted to discuss with their veterinarian are flea/tick and heartworm issues. And yet, when over 1,000 pet owners visited practices as part of Merial's Pet Owner Experience Research and were asked if flea/tick and heartworm issues were discussed during the pet's history taking, approximately 50% said no.



How can pet owners understand the importance of pet health care and the practice's recommendations if veterinarians and their teams don't talk to clients about these topics? Implementing changes to workflow, team responsibilities and communication tools can vastly improve the frequency and success of these conversations.

Bringing clients into the practice

Most practices are seeing a decline in new client numbers; data from about 500 practices in a year-long survey by the Veterinary Hospital Managers Association showed about a 10% decline in new clients during 2014. Attracting new clients to a practice is more important than ever and, of course, bringing clients into the practice is about marketing. In veterinary medicine, marketing is often broken down into "external marketing" and "internal marketing" with different team members focusing on each. Veterinary teams tend to think of external marketing as being the promotion of the practice done via Facebook, the practice's website, advertising in local publications, participation in community events, or other efforts. External marketing will reach both current clients and potential new clients so the goal is to both attract new clients and solidify the relationship with current clients. Internal marketing is generally thought of as being the act of "selling" veterinary services to pet owners who are current clients of the practice via education about the need for care, the value of the services offered and providing a good client service experience.

In addition to the increased pressure to attract clients to a practice, there are also many more ways to acquire new clients than ever before. In addition to designing and implementing marketing programs, it is also even more important to determine what works in actually bringing those new clients in. The steps involved in this practice include:

- Identify where clients heard about the practice
- Review client acquisition metrics
- Determine the cost of acquisition
- Calculate how much revenue the new clients are estimated to bring in while at the practice
- Estimate the life-time profits expected to be generated from these clients

The practice must first track where new clients come from. Often this task falls to the front desk team. How the client heard about the practice should be a question asked on every new client worksheet but it is also critical that the reception team also ask every client and make sure the info was actually recorded for future analysis.

New client numbers are readily available from the practice information management system and these figures should be compared from month to month and from this month in the current year to the same month last year. New client figures can also be compared to published benchmarks. These must be compared as a ratio; the number of full-time-equivalent doctors is the most commonly used basis. Ratio analysis is better because:

- Trends over months or years can be more easily analyzed as the practice grows
- Businesses of different sizes can be more easily compared

In addition to determining where the new clients are coming from and what percentage of total new clients comes from each source; the cost of acquisition must also be calculated as shown in the following example. The ABC Animal Hospital decides to advertise in the Lakeshore Condominium monthly online newsletter as well as write an "Ask the Vet" column in the same issue. The cost per month is $450.00 or $375.00 per month with a 3 month contract. The practice chooses the 3 month contract because they feel it will take that long not only for pet owners to see the promo but to have a need to visit.

The practice obtained 2 new clients in month 1, 6 in month 2 and 7 in month 3 for a total of 15 new clients from a $1,125 investment plus the time to write the "Ask the Vet" columns. They estimate each pet will bring in about $2,250 in revenue over the years it comes to the practice and that a $75 per pet acquisition cost is reasonable.

Perhaps the most important thing to remember about marketing is that you can't sell what you don't have. There is no point in launching into a comprehensive campaign to bring clients into the practice if they aren't going to have a good experience once they get there. You may get them in once, but they won't come back. Every practice needs to review the client service experience from beginning to end and correct any deficiencies. Do clients have to wait 20-30 minutes before they see a doctor? Are doctors and staff able to communicate with pet owners in a way that is friendly, professional and conveys real information? Do clients get callbacks within the promised time? Whatever is wrong with the practice needs to be put right before marketing efforts can be expected to succeed.

As discussed above, profitability is just the MECHANISM which increases practice value and focusing just on the goal of "increasing profits" can cause long term harm to the practice. The direct focus instead should be on the specific activities that improve the operations of the practice and the offerings to the clients or bring more clients into the practice. If these things are done successfully, the indirect result is that profits will increase and the value of the practice will increase.

Smart Ways to Help Clients Pay

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

One of the many unhappy lessons veterinarians and their teams have had to learn from the 2007 recession and the challenging after-years is that clients don't have bottomless wallets filled with cash to spend on veterinary care. Data from the Bayer Veterinary Care Usage Study indicates clients want more payment options; unfortunately many practices don't offer them at all or don't do a good job of telling clients about them. In addition to the changes in the economy, clients are dealing with the increasing costs of veterinary care resulting from the availability of more sophisticated medical options, the extended life span of pets which results in more routine care spending as well as an increased likelihood of the pet developing a serious and/or chronic disease and fee increases well above the rate of inflation. Even clients who are fully committed to providing quality care are looking at payment alternatives. Almost all practices accept cash, credit cards and checks; other payment options include third party veterinary credit cards, pet insurance, wellness plans and in-clinic billing options.

It's not reasonable to think that practices can just give veterinary care away; running a veterinary hospital isn't cheap and veterinarians and their staff have the same need to earn a good living as anyone else. But there are things that can be done.

If clients don't think they will need future veterinary care, why will they be interested in payment alternatives?

This is one of the most important points to be made on this topic. If users of any product or service don't think they will need it in the future, they aren't going to care about finding a way to pay for it. Many pet owners don't really understand the kinds of preventive care their pet will need in the future nor the cost of that care. And they don't really think through the likelihood that the pet will get sick or injured. Veterinarians and their teams have this information and need to incorporate this into the conversations regularly had with clients. Start talking to pet owners about future care and payment alternatives from the first time you see them and don't stop after one conversation. This topic should be regularly revisited. Money is hard to talk about sometimes and the veterinary team doesn't always know how to get started; consider this as a sample script:

"One thing we haven't talked about yet is Michelle's future medical care. We have her scheduled for the rest of her kitten vaccinations so that's all taken care of; but to keep her healthy after that, you will want to have her examined by a veterinarian at least once a year. This will ensure she gets the vaccinations and other preventive care she needs and that we can make sure there aren't any underlying medical things going on.

Just like people, pets get sick too, no matter how well taken care of they are. For instance, some of the most common conditions we see are ear infections, stomach upsets and skin allergies. The problem is, these are never planned events and I always like to let new puppy parents know so they can prepare for the unexpected. If you're not expecting the cost of these things, it can be a shock to the budget. Some people put money aside in a special savings account in case something happens; others like to have a more formal option in place. Here at our practice, we offer encourage pet owners to consider special veterinary credit cards or pet insurance. Would you like me to have Susan come in and talk to you a little more about these options?"

Billing options

For years, many practices used in-house delayed billing plans to help clients who couldn't come up with the cash necessary for their pet's care at the time of service. These generally took the form of held checks or statements sent post treatment with the idea that clients would pay when they received the statement, either in full or in installments. Practices had varying degrees of success in actually collecting these amounts and the trend has been away from in-house options and towards third party payment plans, pet insurance and wellness plans.

While practice owners don't want either themselves or their staff to function as insurance sales people or credit card vendors, those who work in practices already regularly recommend to clients products and services not carried in the practice. Examples include obedience training, pet day care centers, groomers, pet sitters and a wide variety of dietary and other products. Doctors and staff take the time to understand those products enough to be comfortable with the recommendations and help clients understand the options because they think they are of value to the client in taking better care of their pets.

Why is it any different with financial products that allow clients to provide more comprehensive care? Not only do pets benefit from the improved care; veterinary practices benefit because clients who have the financial ability to pay for better care help us practice the kind of veterinary medicine we want to practice and improve the profitability of the practice. A sophisticated study conducted by Veterinary Pet Insurance, one of the largest pet health insurance companies, showed that the company's clients with pet health insurance on average had 41% higher stop-treatment levels, scheduled 40% more veterinary visits, and spent twice as much on veterinary care over the life of their pet. Studies by CareCredit, one of the leading third-party medical financing companies, revealed that 71% of cardholders said that having this financing option affected their decision as to the level of treatment they can provide their pet and that pet owners with veterinary credit cards and that cardholders spent almost 50% more on their pets than non-cardholders.

In order to effectively recommend these payment options, veterinarians and their staff must first of all understand the products themselves. Recommendations to clients are most helpful when they include not only a general recommendation for a kind of product but a recommendation for a specific brand along with the reasons why the practice thinks this product is the best one and a company the practice has had a good experience with. This is no different from medical products; clients don't just want to know that their pets should be on heartworm preventative; they want to know which brand your practice recommends and why. Practice owners and managers need to make sure that team members have the training to then talk knowledgably and enthusiastically to clients about these options. Information should also be available in printed form as well as on the practice's website. Additional client resources will be discussed below. Remember that clients don't just want to be handed a couple of brochures; they want to know what you recommend. If the plans are presented as a last-ditch option instead of a powerful way for the client to provide better care, then clients will likely pick up on this lack of enthusiasm.

Third party veterinary payment cards

Third party veterinary payment plans aren't all the same but in general, their financing arrangements function like a credit card that can be used for veterinary care. Clients can apply for the cards while at the veterinary practice and receive immediate approval. The practice receives its money soon after they provide the care and is not responsible for collecting from the client.

As with regular credit cards, the practice pays a fee to the financing company. Sometimes these fees are higher than those charged with regular credit cards; however, some advantages exist with these dedicated medical credit cards that counterbalance the fee. First of all, the ability to be approved for credit while at the practice means that pet owners can easily make an immediate decision to accept the practice's recommendations for their pets that they might not have been able to do had a source of payment not been available. The higher fee also allows the financing company to offer plans which are attractive to clients and, again, encourage them to provide more comprehensive care for their pets. As with regular credit cards, not all clients will be approved. Not all clients deserve to be approved! Even if some of your clients do not get approved, going through the application process with clients you are considering granting in-house credit to is a good exercise; if the client is denied by a third party financing company you now know that there is a good chance they may not be able to pay off any amounts you let them charge in-house. Several companies offer third party payment plans in the veterinary world. In order to be comfortable recommending both the concept and a particular company to your clients, compare plans and check out the company. Are they helpful? Is it easy to get your questions answered? Is information about their plans readily available? Do any of your colleagues use them? What has been their experience?

Pet health insurance

Another financial option for clients is pet health insurance. As with third party payment plans, understanding the general types of plan options and the companies providing them will help you make intelligent and useful recommendations to clients. When veterinarians, their staff or their clients become unhappy with pet insurance, it generally arises from a lack of understanding of what is reasonable to expect from pet insurance in general or of the specific terms of a particular policy. A couple of points that will help both practice employees and clients understand their options better include:

- Pet insurance isn't right for all pet owners. Several factors for clients to consider in making the decision to insure their pet include their bond with the pet, their philosophical position about how much they would be willing to pay for a pet's care, their level of risk tolerance and the nature of their financial situation. Pet owners need to think about their ability to cover not only basic wellness care (annual exams, vaccines, heartworm tests and preventative, etc.) but also non-routine accidents and illnesses. Some clients can cover the costs of this kind of care with some planning, a savings account, a credit card and access to medical financing as discussed above. But what happens if their pet needs care that is really complicated and expensive or even catastrophic? These are the kinds of events that even the most financially responsible pet owner may have trouble finding the cash for. Pet insurance offers not just claims reimbursement but it also offers piece of mind that when something of an expensive and catastrophic nature happens, care can be provided.
- All companies limit coverage in some way; if they didn't they would pay out more in claims than they took in from premiums and would be bankrupt in months. These limitations come in several forms including deductibles, co-pay %s, annual or lifetime limits, the use of benefit schedules, and coverage exclusions. Practice team members and clients need to understand the coverage of the policy as a whole; you can't just say "well, this policy has a 20% co-pay so it's not as good" or "this policy uses a benefit schedule instead of a % pay so it's not as good"—look at the coverage as a whole compared to the premium. Pet owners also need to be aware of any breed specific conditions that apply to their pets or any particular types of procedures they might want covered (for example, dentistry or acupuncture) and see if their policy includes those items.
- For pet owners or veterinarians to expect that all owners will receive claims payments that equal or exceed what they pay in premiums isn't even a realistic expectation. That doesn't happen with any kind of insurance—how many people have gotten reimbursed for homeowner or automobile insurance claims that have exceeded the cost of the premium? Do

you even expect to? Some percentage of pet owners will pay more in premiums than they receive back in benefits; you could say they were unlucky with their pet insurance or you could say they were lucky with their animal's health. Another group will pay much less in premiums than they get in benefits—these individuals owned pets who were unlucky health wise but they were fortunate enough to have insured their pets. And most pet owners (or owners of any insurance) are going to be somewhere in the middle.

- Companies offer information about their policies and other useful tools/resources on their websites or via phone. Pet owners need to read the information and understand it before recommending or signing up for a policy; if it's not readily available or it's confusing, they should find another company.

Once a pet owner has decided that pet insurance is for them, they need to pick a company and a plan. There are many options out there; it can be a bit daunting to sort through them all. You can help your clients by recommending a couple of companies you are comfortable with. You can also provide them with a list of questions they should ask:

http://veterinarybusiness.dvm360.com/handout-20-questions-veterinary-pet-insurance-companies

Pay by the month preventive care plans

The last alternative payment option to be discussed is pay-by-the-month wellness plans. Pet owners in the Bayer Study loved the idea of wellness plans—i.e. a group of bundled services they could pay for on a monthly basis instead of all at once. The ability to spread payments out gives clients the ability to provide better health care for their pets. The programs must be designed effectively, however, in order to provide a positive return for both pet owners and practices.

So how do these plans work? They are essentially annual preventive care plans that include the specific services the practice feels a pet owner should provide to each pet during a year in order to keep it healthy. These are wellness or preventive services such as vaccines, physical exams, heartworm testing and other diagnostic blood work, and deworming. The plans aren't generally meant to provide care for sick pets although of course there is a little overlap. For example, the physical exam may diagnose an illness and the pets that get dewormed may already have intestinal parasites. But generally, they are focused on keeping pets from getting sick, rather than treating an illness.

What works about these plans, first of all, is that they bring people into the practice. It is much easier to pay $30/month for pet care than to have to write a check all at once for $200. The initial cost of an office visit and physical exam is a barrier for many clients and these plans encourage them to bring their pet to the practice. Veterinarians can't diagnose disease and can't demonstrate to a client how wonderful the practice is if clients don't walk in the door.

Practices also make money from these plans because, just as with gym memberships and gift cards, many people don't use all the services. The increased visits also allow veterinarians to diagnose other conditions that require treatment outside of the care included in the plan. Finally, it's also important to remember that many clients on wellness programs spend more than they normally would have if they weren't on the program; paying monthly is what makes this possible.

There are, of course, some design and operational issues that must be addressed in order for these plans to operate smoothly. These include:

- Payment processing
- Level of integration with the PIMS
- Accounting for the payments
- How to allocate payments to veterinarians
- Dealing with defaults
- Appropriate communication
- Information security requirements

As noted above, the power in programs like these is that they offer clients an incentive to visit the practice. However, this alone won't necessarily keep pet owners visiting regularly; the clients have to have a good experience and find value in the care they get once they get to your practice. In addition to marketing the program effectively, the use of the program must be tracked over time to see if it actually increases revenue, profits, visits and the amount of care provided to patients.

Clients have made it clear they want to provide good care to their pets but they need payment alternatives to do so. Not every new strategy will work for every practice but it would be foolish to ignore the feedback we have gotten from pet owners.

Financial Horror Stories and How to Avoid Them

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

The world of veterinary medicine doesn't look like it used to 10 years ago – excess capacity, a difficult economy and changes in what clients want all impact what's going on in practice. Thriving financially is harder than it used to be and some practices are running into real trouble. Most of it is avoidable if you know what to look for and the steps to take to forestall problems.

Case #1

ABC Animal Hospital is a large companion animal general practice located in a major city in the Midwest. The practice culture is unique with a focus on client service, medical care and employee satisfaction not seen in many hospitals. They have operated out of a very small space since they opened and the dream was always to build a beautiful new hospital that would allow them to continue growing and practice the exceptional medicine they want to practice. A few financial highlights:

- Revenue grew from about $700,000 in the year the practice started to about $5,000,000 seven years later—annual growth rates ranged from 10% to 38% depending on the year.
- Revenue growth flattened out and actually declined in some months in the year before they started their building project
- Profitability in the practice has been average but not great. Expense cuts would have significantly changed the culture of the practice and the management team hasn't wanted to do that
- The practice has little in the way of an emergency fund to weather financial surprises
- After moving into the new building, the practice found it couldn't make its loan payments

What could/should the practice have done to avoid this situation?

Case #2

Dr. Smith is 70 years old and the sole owner of a companion animal practice located in a small city in the southeast. The practice is located in an attractive but not extravagant building in a middle-class part of town. Dr. Smith has owned this practice for 39 years, has strong relationships with his clients and team, is active in the local VMA and is well thought of in his community. He is dealing with some very challenging health issues, is ready to retire and sell the practice and looking forward to getting a good price for it. He needs the money. A few financial highlights:

- Revenue increased 7% in the most recent year but had suffered about 10% decline in the two prior years
- Transactions declining 1-3% each year
- COGS generally 28% of gross revenue in each year
- Support staff costs about 25% of gross revenue in each year
- Rent 4% of gross revenue in each year
- Revenue per doctor, ATC and new client numbers are strong
- Operating profit margin ranges from 1-3% depending on the year
  - What's wrong with the practice financially?
  - What can be done to fix it?
  - What could have been done earlier?

Diabetes in Dogs: Acute Care and Long-Term Management and How You Can Help Clients Pay for it

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Karen Felsted, CPA, MS, DVM, CVPM
PantheraT Veterinary Management Consulting
Dallas, TX

Diabetes mellitus is a common endocrine disorder in dogs and cats. Recent data has shed light on the pathogenesis of the disorder in dogs and cats and has highlighted the role of diet, insulin and novel hypoglycemic therapies. In the majority of cases, the most appropriate therapy in both dog and cats includes the administration of insulin.

The key to successful management of the diabetic patient lies in close communication with the pet owner and prompt recognition and treatment of concurrent disorders.

Key facts

1. Insulin is still the mainstay of therapy in the majority of dogs and cats with diabetes mellitus.
2. Diet is an important part of diabetic management especially in obese patients and cats.
3. Auto-immune disease, pancreatitis and amyloidosis are the most common causes of diabetes in dogs and cats.

Successful management of the diabetic patient involves many factors. An understanding of dietary therapy, insulin preparations, oral and novel hypoglycemic agents and management of concurrent illness, are all required to optimize glycemic control. The goals of therapy are to control clinical signs, prevent or slow the progression of cataracts, avoid hypoglycemia and maintain ideal body weight. An additional goal in cats is to obtain remission. The challenge is to address these concerns while attempting to help the owners deal with what they may consider a time consuming, expensive and chronic medical condition.

Diabetes Mellitus in dogs and cats results from a decrease in insulin secretion from the beta cells of the pancreas and/or a decrease in insulin action. There are three classifications of diabetes:

Type I diabetes is comparable to insulin dependent diabetes mellitus (IDDM) in humans. It results in low basal insulin concentrations with impaired insulin secretion following a glucose load. Treatment requires insulin injections. It is the most common form of diabetes in dogs.

Type II diabetes is similar to non-insulin dependent diabetes (NIDDM) in humans and is managed with dietary therapy and oral hypoglycemics. It causes normal to increased basal insulin concentrations with decreased secretion following a glucose load. Insulin may or may not be required for animals with Type II diabetes.

Type III diabetes is seen most commonly in hormonally-induced diabetes in dogs and cats and is similar to impaired glucose tolerance (IGT) in humans. Diabetogenic hormones (epinephrine, cortisol, glucagon and growth hormone) or medications interfere with insulin action and cause glucose intolerance, which can lead to diabetes.

Etiology and signalment

Canine

There are some distinct differences in the etiology of canine and feline diabetes. In dogs, it is generally thought to be an immune mediated disease with gradual destruction of beta cells. The progression from normal, to glucose intolerant, to diabetes, is generally slow so that most islets (over 90%) are lost before diabetes occurs. Other causes of diabetes in dogs include genetic predisposition, chronic pancreatitis and medication-induced diabetes (*glucocorticoids* and *megestrol acetate*).

Genetic predisposition to diabetes is most common in the following breeds: German Shepherd dogs, Schnauzers, Beagles, and Poodles. Golden Retrievers and Keeshonds are more prone to juvenile diabetes.

Gender is a factor in dogs with females being three times more likely to develop diabetes than males. Generally, diabetes occurs in dogs in middle age (6-9 years) but can also present earlier for specific breeds, particularly the Golden Retriever and Keeshond.

Feline

The most common causes of diabetes in cats are obesity, pancreatitis and most commonly, amyloidosis of the pancreatic beta cells. There appears to be very little gender predisposition to this disease in cats, although it is slightly more common in males than females. As with dogs, the onset of diabetes in cats occurs most often in middle age.

Clinical signs

The clinical signs of diabetes include PU/PD (polyuria and polydipsia) from hyperglycemia, resulting in glycosuria and a resultant osmotic diuresis. Polyphagia and weight loss is common although many animals will still be obese upon presentation. In addition to the polyphagia, there may be variable degrees of dehydration especially in the cat. Cataract formation is very common in dogs with diabetes, but rare in cats. Cats often present with icterus as a result of concurrent hepatic lipidosis and/or pancreatitis. Icterus is not common in dogs unless they have pancreatitis. Cats may also exhibit a plantigrade stance (peripheral neuropathy) that is directly related to the severity and duration of hyperglycemia. Clinical neuropathies do occur in dogs, but are extremely rare.

Differential diagnoses include: hyperthyroidism (in cats), gastrointestinal lymphoma, hepatic disease, renal disease, pancreatitis, hyperadrenocorticism, and acromegaly.

Diagnosis

Diagnosis involves testing for persistent fasting hyperglycemia, with fasting blood glucoses greater than 200mg/dl. Clinicians also will need to rule out transient hyperglycemia that may be due to: post-prandial hyperglycemia; diabetogenic hormones (endogenous or exogenous); and stress hyperglycemia. Stress hyperglycemia can be a problem in cats due to the release of epinephrine when stressed or handled.

Laboratory abnormalities include:

- Hemogram
  - non-specific
  - signs of dehydration
- Biochemistry profile
  - hyperglycemia
  - increases in SAP and ALT
  - increases in bilirubin (usually in cats)
    - hepatic lipidosis
    - pancreatitis
- Urinalysis
  - glycosuria
    - renal threshold for glucose
      - canine 180-220mg/dl
      - feline 240-300 mg/dl
  - ketonuria
  - up to 40% of patients will have positive urine cultures in the absence of an active urine sediment.

Treatment

The number one cause of death in diabetic dogs and cats is not the disease itself, rather, it is the owner's frustration with the disease. This is an extremely important point to remember when treating diabetic animals. Good communication with the pet owner is perhaps the most important component of managing the disease.

It is recommended that clinicians schedule a 30-minute appointment with the client at the time of discharge before sending the diabetic patient home for the first time. During this appointment, clinicians should thoroughly discuss the care required for the patient. Include the following instructions in that discussion: how to give the animal injections; how to store insulin, what types of food to feed and how often; how to recognize the signs of hypoglycemia and how t react to this condition. Also include information on what clinical signs to look for in terms of monitoring water intake and urine production. The client should be give written instructions for use as a reference once they are caring for the patient at home. It is essential that the clinician and veterinary staff strive to educate the caregiver and motivate them to get involved in the care of their diabetic pet.

The goals of treatment include elimination of the clinical signs of diabetes, prevention or slowing of cataract formation and resulting blindness, prevention of potentially dangerous hypoglycemia, and prevention and/or treatment of concurrent illness.

Therapy for diabetes centers on three main areas: Treatment of concurrent illness (i.e., urinary tract infections, pydermas, etc.), insulin therapy, and dietary management.

Concurrent illness

Monitoring for concurrent illness is very important in effectively managing diabetic dogs and cats. Clinicians must effectively recognize and treat the other disorders because the concurrent illness will impact the diabetic regulation and many common diseases have similar clinical signs to diabetes mellitus. Even simple problems such as UTI's and pyodermas can result in activation of stress hormones and result in insulin resistance.

Insulin therapy

There has been a considerable amount of confusion over the various insulin preparations that are available. In general, animal origin insulins are being discontinued as the desire and ability to treat people with human derived insulin preparations has progressed.

There is concern that animals receiving human insulin will develop antibodies resulting in decreased insulin activity and/or effectiveness. Dogs receiving any insulin product that is not derived from pork may make antibodies. However, studies have shown that those antibodies do not interfere with the glucose control. In fact, dogs that made antibodies against insulin had a longer duration of insulin action, which actually enhanced the effect of the insulin rather than decreased its efficacy. A recent study in cats should that 13% developed anti-insulin antibodies. None of the cats should signs of insulin resistance.

The options with human insulin include ultra short acting, short acting, intermediate acting, and long-acting insulins. The short acting insulins are primarily used for ketoacidosis, and therefore, are not covered in this article. The intermediate acting insulins are classified as either NPH or Lente. It is important to note however, that even though they are classified as intermediate, they do not behave the same way in the dog or cat. Lente is actually a mixture of two different insulin preparations, which results in a bimodal onset of actions. This is helpful in some patients because is helps block post- prandial hyperglycemia. Conversely, a lente insulin is not recommended for use in an animal that does not develop post prandial hyperglycemia. It is recommended that NPH be used in the majority of dogs and cats with diabetes and it is also understood that most patients will require two injections a day to achieve glycemic control.

Canine patients

Newly diagnosed patients

1. Vetsulin (porcine origin lente): A zinc, porcine, intermediate acting insulin. Canine and porcine insulin have an identical amino acid sequence thereby eliminating the theoretical complication of anti-insulin antibodies and their effect on glycemic control. The suggested, initial starting dose is 0.5 units/kg BID. This insulin is only available at a concentration of 40 iu/ml (U-40) so please make sure that proper insulin syringes are provided to the owner. Re-assessment of clinical signs and a serial blood glucose curve should be performed 1 week after starting therapy. This insulin must be thoroughly shaken before administration. For additional information see: www.vetsulin.com.
2. Humulin N or Novolin N; These are both intermediate acting, human origin insulins. Suggested starting doses are 0.5 units/kg BID. Re-assessment of clinical signs and a serial blood glucose curve should be performed 1 week after starting therapy. I would avoid NPH insulins from Wal Mart due to product inconsistencies.
3. Glargine:
4. Detemir:
5. PZI:

Transitioning canine patients

If you have canine patients currently taking Humulin L lente insulin, I would switch them to either Vetsulin or Humulin N. The initial dose of Vetsulin or Humulin N will remain the same with re-assessment of clinical signs and a serial blood glucose curve performed 1 week after changing insulin preparations.

With the recent introduction of the AlphaTrak Blood Glucose Monitoring System (Abbott) we have the ability to very accurately measure blood glucose concentrations in both dogs and cats using very small quantities of blood. This will allow both veterinarians and pet owners to obtain very reliable results in both the hospital and home setting. This information can then be used to make informed decisions regarding the management of diabetic patients. These decisions impact the type and dose of insulin selected, the frequency of insulin administration, aid in the assessment of glycemic control, help in preventing hypoglycemic episodes and monitor for remission of diabetes especially in feline patients.

Glycemic control can be evaluated in a numbers of ways. Owner assessment of clinical signs (polyuria, polydipsia, weight gain or loss), progression of diabetic cataracts (dogs), presence of peripheral neuropathy (cats), and episodes of hypoglycemia are often the best indicators of glycemic control. Changes in insulin dosage or documenting remission of diabetes, is best determined by blood glucose measurement. Recognizing that the measurement of blood glucose concentrations can be problematic in the hospital setting (especially in cats as a result of stress induced hyperglycemia) recent work has evaluated the practicality and value of at home blood glucose monitoring in dogs and cats. At home blood glucose monitoring is essential in the management of human patients with diabetes given that a number of the complications associated with long term diabetes are directly related to persistent hyperglycemia. While diabetic retinopathy, nephropathy, painful neuropathies and cardiovascular disease are rare in our veterinary patients, adequate glycemic control is required to eliminate clinical signs and decrease morbidity and mortality in dogs and cats. Control of clinical signs does not require the restoration of euglycemia but rather involves keeping the blood glucose levels below renal threshold for the majority of the day. Renal threshold for glucose is 180 mg/dl in the dog and approximately 280 mg/dl in the cat. It is very important that we remember the owners of diabetic dogs and cats are being asked to do a great deal to help in the management of their pet’s chronic illness and we need to do whatever we can to make the clients job easier while at the same time taking steps to assure maximal diabetic control.

Using the information derived using at home or in hospital glucose monitoring

Dogs

- Dogs on NPH or Lente Insulins
    - If the preinsulin blood glucose concentration is > 360 mg/dl and/or the nadir blood glucose concentration is > 180 mg/dl the dose of insulin is increased by 25%..
    - If the preinsulin blood glucose concentration is 270 to 360 mg/dl and/or the nadir blood glucose concentration is 90 - 180 mg/dl the dose of insulin is maintained.
    - If the preinsulin blood glucose concentration is 190 - 270 mg/dl and/or the nadir blood glucose concentration is 54 - 90 mg/dl use the nadir, clinical signs and the next preinsulin glucose concentration to determine if the dose is decreased (50%) or maintained.
    - If the preinsulin blood glucose concentration is < 180 mg/dl and/or the nadir blood glucose concentration is < 54 mg/dl the dose of insulin is decreased by 50%.

The use of the AlphaTrak Blood Glucose Monitoring System both in the clinic and at home will greatly improve our ability to assess glyemic control and improve insulin therapy. In conjunction with close observation of clinical signs, at home glucose monitoring should go a long way towards improving the quality of life of diabetic pets and their owners.

Diet

There is a considerable amount of reliable research data showing that diets high in carbohydrates, low in fat and high in fiber are helpful in regulating diabetic dogs. These types of diets lower the average insulin dose, the average blood sugar, the amount of urine being produced and glycosolated hemoglobins and fructosamine levels.

The carbohydrates in these diets are complex carbohydrates. It is important to avoid diets high in simple sugars, which includes any commercial semi-moist food, primarily those packaged in foil packets. Diets high in simple sugars are absorbed very rapidly before the insulin has time to work. The goal with diet is to balance the absorption of sugar with the onset of action of the insulin. A high carbohydrate/low fat diets also decreases plasma free fatty acid and cholesterol concentrations, and increases the number and activity of insulin receptors.

High fiber diets reduce insulin resistance. The fiber acts to decrease post prandial hyperglycemia, primarily because it delays gastric emptying. A high fiber diet also decreases absorption of glucose and increases insulin action at the receptor.

It has recently been suggested that diabetic cats be fed a high protein/low carbohydrate diet. This can be accomplished with several commercially available canned diets (Hill's M/D, IVD Development, Purina DM, many other canned kitten diets). These diets may result in remission of the diabetes and elimination of the need for exogenous insulin and/or oral hypoglycemic agents. High protein/low carbohydrate diets more closely resemble the diet of felines in the wild and may help reduce glucose intolerance, insulin resistance and obesity.

Feeding

Ideally, the feeding schedule should be coordinated with the onset of action of the insulin. With dogs, this is fairly easy to regulate, but with cats, it is nearly impossible due to their "grazing" style of eating. For cat owners who may not be able to follow a strict feeding schedule or those with multiple pet households, insulin therapy will have to be adjusted to meet the owner's needs. The most important component of the dietary plan is to stress consistency in the diet. The following feeding schedule can be used for dogs and some cats. With insulin given once a day, feed three meals a day (of equal calories) at six-hour internals. Give the first meal at the time of the insulin injection. For animals receiving insulin twice a day, feed four meals a day. Schedule them to coincide with the insulin injections and feed mid-afternoon and late evening.

If the owner is unable to follow this schedule, advise them to feed twice a day, at the time of injection and 8-10 hours later (for once a day insulin patients); or at the times of insulin injections (for twice a day insulin patients).

Home management

1. Instruct owner on proper injection techniques, injection locations, storage and handling of insulin.
2. Instruct owner on how to monitor clinical signs.
3. Continue feeding schedule and dietary therapy.
4. Instruct owners to initially monitor urine glucose/ketone levels daily, usually in the morning or evening prior to feeding. If persistent glycosuria or ketonuria is observed, ask owner to contact the veterinary hospital.
5. Advise owners of the signs of and treatment for hypoglycemia. Have owners keep a bottle of Karo syrup on hand if signs occur (i.e., weakness, ataxia, seizures) so they can rub syrup on the gums immediately. Instruct them to call the veterinary hospital.
6. Home monitoring of a diabetic cat is frequently based on observance of clinical signs only.
7. Serial sugars after the first week of home management.

Re-check evaluations

1. Obtain owner assessment of clinical signs.
2. Serial blood sugars are helpful due to:
    a. Variability of insulin action in a given patient.
    b. Inaccuracy of random blood or urine sugars in monitoring the degree of glycemic control.
    c. Not particularly helpful as a routine procedure in animals that are well controlled clinically.
3. Body weight
4. Physical examination/ophthalmic exam
5. Discuss urine log book with owner
6. Laboratory work as clinically indicated
    a. Role of glycosylated hemoglobin and frustosamine:
    b. Fructosamine may be helpful in distinguishing stress-induced hyperglycemia from diabetes in cats. These tests can be used every 3 – 4 months as an indicator of long term (2-3 weeks fructosamine; 4-6 weeks glycosylated hemoglobin) glucose control. Rising values indicate the need for further evaluation.

Problems with insulin therapy

- Insulin induced hyperglycemia (Somogyi phenomenon)
    - Hypoglycemia (<65mg/dl) followed by hyperglycemia (>300mg/dl) within 24 hours of insulin injection.
    - Suspect when insulin requirements exceed 2 U/kg and clinical signs persist.
    - Suspect when animal has signs of hypoglycemia in afternoon.
    - Diagnosis with serial sugars.
    - Treat by decreasing insulin dose 25-50% and review insulin administration with the owner to rule out management problems.
    - Re-check serial sugars in one week.
- Rapid insulin metabolism
    - Duration of insulin less than 18 hours.
    - Signs return in the evening.
    - Diagnosis is with serial sugars. Hyperglycemia (>250) within 18 hours of insulin injection without previous hypoglycemia.
    - Treatment:
        - Review management with owner
        - Switch to twice daily insulin administration. Most dogs and cats require insulin twice a day to achieve adequate glycemic control. Consider switching to PZI in cats.
- Insulin Resistance
    - Hyperglycemia (>300) throughout the day, despite insulin dosages > 2 U/kg.
    - Diagnosis based on serial sugars.
    - Potential causes of insulin resistance:
        - Management problems
        - Hyperadrenocoticism
        - Steroid or Ovaban administration
        - Diestrus or pregnancy
        - Acromegaly
        - Concurrent illness, infection
        - Anti-insulin antibodies
        - Hypothyroidism (dogs), hyperthyroidism (cats)
    - If insulin dose exceeds 2U/kg, the animal should be evaluated for one of these causes of resistance.
- Hypoglycemia
    - Insulin overdosage
    - Suspect if animal shows weakness, shaking, ataxia, seizures at time of insulin's peak effect.
    - Therapy (instructions for owners)
        - Mild signs - give food and call veterinarian
        - Moderate signs - apply Karo syrup to the mouth, offer food when alert and then notify veterinarian.
        - Comatose - apply Karo syrup to mouth and take animal to hospital.
    - When hypoglycemia occurs, serial sugars should be performed to re-assess insulin dose

Ultrasound Cases: What Can I Really See With Some Practice and How to Communicate Value to Pet Owners

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

The use of radiography to examine the abdomen is full of complications. Radiographs are very good at determining the difference between bone and gas, but soft tissue and fluid are the same opacity. When dealing with intra-abdominal lesions, the main goal is to differentiate one soft tissue mass from a normal soft tissue structure from abdominal fluid. Ultrasound uses high frequency sound waves to accomplish what radiographs cannot. With ultrasound, fluid and soft tissue can be clearly distinguished from one another, where bone and gas cannot. The purpose of this proceeding is to describe the benefits and uses of abdominal ultrasound to the general practitioner.

Abdominal ultrasound is a unique diagnostic test in veterinary imaging. Unlike blood work, radiographs, computed tomography or magnetic resonance imaging, ultrasound requires the sonographer to both acquire images as well as interpret them. This unique combination is why physicians have allowed technicians to acquire the ultrasound images and that leaves radiologists free to perform other studies and interpret the images acquired. This model has not been accepted in veterinary medicine as yet.

So the first stage to abdominal ultrasound is gaining the technical skill to acquire images. This requires patience and time, but is relatively easy with practice. Where ultrasound skill comes into play is with adaptation for disease processes. It is necessary to know that if you suspect portal hypertension, you need to look behind the left kidney for acquired portosystemic shunts. If you see a thrombus in the splenic vein, you need to evaluate the portal vein for thrombosis as well. This is the degree of medicine that keeps the ultrasound probe in the hands of the veterinarian.

Ultrasound examinations have nearly replaced abdominal radiographs at Michigan State University. As an example, on a given day, we performed up to 20 ultrasound examinations and only 3-5 abdominal radiographic series, generally performed during emergency hours. This replacement has occurred because ultrasound provides better detail and more information about the abdomen compared to plain radiographs. Although we have virtually replaced radiography, radiography is more rapid and gives a better overview of the abdomen compared to ultrasound. For example, a gastric dilation with volvulus can be diagnosed with ultrasound, but it would be easier and more accurate to use radiography to identify the gas filled pylorus displaced dorsally and to the right.

Once the images have been acquired, the next step is interpretation. When ultrasound was first used, it was the first non-invasive, cross-sectional imaging modality. This means that rather than just seeing the outline of an organ, you can now see the portal vein within the liver and the medulla within the kidney. Ultrasound images were compared to gross necropsy examination, but done in a much less invasive manner. Since the image generated can see into the organ, it is very sensitive to find morphologic changes such as masses, cysts, abscesses and tumors. However, unlike gross pathology, you no longer have color and smell to aid in your diagnosis. For this reason, an abscess can look just like a tumor, which can look just like a blood clot. This is why we considered ultrasound very sensitive for disease, but not very specific. The benefit of ultrasound is the ability to identify a lesion in an organ of interest as well as aid in obtaining a sample, either with fine needle aspiration or with a biopsy to help determine the true nature of the lesion.

Common lesions identified using ultrasound include: foreign body obstruction, mucocele formation, splenic hemangiosarcoma and urinary tract disease. Previously, a foreign body obstruction could only be identified if it was completely obstructive, was radiopaque or radiolucent and if there was marked dilation orad from the lesion. With the superimposition of other organ structures, sometimes barium was used to evaluate wall thickness and motility. Ultrasound has virtually eliminated the need for barium studies and allows the evaluation and identification of foreign material, whether completely or partially obstructed, within the gastrointestinal tract. This is because that any foreign material, whether it is made from wood, cloth or metal, will absorb sound and cast a dark shadow deep to the lesion. That coupled with the increased ability to identify small intestinal distension and wall layering, makes the determination between a foreign body obstruction and a neoplastic mass easily distinguished.

A mucocele is a chronic form of cholecystitis. Generally, a patient presents with a chronic history of intermittent vomiting followed by an acute onset of collapse or severe, unrelenting vomiting. Ultrasound is the only method available to non-invasively examine the gallbladder and bile duct for evidence of obstruction or mucocele formation. A mucocele has the unique appearance of linear striations that radiate from the center of the lumen. These radiations are thought to be bile salts trapped within a thick, hypoechoic (dark) mucosal wall. At this stage, the gallbladder is considered a nidis for infection and a surgical emergency since it has a high risk of rupture if left in place.

Large splenic masses are generally easily identified on radiographs or ultrasound (as well as physical examination). The difference is in the dog that presents with acute collapse and a hemoabdomen. It is true that with a hemoabdomen and no history of trauma, you can perform an exploratory surgery to find the source of the bleeding, but this is usually difficult to do. Instead, ultrasound evaluation of the abdomen to look for a mass as well as metastatic disease is considered the non-invasive method of choice to help with the surgical planning.

Lastly, urinary tract abnormalities such as hydronephrosis, perinephric pseudocysts, transitional cell carcinoma and cystitis can all be evaluated without the use for contrast medium or general anesthesia in a rapid non-invasive way using ultrasound. Examination of the kidneys will show if the renal pelvis is dilated or the kidney is surrounded by fluid. With radiographs, since fluid and soft tissue are the same opacity, it is not possible to make this determination without contrast medium, which is considered nephrotoxic. Instead, ultrasound can show the architecture of the kidney as well as help find a distended ureter if one is present. The wall of the urinary bladder is also a dilemma with ultrasound since the urine will obscure the luminal margin. With ultrasound, small areas of mineralization within the mass as well as proliferation of the wall seen with cystitis can be quickly and accurately identified, though differentiating tumor versus inflammation is difficult without obtaining a sample with traumatic catheterization.

Abdominal ultrasound in the general practice has the potential to provide a practitioner with rapid information to help facilitate referral or further diagnostic tests especially in the vague, chronically ill patient. With practice, guidance and perseverance, it is possible to use this modality as a triage tool as well as method to determine the progression and regression of disease.

Laser Use in Physical Rehabilitation and Adding it to Your Practice

Jennifer Wardlaw, DVM, MS, DACVS
Gateway Veterinary Surgery
St. Louis, MO

Karen Felsted, DVM, MS, CVPM, CPA
PantheraT Veterinary Management Consulting
Dallas, TX

Laser therapy is Light Amplification by the Stimulated Emission of Radiation (LASER). Lasers are classified into four levels depending on their potential to harm tissue. Class 1 is a laser pointer used in lectures or at a grocery store while an example of a Class 4 laser would be a surgical cutting laser. Class 3 and 4s are used for low level laser therapy or physical rehabilitation. They are advocated for many things but used mostly for wound healing and pain relief.

Laser therapy cause cellular oxygen production by photons being absorbed into the mitochondria. This in turn causes a proton gradient across the cell and mitochondrial membrane. The gradients result in increased cell permeability. Laser therapy also stimulates the production of ATP, thereby stimulating DNA production. Also laser therapy increases cellular metabolism and growth. This accelerates tissue repair and cell growth in tendons, ligaments and muscles.

There are also indications in human and rodent models that laser therapy may block pain transmission through conduction latencies and selectively inhibit nociceptive neuronal activities. It may also increase endorphins. For this reason laser therapy is being used for muscle trigger points and acupuncture, called acupressure.

Laser therapy is advocated in wound healing due to its ability to stimulate fibroblasts and speed collagen production to repair tissues. It appears to accelerate angiogenesis and neovascularization. Laser is used on edema because it causes vasodilation and improves lymphatic drainage. It appears laser therapy may help with surgical incisions, open wounds and burns. The goal of wound laser therapy is to increase blood circulation, stimulate the reduction of hemoglobin, then stimulate both the reduction and immediate re-oxygenation of cytochrome c oxidase. This is the normal metabolic, wound healing process, just trying to speed it up with laser therapy.

Lasers emit energy, or joules, at a certain wavelength. This wavelength determines how deep the laser will penetrate into the tissue. The power, or watts, of a laser is the rate or speed at which it can deliver the desired energy to the tissues. There are many different lasers with different penetrating wavelengths, but the energy density or dose for square of centimeter of tissue is the critical data point. Not only does the laser light need to fully penetrate the area we want, but it needs to bring the right level of energy to the tissue. Based on the size of the tissue or area we are treating (cm2) is how we determine the total dosage (J/cm2). The power of your laser will determine if that takes you 10 seconds or 10 minutes to accomplish that treatment dose. Research is still ongoing for determining whether continuous wave, or pulsed wave lasers are better, if daily or every other day protocols are superior and what the ideal dosage is for a condition. So given all the variables in laser company styles, format and protocols, it is of paramount importance that we discuss energy density and dosages in the same concise language so we can communicate appropriately; Joules per centimeter squared.

We do know that the minimum dosage in humans to achieve a photochemical response to laser therapy is 5 J/cm2. We also know there are contraindications to laser therapy; active hemorrhage, local steroids, pregnancy, cancer, heart disease, photosensitive medications.

There are limited studies looking at laser therapy, but many are in progress. Once human study should an improvement in pain relief for 2 months and up to 1 year after a two week protocol. A canine study showed similar results with weekly sessions for four to six weeks showing 70% of patients showing some improvement in arthritic pain and gait abnormalities.

The difference between commercially available laser unties lie solely in the wavelength, power density, pulse modulation and aesthetics. The goal is to stimulate the cell, and ultimately the body, to perform its natural functions, but at an enhanced rate.

Intraoral Radiography: Not Just a Fancy Coat Rack

Heidi Lobprise, DVM, DAVDC
Main Street Veterinary Hospital and Dental Clinic
Flower Mound, TX

Karen Felsted, CPA, MS, DVM, CVPM
PantheraT Veterinary Management Consulting
Dallas, TX

Radiology is a vital tool in veterinary dentistry assisting in diagnosis, treatment planning, and monitoring of oral disease. Diagnostically, being able to assess normal anatomy helps to determine if abnormalities exist, including variations in development (missing or aberrant teeth) or acquired diseases that may affect the bone and tooth structure (CMO, hyperparathyroidism, neoplasia). When determining the possible treatment for problems such as feline cervical line lesions, endodontically compromised teeth and periodontal disease, radiology can help the practitioner make a more accurate assessment. Preoperative radiographs can help monitor extractions by revealing abnormal root structures, impacted teeth, tooth resorptionand ankylosed roots. Post-operative films check treatment success. Endodontics requires several films during the procedure to evaluate routine treatment and reveal complications.

Basics of equipment

Radiographic unit

The most commonly used x-ray generator is a standard dental model, which is either wall-mounted or supported by a mobile stand. There are also hand-held units available for greater ease in transportation or use in multiple sites. Staff should minimize their exposure by standing at least 6 feet from the tube head and always at an angle of 90 to 135 degrees from the path of the primary beam.

Films

Intraoral films provide isolation of a specific tooth with excellent detail, with a non-screen, double-coated emulsion film. The No.2 periapical film is the most commonly used, and is similar in size to most digital sensors. Occlusal films (No.4,) are 2 1/4 X 3 inches in size and often used for imaging the incisal areas, to include the canines of larger dogs, and can be useful for nasal imaging. A raised dot imprinted on the film and packet indicates the side that should face the X-ray tube, placing the concave "dimple" away from the tube. Once developed, this dot helps determine the orientation and identification of the teeth. The film is encased in an inner black paper sheet with a layer of lead foil on the backside that reduces backscatter from deeper oral tissues, all in a plastic or paper cover. These films can be hand developed in small containers in a dark room, using a chairside developer, or an automatic developer.

Direct digital

For convenience, increased use and decreased patient anesthetic time, investing in a digital dental system often pays for itself in a matter of months, and greatly increases the learning curve for new users. While the sensors are not inexpensive, being able to immediately see the image on the computer screen is of great benefit for both diagnostic purposes and to be able to adjust the angulation or technique to get a reasonable image. A downside to direct digital is the single size (No.2) of the sensor.

Indirect digital

As a compromise between standard films and direct digital, indirect digital radiography may be accomplished using phosphor plates that are photostimulatable. The phosphorus sensor uses an image plate that can be reused (the outer sleeve is replaced), then the plate is placed in a scanner, so the image can be transferred to a computer. There are more steps with the indirect method and it takes longer than the direct method, but varying sizes of plates can be utilized.

Technique

There are many ways to teach and take dental radiographs; the author’s preference is to have the patient in lateral recumbency and slightly adjust the head position using towels, depending on the image needed. Others prefer dorsal and ventral recumbency for taking radiographs - determine what works best for you and your staff

Parallel

While a parallel technique (film and object parallel with x-ray beam perpendicular) would be ideal to minimize distortion, most areas of the oral cavity do not lend themselves easily to this positioning. The only region where the film can be placed parallel to the teeth is that of the mandibular premolars and molars, with a corner of the film pressing into the intermandibular space. The most mesial (rostral) roots and teeth may not be visible on this view, as the film may be limited by the mandibular symphysis, but aiming the radiographic beam from a slightly rostral oblique position may allow these roots to be imaged.

Bisecting angle technique

For the rest of the teeth in the oral cavity, a parallel positioning is not possible, so, a film is placed as close to a parallel plane to the object (root or tooth) as possible. Remember to place the film so the roots will be imaged, not necessarily the crown. One option is to use a bisecting angle technique for these films by aiming the beam at a line that bisects the angle formed by the long axis of the object (tooth) and the film.

Modified technique

Another way of determining beam position is to first line up the beam (or similar object such as a 2-inch roll of tape) perpendicular to the film. This would result in an image that is too short (shadow of a tree at noon). Next, line up the beam perpendicular to the root (tooth); this image would be too long (shadow of a tree at daybreak). Then, split the difference between these two positions, and the resulting image will be approximately the same size as the object, thus minimizing the distortion (and the beam will be perpendicular to that bisecting line mentioned earlier). Helpful devices, such as connecting two tongue depressors with a pushpin, and using a roll of tape to invisualize where the beam will travel , can help you determine the two positions (perpendicular to film; perpendicular to tooth), so you can aim the beam halfway between the two. This perspective will also help you make appropriate adjustments to an image; if you want to make the image shorter, move the beam to a position more perpendicular to the film.

Challenging radiographs – the cat quick 6

- With the cat in lateral recumbency (e.g. – left side down), take the first image of the mandibular premolars and molar with a parallel technique.
    - If the mesial (rostral) root of the mandibular third premolar does not show, adjust the xray head further ventral and forward
- Take an image of the lower canines and incisors: roll the tongue back into the pharyngeal area to keep the sensor in place better; use the modified technique
- Take an image of the upper canine and incisors with the sensor 'wide' across the palate
    - If you need to isolate the right canine tooth apex better, come slightly off midline
    - Take an image of the maxillary premolars
    - Place the sensor up against the palate
    - Using a tape roll, visualize where the beam would be, if aimed directly perpendicular to the teeth: you will not be coming directly laterally to the maxilla, but slightly from in front
    - Then visualize where the beam would be perpendicular to the film
    - Split the difference
    - The zygomatic arch will always be in the way – if you elongate the image by moving the xray beam more perpendicular to the teeth, the arch 'moves' a little more out of the way.
- Using a clear feline mouth gag (cut part of a tuberculin syringe); place the sensor under the head on the left side (extraoral); the left maxillary premolars will be placed nearly flat on the sensor in this position.
    - Using the tape roll, and angled from the back of the head, look across the arch at an oblique/angle, until you see the palatal surfaces of the left maxillary premolars without the right premolars superimposed over them
        - Make sure the sensor is placed far enough forward and dorsal that the angled beam will go through the teeth and hit the plate.
- 5 of the 6 films are done!
    - Adjust the cat to left lateral recumbency and take the left mandibular premolars

Challenging dog radiographs

- Maxillary incisors – in most dogs with a normal head shape, then ventral portion of the nares will be lined up with the base of the xray cone when positioned
- Maxillary canine apex – palpate where the apex is positioned by running your finger up the buccal jugae to the tip (it is usually somewhere over the second premolar
    - Place the sensor centered at the maxillary second premolar
    - Adjust the xray beam from midline to a slight oblique so the canine is not superimposed over the premolars in the image; make sure it is centered on the spot where you palpated the canine apex
- Maxillary molars – with a skull or model, observe how the molars are in a different 'line' than the premolars
    - Place the sensor in the mouth lined up with the two molars (usually angled in a palatal direction)
    - Aim the beam almost directly onto the sensor (just a slight adjustment)
- Mandibular canines
    - If you place the sensor across both lower second premolars and aim the beam perpendicular to the sensor, you will have both canine apices for good comparison
- Mandibular premolars
    - Since the symphysis restricts the sensor from going far enough forward to get a true parallel image of the first and second premolars, adjust the beam to come from in front of and below the teeth to 'push' them onto the image (or take it extraorally)
- Brachcephalic dogs

- Use extraoral shots as is done for cats

Troubleshooting radiographs

- Teeth are too long, or the apex is not on the film
  - Place the sensor deeper into the palate – you want to see the roots, not the crown
  - Adjust the beam to be more perpendicular to the film – ‘shortens’ the teeth
- Teeth are too short
  - Adjust the beam to be more perpendicular to the tooth – ‘enlongates’ the teeth
- Image shows unexpected bone loss (and crowns are burnt out)
  - Decrease time of exposure; if at lowest time, move xray cone an inch or two away from object

Pain Medication:
A Win, Win Situation for You, Your Patients, and Your Clients

Andrew Claude, DVM, DACVAA
Mississippi State University
Mississippi State, MS

- Historically, it was believed animals did not feel pain or perceived pain differently than did humans. An example of a misconception regarding post-operative pain in animal patients was that pain following surgery benefited animals because it limited movement thus preventing further injury.
- Animals and humans share similar anatomical and physiological nociceptive structures for the production, conduction, and modulation of pain.
- Pain assessment in animals is based on anthropomorphic comparisons, subjective, and objective criteria.

Ethical principles of pain management in veterinary medicine

- The Veterinarian's Oath states, "...the protection of animal health and welfare, the prevention and relief of animal suffering..." Does the Veterinarian's Oath still apply today?
- Since recorded history humans have consistently demonstrated a keenness toward domesticating and caring for animals. Unfortunately, the historical relationship between humans and animals is tainted with various forms of animal cruelty.
- Modern biology presented similarities between humans and animals, thus proving animals were not distinct from humans.
- Charles Darwin's theory of evolution transformed the perception of the relationship between animals and humans.
- In United States, the 1966 Animal Welfare Act and The National Institutes of Health Reauthorization Acts set the stage for social, economic, and legislative actions leading to the modernization of the concept of animal welfare.
- As modern medicine became more scientifically based, pain, although always recognized as an entity of pathology, was difficult to accept because it never completely had a scientific explanation.
- Veterinary medicine was founded originally to benefit the animal agricultural industry and military use of horses. Anesthesia and analgesia were primarily means to help control large animals, protect personnel, and the value of the patient.
- Although human medicine has made tremendous advancements in pain management veterinary medicine still lags behind.
- Society's views of animal pain and welfare have changed dramatically since the Animal Welfare Act was passed in 1966. Today, society no longer tolerates unnecessary animal suffering. The ease of information from the world-wide internet allows people to self-educate on subjects in pet health and welfare. Clients no longer consider pain management options as a luxury for their pet but instead as a mandatory part of an overall procedure.
- Two primary factors that will contribute to the veterinary industry losing significance in society are refusal to change and refusal to charge. Each one of us, as a representative of the veterinary industry, has an obligation to remain educated regarding pet health issues (including pain management), and be the primary source of information about pet welfare for clients, and clients have an obligation to realize financially the importance of veterinarians' expertise in the health and welfare of their pets.

References

ACVAA website: http://www.acvaa.org, American College of Veterinary Anesthesiologists' position paper on the treatment of pain in animals, 2006 http://www.acvaa.org/docs/Pain_Treatment

Carroll G, Analgesics and pain, Vet Clin North Am Small Anim Pract. 1999 May;29(3):701-17

Fajt V, Wagner S, Norby B, Analgesic drug administration and attitudes about analgesia in cattle among bovine practitioners in the United States, JAVMA, 2011, March, 238(6):755-67

Hellyer P, Rodan I, Downing R, AAHA/AAFP Pain Management Guidelines for Dogs and Cats, JAAHA, 2007, Sept/Oct, 43:235-48

Hewson C, Dohoo I, Lemke K, Perioperative use of analgesics in dogs and cats by Canadian veterinarians in 2001, Can Vet J, 2006, Apr;47(4):352-9.

Ideal Outpatient Visits-
From Check-in to Check-out

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

This is an extraordinary occasion for veterinary practice. The rapid changes in technology, medicine, and client expectations have all melded together to yield very unique, rewarding opportunities for those veterinary hospitals who are willing to embrace those changes and fully engage the potential of this challenging business climate.

What's a forward thinking practice to do? Here are the points to consider

1. Client service is dead – client experience is everything

Mrs. Expect comes into the clinic and waits until 3:30PM to see the doctor for her 3:00PM appointment. Dr. Wonderful does an excellent comprehensive physical examination, runs an in-house laboratory panel and prescribes the correct medication. While there an assortment of variables that come into play, how do you think Mrs. Expect discusses this time at the practice with her family this evening at the dinner table? Do you think the words bad service or bad experience was used? Clients no longer assess the service alone in determining their satisfaction, it is the total experience; and they measure not only against other veterinary practices, but other service/professional businesses. Every detail of the entire visit now must be considered. It's no longer about how your practice compares to other practices, it's how your practice compare to other service businesses.

Here is how your practice can engage this change

2. Your team comes first – not your client

Yes, this sounds counterintuitive, but it's true because without the commitment of your team in the belief that they are respected, understood and appreciated, you're your training, marketing and hiring will be of limited value. Treat your team members as well as you want them to treat your clients. What does it truly take to have your receptionist Sarah tell Ms. Delay to come in 20 minutes before the clinic closes instead of telling her that she will have to come in tomorrow? Creating an environment where there is a genuine sense of compassion and interest in the client means that the culture within the clinic itself possesses those qualities.

Here is how your practice can engage this change

3. It's courtesy, not efficiency that builds loyalty

Gather up all those wonderful letters and emails about why you are the best practice and how much your clients love you. Pick out the words that clients use to describe you – peruse some of these words appear – compassionate, caring, empathetic, friendly, loving, and amazing. How many times do you see words punctual, efficient, competent, or my personal favorite, discounted? (Sorry, I just had do put that in there) While you need to be mindful of time, it is courtesy, kindness, compassion and true understanding that create the connection with clients. The receptionist who is more concerned with efficiency instead of making eye contact and using a genuine smile to build rapport with a client has missed a crucial opportunity. And, in this case, who failed? The receptionist? Management?

Here is how your practice can engage this change

4. Expectation is a moving target

Rapidly accelerated change is the constant; only those practices that can reliably evolve along with the increasing and diverse expectations of clients will assure their achievement. The other element in this equation of success is that clients will not always know what they want for their pet. Veterinary practices will need to intrigue clients, invite their curiosity, improve their knowledge and engage their delight to create a loyalty that will yield a desire to make their pet a lifelong patient of the practice.

Here is how your practice can engage this change

Associate Case Studies:
Who Gets Hired and Fired- and Why

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

1. R-e-s-p-e-c-t
It's not just a word, it's what you do. Treat them with respect and model the behavior you expect from them with every employee. Part of respect is praise and feedback; let them know in public when they do well and in private when there's a concern.

2. Leadership
Associates want to know they are on the right path and there is a plan in the practice for moving forward. They want to belong to something bigger than themselves and know that someone they can trust is in charge.

3. Empowerment
Allow your Associates to make decisions and to share their ideas with you. While they may not always make the right decisions, they need to know you will support them when needed. Consider what you learned when you made a mistake and encourage them to make decisions.

4. Make it fit
Send the new associate out to lunch with different departments in the hospital; one day with the veterinary technicians, one day with the receptionists and then lunch with the kennel and exam room teams. Have them talk about the successes of the practice and how we make a difference in the lives of pets every day.

5. Open it up
Have an open house or reception and invite your best clients to meet the new associate. Nothing says welcome like clients who will tell your new employee how wonderful the practice is from the client's point of view.

6. Expectations
Ask them what their expectations are in an employer. Let them know clearly how they will be evaluated and the timeline for performance evaluations.

7. Be proud
Put an ad in the paper welcoming the new associate. Create a flyer that you can give to clients in the practice telling them about the wonderful addition to the practice. Post their picture and biography in the exam rooms.

8. Mentor
Assign a mentor, someone who can assist them, meet with them regularly and help them to integrate into the practice.

9. Time
Set up regular times to meet and talk about cases, comments, and concerns. Encourage the new associate to ask questions when they have them, but also make time so you can demonstrate your commitment to them; and remember, you can't change the tire at 40 mph, slow down and take the time to talk about it.

10. Make sure there are no misunderstandings
Everything should be put in writing, make sure you have an employment contract, job description and policy manual. Go over these with your new associate.

11. WALK YOUR TALK
Make sure you set the example, not only medically but in your actions. Be to meetings on time, treat other employees with respect, get to work on time. Remember that any successful business starts from the top.

Salary, Production, and ProSal: What's Best for Your Practice?

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

Without question the most common question I am asked as a consultant, is "how do I pay my associates fairly?" This is not a concern only for practice owners, but naturally for associates as well. Practice owners wish to pay associates fairly, but also give them an incentive to produce income for the practice. Associates wish to get paid fairly and make as much money as they can. What could be a more natural relationship?

There are basically three ways an associate can be paid. These are salary, production, or a combination of both. Let's review the pros and cons of each of these methods of compensation.

Salary – If an associate is paid strictly on salary, compensation is usually negotiated at the beginning of the year. The amount decided upon can be strictly arbitrary, or it could be based on that veterinarian's previous year's production. The pros of this type of salary arrangement are that both the owner and associate know how much they have to pay or will be paid. There is comfort in the fact of knowing what your expense or income will be. The downside of a salary agreement is that there is no motivation to increase ones production. A veterinarian who does the minimum expected of him or her, will get the exact same compensation as a veterinarian who spends the time to work up cases, educate clients and provides a full service approach to there clients. Is this method of compensation fair to both parties?

Several years ago I lectured and consulted in Sweden. At that time all but one of the veterinary hospitals were run and controlled by the government. I visited several practices owned by the government. Clients would bring their pets into the hospital and ask for a Rabies vaccination and indeed that was all they received. Even if the pet had never received a distemper vaccination, or never had a fecal exam performed, the client would not be asked if they desired any additional services. They only got what they asked for. In addition there were long waiting periods and the facilities themselves were not very impressive. I then visited the one veterinary practice that was privately owned. Talk about night and day difference. The hospital itself was modern and clean. Clients were greeted when they entered the practice, the doctors spent time with the client and their pet. The veterinarians in this privately owned hospital educated clients about there pets needs and provided a full service approach. There was indeed no comparison. In the government owned practices the veterinarians were paid a salary, in the private practice the veterinarians were paid on a percentage of their production. The government wanted to know why the one private hospital was the only one that was profitable! Could you guess some of the reasons why?

Percentage based compensation – Another method of compensating associates would be to pay them strictly on their production. Most experts agree that if an associate is to be paid based on a percentage of their production, they should be paid between 18 to 25% depending upon other costs of employment. Costs of employment include anything that indeed costs the practice money. Therefore any direct cost the practice is incurring due to the employment of the associate must be calculated. As an example if a practice if paying for health insurance, continuing education, dues, licenses, liability insurance, disability insurance and even the cost of matching FICA, all these costs must be determined and included into the calculation to determine the true costs of employment. It is these costs that should not exceed 25% of an associate's production.

The pros of percentage based compensation is that employed veterinarians can be much more in control of there compensation. If it is a real busy month and the associate's production is high, there check will reflect this. This method of compensation also gives an associate a much greater incentive to be productive and help the practice grow. The downside of production based compensation is that there is no guarantee of compensation. If an associate does not produce, they will not get paid. Without prior knowledge of what an associate has produced, this can be a very scary proposition for an associated to enter into.

ProSal formula

Thus the advent of the ProSal formula of compensation for associate Veterinarian's (January 1997 Veterinary Economics). The ProSal formula is without question the best of both worlds. The ProSal formula is a combination of a guarantee base of compensation; however the associate is paid on a percentage of their production.

The way the ProSal formula works is as follows: An associate will be guaranteed a base salary for the year. As an example we may guarantee our associate $45,000 a year. We will then take the guarantee base and divide it by 24 (since the associate will be paid twice a month). This amount will be paid on or about the 20th of each month. At the end of the month we will determine the associate's production and take a percentage of it that was pre-determined and agreed upon (18-25%) and figure out what the associate should have been paid for that month. From that amount we will subtract the prior payment and issue a check for the balance.

An example of this would be as follows

- Guaranteed base of $45,000.00 a year
- Associate will be paid 21% of production
- During the month the associate produced $29,000 of income
- Payment on the 20th of the month = $1,875.00
- (1/24 of $45,000.00)
- Payment of the 10th of the following month = $4,215.00
- (21% of $29,000 = $6,090.00 less $1.875.00)

At the end of the year we would total all the compensation received by the associate. If that total did not exceed the guarantee base of $45,000.00 we would owe the associate the difference. Therefore the guarantee base comes in at the end of the year and in figuring out the fixed payment each month.

This is indeed the best of both worlds. The associate is guaranteed to earn, no less than the guarantee base, but has the potential to earn whatever they wish, within reason. They can't earn less, but they can earn a whole lot more. If they do earn more, than they are of course more productive for the practice and thus a win for the practice as well. In the past eight years that we have been using the ProSal formula there has only been one occasion in which an associate has not earned their guaranteed base. There are hundreds of associates presently being paid under this method of compensation. Indeed, associates themselves love the ProSal formula once they get over their initial fear of it. Owners are always amazed at how much more productive an associate becomes once they are on the ProSal formula. It is truly the best method of compensation for associates that I have seen.

It is important to note, that I do not feel money is the end all. I certainly know that most veterinarians have not gotten into this profession to get rich. Indeed, I feel that quality of medicine and surgery always come first. This however, does not mean that we should not make more money, or provide an associate with an incentive to do so.

Now, let's take a few minutes to ask and answer some of the more commonly asked questions in regards to the ProSal formula:

How do I define production?

Production is defined as fees generated and collected for services the doctor was formally involved in the delivery of. Therefor the doctor must have "hands on" in order to receive credit for service. As an example we might consider and out patient office visit where a doctor has done a comprehensive physical exam, vaccination and sold a heartworm preventative and bottle of shampoo. The doctor in this case would get full credit for all these products and services because they were done during the course of an office visit.

If the client came back a month or two later to purchase more shampoo and if this was done over the counter, the doctor would not get credit for it. The exceptions to this rule are x-rays, laboratory procedures and dentistry, assuming a technician provides these services. The doctor who ordered the procedure or over saw it would receive credit for it.

Even with a good definition of production there will be some grey areas and some overlap between doctors. These should be expected and there needs to be a give and take attitude and one of teamwork established within the practice.

My computer credits the doctor when the service is charged for weather I get paid or not. How do I keep track of this?

Most veterinary software programs do indeed credit the doctor when the service is rendered weather the practice is paid or not. No, it is not fair to the practice to pay an associate their percentage of production when the hospital has not been paid. This is another advantage of the ProSal formula since it hopefully brings the associate into the reality of a client's ability to pay for services rendered.

It is my suggestion that if your software credits associates when the service is rendered the associate should indeed receive credit at that time. At 90 or 120 days, if the account still remains uncollected the amount that was paid to the associate should be deducted from their next "production" check. Therefor we will deal with this problem at the back end instead of the front. If we do get payment the associate will receive their percentage of production in their next "production" check

How do I determine total costs of employment?

As previously stated total costs of employment refer to all costs incurred by the practice to employ an associate. These can vary substantially from practice to practice. The worksheet provided (see figure 1) should help to figure out what the actual costs are. This worksheet should be filled out annually on each associate and given to them. This will help the associate understand how there percentage is figure out and why. The total cost of employing an associate should not exceed 25% of their production. If production does exceed this number the practice is over compensating their associate.

How do I figure vacation and personal leave into the formula?

Under ProSal if an associate does not produce, they do not get paid. True, there is a guaranteed base, but that comes in at the end of the year. The practice should specify in the associate's contract the amount of vacation days and personal leave days they are providing. If an employed veterinarian takes a vacation in a given month, there second check might be less, depending upon their production for the month. The first check is always guaranteed.

This should not be interpreted as the associate not getting paid vacation or paid personal leave days. Instead the associate is getting paid more for 50 weeks of work instead of getting less for 52 weeks of work. Compensation is the same it is only being paid over a different time span

How can my associate be assured that they have received proper credit for services they have rendered?

The associate is entitled to receive a copy of the end of day report which shows what has been credited to his or her account. This may be the itemized audit trail or a specific doctor production report. If there is a mistake is should be corrected as soon as possible and the correction should show up in the next report presented to the associate.

Does the ProSal formula work with part time employed veterinarians?

Yes! The guarantee base will of course be less, but the same benefits of ProSal apply. The associate will be provided an incentive to offer a full service approach and educate clients. The associate will also be rewarded for doing so. Some practices will just pay a part time associate on production, which is fine if the associate is comfortable with this. If not the ProSal formula may be just the ticket.

I am worried about placing my associates on a production basis of compensation because I do not want to affect the harmony of the practice and don't want my doctors more concerned about money, than the patient.

I have heard this comment a lot, but truly have not found it to be a problem. First of all most if not all veterinarians truly care about the animal and if anything we have to constantly remind them, that we are also running a business. Money is by no means the end all, but it is nice to be paid for what we do.

There was one situation where a doctor reviewed all the out patient charts before she decided which one she was going to see. She was trying to figure out which one would generate her more income. When reviewing this doctor it was quite obvious that this was a symptom of the problem, and not the problem itself. This person was quite immature and indeed had a lot of other problems. She was replaced within the practice and all was fine. The bottom line here is that this is used may times as an excuse, but in reality has little basis in fact. Many associates who voice this concern know that if they are placed on production they will find out they are getting paid more than they deserve.

My associate is board certified, or has been with me a lot of years, so should I pay them more than other associates?

No! If an associate is board certified or if a veterinarian has been with the practice for a long period of time they should have increased production and therefore will get paid more, not as a function of there percentage, but rather their ability to produce income. Shouldn't a board certified veterinarian be able to generate more income than one that is not? And if not, why not? A board certified surgeon should certainly be charging more an hour for his or her time, than a veterinarian that is not.

Therefore a board certified veterinarian, or one who has been with the practice for a long time may indeed generate a greater pay check, but it will not be because of there title or length of employment, but instead their ability to produce income.

Do I have to adjust the percentage each year?

It depends if the total cost of employment is close to 25% then you should not adjust the percentage. If the total cost of employment is 21 or 22% you may wish to. Many practices will start an associate off at one percentage and over a three to five year period graduate an associate up. This is a point that can and should be negotiated with the associate. However, one great advantage of the ProSal formula is that there does not have to be re negotiations each year. Therefore a practice may wish to start an associate at a certain percentage and keep them there. The increase in income will come from the associate's enhanced ability to produce income along with fee schedule increases.

There is no question in my mind that the ProSal formula is by far the best method of associate doctor compensation. This formula allows an associate to have some control over her or her income and provides an incentive to be productive. From the practice owner's point of view the ProSal formula provides for a fair and just method of compensation. Most if not all veterinary employers wish to compensate fairly, the only problem was how to do it and the ProSal formula certainly solves that problem.

Stop the Day-to-Day Time-Suckers and Start Managing for the Future

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

Practice Management leadership obligations can be organized into two piles. One pile contains all the regular responsibilities: scheduling, ordering, communicating with vendors, payroll, analysis, human resources, etc. The other pile, often less high, but much more critical, includes the more exclusive responsibilities of leadership: long-range planning, growing practice value, and market strategy. Without an expeditious way of handling the first pile, the second is left to molder and with it the long term success of your business. It is therefore essential to turn to technology and good management practices to make sure that the first pile is completed regularly, accurately and most importantly, expediently, so that practice managers have time to do what's most important: manage.

The schedule

Minimize the time invested in scheduling your employees by first trying to delegate the job. Employees are most capable of working together to devise their own schedule. Educate the team on your expectations for coverage and professionalism when working together on the project, and then follow through with all involved to make sure that the process is fair and positive. Alternatively, turn to online programs like When To Work, which keep the schedule virtual, available to anyone at any time with access to the Cloud, and provide you time saving shortcuts.

Hiring

Reading a full inbox of applications, reaching out to the ones you like by email, struggling to set up times to talk, and blocking out time in your day to meet the many candidates you want to interview can be so overwhelming that we sometimes hire quickly just to end the process and move on with the rest of our tasks. Big mistake. Clearly, great hires are essential to a great practice. Build appealing ads that reach for the very best in the candidate pool, but ads that also include specific directions that make applicants work for the position. Asking the candidate to write a cover letter original to your job for example is a great way of eliminating all lazy applicants from the onset. Of those applicants that land in your inbox, scrap any that haven't followed your directions. Invite the remaining applicants to fill out a more extensive online application preloaded onto your website (more specifics of this will be covered in the lecture). As these secondary applications come in, select only the best candidates and schedule phone interviews. Make it clear at the outset of the call that you'll only be spending a short period of time getting to know one another. Of the applicants that succeed at impressing you on the first call, schedule a second more extensive call.

Seem like a lot? It's actually not. The screening tips described above will cull at least 95% of all applicants before you pick up a phone, leaving you with only the very best to spend time interviewing.

Inventory:

The most time saving approach to inventory is a team of individuals who can be leaned on to count, order, unpack, and document inventory purchases. Begin streamlining your inventory process by reaching out to one of your suppliers for an inventory management course. Merely understanding best inventory management processes is a great start at streamlining your efforts at managing your own practice's supplies. Next, supply your inventory merchant with a list of your accounting software's 'chart of accounts', a list of each expense category in your software and to which each inventory item belongs. Your merchant will be able to break your inventory order down into your chart of account's specific expenses, making the documentation of inventory purchases easy and efficient. Thirdly, collaborate with your practice management software support team to use your software to track additions and subtractions to your inventory count. With the right amount of fine tuning, you'll soon be able to rely upon your inventory software to provide you an accurate count of what you have purchased, how much you have spent, how much revenue you have generated, and what needs to be ordered anew.

Communication

There are as many communication timesavings devices as there are communication time suckers in today's expansive technological world. Today's marketplace provides us ways to streamline the way we keep clients engaged, introduce ourselves to new clients, market our services, follow through with client requests, and on an on. We will cover a number of these in the CVC lecture, but one communication time saving device is so important and so impactful, it deserves mention here, Google Apps. Google Apps is a suite of communication tools that allow small businesses to affordably offer team members company email addresses, a way to share documents, a way to access important team communication pieces, and a chance to explore the dozens of third party apps designed specifically to streamline the work and communication efforts of small businesses. Begin your introduction to Google Apps by watching the product videos they have loaded onto YouTube or simply call the Google support team and take advantage of their swift, helpful advice.

Meetings

Tackle this time sucker with a clear understanding of what you are trying to accomplish. Team meetings should serve your small business in this way: a way to keep your employees oriented towards long term goals and Mission Values, and a way to hone a team effort to service and care. Meetings for the sake of meetings are a big no no. Meetings should begin with a clear objective(s), agenda, and thoughts about ROI. Remember time is money and turning the practice 'off' so that everyone can sip soda and eat pizza is expensive. Depending on content, spending time meeting can be valuable or wasteful. Also, stop thinking of meetings in hour-long blocks of time. Why not 30 or even 10 minutes? Lastly, don't bore team members and suck time out of your day by spending meeting time reading direction to employees. My rule? If you can read it, don't meet it. Team meetings should be huddles during which we discuss specific efforts to date, look forward to what's around the corner, and to make plans for how the group will take on the new challenges.

Online presence

Online presence is what I call a reverse time sucker. We actually spend less time than we should on this all-important aspect of communicating with our existing clients and reaching new ones. Companies that have purchased the optimizing efforts of a third party are most likely spending a lot of money on a very third rate result. The expenditure has saved time, but the overall return, considering how poor the result, is a net negative. Save time and improve online presence both by treating yourself to a crash course in how search engines work. Merely 'google' Google to get started or review the material we have loaded onto our resources page at halowtassava.com. Just know this: the lion's share of online visibility can be achieved by writing original, engaging content (which won't be nearly as hard or as time consuming as you believe it will be). The particulars of this process will be discussed at CVC. For the time being know that saving time with online presence begins with 1) understanding how search engines rank content 2) devising a list of the areas of your business you believe would be worthwhile to promote and 3) spreading out the writing responsibility for these topics to a number of members of your practice.

Drama

Interpersonal relationships, good and bad, waste a significant portion of time for everyone involved. While no manager will ever be excused from talking with employees and helping them sort through problems, it's important that boundaries be drawn. Make sure that your employees live up to a hospital-wide expectation for respectful and emotionally mature interaction. As a supervisor, never participate in gossip or gripe sessions, as you are sure to ignite any number of copycat sessions throughout the building. Work with your team to develop a communication policy that explicitly addresses the deleterious, time-wasting effects of gossip, infighting, negativity, inappropriate communication, and so forth. Write out action plans for how everyone should behave in such circumstances and then hold your team members accountable.

Conclusion

The business of veterinary medicine is too often passed over in the interest of getting routine management responsibilities 'off our desk'. Employee time saving practices and tools to streamline your day-to-day efforts so that you can focus on the more important and valuable parts of management: competitiveness and growth

Build a New Business Model for the 21st Century

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

The financially healthy and growing veterinary practice of the future will have responded successfully to five widening challenges in our industry. These are: the changing demographics of our veterinary workforce, our clients' expectations for fast and convenient service, the push for online visibility, changes in the way we communicate and reach our clients, and the loss of traditional profit centers. We will take a closer look at each of these challenges and a few of the solutions likely to work for veterinarian-owners.

Importance of strategic planning

Before we begin, it's important to note that a major difference between the successful practices of the future and those that will continue to struggle or worse, go out of business, is the former's proactive approach to the challenges outlined above. This is done in the context of a strategic plan, which is a long-range outline of goals designed to keep the practice operating optimally in the face of foreseen challenges. It's unlikely that practices that do not take time to plan for future challenges before they unfold will successfully accommodate for them at when they arrive, since we are living in a world that has the ability to take swift advantage of any weakness or opportunity in the marketplace. So, it's important to note that while the solutions offered in this paper are good ones, they must be taken in the context of a business's long term plans for growth and scheduled as part of an ongoing process of change and improvement.

Changing demographics

The young veterinarians of today and tomorrow differ from their counterparts of thirty years ago. These veterinarians are more likely to be female, carry a significant school debt, and have a different outlook on work-life balance. According to the 2013 AVMA Workforce Study, the women in our industry work 300 less hours annually than their male counterparts. It is unclear whether this statistic represents a work-life balance choice or because women are more likely to take time off for parenthood.

Though a discussion on the over-supply of veterinary services might well come under the heading 'increased competition', we will discuss it here as it underscores another major difference between the veterinary pool of today (and what will be in the future) and the one of yesteryear. According to the 2013 AVMA Workforce Study, excess capacity of veterinary services is pervasive throughout the US and predicted to remain so well into the foreseeable future. In the simplest of terms, this means that there are more veterinarians than there is veterinary work. Because many of the veterinarians in this country are self-employed, this doesn't mean that veterinarians are unemployed, simply underemployed. Still this statistic has an impact on annual wages and drives prices (read profit) for veterinary services down.

It remains to be seen what the full implications of this note-worthy shift in demographics signifies. Already there are buying groups offering partnership opportunities to veterinarians who are interested in working fewer hours and who see the benefit of sharing ownership responsibilities with others. At many of the practices we work with, full-time schedules of veterinary services are regularly cobbled together using the efforts of several part time veterinarians causing unevenness in the practice's culture and consistency. It will be interesting to see how part time veterinarians and veterinarians who are interested in working from home will be linked to their place of employment by technology, perhaps used as part of a plan to offer telemedicine or to field real-time queries from prospective clients and drive business to their practice doors.

Increased demand for service and convenience

After the recession of 2008, companies saved money by using fewer people to do more work. The result is a workforce with long and tough hours. These consumers have less time available to them to shop and are more likely to look for fast, convenient solutions for their product and service needs. According to the Cambridge-based research company, Forrester, e-commerce will increase by 13% this year and by 2017 account for 10% of all retail sales in the United States. It will outpace brick-and-mortal retail store sales for the next 5 years if not longer. An array of companies, with considerable marketing and retailing power, are aware of this trend and are advertising to consumers that they sell online veterinary products, and in some cases, services, that were traditionally only provided by veterinarians. As of 2008, Wal-Mart was estimated to hold an eye-opening 25% of the pet product market with their goals set on 30% by 2010. Because Wal-Mart does not release information on which areas of their business generate what revenue, it is unclear if that they achieved their goal, but their interest in capturing a larger portion of pet supply sales both in their physical store and online is not in doubt. In 2012, the alternative to veterinary-supplied flea medication, Pet Armor, made Information Resources Incorporated's top 10 list of Most Successful New Product Pace-Setters with 126.4 million dollars in sales. Successful veterinary practices of the future will have invested in acquiring and marketing an online store of their own that offers competitive shipping rates and which can be easily navigated and used by their clients.

Communication changes

Like everything else, communication has shifted into the digital world. 1.4 billion people use Facebook worldwide and Twitter hosts more than 400 million 'tweets' of communication each day. But our communication hasn't just shifted to a different forum; it's shifted in form as well. Grammarians and essayists of old would cringe at the corners cut in today's most widely read stories (typically in the form of blogs) and indeed many of them would have difficulty even finding the written word at all, since so much of communication today is videotaped. YouTube is one of the most widely used communication forums in the world and as of March 2014 had one billion users. The successful practice of the future will not have written a white paper on intestinal parasites, but will have set their pen aside, slipped off their lab coat, put their feet up on their desk, and videotaped their thoughts on the matter. They will employ people who are neither afraid of filming or of being filmed. They will have Cell Phones Must Be Carried With You At All Times policy because they will be aware that our most competitive asset, our services and our team, must be digitally shared with the world if we are going to successfully make a case for our unique relevance.

Online visibility

Each day, Americans rely more heavily on the Internet as a way to explore and shop for goods and services. This means that companies are willing to pay more to appear at the top of any search that is related to their business. This is bad news for the small business owner since larger companies have more financial and human resources to apply to the job of improving search engine rankings. In a typical Google search, results appear in a series of pages, the first half of the first page of which is considered to be most valuable since it is unlikely that consumers will spend the time (or need) to scroll further down and look at the remaining search engine results. In this 'top of the fold' as it is called, ad space is sold along the top and right margins of the page leaving only a small space for one or two businesses to appear organically (that is to say, genuinely relevant to the search). While is it likely that even this small strip of Internet real estate will erode, successful veterinary practices of the future will have found a way to digitally transcribe the loving work they do with pets and the connections that they make with their clients using social media. While economics may drive search engines to sell more ad space, they too are aware that their clients want more than the yellow pages of yore where all information was paid for. Search engines will find a profitable way to bring both paid advertiser and organic search results to their clients and the successful practices of the future will work hard to make sure they appear number one in these organic searches.

Loss of profit centers

Flea, tick and heartworm products, our pharmacy in general, spays and neuters, and vaccines are services that have traditionally made up 30% of our revenue or more. In the practices with which we regularly work, spay and neuter sales have seen the steepest decline followed by flea tick and heartworm sales, with a drop in vaccine and pharmacy sales coming up a more distant third and fourth. Successful practices of the future will offset this drop in sales by increasing compliance to preventative care and making the services we provide more appealing to pet owners. They will shift more of their inventory onto their online store and recognize the value of focusing their work time on the services that provide the greatest return on investment.

Conclusion

The competition challenges we are facing because of a surplus of veterinarians, the Internet, big box store intrusion into the market, and the shifting shopping and spending habits of Americans are not going to go away. Like any successful business, the veterinary practice of the 21st century is not a static entity, but one that bends and adapts with the needs of its clients and the market. While each of these future practices may have a unique spin on how it responds to any or all of the challenges listed above, they will share a common practice of reviewing the status quo and making plans for a long term strategy for change in response to it.

Case Study:
Veterinary Phone Call Disasters

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

You've labored over your Facebook page, fretted over two thousand dollars you spent in pet-related community-event sponsorships, agonized over a decision to cancel your yellow page ad: most of us have a blind marketing strategy. You close your eyes, throw a marketing barb out there, and hope that you hit your mark. A substantial amount of time, money, effort and concern is invested in marketing our practice with all efforts bent towards a single end outcome: get the phone to ring.

And yet…take a second to review how much time you've spent managing how that phone should be answered, the kind of person that should answer it, and what should be said at the moment it is picked up.

All that money invested in getting that phone to ring and we leave it to one or two, not-very-well-trained (though probably very well-intended) individuals. Then we add insult to injury by asking them to answer the phone in conjunction with these other responsibilities: personal secretary, switchboard operator, faxer, medical-records-coordinator, food-order-taker, international-health-certificate-signer-offer, greeter, teacher, accountant, cashier, rabies-tag-organizer, etc.

Effectively communicating to our clients is not impossible, in fact, it's not even hard, provided we take a moment and consider what we are trying to accomplish and have the right tools at hand to succeed.

A great first impression

When is the last time you called a business and the phone rang and rang? What was your perception? You weren't thinking, 'oh those poor employees, I'll bet they are really working hard'. Quite the opposite, you imagined a disorganized workplace or worse, apathetic employees who didn't care about you. Regardless if it's true, people are making immediate presumptions about who you are and the kind of business you are running if the phone rings too long; a presumption that is completely antithetical to your Mission and goals.

A greeting that matters

What's in a greeting? A 'this is Mary' or announcing that they have called ABC Animal Hospital is so basic, that I would argue it's not worth paying a human to do. If that's all you want to accomplish with a phone greeting…the introduction to a switchboard… then allow a robotic switchboard operator to handle it. The first sounds of a phone call should communicate how much your practice cares. It doesn't matter if you are busy with three or four other projects, answering the phone in a rush of words 'abcanimalhospitalthisisMaryhowcanIhelpyou' is completely antithetical to your goals. Everyone on the team must be aware of this and be willing to assist with the sometimes over-whelming workload of phone calls. Prioritizing phone calls and client care is something the entire team (owners, doctors, technicians and assistants) must understand. In fact, during the first week of training, all team members should be taught to prioritize responsibilities in this order: employee safety, patient safety, and client wellbeing. In other words, provided you are not going to injury yourself, others or patients, you should look out for opportunities to directly assist clients whether they are on the phone or in the practice.

A tone of voice that conveys understanding and concern

The people who are calling up your veterinary practice are probably a lot like you: well-intended folks who love animals. In this case, they're calling up because they would like some help in caring for those animals. They may be under some stress about the well-being of their pet or how much the services are going to cost, so they might not be as pleasant sounding as you would like them to be. Still, underneath this 'noise', their heart is as full as yours. Letting them know that you care by investing in how you sound will go a long way in defusing any negative emotionality they may be feeling on their end. Additionally, you will make your practice stick out from the roster of practices they may have decided to 'shop' before yours. I would argue that the level of customer service any of us experience on a day-to-day basis is so rudimentary that the smallest efforts you can make on your end will help your practice stand out.

.

Showing that your practice's services and products address the client's needs

How many times have I called practices, told them that my pet had diarrhea, and was provided general guidelines for what I should feed my pet over the next 24 hours? How many times have I told a client care representative or technician that I was concerned about fleas and been given a lunch-and-learn lecture on the flea life cycle? We are more than information booths at veterinary practices. Our job is to listen to clients' needs, show them that we care, and teach them how our services and products satisfy their concerns. Forget about training client care representatives how to be mini-veterinarians. Skip your interests in being non-committal about a veterinary visit. We are in the business of providing medical care. When clients call up for our services, invite them to take part of them. Period. If you are too concerned that a veterinary visit is not worth it given your belief that the problem is too small, then discuss changing

your practice's fee structure with the practice owner or seek out additional education with a veterinary professional so that you understand the value of a visit. Instead of making a pact that you will turn away cases you feel are too minor to address, make a pact that you will make every veterinary visit worthwhile to your clients. No one benefits from keeping your clients at arm's length. Your practice owner has invested hundreds of thousands of dollars in her quest to provide veterinary medical care, love, and concern to the animals in the community. Now invite the community into your practice so that all of you can make good on that commitment.

Catalyze an appointment

Ending a conversation with 'well if you'd like to come in, it's up to you', underlines your own belief that the veterinary visit lacks value. People don't make phone calls to veterinary hospitals because they have nothing better to do with their day. They call because they are concerned. Teach them that they can allay their concerns by making a veterinary office visit and that you and your team will do everything you can to make the patient comfortable, answer the client's questions, and mitigate whatever problem is going on. Instead of fretting about what should or should not be seen, work as a group to evaluate the client and patient experience and do everything you can to improve its take-away value. Remember that all the hours you spend improving your own knowledge base, the services that the practice offers, the improvements to the facility itself, and the commitment you have all made in one another as a team, is wasted if no one gets a chance to experience it first hand.

Challenge the status quo

Today's veterinary offices provide as wide of a range of services as do human hospitals, yet the work systems we have in place for handling the additional volume and complexity of services remain the same: someone up front who answers the phone and two people in the back who treat the patients. Communication has changed so dramatically and increased in volume so much, that we simply must rethink the way we handle this new burden if we are going to be successful. Practices today are experimenting with Live Chat, Facebook, Twitter, texting, YouTube, Pet Portals, and email as an alternative to the telephone when communicating with clients. It is likely that these last few years of rapid changes are only the beginning of many more years to come of additional changes and increased complexity to the way we communicate. Stop putting someone out front and someone in the back because 'that's what you're supposed to do'. Stop relegating the responsibility all of us have to greet, care and welcome our clients to our practice to one or two over-taxed individuals. Sit down as a group and think about the process by which these clients in need come to us and how we tell them 'you're in good hands'. The discussion will be the first step in a journey all of you take to help these animal-loving folks feel more secure and to create a nurturing care facility for patients in need.

Leaders, You are Not Alone:
Top Tips from the Nation's Top Veterinary Leaders

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

Leadership is one of those words that is so frequently used that many of us come into the role of leadership believing we already understand what it means. In truth, successful leadership is an extremely personal journey. Grounded in a handful of principals, the lion's share of leadership is self awareness: awareness of how leadership flows forth from us, how we stand in the way of our employee's success, and how we stand in the way of our own.

But it's also about vision. People who make employee schedules, who order inventory, arbitrate client complaints, hire employees, fire employees and who earn more money to do all of the above are not necessarily leaders. Leadership is not defined by the amount of power you have or by the exclusiveness of your work responsibilities; it is defined by your ability to see a distant, purposeful objective, to lock onto those coordinates, and to move your team towards it.

It's no coincidence that leadership is regularly compared to sports and defined using sport terminology. Words like coaching, team player, team, goal, huddle, and interface are regularly used to define how we should interact with employees and how we should achieve our objectives. The analogy is also meant to flavor our approach to leadership; to give us the sense that leadership is as much about 'calling the shots' as it is about working with other members of the team to execute the directives. What turns us on, both as spectators and participants, is a winning group of individuals. While all of us are likely to have a mental poster or two of our favorite quarterbacks, CEOs, presidents, priests, or war generals, at the core of our esteem is our admiration for these individuals to lead the group.

It's practically cathartic. Humans have been coordinating their efforts to win since the days when we stalked the Wooly Mammoth. At some point in our lives, each of us has been galvanized by the thrill of achieving a goal in the company of others. When we raise our collective voices in the worship of God; when we put on a show for an applauding audience; when we march through the smoldering, hard-won battlefield; we thrill. *Great leaders are not respected for what they do; they are respected for what we do under their leadership*.

Your practice's future success is predicated on your willingness to reevaluate your understanding of leadership, to understand your leadership shortcomings, and your commitment to the persistent effort that it takes to change oneself.

But it's wholly possible that you do not change or improve as a leader because you don't know in which direction to move! One of the biggest hurdles leaders struggle with is the isolation of leadership. Despite training and experience, we regularly encounter problems that are completely new to us; that we must solve in isolation and without the benefits of knowing anyone we can turn to for help. It makes for lonely workdays, and means that many decisions are framed in doubt.

Is it really lonely at the top? It may be a matter of perspective

For assistance in exploring the isolation of leadership, I turned to a number of esteemed veterinary practice managers and owners. The owners and managers I interviewed agreed that their roles were lonely, but interestingly they didn't perceive their loneliness as negative, merely as a product of their unique position and perspective. As Daniel Stobie of Northstar Vets in Robbinsville, NJ commented, "It's hard to know all the stresses and responsibilities that go along with being an owner, so others can't really relate to all the balls you are juggling. You are in a unique situation." Jill Renfrew, industry management consultant and practice administrator, had a similar look on the matter. "Leaders 'get' how the pieces fit together…this global view makes them different and that difference predisposes them to loneliness." Hakim Franklin, who rose from the ranks of Kennel Assistant to his current position as Hospital Administrator at Mt Airy Animal Hospital had this to say, "There are simply less people in the organization who share in your day-to-day work experiences and challenges…once I took on a managerial role, I had to learn to keep a professional distance from those I supervised. I also noticed the employees did the same because I became,'The Boss'."

Leadership traits that cut against the grain

Part of our unique perspective may have something to do with our training as medical professionals. Anthony DeCarlo, both veterinarian and practice owner of Red Bank Veterinary, one of our industry's largest practices, sees how his role as leader separates him from his veterinarian peers. "As a manager we're trained to bring ideas, however imperfect, to the table and make them better through the process of collaboration. As doctors we are trained to be analytical, to take things apart, to find out what's wrong with a thing. One process puts things together; the other takes them apart. There's nothing wrong with either, each have their merits in the right setting, but certainly someone who walks into the boardroom with an intent on being right and interested only in finding flaws is not helpful in moving ideas forward."

Lean on me

While the leaders admitted that aspects of leadership could be lonely, all underlined the importance of ameliorating that loneliness with the input of an objective and caring sounding board; an ear you could rely on to share thoughts and get some feedback. For Anthony Pardo, founder of Pittsburgh Veterinary Specialty and Emergency Center, this person is his wife. “She has been invaluable in providing support for me. The best thing is her ability to listen to the issues as a relatively unbiased observer and give me her opinion on the issues from a more objective perspective.” Jill Renfrew agreed. “I need to have a ‘safe’ zone, a community of friends, where I can work through the trials and tribulations of leadership…In that zone, I am free to work through a problem without fear of reprisal or recrimination.” Anthony DeCarlo leans on those at his practice who are more visionary. “It’s the thinkers, I lean on the most. The ones that are not short sighted and have the long-term, best interest of the practice in mind.”

It’s true. The position comes with drawbacks and risks

“It’s aged me,” admits Jill Renfrew. Anthony DeCarlo, typically a bounding optimist on the topic of leadership, concedes too in part, “Leadership can destroy you if you don’t go into it for the right reasons.” He explained, “If you want to own a practice because you want to have control and make money, you’re going about it all wrong. The leader destined for happiness (and health) is one who passionately wants others to succeed and creates an environment in which they can do that.”

You’ll be a better person for it

But these negative comments by our panel on leadership are misleading. A reprise that each manager returned to was the deep opportunities for growth that leadership provides. Dr. Pardo: “I’m aware that our hospital has an impact on people’s lives, on their welfare, on their livelihood. I take that responsibility seriously and am better for it.” Dr. DeCarlo extolled leadership as a chance to “learn how to make people work productively together. A skill that lasts you forever.” He then added, “Leadership affords you the chance to learn how and why people behave as they do and to take stock of your own actions.” Leadership taught Daniel Stobie to be more patient and open-minded. “ I solicit feedback from multiple people before making a decision, so therefore my decisions are better…I have also learned to take a few days before giving an answer or making a decision, rather than making it on the fly…<this> has proven to serve me and the practice better.”

Additional advice for the lonely leaders out there

If you’re still feeling isolated in your role, here are some parting words of encouragement.

Dr. DeCarlo: “If you’re lonely, it may be a sign that you are going at leadership all wrong. Leaders who try to create opportunities for others to succeed (and for clients to be served well) are not lonely. They are fulfilled; they’re happy; and they have fun. Of course you shouldn’t confuse your responsibility for making tough decisions with loneliness. The former is the task given to a woman or a man of good intention, of vision, and of strong mind. The latter is an effect of holding onto too much control.”

Jill Renfrew: “Recognize that you do not know it all. Excel in aspects of ownership for which you show interest and promise. Surround yourself with others who compliment your strengths and weaknesses and approach life with a spirit of curiosity and adventure.”

Dr. Pardo: “Be fair and honest in everything you do…the rewards will be gratifying if you build a hospital that you are proud of.”

Hakim Franklin: “Leadership will change your life. It’s up to you whether that will be a positive or negative change.”

Dr. Daniel Stobie: “Don’t sweat the small stuff. Focus on the big picture, set goals and stick to them. Plan to re-plan, but never give up.”

5 Sure-Fire Ways to Improve Your Bottom Line

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

The title of this presentation is a bit misleading, because it suggests that fast capital can be injected into your practice with a quick slight of hands. In fact, if you are already in a financial bind, it is probably due to some chronic leadership missteps and in this context, any of the recommendations below are likely to worsen things rather than make them better.

At the end of the day, you are a service company that rides on the trust of clients. Any attempt to treat these trusting individuals as rubes who can be fleeced, may be the final nail in your financial crisis and your business. There's probably no greater turnoff to clients or team members than actions by veterinary owners or practice managers that smack of dishonesty.

While the suggestions below are all likely to work in the short term, true lasting growth will only occur when they are under taken as part of a bigger scheme to improve the practice's leadership and the group's teamwork.

Raise prices

One of the first things we do when meeting with new clients is to review all of the services and inventory items in their software. It's typically an eye taxing process. Most hospitals have 80 or more pages of pills, pill pockets, prescription diets and pet products. What we find are a lot of mistakes. Years of service and product changes and additions have resulted in a database that is not properly categorized or sensibly priced. Print out a usage report for everything sold last year and take the not-so-pleasant, but necessary four hours of time it takes to do two things:

1. Review the list for mistakes in the way items are categorized and priced
2. Highlight high volume, non-shopped services and products.

For information on how to accurately categorize your services in a way that will allow you to use industry benchmarks and manage your return on investment better in the future, go to halowtassava.com resources

Before we go on, I want to say a word about pricing in general. In many practices, vaccines, routines surgeries and exams are priced low. Perhaps it's left over from an age when expenses were so minimal, that the low prices for these shopped services were still adequately profitable. Perhaps the pricing reflects a time when folks wouldn't consider paying anything more than 25 dollars for a 'dog', perhaps it was a loss leader strategy (the process of marking down popular services or products below the break even point as a way to entice clients to come to the store and purchase higher-margin products); whatever the reason this much is true: modern veterinarians are too often left holding the bag on a suite of services and products that aren't priced high enough to be profitable.

Veterinary teams that fail to understand that our most popular services are priced too low exacerbate the problem when they look at the higher prices for all other non-shopped items and call them unfair. Indeed, comparatively, they are priced higher, but they have to be in order to make up for the financial hits on the chin we are taking with every routine visit that we see.

I'm about to recommend a review of your non-shopped services and a sizeable price increase on anything that sees a lot of traffic, but before you do this, you have to sit down with your team members and explain what you are doing and why. I recommend that you share with them some pricing basics. Use the formula of pricing shown on the resources page of the halowtassava.com website to illustrate the logic behind what you are doing. Have a discussion with everyone about the energy, emotion, care and consideration that all of you put into the services you provide. If the team members can't see the value of the money you spend on delivering a product, perhaps they will understand the value of what they bring to the product, every day, every week, every year. In my experience, the number one reason why pricing fails is not because clients believe it to be too high, it's because the team members think it so.

So, review your usage report and single out non -shopped items whose sales volume is high. Ask yourself how a one, two, five or ten dollar increase in price would affect your annual gross sales based on last year's volume. Write the answer in the margin of the page and continue your way through the report. In the end, you may find that by raising prices on only some items, you've found a way to generate more than 30K worth of revenue.

Again, these sorts of tactics are guerrilla warfare. They're designed to give your company a fast infusion of cash; they're a response to a pressing need. In the long term, you want your pricing to have more meaning than 'because we can get away with it'. You want your team members to understand the value of everything that they do, to be able to confidently state a price to a client and believe in it, but in the interim, its okay to raise your surgery fluid charge by 10 dollars. It's a short term solution to what will hopefully be a short term crisis and buy you time until you rally your whole team around a pricing strategy this has credibility and captures everyone's buy in.

But while we're on the topic of services and pricing, I should talk about what I call 'boutique' charges. These are fees that have been employed by some in our industry to raise prices through the back door. I'm talking about charges like 'medical waste', 'venipuncture charge', 'monitoring fee' and so forth. There's nothing wrong with these. They are simply another way of expressing the fact that the charges we have for routine procedures are not sufficient. Instead of raising the prices on shopped items, these

managers have chosen to break out a portion of the expenses that these services generate and put a price tag on them. In my experience, they work. Critical to their success is the belief by your team that they are merited. Woe to the practice manager who invokes a rule that every invoice should have a medical waste fee attached without discussing it with the team first. If team members believe your actions to be nothing more than a trick to shake down clients for more money, your credibility as a 'caring' professional is out the window and so too will be countless other opportunities to distinguish yourself to your clients as truly vested in their interests. If you want to make these charges work, first run them by your team, explain how they allow you to raise prices on shopped services and still keep your practice competitive, explain that you yourself will personally guarantee the satisfaction of any client that complains about them, and that they are not dishonest, but merely stating the price of a service in a different, potentially more positive way.

Agree on a standard of care

Standard of Care has been discussed so frequently, at so many conferences, that we've become somewhat inured against its potential transformational power on a practice. Without question, implementing a hospital wide standard of care is the best thing I have ever done for the practices I have managed and with whom I consult. It rallies the group's effort, reduces errors, identifies more significant patient health problems, improves the image of the practice as expert and caring, and lastly, provides an immediate and significant bump in revenue often in the tens-of-thousands of dollars.

Begin with a look at your clients' compliance with widely accepted recommendations like parasite testing. Review this for the practice and by associate. Then find a benchmark for your practice by running the same report for a rabies vaccine by species (typically the service for which there is the most compliance by our clients). Determine the dollar value and more importantly, the increase in patient wellbeing, if you were to increase your practice's compliance by 10, 20 or even 50% (use the benchmark of rabies vaccine compliance as a realistic top end goal). Many veterinary software applications have compliance reportage options already built in that will make this process easier. Additionally, by using your external laboratory reportage on parasite incidence/samples-submitted ratio, you can work backwards to figure out the number of additional pets that will leave your practice positively identified for parasite infection that would have otherwise gone undiagnosed. What a great message to send to your team: that you are not only being more productive financially, but that you are being better health professionals who are providing each client with more value for their pet's annual visit.

As with all of these recommendations for increased revenue, the most successful standard of care campaign begins with a discussion and the involvement of the whole practice.

Third time reminder calls

If you are using a communication service like Vetstreet, you can simply log into your portal and view your practice's reminder compliance. Otherwise, use your practice's software to determine the number of services that were reminded for and the percentage of those that were satisfied. In most practices this number is less than 75%. Granted, the reason the numbers look so low is because many practices fail to carefully manage their reminders. Clients are sent reminders for services that have been previously declined or for 'lone wolf' services…services that are just far enough outside the time span of other more recognizable services (rabies vaccines for example) to seem too trivial to bother with. Still, capturing a small percentage of these overdue reminder patients is worth a great deal of money. At one practice, we tracked nearly 3000 dollars a month in additional revenue from appointments that we made by calling our overdue reminder list.

In some practices, team members squirm away from the responsibility of calling third time reminders because they believe they are being too pushy. Managers should be empathetic to their concerns and help these folks select the right kind of language to use on the phone. Help them understand that reminding someone isn't nagging, it's being helpful! Clients are busy people too and a call, from someone who sounds like they are genuinely concerned and trying to be helpful, that reminds them about an important service for a mutually loved pet, is a good thing! Have your team experiment with scripts to use for these calls, not so much as something that they should read over the phone, but something to stimulate their own thinking about what to say when reminding clients that it is time to come to the practice.

Review patient charts before the patient arrives

Another excellent revenue-building recommendation that couples nicely with team building is the practice of reviewing patient charts prior to the start of each business day. There are many ways practice teams have devised to accomplish this. In some cases, a client care representative pulls charts the evening before. Other practices use whatever veterinarian is on hand or one of the technicians. However it is accomplished, the through line remains the same. First, confirm that all client and patient data is complete. Review the reminders. Confirm that they are correct and that there aren't any services missing from the list. As a rule, I like to remind for services that I'm going to recommend, not services that have previously been purchased. This means that practice teams have to rely upon the medical history to confirm whether or not a service has been done, but in long run, it's a better way of making sure that each client is more compliant with recommendations.

The next step is to create a checklist for all services and products that you're going to recommend at the time the client arrives. This list is not only designed to make sure that we are not forgetting or missing anything with respect to our recommendations, but to make us look like a well-oiled, professional team when the client arrives. Make sure that any medications are already put together and invoiced in the computer. Print out check-in sheets if you are paperless practice to help you remember the names of family members, the gender of the patient, and any other information that helps you speak familiarly with the client and that makes them feel like they are a stand out at your hospital.

Reducing inventory costs

But improving the bottom line doesn't have to be only about improved revenue. Focusing on savings can offer up a cash infusion that's both sizeable and immediate.

Start with eliminating redundant medications and generics. Yes, generics. Selecting a brand- named product not only helps you secure a positive partnership with a vendor that can provide you many kinds of practice support, but underlines your expertise to the client. Also, generics are more often price shopped, whereas brand names are not. Lastly, brand named drugs typically come with manufacturer's support in the case of any adverse events.

In the practices we visit, it's usual to see COGS hovering around 18-20% of gross revenue. This includes laboratory costs, specialists that charge by the case, radiology fees and any other variable costs incurred by the practice. But just because you see that your COGS number is within these margins or lower, doesn't mean there's not room for additional savings. As practice advisor Dr. Tom Cat says, "Why strive to be average?" There's always room for improvement. With 20 cents of every dollar spent on variable costs, it's worthwhile to review what's up on the shelves one more time to see what can be eliminated.

Reducing payroll

My final advice is this. While every leader bears some responsibility for their business's financial predicament, in many cases the status quo is also due to the half-hearted investment of those who are employed by the business. In the 15 years that I have been managing and consulting, I have yet to find an owner that regretted terminating a lackluster employee. Indeed, what is there to cry about? These team members wear on the productivity of the whole force, chew up a bunch of your valuable leadership time with pettiness, and generally bring down the morale of the whole practice. You're reluctant to let them go because of a bunch of what ifs. What if they badmouth me around town? What if I can't find someone to replace them? What if they're right, I really am a monster. My advice is to let them go and find out, because whatever fallouts occur because of the move, the benefits of the termination will be ten fold greater, not the least of which is an immediate payroll savings because with the lack luster team member gone, the rest of the team will step up, be more productive and potentially make you realize that refilling the position isn't required.

Owners are also wise to consider the amount of money they are spending on their managers. Ideally, all practices should employ autonomous, sophisticated practice managers who fully grasp the weightiness of leadership and who have the ability to think and act like owners. In fact, there's probably nothing better an owner could do to improve their practice's sale value than to work towards a strong team that is led by a capable and shrewd practice manager.

Unfortunately we too often graduate client care representatives and technicians into the role of practice manager, pay them as practice managers, then fail to train them to do the kind of work we need them to do in order to justify their salary. I have visited lots of practices that curtail managers from the opportunity to genuinely lead because they've failed to train them or because they've selected someone with tenure, but not the aptitude for leadership. With an annual price tag of 80K or more, this is an expensive oversight. A fast shot of capital may be the decision to reconfigure the leadership at your practice to either match its money outlay in multiples of their pay or rewrite their job description (and their pay scale) to match their performance.

Conquering the Cold Shoulder: Fixing Team Communication

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

If no one turned round when we entered, answered when we spoke, or minded what we did, but if every person we met 'cut us dead,' and acted as if we were non-existing things, a kind of rage and impotent despair would ere long well up in us, from which the cruellest bodily tortures would be a relief.-William James, The Principles of Psychology

What can be worse than those periods of time when you go days, weeks, months or even years without someone talking to you at work? The icy standoff causes anxiety for those directly and indirectly involved and the wasted time and energy is truly shameful. During our work, we have countless opportunities to improve: to care more, to serve better, to grow, to connect…all squandered because we were too preoccupied with refrigerating the shoulder we're turning towards a colleague.

Many of us are guilty. At some point, medical directors, managers, associate veterinarians, technicians, receptionists, even clients have all turned up the emotional air conditioning and engaged in the habit of not speaking as a way of demonstrating their disapproval and discontent. It's a habit that we need to break as managers or face the deleterious effects it causes to our productivity, workplace satisfaction, employee physical health, and employee retention.

In a paper published online in April 2014 entitled, Is Negative Attention Better than No Attention? The Comparative Effects of Ostracism and Harassment at Work, author Jane O'Reilly et al defines ostracism as: 'When an individual or group fails to take actions that socially engages another, when such actions would be appropriate.'

It's an expensive and widespread occurrence. In studies, nearly 50% of all employees report that they have experienced some form of ostracism in the past 6 months. Employees who are polled on the topic are twice as likely to cite ostracism as acceptable behavior versus more traditional forms of harassment, and ostracism is a better predictor of costly workplace data points such as poor morale and employee turnover.

The paper cited above is only one of dozens on the topic. Most experts agree that ostracism is prevalent in our businesses because it is believed it to be a more socially acceptable way of demonstrating disapproval than traditional forms of harassment, which employees believed to be illegal, socially unacceptable, and more hurtful. In fact, the opposite is true. People who were harassed at work (and I'm referring to legal acts of harassment against non-protected classes of individuals such as yelling, shaming and so forth) experienced fewer negative side effects with respect to productivity, emotional wellbeing and workplace engagement than their counterparts who were ostracized. As the O'Reilly paper states:

Employees who feel left out of the social fabric at work are likely to have reduced levels of commitment to their workplace and higher turnover intentions, and they are more likely to leave their organization should the opportunity arise.

It goes on to conclude:

Ostracism, compared with harassment, has a more negative effect on employees' work-related attitudes of affective commitment and psychological withdrawal.

It's ironic that as veterinary professionals most of us are aware that ostracizing any social animal often leads to the death of the target individual. Though the same is not always true today, at some point in our evolutionary history, human life was directly tied to group acceptance. Our need to be a part or a social group is more than a feeling, it is wired into our makeup. A whopping 65% of all children develop imaginary friends between the ages of 3 and 5, with an additional 33% of that group carrying those relationships through the age of 7. According to Anita Gurian, clinical assistant professor of child and adolescent psychology at the Child Study Center of NYU Medical Center, "Imaginary friends serve several useful purposes. They enable children to try out different relationships at a critical point in their social development. They allow children to explore issues of control, discipline, and power without the anxiety attached to interactions with real authority figures."

Despite the fact that many of us have experienced enormous pain as targets of ostracism, few of us hold back from perpetrating the dynamic. In some cases, we are aware of the destructive anxiety this causes the target of the ostracism, but in many cases, research shows that perpetrators of ostracism viewed it as the most socially acceptable (and legal) form of dealing with a problem co-worker. The disconnect that we have between how we would feel if we were ostracized versus the lack of feeling we feel for those that we target is called an empathy gap.

Ostracism is not reserved for the weakest and lowest members of the group. Practice owners and managers are often singled out by the staff for the cold shoulder treatment. In research done by Jane O'Reilly et al, 50% of all workers who were targets of ostracism believed that their position of power was the distinguishing attribute that caused them to be ostracized from their coworkers.

With so much emotional pain, turnover and productivity at stake, it would be valuable for all managers to take a look at their hospital communication policies and specifically address workplace ostracism. This portion of the communication manual is sometimes referred to as the practice's 'civility policy' and outlines behaviors that are important to the practice's collective, emotional

well-being. Brenda Tassava, CVPM, of Halow Tassava has a copy of this on the Halow Tassava website entitled Committment of Mutual Respect that can be downloaded as a jumping off point when designing similar communication policies for your practice.

Civility policies should include a description of workplace ostracism, how to avoid being ostracized, signs of ostracism, and what to do about it if you are a target or perpetrator. I'll briefly talk about some of these sections below:

Reasons why we ostracize

It's accidental

Team members shouldn't be quick to conclude they are the targets of ostracism. In studies completed on the topic, a majority of people who identified themselves as targets for ostracism later discovered that they had been mistaken. The common signals for ostracism can often be unintentional. Before jumping to the conclusion you are a target of ostracism, be sure you're not a victim of paranoia.

A perception of difference

Another cause for the cold shoulder is difference. People who are perceived as looking, being, or acting outside the social mores of the group are often the target of ostracism. Difference is regularly singled out by social groups. If you find yourself a target for ostracism, ask yourself if there is something you are intentionally or unintentionally doing that negatively distinguishes you from the group. While it would be a mistake to quash individuality as a deterrent to ostracism, understanding the sometimes justifiable reasons why ostracism is taking place can reduce the anxiety that the ostracism induces in the target.

Trust

Many people who ostracize believe that they have been wronged in someway. Typically, it's a trust issue. Owners and manager are often oblivious to how they contribute to a breakdown in trust because they fail to understand how powerful employees perceive them to be. As a leader, you have the power to end someone's employment. The broad reaching impact of that power may not be as obvious to you, as it is to those that work under you. Termination, or risk of termination can cause your employees sleepless nights, concern that they might not be able to provide for their family, and loss of dignity and social standing. Anything that you do as an employer that demonstrates that you are wielding that power disrespectfully, unprofessionally or unjustly is likely to be met with extreme resentment from those that work for you. These employees start to commiserate with their peers about your behavior, band together, in solidarity and… in silence.

Additional behavioral components

Despite the above mentioned empathy gap, there are many of us that understand the profound power of ostracism to inflict pain. If you are a target of ostracism at your workplace you may well be a target of intended enmity. Whoever is responsible has decided for whatever reason to hurt you and they have resorted to ostracism, not only because most practices allow such behavior to go uncorrected, but because they are aware of the decisive pain it will inflict.

Know the signs

Several behaviors in the workplace can be construed as ostracizing. Simply listing these behaviors as part of the practice's communication policy may be sufficient to generate thought and dialogue, and minimize workplace ostracism. Remember to educate your team members that these behaviors still have ostracizing effects whether they are intentional or unintentional.

1. Failure to include someone in a dialogue (it's important to note this applies to clients who may be within earshot of a dialogue between team members)
2. Failure to greet someone or say goodbye during appropriate times
3. Failure to include individuals in electronic communication when appropriate
4. Failure to invite the individual to social functions
5. Ceasing conversation when the target enters the room
6. Lack of eye contact or appropriate body gestures when socially appropriate
7. Failure to respond emotionally or verbally to signs of distress or discomfort in individuals
8. Failure to communicate obvious tensions between individuals
9. Failure to provide job performance feedback when it is appropriate

How to stop it

One of the worst mistakes any supervisor can make is to assume that everyone at the workplace comes with the emotional intelligence, empathy, social skills, and breadth of spirit and mind to understand how to communicate responsibly. Communication manuals should include guidelines for civility and mutual respect that include a discussion on appropriate ways to greet, talk and interact with coworkers in the various points of our workflow interaction.

Ostracism should be defined and directly addressed by articulating specific ostracizing behaviors that are not to be tolerated in the workplace. Examples include recommendations on how to handle all of the above–mentioned incidences. As a rule of thumb,

employees can be encouraged to regularly make a mental review of their peers at work and confirm that they are regularly acknowledging them and letting them know that they are aware of their presence and efforts. Additionally teach employees how to resolve conflict and the importance of dealing directly with employees with whom they may have issues.

Managers and owners should be cautioned against a tit-for-tat response with respect to ostracism. Much of the silence directed at supervisors may have more to do with the supervisor's position than anything else. Employees may simply feel too shy or too timid about initiating conversation with their superiors. As a supervisor, continue to push past silence or awkward treatment directed towards you by your team member by maintaining an even level of social engagement with everyone in your employ. Remember that many managers end up as unwitting perpetrators of workplace ostracism because they innocently fail to engage their team members. Managers and owners can be directed to review the following list as a way to avoid some of the more common forms of ostracism.

1. Regularly greet and say good bye to all employees in the building daily
2. Stay current on employee reviews
3. Confirm that all employees, who pertain to a topic of communication (electronic or otherwise), are included in it.
4. Reward evenly and fairly
5. Evenly distribute your attention and time to all team members
6. Verbally address employee issues as they arise
7. Never use silence as a passive way of displaying disapproval

Each year, it is likely that thousands of veterinary professionals will face the agonizing effects of being pushed away from their health care team into an icy corner of silence. Do what you can as a leader of the practice to increase awareness of ostracism and to decrease the numbers of people who both willingly and unwillingly perpetrate it.

“Right Up”:
Employee Discipline That Shows Results

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

Since my introduction to veterinary practice management I have regularly engaged in a discussion about ‘writing up’ the people that work for me. I have attended conferences on the matter, been given one-on-one coaching by attorneys on the subject, been the one responsible for handing out the written warning, and have seen the flushed, red, shamed, furious faces of those that have been on the receiving end of it. I’m unsure who introduced the workplace-process of formalizing our employee concerns on paper. Perhaps the practice emerged out of our interest in underlining our concern, of proving that we made our concerns known. Perhaps we actually believed the process would pack enough wallop, enough threat, enough gravity to actually change the behavior of a troubled employee. That has not been my experience in either the practices that I have managed or with the ones with whom I consult. I would like to take this opportunity to discuss written warnings, review any labor laws that pertain to them, and postulate on a better alternative.

It’s not the law

Federal law ensures that employees are paid and worked fairly; that they’re safe; that medical expenses for on-the-job injuries are paid; that whistle blowers, veterans, and union members are protected; that employees aren’t forced to take lie detector tests; and that families have the chance to regroup in times of medical crisis (FMLA). There are a few other laws, but the ones mentioned above are the major ones. Absent from the list are protection for the tardy, the rude, the insubordinate, the mean, the lazy, and the ‘I just don’t like yous’. If you have a member of this group on your team and you live in an At Will employment state, termination of the employee can happen at any time. Forty-nine out of fifty states have such laws in affect, Minnesota being the only exception. At Will Employment is defined by the National Conference of State Legislators as:

An employer can terminate an employee at any time for any reason, except an illegal one, or for no reason without incurring legal liability. Likewise, an employee is free to leave a job at any time for any or no reason with no adverse legal consequences.

Those that believe an employee must first be warned about termination are mistaken. As attorney Aaron Morris of Morris and Stone Law Offices writes:

If there is no agreement to the contrary, an employer does not need any reason to fire you. You can be fired on the complete whim of your employer. This is called “at-will” employment. Just as you are free to leave a job whenever you please, the employer can fire you whenever he, she or it pleases.

Illegal reasons for termination

In addition to the above protections, federal law looks out for employees who are old, disabled, compensated unequally (with respect to a protected class), genetically handicapped, harassed (with respect to a protected class), not born in the US, pregnant, racially different, religiously different, retaliated against (with respect to whistle blowing), whose gender is disliked, and who feel like they have been sexually harassed. It’s extremely important to note that if an employee has a beef with you and they can make an argument that your conduct was predicated by their inclusion in one of the above groups, they can file a complaint against your business with the EEOC. Mind, that no amount of write-ups will prevent a case from going before the EEOC if the complaining party is included in one of the above-mentioned protected classes and feels as though they have a case.

Harrassment and retaliation may not mean what you think that they mean

Of the list above, probably no two arguments for discrimination are more misunderstood than harassment and retaliation. Harrassment only exists, in the legal sense, as it applies to a protected class of individuals. For example, getting yelled at or shamed at work by itself is not harassment. Getting yelled at or shamed, because of your inclusion in one of the protected classes of employees listed above, is harassment. In such a case, written documentation of corrective actions against the employee could potentially support your position that your actions as an employer were not discriminatory, but such documentation does not prevent the employee from claiming such a case exists. The exception to this rule is the case of sexual harassment, the grounds for which tend to be exceedingly wide in most states. In my opinion, a thorough understanding of sexual harassment law, as it applies to whatever state in which you are working, is mandatory knowledge for all employees in all capacities at all veterinary practices.

Like harassment, retaliation is likewise misunderstood. Use this case as an example. An employee dislikes her boss and relays this news to a coworker. The coworker, in turn, tells the employer what she has heard. The employer terminates the employee for ‘bad mouthing’ management. That evening, over a glass of wine to commiserate the termination, the coworker confesses to the employee that she is the one who leaked the information to the employer. The employee now believes she has a case for retaliation. She is mistaken.

Retaliation, in the legal sense, refers to whistle blowing on the part of the employee against illegal practices on the part of the employer. For example, an employer is not paying overtime properly to employees. A team member notifies the authorities and the employer is fined. In this case, termination of the employee for the 'whistle blowing' act would be deemed retaliatory. Employees who are terminated for trying to unionize similarly have a case for retaliation, but employers and employees should understand that retaliation, in the legal sense, is specifically defined by the Federal Government and each individual State.

No law requires you to document employee interaction

While documentation of all employee interaction can be used productively, it is not necessary that this documentation be formally presented to the employee for their review or their signature. These 'write ups' may prove that the employer made their concern known to the employee, but it does not mean that the employee agreed, nor does it excuse the employer of any wrong doing or of breaking any labor laws.

Creating a 'paper trail' does not prevent you from paying unemployment

The decision to pay unemployment benefits is made by the your state's unemployment office, not by any law. Every case is handled individually and there are a multitude of examples of employers who were forced to pay unemployment benefits to employees irrespective of the amount of 'write ups' they had on file OR how the employee left the company's employment. I can think of one first hand example of an employee telling an owner to '<expletive> off' before walking out on their job. This employee filed for unemployment arguing that the owner was so awful to work for that they had no alternative but to quit. The unemployment board agreed and the employee received their compensation (despite the fact that the employer has been a successful business owner and upstanding member of the community for more than three decades).

'Write ups' don't change people

Take a moment and consider the 'write ups' you have filed: tardiness, insubordination, workplace errors…in retrospect, do you honestly believe they were successful at changing the offending person's behavior? Our first priority as employers is to hire people who are devoted to our Mission. With that accomplished, our second priority is to cultivate the strengths and minimize the weaknesses in each of these employees to facilitate their successful participation in our Mission goals. This isn't accomplished by retribution, but by empathetic discussion, an objective exploration of the employee's perspective, and a review of the work place systems in which they are asked to participate.

Documenting employee behavior responsibly

In the absence of a legal requirement to document employee behavior, however; there still can be positive and necessary purpose to the practice. Here is a list of ways to use documentation responsibly and positively:

As part of recommended communication

Considering the number of workplace relationships that break due to a lack of communication between employers and employees, think of the value of a communication policy that recommends that employers spell out their expectations for employees in writing and then provides the employee an opportunity to respond in kind. Used in conjunction with respectful dialogue, a written description of each party's thoughts on the whatever matter is at hand, not only serves as proof that the discussion happened, but ensures that each side understands the other.

Journal style documentation

An employee signature on a 'write up' isn't required in order for the document to be valid or to be viewed as truthful. Simply journaling the employee interaction may be sufficient in any case brought against the employer for the violation of any labor law or for unemployment benefit purposes. In some states, the only documents that employees may have a right to access are the ones that they sign. Announcing in the employee handbook that employee interactions will be regularly documented to ensure compliance with all labor laws may be enough of a deterrent to any employee that seeks to press a case against an employer. Without access to all of the information in their file, how will they (or their attorney) know how strong of a defense the employer can mount?

If it's really supposed to be progressive, change the name

Ideally, you have employed individuals in whom you are invested. As we've already indicated, you don't have to 'write someone up' as a stepping-stone to termination or even something you need to do in between now and when you finally make up your mind about termination. Ideally, the process of dialogue between employers and employees is supposed to be constructive, not destructive. Instead of calling your employee documentation 'an employee write up', why not try something like 'progress report'? In fact, one could argue that such language is much more likely to portray you as a fair employer to any third party 'judging' your actions, than it is if you used language like 'write up'. Additionally, isn't it much more likely that both you and the employee will enter a discussion about change more positively when it is put in the context of 'progress' as opposed to 'write up'?

Yes, I get it. A labor law dispute is a BIG DEAL

I'm not so naïve to dismiss the enormous impact of an employment lawsuit against a manager or an employer. I'll also admit the plain truth that some employees can be downright jerks and take a perfectly great small business operation and willfully destroy for their own selfish gain. I do however take a stand against employee management whose only underpinnings are cover-yourself, written admonitions and fear. Most employee lawsuits begin as a feeling by the employee that they have been mistreated and misunderstood. If you want to 'write something up', try your hand at writing and building proactive hiring protocols; work systems that optimally integrate everyone's actions; job descriptions that effectively make clear our expectations; and review processes that effect change. This is a much better way to spend your time as a leader than regularly reminding people in writing that you have the power to terminate them. Is it a method that leaves you open to risk? Yes. But that potential is not just for exposure, but success. The amazing business that you will be will not be predicated on your fear of employee retaliation, but by building management systems that help all of your employees be the very best they can ultimately be.

Why Your Team is Mad at You- And How to Fix It

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

As we discussed in Conquering the Cold Shoulder, nothing can be more debilitating that anger directed towards an individual. In cases where that individual is the manager of the practice, a role that is often performed in isolation becomes only lonelier and more isolating.

Leaders who are currently on the receiving end of an employee's animosity are better served by reflecting on how they are contributing to the problem rather than doting on the incivility of the employee. While these situations may be driven by any number of faults on the employee's side, waiting for the employee to wake up to their folly and mend things on their end will likely do little to resolve things in an expeditious manner. By reflecting on how oneself may be contributing to the situation at hand you are at best kick starting a peace accord, and at the very least, improving yourself as a leader and a person.

Oblivious to your impact

All practice owners, managers and veterinarians should understand that they are figureheads in the practice and that their actions amplified to those over which they lead. Comments, asides, and jokes that would otherwise be innocuous, in settings where the leader is amongst peers, can have a bigger impact when spoken around those in your charge. While all of us like to think that we are part of a work 'family' or that 'at my job, we're all friends', leaders would do well to remember that they have the power to terminate jobs, ruin careers, mess with people's income levels, shame, and impact well being. Be considerate of your employees' sense of security by minding what you say about who they are and how they perform their jobs.

Disrespect

The vast majority of your team members are trying to a good job, often in the absence of clear goals, impactful training, functioning workflow systems and equipment, and a positive work culture. Before you critique the actions of your employees, inquire about the decisions that that they have made and their own thoughts on why the performed the way that they did. Lowering the boom, without benefit of knowing which direction that employee was trying to 'steer the craft', is a mistake.

Acknowledgement

These folks are setting aside their lives, their preferences, their comfort levels and their convenience to serve your business and your direction. Try to see their effort from their perspective and acknowledge it! We draw many comparisons between our employees and members of an athletic team, but when do our practice team members win? In basketball, each hoop shot is cheered. Can the same be true at our practice as we achieve service and care goals? Failure to acknowledge and celebrate great team performance is reneging on a fundamental part of the employee/employer relationship and is a rational source of resentment.

Betrayal

In exchange for a wage, your employees have betrothed their loyalty to you and your company. Not returning the same loyalty to them, to their honor, to their well-being, and their emotional and physical security, is perceived as betrayal. Gossip from peer-to-peer is debilitating enough, but when if the employee finds out that their employer is gossiping about them, the damage is exponentially impactful. Any false act, any act of betrayal on the part of the employer towards the employee, may cripple the employee/employer relationship.

Conclusion

Your employees are not children, they are functioning, rational, capable adults that possess the same feelings and react to circumstances the same way that you do. Thinking otherwise is hubristic and misguided. Before blaming team members for their reaction to you, first think of what you may have done to spark it. While no one deserves the right to behave inhospitably towards another, understanding how you may be engendering that urge in others is helpful in mitigating the instances during which it occurs.

On a more positive note, recognize that fairness, consideration, respect and even love win out in the long term. If you are an employer that has incurred the wrath of your employee, resolution and forgiveness are not only possible, but likely, provided you demonstrate that you are someone that they can trust and provided you maintain an upstanding approach to your relationship with them. Great relationships aren't constructed only of high notes, but include the lows as well. Provided that the overall theme of your behavior is one of respect and trust, the healthy productive part of your employee/employer relationship will be recoverable.

Building a Shopaholic-Friendly Pharmacy

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

Veterinary professionals who worked through the early 1990's probably have a bad taste in their mouths for online pharmacies. These third-party sites that promised to help veterinarians compete with the online-pet-pharmacy movement of the time were in many ways premature. Coupled with internal glitches that confounded veterinarians and pet-owner-clients, as well as a still-weak base of consumers, they delivered up lackluster performances.

Today's online pharmacies have learned from their predecessors and have emerged as strong allies to veterinarians in a market regularly besieged with competitors. It is a good thing too, since the day when a veterinarian can't go without an online pharmacy is soon approaching. Here are four major reasons:

- Competitors are numerous and aggressive
- Online purchasing habits are on the rise
- Competitors are targeting your clients in unprecedented ways
- Clients have an increased need for shopping convenience

More competitors

Everyone is familiar with the nearly ubiquitous 1-800 companies that offer pet medications, but were you aware that companies like Wal-Mart, Target and K-Mart all have a line of veterinary-pharmacy products that they are heavily marketing? Were you aware that Perrigo, a company that owns the right to the generic fipronil product, PetArmor, along with major retail partners, has been developing an OTC market for pet healthcare products traditionally dispensed only by veterinarians? The company believes the PetArmor franchise brand might include more potential products in the flea and tick and health-and-wellness categories "to bring additional vet technologies to the hands of consumers in the mass market" (source: 2013 plstorebrands.com).

Even grocery stores have discovered the lure of including pet pharmacy products as part of their one-stop-shopping model. As of October 2014, Kroger foods not only had a webpage devoted entirely to pet medications, but a four-dollar, generic, pet-medication promotion that lists the names of all of the generic medications for which there is a brand named counterpart. They also had a downloadable pet card that consumers could use for promotions when purchasing their pet medications at Kroger Foods.

Consumer spending habits are changing

It's also important to note that consumers' online spending habits are rapidly on the rise. As of 2012, consumers spent 3.7 billion dollars online on pet related products, up 76% in 4 years (source: 2014 Watt Pet Food Industry.com). Much of this habit has been driven by the marketing efforts of online store giants like Amazon, E-bay, and so forth, that regularly promote the savings-value of online shopping, but a rising amount of this shopping activity is driven by the pervasive and highly effective targeting efforts of popular apps, websites, and social media venues.

Competitors are targeting your clients

Our Internet service providers, our browsers, the applications that we use on our phones and tablets, and by the social media sites are closely watching most of our activity online. Though the details of how this is accomplished are fascinating, they're beyond the scope of this article. None-the-less, most of you are probably aware that this is happening. Any of you who have explored purchasing a product or who have researched a particular topic online, have probably noticed that advertising for this product has started to show up in the sidebars of your online activity and in your browser feed. It's only a matter of time before the Internet discovers that your clients are pet owners and before those owners start to receive invitations to purchase pet-related products and services on a daily basis, several times a day.

The numerous advantages of online pharmacies

Online pharmacies don't have to be just a reaction to the current industry climate; they can also be a proactive strategic response to keep your team members and your company focused on your two biggest strengths: expert care and personal service.

Most veterinary practices spend too much time counting, ordering, unpacking, stocking, tracking, returning, and searching for inventory items that provide them little return on their investment. Most practices are short of team members to begin with. Take a moment to consider the value of employing hard-to-come-by veterinary professionals to labor over low-profit-margin inventory while your valued clients' needs go unmet, while practice phones go unanswered, while patient care follow through falls by the wayside, and so forth. At a typical veterinary practice, veterinary services are wildly more profitable than inventory items. Deciding on how an online pharmacy can help you be both competitive and more focused on client service is more than just a reactionary move to keep up with the times; it's a proactive way to increase client satisfaction, minimize mistakes, and maximize service sale's opportunities.

Selecting the right site for your practice

When looking for an online pharmacy company with whom you can successfully partner, make sure that you confirm the following:

- Test the site's 'user friendliness'. Have the vendor walk you through the process by which client accounts are opened and managed. Make sure that it's easy for you to upload product recommendations into the client's 'cart'. Ensure that it's easy for you to make changes to the products you have in your pharmacy or to know how much to mark them up. Review the sales reportage available to you. As you move forward, it will be necessary to understand how profitable your store is and how much difference it is making in your practice's bottom line. Think about the information that you will require as a practice manager to make future decisions regarding your online pharmacy and product promotion in general and make sure your online pharmacy can give it to you.
- Talk to the vendor about their willingness to assist you with marking up products or with providing you references of some of their clients who've successfully employed the site to grow their practice. Explore how the company can help with marketing the pharmacy, following up with your clients, training your team members how to use the site, or giving your company more of a competitive edge by offering client promotions. As a veterinary business owner, you have more than enough to do with respect to client education and patient care. Finding an online pharmacy isn't just about finding a site that functions; it's about finding a company that can partner with you in sales and growth.

Strategize your pharmacy for maximum benefit

In order for any online pharmacy to truly be successful, it must be conceived within an overall strategy to capture increased compliance and opportunity, and to manage your inventory costs, your practice's physical space and the additional revenue saved by keeping a lower level of inventory in stock.

One of the most immediate benefits a practice manager can obtain with an online pharmacy is the reduction of the physical inventory kept in house. This is an immediate infusion of cash. Use the start of an online pharmacy as a chance to eliminate all generics and all redundancy from your practice's shelves, a process that can free up thousands of dollars and play to your strengths of expert opinion. Confirm that you are using the POS software to track your inventory effectively and to mark it up appropriately. Lastly, print out a usage report on all pharmacy items. Take a moment and review the prices that you have associated with each. Traditionally, we mark up all pharmacy categories by the same percentage, but one doesn't have to do this. When pricing your veterinary pharmacy items, don't think about a percent markup, think about the final margin that you believe your clients will tolerate, and then mark up each item accordingly. Depending on the cost for an item, the mark up may vary within a category. If you match this information against the usage report and mark up only the non-shopped items that have the highest volume sales, you can make strategic price increases that will typically go unnoticed by your team and by your clients, but will have the maximum impact on your practice's gross revenue.

Most veterinarians have understandable concerns that third party pharmacies will cannibalize their pharmacy revenue. These practitioners may be best served by using their online pharmacy firstly as a way of successfully tapping the enormous opportunity of improved parasite control and prescription diet compliance. Online pharmacies can also be used to generate new areas of opportunity heretofore not explored in their practices in the areas of nonprescription diets and pet retail products. Let me explain.

Most practices have year round parasite compliance rates of 35% or so. Were a practice to identify a client that has purchased less-than a year's worth of parasite control for their pet and to remind them to purchase more through their online pharmacy, they would capture additional untapped business, lower their inventory holding costs, and decrease the time their team spends following up with clients. Were they to assist clients with auto-ship options for their pet's prescription diets, they would not only boost client compliance rates for prescription-diet sales that typically hover around a dismal 5%, but generate additional revenue in food sales without the annoying hassle of stocking, labeling and selling this low-margin, cumbersome product. Finally, online pharmacies give veterinarians nearly limitless amounts of free warehouse space to store products for sale to their clients that they typically would not have marketed. For example, every practice owner has an opinion on what foods are better than others, what kind of pet carriers are superior, what gentle leaders work best, and so forth. It's now possible to educate clients on these products and provide them with an opportunity to purchase them through the practice without sending them on a goose chase through the closest, stadium-sized pet retail store.

One final benefit of online stores is their ability to increase a practice's online visibility. Practices that create pages with product recommendations, use correct SEO coding for these pages, and then hyperlink these pages to their store increase their practice's online search rankings. Since many clients are searching for pet related products, having pages on one's website specifically about these pet products not only optimizes your practice's visibility in a way that heretofore has not been possible, but also boosts sales at no additional expense to the practice.

When implementing an online pharmacy, take a good deal of time to first revisit your practice's Mission and long term goals. Starting with a clear understanding of what you are trying to accomplish will help you land your online pharmacy efforts in the right

context. Additionally, you'll be armed with an understanding of how to implement the pharmacy into your practice's workflow, how to roll the idea out to your team, and most importantly how to involve everyone in educating the clients about the site.

10 Take-Home Marketing Tactics to Try Today

Bash Halow, CVT, CVPM
Halow Tassava Consulting
Wyalusing, PA

When I first started in veterinary medicine, there were still many veterinarians who talked about marketing to clients with distain. Anything that smacked of 'selling' struck them as what? Beneath them? Unethical? It was a position they could still afford to hold in a world that hadn't yet been introduced to the Internet on such a wide scale and in a time when competition was still manageable.

But today's veterinary service consumers are a different client entirely. Unlike their predecessors of 15 or 20 years ago, these individuals receive veterinary marketing material daily. It's a stealthy campaign. Web browsers capture the personal preferences and buying habits of your clients literally with every computer keystroke that they make, then sell that information to companies interested in selling services and products. If your clients haven't found alternative online sources for their veterinary products and services showing up in their daily Internet feed, then it's only a matter of time.

In the presentation at CVC, we'll cover 10 specific marketing tactics to try when you return to your practice, but in this paper we're going to cover four aspects of marketing strategy that are essential to making any individual effort successful.

- Market the individual attention, care, and expertise that your practice brings to clients and their pets
- Work from a marketing plan that ties the practice image, education, and marketing materials to specific, long-term plans and goals.
- Create a unified, team approach to client communication
- Augment your marketing campaign with a strong online presence that invites click-throughs to the practice's website and a call to action (appointment)

Strong sense of identity

In order to distinguish your company from the multitude of other veterinary services visible to potential clients online, you must have some distinguishing characteristic, preferably one that plays to your clients' strong interest in trusting, competent care.

Identity can be first explored in your Mission Statement, a document that identifies your business as uniquely relevant to the community, to clients, and to employees. Mission Statements that work succeed in articulating the practice's aspirations in original, captivating language. The message within them should be as inspirational as the forces that first drove the practice owner to open his or her business. Their goal is to describe a light of compassion and dedication in such illuminating terms, that others are drawn to it.

Writing such an evocative document however is only the first step. If a Mission is truly going to assist with an effective marketing campaign, then it's meaning must be understood as it plays out in the day-to-day actions of the practice. This understanding will assist you with selecting the most effective photos and language for your marketing materials.

A marketing plan

Many veterinarians believe that an essential element of marketing is a discount. This is a mistake. Discounting is a passive message to your clients and worse, to your employees, that your pricing has no merit. Additionally it plays to your competitor's strengths: typically low prices and selection. In a world where Wal-Mart overwhelmingly dominates, private business owners that try to compete with special discount pricing will lose.

Rather than rely on a single shot discount campaign to bring in a boost of capital, develop a plan, a series of marketing endeavors that live within a your practice's larger, long-term goals. Typically every marketing plan attempts to answer the following questions:

- *What are the specific goals of this campaign?* Make sure that the goals can be articulated in short, clear sentences.
- *How will our success be measured?* When building a campaign, cite how the outcome of the campaign can be discussed with respect to increased revenue, better client retention, more new clients and so forth.
- *Are our marketing goals attainable?* When building a campaign, make sure that you use internal or external data from similar campaigns as a benchmark for how well you expect the team to perform.
- *Are our marketing goals relevant?* Is this campaign in keeping with the Mission Statement and the practice's long-term goals? Writing clear, sentences on how the campaign fulfills the Mission Statement is helpful in crafting a plan that meshes will with the practice's real reason for being
- *Can our marketing goals be completed in a timely manner?* Does this campaign have a clear, realistic beginning, middle and end? Make sure that you map out the campaign on a calendar and consider the time you'll need to successfully, undertake and complete a campaign.

To see how a practice might use a marketing campaign that has clearly defined parameters and one that underlines value and expertise, let's review the following example.

Assume that a practice is trying to distinguish itself as a resource for quality, life-long preventative care for its patients. Compared to its competitors, the prices that it charges for its well care are nearly 1/3 higher. Instead of embarking on a campaign that discounts

its services to match those of its competitor, the practice decides on a campaign to demonstrate its value and its identity. It sees a litter of adorable, stray kittens that it fosters as an opportunity to both capture the attention of it's audience and to demonstrate the practice's uniqueness, care and expertise. On paper, they write how such a marketing campaign helps the practice achieve its long-term growth goals and its goals for client loyalty and retention. Next it drafts a schedule of regular social media posts, hand out materials, and client education scripts that walk clients through the first year of life for these kittens, along with the value of vaccination, parasite control, neutering, oral care and so forth. Throughout, they confirm that the content of the material that they are creating is reflective of their Mission Statement, works synergistically, and is measurably improving their chances of reaching their long-term practice goals. Because the entire campaign is mapped out in advance, the practice is better positioned to consistently brand and integrates the materials for maximum impact.

A team approach

With a plan completely drafted and an understanding of how the client education can build on itself, it's easier to assign team members specific responsibility in the client education process. By now, everyone must have heard the axiom, 'clients must hear a message 5 times before they will act on it'. By having a marketing plan in place, a schedule of posts, and an understanding of what marketing materials will be needed, each team member can be assigned a specific role in client education. Each marketing element can exist as a piece of a larger message and consequently make the overall message more resonant.

Augmenting marketing with online visibility

One could use a lot of superlatives when discussing the value of using online social media platforms to assist with marketing and could still be in danger of *under*-expressing the value of these extremely powerful tools.

The Internet's reach and it's ability to point consumers towards products that they are likely to be interested in is extremely sophisticated and in fact, unprecedented. Search engines have the ability to sift through content, determine what it is about, and then offer it up to individuals based on the words that these people use in their queries, which sites they visit, where they live, and so forth. The process is not perfect, nor is it straightforward since search engines can't actually 'read' anything. Additionally, because there is so much potentially relevant data, search engines have to have other ways of deciding relevancy.

As of October 2013, Google determines relevance using an algorithm that considers dozens of criteria. Most other search engines employ similar methodologies. Some of the criteria that search engines equate with relevance are:

1. Website popularity…is this a site that see a lot of traffic?
2. Website age…is this a site that's been around awhile?
3. Website size…is this a site that has a lot of content?
4. 'Freshness' of content…search engines like websites with content that is regularly updated
5. Website citation…is this a site that is referenced a lot by others as demonstrated by those that hyperlink their sites to this one?
6. Social Media interest…is the content of this site often shared?
7. Content…does it appear to the search engine that this content is relevant to the consumer's interests?
8. Keyword phrases…Does it appear to the search engine that your content is about what you *say* it about
9. Headings…do subject headings indicate that there is a sizeable amount of information, relevant to the query, contained in your content?

Practices interested in boosting the success of their online marketing can use the above list to their advantage in the following ways:

Website

Since search engines like websites with fresh content, convert your website to a WordPress site. If you haven't worked on a WordPress site before, you'll find that they are as easy to update as a Word file. Their intuitive layout and the ease with which pages can be added, subtracted, or changed, means that practices can have immediate, personal control over their content without waiting for their website administrator to get around to things. It also means that they can steadily build on the site's longevity and size with regular systematic posts (as outlined in your marketing plan). This kind of writing schedule assures that your content will be continually growing and evolving in size, the very things that search engines are looking for. For more information on these sites, visit our blog at Halow Tassava where there are a number of good articles on the topic.

Website citation and Social media sharing

Search engines are drawn to content that others appear to find interesting. Consequently, imbue your online marketing with material that is likely to be references and shared. If you write a blog on vaccines, try adding in a helpful table that includes the vaccine name, a description of how it is administered, a description of the disease it prevents, and any risk assessments that determine if a patient should get one. If you're writing about kittens, perhaps a list of some of the postures they are likely to take if they are in pain, they are sick, or are playing would be interesting to readers. Having charts like these imbedded in your blog entices readers to link to them when writing their own online content, an action that improves your practice's search rankings.

Photograph children and pets at your practice, preferably the two combined. Both subjects are widely shared online. Additionally, giving your blog posts honest, but enticing titles, or associating your posts with captivating, original photos increases the likelihood that people will read and share your online posts.

Lastly, make sure you understand how to cross post all blog content to your social media sites. Many practice owners believe that the secret to increased online visibility consists of regular posts to social media sites. This is only half true. For the best online visibility, practices must both post to social media sites *and* link back to their website, a tactic that encourages the viewer to click through the posts on social Media to the blog post itself which should live on the practice's website.

Content

As mentioned before, all search engines can't read content for themselves, instead, they rely on a series of data points that help them determine how online content might be relevant to online users. Fortunately, many search engines give us tools to help convey to them what our online content is about and why it, above other content, might be more relevant. Understanding how to employ these tools is fast becoming essential knowledge to anyone that posts online with the hopes of attracting readership. Articles on how to use these tools abound. For a complete listing of these resources and a more in depth description of how they are used, please go to our website.

Being a successful practice owner in today's day and age is challenging. Marketing is only one of many new jobs we must undertake in addition to our role as care provider if our business is going to continue to be competitive. However, embracing marketing as an opportunity to both build your business and to more clearly articulate your identity to your clients and team, is a winning combination that not only brings you revenue today, it ensures long term growth for tomorrow.

Stop Receptionists from Turning Clients Away

Jeremy Keen, DVM
Jackson Animal Clinic
Jackson, TN

Crater face, pizza face, Zitty Pimpleson.....we all remember the terrible names for acne. Acne is the worst nightmare of every adolescent. This condition can put a strain on, not only your physical looks, but also your social and emotional health. It attacks just about everyone to a point and, goodness forbid, it doesn't happen on prom night. Acne is defined as the occurrence of inflamed or infected sebaceous glands in the skin. It can drive people crazy, make them uncomfortable and self-conscious, and leave life-long scars. Luckily, after our teenage years, this condition is much less common; however, professionally, our practices are always at risk for this inflammatory infestation.

The face of our practice is what matters the most in the client's eyes and if it is not smooth and beautiful, then most clients will not be interested in the heart of the practice. Any small blemish can have a huge impact on how successful your practice is. It's time for you to take a good, long look inside of the face of your practice and decide if you're a Hollywood Hottie or a Bumpy Buster in need of some Clearasil.

Avoiding the receptionist roadblock

The first team members your clients will meet are the receptionists. Your receptionist team will have one of the greatest impacts on how well your client base grows. Here are a few traits that a receptionist must possess in order to avoid these pesky pimples:

Respect thy client and pet

when a client enters your practice, the receptionist should attempt to greet the client and pet by name. The receptionist also needs to take the time to state the reason for the visit.

Great phone personality

Every practice needs to strive to have a standard phone greeting in place. This greeting must contain a polite hello, followed by the team member's name, the practice name, and something to the effect of “how may I serve you?” When a potential new client calls, the receptionist needs to schedule a “meet and greet” appointment and also mention the clinic website.

Strategic scheduling

When scheduling an appointment, a receptionist needs to take the time to offer many options if at all possible. This allows the client to schedule an appointment with as little stress as possible as well as proves to the client that you respect his or her busy schedule. When a client is checking out, the next follow up appointment needs to be scheduled at that time. When it comes to client compliance, this is where we really fall short in the veterinary industry. We, as veterinarians, complain when a patient does not show up for a follow up that we swear we “told” the client about but most likely did not relay that information onto our receptionist. I recommend that every practice have a scheduling protocol in place and stick to it.

Be hospitable

One of the best customer service steps that we can take, next to treating the client and patient with respect, is being hospitable and helping the client and pet feel at home. The receptionist should offer every client a lite snack and water or coffee. One of the best, most inexpensive practice builders that you can implement is having a refreshment area in the waiting area. It needs to be out of reach from pets and small children and needs to remain clean at all times. Some other small gestures that a receptionist can take, that make a world of difference to the client, include holding the door open for them, carrying an umbrella out during a storm, helping them out with their pets, and providing hooks to place the pets leash on while checking out.

Confrontation= calm

Unfortunately, there will be times when things don't go so smoothly for clients and it is inevitable that we will have upset clients from time to time. Sometimes receptionists have to play the role of psychologist just as much as customer service representatives. The first rule is to try to always stay calm and not become defensive. Always remember that a lack of communication is what leads to most client complaints. Once again, I recommend that receptionists take the role of a psychologist during confrontations and first take time to listen to the complaints, make a list of each complaint, and then cover them one by one. By doing this, the receptionist is able to prove to the client that the complaint is taken seriously and everything is being done in order to resolve the issue. If the issue cannot be resolved by doing this, then it should be taken to the office manager.

Don't wing it

A great receptionist must be aware of and thoroughly know all clinic policies. There is nothing more frustrating for a client than to be told one thing when checking in and then told a completely different policy while checking out or in the exam room. This is not just the full responsibility of the receptionist but they must know these policies. The only way to avoid confusion in this area is for the entire veterinary team to be on the same page on clinic policies.

No assumptions

One of the most important aspects of a great receptionist is that he or she asks questions when something is not crystal clear. There will always be small mistakes that pop up but the only way to learn from these is to ask how to correct the mistake. This is a crucial trait for a receptionist to portray. The last conversation the client has is with the receptionist and we would hate for the client to leave with conflicting information, or even worse, the wrong medication or instructions.

The golden rule

Treat others the way that you wish to be treated. Are your receptionists treating clients like family? Are they complimenting Mrs. Smith on her outfit or Fluffy's new Halloween costume? If not, they need to. All receptionists need to go the extra mile to make clients feel at home. We want our clients to think of us as family. Having said this, receptionists must also remember to manage their time well. I recommend giving each client and pet a specific compliment, then allowing a short reply from the client, and finish up by saying “well let's get Fluffy all checked in so we can get her on her way to continuing to live a healthy life.”

Know your role

A knowledgeable receptionist is a great receptionist but it's also important to know when to stop. Most receptionists are very good at handling some of the more common client questions (what are heartworms, what products prevent fleas, etc.) but every now and then, receptionists can go too far and accidentally diagnose. Most receptionists are so knowledgeable that they don't even notice when they do this. This is when knowing too much can be dangerous. I think every clinic owner and manager should set up a list of client questions that receptionists are allowed to answer and which ones need to be passed on to other staff members. We all frown when we see a stack of charts for call-backs, but it's the safest route to go and it's practicing good medicine. We must also remember that the best way to prevent diagnosing over the phone is to schedule the patient for a visit with the veterinarian.

Some great ways to help receptionists obtain these key traits are by utilizing role play and lunch and learns. Using role play during staff meetings allows receptionists to ask questions and point out faults, successes, or mistakes. This also provides a comfortable and fun environment in which to learn from each other.

Small Things Technicians Do to Congest Clinics

Jeremy Keen, DVM
Jackson Animal Clinic
Jackson, TN

Avoiding technician traffic

A clinic's technicians can easily cause many bumps on the face of your practice before the veterinarian is ever seen, and many of these bumps are so easy to prevent. Once again, get the Clearasil out and let's go to work. Here are some ways that you can make sure you have tremendous techs and keep the face of your practice a Beautiful Betty!

Get to know the client and pet

The first, and most important, step for technicians is to greet the client and pet and introduce themselves. The technician needs to check out the client information sheet prior to entering the exam room. This allows the technician to call the pet and client by name and also become familiar with some of the pet's medical history. I highly recommend that technicians pay close attention to the client and pet's body language and listen for any comments the client may have. These can be positive or negative comments, such as preference in veterinarian, a bad memory in an exam room, or certain precautions to take with the pet. Once these key pieces of information are overheard, the technician can make a note or alert in the computer so that the whole veterinary team will know in the future.

Explain the process

During many patient visits, certain diagnostics are required. Clients and pets can become very anxious and stressed about these diagnostics especially if they are unfamiliar with the testing procedure. This is the best time for the technician to shine. The biggest mistake a technician can make is in the initial dialogue. Too often does one walk into an exam room and say “hello Mrs. Smith, I am going to take Fluffy in the “back” for her tests.” The client usually agrees but at the same time is thinking, what the heck is going on and where is the “back.” Is it dark and scary back there with dripping water and a mad scientist doctor holding a scalpel blade and needle? Of course the client will never tell you about this thought but I guarantee you it happens all the time. I will admit that, the majority of the time, clients are fine with their pets being taken to the treatment area for diagnostics, but for goodness sake, work on the dialogue leading up to this. I recommend having a standard exam room dialogue for technicians to use. It should go step by step like the following:

1. Greet the client and patient by name
2. Kneel or sit down to pet the patient, or if the pet is anxious, at least kneel or sit down in order to get to the client and pet's level
3. Explain the process of collecting samples for diagnostics, heartworm tests, fecal analysis, etc.
4. Finally, ask permission to “borrow” the pet. I recommend saying “Mrs. Smith may I “borrow” Fluffy and take her to our “playroom” for the diagnostic samples?'

By using great body language and choosing words wisely, a technician can easily shine in the exam room and the client and pet's stress level will be kept to a minimum.

Great phone personality

I believe that every practice needs to strive to have a standard phone greeting in place. The phone greeting must contain a polite hello, followed by the practice name and team member's name, and something to the effect of “how may I serve you?”

Interactive

If you want to add more craters to that pimply face of your clinic, I recommend hiring a technician that is a depressive dud. However, if you are ready to dive into the Clearasil, you need to hire technicians that are interactive with staff and clients. Interaction is just as much body language as it is verbal. Great technicians have the ability to interact and communicate with clients in an informative and polite manner. Technicians must be able to remain calm while communicating with clients because they will receive many questions that may be redundant, however, it must be remembered that the client may not know the answer. I recommend that technicians treat every client as if they are brand new pet owners no matter how much of an expert they may be. A great technician goes into an exam room with an open mind and the desire to educate.

Enthusiastic

There is no greater team member than one who is enthusiastic about his or her job. Enthusiasm can go a long way in any industry and this especially applies to veterinary medicine. When you have an enthusiastic employee, his or her personality and actions will rub off on the entire team.

Parasite 101

Technicians must, must, must know about common parasites and the preventative medications used for each. Most practices feel their clients are well educated on fleas, ticks, and heartworms, but the majority of clients have no clue. A vital part of the technician’s job is to take the time to thoroughly educate clients on the danger of these parasites and what can be done to prevent them. Technicians must remember to talk in normal language when discussing these issues. For example, it is of no value to a client if a technician says, “the

Ivermectin in this product is used to prevent heartworms and the Pyrantel is used to prevent Ancylostoma and Toxocara." What tha!! I don't even recommend calling them intestinal parasites. The best way to describe these parasites is by using common language and being graphic. For example, Tina the tech could say "this preventative is used to treat heartworms and intestinal worms. Heartworms are like worms you see on the ground that get into your pet's heart and cause blockages. Other intestinal worms that need to be prevented include hookworms, roundworms, and whipworms. These worms get into the stomach and intestines and eat away at the intestinal wall and cause your pet to become very sick. Also, some of these worms are contagious to people (for the love of Pete, don't use the word Zoonotic) and by giving this preventative every 30 days, we can keep all of these horrible things from happening." By using this type of language, we can easily describe to the client what we are preventing as well as be graphic enough so that the point gets across. During my personal discussions with clients, I can tell they understand the importance of heartworm prevention, but once I mention that the clients, or their children, can contract some of these worms, their eyes get big and then they are all about some prevention. Once again, I recommend having a standard dialogue for technicians to go by while explaining parasite prevention. Great technicians are full of animal knowledge and this information needs to be translated on to every client.

Exit strategy

No part of the client visit may be more crucial than when it comes time to being discharged. This is where communication is most important among the veterinary team. Each clinic must have a certain strategy or protocol in place for this step. As far as the technician goes, it should be his or her job to gather all medication, treatment information, and remaining pertinent diagnostic information from the veterinarian before allowing a client to be discharged. I recommend the exit strategy to flow as the following:

1. Veterinarian discusses diagnostic results, overall diagnosis, and treatment plan
2. Technician performs an overview of medications, diagnostic results, and treatment with the veterinarian
3. Technician discusses and explains medications with the client as well as makes sure all information on the medication label is correct. You may call the medications by name but you also need to explain if it is an antibiotic, anti-inflammatory, etc.
4. Ask the client if he or she has any questions or if there is anything that is not clear
5. Walk the client and pet to the reception area. If the client is elderly or disabled, please offer to carry or walk the pet for them.
6. Once in the reception area, it is the technician's responsibility to reiterate everything to the receptionist. The technician needs to refer to the client and pet by name, explain what treatments and diagnostics occurred, and what medications are being sent home. The technician also needs to relay any recheck appointment information on to the receptionist.
7. Politely thank the client for visiting the clinic and for allowing you to serve them

These are numerous qualities of terrific technicians as well as tips to create a terrific tech. Some of the best ways to help create and maintain great technicians, include implementing lunch and learns and continuing education opportunities. The educational events can focus on puppy and kitten behavior, pet training, healthy treats for pets, parasite prevention, and numerous other areas. I also recommend applying role play during staff meetings. This allows for a very comfortable setting and often educational and comical atmosphere. Role play also allows staff to point out or realize any areas of concern or success in the everyday operations of the clinic.

How DVMs Drive Clients Crazy- and How to Avoid It

Jeremy Keen, DVM
Jackson Animal Clinic
Jackson, TN

Avoiding the DVM detour

We, as veterinarians, do so many great things in practice. We are surgeons, internists, dermatologists, ophthalmologists, and so much more. To most of our clients, I am sure we are seen as perfect; however, there are many areas outside of the medical or surgical aspect of practice that we must remain aware of in order to maintain this "perfection." We can all be the greatest surgeon or internist but if we don't remain aware of our client's needs, then many clients will be taking a DVM detour and looking for a vet who will. In order to avoid this detour, and for the sake of not adding any more pimples to our pretty practice face, every veterinarian must portray the following:

Communication is key

Congratulations, you are a doctor, but please don't talk like a doctor. We must remember to talk in normal, everyday language so that our clients can understand what is going on. Our clients already know that we are smart, we don't have to use big medical terms to prove it. I'm not saying that we don't need to use the correct terms, we just need to state the medical terminology and then explain what it means in client friendly language. It doesn't matter how smart or skilled you are, if you cannot communicate with clients, they will swerve off the main road and take that detour that will be so detrimental to your practice.

Know thy client

A veterinarian should always introduce himself by name to the client and call the pet by name upon entering the exam room. If you are seeing a client whom you have already met, you should still shake their hand and welcome them to your hospital. Please do not walk into an exam room and say "so Fluffy is here for itchy skin, let's get started." You may treat and fix the itchy skin and do a great job medically speaking, but how in the world is the client going to remember which fantastic vet to come back to if you never mentioned your name. Even worse, how is that client going to recommend you to others if he or she does not know your name? Word of mouth is one of your best practice builders, so wouldn't it be good to have a DVM name to go along with your client's success story?

Discuss the physical examination

Always be vocal and keep open communication during your examination. Explain what is being examined (and why) and make sure to thoroughly discuss any abnormalities. During the course of my examination, I prefer to explain each step as I go along and then discuss any abnormalities and recommended treatments. If the client presents with a certain health complaint for the patient, you need to perform a thorough physical examination, while being vocal through each step, but always return to the area of concern. By this, you need to discuss all abnormalities or concerns during the examination but always focus on the presenting complaint during the final stages of the examination.

What's the plan

Following a thorough physical examination, the veterinarian needs to sit down with the client and personally discuss all diagnostic results and treatment plan. We need to make sure to cover each aspect of the blood work, not just the abnormalities, and discuss what our treatment goals are. At the end of the discussion, we need to make sure the client has an understanding of what the issue is and how it is going to be treated. We need to make sure to give the client a handout that further discusses the health issue and then decide on a recheck evaluation before finishing the conversation. The use of a good, thorough handout discussing the disease will allow the veterinarian to briefly discuss the issue, send the client home to read over the handout, and then follow up with the veterinarian to discuss it in more detail if needed.

Offer the best!!

Our job as veterinarians is to keep our client's pets as healthy as possible. Our job is not to be a psychic and try to guess how much money our client is willing to spend. This is where we mess up all the time. We must learn to never pre-judge what our clients are willing to do for their pets. This is the most dangerous thing a DVM can do, not only financially for the practice, but it can also lead to numerous misdiagnosed cases.

Avoid the sticker shock

The best way to prevent from pre-judging clients is to provide an estimate for the best diagnostic and treatment plan for each individual pet. Some clients will tell you that cost is no object, but giving estimates is a good habit to get into. When it comes time to pay the bill, some "sticker shock" clients will complain, but most will just pay the bill and then never come back. Having an estimate ahead of time allows the client to make the best financial decisions. If the client cannot afford to take on the best diagnostic and treatment plans, then that is the time to discuss secondary options.

Take time to listen

We should all allow ourselves a couple of minutes to give each and every client our undivided attention. By doing this, we have gained the respect of our clients as well as proven to them that we are completely in tune to what is going on with their pet. During

these couple of minutes, I recommend holding the pet or playing on the floor with the pet while maintaining eye contact with the client.

Knowledgeable on nutrition

We, as veterinarians, all need to be educated on nutrition for our patients. Most of us see a large percentage of overweight pets on a daily basis and often times we try to avoid the nutrition and exercise talk. By doing this, we are helping no one. Nutrition is an area in practice that can become a unique niche. By taking a couple of minutes to discuss individual nutritional plans, offer healthy treat lists, and discuss supplements, we will prove to every client that we care. Many veterinarians hate to embark on the nutrition journey with clients and it can be very difficult at times; however, in the long run, it proves to our clients that we truly care.

Handouts

As veterinarians, we can spend all day discussing and explaining to clients the specifics of a disease that their pet may be dealing with (heartworm disease, thyroid disease, kidney insufficiency, diabetes, etc.), but when that client leaves the hospital (unless the client has a medical background), he or she will still be overwhelmed and probably confused by what this disease means in their pet and how it must be treated. This is where a very detailed handout will come into play. Veterinarians, as client educators, should have handouts describing the most common diseases that are seen in our patients, or at least take the time to photocopy a brief, simplistic description of the disease process for the client. I send home many handouts every day, and for my chronic disease patients or long term medication users, I have formulated a handout describing the follow up examination and testing protocols that are needed. This not only provides useful information for the client, but also reduces the amount of confusion the client may feel.

Blame causes hostility

There are always times when we, as veterinarians, have tough days. We may be dealing with some very sick patients and mind-boggling cases, performed a number of euthanasias in one day, or just feel as if we are constantly chasing our tail. You have to admit that seeing a patient chase its tail is very humorous, but when we as doctors do it just to keep up, it can become frustrating. During these stressful times, it is so easy to allow our emotions to determine our actions, but we must strive not to do this. It seems that when we have great days, nothing can go wrong, but when we have frustrating and emotional days, the whole veterinary world turns upside down. It never fails that this will be the day when you have Tucker the train wreck coming in for a recheck examination. Tucker is that patient that you know you have diagnosed correctly but the client is not complying with the treatment recommendations and frustrations are at an all-time high and patience is running out. It would be so easy to blame the client for not being compliant and that is why Tucker is tumbling down the quality of life drain. At any time in life, whether it be in veterinary medicine or not, blame causes a feeling of hostility. It is human nature to feel embarrassed or belittled when you are blamed for something. Blame achieves nothing and it only causes negativity for the doctor-client-patient relationship. When this situation occurs we must remember to listen to the client first. Take notes on what the client is doing at home to care for Tucker. We must also obtain a detailed history of Tucker's condition and any improvements or declines in his status. By doing this, we are taking a step back and making sure that we and the client are on the same page. We need to also review the diagnosis and treatment plan that has already been put into effect so that we can find any misunderstandings. Finally, if the client is still not comfortable with the diagnosis or treatment plan and he or she continues to be non-compliant with your recommendations, don't be afraid to offer a second opinion. Also, remind the client that you will always offer the best standard of care for Tucker no matter what treatment the client selects. By taking these few easy steps during the situation, you have not blamed the client for lack of care, you have maintained a trusting relationship and an open road of communication, and you have re-assured the client that your main concern is Tucker's comfort and quality of life.

We, as veterinarians, are in the driver's seat when it comes to keeping our clients happy. We set the tone when we enter the exam room, during the exam, and before the client and patient are discharged. If we see each client and patient as just another number walking in the clinic door, then we might as well head out to the road and put up the detour sign because you are in need of some serious construction. However, if we see each client and patient as an opportunity to educate, listen to, and offer the best standard of care, we will never lose.

Say This, Not That:
The Art of a Great Recommendation

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

The quality of the veterinary care we can give depends on our ability to communicate with the client, gain their trust, and help them understand why their compliance is so important. Interacting and communicating with people is a key part of veterinary medicine. Yet despite this fact, the people part of the equation is often overlooked in veterinary schools. Most veterinarians are great with animals but what about people? Whether we like it or not, veterinary medicine is a service business, and communicating with people is paramount to success and ultimately ensuring that animals get the care they need.

Why does communication matter so much?

Owners want to be treated with respect, kindness, and compassion. They want to understand what's wrong with their pet and know all treatment and management options. When clients do not understand a recommendation, they often fail to follow it. Proficient veterinary skills and knowledge are key, but if you don't know how to communicate what you recommend effectively, chances are your clients won't either. In addition, legal action and complaints against veterinarians are not uncommon and often stem from poor communication between veterinarian and owner. Now days, veterinarians must be expert not only in animal illnesses and the vast array of treatment options and specialist care, but also be in tune with human emotions and needs and be skilled communicators. Veterinarians need to know the basic principles of good communication in order to successfully serve their animal patients.

Goals of successful communication

The goal of effective communication is simple: to empower our clients with the knowledge required to make an informed decision about their pets' health care.

The veterinary communication cycle

As veterinary professionals we interact with not only pets but also their owners each and every day, it is important to understand how the multifaceted communication process works in order to assure that the messages we send clients are received appropriately. The communication process includes multiple components, and each component is critical to effective and thorough communication. The communication cycle begins before a client enters are clinic, while they wait for their exam, during the examination and even continues after the examination concludes and the client leaves the practice.

Before the exam

Our industry focuses a lot on communication during a veterinary visit BUT it's also important to communicate with our clients before and after their visits.

How can we communicate important pet health topics with our clients before their pet is examined? Communicate with your clients before their actual visit with reminders, targeted alerts about local issues, and educate them about important healthcare topics via newsletters, social media and mailings.

In the waiting room

Take advantage of the time our clients spend in the waiting room, or in the exam room by providing educational pamphlets, videos and more.

Communicating in room

The first step in communicating effectively with your clients is to develop a relationship with your clients and their pets. Next you need to explain what you are doing when examining their animal and why. Exams are a great opportunity to share your knowledge and educate your client about pet healthcare. Talk while you examine your patient; explain why you are looking in their pet's eyes, ears and mouth. What might you find? Likewise if you recommend diagnostic testing explain why. What does the lab work evaluate and why is that important? If your exam uncovers a problem. Be sure to tell patients the problems precisely and in simple terms. Inform them of how the problems occurred and inform them of the treatment recommendations.

Let them know what may happen if treatment is delayed or ignored. Be sure your recommendations are clear and involve them in the decision making process.

Utilize technology

One of the goals of effective communication is to get your clients to take action and ultimately ensure that their pets get the treatment and care you recommend. To accomplish this goal, clients need a sense of urgency and ownership. Take advantage of the numerous

“high tech” gadgets that allow you to illustrate conditions to your clients. Many programs allow you to use 3D to show a client conditions like torn ACL ligaments or luxating patellas. You no longer have to rely on your drawing or verbal explanation, these programs help you illustrate common medical conditions. Clients are more likely to follow your recommendations is they understand what the problem is and what you recommend. The power of showing clients is further enhanced when you are able to educate them on cause and effect using these patient education software programs.

Everyone needs to be on the same page

The need for effective communication extends to colleagues and staff members. We are part of a healthcare team, which may include receptionists, veterinary assistants,veterinary technicians, an office manager and professional colleagues.

How many of your staff interact with your clients during a routine visit? And how often do your team members interact with your clients daily? What are your clients hearing from your various team members? Is it a consistent message and theme? Consistency is the first step to effective communication. The fact is many people communicate with clients throughout their visit and they all need to be on the same page.

Reinforce your recommendations

Be sure to reinforce your recommendations by communicating with your clients year-round. Take every opportunity you have to communicate the importance of preventive care by sending out monthly newsletters and sharing blogs and articles that talk about why regular check-ups are so important. Most veterinary software allows you to conveniently connect electronically with your clients. You can communicate with your clients via e-newsletters, postcards and by sharing articles and blogs on your website and social media sites. In addition be sure to notify your clients about promotional activities like dental month or diabetes month. These not only inform your client about your promotions during these month but they help educate your client about important health topics. Likewise make sure clients know where to get more information. After the visit-be sure they know where to get additional reliable info.

Summary

It doesn’t matter if you are the best surgeon or diagnostician in the world; if you can’t communicate with your clients, you can’t win. If your clients don’t say yes to your recommended treatment, your patients will not get the care they need. Effective communication requires patience, effort, humility, and a process for improvement.

5 Secrets to Lifelong Clients

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

Client retention is one of the most important components to a successful practice. As an industry, we devote a lot of time and money seeking new clients, and spend relatively little trying to keep existing clients. Every veterinary practice needs to know not only how to attract new clients, but also how to keep them for life, so they come back year after year, and pet after pet.

So what are the secrets to keeping your clients for life? Actually, a lasting client-doctor relationship is similar to a lasting friendship. So what is it about our long-term friends that make them friends for life? Why is it that even if you haven't seen or talked with your friends in awhile, when you finally reconnect, it feels like no time has passed and your friendship is the same as it always has been. That's the type of relationship you want with your clients. Whether you see them once a year or more often, every visit should feel the way it feels when you're with an old friend.

So what are the elements of a lasting friendship?

1. **Bond**

The foundation to a good relationship is a strong bond. Take time to get to know your clients and develop a relationship. Find out about your clients. Ask about their human family, their hobbies, where they come from, etc. You might find out you have a lot in common with your clients if you take the time to get to know them.

2. **Trust**

Trust is essential to all good relationships. Whether it's a friendship, marriage, or business relationship, trust is essential. Always be honest and admit any mistakes. It may not be easy to admit our mistakes, but by doing so, you are showing your clients that you care honesty and value it above all else. In the end, most clients will respect and trust you.

3. **Reliable**

Be there for your clients when they need you. Return their calls and emails in a timely fashion. No one likes to be ignored and clients are no different. It's also important to be there for your clients during hard times. Make sure you reach out to your clients when they are dealing with family tragedies, and of course, when they lose a beloved animal friend. Just like long-term friends, clients will appreciate knowing that you are thinking of them during their time of need.

4. **Respect and feeling cared**

Most good relationships are built on mutual respect. The same is true for doctor-client relationships. It's important that you and your entire staff treat all your clients with respect. This starts the minute they call the clinic for an appointment, and continues until they leave the clinic. Likewise, make sure your clients know that you care about them. Send thank you notes to new clients, thank clients for their feedback and reviews, and communicate with your clients multiple times throughout the year so they know you are thinking about them and haven't forgotten them.

5. **Communication**

Friends are people you can talk to and get advice from. Clients, like friends, need to feel that you are someone they can talk to and communicate their needs with. Just like people want their friends to be able to listen, they also want them to be able to communicate clearly and effectively. And obviously its imperative you speak the same language in order to be close to someone. The same holds true of good client-doctor relationships. You need to speak in a language you're your clients will understand and skip the detailed medical jargon.

How to Deal with Dr. Google

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

Put yourself in your client's shoes. It's Friday night and after a long day at work, you return home only to discover that your dog's sick. Of course, your regular vet's office is closed because it's after hours. You're not thrilled about waiting a few hours at the emergency clinic. And to top every, you're hungry and tired. What do you do? If you're like most pet owners, you're going to check-in with Dr. Google.

Whether we like it or not, we live in a world of smartphones and the Internet. We must accept the fact that our clients routinely rely on Google to learn more about their pet's health and everything else, for that matter. Of course, not everything you find on the Internet is true, so we must be prepared to dispel the misinformation promoted by the web. Many of these myths are only inaccurate, but also downright harmful.

Why do people turn to Dr. Google?

Clients turn to Dr. Google for different reasons. Sometimes they simply want to learn more about their pet's condition. Or they might be afraid to ask their vet a particular question. Finally, some want to find out if they need to bring their pet to the vet for their problem.

What affect does Dr. Google have on your practice?

Unfortunately, the Internet is riddled with misinformation. Anyone can post an article about pet health, whether they have a DVM behind their name or not. Besides being inaccurate, this misinformation can be harmful. At the very least, it can result in a delay of treatment, or at the very worst, expose pets to harmful home remedies. Clients who rely on Dr. Google often skip routine exams and preventive care. Visits are also lengthier since you have to spend extra time dispelling misinformation or convincing clients that what they read online does not apply to their pet.

What can you do about Dr. Google?

Whether you like it or not, Dr. Google is here to stay. However, our job as veterinarians has not changed: we still must provide the best care for our client's pets. One new responsibility we face in the 21st century is helping our clients navigate the Internet.

What you should do

1. Be sure your clients check with you before changing their pet's medicine or food, etc.
2. Make sure your clients realize that nothing replaces a hands-on on exam by a trained professional.
3. Create a list of reliable websites for clients.
4. Give educational handouts.
5. Create a library of articles for your clients.
6. Include reliable, resource links on your website.

What you should not do

1. Ignore it and hope it goes away.
2. Refuse to talk about your client's Internet research.
3. Make the client feel bad that they cheated on you with Dr. Google.

How to Build a Great Clinic Team

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

Let's face it; veterinary medicine is a team sport. The final score, client satisfaction, depends upon everyone's efforts, not just the doctor's. Don't believe me? Who do we trust to make a good first, and last impression on our clients? We rely on our staff, of course. The success of a veterinary practice depends upon having a cohesive team that works well together. Without an effective team, your clinic may not run smoothly and could send your clients running for the door. Your team and how well they work together also influences the office environment and the energy they project to your client. It's easy to see how your team can be your practice's greatest asset, or greatest liability. So how can you assemble the best veterinary team possible?

Recruit strong players

You want to build your team from the very best prospects, and hiring a new staff member should be taken as seriously as the NFL draft. In order to attract the most applicants, invest in placing ads that clearly detail what you are looking for and consider pre-interview questionnaires to narrow your focus on players who will fit best with your team. Be sure to conduct face-to-face interviews to get a chance to evaluate your possible team player. Don't be afraid to ask other team members what they thought of the interviewee. What was their attitude like? Skills? Remember you can teach skills, but you may not be able to change attitudes.

Define the player's roles

Expectation management is key to any successful relationship. Expectation management refers to simply letting someone know what's expected of them upfront. Whenever you hire a new team member, make sure you give clear expectations from the start. You can't expect people to perform well if they don't understand their role and position on the team. Make sure you define positions and give prospective employees a full description of duties to avoid the perception that you are adding on jobs later. Ensure everyone understands what their job duties are and what will be expected of them. Make detailed written job descriptions to avoid possible misunderstandings. Policies lay a strong foundation for the practice provided that they support the mission and goals. Furthermore, policies need to include both positive and negative consequences for compliance. Expectation management leads to job satisfaction for team members.

Train your new players

In addition to defining their role on the team, be sure to give them adequate training. A few weeks of training can really boost a new hire's confidence level and help them to acclimate to your team. Once you've found the right team member, avoid putting them in situations that will overwhelm them before they are trained effectively. When training new hires, why reinvent the wheel? Create training tools and handbooks for everything that your team members will need do know so that each new recruit has accessible references they can use.

Set goals

Similar to defining player roles, establish goals for the team in order to give the team direction. Make sure these goals are clear, attainable, and ultimately promote your practice's mission. Help your team achieve these goals by breaking them down into obtainable steps. Give your team members guidance as to how they can contribute and accomplish the team goals.

Offer feedback and praise

Regular evaluations of your team members are a great way to provide feedback. Without feedback, staff members have no way of knowing how they are doing. Evaluations should praise team members for jobs done well. Praise reinforces the actions and behaviors you wish to promote and also raises the team morale. If goals are not being met, use constructive criticism to engage staff members and encourage accountability. Recognize outstanding staff members with awards to promote an office environment of excellence.

Lead

Remember that every team needs a leader. As the veterinarian, take it upon yourself to lead by example. Promote the attitudes and behavior you expect from everyone else by setting the standard yourself. Make sure your actions don't contradict your expectations. Team members are more likely to buy-in if they see their team leader following the practice mission.

Don't be afraid to trade players

The fact is most great teams didn't start off as dynasties. Great teams make adjustments, and even dynasties have rebuilding seasons. Sometimes talented players have to be traded or cut if they don't help their team. Veterinary teams are no different. It may take time

and several changes to obtain the right mix and combination of staff members that work well together. Don’t be afraid to let people go and find new ones they don’t fit well with your existing team.

Know how to keep players

When you have a winning team, it is important to try to keep the team together. Show your commitment to the team by rewarding excellence with bonuses and other incentives. Besides rewards, promote team retention by making your clinic an enjoyable work environment. Your goal is to make your employees want to come to work because work is fun. Think of companies like Google and Southwest. Apply what these companies do in your veterinary clinic so that your employees want to work and not seek other employment.

Running a veterinary practice takes a lot of hard work and time. Having a skilled team can make all the difference. Effective veterinary teams help you run your clinic more efficiently and will leave a positive impression on your clients.

What to do with a Bad Online Review

Ruth MacPete, DVM
MacPete Veterinary Service
San Diego, CA

There is no doubt online reviews have changed the way businesses are reviewed and rated. When was the last time you used a Zagat guide to look for a restaurant? Nowadays, if you want to find a highly rated restaurant, you grab your smartphone and "Yelp" it. Online review websites like Yelp, Angie's List, and Google+ have revolutionized the way people find and ultimately choose businesses. Online reviews can be shared with the world from anywhere within seconds. These reviews are becoming more and more important for businesses, including veterinary clinics. New clients who once turned to their neighbors and friends for recommendations now turn to Yelp and Angie's List to find a new veterinary clinic. BrightLocal Local Consumer Review Survey 2014 reported that approximately 88% of consumers surveyed said that they trust online reviews as much as personal recommendations. Online sites can be great for businesses, helping them increase clientele and grow revenue.

BrightLocal Local Consumer Review Survey 2014 revealed that 88% of consumers regularly or occasionally use online reviews to determine which local business to use. Consumers are becoming more and more familiar with online review sites and surveys show they trust them and use them to pick and choose businesses. The growth of smartphones means it's even easier for consumers to look at online reviews at any time and anywhere. Therefore it is important veterinary clinics to open business accounts on several review sites, monitor them regularly, and also to routinely seek online reviews.

But what do you do if you get a negative review? Bad reviews can be detrimental to businesses. So how should you deal with a negative online review?

Take a deep breath

It is important to not immediately respond to a negative online review. Your response can determine whether a negative review hurts or actually helps your business. So relax, calm down and always avoid reacting with anger.

Find out the facts

Before you respond, be sure to do a little detective work. Find out what happened and who was involved. The goal is to keep an open mind and get the facts from everyone involved. Was this an isolated event? Or is this a recurring problem that requires you to fix a systematic weakness? Keep in mind that a negative review can viewed as a learning opportunity for your hospital and can actually improve your practice's customer service in the long run.

Address the negative review

Once you are calm and have collected the facts, it is time to acknowledge your critic and address the negative review. Treat your online reviewer as you would any client that verbalizes a complaint. The first thing you would do is offer a sincere apology. Take responsibility, apologize for their grievance, and then offer to make it up to the client. It's important to respond to the negative review publically and also privately. Public responses allow other potential customers to see that you care about customer service. Privately you can go into more detail about how you would like to make it up to the client and restore their trust in your clinic. Your response to the negative online review may actually cause the reviewer to edit or remove their negative comments if they feel that the situation was handled well. Whether the negative review is removed or not, a tactful, sincere acknowledgment of the negative review shows you care about customer service and can make all the difference between attracting, or scaring away future clients.

Know when to move on

Unfortunately, even if you handle the negative review well, you may not get anywhere with this client. Be familiar with what different review sites will remove and what they will not. If you are unable to remove the negative comment, remember it's not the end of the world. Move on knowing that you tried. The important thing is you stayed professional and other potential clients will see that.

Dilute negative reviews with positive reviews

One or two negative reviews are not the end of the world. While you may not be able to get the client to take down a negative review, you can take control of online review sites that frequently rank in the top of search engine results pages. Become an active participant in guiding a positive conversation about your brand on those sites. Make your presence on online review sites positive by soliciting positive reviews from your best customers. There's nothing wrong with asking happy customers to write a review. Remember the more positive reviews, you can lessen the effect a few negative comment will have on your overall rating.

The Case for Emotional Intelligence in Practice

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Ever witness the devastation that you leave in your path when you're in a bad mood? Great leaders are emotionally aware, of self and of others. In this session, you will learn how to positively influence the group's emotions, differentiate between common leadership styles, and apply them at the right time. You will also chart your own path to becoming an emotionally intelligent leader. Don't be that person who leads the team right down the drain!

After attending this session, you will be able to:

- Understand that effective leaders move the collective emotions of the group in a positive direction
- Recognize the most common ways people demonstrate lack of emotional intelligence
- Avoid typical emotional intelligence challenges common to veterinary leaders

Primal leadership

Great leaders motivate us and move us to do better than we thought we could. When we try to explain "great leaders," we think of strategy, vision, and powerful ideas. But the reality is PRIMAL: Great leadership works through emotions. Whatever a leader does, her success is linked to HOW she does it. It's important to realize how influential emotions are on our ability to lead and the relationships we create with others.

Most people recognize that moods have an effect on the workplace, but perhaps you think of moods as "too personal" to discuss as part of work. Review the "Checklist on the Appropriate Expression of Feelings and Emotions" below to help you understand just how much your moods affect the people at work.

1. Do I feel that it's all right to express my feelings and emotions and to talk about them?
2. Have I learned that feelings and emotions are dangerous?
3. Do I allow my emotions to flow spontaneously without trying to push them down?
4. Do I feel that I have to manufacture or make up emotions that I don't really feel in order to please others or because I think I should feel certain emotions?
5. Are there emotions that I overdo (e.g., anger, depression, self-pity)?
6. Are there emotions I refuse to experience (e.g., hurt, enthusiasm)?
7. Do I let my emotions add life and color to my conversations?
8. Do I control my emotions too much?
9. Do I use my emotions to control others and get them to do what I want them to do (e.g., to leave me alone)?
10. Do I express or talk about my emotions when they come up in the here and now?
11. Do I save my emotions for a later, safer time?
12. Do I feel that I have a right to be emotional, to assert my emotions without stepping on the rights of others?
13. Do I ever use my emotions to step on the rights of others?
14. Am I willing to take reasonable risks in expressing my emotions? That is, do I experiment with emotions that I ordinarily hide or avoid? For instance, can I, in a reasonable way, express negative emotions in the here and now to another person?
15. When others are expressing emotions, do I get scared or annoyed?
16. Do I try to get them to stop expressing their emotions?

The emotional task of the leader is what relates to "primal." It is the original and most important act of leadership. In modern-day work culture, this primal task is largely invisible but remains foremost among the many jobs of leaders. You need to drive the collective emotions of the group you are leading in a positive direction and clear the smog associated with toxic emotions. In any human group, the leader has maximal power to sway everyone's emotions.

If people's emotions are pushed toward enthusiasm, their performance soars. If people are driven toward rancor and anxiety, they are thrown off stride.

Primal leadership extends beyond getting tasks done. Followers look to leaders for emotional support: EMPATHY. When leaders drive emotions positively, we call this RESONANCE.

The reason a leader's manner (how s/he does things) matters is because of the design of the human brain. Our limbic system is our emotional center in the brain, and it is an open-loop system. We rely on connections to other people for our own emotional stability! The open-loop limbic system is a winning design because it allows feeling animals to come to one another's rescue.

We transmit emotional signals that literally affect the physiology of those around us. It is a part of daily life, but we are often not aware of it. In conversations, a person's heart rate will mirror the other's. When three strangers sit next to one another for three minutes in silence, the most emotionally expressive of the three transmits his mood with NO WORDS.

Moods at work are like the ingredients in a soup. Each person contributes his/her own flavor, but the spiciest one is the leader. Why? EVERYONE watches the boss! The leader talks more. The leader is listened to more carefully. The leader is first to speak on a subject. Others' comments are more often "parroting" or affirmation of the leader's comments. When others in a group raise a question, the rest of the group looks to leader for a reaction.

Regardless of who the emotional leader is, s/he has a knack for being a limbic attractor. Not all emotions spread the same way. Cheerfulness and warmth are the best (easiest to spread). Irritability is less contagious. Depression hardly spreads at all. Laughter is the most powerful transmitter in the open loop system. Of ALL emotional signals, smiles are the most contagious. We literally get "emotionally hijacked" by laughter. It is impossible to really fake laughter. In a neurological sense, it is the shortest distance between two brains. Most work-related laughter has nothing to do with jokes or pranks; it's a response to friendly interaction.

Emotions are highly intense, fleeting, and sometimes disruptive to work. Moods tend to be less intense and longer lasting and typically don't interfere with work, but the research shows that mild but prolonged anxiety (over three days) can decrease productivity. Good and bad moods perpetuate themselves and skew the employees' perception of the emotional climate of work.

Ever had a sour relationship with a boss or mentor that came home with you and disrupted sleep or eating habits? Let's talk about emotional hijacking! Negative emotions are the worst: chronic anger, anxiety, and a sense of futility. The most frequent cause of negative emotions at work is the relationship with the boss! (90% in Yale study). Distress erodes EI and decreases a person's ability to be empathetic.

The percentage of time people feel positive emotions at work turns out to be one of THE strongest predictors of work satisfaction. It directly correlates to attrition and retention. Put simply, leaders who spread bad moods are bad for business. Common sense holds that upbeat employees are more productive. For every 1% improvement in the service climate, there is a 2 % increase in revenue!

Overall, the climate, or how people feel about working at a company, can account for 20% to 30% of business performance. What drives climate? 50% to 70% of how employees perceive their organization's climate can be traced to the actions of one person: the leader.

Resonant leadership comes naturally to emotionally intelligent leaders. It is defined as synchronous vibration; to resound; the prolongation of sound by reflection. It is leadership with heart. Without heart, you may manage, but you cannot lead.

Dissonance, on the other hand, is an unpleasant, harsh sound; lack of harmony. The discordant leader produces groups that feel emotionally discordant. People have a sense of being continuously off key. A survey of 1,000 US workers revealed that 42% experienced incidences of yelling and verbal abuse at least once during the year.

The emotional toll of dissonance is toxicity. Toxicity results in emotional hijacking. The fight-or-flight response is triggered and people tune out or stonewall. Dissonance dispirits people and sends them packing. Leaders do not usually intend to create dissonance, but they lack the EI to change. The most important of these competencies is empathy. The great leader must have the intellect to grasp the specifics and challenges at hand (analytical thinking is critical). Intellect gets you in the door, but EMOTIONS ARE MORE POWERFUL THAN INTELLECT.

Why? The thinking brain evolved from the limbic brain, and it continues to take orders from it when we perceive a threat. The amygdala is the trigger point. It has worked for 10,000 years to help us survive. We face complex social realties with a brain that has been designed for physical emergencies. Hijacking occurs when we find ourselves swept away by anxiety or anger better suited for bodily threats. The signal goes from amygdala to the prefrontal area of the brain. It receives ALL information and decides what to do with it.

On the neurological superhighway, are you crashing or safely parked? The dialogue between the neurons in the emotional centers and the prefrontal areas orchestrates thoughts and feelings. Biologically speaking, the art of resonant leadership interweaves our intellect and emotions.

The four domains of emotional intelligence

1. Self-awareness: *Can I accurately identify my own emotions and tendencies as they happen?* The competencies are emotional self-awareness, accurate self-assessment, and self-confidence.
2. Self-management: *Can I manage my emotions and behavior to a positive outcome?* The competencies are self-control, transparency, adaptability, achievement orientation, initiative, and optimism.
3. Social awareness: *Can I accurately identify your emotions and tendencies as I interact with you?* The competencies are empathy, organizational awareness, and service orientation.
4. Relationship management: *Can I manage my interactions with others constructively and to a positive outcome?* The competencies are inspiration, influence, developing others, change catalyst, conflict management, and teamwork and collaboration.

Self-awareness

The research shows that the domains are closely intertwined and actually build on one another. A leader cannot manage his emotions if he has little or no awareness of them. If his emotions are out of control, his relationships suffer. Self-awareness facilitates empathy and self-management, and these two, in combination, allow effective relationship management. EI leadership builds up from a foundation of self-awareness.

Self-aware leaders understand their values and goals and dreams. They know where they are headed and why. They are attuned to "what feels right." More telling (but less visible) is a propensity for self-reflection and thoughtfulness.

Our guiding values are housed in the prefrontal area of the brain. What we like is easier to access, and what we loathe is least accessible. From a neurological standpoint, what keeps us moving toward our goals in life comes down to the mind's ability to remind us of how satisfied we will feel when we accomplish our goals. This capacity resides in the circuitry between the amygdala and the left prefrontal cortex.

Intuition or "gut" is self-awareness. Intuition works best when used with fact. Much of our learning in life comes from experiences of observation and feelings that we store in the basal ganglia (by the spinal cord), which is the most primitive part of our brains. You may feel like, "I just know it." YOU DO! Emotional intelligence offers a route to that knowledge.

Self-management

Self-management is the leader's primal challenge. From self-awareness flows self-management, the drive that all leaders need to achieve their goals. A brain scan of someone who is anxious shows high activity in the amygdala and the right side of the prefrontal area in particular. The emotional centers are driving or reverberating.

This high activity in the pre-frontal zone makes us fix our attention and obsess about our source of stress. The left side of the prefrontal area inhibits the neurons from the amygdala and so keeps us from being hijacked or captured by our stress. Self-management is the component of EI that keeps us from being a prisoner of our own feelings. It allows emotional clarity and concentrated energy that leadership requires. When we encounter others, we have "dueling amygdalas" that create either resonance or dissonance. Staying upbeat and enthusiastic is a learned CHOICE!

Empathy

Leaders with empathy are able to attune to a wide range of emotional signals, letting them sense the felt, but unspoken, emotions in a person or group. Much of this information is adapted from *Primal Leadership* by Goleman, Boyatzis & McKee, which we recommend if you'd like to delve into this topic further.

There is a business case to make for empathy. Of all the domains of emotional intelligence, it appears that social awareness may be the easiest to recognize. We have all felt the empathy of a coworker and recognized its impact, yet rarely in business is anyone recognized for his/her empathetic behavior. The word makes people uncomfortable in a business setting.

BUT empathy is critically important! It is the single most important competency to be an effective leader. It's not, "I'm OK, you're OK" mushiness. It does not mean feeling others' feelings and reacting how they want you to. It means taking the employees' feelings into thoughtful consideration and then making intelligent decisions that work those feelings you're your response.

When leaders can truly be responsive to others' feelings, they have another tool to guide the systems and stay on track. Empathy is the key to retaining talent. OF ALL THINGS UNDER CONTROL, climate is the main reason talented people leave a job, and take your knowledge with them!

Relationship management

The triad of self-awareness, self-management, and empathy all come together in this final component of emotional intelligence. Relationship management is the art of handling relationships begins with authenticity: acting from one's genuine feelings.

Friendliness with purpose moves people in the right direction because we know we cannot perform our jobs alone. Socially skilled leaders have a knack for finding common ground. It does NOT mean they socialize continually; it means they work under the assumption that nothing gets done alone. Relationship skills allow leaders to put EI to work, but the well-orchestrated use of leadership styles really sets great leaders apart.

Leadership styles in a nutshell

To help you further understand how to be a great leader, we'll talk about the six basic leadership styles: visionary, coaching, affiliative, democratic, pacesetting, and commanding. For each style, we'll cover how it builds resonance, the impact it has on the work climate, its positive aspects, and when it doesn't work.

Visionary

The visionary builds resonance by moving people toward shared dreams. The impact on the work climate is the most strongly positive out of all the styles. The visionary keeps people focused on the future, not the present. S/he is gifted at retaining employees and allows people to see and feel how they fit into the grand scheme of things and answers the "why" question every employee has.

What makes a visionary? Inspirational leadership is an emotional intelligence competency. You need self-awareness and self-confidence. Transparency is crucial. Empathy is the most crucial competency.

It's appropriate when changes require a new vision, or when a clear direction is needed. It works best to turn around a company or when the business is in need of a fresh start. It doesn't work when a leader is working with a team of experts, or peers who are more experienced than you are. In that case, you might be viewed as pompous and seen as out of step with the agenda at hand. Caveats aside, it's still a powerful style of leadership.

Coaching

The coach builds resonance by connecting what a person wants with the organization's goals. The impact on the climate is highly positive. It's appropriate when you need to help an employee improve performance by building long-term capabilities.

Coaching is the art of one-on-one interaction. Coaches focus on personal development, with the tasks at hand as tools for that development. They communicate general interest in people rather than tools that are needed to get the job done.

The coach helps staff identify unique weaknesses and strengths and connect them to personal and career aspirations. Coaches are great at delegating and developing peoples' stretch goals. They can tolerate short-term failure. They create a really positive mood in the work environment.

Coaches have well-developed emotional intelligence competencies of developing others, self-awareness, and empathy. This is great for employees who are motivated and want to be developed. It's not so great with employees who lack motivation or requires excessive feedback. When executed poorly, coaching looks and feels more like micro-managing and creates a lack of confidence, leading to a downward spiral in performance.

Affiliative

The affiliative leader builds resonance by creating harmony by connecting people to each other. The impact on the climate is positive. Affiliative leaders are relationship builders, with the ability to openly share their emotions or express how they feel. They place less emphasis on accomplishing tasks and more emphasis on how employees feel. They build loyalty and commitment to the company.

What makes an affiliative leader? They are great at collaborating. They promote harmony and foster interaction. Their key competencies are conflict management and empathy.

This style shouldn't be used alone. A leader who focuses on praise can allow poor performance to go uncorrected. Employees are left to figure things out on their own. This style is very powerful when combined with the visionary style. It's appropriate to use this style to heal rifts in a team, motivate during stressful times, strengthen connections, restore harmony, increase morale, improve communication, or repair broken trust.

Democratic

The democrat builds resonance by valuing people's input and getting commitment through participation. The democratic style can best be summed up by, "Let's talk it over." The democrat keeps morale high and builds a positive climate. The impact on the climate is positive.

What makes a democratic leader? Teamwork, collaboration, and conflict management are the critical competencies. Empathy is a key competency. These people are superb listeners.

It's appropriate to use this style to build buy-in or consensus, or to get valuable input from employees. This style works best when the leader is uncertain about what to do. It can help bring to the surface ideas to implement the vision. When overused, there are endless, intolerable meetings. It's not good when decisions need to be made quickly.

Pacesetting

The pacesetter builds resonance by meeting challenging and exciting goals. They tend to be very unclear about guidelines and expect people to "just know what to do." They can appear as if they don't care about people's feelings, resulting in a climate of dissonance. More often than not, this style poisons a climate and forces employees into survival mode, resulting in no innovative thinking and constricted talent. The impact on climate can be highly negative if execution is poor.

Pacesetters base their actions on their drive to achieve. They tend to excel at the technical aspects of their jobs, but feel disdain toward the cooperative bent that leadership demands.

Use this style sparingly. Used incorrectly, it leaves employees feeling pushed too hard. It works well with the passion of visionaries and team-building of affiliative leaders. It's appropriate when you need to get high-quality results from a motivated and competent team.

Commanding

The commander builds resonance by soothing fears by giving clear direction in an emergency. The style can best be summed up by, "Do it because I say so." Commanders demand immediate compliance without offering explanation. Their performance feedback is often focused ONLY on things that are wrong, which erodes people's sense of pride in their jobs and their self-confidence. The impact on the climate is highly negative if the style is misused.

This style lacks a critical tool that all leaders need: the ability to give people the sense that they fit into the grand scheme of things. These leaders do have the competencies of influence, drive for achievement, and initiative. Emotional self-control is the most critical competence if this style is to have any lasting, positive impact. The medical community is a breeding ground for this type of leadership. Many medically trained professionals do not know that there are other, more effective ways to get things done.

This style should be used only when a company is in crisis and/or employees need to be shocked into a new reality. It's appropriate to use it to kick-start a turnaround, or with problem employees.

Everyone has read accounts of leaders who have this style and have achieved success, but did they really? Usually people below them protect employees from their deficient emotional intelligence skills. When people have to work for these "SOB" bosses, they just don't. Talented people leave.

Learning how to be a great leader

You CAN learn the skills you need to be a great leader. Research shows that leaders can improve and DO improve, if they are willing. It is limbic learning, experiential. Because it happens at this primal level, the learning lasts a lifetime. Self-directed learning is defined as intentionally developing or strengthening an aspect of who you are or who you want to be, or both.

Self-learning involves five discoveries, each representing a discontinuity. The goal is to use each discovery as a tool to making the necessary changes to become more emotionally intelligent. The learning is recursive: The steps do not occur in an orderly way, but rather follow a sequence, with each step demanding different amounts of time and effort. This results in a sustainable transformation.

You have to ask yourself these questions:

Who is my ideal self? Who do I want to be? What do I want out of life and work?

The idea self is where change begins. You discover who you would like to be and what you want in your life and work. This development requires a deep reaching into your gut. You know you have touched it when you suddenly begin to feel passionate about the possibilities your life holds. When the gap between your ideal self and your work-imposed self becomes evident, the result is apathy or rebellion.

Who is my real self? How do I act? What are my strengths—where my ideal and real self overlap? What are my gaps—where my ideal and real self differ?

Are you a boiling frog? If you drop a frog into a pot of boiling water, it will instantly jump out, but if you place it in cool water and gradually raise the temperature to boil, it will stay in and boil! Leadership analogy: We settle into routine or allow small compromises for convenience. Inertia sets in.

Taking stock requires self-awareness. Take an inventory of your talents and passions: the person you actually are as a leader. Beware of self-delusion and vital lies. Use the 360-degree review to reveal blind spots. The people who do the review must interact with you on a regular basis, and you must reveal yourself to them.

What is my learning agenda? How do I build on my strengths while reducing gaps?

When we do see our blind spots, we tend to focus on those rather than strengths. Emphasis on gaps arouses right frontal cortex activity, which produces anxiety and defensiveness. For sustainable change, we need to focus on strengths first while reducing gaps.

Rather than a performance-improvement plan, make yourself a "Learning Agenda." The focus is on the possibility of change rather than rehabilitation. Goals should build on strengths, not focus on weaknesses. The goals must be your own and not be imposed by others. Learning goals should allow for preparing for future in different ways. They must be feasible, with manageable steps. They must suit your learning style.

How can I experiment with new behaviors, thoughts, and feelings?

Experimenting reconfigures the brain. You begin the process of experimentation when your agenda, and the steps leading up to it, have prepared you to focus your attention on what to do.

How can I practice the new behavior, building new neural pathways so that I can master the concepts?

You build new neurons or paths from the primal brain to the prefrontal area that shift from right to left. Improving EI takes months rather than days. Repetition and practice are vital.

How can I develop relationships that make change possible? How can I build trusting relationships with people like coaches, who help support and encourage me at each step during the process?

Leadership is intrinsically stressful, because we are trained to have the answers and are not keen on trying new approaches. Change leaders develop mentor relationships. The mentor must be more than a coach, and the relationship needs to be one of trust candor and support.

Action plan

- This week, I will:
- The outcome for me is:
- The outcome for the organization is:
- This month, I will:
- The outcome for me is:
- The outcome for the organization is:
- The outcome for the organization is:

Commando Conversations: Becoming Conflict-Competent

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Conflict brings out the flight-or-fight response in everyone. But once you understand the mechanics of conflict and how you can manage your own emotions before, during, and after conflict, it doesn't seem so scary. You'll learn why it's crucial to be conflict-competent and how to build the skills you need to stay calm, cool, and collected during tough conversations.

After participating in this session, you will be able to:

- Appreciate the importance of developing your skills in conflict competence
- Define the basic dynamics of conflict
- Identify your personal triggers and hot buttons
- Understand strategies to more effectively engage in conflict
- Avoid destructive methods of engaging in conflict

What is conflict?

Conflict is any situation in which people have *apparently* incompatible interests, goals, principles, or feelings. It is triggered by 1) precipitating events, where someone says or does something that causes us to believe that their interests, goals, principles, or feelings are incompatible with or threatening our own, and 2) hot buttons, which are situations or behaviors in others that tend to frustrate or irritate us enough to cause us to overreact.

There are two type of conflict: cognitive and affective. Cognitive conflict is focused on tasks and problem-solving and based on a seemingly incompatible difference of ideas. Arguments can be spirited, but the emotional tone remains neutral or even positive. It can lead to creativity, energy, higher productivity, and strengthened relationships. Affective conflict is when you are blaming people or proving the other person is wrong. People feel threatened, and it is typically associated with negative emotional tone and ongoing tension. It can lead to poorer morale, bad decision-making, and destroyed relationships.

The costs of conflict include

- Stress
- Wasted time
- Lowered morale
- Increased turnover
- Higher absenteeism
- Grievances
- Lawsuits
- Poisoned relationships
- Aggression
- Retaliation
- Harmed reputation
- Derailed careers
- Anger
- Fear
- Defensiveness
- Negativity
- Hurt
- Embarrassment

The benefits of conflict include

- Improved communication
- Open information sharing
- Vigorous creation of ideas
- Higher-quality decision-making
- Improved working relationships
- Innovative solutions
- Less stress, more fun!

What is conflict competence?

Conflict competence is the ability to develop and use cognitive, emotional, and behavioral skills that enhance productive outcomes of conflict while reducing the likelihood of escalation or harm.

The 10 truths of conflict competence are

1. Conflict is inevitable and can lead to positive or negative results depending on how it is handled.
2. While people generally see conflict as negative and prefer to avoid it, better results can emerge from engaging it constructively.
3. In order to overcome reluctance to address conflict, people need to believe it is important to do so, thus recognizing the tremendous value of managing conflict effectively.
4. Individual conflict competence involves developing cognitive, emotional, and behavioral skills that enable one to cool down, slow down, and engage conflict constructively.
5. Cognitive skills include developing self-awareness about one's current attitudes and responses to conflict and an understanding of conflict's basic dynamics.
6. Emotional skills include understanding one's emotional responses to conflict, regulating those responses to attain and maintain emotional balance, understanding and responding to the emotions of one's conflict partners, and, when necessary, slowing down to allow extra time to cool down.
7. Behavioral skills include engaging constructively by understanding others' perspectives, emotions, and needs; sharing one's own thoughts, feelings, and interests; collaborating to develop creative solutions to issues; and reaching out to get communications restarted when they have stalled.
8. Engaging constructively also involves reducing or eliminating the use of destructive behaviors characterized by fight-or-flight responses to conflict.
9. In team settings, conflict competence includes creating the right climate to support the use of the "cool down, slow down, and engage constructively" model among teammates so they can have open and honest discussion of issues. Creating the right climate includes developing trust and safety, promoting collaboration, and enhancing team emotional intelligence.
10. In organizational contexts, conflict competence involves creating a culture that supports the "cool down, slow down, and engage constructively" model. This includes aligning mission, policies, training programs, performance standards, and reward structures to reinforce the conflict competence model. It also includes creating integrated conflict-management systems to support these cultural changes.

How does a leader become conflict competent?

A conflict-competent leader must be able to self-diagnose and have a high degree of self-awareness in order to handle personal conflicts effectively. S/he must be an expert observer of others so evidence of conflict can be spotted early. S/he must be able and willing to intervene in the discussions of, coach, and influence those who are in conflict. A conflict-competent leader has the ultimate goal to build organizational conflict competence, where all team members are self-monitoring and conflict is viewed for its strategic value.

On your journey to becoming conflict competent, you will 1) develop your emotional response by building awareness of your own responses to conflict and your hot buttons/triggers, 2) develop your cognitive abilities by learning mental models and basic dynamics, and 3) develop your behavioral response by applying new skills: cool down, slow down, and engage constructively.

How do you currently respond to conflict? What are your hot buttons and triggers? Hot buttons or triggers are situations or behaviors which can hold an emotional charge. Once triggered, the person will attribute negative motives to other person, overreact, and set off the retaliatory cycle. There are several types of people who may push your buttons, create an overreaction, and potentially cause conflict. Some you might recognize are those who are: unreliable, overly analytical, unappreciative, aloof, micro-managing, self-centered, abrasive, untrustworthy, or hostile.

How do you regain emotional balance or "cool down"? Use these helpful tools:

- Reframe the situation, otherwise known as cognitive reappraisal. Examine the facts underlying a conflict for nonthreatening, alternative explanations.
- Be mindful by paying attention on purpose, in the present moment, and non-judgmentally to things as they are. Observe what you are feeling and thinking, rather than being caught up in the thoughts and feelings.
- Change your focus. Disrupt negative emotional reactions by breaking the mind's absorption on thoughts related to the conflict.
- Cultivate positive emotions. What brings you a deep sense of peace, contentment, and happiness? Use humor and laughter to foster a sense of gratitude. Think of what things inspire you and make you happy. Positive emotions have a cumulative effect, so reflect on these uplifting thoughts daily.

- Build your resilience. It takes time to recover from strong negative emotions. Decrease the time it takes you to recover from emotional hijacking by building your capacity to respond effectively. Focus on core concerns.
- Create positive emotions by focusing on the five core relational concerns common to all people:
    - Appreciation: acknowledge others
    - Affirmation: build connections
    - Autonomy: right to make own decisions
    - Status: acknowledge skills/talents
    - Role: define importance of each job
- Show respect. Use the Canadian Human Rights Commission Model, VALUED. This stand for Validate, Ask (open-ended questions), Listen (to test assumptions), Uncover interests, Explore options, Decide (on solutions).
- Slow down. When negative emotions are aroused in conflicts, we enter a refractory period, in which emotions hold sway over our rational mind. Take a time out to allow yourself extra time to apply some cooling-down techniques.
- Practice using constructive language. “I’m upset right now and need some time to cool down so I can listen to you with the attention you deserve.” “This is an important issue and deserves our full attention. I need a little while to reflect on this so that I can do it justice.”

What are the constructive responses to conflict?

Reaching out

Reaching out is an overt attempt to resume communications with one’s conflict partner once a conflict has arisen. Give an overt invitation. Intend to address emotional damage. Offer to take responsibility and apologize. Express interest in resolving the issue.

Perspective taking

Perspective taking means putting yourself in the other person's position and trying to understand that person's point of view. Listen for understanding. Focus only on the substance. Check for understanding and satisfaction. Focus on the other party’s emotions. Demonstrate empathy.

Expressing emotions

When you express emotions, talk honestly with the other person and express your thoughts and feelings. Become aware of your own feelings. Try transparency. Own your feelings. Contrary to a common misconception, effective expression of emotions, thoughts, and interests is a sign of strength, forthrightness, and honesty. Hiding thoughts and feelings is the appearance of dishonesty, which leads to mistrust, which prolongs conflict.

Creating solutions

In creating solutions, you brainstorm with the other person, ask questions, and try to create solutions to the problem. Be careful not to rush to solutions too quickly, which results in agreements that only superficially address the issue or satisfy only one partner. Use in combination with adapting and reflective thinking in order to generate collaborative outcomes.

Reflective thinking

When you think reflectively, you analyze the situation, weigh the pros and cons, and think about the best response. Notice your own reactions and reactions of others during conflict. Be aware of the immediate and ongoing impact of the conflict on oneself and all the other parties involved. Think through alternatives to responding to the conflict.

Before an impending conflict, ask yourself why you think the conflict is imminent. Is there something that can be done now to defuse the conflict? During a conflict, ask yourself if you have to respond now or if it can wait until you have time to reflect on the issues and potential solutions. Are emotions in control enough to continue conversing or do you all need some “cooling-off time”? Are your tone, body language, words, or stance contributing to the conflict? After a conflict, ask yourself what the primary issue was in the conflict and what alternative solutions existed. How well did you communicate during the conflict, and is there anything you wish you had done differently? Is there any follow-up you would like to initiate to reduce the impact of something you wish you hadn’t said? What can you do now to try to resolve the conflict and minimize any further damage?

Adapting

Adapting means staying flexible and trying to make the best of the situation. Have an optimistic mindset that views conflict as an inevitable part of the workplace (and life in general). Be willing to entertain a wide variety of alternatives for resolution. Be aware of changes or opportunities that signal the potential for engaging in problem-solving and conflict resolution.

Delay responding

When you delay responding, you wait things out, let matters settle down, or take a "time out" when emotions are running high. Cool down to regain emotional balance. Slow down or walk away. You must be accountable and committed to come back and engage with the conflict.

What are the destructive responses to conflict?

Winning at all costs

If you try as hard as you can to prevail in a conflict and argue vigorously for your own position, you are engaging in "winning at all costs." People who do this consistently run the risk of losing the opportunity for win-win solutions and tend to alienate the other person by appearing unreasonable and selfish.

Early in the conflict, identify your fundamental goals—what you *really* want or need. Learn the different between disposable, non-essential, and essential needs. Remind yourself that it is not "me against her," but "us against the problem." Look for an acceptable compromise and win-win solutions.

Displaying anger

Raising your voice or using harsh, angry, or aggressive words are signs of angry feelings. People who frequently display anger often escalate conflict, even causing fairly minor disagreements to become quite serious, which results in erosion of trust, teamwork, and open communication. People who display anger are also overlooked for promotions and raises because they are perceived as lacking impulse control and the skills needed to manage, motivate, and lead.

Your goal is to acknowledge the anger you feel and yet express it in a non-aggressive manner. Get to know yourself and your hot buttons better. Remind yourself that you are in control, and the anger will pass. Take a private moment with JUST yourself to rant, rave, scream and otherwise express how you are feeling. Begin sentences with "I" statements, practice asking for a time-out, and use the delay responding technique.

Demeaning others

This is the most destructive of all responses to conflict because it is hard to ignore when a person indicates contempt or disrespect for us personally. Contempt includes laughing, being sarcastic, rolling your eyes, talking while other people are talking, and directing comments toward someone's personality rather than their performance. It frequently escalates conflict and almost always leads to feelings of resentment, anger and hopelessness toward the person who acts this way.

Balance criticism with praise. Express appreciation for differing opinions and approaches. Attack the problem, not the person. Don't use sarcasm or cynical remarks. Ask for coaching and feedback from those you respect. Remind yourself: *My goal is to inform and encourage, not hurt or demoralize.*

Retaliating

Trying to get even, lying, one-upping, obstructing the other person, or getting revenge on him or her later is retaliation. This technique prolongs and escalates conflicts and gives the signal that you are not a team player, and that you do not accept the legitimacy of the initial outcome of the conflict.

Reflect on what the cost or impact has been, both personally and professionally, as a result of your past retaliatory behaviors. Remind yourself of your personal values, and try to depersonalize the conflict. Practice openly discussing your hurt, envy, or anger. Respond positively when faced with a conflict. Be the bigger person. Make the first move to stop the conflict cycle. Turn the other cheek. Show respect for, and if necessary, forgive the other person.

Avoiding

You are avoiding if you are trying to keep your distance from the other person, or acting distant or aloof, or ignoring the problem all together. This technique prolongs and escalates conflict and shows that you are not a team player or a good leader. It contributes to dysfunctional culture and contributes to good people walking out the door.

To tackle this problem strategy, feel the fear and take action anyway. Envision what you want and remember why taking action is necessary. Start small and then continue your progress by addressing more easily-resolved issues first, then work up to more complicated ones. Make a public commitment to take action.

Yielding

Giving in to the other person in order to avoid further conflict, or doing what the other person wants just to make life easier or end an argument is yielding behavior. While the conflict appears to be resolved on the surface, the underlying causes often will not be addressed, and are likely to recur. A person who frequently yields is then less effective on those occasions when it *is* necessary to work hard to defend one's position.

Why do you yield? Remember that a productive relationship based on direct communication will benefit all concerned. Prepare for difficult conversations by planning how you can state your needs and wants. Push yourself to be the one to come up with solutions. Remind yourself to be persistent.

Hiding emotions

Are you concealing your true emotions about a situation from the other party? While there are times when it is helpful not to express every emotional response you have, frequently hiding your emotions becomes destructive, because it deprives the other person of useful information about how you really feel. Thus it decreases the likelihood that you will reach a truly mutually satisfactory agreement. It leads to mistrust because your verbals and non-verbals are inconsistent.

Avoid one-word answers like, "Fine." Use "I" statements and describe your emotional state. Be calm, not out of control. Practice feeling your emotions bodily and describing the experience to friends or family members you trust. Practice expressing emotions in

the mirror so you can see how your non-verbals change with each emotion. Practice explaining your emotional state in an informative and professional way that casts no blame. Remind yourself that how you feel is *important* to the conflict-resolution process.

Self-criticizing

You are self-criticizing if you are reflecting over and over on the situation and about things you wish you'd done or said and telling yourself you could have handled things better. Honest self-appraisal is good, but overly negative evaluations of self can produce negative emotions and feelings of helplessness that impair your judgment, as well as affect your behavior and health.

It perpetuates conflict by continually attempting to solve it “perfectly.”

Seek feedback from trusted co-workers and friends. Compare your self-appraisal with those offered by others. Commit to bring your self-appraisal more in line with others. Reflect: Why do you *choose* to beat yourself up? Which situations trigger your self-criticisms? Avoid linking your self-image to the conflict, and quit taking it personally. *I'm a work in progress, and that's enough for today.*

How conflict competent do you want to be?

Action plan

- This week, I will:
- The outcome for me is:
- The outcome for the organization is:
- This month, I will:
- The outcome for me is:
- The outcome for the organization is:
- The outcome for the organization is:

How to Build a Conflict-Competent Team

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Is it every person for himself or herself at your practice? Working in teams can be a much more efficient way to get things done. Learn how to build teams from the ground up and keep them running smoothly.

After this session, you will be better able to:

- Design teams by analyzing required tasks and assigning the appropriate people to those tasks
- Identify roles for each team member
- Define the process for team interaction
- Optimize team performance and deal with performance problems

There are three major considerations for building a team: the tasks, the people, and the relationships. We'll cover each of those in turn.

The material for this presentation is from *Making the Team: A guide for Managers* by Leigh Thompson. We reference the chapters titled, "Building the Team: Tasks, People, and Relationships" and "Performance and Productivity: Team Performance Criteria and Threats to Productivity."

Phase I: Tasks

The first step in building a good team is to analyze the work that needs to be done:

- What work needs to be performed?
- How much authority does the group have over its own work?
- What is the focus of the work?
- What is the degree of interdependence in the team?
- One solution or several possible solutions?
- Are the team members' interests aligned?

When the team has more authority, there is more involvement and motivation, the manager has less control, and the teams' objectives may not be aligned with those of the larger organization.

Focus of work

Broad Objective	Dominant Feature	Process Emphasis	Threats
Tactical, e.g. surgery, military	Clarity	Focused objectives Role clarity Well-defined operational standards Accuracy	Role ambiguity Lack of training Communication barriers
Problem-Solving, e.g. disease control	Trust	Focus on issues Separate people from problem Consider facts, not opinions Conduct thorough investigation Suspend judgment	Failure to stick to facts Fixate on solutions Succumb to political pressures Confirmatory information search
Creative, e.g. HBO	Autonomy	Explore possibilities and alternatives	Production blocking "Lumpy" participation

There are several degrees of task interdependence. With pooled interdependence, group members work independently and then pool their work (e.g., department store). With sequential interdependence, there is a classic assembly line or division of labor. Those down the line are more dependent on others (e.g., a car manufacturer). Reciprocal interdependence is the highest level of interdependence. Every member is dependent on others at all levels (e.g., a rowing team).

Is there one solution or several possible solutions? A demonstrable task has one correct solution (e.g., building a house conforming to a blueprint). A non-demonstrable task has no single best answer (e.g., a consulting team). There is a chance of considerable disagreement if the indices of performance are not decided.

Are the team members' interests aligned, and how are they compensated? A mix of cooperative and competitive interests works best, where there is an incentive to work with one another and compete with others. In this case, there should be rewards for both individual and team performance.

Phase II: People

The second step in building a good team is to analyze the people:

- How many people should be on the team?
- Who is ideally suited to do the work?
- What skills are required?
- What type and level of diversity is optimal in the team?

Pick the right number of people for the team. Managers seem to have an overstaffing bias, and smaller teams are rare. But they tend to work harder on a wider variety of tasks. They assume more responsibility for team performance. Oversize teams, though are less cohesive. Members are more self-conscious and avoid serious topics with frivolous conversation. In addition, the equality of member participation decreases. Managers seriously underestimate how coordination problems multiply when team members are added.

How do you know who is ideally suited to do the work? The more you know about the task, the better you suit people to it. Does it require technical or functional expertise? Task-management skills? Interpersonal skills?A well-rounded team member is a statistical rarity. Rely onelf-reports, past accomplishments, and 360-degree reports to determine how well suited a person is to a particular task.

What type and level of diversity is optimal in the team? Diversity is beyond gender, race, or disabilities. You need diversity in terms of functional skills. The advantages of a diversified team include multiple viewpoints and better decision-making, which gives you a competitive advantage.

What do you diversify based on? Social category (age, sex, race)? This isn't very constructive. Informational diversity (education, work experience)? These team members debate constructively. Values diversity (work values, goals)? They are likely to engage in destructive conflicts.

How much diversity? If the team is too diverse, it's difficult to get anything done. We experience some level of interpersonal congruence, which is the degree to which we see ourselves as others see us. Usually, the more diverse the group, the conflict there is. There is task conflict (due to different functional backgrounds) and emotional conflict (due to race, age). A person who is the only member of his/her social category feels isolated and may experience role entrapment.

Phase III: Relationships

The third step in building a good team is to analyze the relationships:

- How do team members socialize with each other?
- What roles are negotiated among team members?
- Which norms are conducive/harmful?
- Is cohesion in the team important?
- How is trust developed, threatened, and rebuilt among the team members?

When there is a newcomer in the team, everyone completes an evaluation—a cost-benefit analysis, as it were. Teams evaluate the newcomer and vice versa. Is the new person beneficial to the team? Is the team beneficial to the new person? How committed is the individual to the group and the group to the individual?

Everyone goes through a role transition from nonmember to quasi member to full member. Once on the team, each member has a role. Roles and negotiations are not explicitly talked about. Rather, people engage in actions designed to take on that role, which are accepted/rejected by others. Task masters take the role of managing the team in terms of the work to be done. They are the team leaders. Others take on the role of socio-emotional master. This person's focus is on satisfying the emotional needs of the team. S/he manages the people aspects of a team and restores harmony and cohesion.

Status systems develop within minutes after teams are formed. There is a process by which people acquire authority to be the task master or the socio-emotional master. Team members intuitively take note of one another's personal qualities that they think are indicative of ability. Real status characteristics are qualities relevant to task at hand, e.g., experience. Pseudo status characteristics are factors like sex, age, ethnicity, and cultural background.

Team norms are not the same as rules. Norms make it easier for people to respond appropriately under new or stressful conditions. Norms add structure to the team. They reduce threats to productivity. Norms are left to natural processes and interaction patterns. The disruptive, least self-conscious people set unfavorable norms. Team Norms

At times, norms may also be in conflict. Something that is right in one department may not be so in another. What happens when someone regularly breaks norms? Try to correct them for a long period, else practices like ostracism persist. Long-term habits of breaking the norms are detrimental to both organization and the individual.

In terms of cohesion, the relationship between team cohesion and performance is primarily correlational rather than causal. Cohesion is also known as solidarity, morale, community, and fellowship. It is a crucial ingredient for team viability. Cohesive behaviors include: showing signs of mutual affection, displaying coordinated patterns of behavior, giving enough credit to team members, and participating in team activities.

Trust is confidence one person places in another that the other will honor all commitments. Not everything can be covered in a contract, so we need trust. There are different types of trust, including incentive-based trust (e.g., bonuses), trust based on familiarity, trust based on similarity (e.g., alumni of the same school), and trust based on social networks.

Implicit trust is trust in others in the absence of any rational reason or obvious similarity. We attend to some subtle signals in a social interaction, and we are not aware of their influence. Examples are flattery, instant attitudes (intense likes or dislikes for a novel object), mere exposure ("He grew on me."), schmoozing ("Let's have lunch sometime."), and mirroring, called "social contagion." This is copying one another's posture, facial expression, tone of voice, and mannerisms.

Team performance criteria

There are essential conditions for team success. Team members must:

- Bring adequate knowledge and skill to bear on the task
- Exert sufficient motivation and skill
- Coordinate activities and communication

In terms of knowledge and skill, the person must have average cognitive ability, interpersonal skills, and decision-making skills. Interpersonal skills include openness and self-disclosure, knowledge of each other, ability to predict other's reactions and responses, and capacity for conflict and evaluation.

Coordination is the combined synchronization of all strategies of team members. Coordination problems increase with team size. We recommend single-digit teams. Have an agenda. Train team members together. Practice. Minimize links in communication. Set clear performance standards.

Here's a team performance equation you can use:

- AP = PP + S: T
    - AP = Actual Productivity
    - PP = Potential Productivity
    - S = Synergy
    - T = Performance Threats

There are four factors to consider when analyzing the performance of your team: productivity, cohesion, learning, and integration.

Productivity

- Does the team have a clear goal?
- Which objective performance measures will be used to evaluate results?
- Who are the legitimate clients of the team?
- Under what conditions should the goal change?
- What sources of information should the team consider to assess whether the initial goal should be changed?

Cohesion

- Does the team enjoy working together?
- What conditions could lead to feelings of resentment?
- What conditions could prevent team members from working together in the future?
- How are team members expected to accommodate to changes, such as additions to team, growth, and turnover?

Learning

- How can team members best learn from one another?
- Do the individual team members grow and develop as a result of team experience?
- Do team members have a chance to improve their skills or affirm themselves?
- What factors and conditions could block personal growth?
- Are individuals' growth needs understood and shared by group members?

Integration

- How does the team benefit the larger organization?
- Are the team's goals consistent with those of larger organization?
- What other groups, departments, and units are affected by the team?
- What steps has the team taken to integrate its activities with those of others?

Action plan

- This week, I will:
- The outcome for me is:
- The outcome for the organization is:

- This month, I will:
- The outcome for me is:
- The outcome for the organization is:
- The outcome for the organization is:

Leaders or Managers: What's the Difference?

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Most employees want to say they have "the greatest boss in the world," but most do not. Bad bosses are the number-one reason employees leave organizations. There is an abundance of literature and many studies about the qualities of great bosses and the differences between managers and leaders. Veterinary medicine does not create good bosses.

After this session you will be better able to:

- Identify key skills needed to be a great manager
- Appreciate the need to coach employees according to their unique learning styles and strengths
- Handle employees' failures and coach them up or out of your organization

What do good bosses do? There is one outstanding characteristic: All great managers have the ability to discover what is unique about each person and capitalize on it.

Average managers play checkers; great managers play chess. In checkers:

- All the pieces are uniform and move in the same way.
- There is a need to plan moves, but all the players move at the same pace and on the same path.

In chess:

- Each piece moves in a different way, and you can't play unless you know how each piece moves.
- You won't win unless you put considerable forethought into how the pieces move IN ADVANCE.

Are you a leader or a manager?

A manager

- Turns one person's talent into performance.
- Succeeds only when they can identify and develop the differences in people.
- Challenges each person to excel in his/her own way.

A leader

- Discovers what is universal and capitalize on it.
- Cuts through differences and focus on the needs that we all share.

Great managers are quick to capitalize on the unique strengths of employees, because it's cost effective and a time saver. He/she will capitalize on strengths because it makes people need one another.

Great managers will introduce a healthy degree of disruption to your practice. They will:

- Shuffle existing hierarchies.
- Shuffle assumptions about who can do what.
- Shuffle existing beliefs about where true expertise lies.

Great managers do these things because they can't help it! They are astute about managing the needs of people.

Perhaps you are experiencing the classic symptoms of "No Team." After months of training and coaching your team to better performance, you're not seeing results. Meetings are a rehash of all the same things. You seem to get new hires that look just like the old hires. To get new results, change the management!

Identify each employee's unique talents and help them use those qualities to excel. Embrace eccentricities. Emphasize that the company's culture appreciates differences. Celebrate the uniqueness of each employee.

Use these three tactics

- CONTINUOUSLY tweak roles to capitalize on individual strengths.
- Pull the triggers that activate employee's strengths.
- Tailor coaching to the individual's learning style.

The benefits of this management are

- You save time.
- The team takes ownership for improving their skills.
- The team learns to value differences.

Capitalizing on individual strengths

How do you identify your employees' strengths? Ask questions and observe.

- What do they like the best about their jobs?
- Which tasks do they look forward to, and which tasks do they avoid?

- Ask them, “What was the best day you had at work in the last three months?”
- Listen for activities they find intrinsically satisfying.

Weakness doesn’t mean lack of skill. It can be any task that drains your energy or is an activity that when you start it, all you can think about is stopping.

- Ask, “What is the worst day you have had in the last three months?”

For the purpose of this management task, we want to downplay discussions of weakness. Offer training to help them overcome shortcomings stemming from lack of skills or knowledge. Find the employee a mentor/partner with complementary talents. Think about the mechanics of your business and reconfigure work arrangements. Don’t be afraid to be unconventional.

Self-awareness vs. self-assurance

Do we want an employees armed with the knowledge of their limitations, or do we want them to be confident in their abilities? Focus on strengths. In other words, people get more reward from knowing they are doing a job well than from understanding what parts of the job they are weak at.

Some would argue that employees can get too confident. Perhaps, but It is the manager’s job to simultaneously communicate the importance of employees’ tasks and the real complexity of the obstacles that they will need to overcome to be successful.

Your objective is to create a state of mind in the employee—a realistic assessment of the obstacles and difficulties associated with the goal combined with the confidence to take the goal on (optimism.)

When an employee fails, unless the failure is attributable to factors beyond the employee’s control, they must accept that failure was lack of effort on their part (psychological pressure.)

This obscures self-doubt. It is not that you are not capable, but perhaps it is because
you didn’t develop enough skills or you didn’t try hard enough. If there is repeated failure, apply more training if it is lack of knowledge or skill. If the employee does not respond, it is because s/he does not possess the talent or skill to do the job. Manage around their weakness to neutralize it, but don’t keep exposing them to failure.

- Find them a partner/mentor that is strong where they are weak.
- Rearrange the employee’s work world to render the weakness irrelevant.
- Use “triggers.”
    - Time of day?
    - Night or day strengths?
    - Time with boss? A little or a lot?

The most powerful trigger is recognition.

Activating employee strengths

Source of recognition

- Peers
- The boss
- Others with similar experience
- Clients

Type of feedback

- Publicly celebrate achievements.
- Tell them privately, but vividly, why they are such valuable team members.
- Give them professional/ technical awards.
- Take photos of them and the “best” clients.

Coach to the learning style

- If their learning style is:
    - Analyzer: Requires extensive information before accepting a task; hates making mistakes.
- Coach them by:
    - Spend ample training time, role play, give them time to prepare for challenges.
- If their learning style is:
    - Doer: Uses trial and error to enhance skills while grappling with tasks.
- Coach them by:
    - Assign simple tasks, explain desired outcome, then get out of the way. Gradually increase the complexity of tasks to be assigned.
- If their learning style is:
    - Watcher: Hones skills by watching other people in action.

- Coach them by:
    - Have them shadow top performers.

The art of success

At the heart of a great manager's success is the ability to appreciate individuality. But great managers need other skills as well:

- Hire well.
- Set expectations.
- Instinctively interact with others in a productive fashion.

Great managers vs. mediocre managers

Mediocre managers hope (or assume) that all of their employees will be motivated by the same things and driven by the same goals. They define behaviors and tell employees to work on skills that don't come naturally. They encourage sameness and view their job as transformation rather than development.

Great managers "play chess." They define expectations and outcomes. They encourage individuality and don't try to change a person's style. They know their employees will differ in how they think, how they build relationships, how altruistic they are, how patient they can be, how much of an expert they need to be, how prepared they need to be, what challenges them, what drives them, and what their goals are (whew!!)

Differences in traits and talents are like blood types. They cut across superficial variations of race, sex, and age and capture each person's uniqueness. Like blood types, these traits of people are enduring and resistant to change.

Your most precious resource is time. Why waste it pushing a rock up a hill? Great management is about the RELEASE of talent and skill, not the transformation. It is about constantly tweaking the environment to allow the employees' unique contributions and styles to develop. Success as a manager depends almost entirely on your ability to do this.

Action plan

- This week, I will:
- The outcome for me is:
- The outcome for the organization is:
- This month, I will:
- The outcome for me is:
- The outcome for the organization is:
- The outcome for the organization is:

How to Rally Your Associates to be Practice Leaders

Shawn McVey, MA, MSW
McVey Management Solutions
Austin, TX

Are you prepared to take the step from manager to leader? Learn how to define your daily tasks as leadership or management, recognize what success in both management and leadership looks like, and understand the leadership drivers you'll need in order to successfully fulfill your role as an administrator.

After attending this session, you will be able to:

- Define your daily tasks as leadership or management
- Recognize what success in both management and leadership looks like
- Understand the leadership drivers required in order to successfully fulfill your role in an administrative position

This material is adapted from the following sources: Peter Stephenson's Naked Leadership, Executive Coaching, and The Bulletproof Executive; Daniel Goleman's Emotional Intelligence and Understanding Emotional Intelligence; Muriel Solomon's Working with Difficult People; and Richard Kock's Managing without Management.

What are the differences between managers and leaders?

A manager is more directive and controlling. He measures, assesses, implements, and focuses on the status quo. A leader is more motivating and empowering. He coaches, listens, creates a vision, and focuses on change. When times are tough, leaders prove themselves by taking risks, taking initiative, acting decisively, and communicating effectively. They ARE the good example.

If you recognize that you're more of a manager and would like to become more of a leader, try these tactics: Share good news. Establish small, achievable goals. Articulate the big picture. Give emotional support. Verify that employees have the right tools. Keep people informed.

People who run veterinary hospitals are usually defined by how well they do four things: create an agenda, develop a human network to achieve the agenda, implement, and achieve outcomes. We'll talk about those four aspects of leadership in more detail.

When it comes to creating an agenda, managers plan and budget, establish detailed steps and time-saving tables to achieve results, and allocate necessary resources to make it happen. Leaders establish direction, develop a vision for the future, and develop strategies for producing the changes needed to achieve the vision.

When developing a human network, managers organize and staff. They establish a structure to accomplish a plan. They delegate work as necessary, provide policies and procedures to help, and create systems to monitor the plan. Leaders align people, communicate by words and deeds to all whose cooperation is needed, and create teams that understand and accept the vision and strategies.

To implement, managers control and solve problems. They monitor results vs. the plan in detail and identify deviations in the plan and organize to resolve them. Leaders motivate and inspire. They energize people to overcome barriers to change (political, bureaucratic and resource) by satisfying basic but unmet human needs.

To achieve outcomes, managers produce predictability, order, and consistent key results. Leaders initiate change in order to achieve outcomes, which is often dramatic and very useful.

Overall, managerial culture emphasizes control and rationality. A manager is a problem-solver who is usually neither genius nor heroic. She is rather persistent, tough-minded, and analytical. She is willing to work hard, be tolerant, and express goodwill.

Managers adapt impersonal, passive attitudes toward goals. Goals are derived out of necessity and a business plan. Leaders are driven to change attitudes and influence the way that people think about possibilities.

Managers view work as an enabling and educational process. To get people to accept solutions to problems, they must coordinate and balance opposing views. A manager's need to control and feel safe overrides the desire to be a risk-taker.

Leaders develop fresh approaches to long-standing problems and bring up new options. They project images of success. They help people visualize change. Leaders work from high-risk places, as they are addicted to excitement.

What are the warning signs that the job is too much for you?

IQ is necessary. EQ is enhancing. It's a proven fact that all the attributes of the information age, along with superior EQ, produce superior results. A leader must leverage people and teams to the fullest extent possible and see human beings as human beings rather than as physical assets.

Can you run the practice?

- WARNING SIGNS:
    - You are in too many meetings and involved in too many tactical/operations decisions.
    - There are too many days when you feel you have lost control of your time.

This problem happens because the sheer volume and intensity of demands catch you by surprise. You may also lack sufficient time-management skills. You also mourn the loss of being close to the patients and clients. And perhaps you weren't prepared for the paradox of having to let go and let others be in control.

You have to realize that you can't monitor everything. Learn how to shift your influence from direct to indirect. Articulate and communicate a clear and simple strategy for where the business is headed. Institutionalize rigorous structures and processes to guide, inform, and reward. It's your job to select and manage key talent.

Are you too involved?

- WARNING SIGNS
    - You have become the bottleneck.
    - Staff is overly inclined to consult you before they act.
    - People start using your name to endorse ideas: "Shawn says…"

You may get stuck in this rut because your direction and vision are unclear. There's no clearly articulated plan, and the roles are unclear. Regardless, you have to realize that giving orders is very costly.

What happens when you do it? You trigger resentment and defensiveness. Second-guessing demoralizes your staff. In fact, decisions should not come to you until every other path has been exhausted.

Do you know what's going on?

- WARNING SIGNS
    - You keep hearing things that surprise you.
    - You learn about events after the fact.
    - You hear concern and dissenting views through the grapevine rather than directly.

This happens because information is almost always filtered when it gets to you. Former peers and subordinates are on guard because you influence careers. People naturally protect themselves from consequences.

What to do? Seek outside feedback and counsel. Hold informal meetings with employees. Seek information from front-line employees. Ask a lot of questions!

Are you sending the right message?

- WARNING SIGNS
    - Employees circulate stories about your behavior that magnify or distort reality.
    - People around you act in ways that indicate they are trying to anticipate your likes and dislikes.

Everyone in the practice watches and judges your every move. What to do? Avoid speculative discussions with employees. Learn about the signals that you send. Strive for consistent and simple messages.

Are you the boss?

- WARNING SIGNS
    - You don't know where you stand with the owners or the Board members.
    - Roles and responsibilities of the directors/owners and management are not clear.
    - Management meetings are limited to reporting on results and management decisions.

It sucks to be you. Really, now you have multiple bosses, not just one. You are personally accountable, and your boss is not your friend. You have to move into your new role with grace.

Are you keeping your head?

- WARNING SIGNS
    - You give interviews about you, rather than the practice.
    - You have few, if any, activities that are not connected to the business.
    - Your lifestyle is more lavish or extravagant than that of other leaders in the business.

This problem happens because of the attention and admiration that come with the job, which makes introspection difficult. Everyone said the job was much harder than they thought it was going to be. Personal and family responses change.

What to do? Make an effort to stay humble. Manage organizational context rather than focusing on day-to-day operations. Set the tone and define practice culture through behavior and actions. Remember that position does not guarantee the right to lead. Maintain your moral compass.

The five tasks of a leader

There are five tasks that an effective leader has down cold:

1. Influencing
2. Synergizing
3. Enabling
4. Energizing
5. Trusting

Influencing means attaining results with people outside your direct control. To do this, you have to sell yourself, build networks, create your own goals, hone your time-management skills, and perform like a champ in meetings and during presentations.

Synergizing means attaining superior results with peers. You need the ability to choose effective players and set up effective teams. It also involves maximizing the power of interpersonal relationships, using your conflict-resolution skills, and leading across the organization.

Enabling means attaining superior results with people for whom we are responsible. You manage, coach, motivate, and delegate. You also are a master of systems and processes.

Energizing involves recognizing job fit for all team members and managing talent. You recognize emotional currents and respond to redirect them. You attract and retain employees.

You also adopt and advise about appropriate coping mechanisms when human needs are not met.

Trusting is attaining superior results by getting people to believe in the reliability of the organization. You set the example with consistent behavior and stay in alignment with vision and values. You are the change manager. Trust is the quintessence of leadership.

The myths and truths of leadership

You don't have to be the point person! In fact, it's a balance of leading and managing. It's not about leading direct reports. It's about leading the people around you. You don't have to use the latest management techniques, because leadership is about you in action. You need emotional intelligence as well as book smarts. And leadership is not about a long list of skills; it's about five key activities, achieved through competencies.

Influencing myths and truths

It's a myth that the power is all at the top and it's all about what you know. Power is anywhere, and you better know who has it. It's about what you know, as well as who you know!

You can't just wing it at meetings, telling stories and making it all about content. In fact, you have to ask astute questions and be an active listener. You need to place as much emphasis on process as on content.

Don't hide! If you are not selling your organization externally, you may be viewed as just a cost. It's easier to spend time with lower-level allies. Get to know high-yield allies. If you can't run a meeting, remember that God gave you two ears and one mouth. Use them proportionally. If you can't write well, why would anyone read your work? How you come across is more important than what you know.

Synergizing myths and truths

It's a myth that your direct reports are most important. You have to be a team player with peers as well. You may think you know how you come across because you know yourself. In fact, you come across differently than you think, especially when you are under pressure. It's a myth that the best teams are teams who get along well. There is a broad range of styles, and there will be some conflict. To synergize, you may think you need to avoid conflict. The truth is that you must manage conflict, and manage it well. Lastly, planning is not about strategy then structure. It's about leveraging people.

Don't hide! You must have functional groups and teamwork. The best way to have effective relationships is to communicate in a way that relates to the operating style of the team member. Behavioral flexibility is the key. If the team processes don't work, neither will your team. You will lose good people, hire good people, and develop good people. It's all about good people. Continuous improvement requires continuous coaching.

Enabling myths and truths

Rather than focusing on quarterly results, you need to focus on the outside environment as well. Otherwise, you will not be around to report on quarterly results. Though it's important to keep employees informed, you also need to hear from them and actively listen to their concerns. You may think that people can only motivate themselves, but leaders and organizations are the key motivators.

Some leaders come from a strong attitude of, "Never abdicate." The truth is that abdication and direction are powerful tools. Another myth is that personal accountability is all about taking it and working with it for results. Reporting on results is just as important. Celebrate success and effect remedies. Lastly, a consistent leadership style is not what's best. Your leadership style needs to flex.

Don't hide! If your antenna is up, you will get reception. Poor delegation is one of the greatest causes of bottlenecks, low morale, and poor productivity. It is also the greatest opportunity. Don't hide from personal accountability, and don't let others hide, either. Vary your coaching approaches, but above all, coach.

Energizing myths and truths

It's a myth that job fit is all about individuals fitting the job. It is equally about the organization fitting the individuals. If you think that self-motivation is a given, think again. The culture can make or break motivation. Good talent does not care of itself. If you don't manage your talent, it will go elsewhere. Talent management is not all about fast promotion. You need to provide continuous development in a stimulating environment. Career management is not solely the individual's responsibility. Leave it to them, and they will manage their careers elsewhere.

Don’t hide! Seek and deliver strong job fit. If you are overly stressed, is it within your control to do something about it? Confront the career stage you and others are in and develop plans to move each person forward. Avoid slash-and-burn hiring and firing scenarios. Be candid in your review process. Talent management should receive just as much attention as the client base.

Trusting myths and truths

Agreeing on and articulating values is the most difficult part, right? Wrong. Making values real and upholding them is the biggest challenge. And it’s not just executives who should lead the business. All employees can lead the business. It’s a myth that change management requires charisma. Change management requires adaptability, compromise, resilience, and two-way communication.

It’s a common misperception that if you restructure, you will cut costs and improve the bottom line. If you restructure and do it well, you MAY improve the bottom line. Staff morale after restructuring is not the biggest problem. Poor leadership at times of change is the biggest problem.

Don’t hide! Employees will give their all only if they trust you. Always walk the talk of the vision and values. In times of change, the leader needs to be more visible.

Action plan

- This week, I will:
- The outcome for me is:
- The outcome for the organization is:
- This month, I will:
- The outcome for me is:
- The outcome for the organization is:
- The outcome for the organization is:

Stop the Price War and Show Value to Clients (Parts 1 & 2)

Mark Opperman, BS, CVPM and Sheila Grosdidier, BS, RVT
Veterinary Management Consultants
Evergreen, CO

What is "perception of value?"

1. The "Three Minute Syndrome"
2. Internet Reviews Online - Is there a review posted about your practice?
3. How is "Perception of Value" Measured?
4. What Effect Does It Have on Your Practice?

How do clients determine a practice's "perception of value?"

Value = Benefit / Price

Let's put ourselves in our clients' shoes and try to determine our practice's "perception of value"

The initial contact

- Telephone
  - Message on hold
  - Telephone etiquette
- In person

The initial impression

- Signage
- Outside Physical Environment
  - Building appearance
    - Your entrance-way
  - Parking lot
  - Landscaping
- Marriott versus Motel 6
- Entering the Reception Area
  - Appearance of reception room
  - Cleanliness, odor control
  - Comfort of seating
  - Distractions - ease of managing one's pet
  - Background music
  - Condition and age of magazines and client education material
  - Posters and informational wall hangings affixed to the wall
- The Receptionist: The first and most important contact
  - How was the client greeted?
    - Smile; Use of pet's name; Knowledge of what services the client needs
      - How well do our receptionists present themselves?
        - Professional, Knowledgeable & Informative, Uniforms & Name Badges, Organized or Disorganized, Handling of stressful situations
      - I can't find the medical record!
        - Paper Files vs. Electronic Files
        - New Client Form
        - Writing Tablets
- The Wait: constructive or destructive time?
  - How long is too long? _____
    - Communication with the client
  - Appointments kept on schedule
    - Ten Minute Flex Scheduling
    - "E" Slots
    - Discharge Appointments
  - Effectively utilizing this time

- Educational CDs, DVDs or video tapes
- Client handouts
- Exam Room Technicians

Technician Appointments	10 Minute	20 Minute	30 Minute	40 Minute
Nail Trims	Recheck Appointments Seen Within Past 30 Days	Canine/Feline Annual Visits —Under 6 Years Old—	Canine/Feline Annual Visits —6 Years or Older—	New Puppy or Kitten Visit
Blood Draws Only	Nail Trims with Doctor	Check Paw, Minor Medical Problem, Etc.	New Pet Visit —1 Year or Older—	ALL Exotics Visits
SQ Fluids	Anal Gland Expression with Doctor	Health Certificate / Exam	Check Ears or Check Skin (Itching), Allergies	Skin Lesions, Ear & Skin Problems, Bad Allergies
Suture Removals	Microchipping Only with Doctor	Soft Paws Applications	Check limping or Check lump	
Anal Gland Expression	2nd Bordetella Vaccination	Six Month Exam	ADR or Vomitting, Diarrhea, Not Eating, Etc.	
Microchipping Only	2nd Lyme Vaccination		Most Medical Problems	
			Animals Starting Allergens	

The office visit

- Escorted to the exam room
- Greeted by doctor or exam room technician
- Appearance of exam room
    - Distractions
- Appearance of doctor and staff
- The “ideal” out-patient office visit
    - Greeting
    - Overview of visit
    - Special touches
    - What else needs to be handled?
    - Client needs communicated to doctor
    - Physical exam
    - Review & recommendations
- Doctor’s “bed side manner”
    - Body language
    - Quality of time spent
    - Handling of patient
    - Communicative ability
    - Treatment of patient
    - Use of paraprofessional staff
    - To treat or not treat in the exam room
    - Concluding the visit
- Eight steps to a successful exam room visit
    - Introduction
    - Talk to and touch the pet
    - Do something

- Say something
- Show something
- Give them something
- Listen
- End on a positive note

The exit

1. Processing paper work
2. Filling prescriptions
3. Handling of payment
4. Answering questions

ABC Veterinary Hospital

Insert Logo Here

NEW CLIENT FORM

Thank you for giving us the opportunity to care for your pet(s).
So that we may become better acquainted, please complete the following:

CLIENT INFORMATION Date _____

Name _____ Spouse's Name _____

Address _____ City _____ State _____ Zip _____

Phone _____ Work Phone _____ Spouse's Work Phone _____

Place Of Employment _____ Best Time To Reach You _____

Driver's License # _____ Social Security # _____ E-Mail Address _____

All Fees Are Due At The Time Services Are Rendered

Please indicate choice of payment. ☐ Cash / Check ☐ Visa ☐ MasterCard

How did you become aware of our clinic? ☐ Drove by ☐ Yellow Pages ☐ Previous Client ☐ Other _____

☐ Personal Recommendation *(Whom may we thank?)* _____

	PET # 1	PET # 2	PET # 3
NAME			
BREED			
DATE OF BIRTH			
COLOR			
SEX; SPAYED OR NEUTERED?			
YOUR DOG'S VACCINATION HISTORY:			
RABIES			
DHLP PARVO CORONA			
BORDETELLA			
INTRA TRAC II			
FECAL (STOOL SAMPLE)			
HEARTWORM TEST/PREVENTION?			
YOUR CAT'S VACCINATION HISTORY:			
RABIES			
DIST-RHINO CHLAMYDIA			
LEUKEMIA TEST			
LEUKOCELL			
FECAL (STOOL SAMPLE)			

Our pet(s) is: ☐ Member of our family ☐ Child's pet ☐ Backyard pet

Any previous serious illnesses or surgeries? _____

Any allergies to vaccinations or medications? _____

Is your pet on any special diets or medications? _____

Would you like to be present during treatment to your pet? ☐ Yes ☐ No

Revised: _____ 200__ / _____ 200__ / _____ 200__

PRE-EXAM CHECKLIST
CANINE

Date: _____ Recommending Doctor: _____

After reviewing your pet's health record, we have found _____ is due for the following examinations / vaccinations / lab procedures to help maintain a healthy life.

☐ **Physical Examination** **Due Date:** **Recommended:** **Declined:**
A comprehensive physical examination is suggested on an annual or semi-annual basis. Just as with people, a physical examination may be the most important component of an office visit, allowing the veterinarian to completely examine your pet and discuss any medical problems found. All pets will have a comprehensive physical examination prior to vaccination.

☐ **DHLPP + C** **Due Date:** **Recommended:** **Declined:**
A vaccination to protect your dog from four diseases – distemper, hepatitis, leptosporosis, parainfluenza and coronavirus. These diseases are debilitating and can cause death. Nearly every dog will be exposed during its lifetime, making vaccination a must. Parvo is an intestinal viral infection that results in bloody diarrhea, fever, vomiting and extreme depression. It is highly contagious and life threatening. Coronavirus is a disease similar to parvovirus, but less threatening.

☐ **Bordetella/Parainfluenza** **Due Date:** **Recommended:** **Declined:**
A vaccination given to dogs to prevent tracheobronchitis (Kennel Cough) which is caused by a highly contagious combination of a virus and bacteria, causing a dry hacking cough that can persist for six or more weeks. If your pet is kenneled, groomed, shown, or around other dogs, we recommend vaccinating semi-annually annually .

☐ **Lyme Disease** **Due Date:** **Recommended:** **Declined:**
A bacterial disease transmitted by the deer tick which affects both humans and animals. If your dog lives in an area where there are deer ticks, it should be vaccinated.

☐ **Rabies** **Due Date:** **Recommended:** **Declined:**
A vaccination that is required by the state government for both dogs and cats. Vaccinations help prevent this your dog from contracting this deadly disease.

☐ **Fecal/Stool Test** **Due Date:** **Recommended:** **Declined:**
A quarterly semi-annual annual test to detect intestinal parasites that threaten your pet's health. Regular microscopic examination of your pet's stool should be done for early detection and treatment. It is possible for people to get roundworm and hookworm from infected pets.

☐ **Urinalysis** **Due Date:** **Recommended:** **Declined:**
Recommended quarterly semi-annually annually to detect bladder infections, diabetes, bladder stones, kidney disease, cancer and other conditions.

☐ **Electrocardiogram** **Due Date:** **Recommended:** **Declined:**
Recommended by the veterinarian as needed to detect irregularities with the heart rate and rhythm for puppies, before surgery, and with consideration to breed. (Important for Dobermans, Boxers, Cockers, and large breed dogs.)

☐ **Blood Pressure** **Due Date:** **Recommended:** **Declined:**
Recommended yearly for senior pets. High blood pressure may lead to or be a symptom of disease.

☐ **Heartworm Test** **Due Date:** **Recommended:** **Declined:**
A simple blood test done within our hospital to detect an active infection or a reaction to an early infection. Heartworms are transmitted through mosquitoes and can be fatal if untreated. Preventive medication is available in oral or topical forms.

☐ **Geriatric Blood Profile** **Due Date:** **Recommended:** **Declined:**
A blood workup recommended yearly quarterly semi-annually annually to help detect many of the problems caused by aging. Early detection of disease allows the doctor to begin treatment earlier and keep your pet healthier as it ages. A blood sample can be drawn during the office visit.

☐ **Dental Health Care** **Due Date:** **Recommended:** **Declined:**
Tartar accumulation and gum disease affect most pets. Periodontal disease can lead to infection in the liver, kidneys and heart. This can best be prevented with regular dental care. Dental care starts at home by brushing or cleansing your pet's teeth with animal toothpaste or cleansing products. Ultrasonic cleaning and polishing under anesthesia is recommended as needed.

☐ **Baseline X-rays** **Due Date:** **Recommended:** **Declined:**
Recommended yearly or as needed for seniors to detect heart and lung disease, cancer, and other abnormalities.

☐ **Intraocular Pressure** **Due Date:** **Recommended:** **Declined:**
Pressure within the eye will help us diagnose glaucoma before it becomes a serious problem or causes blindness. Certain breeds are more prone to glaucoma, such as Boston Terrier, Cocker Spaniel, Poodle, Shih Tzu, Great Dane, and more. All pets over 6-7 years should also be checked annually.

☐ **Flea and Tick Control** **Due Date:** **Recommended:** **Declined:**
Fleas can cause a number of severe problems, including allergic dermatitis due to flea bites (caused by the saliva of the flea) and tapeworm. Ticks also carry Lyme Disease, a debilitating illness.

PRE-EXAM CHECKLIST
FELINE

Date: _____ Recommending Doctor: _____

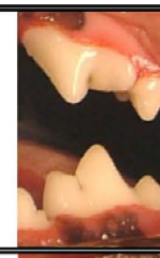
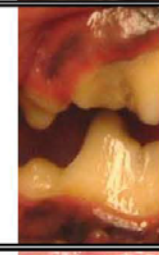
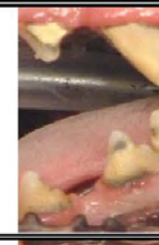
After reviewing your pet's health record, we have found _____ is due for the following examinations / vaccinations / lab procedures to help maintain a healthy life.

❑	**Physical Examination**	**Due Date:**	**Recommended:**	**Declined:**
	A comprehensive physical examination is suggested on a(n) quarterly semi-annual annual basis. Just as with people, a physical examination is the most important component of an office visit, allowing the veterinarian to completely examine your pet and discuss any medical problems found. All pets will have a comprehensive physical examination prior to vaccination.			
❑	**Feline Combination Vaccine**	**Due Date:**	**Recommended:**	**Declined:**
	A vaccination for cats that helps protect them from three diseases: Feline respiratory diseases (Rhinotracheitis and Calici virus) and Panleukopenia which is known as distemper. All are highly contagious viruses which are easily transmitted between cats and can be fatal. Vaccination is your pet's only protection.			
❑	**Feline Leukemia (FeLV)**	**Due Date:**	**Recommended:** Test Vaccine	**Declined:**
	A vaccination for cats to aid in prevention of feline leukemia. Similar to AIDS virus, the FeLV virus severely depresses the immune system so the cat's body can't fight off diseases. The feline leukemia virus is a major cause of death in cats. There is no successful treatment, but there is a vaccine! Testing for feline leukemia should be done prior to vaccination as this disease can be transmitted from mother to newborn or can lay dormant in the cat for years before symptoms are present.			
❑	**Chlamydia**	**Due Date:**	**Recommended:**	**Declined:**
	A feline upper respiratory disease that is highly contagious and widespread. It is usually not a deadly disease, but once a cat is exposed, it may have respiratory difficulties for years.			
❑	**Feline Infectious Peritonitis**	**Due Date:**	**Recommended:**	**Declined:**
	A deadly viral disease that has no known cure. The disease has many varied symptoms and is spread by contact with other cats or exposure to feces or urine. It is slowly becoming more common in the feline population. If your cat goes outside, it may be a candidate for vaccination.			
❑	**Rabies**	**Due Date:**	**Recommended:**	**Declined:**
	A vaccination that is required by the state government for both dogs and cats. Vaccinations help prevent your cat from contracting this deadly disease.			
❑	**Fecal/Stool Test**	**Due Date:**	**Recommended:**	**Declined:**
	A(n) quarterly semi-annual annual test to detect intestinal parasites that threaten your pet's health. Regular microscopic examination of your pet's stool should be done for early detection and treatment. It is possible for people to get roundworm and hookworm from infected pets.			
❑	**Urinalysis**	**Due Date:**	**Recommended:**	**Declined:**
	Recommended quarterly semi-annually annually to detect bladder infections, diabetes, bladder stones, kidney disease, cancer and other conditions before they can cause serious illness to your pet.			
❑	**Electrocardiogram**	**Due Date:**	**Recommended:**	**Declined:**
	Recommended to detect irregularities with the heart rate and rhythm.			
❑	**Blood Pressure**	**Due Date:**	**Recommended:**	**Declined:**
	Recommended by the veterinarian as needed to identify health risks such as strokes, eye and kidney disease.			
❑	**Heartworm Test**	**Due Date:**	**Recommended:**	**Declined:**
	A simple annual blood test performed within our hospital to detect an active infection or a reaction to an early infection. Heartworms are transmitted through mosquitoes and can be fatal if untreated. Preventive medication is available in oral and topical forms.			
❑	**Geriatric Blood Profile**	**Due Date:**	**Recommended:**	**Declined:**
	A blood workup recommended quarterly semi-annually annually on pets eight years or older to help detect many of the problems caused by aging. Early detection of disease allows the veterinarian to begin treatment earlier and keep your pet healthier as it ages. A blood sample can be drawn during the office visit.			
❑	**Dental Health Care**	**Due Date:**	**Recommended:**	**Declined:**
	Tartar accumulation and gum disease affect most pets. Periodontal disease can lead to infection in the liver, kidneys and heart. This can best be prevented with regular dental care. Dental care starts at home by brushing or cleansing your pet's teeth with animal toothpaste or cleansing products. Ultrasonic cleaning and polishing under anesthesia is recommended as needed.			
❑	**Intraocular Pressure**	**Due Date:**	**Recommended:**	**Declined:**
	This test, along with others, helps evaluate the health of the eye and can diagnose diseases such as glaucoma.			
❑	**Flea and Tick Control**	**Due Date:**	**Recommended:**	**Declined:**
	Fleas can cause a number of severe problems, including allergic dermatitis due to flea bites, caused by the saliva of the flea, as well as tapeworm.			

Your Animal Hospital
DENTAL REPORT CARD

Date:_____ Dr._____

Patient:_____ Owner:_____

❒ **NICE JOB!** **No sign of plaque or tartar**		Home dental care is needed to maintain these healthy teeth and gums. Brushing your pet's teeth regularly is ideal. There are also products available to help make home dental care easy and hassle free.
❒ **Grade I / Mild Gingivitis:**		Margin of attached gum is inflamed and swollen. Plaque covering the teeth. ***Home dental care needed. Dental cleaning to remove current plaque buildup within next year if no improvement.***
❒ **Grade II / Moderate Gingivitis**		Entire gum is inflamed and swollen. Mouth is painful and odor is noticed. ***Dental cleaning to remove tartar is needed within the next month. Addition of tartar control diet and home dental care needed afterward for prevention.***
❒ **Grade III / Severe Gingivitis**		Cherry red and bleeding gums. Gum is destroyed by infection and tartar. Sore mouth and bad breath. Odor is evident. ***Dental cleaning to remove tartar is needed immediately. Addition of tartar control diet and home dental care needed to prevent recurrence.***
❒ **Grade IV / Periodontal Disease:**		Chronic infection is destroying the gum, tooth and bone. Bacteria is spreading through the body via the bloodstream and may damage the kidneys, liver and heart. ***Dental cleaning to remove tartar is needed immediately. Some teeth may be loose and in need of extraction. Home dental care***

y for prevention. *afterward is necessar*

Medical Care Plan

Dermatology

ABSCESS

An abscess is a pocket of infection that contains pus. They often result from a bite where the skin is broken and hair and bacteria are trapped under the skin. The wound then seals and the abscess develops. This is usually quite painful and your pet could be less active and have a fever during this time. Surgical treatment is sometimes necessary to drain the abscess, and then your pet will be placed on antibiotics. With severe infection, your pet will possibly need to be hospitalized following surgery.

ESTIMATE OF COSTS FOR DRAINING ABSCESS

Examination	$ 0.00		
Anesthesia	0.00	-	$ 0.00
OR Usage and Materials	0.00		
Draining and Flushing Abscess	0.00	-	0.00
Drain Tube	0.00	-	0.00
Antibiotic Injection	0.00		
Elizabethan Collar	0.00	-	0.00
Patient Day Care/Hospitalization	0.00		
Antibiotics to go Home	0.00	-	0.00
TOTAL	$0.00	-	$0.00

For severe or difficult to treat cases:

Hospitalization (per day)	$ 0.00
Antibiotic Injection (each)	0.00
Daily Doctor Professional Care	0.00

Additional treatments:

Recheck exam recommended 3-7 days after treatment/surgery	$0.00
Suture and drain tube removal up to 7-10 days	Included

Signed_____ Date: _____

Owner

Setting Fees You're Comfortable With

Mark Opperman, BS, CVPM and Sheila Grosdidier, BS, RVT
Veterinary Management Consultants
Evergreen, CO

"Shopped" and "exposed" services

Calculate your fees based on

a. Overhead costs per minute
b. Direct costs at percent (%) mark-up
c. Return on time to the doctor

In hospital service fees - overhead costs per minute

a. Calculate overhead costs/minute/DVM
b. Formula: ALL expenses – compensation to doctors (both owners & associates) including related costs – inventory costs ÷ number of hours the doctors are scheduled (both office hours & surgery) ÷ 60

In hospital fees - direct costs

a. Direct costs definition: Inventory costs, costs of materials used in the procedure
b. Formula: 2x cost due to costs of ordering

In hospital fees - return on time to the doctor

a. Return on time to the Doctor definition: Per minute cost of the doctor's time spent on a procedure
b. Formula: Cost of DVM's time/minute x # of minutes spent on procedure
c. In hospital procedures
d. Surgery
    i. General/Soft Tissue
    ii. Orthopedic

How to determine pharmacy fees

a. Set % mark-up
b. Minimum per pill charge
c. Pharmacy preparation charge
d. Minimum Rx charge

Outside laboratory

a. 2 x cost plus $5.00, or
b. 2.5 x cost

Ideal Outpatient Visits-
From Check-in to Check-out

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

This is an extraordinary occasion for veterinary practice. The rapid changes in technology, medicine, and client expectations have all melded together to yield very unique, rewarding opportunities for those veterinary hospitals who are willing to embrace those changes and fully engage the potential of this challenging business climate.

What's a forward thinking practice to do? Here are the points to consider

1. Client service is dead – client experience is everything

Mrs. Expect comes into the clinic and waits until 3:30PM to see the doctor for her 3:00PM appointment. Dr. Wonderful does an excellent comprehensive physical examination, runs an in-house laboratory panel and prescribes the correct medication. While there an assortment of variables that come into play, how do you think Mrs. Expect discusses this time at the practice with her family this evening at the dinner table? Do you think the words bad service or bad experience was used? Clients no longer assess the service alone in determining their satisfaction, it is the total experience; and they measure not only against other veterinary practices, but other service/professional businesses. Every detail of the entire visit now must be considered. It's no longer about how your practice compares to other practices, it's how your practice compare to other service businesses.

Here is how your practice can engage this change

2. Your team comes first – not your client

Yes, this sounds counterintuitive, but it's true because without the commitment of your team in the belief that they are respected, understood and appreciated, you're your training, marketing and hiring will be of limited value. Treat your team members as well as you want them to treat your clients. What does it truly take to have your receptionist Sarah tell Ms. Delay to come in 20 minutes before the clinic closes instead of telling her that she will have to come in tomorrow? Creating an environment where there is a genuine sense of compassion and interest in the client means that the culture within the clinic itself possesses those qualities.

Here is how your practice can engage this change

3. It's courtesy, not efficiency that builds loyalty

Gather up all those wonderful letters and emails about why you are the best practice and how much your clients love you. Pick out the words that clients use to describe you – peruse some of these words appear – compassionate, caring, empathetic, friendly, loving, and amazing. How many times do you see words punctual, efficient, competent, or my personal favorite, discounted? (Sorry, I just had do put that in there) While you need to be mindful of time, it is courtesy, kindness, compassion and true understanding that create the connection with clients. The receptionist who is more concerned with efficiency instead of making eye contact and using a genuine smile to build rapport with a client has missed a crucial opportunity. And, in this case, who failed? The receptionist? Management?

Here is how your practice can engage this change

4. Expectation is a moving target

Rapidly accelerated change is the constant; only those practices that can reliably evolve along with the increasing and diverse expectations of clients will assure their achievement. The other element in this equation of success is that clients will not always know what they want for their pet. Veterinary practices will need to intrigue clients, invite their curiosity, improve their knowledge and engage their delight to create a loyalty that will yield a desire to make their pet a lifelong patient of the practice.

Here is how your practice can engage this change

Associate Case Studies:
Who Gets Hired and Fired- and Why

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

1. R-e-s-p-e-c-t
It's not just a word, it's what you do. Treat them with respect and model the behavior you expect from them with every employee. Part of respect is praise and feedback; let them know in public when they do well and in private when there's a concern.

2. Leadership
Associates want to know they are on the right path and there is a plan in the practice for moving forward. They want to belong to something bigger than themselves and know that someone they can trust is in charge.

3. Empowerment
Allow your Associates to make decisions and to share their ideas with you. While they may not always make the right decisions, they need to know you will support them when needed. Consider what you learned when you made a mistake and encourage them to make decisions.

4. Make it fit
Send the new associate out to lunch with different departments in the hospital; one day with the veterinary technicians, one day with the receptionists and then lunch with the kennel and exam room teams. Have them talk about the successes of the practice and how we make a difference in the lives of pets every day.

5. Open it up
Have an open house or reception and invite your best clients to meet the new associate. Nothing says welcome like clients who will tell your new employee how wonderful the practice is from the client's point of view.

6. Expectations
Ask them what their expectations are in an employer. Let them know clearly how they will be evaluated and the timeline for performance evaluations.

7. Be proud
Put an ad in the paper welcoming the new associate. Create a flyer that you can give to clients in the practice telling them about the wonderful addition to the practice. Post their picture and biography in the exam rooms.

8. Mentor
Assign a mentor, someone who can assist them, meet with them regularly and help them to integrate into the practice.

9. Time
Set up regular times to meet and talk about cases, comments, and concerns. Encourage the new associate to ask questions when they have them, but also make time so you can demonstrate your commitment to them; and remember, you can't change the tire at 40 mph, slow down and take the time to talk about it.

10. Make sure there are no misunderstandings
Everything should be put in writing, make sure you have an employment contract, job description and policy manual. Go over these with your new associate.

11. WALK YOUR TALK
Make sure you set the example, not only medically but in your actions. Be to meetings on time, treat other employees with respect, get to work on time. Remember that any successful business starts from the top.

Salary, Production, and ProSal: What's Best for Your Practice?

Sheila Grosdidier, BS, RVT and Mark Opperman, BS, CVPM
Veterinary Management Consultants
Evergreen, CO

Without question the most common question I am asked as a consultant, is "how do I pay my associates fairly?" This is not a concern only for practice owners, but naturally for associates as well. Practice owners wish to pay associates fairly, but also give them an incentive to produce income for the practice. Associates wish to get paid fairly and make as much money as they can. What could be a more natural relationship?

There are basically three ways an associate can be paid. These are salary, production, or a combination of both. Let's review the pros and cons of each of these methods of compensation.

Salary – If an associate is paid strictly on salary, compensation is usually negotiated at the beginning of the year. The amount decided upon can be strictly arbitrary, or it could be based on that veterinarian's previous year's production. The pros of this type of salary arrangement are that both the owner and associate know how much they have to pay or will be paid. There is comfort in the fact of knowing what your expense or income will be. The downside of a salary agreement is that there is no motivation to increase ones production. A veterinarian who does the minimum expected of him or her, will get the exact same compensation as a veterinarian who spends the time to work up cases, educate clients and provides a full service approach to there clients. Is this method of compensation fair to both parties?

Several years ago I lectured and consulted in Sweden. At that time all but one of the veterinary hospitals were run and controlled by the government. I visited several practices owned by the government. Clients would bring their pets into the hospital and ask for a Rabies vaccination and indeed that was all they received. Even if the pet had never received a distemper vaccination, or never had a fecal exam performed, the client would not be asked if they desired any additional services. They only got what they asked for. In addition there were long waiting periods and the facilities themselves were not very impressive. I then visited the one veterinary practice that was privately owned. Talk about night and day difference. The hospital itself was modern and clean. Clients were greeted when they entered the practice, the doctors spent time with the client and their pet. The veterinarians in this privately owned hospital educated clients about there pets needs and provided a full service approach. There was indeed no comparison. In the government owned practices the veterinarians were paid a salary, in the private practice the veterinarians were paid on a percentage of their production. The government wanted to know why the one private hospital was the only one that was profitable! Could you guess some of the reasons why?

Percentage based compensation – Another method of compensating associates would be to pay them strictly on their production. Most experts agree that if an associate is to be paid based on a percentage of their production, they should be paid between 18 to 25% depending upon other costs of employment. Costs of employment include anything that indeed costs the practice money. Therefore any direct cost the practice is incurring due to the employment of the associate must be calculated. As an example if a practice if paying for health insurance, continuing education, dues, licenses, liability insurance, disability insurance and even the cost of matching FICA, all these costs must be determined and included into the calculation to determine the true costs of employment. It is these costs that should not exceed 25% of an associate's production.

The pros of percentage based compensation is that employed veterinarians can be much more in control of there compensation. If it is a real busy month and the associate's production is high, there check will reflect this. This method of compensation also gives an associate a much greater incentive to be productive and help the practice grow. The downside of production based compensation is that there is no guarantee of compensation. If an associate does not produce, they will not get paid. Without prior knowledge of what an associate has produced, this can be a very scary proposition for an associated to enter into.

ProSal formula

Thus the advent of the ProSal formula of compensation for associate Veterinarian's (January 1997 Veterinary Economics). The ProSal formula is without question the best of both worlds. The ProSal formula is a combination of a guarantee base of compensation; however the associate is paid on a percentage of their production.

The way the ProSal formula works is as follows: An associate will be guaranteed a base salary for the year. As an example we may guarantee our associate $45,000 a year. We will then take the guarantee base and divide it by 24 (since the associate will be paid twice a month). This amount will be paid on or about the 20th of each month. At the end of the month we will determine the associate's production and take a percentage of it that was pre-determined and agreed upon (18-25%) and figure out what the associate should have been paid for that month. From that amount we will subtract the prior payment and issue a check for the balance.

An example of this would be as follows

- Guaranteed base of $45,000.00 a year
- Associate will be paid 21% of production
- During the month the associate produced $29,000 of income
- Payment on the 20th of the month = $1,875.00
- (1/24 of $45,000.00)
- Payment of the 10th of the following month = $4,215.00
- (21% of $29,000 = $6,090.00 less $1.875.00)

At the end of the year we would total all the compensation received by the associate. If that total did not exceed the guarantee base of $45,000.00 we would owe the associate the difference. Therefore the guarantee base comes in at the end of the year and in figuring out the fixed payment each month.

This is indeed the best of both worlds. The associate is guaranteed to earn, no less than the guarantee base, but has the potential to earn whatever they wish, within reason. They can't earn less, but they can earn a whole lot more. If they do earn more, than they are of course more productive for the practice and thus a win for the practice as well. In the past eight years that we have been using the ProSal formula there has only been one occasion in which an associate has not earned their guaranteed base. There are hundreds of associates presently being paid under this method of compensation. Indeed, associates themselves love the ProSal formula once they get over their initial fear of it. Owners are always amazed at how much more productive an associate becomes once they are on the ProSal formula. It is truly the best method of compensation for associates that I have seen.

It is important to note, that I do not feel money is the end all. I certainly know that most veterinarians have not gotten into this profession to get rich. Indeed, I feel that quality of medicine and surgery always come first. This however, does not mean that we should not make more money, or provide an associate with an incentive to do so.

Now, let's take a few minutes to ask and answer some of the more commonly asked questions in regards to the ProSal formula:

How do I define production?

Production is defined as fees generated and collected for services the doctor was formally involved in the delivery of. Therefor the doctor must have "hands on" in order to receive credit for service. As an example we might consider and out patient office visit where a doctor has done a comprehensive physical exam, vaccination and sold a heartworm preventative and bottle of shampoo. The doctor in this case would get full credit for all these products and services because they were done during the course of an office visit.

If the client came back a month or two later to purchase more shampoo and if this was done over the counter, the doctor would not get credit for it. The exceptions to this rule are x-rays, laboratory procedures and dentistry, assuming a technician provides these services. The doctor who ordered the procedure or over saw it would receive credit for it.

Even with a good definition of production there will be some grey areas and some overlap between doctors. These should be expected and there needs to be a give and take attitude and one of teamwork established within the practice.

My computer credits the doctor when the service is charged for weather I get paid or not. How do I keep track of this?

Most veterinary software programs do indeed credit the doctor when the service is rendered weather the practice is paid or not. No, it is not fair to the practice to pay an associate their percentage of production when the hospital has not been paid. This is another advantage of the ProSal formula since it hopefully brings the associate into the reality of a client's ability to pay for services rendered.

It is my suggestion that if your software credits associates when the service is rendered the associate should indeed receive credit at that time. At 90 or 120 days, if the account still remains uncollected the amount that was paid to the associate should be deducted from their next "production" check. Therefor we will deal with this problem at the back end instead of the front. If we do get payment the associate will receive their percentage of production in their next "production" check

How do I determine total costs of employment?

As previously stated total costs of employment refer to all costs incurred by the practice to employ an associate. These can vary substantially from practice to practice. The worksheet provided (see figure 1) should help to figure out what the actual costs are. This worksheet should be filled out annually on each associate and given to them. This will help the associate understand how there percentage is figure out and why. The total cost of employing an associate should not exceed 25% of their production. If production does exceed this number the practice is over compensating their associate.

How do I figure vacation and personal leave into the formula?

Under ProSal if an associate does not produce, they do not get paid. True, there is a guaranteed base, but that comes in at the end of the year. The practice should specify in the associate's contract the amount of vacation days and personal leave days they are providing. If an employed veterinarian takes a vacation in a given month, there second check might be less, depending upon their production for the month. The first check is always guaranteed.

This should not be interpreted as the associate not getting paid vacation or paid personal leave days. Instead the associate is getting paid more for 50 weeks of work instead of getting less for 52 weeks of work. Compensation is the same it is only being paid over a different time span

How can my associate be assured that they have received proper credit for services they have rendered?

The associate is entitled to receive a copy of the end of day report which shows what has been credited to his or her account. This may be the itemized audit trail or a specific doctor production report. If there is a mistake is should be corrected as soon as possible and the correction should show up in the next report presented to the associate.

Does the ProSal formula work with part time employed veterinarians?

Yes! The guarantee base will of course be less, but the same benefits of ProSal apply. The associate will be provided an incentive to offer a full service approach and educate clients. The associate will also be rewarded for doing so. Some practices will just pay a part time associate on production, which is fine if the associate is comfortable with this. If not the ProSal formula may be just the ticket.

I am worried about placing my associates on a production basis of compensation because I do not want to affect the harmony of the practice and don't want my doctors more concerned about money, than the patient.

I have heard this comment a lot, but truly have not found it to be a problem. First of all most if not all veterinarians truly care about the animal and if anything we have to constantly remind them, that we are also running a business. Money is by no means the end all, but it is nice to be paid for what we do.

There was one situation where a doctor reviewed all the out patient charts before she decided which one she was going to see. She was trying to figure out which one would generate her more income. When reviewing this doctor it was quite obvious that this was a symptom of the problem, and not the problem itself. This person was quite immature and indeed had a lot of other problems. She was replaced within the practice and all was fine. The bottom line here is that this is used may times as an excuse, but in reality has little basis in fact. Many associates who voice this concern know that if they are placed on production they will find out they are getting paid more than they deserve.

My associate is board certified, or has been with me a lot of years, so should I pay them more than other associates?

No! If an associate is board certified or if a veterinarian has been with the practice for a long period of time they should have increased production and therefore will get paid more, not as a function of there percentage, but rather their ability to produce income. Shouldn't a board certified veterinarian be able to generate more income than one that is not? And if not, why not? A board certified surgeon should certainly be charging more an hour for his or her time, than a veterinarian that is not.

Therefore a board certified veterinarian, or one who has been with the practice for a long time may indeed generate a greater pay check, but it will not be because of there title or length of employment, but instead their ability to produce income.

Do I have to adjust the percentage each year?

It depends if the total cost of employment is close to 25% then you should not adjust the percentage. If the total cost of employment is 21 or 22% you may wish to. Many practices will start an associate off at one percentage and over a three to five year period graduate an associate up. This is a point that can and should be negotiated with the associate. However, one great advantage of the ProSal formula is that there does not have to be re negotiations each year. Therefore a practice may wish to start an associate at a certain percentage and keep them there. The increase in income will come from the associate's enhanced ability to produce income along with fee schedule increases.

There is no question in my mind that the ProSal formula is by far the best method of associate doctor compensation. This formula allows an associate to have some control over her or her income and provides an incentive to be productive. From the practice owner's point of view the ProSal formula provides for a fair and just method of compensation. Most if not all veterinary employers wish to compensate fairly, the only problem was how to do it and the ProSal formula certainly solves that problem.

Associate Skills:
Why Leadership and Personality Matters

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

Owner or associate - regardless of which you are in practice, your leadership ability and personality affect the entire team. Owners and associates will learn how to lead a positive, productive team while learning how to work with other personalities, and honing in on their own strengths and weaknesses.

Every person on the veterinary team has responsibilities, and must be held accountable for their actions. This includes owners and associate veterinarians who often feel their behavior and attitude is justified because of “who they are” on the team. Therefore the key take-away point of this lecture: Team members act as their leadership acts. They work as they are lead. They succeed if given success to follow.

Great leadership starts at the top. Since owners can set the stage for the entire team to work in a positive or negative culture, many associates feel that they do not have “any say so” in the practice. It has been stated that “what they say or think does not matter”, therefore, they simply show up for their job, see the clients and patients, and go home at the end of the day. The fact is, associates have more effect on team members than they believe. Associates are viewed by team members as leaders who make decisions for clients and their pets, on a daily basis. The methods by which associates lead and communicate with fellow team members has a huge affect on how team members deliver the message(s) to clients and provide care to the patients.

Associate veterinarians are leaders that share a mission and a vision; a mission and vision that should shared unanimously by all team members, but is often hidden behind office politics. Every team member, DVM and non-DVM staff entered this profession for the love of animals, with a mission to treat all with respect, dignity and courtesy. When associate veterinarians uphold the mission and vision, they can positively influence other team members to do the same. It starts at the top. Associate veterinarians are leaders that should be driven to inspire and motivate; *inspire and motivate all team members and clients.*

Associate veterinarians should lead with integrity. Team members wish to follow those with strong morals, values, and ethics. With integrity comes respect. Respect is consideration or esteem given to another person. Each member of the team must respect other team members’ education, skills, and values. Without respect for each other, team members’ morale and self-esteem drop, producing a negative attitude for the entire team. Associates must understand that not all employees have the same thoughts and philosophies, and many people complete tasks differently based on education or previous skill sets. This can be accepted as long as the same ultimate goal is reached in a timely manner. Each member possesses expert skills and credentials that warrant respect, and associates have an uncanny ability to drive this respect among the team.

Empowerment and trust in the team is sometimes difficult for associates. Empowered employees are only as good as their expertise, and expertise comes from training with associates and exceptional leadership. It is imperative to train team members on a continual basis. The strongest employees accept training as a way to improve themselves and the practice. When employees have pride for their workplace and are empowered to improve the daily operations, they will exceed expectations. Emotional ownership of a practice (vs. financial ownership) yields high returns. Team members can never receive enough training. As an associate, step up and offer to train and motivates team members on a continual basis.

Team members receive energy through recognition. Team members should be recognized for a job well done as soon as it is warranted. Many team members only hear of mistakes they have made and the necessary corrections and never hear about the excellent quality of work they produce. Positive situations need to be recognized and brought to the attention of all team members so they can all benefit. Amazing associates know that high performing teams are high producing teams, and they succeed together.

Actions speak louder than words. Behave as you expect others to behave, which will drive the shared values and vision. When a leader is “grumpy” and snaps at fellow team members or talks in a condescending voice, the team moral drops. Not only does this affect the inner dynamics of the team, it affects the communications that will occur with clients throughout the day. When associates and leaders talk in a condescending tone, the authority has just been given to the team to talk to others (including clients) in the same tone of voice. Take ownership for your actions and apologize when appropriate. We are only human. We all make mistakes, and we learn from our mistakes. Admit to your team when you have made a mistake, and they will admit theirs, to you.

The personality of individuals certainly has a dramatic affect on communications within the team, and with clients. With each type of personality come advantages and disadvantages, as well as behavioral predispositions. It is important to learn how to appreciate and leverage personalities for the greatest success. Teams that understand and accept different personalities tend to have higher producing employees, higher client compliance and retention.

Several different personality tests are available, including Myers-Briggs, Keirsey, Merrill Reid, True Colors and Disc, to name a few. The point of learning about individual personalities is not to single one out, but to gain a better understanding of how to communicate better. This same theory can be applied to clients, which will also enhance client communication.

Each personality test has slight variation in terms used to describe characteristics. For the purpose of this lecture and its relationship to veterinary medicine, we will use the descriptions provided by the Pawsonality Assessment, courtesy of Patterson Veterinary.

Drivers can be described as being direct, assertive, demanding and seek results. They are similar to the Border Collie breed, in that they are always seeking the quickest way to get from point A to point B. They are efficient, can multi-task, and generally expect the same from others. Because they expect everyone to be the same as them, they come across to others as being intolerant and impatient. Analytics on the other hand, think in a controlled and orderly fashion. Just as the characteristic states, information must be analyzed before a decision can be made. Analytics will have a plan (and sometimes Plan B, in case Plan A does not work out) in place, before any procedure is carried out. Here in lies a clear example of a personality conflict: a driver determines how to get from point A to point B as efficiently as possible, and the analytic is making a plan to get from Point A to Point B as successfully as possible. Therefore, drivers will perceive analytics as slow decision makers; analytics perceive drivers as pushy and making rash decisions.

Expressive personalities are like social butterflies. Imagine a golden retriever: always happy, their tail is always wagging. They are enthusiastic, impulsive, dramatic, animated, and very charming. These social butterflies can charm the pants off a client, and create a warm and hospitable environment. They often have the highest acceptance when making recommendations to clients. The disadvantage to this happy personality: they are easily distracted. Therefore, they are great idea generators and make everyone happy, but they often cannot follow through with what was originally assigned to them. This can make the driver and an analytic personality crazy, until they realize how best to communicate with them, and learn what to expect.

Last but not least, we have the amiables. An amiable is a peacemaking personality; they do not like conflict or confrontation. They are friendly, supportive, patient and loyal. The Labrador breed (in general) is a very loyal breed – they always stay by their owner, and rarely disappoint. Since they do not like conflict, drivers and analytics often discount Labradors, creating a distinct personality clash.

As indicated earlier, people with different personalities have different strengths and weaknesses. Since one person does not possess all the characteristics to be a high achiever, mover and or shaker, it is important to utilize the strengths of all team members and minimize potential weaknesses. This is team diversity that develops respect and rapport with one another, and is driven by leadership – associates included!

How to be the Leader Your Team Needs

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

Teams follow their leaders. In fact, what the team does (or does not do) is in direct correlation to their leader (s). However, many veterinary practices lack the leadership needed to produce a positive, effective and efficient culture. Participants will gain an understanding of the importance of great leadership, and will take home tools to produce the dream team.

Every person on our veterinary team should be a leader. Why? Because *every* team member leads our clients on a daily basis. Team members educate clients and lead them to make the right decision regarding the healthcare for their pet. Through education, positive persuasion and leadership, a bond is established, resulting in an increase in client compliance and retention. However, leadership does not just happen; it starts at the top with owners, administrators and practice managers.

Leadership has been described as the process of social influence in which one person can enlist the aid and support of others in the accomplishment of a common task.[1] In general this task or tasks include providing outstanding customer support to our clients and superior medical service to our patients. In fact, this is probably a brief description of you mission statement (or should be!) That being said, if you do not have a mission, vision or values statement in place, then how can management enlist the aid and support of others to accomplish the common task? They do not know what the common task is that must be completed, together.

Create a mission, vision and values statement

A mission, the vision and the values (MVVs) of a hospital are core competencies that must be integrated in every practice. MVVs set the structure, creating a positive culture, and goals that help define team member expectations. Without these, team members have no direction; they simply show up to work and complete the tasks assigned to them. Owners make it day to day, with no clear light at the end of the tunnel, and managers struggle to implement successful goals and policies to increase value in the hospital. The mission and vision should be evaluated every couple of years, ensuring that they are still in alignment with the beliefs of the owner.

Leadership

Leadership, not just management, is vital to the success and growth of a practice. Leadership is influence, as defined above. Leaders motivate team members into action, and inspire them to be the best that they can be. They guide through effective communication, and create an environment that facilitates teamwork.

Leadership is about character, behavior and actions (actions speak louder than words!). Every leader must look in the mirror; are the characteristics and behaviors that one is striving for (within the team) exhibited day in and day out (by oneself)? Through these characteristics, leaders compel individuals to pursue the mission, value and goals of the leader.

In modern society, leaders must strive to achieve short- and long-term goals; create effective, efficient methods to complete tasks; and be proactive instead of reactive to situations. A leader's personal effectiveness can directly influence a hospital's success. Leaders must determine the most effective method to manage team members and be able to recognize their own strengths and weaknesses as well as those of others. A motivating leader generates enthusiasm and excitement and an organized leader provides the path to achieve goals; the best type of leader does both. A leader sets the practice's vision and goals, communicating the vision to the team so they may help accomplish those goals.

Leaders must hold themselves to a higher standard of patient care, customer service, performance, and personal behavior. Leading by example has a much more profound effect on team members than leading by directive. Examples show team members what is expected of them when it comes to patient and client care. All team members should be held accountable for providing the best care possible, and leaders can set the stage for this to occur. Leadership that promotes a poor standard of care and professionalism will also affect the team, as team members are only as good as their leaders. Managers of this type should be terminated because they will cause the team to disintegrate and the practice to fail. Owners of this type must re-evaluate themselves and consider self-development if he or she wishes to have a successful practice.

Leadership qualities

Leaders must possess several qualities to be successful. Self-confidence, sincerity, and enthusiasm for the job are essential. Leaders are effective listeners and accept diverse cultures. To have an effective team, a leader must be a team player and work to solve problems, innovate, and renovate existing policies, procedures, and environments. Leaders explain how to accomplish a task and give a challenge to the team. This allows the team members to think for themselves creatively, which can develop leaders for the future.

---

[1] Wikipedia, http://en.m.wikipedia.org/wiki/Leadership; accessed 11/2014

Effective leaders possess self-confidence. They believe they have the ability to complete tasks efficiently and effectively. Leaders accentuate positive personal attributes and do not dwell on negative weaknesses. Self-confident leaders take risks and are able to make recommendations and changes without delay.

Genuineness and sincerity come from within and promote trust and communication. Team members know the suggestions and changes made by sincere leaders enhance the skills of all involved. It is important to show appreciation for peoples contributions and create a culture that celebrates values and victories. It is genuine acts of caring that lift people up and creates a desire to exceed expectations.

Enthusiasm shows that leaders are interested in their practices and the steps needed to make it successful. Enthusiasm is contagious to fellow team members and should be a part of practice culture. Enthusiastic team members are excited to come to work, enjoy sharing experiences with others, appreciate humor, and enjoy the team-work environment.

Listening effectively has become a lost skill in today's world; talking has overtaken listening. Listening is the ability to receive, attend to, interpret, and respond to words and body language. Poor listening skills can result in misinterpretation of information, leading to malpractice in the medical field. Poor listening and interpretation can cause a communication breakdown when a leader is trying to manage a practice effectively and lead team members in a positive style.

One of the most important skills for effective leadership is to be an effective communicator. Communications must be done in a clear and pleasant manner. Effective communicators think clearly, talk sparingly, and listen intently. It is imperative to think topics through before jumping to a conclusion. All issues must be understood and interpreted before an action can be taken. Rash decisions should not be made, or devastating results may occur. Time should be taken to interpret the facts and prevent immediate judgments. Talking too much can be a problem itself and greatly inhibits listening. Tone is as important as talking; positive, enthusiastic tones are much more effective than negative, authoritarian tones.

Exceptional leaders create environments where team members are empowered to communicate openly, voice their concerns, and make changes where necessary to produce an improved service. Inhibiting this environment can be detrimental.

Ethnic cultures have different means of communication, and an effective leader must be able to determine the best method of communication for each. Morals and ethics vary among ethnicities, ultimately affecting the learning and training abilities of different team members. Leaders must be accepting of diverse cultures, welcoming the different qualities each possesses, and work with them to provide the best leadership possible.

Veterinary practice is a team business. A team is a simple concept: a group of individuals with different skills and attributes, which contribute the positive culture of the hospital. Effective leaders build teams that allow the business to succeed at all levels, including providing excellent patient and client care and maintaining a friendly and cohesive work environment, all while being able to create and maintain a profit for the practice. Leaders invite creative thinking from team members, and integrate this creative thinking into daily conversations. Creative thinking facilitates productive, problem solving team members that are not afraid to move outside the box.

When building teams, exceptional leaders attract the right people, and place them into the right positions. They also integrate personal growth with practice growth, which encourages career development of each team member. Without personal growth and development, the practice growth is stalled.

Leaders must possess skills to solve problems before they arise—to be proactive instead of reactive. Leaders determine the problem; collect, listen, and interpret the facts; and present a variety of solutions to the team. Team members should be asked how they would resolve a situation; their point of view is *critically* important in problem resolution. In addition, problem solvers are accountable and productive.

Leadership skills are not developed overnight; they come with patience, education, and trial and error. Managing a practice has both wonderful and terrible days. A leader is sometimes viewed as a "good guy," sometimes as a "bad guy," and sometimes as uncaring and lacking compassion. However, the success of a business can depend on the quality of the leader. Someone who is capable of being either a good guy or bad guy when necessary will keep the team focused so they provide excellent quality of care.

It Could be You:
Protect Yourself from Embezzlement

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

No one hires a thief; however, fraud and embezzlement occur in small businesses everyday. Participants will gain an understanding of when and how embezzlement occurs, and will leave with tools needed to decrease risk in the practice.

We would never hire a thief to work in our hospitals (intentionally, that is). Shockingly, theft and embezzlement happen everyday in veterinary practices. Often, we don't know how or where it occurs, or how to stop it when it is occurring. It starts with something little (stealing postage or stamps); the perpetrator then gains confidence in their skills and advances to something a bit more complex (inventory and supplies). Eventually, the dollars add up, which should attract the attention of the owner.

Many practices have fraud *opportunities* available, yet do not have a checks and balance system in place. Which of the following may be occurring, or has occurred in your practice?

Time: Employees arrive at the practice to begin their shift. They clock in, pour a cup of coffee, eat breakfast, *then* begin work. If this occurs daily, with an average of 5 employees, your total loss to time card fraud could be 3600 minutes, totaling over $900 per year. Doesn't seem like much? Wait till you add it to the additional areas outlined below.

Paper goods, inventory and medical supplies: One person orders supplies, receives the goods and places them in their appropriate storage location. Inventory is never tracked and the physical amount on hand is never compared to the computer count. Product can be taken by employees or given away to clients. Some employees intend to charge themselves (but forget); others feel the practice owes them the product, as their pay is not high enough to compensate for all they do for you. Unless you are tracking your inventory, you will never know this product is missing. Take a look at companies on the Internet to see what products and diagnostic testing kits may be selling in your area. Since inventory is rarely tacked in the veterinary practice, a dollar amount cannot be applied here. However, practices spend an average of 20-30% of their gross income on medical supplies. For a million dollar practice, this could be $200,000-$300,000 spent annually, with a hope of at least $400,000 to $600,000 (with a 100$ mark up) received in return. How much of these profits could you be missing?

Controlled Substances and prescription pads: These drugs and pads have a high dollar value on the street, and can enable an employee with a substance abuse problem. Ensure Controlled Substances are locked up according to DEA regulations and balanced on a monthly basis. Investigate any discrepancies immediately.

Cash: Cash is the easiest to steal and cover up. Team members accept cash, end of day reconciliations should be completed, and deposits must be made. End of day reconciliations should be compared to the deposits made to the bank (cash and checks) by someone other than the team members accepting cash, as this is an easy place to alter documents. It should be policy that every invoice is closed out, then a receipt generated when a client makes a payment. This will allow an audit trail to pick up any deletions of transactions made by team members. To add an additional layer of security, password protection should be enabled for any deleted invoices.

Client Credit Card Numbers: NEVER keep client credit card numbers on file. Employees can sell credit card numbers – racking up hundreds of thousands of dollars in charges. Protect your client's data – by following the Red Flags Rule established by the FTC. This should also be extended to client social security numbers; if any social security numbers are kept in files- shred them immediately.

Unauthorized discounts: Employees like to give friends and family a break, or perhaps give themselves a greater discount than authorized. Review your family and friends discount policy, along with the employee benefits. In addition, consider adding a password to the PMS in order to change the price of items or services. All discounts should be given a code, which will enable the owner/manage to start tracking discounts being given (and ensure they are authorized). According to Well Managed Practices 2011 (Tumblin, *Veterinary Economics*), 15-25% of gross income is lost, due to missed charges and discounts. If your practice is a million dollar practice, this could be $150,000-$250,000 dollars. Since discounts and missed charges are rarely tracked, practices can't put a true dollar amount on this factor.

Padding payroll: Does your practice have any oversight on payroll, or is one person responsible? Padding payroll hours and hourly rates can cost the practice thousands of dollars per year.

Padding Production: Yes, padding production. It has been shown that associates have adjusted production amounts in order to increase their production bonus. Enable a password in the practice management software to prevent the unauthorized change of production credit.

Accounting: Creating duplicate invoices, paying a creditor twice (and accepting the refund personally), and payment to a factious creditor has been reported. Paying personal and practice utility bills with the same check has also been reported.

The above are just a few fraud/embezzlement opportunities that exist in veterinary practices. Owners must put a checks and balance system in place to decrease the potential opportunity. Fraud will never be 100% preventable, but actions must be taken to decrease the risk.

Your practice action plan

1. **Step 1:** Return to the practice and review every opportunity in which theft, fraud or embezzlement could occur.
2. **Step 2:** Create a checks and balance system for each opportunity identified. One person cannot be in charge of the checks and balances; this is a multi person job. Do not forget to review payment accepting procedures, deposits, end of day reconciliation, inventory ordering, receiving and invoice reconciliation; invoice payments, checking account and credit card reconciliation, payroll and tax payments.
3. **Step 3:** Monitor the checks and balance system and tweak as needed.

Shake Things Up to Grow Your Practice

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

Making your practice more profitable and positioning it for continued success isn't about luck. You don't roll the dice and hope to meet your medical and financial goals for the year. Being profitable is about playing the right hand at the right moment and making changes in your practice that maximize your strengths. So use these five critical steps to ensure your practice will be flush with success.

Step #1: Enhance patient care

Differences in medical philosophies baffle doctors, staff, and clients and can lead to shortcomings in patient care. Say your standard is to perform annual wellness testing on all your senior patients. But only two of four doctors follow the protocol. This puts half your patients at a medical disadvantage. Don't make people guess what you want. Define your standards of care, get them in writing, and use them as a teaching tool to communicate your expectations to doctors and staff. Your goals are to provide high-quality care, nurture lasting client relationships, cultivate happy, productive doctors and staff, and enjoy a fun, profitable practice.

Every team member at your practice must be knowledgeable about your standards for the sake of consistency and continuity. It's up to you to teach and mentor your team members and communicate your expectations for upholding those standards of care. An effective training program ensures that new team members start off on the right foot and become successful. Regular internal and external CE encourages team members to grow and will net your practice major rewards in the future. Improving staff expertise frees you to focus on other things – like seeing more patients, taking a lunch break or ending the day on time.

Step #2 Create client-centric experiences

Yes, it's easy to go on autopilot in the exam room – especially when this is the sixth time today you've explained the importance of heartworm and flea prevention or discussed why it's not a good idea to delay the dental prophylaxis any longer. These days, however, you simply can't afford to coast. Every time you're about to step into the exam room, take a moment to refocus your energy on this particular client and patient. Look at the chart and note a couple of unique characteristics about this pet and owner. Then mention them during the visit.

The bottom line is that you want your clients to receive care that's relevant to them, custom-built for their pet, and different from what they can get anywhere else. Rather than talking throughout the appointment, try pausing for a few minutes at appropriate moments so you can listen – truly listen – to what your clients are saying. Make the experience about them. Being strongly present with each client and each patient creates inspiration in pet owners. Inspiration creates magnetism. And magnetism gets your clients to "yes".

Step #3: Improve profitability

Define your goals for spending and revenue growth. Set revenue and expense goals and then share them with the team members who'll help you achieve them. And don't forget to measure and analyze your performance. Create a systematic approach to reviewing your monthly results, and develop an action plan to respond to problems or opportunities you identify during this review. Search "budgeting basics worksheet" at www.dvm360.com for a tool to get you started. See figure 1, WellMP® Revenue Chart.

Step #4: Tap into revenue growth

Send consistent messages to clients with concise, clear, and specific recommendations. Clients should hear the same message from everyone on your team. If your standard is six-month exams for all senior patients, and the doctor and the technician explain that in the exam room but the receptionist says, "See you next year," the client will leave confused. Set compliance targets for the services you perform most often and that are most important to your patients and monitor the results (for a detailed plan on how to do this, see "Hit Your Goals" - Figure 2). Provide timely reminders about important services. Proactively take the lead with your clients by offering to schedule the next appointment at the end of the visit instead of waiting for the client to ask about additional care or other services.

Billing clients for all care provided is an opportunity to improve profit without raising fees. Track how often and by how much you're missing charges by completing a Case Review. Pull a random sample of 10 hospitalized cases and 10 outpatient visits for each doctor. Divide the cases among your healthcare team and ask them to compare the medical record of services provided to the client's invoice for services billed. Make a copy of the invoice and write a list at the bottom of the care that was provided for free (either intentionally or unintentionally) and the amount of the usual fee. (See "Case Review Summary", Figure 3 to help you tally the results.) Discuss and identify why the charges were missed. Are the doctors recording charges at the time of treatment – or waiting until later? Are they waiting until discharge to record charges for hospitalized cases? What discounts are doctors giving? Are your

team members creating estimates on the fly and underestimating prices? These scenarios lead to missed charges. Once you have an idea of why charges are slipping through the cracks, develop an action plan to improve how your practice charges for care provided.

Step #5: Protect your pharmacy

They may not know it, but clients receive amazing benefits if they purchase medications like heartworm, flea, and tick products from you rather than a pet specialty store or Internet pharmacy. Your job is to educate them about these benefits. Emphasize your quality control for handling and storing drugs. Share information about manufacturer guarantees. Highlight the convenience of purchasing necessary medications during client visits or ordering from your practice's on-line home-delivery pharmacy.

Plus – and this is very important – be sure clients know that your products are comparably priced. Many national retailers claim that they're less expensive, but often it's simply not true. Clients, however, don't realize this unless you point it out

The potential impact on revenue from lost product sales is significant, and many Well-Managed Practices are feeling the pinch. Thirty-four percent of Benchmarks 2013 participants report that their volume of medication dispensed dropped 5 percent or less in the last two years, while another 37 percent reported a decline of 6 percent to 10 percent (see Figure 4 for a year-to-year comparison).

In an Elanco-sponsored survey of approximately 1,600 dog owners, four out of five owners purchased flea medication from only one place, and 36 percent purchased exclusively through their veterinary clinic. Building your own online pharmacy may help increase those numbers. Plus, the study found that dog owners who purchased their flea and tick medication through their veterinarian were likely to visit the practice more often in the preceding year than pet owners who purchased from warehouse retailers or online pharmacies. So encouraging clients to buy from you not only protects revenue from that sale but also bonds pet owners to your practice and may even help drive up visit rates.

Step #6: Market your practice

For some, the word marketing conjures up thoughts of pushy salespeople touting their product or service as the "best", whether that claim is true or not. Some veterinary practices have been reluctant to advertise because of concerns it would seem unprofessional. If you share similar opinions, it's time to let go of the negative and embrace the positive side of marketing.

Marketing is really designed to create awareness and educate potential and existing clients about the care their pets need and the services and products you have available. Marketing drives client visits and revenue growth. Patients are more likely to get the care they need because of marketing. Your marketing plan will identify the messages you want to promote, the platforms/formats you'll use to get your messages out, who's responsible for each segment of the plan, how much time will be allotted to implement each segment of the plan, the budget you've got to work with, the results you want to accomplish, and a plan for monitoring and tracking the results.

Figure 1 – WellMP® revenue chart

The key to successful revenue is to consider every factor that affects your revenue. Shown below are the 12 critical components of revenue and comparisons from Well-Managed Practices®. Measuring your practice's results against these benchmarks will help you identify opportunities for growth.

Revenue

	WellMP®	Your Practice
All revenue	$617,100/Doctor	$_____
Medical revenue	$555,100/Doctor	$_____
Other revenue	$ 62,000/Doctor	$_____

Average doctor transactions (ADT)

	WellMP®	Your Practice
ADT	$173	$____
Exam	$ 50	$____
Other	$ 61	$____

Transactions

	WellMP®	Your Practice
All transactions	5,200/Dr.	_____
Medical transactions	2,900/Dr.	_____
Other transactions	2,300/Dr.	_____

Fees

The overall fee structure and the service/product mix are the two main determinants of a hospital's ADT.

Services

Active Clients

WellMP®	Your Practice
990/Dr.	_____

Visitation

	WellMP®	Practice
Medical	3.0/yr.	_____
Other	2.2/yr.	_____

Accounts Receivable

WellMP®	Your Practice
1.6%	_____

New Clients

WellMP®	Your Practice
18/Mth/Dr.	_____

Retention

WellMP®	Your Practice
4.3 yrs.	_____

Awareness

How well known is your practice in the community?

Visits Scheduled

WellMP®	Your Practice
70%	_____

Age of Active Patients

	WellMP®	Your Practice
< 3 yrs.	27%	_____
3-6 yrs.	26%	_____
6-9 yrs.	22%	_____
> 9 yrs.	25%	_____

Figure 2 – Hit your goals

Randomly choose 20 outpatient medical records per doctor. Compare the care provided per the medical record to the ideal care outlined in your standards. Identify whether:

- The recommended care met your practice's standards.
- The patient received the recommended care.
- The record noted any recommended care the client declined.

Compile the results and calculate your client compliance rates. If your actual compliance rates are lower than your targets, discuss the results with your team and develop an action plan to improve your success rate.

Example

A three-doctor practice with 4,500 active patients (60% canine, 40% feline) pulled 60 medical records. Thirty of the record samples were canine patients and thirty were feline patients. The hospital's standard of care includes annual fecal exams and annual heartworm testing for all patients. The staff reviewed the record sample for compliance with fecal and heartworm testing. Their results follow.

Services	Active Patients		Target Increase		Tests Needed		Fee		Increased Revenue
Fecal exams: The team reviewed 60 records: 30 of the patients had a fecal exam. So the compliance rate was 50 percent.	4,500	x	20%	=	900	x	$23 fee	=	$20,700
Canine heartworm testing: The team reviewed 30 records; 24 patients had a heartworm test. The compliance rate was 80 percent.	2,700	x	15%	=	405	x	$40 fee	=	$16,200
Feline heartworm testing: The group reviewed 30 records; nine of the patients received a heartworm test. The compliance rate was 30 percent.	1,800	x	15%	=	270	x	$50 fee	=	$13,500

Total potential increase in revenue = $50,400

Figure 3 – Case review summary in a well-managed practice®

Doctor or Practice Name _____

Outpatient Case Analysis

1. Number of cases reviewed _____
2. Number of cases with missed charges _____
3. Percent of cases with missed charges (line #2 ÷ line #1) _____
4. Total dollar value of missed charges _____
5. Average dollars missed per case (line #4 ÷ line #2) _____
6. Estimated annual number of outpatient cases _____
7. Estimated annual missed charges (line #6 x line #3 x line #5) _____

Types of services or products missed

_____ _____
_____ _____
_____ _____

Inpatient Case Analysis

1. Number of cases reviewed _____
2. Number of cases with missed charges _____
3. Percent of cases with missed charges (line #2 ÷ line #1) _____
4. Total dollar value of missed charges _____
5. Average dollars missed per case (line #4 ÷ line #2) _____
6. Estimated annual number of inpatient cases _____
7. Estimated annual missed charges (line #6 x line #3 x line #5) _____

Types of services or products missed

_____ _____
_____ _____
_____ _____
_____ _____

A. Total estimated annual missed charges (Outpatient line #7 + Inpatient line #7) _____
B. Total annual doctor transactions (Outpatient line #6 + Inpatient line #6) _____
C. Estimated increase in Average Doctor Transaction (line A ÷ line B) _____

Figure 4 – Slipping product revenue

How much has your volume of medication dispensed declined in the past two years because clients are using internet pharmacies?

	2013	**2011**	**2009**	**2007**	**2005**
No change	23%	13%	13%	15%	19%
Less than or equal to 5%	34%	48%	52%	63%	65%
6% to 10%	37%	32%	28%	27%	12%
11% to 20%	5%	7%	5%	3%	4%
More than 20%	1%	0%	2%	1%	0%

Source: Benchmarks Well-Managed Practice Studies by Wutchiett Tumblin and Associates and Veterinary Economics

It's Time to Get Serious about the Budget

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

What would you do with an extra $10,000 to $20,000? How about an extra $50,000? Perhaps you'd invest in that new piece of equipment you've been eyeing. Perhaps you'd invest in raises for deserving staff members. Perhaps you'd set it aside to build a cushion for a rainy day, or even give yourself an overdue raise. It's fun to dream about the possibilities of extra cash in your pocket.

Watching what you spend may come naturally in your practice. You work with a practice budget, compare your numbers to the WellMP benchmarks, and adjust your spending when necessary. If so, kudos to you and your staff! But if you're not quite where you'd like to be when it comes to taking charge of your expenses, now's the time to put your expenses on a diet.

Rather than adopting the "starvation" approach to accumulate the extra cash, start with these Five Easy Slim Downs and these benchmarks to help you pinpoint where your spending is a little heavy. Then get started with your practice slim down to save that extra $10,000 to $20,000 towards your dream list.

Pare down your drug inventory

If your shelves are looking a bit bloated, it's time to eliminate the excess. Veterinarians have many wonderful drugs to choose from to treat patients. But carrying every wonderful medication that's available ties up a lot of cash and creates confusion for the staff and for clients. Doctors – unite! Create a list of the medications that you believe in the most. Conduct a scientific comparison of the duplicate products you have on your shelf. Consider the pros and cons, safety, and efficacy of each. Make your case scientifically and medically and come to a consensus among the doctors about what's your best and second choice. Then eliminate any other redundant items from your shelves.

- Tip: Stock $10,000 to $16,000 of drugs and medical supplies per full-time equivalent doctor, or about one month's supply. This includes heartworm, flea and tick products and excludes diets.
- Tip: Spend 8% to 9% of revenue on drugs and medical supplies. Spend 4% to 6% of revenue on heartworm, flea and tick products.
- Tip: Move infrequently-used medications to your on-line store.

Evaluate your labor cost

What one or more things could you do differently to increase efficiency and productivity in your hospital? It's not unusual for different practices to have the same level of staff support, but significantly different levels of doctor production. I'm currently working with two practices, each with a 4 to 1 staff-to-doctor ratio; one generates about $440,000 of medical revenue per FTE doctor and the other generates $670,000 per FTE doctor. What accounts for the $230,000 difference? Explore the following opportunities to rev up your practice's productivity.

- Do more with less. Bump your pay scale to attract more skilled and efficient employees. We've all experienced the employee who seems to get twice as much done in half the time as two other employees combined. You might find that an employee who merits $18 an hour could easily complete the work of two, less productive $12 an hour employees. The result: an annual savings of $10,000 to $12,000 depending on the benefit package.
- Streamline your processes. It's easy to get into the routine of "that's the way we've always done it." Take a fresh look at your protocols – are you doing things the easiest, most efficient way, or could you streamline the process? Are staff members duplicating efforts? Eliminate the redundancies. Are you taking extra time to track information that no one is using? Then stop.
    - Tip: Hold a contest for your staff. Ask each staff member to submit one or two ideas to improve efficiency throughout the hospital (reception, exam rooms, treatment, surgery, boarding, etc.). Give awards for the top four ideas (first, second, and third place, and honorable mention). Be sure your awards are meaningful and compelling. For example, first prize gets a paid day off; second prize gets a gift certificate for a local spa; third prize a gift certificate for a favorite local restaurant; and honorable mention gets tickets to the movie of their choice. Or, you could let the winners choose which award they would like out of your offerings.
- Get organized. Clutter and untidy work stations add to the chaos of busy days. Spend a day eliminating the mess. Move frequently used items to more accessible parts of the hospital to eliminate wasted steps. Move rarely used items to storage. Get rid of items in storage that you haven't used for a year or more. Adopt the creed: reduce, reuse, recycle. The hospital will look better, and the doctors and staff will feel better and be more productive!
- Convert under-utilized space to a medical purpose. Some hospitals have idle or under-used space that's begging for use as a medical area. For example, convert a food storage space to another exam room. Convert an under-utilized retail

space to a patient discharge room. Convert an under-utilized storage space adjacent to treatment to a dental suite or a procedures room.

- Tip: Hold a contest for your staff to solicit their ideas about under-utilized areas of the hospital that could be converted to medical use. Give awards for the top ideas (see suggested prizes above).

Bump up your use of technology

Update and/or replace hardware to reduce wasted time waiting for the computer to process or recovering from a crash because the system can't handle the hospital's current needs. Update your software to the latest version. Replace your software if the company hasn't provided updates for years or their support is poor. Convert to electronic medical records to eliminate wasted time searching for lost or misplaced records. Technology saves time and reduces frustration when used well.

- Tip: Hire a trainer from your practice management software company to spend a day with your staff teaching them more about your software's capability. Staff members know the basics. But they may not be aware of all the shortcuts that help streamline their work, or the options that help enhance client service and patient care. The return you'll receive will be much greater than the cost of the training. Example: One veterinary practice estimated that the knowledge they gained from the training saved three staff members an hour a day, which amounted to an annual labor savings of about $15,000.

Revisit your administrative costs

It's easy for fixed overhead spending to creep up without realizing it. Don't let the word "fixed" change your mind about giving these expenses another look.

- Use e-mail for reminders, newsletters, educational materials, and other client correspondence instead of the U.S. postal service. Postage adds up and clients may actually prefer to receive information via e-mail.
- Take stock of your office supplies. Organize your inventory in one central location so everyone knows what you have on hand before requesting and ordering more. Change reorder points to minimize the amount of inventory you have on the shelf before placing a new order.
- Evaluate employee health insurance. Talk with your insurance agent about health insurance policies with higher deductibles and co-pays. Sometimes the premium savings is greater than the difference in the deductible, so you can offer to pay part or all of the difference in the deductible and still lower the practice's cost. Ask your agent to research other policies with lower premiums and similar coverage options. Consider having employees cover part of their health care.
- Assess your Workers' Compensation Insurance rates. Coverage managed by a private insurance company, if an option in your area, might offer better rates than a fund managed by your state.
- Conduct an energy audit in your practice. A professional energy audit gives you a clear picture of where your practice is losing energy and what you can do to save money. Possible resources to conduct the audit include your state or local government energy or weatherization office or your electric or gas utility company. Per www.energy.gov, you can save 5% to 30% on your energy bill by making the recommended upgrades. Visit www.greenyour.com for an energy audit checklist.
- Investigate the possibility of refinancing your debt. If you've got any high-rate loans, act now to see what your options are for getting into a more favorable rate.

Think twice before investing in equipment

Do the math to determine if the equipment purchases you're planning will pay for themselves in a reasonable timeframe. Investing in equipment helps you enhance patient care and client service, and grow your practice. But fabulous equipment rarely used, is a poor investment. Take the time to evaluate how often you'll use the equipment and the revenue potential before taking the plunge.

Compare your expenses to these benchmarks

Variable expenses (as a percentage of total revenue)	
Drugs and medical supplies (includes radiology, surgery and hospital supplies but excludes food, shampoos, etc.)	9.8%
Heartworm, flea, and tick products	3.9%
Laboratory	4.0%
Diets (therapeutic and retail)	2.9%
Over-the-counter retail products (e.g. toys, collars, shampoo)	0.4%
Credit card fees	1.5%
Bad debt, collection fees	0.1%
Cremation, care of remains	0.5%
Sales and use tax	0.7%
Medical waste disposal/radiation badget monitoring	0.1%
Total	**24.0%**
Fixed expenses (as a percentage of total revenue)	
Advertising and promotion	0.8%
Bank charges (monthly maintenance fees)	0.1%
Business consulting services	0.3%
Business meetings	0.1%
Charitable contributions	0.1%
Continuing education, meetings, and travel	0.4%
Entertainment	0.1%
Equipment repairs, maintenance, and support contracts	0.4%
Health insurance	2.0%
Laundry and uniforms	0.1%
Legal and accounting fees	0.5%
Liability insurance	0.2%
Licenses and permits	0.1%
Miscellaneous	0.4%
Office and computer supplies	0.7%
Payroll service costs, retirement plan administration fees	0.2%
Postage, freight, and delivery	0.2%
Printing	0.2%
Professional dues and subscriptions	0.2%
Technical (IT) support contracts	0.3%
Telephone, answering service, internet connection	0.5%
Workers' compensation insurance	0.4%
Total	**8.3%**
Non-doctor staff compensation (gross W2 wages as a percentage of total revenue)	
Wages	21.6%
Payroll taxes & retirement contributions	2.5%
Total	**24.1%**
Facility expenses (as a percentage of total revenue)	
Annual rent or mortgage payments (excluding property taxes, insurance & utilities)	5.4%
Utilities (gas, water, electric)	0.8%
Janitorial, housekeeping, and garbage	0.4%
Facility repairs, maintenance, lawn care, and security monitoring	0.6%
Property insurance	0.2%
Real estate taxes	0.5%
Total	**7.9%**
Reinvestment	
Medical equipment	2.0%
Computer equipment	1.0%
Facility improvements	1.0%
Total	**4.0%**

What Well-Managed Practices Pay- Are You in the Ballpark?

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

Practices must stay on top of current trends in doctor and staff compensation and benefits to remain competitive and attract efficient, effective and productive employees. Pay scales must also reflect the level of education, experience, skill and personal attributes you want employees to bring to the table. So, what are the latest trends? Benchmarks 2013 – A Study of Well-Managed Practices® sheds light on this hot topic.

Employed veterinarians

The majority of practices now pay their doctors some form of incentive-based compensation. About 27% pay purely based on production. Another 48% pay doctors a guaranteed base plus a percentage of production over a required minimum. The remaining 25% pay their doctors a fixed salary.

Practices who use a blended rate – i.e., one percentage applies to all medical service and product production – typically pay their doctors between 16% and 21%. Where they fall in the range is dependent upon the practice's staff-to-doctor ratio. The more staff the practice provides to assist the doctors, the lower the percentage paid to the doctors. The additional staff members allow the doctors to produce at a higher level, which increases doctor compensation. The practice also has an added layer of overhead because of the additional staff members, which the doctors must help support.

Practices who use a split-rate – i.e., one percentage applies to medical service production, and a different percentage applies to medical product production – typically pay their doctors between 22% and 26% for services, and 4% and 10% for products. The service/product split – i.e., how much of medical revenue comes from services and how much from product sales - and the staff-to-doctor ratio will both impact where you end up in the stated ranges.

To make any percentage-based compensation system work, every team member must understand what is and isn't credited to the doctor's individual production. Doctors receive credit for all medical service revenue provided during an outpatient appointment, in-hospital treatment, or dental and surgical procedures. Doctors also receive credit for medications and therapeutic foods dispensed during an outpatient appointment, during in-hospital treatment, or at the end of a patient's hospital stay.

Prescription refills and additional food or product purchases that don't involve a doctor are credited to a hospital provider. The doctor receives credit for the refill only if it requires his or her time to review the record, assess if the medication or dosage needs to change, and give direction to the staff member who will fill the prescription. Doctors never receive credit for boarding, grooming, or retail purchases.

When multiple doctors collaborate to treat a patient, the doctor who provides each point of care receives credit. For example, if Doctor A examines and admits a patient to the hospital on Day 1, and Doctor B provides or supervises the hospital treatment on Day 2, Doctor A gets credit for everything on Day 1, and Doctor B gets credit for Day 2.

See **Figure 1** for the latest on starting salaries for associates based on years of experience. See **Figure 2** for other employee benefits.

Non-doctor staff compensation

Practices spend between 21% and 25% of revenue on staff compensation, payroll taxes, and retirement contributions. This includes all non-doctor staff positions *except* groomers – so, hospital administrators, practice managers, receptionists, credentialed technicians, veterinary assistants and kennel/ward attendants are in this number. Where you fall in this range will depend on the cost of living in your area, the skill set of your staff, and your staff-to-doctor ratio. See **figure 3** for the latest pay ranges by position.

If your staff costs are high, start by evaluating productivity. Often the issue isn't over-spending, but rather lower-than-expected productivity. Low productivity has a variety of reasons. Sometimes it's caused by giving away or significantly discounting care that the practice provides. Sometimes it's related to a lower-than-warranted fee structure. Sometimes it's due to a lack of skills or inefficient processes. And, sometimes a practice employs people who are a poor fit and who put a damper on the morale of the other team members. Before you start thinking of ways to cut staff expenses, first determine why your cost is high.

Resources to help evaluate your compensation and benefits

- Benchmarks 2013 – A Study of Well-Managed Practices®
- Compensation and Benefits by AAHA Press
- On-line sources such as www.salary.com or www.payscale.com

Figure 1 – Starting salaries for employed veterinarians

Years of Experience	Median	75th Percentile
0 to 2.9 years	$67,500	$75,000
3.0 to 5.9 years	$76,000	$90,000
6.0 to 10.9 years	$79,500	$100,000
11.0 to 15.9 years	$90,000	$105,000
16.0 to 19.9 years	$87,500	$106,500
20+ years	$94,000	$105,000

Source: Benchmarks 2013 – A Study of Well-Managed Practices® by Wutchiett Tumblin and Associates and Veterinary Economics; the latest compensation and benefits results from Benchmarks 2015 will be provided during the presentation.

Figure 2 – Benefits in well-managed practices

	Percent Who Provide
Continuing education	96%
Staff single coverage health insurance	87%
Staff family coverage health insurance	23%
Dues & licenses	87%
Retirement plan	85%
Bonus commission	39%
Disability insurance	27%
Child care	2%

Source: Benchmarks 2010 – A Study of Well-Managed Practices® by Wutchiett Tumblin and Associates and Veterinary Economics; the latest compensation and benefits results from Benchmarks 2015 will be provided during the presentation.

Figure 3 – Pay ranges by position

Position	Low Median	Low 75th Percentile	High Median	High 75th Percentile
Hospital Administrator	$22.00	$28.00	$24.25	$30.00
Practice Manager	$21.00	$27.00	$23.30	$28.75
Receptionist	$11.00	$12.00	$15.75	$18.20
Credentialed Technician	$14.00	$16.15	$18.60	$22.00
Veterinary Assistant	$10.65	$12.00	$15.00	$17.00
Ward/Kennel	$8.50	$10.00	$12.00	$13.80

Source: Benchmarks 2013 – A Study of Well-Managed Practices® by Wutchiett Tumblin and Associates and Veterinary Economics; the latest compensation and benefits results from Benchmarks 2015 will be provided during the presentation.

Write an Rx for Your Success (Parts 1 and 2)

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

Financial security for your practice and your family takes planning and paying attention. Where do you begin? Take these steps today to ensure a strong, stable future.

Establish effective documentation systems
Use veterinary and accounting software and a Management Statement™ to manage your patient and financial records. Execute partnership/shareholder contracts, a buy/sell agreement, lease agreements for equipment and the facility, employment agreements, etc.

Create a foundation for effective practice leadership
Identify the leaders, doctors, and advisors required for practice success. Establish and define responsibility for areas of management for the owners. Create an internal communication structure. Establish and define the management positions at the staff level. See Collaborative Teamwork Charts.

Envision the ideal healthcare team
Determine the key positions and the number of support staff needed to meet patient care and client service goals. Define the parameters for selecting the right people for each position. Establish the pay scale by position and for each level of competency within each position. Identify the training and education required for continued growth. Define the evaluation and promotion protocols for your practice.

Determine if the facility configuration and size continues to meet your clients' and patients' needs
Do you have a well-designed site and floor plan with ample parking, a sufficient number of exam rooms, and ample treatment and surgery areas? Does your location continue to be desirable? Is it visible, accessible, and have room to grow? Pay attention to your physical appearance – the grounds, building, and staff must present a professional, clean, well-maintained image. Stay in tune with your environment to ensure it's stress-free, warm and welcoming.

Develop a practice budget
Start with the information you already know – your current year-to-date revenue and expenses. Also consider any additional goals you want to achieve. Lastly, look at benchmarks set by other practices to get an idea of spending levels (see Benchmarks 2015 A Study of Well-Managed Practices® at www.wellmp.com/Benchmarks, or Financial Productivity Pulsepoints by AAHA). Keep this data handy as you plan your revenue and expense changes for the coming year.

- **Revenue.** How much will revenue grow next year? Consider planned fee changes, compliance initiatives that will result in providing more of existing services, and new services you're adding to the practice such as laser therapy, ultrasound, behavior consulting, rehabilitative therapy, or acupuncture.
- **Expenses.** How will your operating expenses change next year? Have you targeted a reduction in some line items like inventory costs? Are you planning increases in other items like staff compensation or equipment purchases? Determine where your spending will remain the same, drop or rise.

Develop a personal budget
Tracking your personal household income and expenses and developing a budget provides an organized, systematic approach to efficiently measure and analyze your personal financial position. Begin with the information you already know – your current year-to-date income and expenses. Then consider any changes or new goals for the coming year.

- ***Income*** - Is your share of income from the practice or any other businesses you own likely to increase or decrease? Is your spouse/partner expecting any increases or decreases in income? Project how your household income will change for the coming year.
- ***Expenses*** – How will your required expenditures change in the coming year? Consider loan/lease repayments on credit cards, autos, your home, or any other debts. Plan for any expected increases in property taxes, insurance, utilities, medical expenses, and auto expenses. Do you have any home repairs on tap? What about alimony or child support? Consider any changes to discretionary expenditures like clothing, travel and vacations, entertainment, club dues, gifts and charitable contributions, etc. And, don't forget about contributions to savings and retirement accounts or your children's educational funds.

Manage your debt

Maintain a Debt Worksheet that tracks all outstanding loans and leases and includes the original debt amount, payoff date, interest rate, monthly payment, and current outstanding balance. When you've got extra cash, make additional payments on loans with no pre-payment penalties to reduce the interest paid over the life of the loan. Apply the extra payments towards the highest interest-rate loans first.

Have appropriate insurance coverage

Talk with your insurance representative to determine your personal and practice needs, including:

- Auto: consider bodily injury, property damage liability, personal injury, uninsured or underinsured motorist, and collision and comprehensive coverage
- Home property insurance: protection for your dwelling, other structures, and personal property, reimbursed living expenses, flood, earthquake, water backup, identity theft restoration, and a personal umbrella policy.
- Practice property insurance: two types of policies - named-perils policy, which only covers losses resulting from particular events named in the policy, and an all-risk policy (also known as special form coverage) which covers all events except those specifically named. The type of business and your location and region of the country are all considered when determining which risks are more likely to affect your business. Property insurance covers loss from fire, theft or vandalism, provides financial assistance to help cover the cost to rebuild or repair business property so that operations can continue with as little disruption as possible, and includes compensation to repair damaged business property or replace what you've lost. Other available coverage includes undamaged stock, data or records, computer virus, intangible coverage, off-premises property, and terrorism.
- Employment Practices Liability Insurance: protects against claims filed by disgruntled employees.
- Health Insurance: provides coverage for medical costs.
- Liability/Malpractice Insurance: protects professional advice- and service-providing individuals and companies from bearing the full cost of defending against a negligence claim made by a client, and damages awarded in such a civil lawsuit.
- Workers' compensation: offers payments to employees who are (usually) temporarily, unable to work because of a job-related injury; compensates for economic loss (past and future), reimbursement or payment of medical and like expenses, general damages for pain and suffering, and benefits payable to the dependents of workers killed during employment.
- Disability Insurance: designed to replace anywhere from 45-60% of your gross income on a tax-free basis should a sickness or illness prevent you from earning an income in your occupation.
- Business overhead expense: reimburses a business for overhead expenses should the owner experience a disability. Eligible benefits include: rent or mortgage payments, utilities, leasing costs, laundry/maintenance, accounting/billing and collection service fees, business insurance premiums, employee salaries, employee benefits, property tax, and other regular monthly expenses.
- **Life Insurance:** provides cash to your beneficiary(s) in the event of death. Life insurance proceeds are often used to fund the purchase/buy-back of a deceased partner's share of the practice.

Review contracts and agreements regularly

Review Employment Agreements annually, practice Operating Agreements every 3 to 5 years and whenever you're planning a partial or full practice sale, and Buy Sell Agreements every 3 to 5 years and whenever you're planning a partial or full practice sale.

Clean up your financial records

Eliminate the mixing and mingling of personal and practice expenses. Be sure that the practice financial statement reflects only the operating expenses of the practice. Prepare and review the practice's financial statements on a monthly basis. Prepare separate, cost-center financials if you're a mixed animal or multiple-location practice.

Conduct annual strategic planning meetings

Strategic planning is a must for businesses to excel and move forward. To determine where the practice is going, you need to know exactly where it stands, then determine where you want to go and how to get there.

Complete a financial security plan

Financial planning entails identifying your desired standard of living/income needs, your existing sources of income and the value of your investments, and the value of your practice and any other businesses you own. See figures 1 and 2 and see www.wellmp.com/managementtools/itemS2.

Identify who will buy your practice

Will you sell to an existing partner, a current or future associate, an outside independent practitioner, or a corporate consolidator?

Prepare your buyer

If you're planning to sell to a current or future associate, develop a plan to mentor him or her about the business of veterinary medicine, involve the associate in management decision-making, explain the sale process, illustrate affordability and discuss financing.

You can't plan for every eventuality, but using last year as your baseline, learning from your mistakes, setting quantitative goals that can be measured, and creating a plan to ensure you achieve your goals will put you well on your way to accomplishing financial security.

Figure 1 – Investment sources

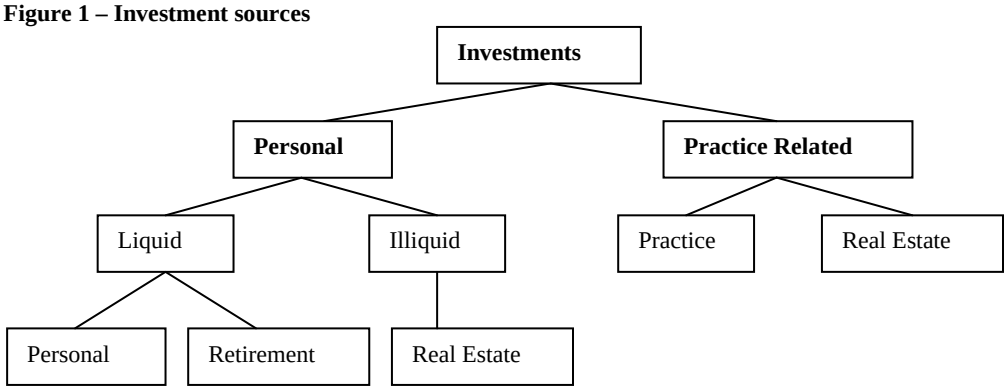
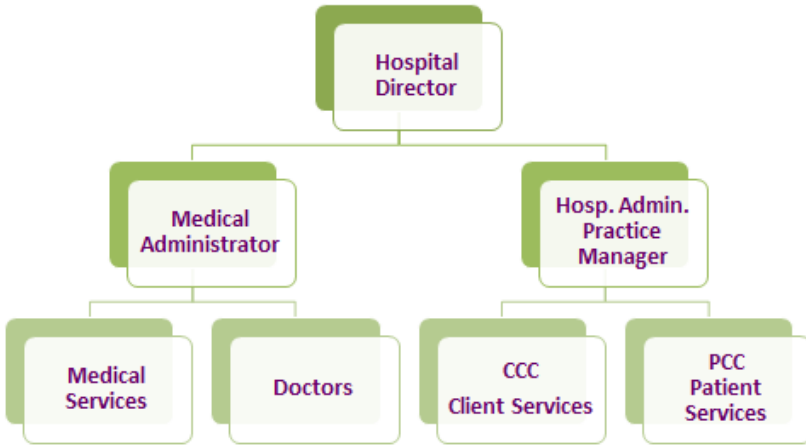


Figure 2 – Planning for financial security

Expenses			Income	
Living Expenses	$ 110,000		Personal Investments	$ 700,000
Tax Liability		40,000	Practice Real Estate	700,000
Annual Cost of Living	$ 150,000		Practice	?
Annual Cost of Living	$ 150,000		*Future Value of*	*$1,400,000*
Return on Investment		÷ 6%	*Investments without Practice*	*Investment Base Required*
$2,500,000				
Target Value	$2,500,000			
Value without Practice	1,400,000			
Shortfall	**$1,100,000**			

Collaborative teamwork organizational charts



Find Practice Health- Get LEAN!

Denise Tumblin, CPA
Wutchiett Tumblin and Associates
Columbus, OH

Products made in Japan 50 years ago evoked images of mass-produced, low-quality goods. Today Japanese brand names such as Toyota, Lexus, and Honda signify quality and durability. How were the Japanese automakers able to improve quality and reduce cost? Did they just get lucky? No, they got Lean!

While Lean started in manufacturing, Lean processes translate to service industries too. There are tremendous opportunities for the use of Lean in healthcare. A study of human healthcare facilities concluded that the facilities spent 75% of their time on non-patient tasks related to communicating, coordinating, and documenting care. In addition, a 2003 report by the New England Journal of Medicine reported a 45% defect rate in human healthcare. The overall goal of applying Lean strategies in healthcare is to initiate a process of continuous improvement to improve patient outcomes while lowering costs.

Several human healthcare facilities have used these statistics as a lever for implementing Lean. The results are impressive. ThedaCare, a Wisconsin-based health system, reduced inpatient total cost of care by 25% while improving patient satisfaction to nearly 100%. Seattle Children's new surgery center reduced nonoperative time by 50% versus the main campus surgery center.

Lean defines waste as any activity clients view as not adding value to their experience and not meeting their needs. By focusing on activities which meet the needs of the client, you will realize benefits such as:

- Improved patient care
- Improved client satisfaction
- Improved staff satisfaction
- Reduced inventory
- Improved flow of patient care
- Reduced expenses

Waste goes beyond expired medications. Lean identifies seven areas of waste.

- Unnecessary services. Do your appointment scheduling and patient protocols include redundant activities?
- Mistakes. Does your staff regularly need to redo and correct errors?
- Delays. Do equipment failures and wait times for obtaining charts, medications, and other information happen regularly?
- Unnecessary motion. Could you move equipment or supplies to reduce or eliminate wasted effort to increase efficiency?
- Over-processing. Review your protocols and processes on a regular basis to determine if they are still relevant and provide value.
- Excess inventory. This goes beyond the products stocked for retail sale and doctor use. For example, too many files leads to the need for more cabinets and more floor space. Do you have files and equipment you have not used for months cluttering your work area?
- Excess transport. Do you juggle patients and clients among rooms?

In addition to the above areas, are you "wasting" the skills of your employees? Do you offer your staff the ability to use their creativity and knowledge to the fullest? Lean processes offer staff members an opportunity to add to practice profitability by creating ways to eliminate waste. The traditional top-down management style places stress on the owner to lead initiatives and ensure implementation. Lean processes empower employees to inspect their own work and redesign their work processes to maximize efficiency. The result - more time to practice medicine and staff members have newfound enthusiasm for their work.

One of the strengths of Lean is its focus on action. You can get started right away with a small project, see immediate results that excite you and your staff, and leverage this momentum to take on a larger project. The first step - designate a Change Agent. The leader of your Lean initiative must have an open mind about change and be able to make things happen. He or she can seize upon a frustrating experience and turn it into an opportunity to start a Lean project. For example, a staff member may struggle to find needed medical equipment in a storage area. The Change Agent can use this experience as an opportunity to rearrange the storage area in a way that makes items easy to find and reduces frustration and wasted time.

The Change Agent begins the Lean project by implementing the 5S System for the targeted area of improvement. While originally 5S was used as a tool for maintaining clean work areas, it has evolved into a systematic method for reducing costs, improving work flow, and empowering employees to assist in reducing waste. The staff members closest to the service now have the authority and tools needed to improve work processes or work areas.

Once the first Lean project has been identified, begin by taking photographs or video of the area of focus. Before and after pictures are a powerful tool for showing staff members the benefits derived from Lean initiatives. Next, utilize the 5S steps.

1. Sort
    - Eliminate unneeded items within the target area. Dispose of items that aren't needed. Fight the urge to hold onto items because you might need them in the future.
2. Set-In-Order
    - Current State. During this step, document the location of each item and the current work flow. Create a map of the area to outline it, identify the large items, and map the flow of patients, clients, employees, and paperwork. Label all significant items, so they are easily identifiable to staff members. This process, called mapping a value stream, creates a one page picture or flow chart of the current process, and helps identify redundant steps and unnecessary motion.
    - Future State. With the current state mapped, now create a future state value stream map. How can you eliminate waste identified in the current state value stream map? What is the ideal flow for completing a task? Brainstorm with your staff to create an area which has great flow, is well ordered, and reduces unnecessary movement. Items are now well-labeled and anything can be found within seconds. Everything has a place and there is a place for everything.
3. Shine
    - Inspect, clean, organize, and de-clutter the area and items within the area. Repair or replace frayed cords, bad bulbs and batteries, and worn-out parts.
4. Standardize
    - Create standards and visual controls such as signs and checklists to improve efficiency and reduce errors. Signboards and color code indicators provide important information at a glance.
5. Sustain
    - Teach employees your Lean processes and protocols, so everyone understands the benefits. Continue to evaluate additional Lean opportunities.

As with any change, you may encounter staff resistance. People may not understand the need for change, may fear it will lead to more work, or may not understand that they will be playing a key role in determining the changes. Commit to the program, explain the need for the changes, and address the fears of the resistors. Unfortunately about 10% of the workforce might remain resistant to the change and leave. But those who embrace Lean will enjoy improved safety, work flow, and reduced costs that lead to increased customer satisfaction, employee engagement, and practice profitability. Don't wait to realize the benefits of Lean. Implement Lean in your practice now!

Pebbles in the Stream: Nephroureterolithiasis

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

- Most (probably > 90%) upper urinary uroliths are composed with calcium oxalate.
- Upper urinary tract urolithiasis is being recognized more frequently.
  - 50 fold ↑in upper urinary tract stones between 1980-2000
  - Nephroliths not associated with higher mortality in Feline CKD
  - Ureteroliths associated with higher mortality in Feline CKD
  - In 19 cats treated with renal transplantation for ureterolithiasis
    - 5/18 developed new calculi
  - 23% of cats presented for peritoneal dialysis, 60% survival
  - 50% of hemodialysis patients
- **Clinical signs**
  - Upper urinary tract uroliths (nephroliths and ureteroliths) can lead to obstruction to urine flow, deterioration of renal function; serve as a nidus for bacterial urinary tract infection, hematuria, or pain.
    - Clinical signs, when present, include systemic signs associated with renal failure or pyelonephritis, vague signs (abdominal pain, arched back, vomiting, or anorexia) or hematuria.
    - Sometimes animals present for an abrupt change in behavior or an acute onset of abdominal pain or vomiting when an acute ureteral obstruction occurs; this may be mistaken for intervertebral disk disease.
- **Clinicopathologic finding**
  - Most common clinicopathologic findings include azotemia, hyperphosphatemia, hyperkalemia, hypercalcemia, anemia, and hypocalcemia. Many of these may be related to the associated CKD.
- **Diagnosis**
  - Combination of survey abdominal radiography and abdominal ultrasonography has a 90% sensitivity.
  - Additional techniques to consider include excretory urography, excretory CT, antegrade pyelography, and determination of GFR (with and without furosemide)
- **Treatment**
  - General principles
    - Not all upper tract uroliths require treatment especially by surgery.
      - In one study, presence of nephroliths without ureteral obstruction, was not associated with progression of chronic kidney disease
    - Treat ureteral obstruction if present
    - Treat secondary issues
    - Manage CKD – 80% of feline nephroliths occur in cats with CKD
  - Supportive therapy
    - IV fluid therapy
      - The most important component of therapy. Rehydrate and monitor hydration status. This should be done over 6-12 hours if possible.
    - Treat hyperkalemia if life threatening characterized by bradycardia, sinoatrial arrest, that may result in ventricular tachyarrhythmia
      - Calcium gluconate: 10% solution: 0.5 ml/kg IV over 10-20 min
    - Analgesia as patients may experience renal “colic”
    - Manage nausea / vomiting
    - Anti-hypertensives – treat systemic arterial hypertension, if present
      - In one study, “aggressive” amlodipine therapy was safe and effective and associated with decreased mortality
      - Amlodipine: 0.25 mg/kg PO q1h for up to 3h with a goal to lower systolic blood pressure to < 160 mmHg
    - Nutritional support
    - Antimicrobials (if infected)
- **Medical management**
  - Struvite, urate, and cystine uroliths may be medically dissolved; however, with nephrolithiasis, dissolution times are typically long and monitoring of urolith position and renal function is important.
  - Consider **dialysis** for stabilization. Dialysis is the process of removing solutes and/or water from plasma to another dialysate through a semi-permeable membrane. The 2 types of dialysis are peritoneal dialysis and hemodialysis. It involves the use of one type of semi-permeable membrane that allows the passage of small molecules while preventing the transfer and loss of large molecules. In peritoneal dialysis, the peritoneal membrane, interstitial tissue, and capillary endothelium act as the membrane. In hemodialysis, blood is circulated outside of the body through a dialyzer.

- **Nephrostomy tubes**
  - A nephrostomy tube may be placed for urinary diversion in order to relieve pressure on obstructed kidney. One end is curled (pig-tailed) that has a locking mechanism to maintain it in the dilated renal pelvis. Tubing exits the body wall and is connected to external urine collection bag
- **Medical expulsion therapy (MET)**
  - **Increase urine output**
    - IV fluids
    - Diuretics
      - **Mannitol (20%)**
        - Do not use if under- or over-hydrated
        - Dosage: 0.25-1.5 mg/kg IV over 10-20 min for 1 or 2 doses
  - **Relax ureteral smooth muscle**
    - **Alpha blockers**
      - In humans, these are a mainstay of treatment
      - **Prazosin:** 1 mg/15 kg PO q12h
    - **Amitriptyline**
      - Has been shown to relax urethral smooth muscle in cats
      - Dosage: 1-2 mg/kg PO q12h
  - **Decrease edema and inflammation**
    - Steroids such as dexamethasone (0.1 mg/kg IV q12-24h)
- **Intervention**
  - Surgical removal is not necessary for upper urinary tract uroliths but may be required
  - So – when to intervene?
    - BIG question
    - Non-responsive to medical management, and increasingly azotemic
    - Ureterolith with obstruction
      - Relieving obstruction may not return renal function; however, it may prevent further deterioration
    - Evidence of pyelonephritis
    - +/- stone size/number increasing
- **Lithotripsy**
  - Extracorporeal shock wave lithotripsy (ESWL) is a standard of care for many human patients with upper urinary tract uroliths, and has been performed successfully in dogs and cats.
  - Acceptable canine candidates are those with nephroliths smaller than 2-3 cm in their greatest dimension or ureteroliths.
    - With bilateral nephroliths, both kidneys are treated at the same time, unless there is concern about compromising renal function further.
    - More than 100 dogs with nephroliths or ureteroliths have been treated at 3 institutions.
    - Most of the uroliths were composed of calcium oxalate.
    - Most canine upper urinary tract uroliths fragment with 1 or 2 treatments.
  - Feline upper urinary tract uroliths appear to be more difficult to fragment with ESWL than in dogs, and renal function is more likely to be compromised.
    - Successful fragmentation has been reported to occur in < 20-25%.
    - Although renal function was normal in 4 healthy cats undergoing lithotripsy[1] lithotripsy of clinical cases of upper urinary tract urolithiasis in cats suggests that many cats, particularly those with pre-existing renal disease, experience renal function compromise or worsening of their renal failure.
  - While lithotripsy is considered safer and less invasive than surgical removal of upper urinary tract uroliths, there are risks.
    - Abdominal pain, hemorrhage, and bruising of the kidneys occurs, and hematuria may be observed immediately after the procedure.
    - More significant hemorrhage within or around the kidney may occur in some cases.
    - Residual stone fragments often take several weeks to move from the kidney into the urinary bladder.
    - Transient or permanent ureteral obstruction can occur.
    - If permanent and progressive ureteral obstruction occurs, it requires re-treatment by lithotripsy or surgical intervention.
    - Uncommon complications include pancreatitis, bowel irritation, hemolysis, and systemic hypertension.
- **Ureteral stent**
  - In patients where nephroureteroliths cannot be managed surgically, urinary diversion may be accomplished by placing a ureteral stent.
  - Usually a double pig-tailed stent is placed surgically, fluoroscopically, or via cystoscopy.
  - One of the pig-tails is placed so that it is within the dilated renal pelvis and the other pig-tail is placed so that it is within the urinary bladder.
  - The body of the stent connects the 2 pigtails and provides diversion of urine flow around the obstructive ureteroliths
  - Stents are often used with neoplastic ureteral obstruction

- **Subcutaneous urinary bypass device (SUB)**
  - Used to divert urine from renal pelvis to urinary bladder bypassing the ureter
  - Similar to a nephrostomy tube; however, used long term and implanted subcutaneously
  - A locking pig-tail catheter is inserted into the renal pelvis and the kidney is pexied to the body wall (nephropexy)
  - Tube is tunneled subcutaneously to a metallic port that is implanted subcutaneously just off of ventral midline
    - The metallic port is used for collecting a urine sample using a special needle (Huber needle)
  - A tube exits the other side of the port and re-enters the abdomen and is inserted near the apex of the urinary bladder, which is pexided to the ventral abdominal wall (cystopexy)
  - These are often used with neoplastic ureteral obstruction
- **Comparison of medical vs surgical management**
  - In a retrospective analysis of medically versus surgically managed patients with ureteroliths, surgically managed patients tended to do better over a longer time.
  - Surgery, though, was associated with more complications primarily in the perioperative period.
  - There was a recurrence rate of 40%.
- **Renal transplantation**
  - A retrospective study of 19 cats with renal failure associated with calcium oxalate urolithiasis has been published
    - There were 13 females and 7 males
    - All cats were azotemic and 17 were anemic
    - Hypercalcemia was present in 7 cats
    - Mean duration of survival in all cats was 605 days
      - 8 cats were alive 282-1,005 days (median = 1,305 days)
      - 11 cats died 2-1,197 days (median = 300 days)
      - 5 cats formed uroliths in their allograft kidney
        - 2 were hypercalcemic
        - 4 died following complications associated with urolith formation
- **Post-obstruction relief**
  - Fluid therapy – VITAL
    - Post-obstructive diuresis may be heavy
    - Type of fluid depends on rate but is usually either crystalloid or crystalloid with 2.5% dextrose
  - Electrolytes
    - Hypokalemia may occur with diuresis
    - Supplemental potassium chloride added to IV fluids should not exceed 0.5 mEq/kg/hr
  - Analgesia: depending on procedure performed, continued analgesia should be considered
- **Manage the chronic kidney disease**
  - Manage patients with nephroureterolithiasis also have CKD. See IRIS guidelines (http://www.iris-kidney.com)
  - Summary of management
    - Nutrition: patients that are azotemic (IRIS CKD stage 2, 3, or 4) should be fed a "renal diet", which are modified to be lower in protein, phosphorous, and sodium, alkalinizing, higher in potassium, calorically dense, highly digestible, B-vitamin replete, and contain omega-3 fatty acids. Minimizing uremic gastroenteritis using H2-blockers, mucosal protectant agents, etc also help.
    - Hypokalemia: may occur with CKD especially in cats. The goal is to maintain serum potassium concentrations in the mid to upper half of the normal range. If diet does not accomplish this, then potassium supplementation using potassium citrate (initial 75 mg/kg PO q12h) should be done
    - Metabolic acidosis: Renal diets are formulated to be alkalinizing, but if additional alkalinization is required, potassium citrate may be administered
    - Proteinuria: In azotemic patients with urine protein creatinine ratios greater than 0.4 (cats) or 0.5 (dogs), administration of an angiotensin converting enzyme inhibitor (**enalapril** or **benazepril**: initial: 0.25 mg/kg PO q12h) should be considered. If needed an angiotensin receptor blocker may also be administered (**losartan**: initial: 1 mg/kg PO q12h). Adverse events include hyperkalemia, hypotension, and gastrointestinal signs
    - Hydration: Patients with CKD are polyuric & polydipsic; therefore, feeding a canned diet may aid in maintaining hydration. Many cats, however, require supplemental fluids that can be administered subcutaneously or via feeding tubes
    - Non-regenerative anemia: this occurs commonly with CKD. Treatment involves maintaining good nutritional status, minimizing uremic gastroenteritis, and hormonal replacement therapy with iron supplementation. Although erythropoietin has been used, I typically use **darbepoetin** (1.5 ug/kg SQ q7d) with **iron dextran** (dogs: 10-20 mg/kg IM q7-21d; cats: 50 mg IM q21-28d). The goal is to achieve a hematocrit of 35-40%.
    - Systemic arterial hypertension: The goal with CKD is to keep systolic blood pressure < 150 mmHg. Angiotensin converting enzyme inhibitors decrease pressure by approximately 10 mmHg; however, **amlodipine** (dogs: 0.1-0.4 mg/kg PO q24h; cats: 0.625-1.25 mg PO q24h), a calcium channel blocker, decreases it by approximately 50mmHg and is a more effective anti-hypertensive agent.
    - Renal secondary hyperparathyroidism: Management includes decreasing serum phosphorous concentrations using a low phosphorous diet, administering a phosphate binder (e.g. aluminum hydroxide: 30-90 mg/kg PO divided q12h), or

by administering calcitriol (calcitriol has been shown to improve survival in dogs with IRIS CKD stage 3 and 4 disease, but is not beneficial in cats).

Suggested reading

Polzin DJ. Chronic kidney disease In: Bartges J,Polzin DJ, eds. Nephrology and Urology of Small Animals. Ames: Wiley-Blackwell, 2011;433-471.
Berent A. Indwelling urinary catheters and stents In: Bartges JW,Polzin DJ, eds. Nephrology and Urology of Small Animals. Ames: Wiley-Blackwell, 2011;329-339.

Why Cats are not Small Dogs: Feline Nutrition

Joe Bartges, DVM, PhD, DACVIM, DACVN
Cornell University Veterinary Specialists
Stamford, CT

Dogs and cats require the same basic nutrients as other nonherbivorous animal species, i.e. energy, protein (amino acids), minerals, vitamins, and waters. Commercial pet foods are almost all "total mixed rations", designed to provide all needed nutrients in the correct proportions in a single feed. Cats diverged from the evolutionary tree in the late Eocene period. They have adapted to a strict carnivore feeding pattern. Members of Carnivora vary from piscivores, herbivores, and omnivores. Although many species of animal may be carnivorous, few are true carnivores. A true or obligate carnivore is an animal that requires animal tissue to meet its metabolic and nutritional needs. This rare classification is one of the many unique features of the cat. The cat is so completely adapted to its carnivorous lifestyle that significant changes have occurred in virtually all aspects of the cat, including their behavior, anatomy, and unique nutritional metabolism. Anatomically there are a variety of external features that enhance the cat's predatory capabilities. Several less obvious features impact their nutritional needs, as well. The cats piercing and shearing teeth are good for tearing meat from bones and into bite size morsels but provide little pre-digestive action on the food. Sensitive vibrissae, retractable claws, and enlarged optic lobes are anatomic adaptations specifically for hunting. The intestinal tract of the cat is relatively short, simple, and absorbs approximately 10% less nutrients than their canine counterpart. These two features are of little consequence to cats eating a highly digestible diet of animal meat and tissue but can become important in cats fed lower quality diets. Over time, 3 key evolutionary strategies occurred in the cat that resulted in its unique and highly specialized nutritional requirements. The basic changes include 1) a key metabolic enzyme is low or missing; 2) an alternate enzyme pathway is more active; and 3) the lack of enzyme adaptation with changing dietary intake. These changes have allowed increased metabolic efficiency by not "wasting" protein or calories on unneeded enzymes and pathways, or have provided an efficient disposal system for certain nutrients. These changes can be identified in each of the nutrient groups (protein, carbohydrate, fats, minerals, and vitamins). The resultant metabolic peculiarities mean cats need meet to provide essential nutrients. Also, low tolerance to other nutrients demonstrate cats intolerance to non- meat foods. Examples include and intolerance to glutamate (an amino acid high in plant proteins), and fructose (a fruit sugar).

Energy

It is generally assumed that 45 kcal/lb/day of metabolizable energy is the maintenance energy requirement of the adult cat; however, ranges exist from 40-80 kcal/lb/day.

$$RER = BW_{kg}^{0.75} \text{ or } RER = [30(BW_{kg}) + 70]$$

The RER is then multiplied by a factor to give maintenance (or daily) energy requirements (MER)

Life Stage	Canine Factor	Feline Factor
Gestation	1.0 – 3.0	1.6 – 2.0
Dogs – first 1/2 - 2/3	1.0 – 2.0	
Dogs – last 1/3	2.0 - 3.0	
Lactation	2.0 – 8.0	1.0 – 2.0
Growth	2.0 – 3.0	2.0 – 5.0
Adult intact	1.8	1.4
Adult neutered	1.6	1.2
Senior	1.4	1.1
Work – light	2.0	
Work – moderate	3.0	
Work – heavy	4.0 – 8.0	
Obese prone	1.4	1.0
Weight loss	1.0	0.8
Weight gain	1.2-1.4 ideal	0.8-1.0 ideal
Critical care (usually)	1.0	1.0

Protein

The protein requirement of the cat is higher than that of the dog. It is recommended that protein levels in adult maintenance cat foods be at least 25-30% on a dry matter basis, and most adult foods contain close to 40%. Because cats derive some of their metabolizable energy from protein and because they cannot down-regulate hepatic enzymes involved with gluconeogenesis, adult cats should be provided 12-13% of their calories as protein, and kittens should be provided 18-20% of their calories as protein. Also, since palatability appears to be of more importance in affecting food intake in cats, cat foods generally contain more meat-source proteins. Although the mechanism not entirely understood, sulfur amino acids (methionine and cystine) which are needed for hair and taurine synthesis, are also required in high amounts. The cat has a unique requirement for taurine, a sulfonic acid amine, frequently lacking in

protein sources commonly used in dog foods. Taurine is essential for normal heart, reproductive, visual, neural, and immune function, to name just a few of its roles. The cat can only synthesized small amounts. This poor synthetic ability, combined with an obligate loss of taurine in the bile makes taurine an essential amino acid in the cat, unlike most other species. Seafood products contain the highest levels of taurine. Based on data, it is recommended that cat food contain 0.15% taurine on a dry matter basis. Cats also have a higher arginine requirement than dogs. Arginine is an essential amino acid that deserves special consideration in the cat diet. Because the protein catabolic pathways are so active in the cat, the urea cycle must be similarly active to rid the body of nitrogenous waste. Arginine is a key substrate in the urea cycle and its absence will shut down this critical pathway. If it is absent in even a single meal, toxic accumulations of ammonia have been known to occur within 24 hours.

Fat

High fat content in rations (cats prefer 20-25% dietary fat and up to 60% on a dry matter basis) has been found to increase palatability. The fat requirement of the cat is somewhat unique in that the cat cannot convert linoleic acid (an 18 carbon fatty acid) to arachidonic acid (a 20 carbon fatty acid) because cats have decreased activity of Δ6-desaturase. Therefore, arachidonic acid is an essential fatty acid for cats. Since vegetable oils contain no arachidonic acid, some animal-source fat is essential for cats. Overall, cats require approximately 10-20% dietary fat on a dry matter basis.

Carbohydrates

Cats have no nutritional requirement for dietary carbohydrates. The cat lacks the liver enzyme, glucokinase, responsible for the metabolism of large quantities of glucose and has a limited ability to utilize fructose (presumably due to low fructokinase activity). Thus, diets high in sucrose and simple sugars are not efficiently metabolized in the cat. Cats also have pancreatic amylase and demonstrate a dietary limit to high loads of simple starches. This does not mean that cats cannot use quality carbohydrates in the diet. Carbohydrates serve as an important source of energy in most commercial diets and are well tolerated.

Vitamins

Key vitamins required by the cat in either higher levels or as the preformed vitamin include: vitamin A, niacin, and vitamin D. These vitamins are in high concentrations in animal tissues. The cat cannot convert carotene to vitamin A; therefore, dietary vitamin A is essential. This is of no consequence when commercial rations are fed since the manufacturer adds vitamin supplements. Also, the cat cannot convert tryptophan to niacin; thus, dietary niacin is essential. Niacin is typically added as a supplement to most commercially available diets. Cats have a dietary requirement for pyridoxine (vitamin B_6). Niacin and pyridoxine are involved with protein metabolism, which is further evidence of the true carnivorous nature of cats. Vitamin D is not synthesized in cats exposed to sunlight because alternate pathways deplete the skin of important precursor molecules. Thus, cats require a preformed source of vitamin D in the diet. It is unknown if plant sources of vitamin D are equal in activity to animal products. B vitamins are critical to 1 carbon transfers and protein metabolism. Thus, cats have a relatively high requirement for several of the B vitamins.

Minerals

Mineral requirements of cats are probably similar to those of dogs; however, little experimental evidence is available. The role of magnesium in the development of struvite crystalluria, matrix-crystalline plugs, and urolithiasis is debatable. Although early studies in the 1980's implicated dietary magnesium as a main cause of struvite formation, later studies did not confirm this. Apparently, in the early studies, magnesium oxide, an alkalinizing salt, was used. This resulted in alkaluria and struvite formation because struvite solubility decreases with increasing urine pH. A later study compared similar amounts of magnesium oxide with magnesium chloride, an acidifying salt, and found that struvite solubility did not decrease with increasing amounts of magnesium chloride. Clinical studies, however, have shown benefit of reducing magnesium intake in the treatment of struvite uroliths and prevention of struvite matrix-crystalline plug formation. Magnesium restriction may be contraindicated in cats that are predisposed to calcium oxalate formation because magnesium is an inhibitor of calcium oxalate crystallization. The role, if any, of magnesium in calcium oxalate formation is unknown. Potassium deficiency is sometimes seen when highly acidified diets are marginal in potassium content. Even though such diets may meet the minimum nutrient requirement the alteration in the ion balance of the diet results in greater K+ excretion in the urine and thus a greater need. Other mineral deficiencies that have been noted include: a) calcium deficiency, or nutritional secondary hyperparathyroidism, a rickets like condition that develops from feeding poorly balanced meat diets; b) zinc deficiency, which can impair immune function as well as cause cleft palates in newborn kittens; c) copper deficiency, which causes anemia, fetal deaths or deformities, as a result of poorly available copper sources and zinc excess.

Water

Water requirements of cats are probably similar to those of dogs (20-30 ml/lb/day) under normal conditions; however, cats apparently are able to conserve water more efficiently than dogs. There is no experimental evidence to support the hypothesis that cats become dehydrated when fed dry rations, as long as an adequate amount of clean water is available.

Feeding adult cats

There are several factors that influence the amount of food a normal adult cat requires to maintain good body weight and condition. The more active the cat, the greater the nutrient requirement. In order to maintain body heat and condition, cats require more nutrients, and particularly more energy, during cold weather if exposed to the outdoors. Like human beings, cats are individuals with individual food requirements. Even when all other factors are the same, 2 cats of the same size, age, and activity, may need different amounts of food simply because of differences in metabolism. In contrast to the situation in dogs, lean body mass does not decrease as cats age, and energy requirements do not decrease in old cats. It has been speculated that body composition and energy requirements remain constant in older cats because the amount of activity remains constant (young adult cats are relatively inactive compared with young adult dogs), and cats maintain this relative inactivity throughout adulthood. Another difference between older dogs and older cats is that overall efficiency of nutrient digestion is maintained as dogs get older, but digestive efficiency tends to decrease in older cats. Fat is the nutrient most affected by the decrease in digestive efficiency. Older cats appear to compensate for this decreased digestive efficiency by increasing the quantity of food consumed. When consumption of digestible calories was measured, young and old cats consumed similar amounts of digestible calories per unit of body weight. Some investigators also reported that protein digestion was decreased in older cats; however, this has not been found in all studies. The physiological mechanism causing digestive efficiency to decrease as cats get older is unknown. Speculative mechanisms include decreased quantity of pancreatic enzymes or decreased secretion of bile acids (possibly related to the fact that, in cats, conjugation of bile acids is solely with taurine, and possible age-related changes in taurine metabolism in cats). Regardless, it appears cats can reasonably compensate for the decrease in digestive capability provided food is not restricted in quantity or caloric density.

Cats obtain energy from dietary carbohydrate, fat, and protein; therefore, they require greater dietary protein and fat when compared with dogs. Commercial dry foods are typically carbohydrate-based; thus, they must meet or exceed requirements for essential amino acids (including taurine), essential fatty acids (linoleic and arachidonic acid), and maintenance of acid-base metabolism. Manufacturing procedures used in the production of cat foods are similar to those used in the dog food industry. However, there are more gourmet (and, therefore, unbalanced) canned cat-food products on the market than dog food products. Cat foods tend to more expensive because animal-derived protein and fat must be used, whereas, dog foods are primarily carbohydrate-based. There are basically three different types of cat foods that are available: dry, canned, and semi-moist. Each of these can be nutritionally complete and balanced. Usually canned and semi-moist foods are more palatable, but cost more per feeding than dry foods. Propylene glycol can no longer be used as a humectant in cat foods because of the association with Heinz-body hemolytic anemia.

Since cats tend to be nibblers and prefer small amounts of food several times during the day, a dry food works quite well. The amount of food required by a cat for one or two days may be placed in a clean bowl and left in a convenient place for the cat, but an out-of-the-way-place for the owner. If dry food is moistened, it should be offered twice a day. Semi-moist food remains fresh in the bowl for several hours, but dries out and becomes hard. Since canned food can also dry out and become unpalatable, it should be fed several times during the day. The remaining portion, if any, should be stored tightly in the refrigerator. The average cat requires approximately 300 kcal/day. This is typically about 3 oz. (one 8-oz measuring cup) of dry food, or nearly 3 oz. (one 8-oz measuring cup) of semi-moist food (usually 1 small packet or ½ of a larger packet), or 6-8 oz of a canned food (usually 1 small can or ½ of a larger can). Remember that food intake may vary from day to day. This is not a problem unless it persists for several days.

Gestation

Unlike dogs that tend to gain weight during the last third of gestation, cats steadily increase their body weight throughout gestation and the weight gain is proportionate to the numbers of kittens. Although kittens grow primarily during the last third of gestation in a manner similar to puppies, cats apparently gain weight as adipose tissue in early pregnancy. Once bred, a queen should continue to consume a normal pre-breeding quantity of food during early pregnancy, but this will increase steadily. At about 3 weeks of gestation, most queens undergo a short period of partial appetite loss that typically lasts for 3-10 days. A slight transient weight loss may occur as well. Therefore, just 3 weeks into pregnancy, two normal episodes of appetite loss are experienced by a normal pregnant queen; once during estrous and breeding and once again about 3 weeks into gestation. A certain amount of owner anxiety is to be expected, and it is important to resist making changes in the diet every time a queen reaches a dip in the roller coaster. These events are consistent with although not necessary for normal and even exceptional reproductive performance. Feeding a high-quality complete and balanced ration is more appropriate to normal gestation than several dietary changes or supplementation.

Throughout gestation, the queen will show a steady increase in body weight, but it will increase dramatically during the final third of gestation. Growing kitten fetuses, developing placental tissues, fluid, and developing mammary glands contribute to the queen's increasing body weight and nutrient requirements. Food consumption should increase more rapidly and the queen will become more "fleshy" as adipose tissue is stored in preparation for lactation. Free choice feeding or multiple daily feedings are appropriate. Consumption of smaller meals at more frequent intervals is normal. Queens carrying large litters may become uncomfortable during the last trimester leading to reluctance to exercise, decreased food intake, and potentially, difficulty during parturition. As queening

nears, the queen may again lose her appetite. In many queens, food refusal during the ninth week of gestation is a good indication that birth will occur within the next 24-48 hours. Usually within 24 hours postpartum, the queen's appetite will return and food consumption will increase over pre-parturition. Food and water consumption should be encouraged. This can be accomplished by feeding a canned product or by moistening a dry product. A diet formulated for growth or gestation/lactation should have been fed throughout pregnancy beginning shortly after confirming the queen to be pregnant. This diet typically contains a minimum of 35% protein and 17% on a dry matter basis. By the end of pregnancy, a queen should be consuming 25-50% above her normal maintenance energy requirements.

Lactation

The demand for milk by nursing kittens will continue to increase for about 20-30 days. A queen's food and water requirements will also increase during this time. During peak lactation, the queen's food intake may be 2-4 times maintenance levels, whereas at the end of gestation, intake levels are usually 25-50% above maintenance. Because kittens become interested in solid food at about 3-4 weeks of lactation, and because the queen's interest in nursing begins to decline at about the same time, the demand for milk, and hence the queen's food intake, should gradually reduce. By weaning, the queen's food consumption should again be near maintenance levels. If body weight declines excessively during lactation, reconditioning following weaning should be attempted. A diet designed for growth or gestation/lactation should be continued during lactation, and can be used to recondition the queen if necessary.

Weaning

For queens that maintain significant milk production immediately after removal of the kittens, mammary congestion and discomfort can be a problem. Resolution of this problem may be hastened by limited feeding (no food on day of weaning, then ¼, ½, and ¾ of normal maintenance food levels for successive post-weaning days), if the body condition of the queen permits. Also, starting kittens on solid food at 3-4 weeks of age will reduce milk demand over time. Cool, fresh water that is changed daily should be available to the queen at all times. During pregnancy, water serves as a carrier of nutrients to, and of wastes eliminated from, developing fetuses. Adequate water consumption is necessary for thermoregulation and milk production. Depending upon the queen's body condition and progress of the kittens, weaning may take place around 6 weeks of age. Most healthy kittens that weigh over 500 gm at age 6 weeks can be weaned. Smaller kittens may be too immature to benefit from additional time with the queen provided her physical condition permits. Some queens will cycle again prior to weaning and prevention of mating is desirable. After weaning, the queen should be placed in a low-stress environment, and the diet gradually changed back to an adult maintenance diet.

Growth

During nursing, kittens will begin to explore their environment. It is during this time that they may be introduced to solid food. The food should be a diet designed for growth/gestation/lactation, which the queen should be consuming. Supplementation is not necessary if a good quality diet designed for growth is fed to the newly weaned kittens. Kittens will increase body weight quickly at first, but weight gain will taper as they approach maturity, which in most cases is between 6-8 months of age. At this time, the diet may be changed from one designed to promote growth to an adult maintenance food.

Bringing Your Dog to Work

Jeanine Berger, DVM, DACVB, DACAW, CAWA
San Francisco SPCA
San Francisco, CA

Bringing your dog to work is a privilege and comes with certain responsibilities. This presentation offers an overview of the many things to consider when planning on bringing a dog to the workplace. We will discuss the steps needed to prepare your best friend to be a team member at work, and not a distraction for everyone.

There are many reported benefits of having your dog at work:

- Dogs make for happy people and can make for calmer meetings that could otherwise get heated
- Ensures workers get breaks throughout the day, increases physical and mental health
- Inspires creativity and productivity
- Increases morale, provides comfort and lightens the mood of employees
- Saves employees money for doggy day care

It is important to keep realistic expectations about your 4-legged team member:

- Not all dogs get along with all people and dogs all the time
- Time management – they need potty breaks
- There might be food/chemical/object hazards and toxins for dogs at your work place

Office space: Setting up for success – tools of the trade:

- Bedding and quiet spots for dogs
- Gates and x-pen locations
- Treat bowls in multiple locations
- Play/potty areas
- Poop bags
- Placards for office door
- Leashes, collars, head halters, front buckle harnesses, and name tags
- Respecting space of other dogs and people who don't like dogs

Prepare your dog mentally and physically for a work week:

- Medical exam – flea and heartworm prevention, vaccines and deworming
- Introduce to dogs and people on neutral territory
- Start small – ½ day at work for the first few times, then increase gradually
- Take multiple walks through the office to introduce to people and dogs
- Bring food dispensers and chew toys to keep your dog occupied while you work
- Anxitane®, Adaptil™, Thundershirt™ and CD - Through a Dog's Ear™ to help ease any stress

It is important to understand that not everybody in the work environment is dog savvy, and an owner might have to help co-workers understand life from a dog's perspective. In order to avoid miscommunication in the office between humans and dogs it is helpful to educate co-workers about understanding canine body language.

Bringing your dog to work is a privilege and not a right. Be respectful of everyone in office – one negative encounter could ruin this for every other canine team member. Keep in mind that aggressive animals do not belong in an office environment. The office is not a place for behavior modification, nor should it serve as a dog park for your dog's entertainment. The dog should be a delightful addition to the office and serve as an ice breaker, but should never be a distraction. It is important to have clear understanding of any off-limit areas, such as conference rooms. Preparation is half the battle and can help to avoid problems. Know your dog and his/her limits is also key.

1. Management: Safety and avoidance

In order to set your dog up for success in the office, strict management may be needed at the beginning. Initially, the owner will have to set the stage and manage the pet's environment so as to avoid any situations in which the pet may display any unwanted behaviors. The owner should begin by mentally taking note of all situations where the pet displays unwanted or unacceptable behavior(s), such as barking at people or other dogs in the office, or whining when the owner has to leave the dog alone in the office to go to a meeting. In addition to supporting overall success, management may also be a safety recommendation in some cases.

2. Structuring the relationship with the pet and strengthening the human-animal bond

There are many advantages to using a reward-based program as part of a training program for a pet. First, it is a program that fits all pets and all people, regardless of breed, age, size, gender or personality-type. With non-confrontational techniques, people and pets involved are enjoying each other's company and there is lower risk of escalating aggression problems. It will help to teach pets how

to be better prepared to live within human society. It will help improve behavior and teach the pet to learn to trust people due to the predictable interactions with positive outcomes. If the pet has learned to consistently follow commands at home or in other low stress situations, it will make it easier for him/her to follow commands at work when distracted or while more anxious. Finally, it will help build confidence by providing clear communication and enjoyable outcomes for desired behaviors. If you are taking you canine partner to work, treat him/her with the same leadership and respect you like to be treated.

3. Tools

Tools are any equipment that will help with the implementation of the management plan and the reward-based training program. The list is endless, but could include items such as baby gates, kennels, crates, screen doors, window covers, leashes, tethers, head halters, front buckle harnesses, basket muzzles, clickers, target sticks, MannersMinders, treat pouches, treats, relaxation mats, food-dispensing toys and puzzles, interactive toys, Relaxation music, visual entertainment (DOGTV), and many more.

NOTE: My list does **NOT** include anti-bark devices, shock collars, prong collars, shaker cans, throw chains and other pain and fear eliciting items – tools that help suppress behaviors by instilling fear rather than help teach new positive behaviors and emotions. Suppressing behaviors with intimidation and punishment can lead to increased fear, anxiety and aggression.

4. Gradual introduction to the work place to ensure positive emotional and behavioral response

Keep in mind that most animals will have to be prepared for a full day at work and a gradual introduction to an 8 hour work day can help to make this endeavor a full success. It will help in building a dog's confidence by providing clear rules. Positive reinforcement training ensures enjoyable outcomes for good behavior. Every session should be brief and always end by rewarding the display of positive behavior(s). Coming to work on a day off for a few hours can help ease the dog into a regular work schedule.

Resources

Dogs at work – A practical guide to creating dog friendly workplaces by Liz Palika and Jennifer Fearing, Humans Society press
For handouts and helpful exercises see: https://www.sfspca.org/behavior-training/dog-behavior-resources

Thyroid Disease in Dogs and Cats

David Bruyette, DVM, DACVIM
VCA West Los Angeles Animal Hospital
Los Angeles, CA

Hyperadrenocorticism in cats

Hyperadrenocorticism develops most commonly in middle-aged to older cats (mean age = 10.4 years; range 6 - 15 years). Of the reported cases of feline Cushing's syndrome (78%) have been females. This female sex predilection resembles the human syndrome and contrasts with canine hyperadrenocorticism, where no sex predilection occurs.

The most common historical findings and clinical signs associated with feline hyperadrenocorticism are polyuria, polydipsia, and polyphagia. These signs likely correspond to the high incidence of concurrent diabetes mellitus (76%) found in cats with hyperadrenocorticism, and are consistent with the lack of overt signs preceding marked glucose intolerance observed in experimentally-induced disease. The typical "Cushingoid" pot-bellied appearance with hepatomegaly, weight gain, and generalized muscle wasting is common in cats as in dogs. Dermatologic abnormalities frequently recognized include an unkempt hair coat with patchy alopecia, and very thin skin prone to traumatically induced tears and secondary infections.

Hyperglycemia is the most common laboratory abnormality found on serum biochemistries. Cats appear more sensitive to the diabetogenic effects of glucocorticoid excess than dogs. Cats with concurrent diabetes mellitus often exhibit cortisol-induced insulin resistance, requiring high daily doses of insulin to control their hyperglycemia and glucosuria. Hypercholesterolemia is also common, and may relate to insulin resistance and increased lipolysis. Cats lack the steroid-induced isoenzyme of alkaline phosphatase found in the canine, and the half-life of the enzyme appears to be significantly shorter in the cat. Elevation of serum alkaline phosphatase (SAP) is present in only approximately one-third of cats compared to nearly 90% of dogs with hyperadrenocorticism. Increases in SAP and the hepatocellular enzyme ALT appear to correspond with the regulation of the diabetic state, rather than representing direct indicators of glucocorticoid excess. These enzymes frequently normalize with adequate regulation of diabetes, even without therapy directed towards the hyperadrenocorticism. Hematologic findings associated with hypercortisolemia (lymphopenia, eosinopenia, and neutrophilic leukocytosis) occur inconsistently in feline hyperadrenocorticism. Despite clinical polyuria and polydipsia, cats appear to maintain urine specific gravities of greater than 1.020 more frequently than dogs, and only occasionally exhibit dilute urine and decreased blood urea nitrogen concentrations commonly seen in dogs with hyperadrenocorticism.

Endocrinologic evaluation of cats suspected of hyperadrenocorticism involves screening tests to confirm the diagnosis, and differentiating tests to distinguish pituitary-dependent disease (PDH) from adrenal tumors (AT). Adrenocorticotropin (ACTH) stimulation testing in adrenocortical hyperfunction is not as definitive as for hypoadrenocorticism. Fifteen to 30% of cats with confirmed hyperadrenocorticism have had normal cortisol response to ACTH administration (false negatives). In addition, stressed cats and those with non-adrenal illnesses may show an exaggerated response to ACTH in the absence of hyperadrenocorticism (false positives). A normal urine cortisol-to-creatinine ratio (UCCR) can be used to exclude the diagnosis of hyperadrenocorticism in cats as described in dogs. The UCCR is attractive due to the ease of sampling compared to other endocrine function tests, but is non-specific and will be elevated in a variety on non-adrenal illnesses. An exaggerated ACTH stimulation test or an elevated UCCR should be pursued with suppression testing prior to initiating any therapy.

Normal cats are more variable than dogs with respect to the degree and duration of adrenocortical suppression following dexamethasone administration. Intravenous doses of dexamethasone that have been evaluated in the cat range from 0.005 to 1.0 milligrams per kilogram. A dosage of 0.01 mg/kg of dexamethasone, commonly used in low-dose dexamethasone suppression testing in dogs, led to a significant drop in serum cortisol levels in ten normal cats, but 2 of the cats showed a slight escape from suppression by 8 hours after injection. Intravenous dexamethasone sodium phosphate (DSP), 0.01 and 0.1 mg/kg, produced equivalent reductions of plasma cortisol levels, but suppression was sustained below baseline longer with the higher dosage. Cats with various non-adrenal illnesses have also shown inadequate cortisol suppression after a low-dose (0.01 mg/kg) of DSP. The 0.1 mg/kg dosage of dexamethasone seems to more reliably suppress cortisol levels in normal cats and cats with non-adrenal illnesses. Elevated cortisol levels eight hours post-dexamethasone injection, using the 0.1 mg/kg dosage, appears to be a sensitive a diagnostic test for feline hyperadrenocorticism (89%) similar to the low-dose (0.01 mg/kg) screening test in the dog.

The combined dexamethasone suppression/ACTH stimulation test has been used successfully to diagnose hyperadrenocorticism in the cat. Affected cats display inadequate suppression of cortisol 2-4 hours after an injection of 0.1 mg/kg of dexamethasone, and an exaggerated response 1-2 hours after ACTH stimulation. The ability of the combined test to discriminate PDH from AT is unclear. Several cats with confirmed pituitary disease failed to suppress 2-4 hours after dexamethasone. Extending the duration of post-dexamethasone monitoring, or using higher doses of DSP may improve the ability of the combined test to distinguish PDH from AT. Currently, the combined test does not appear to offer more clinical utility than either the ACTH stimulation or dexamethasone suppression test evaluated separately.

An ultra-high dose, 1.0 mg/kg, dexamethasone suppression test has been used to distinguish PDH from AT in the cat. Two cats with hyperadrenocorticism diagnosed by the combined high dose dexamethasone suppression/ ACTH stimulation test had exaggerated responses to ACTH with no cortisol suppression 2-4 hours after 0.1 mg/kg DSP. These cats did suppress following the ultra-high dose of dexamethasone, and were later confirmed to have PDH. Cortisol levels should be monitored at several time points following dexamethasone administration to determine if any suppression (a 50% or greater reduction in pre-test values) is occurring. Cats with PDH may show suppression 2, 4, or 6 hours into the test only to escape from the suppressive effects of dexamethasone by 8 hours. One cat with an adrenal adenoma failed to suppress following dexamethasone doses ranging from 0.1 to 1.0 mg/kg. As is the case in dogs, suppression following high doses of dexamethasone is diagnostic for PDH, but failure to suppress requires further testing to distinguish pituitary from adrenal disease.

Determination of plasma ACTH concentrations is an effective way of diagnosing PDH. The normal range of plasma ACTH is lower in cats than in dogs, and many normal cats may have concentrations of ACTH below the lower limits of the sensitivity of the assay. Cats with PDH will have normal to elevated ACTH concentrations while cats with adrenocortical adenomas or carcinomas will have undetectable plasma ACTH levels. Plasma ACTH samples need to be collected and handled carefully. Veterinarians should consult their diagnostic laboratory for specific instructions prior to performing the test. Incorrect sample handling can falsely lower measured values. Normal to elevated plasma ACTH levels support a diagnosis of PDH, whereas low concentrations may require additional diagnostic testing. As in the differentiation of canine hyperadrenocorticism, ACTH levels should only be used to distinguish PDH from AT after hyperadrenocorticism has been confirmed by other screening diagnostics.

Pituitary-adrenal function tests need to be interpreted in conjunction with historical, clinical, and clinicopathologic findings before any conclusions can be drawn. No single diagnostic test is infallible. Equivocal results or discordant findings should be reevaluated. Hyperadrenocorticism is an uncommon disorder in cats. Consequently, false positive test results should be anticipated. Interpretation of endocrinologic testing should incorporate all available information before any therapeutic intervention is attempted.

Diagnostic imaging can facilitate differentiation of PDH from AT when screening tests and clinical findings suggest hyperadrenocorticism. Approximately half of canine adrenal tumors are mineralized and can be recognized radiographically. The frequency of mineralization in feline adrenocortical tumors is unknown, but up to 30% of normal cats may have calcification of their adrenal glands. Abdominal radiographic findings in cats with hyperadrenocorticism included hepatomegaly (69%) and obesity. Ultrasonographic evaluation of adrenal size and morphology has been described for dogs and cats. Nonfunctional adrenal tumors can be incidental findings in humans undergoing abdominal imaging. The incidence of "silent" adrenal masses in the cat is unknown. The presence of unilateral adrenomegaly or distortion of adrenal architecture in a cat suspected of hyperadrenocorticism is strong evidence of AT. Abdominal computerized tomography (CT) and magnetic resonance imaging (MRI) offer improved resolution for the detection of adrenal tumors or hyperplasia. CT and MRI detection of pituitary masses is also now feasible for small animal patients.

Adrenal tumors accounted for 22% of the reported cases of feline hyperadrenocorticism. Half of the adrenocortical tumors were found histologically to be adenomas and half carcinomas. The treatment of choice for adrenal tumors is surgical adrenalectomy. Two cats with adrenocortical adenomas responded well to unilateral adrenalectomy, with clinical signs resolving over 4 to 8 weeks. One cat with an adrenal adenoma removed surgically developed a recurrence of signs 12 months postoperatively. An adenoma of the contralateral adrenal gland was diagnosed. The cat survived a second adrenalectomy and was disease-free for over two years following the second procedure. Surgical therapy and long term follow-up for adrenocortical carcinomas in cats has not been reported.

Treatment options for pituitary dependent hyperadrenocorticism in the cat include both surgical and medical alternatives. Bilateral adrenalectomy followed by mineralocorticoid and glucocorticoid replacement therapy was performed in 11 cats. Nine cats responded well to surgery with cessation of polyuria and polydipsia, regrowth of hair coat, and marked improvement (4) or resolution (5) of diabetes mellitus. One cat developed acute signs of circling, wandering aimlessly, and apparent blindness 2 months post-operatively. An expanding pituitary tumor was suspected, but no necropsy was performed. Two cats died within one week of surgery from sepsis. Survival times for 6 cats with adequate follow-up after bilateral adrenalectomy for PDH ranged from 1 to 12+ months (median 5 months). Two cats are still alive, one year post-operatively. These results suggest that surgical complications of bilateral adrenalectomy may be less frequent in cats than in dogs.

Surgical treatment can also include transsphenoidal hypophysectomy which is performed at WLA for cats with pituitary masses extending above the sella (macroadenoma). Cats with functional tumors have similar success rates to those reported in dogs with PDH.

Four drugs (ketoconazole, mitotane, metyrapone and trilostane) have been investigated for the medical management of spontaneous feline hyperadrenocorticism. Ketoconazole, an antifungal imidazole derivative, has been shown to inhibit adrenal and gonadal steroidogenesis in humans and dogs. One month of ketoconazole (15mg/kg orally twice daily) administration in 4 cats did not significantly reduce baseline plasma cortisol or ACTH responsiveness at doses 3 times greater than those effective in dogs. Two of 4 cats treated with 10 - 20 mg/kg/day of ketoconazole had adequate control of hypercortisolemia. One of the 4 cats developed severe thrombocytopenia after only one week of therapy and had to discontinue the medication. A cat with adrenocortical adenocarcinoma

treated with 30 mg/kg/day for 3½ months showed improved regulation of diabetes and reduction in pu/pd despite no improvement in hyperresponsiveness to ACTH. The cat ultimately was euthanized subsequent to a non-healing skin laceration, chronic infections, and worsening insulin resistance. No evidence of hepatotoxicity or thrombocytopenia was seen at the 30 mg/kg/day dosage of ketoconazole, but the effectiveness and safety of this therapy remains questionable.

Mitotane, o,p'-DDD, is an adrenal cytotoxic agent and has been used successfully to treat dogs with PDH and AT. Use of mitotane in cats has been discouraged due to the feline sensitivity to chlorinated hydrocarbons. Three of 4 normal cats treated with o,p'-DDD at dosages ranging from 25 - 50 mg/kg, divided twice a day, tolerated the drug well, and remained clinically normal throughout treatment with mitotane. Only 2 of the 4 cats showed a decreased responsiveness to ACTH with mitotane. The cat with the largest reduction in post-ACTH cortisol levels developed vomiting, diarrhea, and partial anorexia lasting 2 weeks after a 50 mg/kg dosage of mitotane. Two cats with PDH treated with o,p'-DDD (25 mg/kg/day x 25 days, and 25 - 50 mg/kg/day x 59 days) tolerated the drug without apparent toxicity, but therapy was ineffective in controlling clinical signs in either cat. A cat with PDH treated with mitotane (50 mg/kg/day x 1 week, then 50 mg/kg/week) developed signs compatible with iatrogenic hypoadrenocorticism after 40 weeks of therapy with o,p'-DDD. At that time the cat was anorectic, lethargic, and exhibiting neurologic signs including mydriasis, pacing, and head pressing. Computerized tomography revealed a large pituitary mass extending above the sella turcica. Mitotane was discontinued, and the cat was treated with ^{60}Co teletherapy. Subsequent CT examinations revealed shrinkage and then disappearance of the mass 10 months post-irradiation. The cat was euthanized for continued diabetes mellitus and post-irradiation cataracts 2 years after the initial diagnosis of hyperadrenocorticism. We have had 3 other cases where a positive response to mitotane was observed clinically.

Metyrapone, an inhibitor of the 11-b-hydroxylase enzyme that converts 11-deoxycortisol to cortisol, has been used effectively in man to reduce the clinical signs of hypercortisolemia. A reciprocal rise in plasma ACTH levels occurs with falling cortisol concentrations and can eventually override the enzymatic block, allowing a return of clinical signs. In humans, metyrapone is utilized as an adjunctive therapy with pituitary irradiation or surgery. Dosages ranging from 195 - 250 mg/day have been used in cats with hyperadrenocorticism without observed toxicity. In a recent report, a diabetic cat with PDH and severe nonhealing skin wounds was treated with 65 mg of metyrapone orally 3 times a day. After 2 days of therapy the cat developed signs of glucocorticoid deficiency including depression, tremors, and ataxia. The cat improved rapidly following treatment with injectable steroids, and was discharged on twice daily metyrapone therapy. Cortisol response to exogenous ACTH was absent when evaluated on day 7. The cat was re-examined 24 days later after a hypoglycemic episode. The cats skin wounds had resolved and hair regrowth was evident. A follow-up ACTH stimulation test revealed a slightly exaggerated response. The cat underwent successful bilateral adrenalectomy and was euglycemic, with a normal haircoat, 4 months post-operatively. Two of 3 other cats reported in the literature also showed clinical improvement with metyrapone therapy, but follow-up periods were short (less than 6 months). Whether longterm therapy with metyrapone can control hypercortisolemia in cats, or whether rising ACTH levels eventually overwhelm enzymatic blockade has not been determined. Metyrapone appears to permit rapid correction of hyperadrenocorticism in some cats, and may be useful for pre-surgical stabilization prior to adrenalectomy.

We have recently evaluated the safety and efficacy of trilostane therapy (Vetoryl, Dechra Pharmaceuticals) in 15 cats with PDH. Clinical signs (13 of 15 cats) and ACTH stimulation testing results (13 of 15) improved with trilostane therapy. Diabetes mellitus was reported in 9/15 cases. Insulin requirements decreased by 36% within 2 months in 6/9 diabetic cats. Median survival time was 617 days for all cats (range 80-1,278 days). Complications included weight loss, urinary tract infections, chronic kidney disease, seizures, and recurrent pancreatitis. Hypocortisolemia was documented in 1 case. Cause of death occurred as a result of non-adrenal or non-diabetic illnesses (renal failure, seizures [caused by hypoglycemia or unknown]), or lymphoma. Trilostane ameliorates clinical signs of HAC in cats, is tolerated well in the long term, and can lead to improved regulation of diabetes. It should be considered first line therapy for cats undergoing medical management of PDH.

Hyperadrenocorticism in dogs

A. Pituitary-dependent hyperadrenocorticism
    1. Surgical management
        i. Bilateral adrenalectomy
            1. Technically difficult
            2. Poor surgical/anesthetic risk
            3. Permanently hypoadrenal and require lifelong replacement therapy

B. Hypophysectomy
    1. See discussion at the end of this section
    2. Lifelong therapy with thyroid hormone and prednisone necessary.
    3. Medical therapy

Trilostane therapy of canine hyperadrenocorticism

The efficacy and safety of trilostane in the treatment of canine PDH were evaluated in a multicentre study at the Royal Veterinary College in London, the Veterinary Teaching Hospital in Dublin and Small Animal Hospital in Glasgow. Seventy-eight dogs with confirmed PDH were treated with trilostane for up to 3 years. The starting dose varied from 1.8 to 20 mg/kg (mean = 5.9 mg/kg).

Trilostane appeared to be well tolerated by almost all dogs with only 2 dogs developing signs and biochemical evidence of hypoadrenocorticism. One of these dogs recovered with appropriate therapy. The other died despite withdrawal of trilostane and administration of appropriate therapy. A further two dogs died within one week of starting trilostane but in neither case could a direct link with the trilostane therapy be established. The low prevalence of side effects compared favourably to those reported with mitotane.

Trilostane was found to be nearly as effective as mitotane in resolving the signs of hyperadrenocorticsm. Polyuria, polydipsia and polyphagia had dissipated in 40 dogs within 3 weeks after starting trilostane. Within 2 months, a further 20 dogs showed decreases in their water and food consumption. These improvements were maintained as long as the dogs remained on adequate doses of trilostane. Skin changes resolved in 24 out of 39 (62%) of dogs that initially presented with dermatological signs. All of these improvements were maintained as long as the dogs remained on adequate doses of trilostane. Only 8 dogs that were treated with trilostane for more than 2 months showed poor control of clinical signs. In contrast, mitotane is effective in about 80% of cases of pituitary dependent hyperadrenocorticism (PDH).

Trilostane caused a significant ($p<0.001$) reduction in both the mean basal and post-ACTH stimulation cortisol concentrations after 10 days of treatment. The post ACTH cortisol concentration decreased to less than 250 nmol/l (9 µg/dl) in 81% of dogs within one month and in another 15% at some time whilst on treatment. These improvements were also maintained in the study population for the duration of the trial.

Thirty-five dogs had at least one dose adjustment over the treatment period. The dose was increased in 23 dogs up to four times the starting dose. In one dog the dose was increased nine fold over a period of six months. The dose was decreased in nine dogs to as low as a quarter of the starting dose.

The mean survival of all trilostane treated dogs was 661 days. Direct comparison with mitotane was difficult as 65% of the dogs were still alive at the time of censor and therefore the mean survival may still increase.By comparison, the mean survival of mitotane treated dogs has been reported to be 810 to 900 days.

Dosage and administration

The current suggested initial starting dose range for dogs with PDH is 1-2 mg/kg once daily. This needs to be adjusted according to clinical signs and serum cortisol values (see below). Doses up to 40-50 mg/kg (divided twice daily) have been given with no unwanted side effects. In some dogs twice daily dosing may be necessary. The drug is given with food.

Transsphenoidal hypophysectomy

A variety of treatments are available for PDH. Medical treatment options include drugs that chemically destroy the adrenals (lysodren or op-DDD) inhibit enzymes in the adrenal leading to the synthesis of cortisol (ketoconazole, trilostane) or inhibit the release of ACTH from the pituitary gland (Anipryl or selegiline). While these treatments can improve the clinical signs in 40-80% of patients they need to be chronically administered, necessitate frequent monitoring and do not cure or address the primary cause of the disease (the pituitary tumor). In humans, surgery to remove the tumor is the most successful long-term therapy. The most common approach used is the transsphenoidal method, in which a passage way is made in the sphenoid sinus, an air space behind the back of the nose, which is just below the pituitary gland. Surgical cure rates for PDH are reported to be in the range of 65-85%, although more recent long-term follow up data suggest that the recurrence rate is as high as 25 % within 5 years. When no discrete adenoma can be identified, remission of hypercortisolism is observed in only about 40%. Surgery has also been used to treat PDH in dogs. Several groups, most notably in the Netherlands have performed these surgeries with success rates paralleling those reported for humans. However, these surgeries have generally not been performed in the US. Veterinarians at VCAWLAAH, in collaboration with human neurosurgeons that regularly perform transsphenoidal surgery in humans have developed the methods to perform these surgeries in the US and are conducting a research study to determine how effectively these surgeries can be performed.

Hypoadrenocorticism

Primary hypoadrenocorticism has been described in cats. Addisonian cats are middle-aged, with a median age of 4 years (mean 5.8 +/- 3.7 years) and range in age from 1.5 to 14 years. No sex or breed predilection is seen. The most common historical problems include lethargy, anorexia, and weight loss. Unlike dogs with adrenal insufficiency, diarrhea is not noted in Addisonian cats. Forty percent of cats have histories of episodic vomiting. Similar to hypoadrenocorticism in the canine, cats often have a waxing and waning clinical course, including temporary "remissions" associated with parenteral fluid and/or corticosteroid administration.

The most common findings on physical examination include depression, weakness, and mild to severe dehydration. Up to 40% present with in severe shock with weak pulses, slow capillary refill times, and extreme weakness or collapse. The duration of clinical signs preceding the diagnosis of hypoadrenocorticism ranges from 5 to 100 days, with a median of 14 days.

Clinicopathologic findings in cats with primary hypoadrenocorticism parallel the patterns seen in the dog. Serum electrolyte changes characteristic of mineralocorticoid deficiency are seen in most cats. Serum sodium:potassium ratios are less than 24 (range 17.9-23.7) with hyponatremia, hypochloremia, and hyperkalemia. All cats have had mild to severe azotemia (blood urea nitrogen 31-80 mg/dl, normal range 5-30 mg/dl; creatinine 1.6-6.0 mg/dl, normal range 0.5-1.5 mg/dl), and hyperphosphatemia (inorganic phosphorus 6.1-9.1 mg/dl; normal range 3.0-6.0 mg/dl). Hypercalcemia has been noted in one cat. Despite signs of dehydration and prerenal azotemia, urine specific gravity was greater than 1.030 in only 40% of cats. The loss of renal medullary solutes, particularly sodium, is believed to result in impaired renal concentrating ability. Distinguishing hypoadrenocorticism from acute or chronic renal failure is critical to establishing an appropriate prognosis for clients.

Long-term management of cats with primary hypoadrenocorticism requires lifetime mineralocorticoid and glucocorticoid supplementation. Oral fludrocortisone acetate (0.1 mg/day) or intramuscular injections of desoxycorticosterone pivalate (DOCP; 10 - 12.5 mg/month) have been successful in maintaining Addisonian cats. The dose of mineralocorticoid is adjusted as needed based on follow-up serum electrolyte concentrations monitored every one to two weeks during the initial maintenance period. Normal electrolyte parameters 2 weeks following DOCP suggests adequate dosing, but does not provide information concerning the duration of action of each injection. Eighty percent of dogs require DOCP more frequently than every 30 days (5% need to receive DOCP every 3 weeks), so frequent sampling during the early management period is recommended. Prednisone, 1.25 mg orally once a day, or intramuscular methylprednisolone acetate, 10 mg once a month, can be used to provide adequate long term glucocorticoid supplementation. Cats surviving the initial adrenal crisis can be managed successfully for many years. 60% of cats diagnosed with primary hypoadrenocorticism are alive a median of 2.75 years after diagnosis. With appropriate glucocorticoid and mineralocorticoid supplementation, cats with adrenocortical insufficiency should have a normal life expectancy.

Primary hyperaldosteronism

Feline primary hyperaldosteronism is diagnosed based on clinical signs, serum biochemistry, plasma aldosterone concentration, adrenal imaging and histopathology of adrenal tissue. Cats may present with blindness caused by systemic hypertension. Many will also present with weakness resulting from hypokalaemic polymyopathy. Elevated concentrations of plasma aldosterone and adrenocortical neoplasia have been documented in all cases. Seven cases had adrenal adenomas (unilateral in five and bilateral in two) and six had unilateral adrenal carcinomas. Three cases underwent medical treatment only with amlodipine, spironolactone and potassium gluconate; two cases survived for 304and 984 days until they were euthanized because of chronic renal failure, while the third case was euthanized at 50 days following failure of the owner tomedicate the cat. Ten cases underwent surgical adrenalectomy following a successful stabilization period on medical management. Five cases remain alive atthe time of writing with follow-up periods of between 240 and 1803 days. Three cases were euthanized during or immediately following surgery because ofsurgical-induced hemorrhage. One cat was euthanized 14 days after surgery because of generalized sepsis, whilst the remaining cat was euthanized 1045 days after surgery because of anorexia and the development of a cranial abdominal mass. It is recommended that primary hyperaldosteronism should be considered as a differential diagnosis in middle-aged and older cats with hypokalaemic polymyopathy and/or systemic hypertension and this disease should no longer be considered a rare condition.

In recent years, there has been renewed interest in primary hyperaldosteronism,particularly because of its possible role in the progression of kidney disease.While most studies have concerned humans and experimental animal models, a recent paper highlighted the occurrence of a spontaneous form of (non-tumorous) primary hyperaldosteronism in cats. At presentation, the main physical features of 11 elderly cats were hypokalemic paroxysmal flaccid paresis and loss of vision due to retinal detachment with hemorrhages. Primary hyperaldosteronism was diagnosed on the basis of plasma concentrations of aldosterone (PAC) and plasma rennin activity (PRA), and the calculation of the PAC:PRA ratio. In all animals, PACs were at the upper end or higher than the reference range. The PRAs were at the lower end of the reference range, and the PAC:PRA ratios exceeded the reference range. Diagnostic imaging by ultrasonography and computed tomography revealed no or only very minor changes in the adrenals compatible with nodular hyperplasia. Adrenal gland histopathology revealed extensive micronodular hyperplasia extending from zona glomerulosa into the zona fasciculata and reticularis. In three cats, plasma urea and creatinine concentrations were normal when hyperaldosteronism was diagnosed but thereafter increased to above the upper limit of the respective reference range. In the other eight cats, urea and creatinine concentrations were raised at first examination and gradually further increased. Even in end-stage renal insufficiency, there was a tendency to hypophosphatemia rather than to hyperphosphatemia. The histopathological changes in the kidneys mimicked those of humans with hyperaldosteronism: hyaline arteriolar sclerosis, glomerular sclerosis, tubular atrophy and interstitial fibrosis. The non-tumorous form of primary hyperaldosteronism in cats has many similarities with "idiopathic" primary hyperaldosteronism in humans. The condition is associated with progressive renal disease, which may in part be due to the often incompletely suppressed plasma renin activity.

References

Mellet, AM, Bruyette D, Stanley S: Trilostane therapy for spontaneous hyperadrenocorticism in cats: 15 cases (2004-2013). J Vet Int Med 27: 1471-77, 2013.

Bisignano J, Bruyette D: Feline Hyperaldosteronism. J Vet Med 19: 76-87, 2012.

Mamelak A, Owen T, Bruyette D: Transsphenoidal surgery for pituitary adenomas using a high definition video telescope in dogs with Cushing's disease. Vet Surg Jan 27: 1532-1543, 2014.

Managing Expectations and Maximizing Patient Outcome with Cardiovascular Disease

Barret Bulmer, DVM, MS, DACVIM
Tufts Veterinary Emergency Treatment and Specialties
Walpole, WA

Veterinarians are often limited to drawing conclusions about a patient's response to therapy following a 15-minute examination within the confines of the veterinary hospital. Therefore collecting a thorough and accurate history from owners caring for pets with heart disease is vital to their appropriate medical management. Similarly technicians often perform vital roles as a point of contact, facilitator of a diagnostic plan and administrator of patient care. This lecture will review techniques to try and maximize outcome in animals with cardiovascular disease.

The history/assessment of clinical status

1. **Have you recognized any coughing or increased respiratory rate/effort?**

No matter the underlying etiology congestive heart failure is a common endpoint for patients with substantial underlying heart disease. Congestive heart failure is recognized as either pulmonary edema, pleural effusion or ascites depending on which side of the heart is afflicted. Fluid accumulation within the alveoli stimulates receptors that produce, in general, a non-productive cough, often accompanied with increased respiratory rate or effort. Interestingly many owners report this cough is worse in the evening hours when their pet is resting (in comparison to coughing subsequent to tracheal collapse that often occurs during leash walks, with excitement or with positional changes). Owners may identify that their dog is unable to lie down comfortably or their cat sits in sternal recumbency and is reluctant to move. With right-sided heart failure substantial volumes of ascites may accumulate, a finding that owners may have mistaken for weight gain.

2. **Have you recognized any inappetence/reluctance to eat or weight loss?**

Adequate nutritional support is important for pets with heart disease. In some instances we prescribe low sodium, and therefore sometimes less palatable, diets for patients with heart failure. Several of the medications we prescribe, i.e. furosemide, can reduce potassium concentrations if there is inadequate food consumption. Hypokalemia is of concern because it reduces the efficacy of our diuretics and may be associated with lethargy and worsening inappetence. Weight loss is important to document because many of our medications are prescribed on a patient's ideal body weight.

3. **What time did you administer medications and do you need any refills?**

Drugs used to treat cardiovascular disease have variable and sometimes prolonged (e.g. amlodipine) half-lives that influence the timing of events like blood sampling and blood pressure measurement. In many instances we can also determine the efficacy of a medication based on the physical examination and the timing of drug administration. The best example is the beta-blocker, atenolol. Beta-blockers like atenolol are effective at reducing the heart rate within approximately two hours of administration and often have limited efficacy by 12 hours. Therefore, a patient that has an elevated heart rate five hours after atenolol administration may very well need a higher dose to attain the target heart rate.

An equally important part of this question is whether the owner needs refills for their pet's medication. One of the most common causes for recurrence of heart failure is failure to administer the prescribed medications. Therefore, it is important to emphasize that although their pet appears stable and well compensated it is vital to continue their medical therapy.

4. **Have you recognized any improvement in your pet's well being/clinical status?**

Although it is rare that we are able to "cure" a pet's heart disease we can often very effectively reduce their clinical signs and improve their quality of life. If a diagnosis of heart failure has been made and the appropriate medications are administered the pet should display a reduction in their previous clinical signs. If there is no improvement or if there is progression of their disease process we are either a) not treating the appropriate disease or b) not treating the disease appropriately. It is important that we identify failure to respond to therapy so we can determine the appropriate diagnostic and therapeutic strategy.

Neurolocalization-
Why Does this Dog Walk So Funny?

William Bush, VMD, DACVIM
Bush Veterinary Neurology Service
Frederick, MD

When a client presents with a dog or cat the goal of the examination is to determine the location of the disease within the body for the problem. Once the location is known then limiting the list of possible causes to just a few becomes easy when considering the location, age, and breed and disease progression. A useful discussion can then occur regarding the diagnostics, treatments and prognosis for the likely disease (s) that caused the client to present with their pet. In neurology, this is especially important in because problems are often life-threatening, rapidly progressive and diagnostic testing often involves MRI of the diseased part of the nervous system. Simply observing a patient's mentation / behavior, posture (how they support themselves against gravity) and gait (how they move) will typically allow an observed to determine the location within the nervous system. We will used video case examples to demonstrate lesions within the forebrain, vestibular system, cerebellum, spinal cord and nerve / muscle.

Forebrain
The forebrain consists of the cerebrum and thalamus and lesions with this area produce seizure and behavior changes like confusion, irritability (headache?), and inappropriate elimination. The forebrain receives sensory information (visual, tactile) from the opposite side of the body. A lesion on the left forebrain can result in an inability to recognize or process incoming information from the right side of the body. This phenomenon is called hemi-inattention or hemi-neglect. Strength, balance and gait are normal because these attributes are controlled by the brainstem. A patient with a left forebrain lesion might bump into things on the right, turn their head or circle only to the left and place the limbs on the right side away from midline.

Vestibular system
The vestibular system controls head and body position while we are at rest and moving (accelerating, decelerating). The receptors that receive information about head position, acceleration and deceleration are called the semi-circular canals and are located in the bones of the inner ear and the information is processed within the brainstem. Disease of either the nerve or brainstem can generate signs of vestibular disease which include head tilt, side-stepping (drunk appearance), and spontaneous eye movement (nystagmus). If the lesion is within the brainstem then dullness, weakness, and other nerve abnormality are often noted.

Cerebellum
The word cerebellum means 'little brain' and half the neurons of the brain are located within the cerebellum. The cerebellum is located just above the brainstem, behind the osseous tentorium within what is called the cranial caudal fossa. The role of the cerebellum is to smooth out and control movement – the cerebellum does not generate gait or strength. Lesions of the cerebellum produce a characteristic high- stepping gait and patients can have a movement associated (intention) tremor. Cerebellar lesions do not produce behavior changes or weakness although patients may hold their pelvic limbs away from midline or wide-based... A head tilt and spontaneous eye movements can be seen with cerebellum disease but are far more common with disease of the vestibular system.

Spinal cord
The spinal cord delivers signals from the brainstem to the nerve and muscle to generate gait. It also delivers information from peripheral receptors about limb position to the brain. A severe lesion of the spinal cord will produce paralysis whereas a mild to moderate lesion will produce weakness from failure of delivery of signals to the nerve and muscle. Poor coordination or proprioceptive ataxia of the limbs will also be noted from poor delivery of signal about limbs position to the brain. Weakness and ataxia or a disordered gait are characteristic of spinal cord disease. Spinal cord lesions often cause moderate to severe pain from compression, stretching, or inflammation of the meninges, nerve root or vertebral column structures. Consequently behavioral changes associated with pain (abnormal vocalization, slow to sit and rise, unwilling to move) or abnormal posture (arched back) are often noted. Spinal cord disease is sometimes called upper motor neuron disease. Lesions of the spinal cord cause weakness, ataxia and/or severe pain.

Nerve / muscle
The nerves start within the spinal cord and carry signals to activate the muscle. An intrinsic, reflexive system of nerves automatically or reflexively produces muscle tone and support against gravity. Disease of the nerve, muscle or their connection (neuromuscular junction) produces the same symptoms and is referred to as lower motor neuron disease or neuromuscular disease. Nerve /muscle disease causes weakness and less commonly paralysis and does not produce incoordination or ataxia. Whereas muscle tone is often increased with upper motor neuron disease, in lower motor disease there is reduced muscle tone. Patients might stand with their hocks

or carpi dropped or too low to the ground. A primary characteristic of this disease is a short-strided or choppy gait where the patient acts as though they are walking on egg shells. Neuromuscular disease patients are seldom painful. Coughing, gagging, a respiratory stridor, and a change in the bark might also be noted from weakness of the nerves and muscles going to the back of the throat (pharyngeal area) and voice box (larynx). Patients may appear dull if they are systemically ill from pneumonia which is commonly associated with pharyngeal disease.

Table 1. Characteristic behaviors, gaits and postures for neurological lesions

Location	Forebrain	Cerebellum	Vestibular	Spinal Cord	Nerve / Muscle
Behavior	Confused, seizure	Normal	Dull	Painful	Normal
Gait	Not weak, circling	High stepping	Side stepping	Unpredictable	Short strides
Posture	Head turn, limbs held out to side	Intention tremor	Head tilt	Normal to unable to stand	Normal to unable to stand

Note: Behavior or level of awareness can be normal with a lesion in any part of the nervous system

References

De Lahunta AD, Glass E. Small animal spinal cord disease. In: De Lahunta AD, Glass E, eds. Veterinary Neuroanatomy and Clinical Neurology. St. Louis: Saunders Elsevier, 2009; 243-284.

De Lahunta A. Veterinary Neuroanatomy and Clinical Neurology. 2nd Edit, W.B. Saunders, Philadelphia, 1983

Dental Equipment Maintenance and Technician Safety

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

A current trend in veterinary medicine is a reduction in elective surgeries in small animal practice. Spays and neutering procedures are being done earlier and earlier at the rescue or at low cost clinics. That change has affected the small animal practice dramatically which has focused much attention to the mouths of our patients.

Small animal general practitioners are looking towards dentistry as a way of increasing wellness care while supporting the operating and treatment room activities. With an increased focus, there is an increase of the number of dental procedures being performed in practice and this necessitates us to look at both equipment maintenance and technician safety.

There is nothing more frustrating than equipment failure during a procedure for both the veterinarian and the technician. Therefore, is it important to schedule some time during the week that will be devoted to equipment maintenance.

Dental unit compressor maintenance

Some dental units come equipped with a small compressor. Some practices have a compressor outside of the dental department and the units are connected with quik-connections. In either case:

Oil-cooled compressors have either a view port or a dipstick with which to monitor the oil level. This should be checked weekly. Consult your compressor's owner manual to determine the type of oil required.

Condensation also accumulates in the barrels of the compressors. There are drains (either wing nut type or screw type) at the bottom of the compressors. These air storage tanks need to be drained weekly for busy dental departments and monthly for smaller departments.

High speed handpiece maintenance

After use

1. Remove the handpiece from the dental unit tubing.
2. Wipe the outside of the handpiece with a clean gauze or paper towel moistened with water or alcohol. If you have a handpiece equipped with a fiber optic light source, make sure that is wiped clean as well. Do not use harsh cleaning solutions and do not vibrate in the ultrasonic cleaner.
3. With the bur in place, spray a short burst of special handpiece lubricant (refer to manufacturer's owner's manual) into the air drive hole. This is usually the smaller and often shorter of the holes.
4. Reattach the handpiece to the dental unit tubing and depress the foot pedal for 30 seconds allowing the lubricant to circulate through the handpiece and to expel any excess oils from the air line. Allow the lubricant from the handpiece to discharge onto a paper towel and inspect for color. This should all be clear. If not, repeat the lubrication process described above until it is clear.
5. Remove the old bur.
6. Dry the exterior of the handpiece thoroughly (any excess oil will soak through the autoclave pouch, disrupting instrument sterility and will risk paper char).
7. Follow manufacturer's owner manual for autoclave time and pressure (Never exceed 135 degrees C).

Before use

1. Place a new or sterilized bur in handpiece. Secure in appropriate bur into the chuck of the handpiece and finger tighten the chuck closed around it by mounting the Chuck Wrench or by releasing the Push Button on the end cap of the Push Button Type handpiece.
2. Spray lubricant into drive air hole.
3. Allow handpiece to run for 20-30 seconds.

Cartridge replacement

1. If, after lubricating the high speed handpiece, there is excessive drag (the handpiece is not spinning with adequate RPM), it may be necessary to replace the turbine cartridge.
2. A bur should be in place.
3. Use the manufacturer's end cap wrench to remove the end cap turning the wrench counter-clockwise.
4. Gently push the turbine out by pushing gently on the bur.
5. Remove debris from the turbine from the inside of the handpiece with a cotton tipped applicator.
6. Insert a new turbine into the head of the handpiece by aligning the locating pin to the guide dot on the head.
7. Make sure the back of the cartridge sits flush with the back of the handpiece.
8. Secure the end cap back in place with the end cap wrench.

Low speed handpiece maintenance

1. If your low speed handpiece has a motor section with a detachable sheath, the motor does not need to be sterilized.
2. Slide the attachment ring up to detach the sheath.
3. Dental motors and sheaths require a higher viscosity oil than high speed spay.
4. One to two drops of oil in the drive airline is all that is necessary.
5. Attach the motor to the drive airline and run to distribute the oil.
6. Wipe away the excess with a paper towel.
7. The straight sheath does not require lubrication.
8. Clean the outside with a moist gauze or paper towel and dry.
9. Place in a sterilization pouch and sterilize.

Disposable polishing angle

1. It saves maintenance times because you simply through it out.
2. No cross contamination.
3. 90 degrees reciprocating head
    a. Does not wind into long hair of some animals.

Autoclavable prophy angle

1. Dip the head of the prophy angle in a small amount of handpiece cleaning solvent.
2. Run for 1 minute changing directions of the gears from forward to backward.
3. Wipe off and insert prophy cup.
4. Periodically follow the manufacturer's instruction in the owner's manual and disassemble the prophy angle to oil the gears.

Hand instrument sharpening

1. Put a drop of sharpening oil on an Arkansas Sharpening Stone
2. Hold the dental instrument either against a firm surface at a 90 degree angle to the floor with the toe facing you.
3. Place the oiled sharpening stone at a 115 degree angle and move up and down until a sharp angle is obtained.
4. Wipe filings and excess debris off with a conical stone.

Winged elevator sharpening

1. Match the angle of the back edge of the winged elevator against the Oiled Arkansas Stone.
2. Hold the instrument steady.
3. Move the stone down the back of the instrument on the right side, then the middle then the left.
4. Use the conical stone on the inside of the winged elevator to remove filings.
5. If there are notches in the instrument left from improper extraction techniques or if the instrument has been bent, send it off for professional instrument care OR replace the instrument.

Operator/technician safety

Ergonomics

1. Maintain proper posture
    a. Upper back
        i. Your elbows should be at a 90 degree angle
        ii. Use magnification and good lighting to reduce the need to bend the neck and shoulders
    b. Lower back
        i. Adjust the height of the seat so that your feet are flat on the floor with your knees slightly lower than the hips.
    c. Hands
        i. Hold the instruments in a modified pen grasp
            1. Neutral position
            2. Relaxed position
            3. Stabilized hands when possible

Personal safety

1. Contaminants
    a. Two foot spray, splash and spatter zone
    b. Wear eye protection at all times
        i. Goggles
        ii. Safety glasses
        iii. Chin length full face shields

c. Wear mask
    i. Have a filtration level of at least 95%
    ii. Minimize goggle fogging
d. Protective clothing
    i. Really should protect your skin and work clothes (CDC)
e. Gloves
    i. Right size
    ii. Allow for good tactile sense

2. Radiation
    a. 6 foot 8 inches from beam when barriers are no available
    b. Primary Barriers (needed when within the beam)
        i. Lead gowns
        ii. Lead curtain
    c. Secondary barrier
        i. Dry wall is considered an appropriate secondary barrier
    d. Dosimeter
        i. Collar level

Dental Charting:
It is More than Just Xs and Os

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

As a frequent consultant and instructor, I have the incredible opportunity to meet many of you within your own practices. When I ask if you chart your dentistries, most of you enthusiastically report that you do. This is a positive change from the past. Now, I would like to take this opportunity to look at the dental chart in detail and review the importance of this document.

But before we start looking at the document and how to record your findings, I recommend we review some anatomical terms as they relate to the mouth and associated structures.

First, you should know the proper and expected dentition of puppies and kittens versus adult dogs and cats. In the puppy, there are no deciduous first premolars or molars. In the kitten, there are no deciduous molars. Also, it important to know the eruption schedules. In the puppy, primary or deciduous teeth begin to erupt around 3-6 weeks of age. Usually, by 6 months of age, the adult teeth are replacing the primary teeth. Also, it should be mentioned here that many of the "micro-breeds" tend to experience a delayed eruption. This is important information when planning treatment options for extracting retained deciduous teeth.

Begin the assessment of the head by looking at your patient squarely in the face and note any swellings or asymmetry while the patient is still awake and conscious. Note any facial abnormalities such as unilateral facial swellings.

If the patient is cooperative, a conscious intraoral exam can be very beneficial is case planning as well. Things to note are; the bite, tooth occlusion and any tooth-to-tooth contact and any tooth-to-tissue contact. The tissues of the gingiva, the mucosa and the lips all should be examined and notes made of any abnormalities. Also, note any odor, discharge, swelling, tumors, etc.

Once you feel a good conscious intraoral exam was performed, the patient should be anesthetized for the comprehensive assessment. This is when you are able to gather the most information. One person should be performing the examination and another should be recording the information. It is a good practice to have the person who is performing the anesthesia make the notations on the dental chart.

Tooth identification

There are several different methods of referring to each tooth. A tooth can be identified with an abbreviation. For instance, the left upper fourth premolar would be noted as LUPM4. The benefit of that is that everyone can understand that.

The other method is called the modified Triadan numbering system. The first number refers to the quadrant that the tooth is found. The second and third refer to the tooth position starting rostral and moving caudally. The right upper arcade is the 100 series, 200 is the left upper arcade, 300 series is the left lower arcade and the 400 series is the right lower arcade. Tooth 401 would be the right lower first incisor and tooth 411 is the right lower third molar.

Deciduous teeth are the 500,600,700 and 800 series in the same pattern.

The modified Triadan numbering system applies to the cat dentition as well. The difference is that they have fewer teeth. The cat have no upper first premolars, they have no first and second premolars on the lower arcades and there is only one molar in each arcade.

So here are some easy landmarks for you:

- The first incisor is always 01
- The canines are always 04
- The first molars are always 09

Anatomical direction:

- Tooth surfaces that touch the front lips – labial
- Tooth surfaces that touch cheeks – buccal
- Tooth surfaces that touch palate – palatal
- Tooth surfaces that touch tongue – lingual
- Anterior portion of a tooth – rostral
- Posterior portion of a tooth – caudal

So, once you have performed the complete visual oral assessment, it is time to start making notes on the dental chart. The purpose of a dental chart is to make record of the state of the mouth on that day. A veterinarian that was not involved in the procedure at all should be able to understand exactly what condition each tooth was in just by looking at this chart.

Often I have gone to practices that state they chart their dentistries. In fact what they do is circle all missing teeth and "x" out all extracted teeth. Complete charting involves much more than that. There should be adequate room to make notes as to signs,

diagnosis, treatments, prescriptions and take home instructions. An anatomical graphic showing every expected tooth in that species should be present and large enough that you can make notations of periodontal probing depths on at least two surfaces.

Periodontal probing

Since the statistic is that 70-85% of all companion pets over the age of 3 have periodontal disease, we need to make notations as to the pocket depth on each tooth. Without these numbers, there is no way that we can follow the progress of the therapy.

There are a number of periodontal probes available. I find that it is easiest for measurement of pocket depth is you choose a Williams periodontal probe. This instrument has markings at each mm. There is a heavier band at 4-5mm, 9-10mm, 14-15mm. This instrument is positioned parallel to the crown and gently guided under the sulcus of the tooth until the tip reaches the ceiling or the floor of the pocket. The intention of the technician using this instrument is to detect and measure periodontal pockets and clinical attachment loss. At the very least measurements should be recorded at the deepest pocket depth on the mesial and buccal aspects of the teeth and the lingual and palatal aspects of the teeth. Any pocket depth greater than 1 mm in a cat or 3mm in a dog is considered a periodontal pocket.

Other critical notations are tooth fractures; enamel fractures, uncomplicated crown fractures, complicated crown fractures, uncomplicated crown root fractures, complicated crown root fractures and root fractures. The classification of these fractures can be found at www.avdc.org.

An explorer is the very pointed tipped instrument used to enhance tactile sensation. This instrument allows the technician to detect any abnormalities in enamel integrity. The sharp end will transfer a change in feel when in contact with tooth resorptions, enamel hypoplasia and carious lesions.

Other gross clinical observations

All other abnormalities should be noted:

- Discolored teeth
- Fractured teeth
- Mobility
- Furcation exposure classification
- Tooth resorption classification (www.AVDC.org)
- Fistulae
- Crowding
- Tooth rotation
- Abrasion versus attrition
- Enamel defects
- Foreign bodies
- Oral masses
- Supernumary teeth
- Stomatitis

A very comprehensive list of appropriate abbreviations can be downloaded from http://www.avdc.org/traineeinfo.html.

Intraoral radiographs are taken and those findings associated with each tooth should be noted on the record. Once the veterinarian has made a diagnosis and treatment plan, this is shown and noted on this chart as well.

As you progress in increasing your dentistry skills, there will be more and more things diagnosed and different treatment options will be offered and provided. This document will be your way of providing a means of clear communication for individuals within your practice and to those you are referring care.

The standard of care expected by the state boards in relation to dentistry is increasing every year. AAHA standards also make it clear that good record keeping and charting for dentistry services provided is expected. Since the down turn in the economy has hit dentistry services and surgery services hard across the country, we should look at this opportunity as a “speed bump”. Speed bumps are provided in order for us to slow down and evaluate the current conditions. This is an excellent opportunity for us to take this skill to the next level.

Out of Sight!
Are Intraoral Radiographs Important for a Complete Dental Assessment?

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

Are dental radiographs essential for professional veterinary dental care? Absolutely! In practices that use radiology to evaluate dentistry patients with obvious clinical findings, radiographs revealed additional pathology in 50% of dogs and 53.9% in cats. In cases that had no gross pathology present, radiology exposed clinically relevant findings in 27.8% of dogs and 41.7% in cats. So, when practices are providing dentistry without evaluating the health of the tooth below the gum tissue, they are missing a vast amount of disease.

To provide this service, a dental X-ray unit is not necessary. For some years, vet dentists used their regular medical X-ray unit successfully. The key is to use intraoral film. This task is awkward and time consuming. Often it means transporting the anesthetized patient to a totally different room in the practice. But, it can be done.

Many veterinary hospitals site cost to the clinic as the number one reason for not purchasing a dental radiographic unit. Unfortunately, they are mistaken. Of all pieces of equipment in a practice, this unit is relatively inexpensive. To purchase a regular dental X-ray unit, the cost would amount to about $4,000. If the practice goes digital, software and sensor can cost from $6,000 to ~ $9,200.

A cost analysis is valuable when evaluating the profitability of equipment. Let's say, for example, a practice is performing 3 dentistries per day. On the average they take (and this is very conservative) 10 radiographs per day. The average fee is $10-20 per view, so let's split it in the middle…$15 per radiograph. That produces $150 per day. Do these 5 days per week; the practice generates $750 per week. Do these 50 weeks per year, the practices produces $37,000 per year. The equipment paid for itself in less than 6 months just on the revenue brought in by the images itself. I haven't included the increased pathology found and the revenue generated by treating it. These numbers are very reasonable in a large, multi-vet practice.

Consider a small, 2 vet practice. Let's imagine they perform 3 dentistries per week. They take 10 radiographs per week at $15 each. That is $150 per week. Do these 50 weeks a year and the practice has grossed $7,500 a year. The equipment in that scenario paid for itself in less than 2 years. After the equipment is paid off, except for incidental supplies, the rest is all profit.

To use a medical X-ray unit, it is preferred that the head of the unit can be lowered and the angle changed. A focal distance of 12 inches is best. To be able to use the bisecting angle technique is often necessary to reposition the patient. Different X-ray units have different technique charts but you can try using 100 mA, 65 kVp at 1/10th second and adjust the technique accordingly.

Dental radiographic units have heads that are more adjustable so that the patient does not have to be manipulated and repositioned as much. The radiographic detail is much better.

So, once a practice decides it is interested in providing this service, some training and education is required. Fortunately, there are many venues for this education. There are numerous training facilities across the country; there are convenient online courses, many wonderful books and journals. Recognizing normal versus abnormal requires some knowledge of each.

Safety is also an important factor. It certainly is a fact that digital radiographs require about 1/10th of the radiation required when exposing film. But, that doesn't mean that one shouldn't prudently provide radiation protection. Stay 6 feet away from the head of the X-ray unit, do not stand directly in the line of the beam, do not hold the sensor with your hand, and always wear your radiation badge.

There are hand-held X-ray units available. These are often sought because they do not take up a large footprint within the dental operatory. But, their approval is provided for use at an arm's length. These units are heavy and that may be difficult.

Once you have obtained the equipment and you have training in getting diagnostic images, it is important to begin to understand the baseline for normal versus abnormal tooth development and pathology. I recommend the following book when you are first getting your feet wet in this service:

Atlas of Dental Radiography in Dogs and Cats, 1e by Gregg A. DuPont DVM FAVD DAVDC and Linda J. DeBowes DVM MS DACVIM DAVDC (Jul 25, 2008)

In a normal, young patient, it is important to know that the dentinal wall is very thin and the pulp chamber is wide. As the patient ages the dentinal wall thickens hence the pulp canal narrows. Also, in very young animals, the apex of the tooth is still open. As they age, the apex closes.

Indications for radiographs are vast:

- areas where there are missing teeth
    - Impacted teeth often cause dentigerous cysts. As the tooth is developing, there is a sac of epithelium that covers the crown of the tooth. During eruption through the gingiva, the sac is lost. If the tooth is embedded,

the sac remains and often begins to secrete fluid. As the fluid accumulated, a cyst forms. As the cyst enlarges, the surrounding bone is destroyed.

- to evaluate teeth experiencing periodontal disease
    - It is not enough to clean a periodontal pocket without radiographing the tooth to evaluate bone loss and whether or not the patient has secondary endodontic disease.
- to document destruction caused by tumors, including epulides
    - when evaluating tumor or epulide activity, radiographic findings should accompany the biopsy so that the pathologist can consider this in his/her diagnosis
- to evaluate discolored, worn or fractured teeth
    - Is there endodontic disease and what are the options for care?
- prior to extraction
    - What are the roots like?
        - Sometimes there three roots on a two rooted tooth
        - Sometimes the root is already fractured or resorbed
        - Sometimes mandibular molar roots curl at a 90 degree angle
        - Sometimes mandibular molar roots cross
- Are the roots ankylosed?
    - No point in trying to take out a root if it has been incorporated into bone (usually feline)
- What is the quality of the remaining bone
    - Is there sufficient bone to safely extract a tooth without fracturing the jaw?
    - Is there already a jaw fracture?
- post extraction
    - this documents complete root extraction
    - it documents the remaining integrity of the bone
- facial trauma

In summary, to provide complete and professional dentistry that will keep your patients happy and healthy, radiographic evaluation is very necessary. Extracting a tooth without radiographs is the same as repairing a femoral fracture without radiographs.

Some specialists feel that by the end of the decade, dental radiographs will be standard of care in veterinary medicine. Our clients are becoming ever so much more sophisticated in their expectations for their veterinary care. This is everyone's opportunity to be ahead of the curve rather than trying to play catch up.

Pain Management and Regional Nerve Blocks in Small Animal Dental Patients

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

It is fair to say that, anesthetically, dentistry can be very time intensive. Once the dental prophylaxis is completed, the patient's mouth has been charted, and a full series of intraoral radiographs is ready for evaluation, some patients may have already been under anesthesia for over an hour. A patient that will undergo multiple extractions, oral surgery, endodontics, etc. can be anesthetized for 2-3 hours.

As an adjunct to general anesthesia, regional nerve blocks can be added to increase patient safety by dramatically decreasing the amount of inhalant anesthetics needed for such long procedures. Nerve blocks will also significantly improve post-operative comfort.

During the pre-operative exam, it is often obvious when a procedure will include some level of discomfort. At this point, it is wise to plan on adding local anesthesia. The technician can calculate the dose of the chosen local anesthetic, prepare the syringe and label it accordingly.

Perform the regional block after the patient is under an appropriate level of general anesthesia, the monitoring devices are in place, the IV fluids are running and the condition of the patient is stable. This gives the block time to work before any pain is caused. It is infinitely better to prevent, than to treat pain.

There are a number of drugs used for local anesthesia, each varying in their dose, onset of action, duration, and toxicity. For simplicity, let's concentrate on Bupivicaine*.

Bupivicain

Again, depending on the reference, onset of action has been reported as long as 20-30 minutes with a duration of 2.5-6 hours.

Five common dental blocks

1. Local infiltration

This method can be employed when only a small area requires anesthesia. The anesthetic agent can be injected into the gingiva, mucosa or periodontal ligament. When radiographs show bone loss around a specific tooth, a local anesthetic agent can be infiltrated apical to that tooth. Also, as an adjunct to an infraorbital block, the maxillary teeth can be blocked by infiltration palatal to that specific tooth. But, local infiltration of anesthetics is not the most effective means of blocking dental pain.

2. Infraorbital nerve block

The infraorbital foramen is easily palpated in the dog and cat. It can be found apical to the maxillary third premolar. Through this foramen passes several nerves that supply innervation to the maxillary arcade. Insert the needle through the buccal mucosa where it forms a crease and direct it towards the foramen in a rostrocaudal direction. Pass the needle until it is at the opening of the foramen. Aspirate in several planes. Slowly inject the agent in an attempt to bathe the exiting nerves supplying the rostral structures. When the more caudal teeth are to be blocked, finger pressure is held over the wheal of local to "force" the agent deeper into the foramen, thus blocking those structures.

Other sources recommend actually passing the needle just inside the foramen and instilling agent to block rostral structures and then advancing the needle gently into the foramen to instill more through the foramen (aspirating frequently). Digital pressure is used to prevent the local agent from then exiting from the foramen.

3. Maxillary block

Walk the needle around the most caudal aspect of the upper maxillary second molar. Pass the needle into the space just under the eye. This is where the nerves pass to enter the infraorbital foramen. Make sure you use sharp, short needle with a finger stop employed so as to not advance the needle into the globe of the eye. Do not pass this needle to full depth. Just advance it so that the bevel of the needle just passes underneath the soft palate. Do not advance aggressively. The globe of the eye is large in cats and many brachecephalic breeds.

4. Mandibular (or inferior alveolar) block

When attempting to block the mandibular structures, the mandibular nerve needs to be blocked. There are two ways to accomplish this. To block this nerve intraorally, slide your index finger along the mandible caudal to the last molar until you feel an indentation. With the other hand, introduce the syringe until the needle is at the opening of the foramen. Aspirate then inject.

Another method is called the Transcutaneous Approach or the Extraoral Approach. A small area of hair is clipped and prepped at the angle of the mandible. The foramen is palpated as in the previous method. The canine mandible has a notch anterior to the angular process (the cat does not). Insert the needle through the skin until the needle hits the mandibular notch. Then gently walk the needle medially then gently guide the needle to your other index finger. Your needle should be trapped between the Inferior Alveolar Foramen and your finger. When you are sure of your placement, aspirate, then inject.

5. Mental block

There are three mental foramina. The middle mental foramen is the largest. In large dogs this can be palpated apically between the first and second premolars. The needle is inserted under the submucosa just to the entrance of the foramen. Aspirate and inject. If the interest is in blocking the rostral mandibular structures put a minute's worth of finger pressure to ensure the agent anesthetizes the incisors and canine.

In the cat, the needle is introduced through the submucosa into the labial frenulum and directed caudally. Aspirate and inject.

Some important rules for administering local anesthetic agents:

- Do not attempt to instill the local anesthetic agent until the patient is completely under general anesthesia.
- If multiple sites are to be anesthetized, the total calculated dose must be divided by the number of sites.
- Change needles between sites. A sharp needle gives the anesthetist the best advantage for accurate placement. Dull needles require too much effort.
- Always, always aspirate prior to injecting.
- It is recommended to decrease the calculated amounts by 30%-40% for old or cachetic pets.
- Injection into infected tissue is contraindicated.
- Be aware that you may have the level of inhalant anesthesia low while working on one side of the pet. It is often necessary to increase the patient's plane of anesthesia before turning them. It is possible to keep the anesthetic level so light that moving the patient may begin to awaken them.

Finally, the technician experienced in the use of dental blocks will notice the positive impact for his/her patients. The anesthetic procedure will be more even, the recoveries will be smoother, and the patients will be ambulatory and will eat sooner post-operatively. Just as importantly, client satisfaction will increase because they will perceive the experience as less stressful for their pet.

*In the past, I have always lectured that combining both Lidocaine and Bupivicaine provided both quick onset and long duration. Although, anecdotally this always seemed to work well, current literature suggests that when combining both drugs you are losing some of the duration of the Bupivicaine. I now use Bupivicaine alone in the syringe and my experience has showed no negative aspects of using it as a stand-alone agent.

Periodontal Disease:
The Most Prevalent Veterinary Disease

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

Peri- : Prefix meaning around or about
-odont: having to do with tooth
-ium: indicates a biologic structure

If we use this information, it means that periodontal disease is a disorder of structure having to do with the tissues that surround and support the teeth, including the gums, cementum, periodontal ligament and alveolar and supporting bone.

The structures of a tooth

- Enamel: hard white substance covering the crown of a tooth
- Dentin: the main boney part of the tooth beneath the enamel and surrounding the pulp chamber and root canals
- Gingiva: the gums of the mouth. The gingiva is made up of epithelial tissue that is attached to the bones of the jaw and surrounds and supports the bases of the teeth.
- Gingival sulcus: the groove between the surface of the tooth and the epithelium lining the free gingiva.
- Free Marginal Gingiva: the portion of the gingiva that surrounds the tooth and is not directly attached to the tooth surface.
- Attached Gingiva: the portion that is firm, resilient, and bound to the underlying cementum and alveolar bone.
- Cementum: A bonelike substance covering the root of a tooth.
- Alveolar bone: The alveolar process is the thickened ridge of bone that contains the tooth sockets on bones that bear teeth.
- Periodontal Ligament: the fibrous connective tissue that surrounds the root of a tooth, separating it from and attaching it to the alveolar bone, and serving to hold the tooth in its socket.
- Furcation: the space between two roots

Periodontal disease is the most prevalent medical condition affecting our dogs and cats. As a matter of fact, it is suggested that most pets over the age of three years of age are experiencing some level of periodontal disease.

Bacteria in the mouth form a thin, slimy film on the teeth, otherwise known as biofilm. When that biofilm covers the teeth, it is called plaque. If the plaque is not removed, the minerals in the saliva join with the plaque and harden into a substance called tartar or calculus. The bacteria secret toxins and that sets off an inflammatory response. This is the primary cause of periodontal disease.

There are stages of periodontal disease

- Normal: Clinically normal. No inflammation evident
- Stage 1 PD (periodontal disease): Gingivitis without any attachment loss
- Stage 2 PD: Early periodontal disease. There is less than a 25% attachment loss and/or a stage 1 furcation involvement.
- Stage 3 PD: Moderate periodontitis: There is a 25-50% attachment loss and/or a stage 2 furcation involvement.
- Stage 4 PD: Advanced periodontitis. There is a greater than 50% attachment loss and/or a stage 3 furcation involvement.

Periodontal disease is much more than just an aesthetic issue for pets and their owners, although the odor may be the client complaint necessitating the visit. Periodontal disease can lead to oral discomfort, as well as tooth loss. It has also been strongly documented in human medicine a link between periodontal disease and numerous problems such as an increased risk of stroke, myocardial infarction, atherosclerosis and difficulty regulating diabetes due to the inflammation. It has also been suggested that people over 60 years of age may suffer from delayed memory as well. We now have studies in dogs showing a correlation between periodontal disease and microscopic changes in heart, liver and kidney tissue.

The periodontal patient needs first to have a thorough assessment, cleaning, and charting to determine the degree and severity of the disease process. Radiographs are also needed to determine if there are any teeth endodontically challenged secondary to the periodontal disease. A critical piece of the puzzle is determining the ability and willingness of the owner to provide care at home. Although there are treatments available, if the owner is not willing to provide meticulous home care, severely affected teeth should be extracted.

In the event you have an owner that is motivated to do home care, treatment options are:

Root planning and subgingival curettage

When periodontal pockets have been identified, it is imperative that the plaque and calculus be removed from the root surface. Ultrasonic and sonic hand pieces can be used hasten the work, since our veterinary patients are under general anesthesia. The scalers

actually vibrate at a frequency that breaks down bacterial cell membranes. This does hold a therapeutic advantage. However, the tips do not provide the same horizontal flat surface as hand instruments do. Therefore, it is recommended to follow ultrasonic pocket treatment with engaging the curette with the root surface and pull with a downward motion in a cross hatch fashion.

The goal of root planing is to scale the root. Since the cementum is softer, it is more affected by tartar build up and inflammatory by-products. So root planing removes the roughened cementum, impregnated with toxins.

Care needs to be taken not to be overly aggressive in planing. Cementum itself does contain substances that augment attachment.

The pocket itself needs to be treated as well. A curette is used to debride the diseased tissue from the pocket, leaving a healthier tissue bed for healing and reattachment.

Perioceutics

These are products that are employed to provide a medicant to the disease periodontal pocket.

Doxirobe gel (zoetis)

This is a doxycycline polymer preparation that comes as a two syringe system. The polymer syringe mates with the antibiotic syringe. The plungers are depressed in a back and forth motion 100 times. A blunt cannula is attached and can be bent to whatever angle is most appropriate. The gel is introduced into the treated periodontal pocket (greater than 3mm deep). A few drops of water on the gel and the matrix harden. A plastic filling instrument or titanium covered beaver tail instrument is used to pack the material into the pocket. This will remain in place for 2-3 weeks. Another advantage of Doxycycline is that it has an anticollagenase effect. This aids in tissue reattachment.

Clindoral (TriLogic pharma)

This is a preloaded syringe system that comes ready to use. Attach the blunt cannula and with the head of the pet upright, instill the Clindoral filling the pocket. Hold the head in the same position for 1-3 minutes for complete gelation. An instrument can be used to pack the material. The material slowly resorbs over a 7-10 day period.

Consil and osteoallograph

Guided Tissue Regeneration. Both products are synthetic bone graft materials. This is a more advanced procedure and referral to a dental specialist may be indicated if your veterinarian is not familiar with this product. This is a material that is most effective for areas where there has been vertical bone loss. This procedure is a surgical procedure necessitating a surgical flap. Care must be taken to rule out any oral nasal fistulae or antral nasal fistulae. Otherwise, these materials will migrate into the sinuses and will be very irritating for the patient.

Systemic antibiotic use

When providing periodontal therapy, these sites are considered “open and draining”. Treatment by combining scaling and extraction is not an indication for systemic antibiotic treatment. There are, however, some specific indications for adding a systemic antibiotic:

- When local tissue is severely infected and periodontal therapy required surgery to expose bone or if teeth were extracted from severely infected bone.
- Osteomyelitis
- CUPS (chronic ulcerative paradental syndrome): mucosal immunopathy
- Prevention of bacteremia in specific cases
    - Patients with clinically evident cardiac disease
    - Patients with clinically evident renal or hepatic disease
    - Patients with prostheses; ocular, total hip replacements, patients with anterior cruciate repairs using nonabsorbable material
    - Patients with splenectomies
    - Patients with clean surgical procedures with severe periodontal disease
    - Chemotherapy patients
    - Patients with concurrent auto-immune disease

Home care

When periodontal therapy is provided, it is critical to provide explicit home care instructions:

- List all dispensed medications and when should the client begin the medications
- When may the patient eat next and what may they eat?
- When may the client resume or begin tooth brushing?
- When is their recheck appointment?
- When do you want to schedule the next dentistry? This is influenced by the client, the size and breed of patient, the budget of the client, etc.

Periodontal disease is the most common condition in our companion pet population. Prevention is the gold standard and that includes owners brushing their pet's teeth…daily. Probably one of the most important activities the technician plays is in educating the client on how to maintain a healthy mouth.

Gaining Compliance:
Getting those Dentistries to the Table

Vickie Byard, CVT, VTS (Dentistry), CVJ
PetED Veterinary Education and Training Resources
Warminster, PA

A well-known fact: The statistic is that 70-80% of all companion animals over the age of three have some level of periodontal disease. Yet, it is probably the most ignored disease in dogs and cats. Most practice websites strongly tout that they are wellness practices. Can they say that if, indeed, they are not recommending dentistry services and care?

Before an individual ever entered a veterinary technician school, they were already trained by the veterinary practices they took their own pets to, how very important vaccines are. We have come to expect that a wellness visit to the vet may very well include vaccines. These are vaccines that the majority of pets will most likely never be exposed to. But, that same individual has been successfully trained to provide this care.

Now, vaccinating dogs and cats is an important practice. But, this scenario speaks to the truth of how veterinary professionals are trained, in their personal lives, in school and in their chosen practice. Yet, most pets would have never contracted any of the diseases for which they were vaccinated, but almost all will suffer with dental problems.

Interesting to know, a 2002 AAHA client-compliance survey revealed that the responsibility for the failure of owners to provide dental services for their pets was the person responsible for giving the recommendation. Most veterinarians felt that cost was the deciding factor against dentistry. The survey showed only 7% responded that cost was a factor. The survey showed that they actually either did not receive a recommendation for dentistry, they didn't understand the importance, and they forgot the recommendation or their vet didn't follow up. So, that means that each of these concerns must be managed before compliance will be gained. *Provide an informal survey to determine how many of your staff has provided dentistry within the last 18 months for their own pets, and if not….why? The responses will be eye opening as to what is going on internally as far as recommendations.

Training begins at the practice level. All staff members need to be on the same page as far as dentistry is concerned. This means that everyone from the receptionist to the practice administrator must understand their role and "buy in" to the importance of this care.

First, what is the impact of dental disease on the patient? The result of recent research demonstrates the association between inflammatory periodontal disease and cardiovascular disease, respiratory disease, liver disease, kidney disease, and joint disease. So, when the mouth is cared for, the vital organs are subsequently cared for.

What about patient comfort? Animals live with fractured teeth, multiple tooth root abscesses, oral ulcerations and more. But, because they do not stop eating, or become noticeably lethargic, many clients perceive that the pets are not uncomfortable. On the contrary, experience shows that most clients notice the positive change in behavior after the dentistry is provided.

So, how can train everyone on staff be trained? Staff meetings and staff education. Close the practice down for 2-3 hours and provide the staff with that training. Receptionists should understand dentistry services, terminology and products dispensed.

Technicians should be trained to "flip the lip" every time they examine a pet. The veterinarians should be trained to discuss the oral status and make appropriate notations in the permanent medical record every time they perform a physical exam.

Also, when a recommendation is made by the veterinarian that dentistry should be provided, reminder cards can be generated by most veterinary software packages.

Along with the staff, the clients have to begin to expect a report about their pet's mouth as much as they expect vaccines. The clients will come to expect this when the practice is consistently saying the same message time and time again. It is no coincidence that large companies spend millions of dollars interrupting programming on television repetitively. It may take a client 10 times of hearing that their pet needs to have dentistry before they value the information enough to jump over the barriers to that care.

Many drug companies provide professional posters highlighting oral disease. These can be placed around the practice. Some practices create photo albums filled with before and after photographs. Practice websites can have articles and case presentations stressing positive outcomes. Computer software makes it possible for the practice to produce brochures informing clients of the importance of good oral care.

After expensive dentistry procedures, technicians experience clients lamenting that, if they had only known, they would never have let their beloved pet's mouth get so bad. In an attempt to give them the critical information required to maintain their pet's oral health, your practice could provide monthly seminars for the clients on dentistry.

As stated above, cost is a barrier, but more prevalent is the fear of anesthesia. Your practice can create a PowerPoint presentation explaining that you minimize anesthetic risk to the patient and how you do that:

- Complete physical examination
- Heart auscultation
- Lab work is provided prior to the procedure to ensure that the kidneys and liver are functioning properly.
- Tailored anesthetic drug protocols for each patient

- Elegant monitoring (show photos of pulse oximeter, ECG, blood pressure monitor, Bare Hugger, IV fluids, IV fluid pump)
- Certified veterinary technicians are responsible for monitoring their pet

Clients also need to hear that if there are any concerning changes on any of the monitor devises, steps will be taken to correct it. If the necessary changes do not improve, the patient will be recovered and rescheduled using a different anesthetic protocol. **Treat every pet as if it were your own.**

The presentation also can walk the client through some clinical cases. Use clinical photos that look normal but show the radiographs that prove otherwise. These cases provide the opportunity to discuss:

- Different grades of dental disease
- Resorptive lesions
- Periodontal disease
- Fractured teeth
- Malocclusions
- Tooth crowding
- Retained deciduous teeth
- Dentigerous cysts
- Gingival hyperplasia
- Chronic ulcerative paradental syndrome
- Lymphocytic Plasmacytic Stomatitis
- Others

You can also discuss:

- Tooth brushing
- Dental diets
- Veterinary Oral Health Council acceptance
- OraVet
- Sealants
- Water additives
- Appropriate chew toys

These are some ideas of how to incorporate communication and marketing strategies into your practice in order to treat the most prevalent disease we come across. The benefit to the patient is better overall health and a dramatic decrease in undisclosed pain.

The benefit to the practice is multifold. It creates a lucrative profit center that can increase revenue to the practice which ultimately should translate to the ability to provide better staff salaries.

Approach to Cutaneous Cytology

Rudayna Ghubash, DVM, DACVD
Animal Dermatology Clinic
Marina del Ray, CA

Skin cytology is defined as the microscopic evaluation of material collected from the skin. It allows for microscopic evaluation of both cells and organisms. Skin cytology can provide extremely valuable information as to type and degree of infection present, evidence or suggestive features of parasites, a normal or abnormal immune response, or demonstrate the presence of immune mediated or neoplastic diseases. It is an inexpensive test to perform, but can provide very significant diagnostic information extremely rapidly, which can be used at the time the patient is presented to guide medical recommendations.

Skin cytology is probably the most common diagnostic test performed in veterinary dermatology practices. On a daily basis I'll examine upwards of 30-50 cutaneous cytology slides, which allows me to make medical decisions immediately. Obtaining cytology samples is typically quite easy and straightforward, and with practice the vast majority of samples can be read and interpreted in-house. In cases where the veterinarian and veterinary nurse are unsure of what they are examining, the samples can be sent on to a clinical pathologist for evaluation. I highly suggest if you work in a practice where samples are routinely sent to a clinical pathologist that you examine the sample before it is sent away, and then compare with the report from the laboratory (or make a copy to look at while reading the pathology report). This is a nice way to teach yourself with the cases that are seen on a daily basis. The disadvantage of being dependent on a pathologist to evaluate all cytology samples is that it eliminates the ability for rapid results and immediate decision making about how to treat the patient. I find this less of a concern in cases of neoplasia/autoimmune disease, but more of a concern when evaluating bacterial or yeast skin and ear infections.

In veterinary dermatology the vast majority of cytology is used to direct empirical therapy of bacterial and/or yeast skin and ear infections. In cases where culture and sensitivity are being pursued (for example in a case with a skin infection that hasn't responded well to standard antimicrobial therapy) I still always recommend performing skin cytology first-I have had situations where I see too numerous to count rod shaped organisms on cytology and then the lab only grows a coccoid bacteria, indicating that the lab did not grow all the organisms seen and a repeat culture is indicated.

Samples for skin cytology can be collected via direct impression smear, using clear adhesive tape to lift the sample, using a cotton swab to obtain exudate (swab smears), scrapings, fine needle aspiration, or using metal spatulas (or something similar) to obtain material from nail beds. Different slides should be used for different locations and lesions, and the slides should be labeled accordingly. In most cases, no cleaning or disinfection of the sample is indicated, and in fact doing this can make obtaining a proper sample more difficult.

Most samples, other than tape, are heat fixed, and then stained with Diff Quik or a comparable stain. The slides are dried (naturally or with a hair dryer, lighter or bibulous paper-I prefer a hair dryer) and then examined microscopically. Important things that are identified on cytology include bacteria, yeast, neutrophils, eosinophils, acantholytic cells (the cells that are present in pemphigus foliaceus or, more rarely, dermatophytosis) and neoplastic cells.

The most expensive requirement to perform cutaneous cytology is a good quality binocular microscope with a strong light source and high quality lenses. Many veterinary practices will use a separate microscope to perform cytology vs fecal exams, which prevents the expensive lens required to effectively read cytology samples from getting coated in floatation solution. Even with proper care microscopes will get dirty and should be professionally cleaned at least once yearly.

I will typically start by examining my slide on the 10x location to evaluate where the best sample is present, and then I'll proceed to the oil immersion view at 100x to evaluate for microorganisms and closely evaluate the cells. It is always recommend to begin at a low magnification to find an area where cellular material appears to be present, and then go to oil immersion for identification.

To become adept at what is abnormal, the cytologist must first become comfortable with what is normal. Cytology samples can be taken from the ears and skin of normal cats and dogs from various sites to look for normal structures such as keratinocytes, melanin, wax (especially from ear samples) and lipids. Melanin, especially, is often mistaken for rod shaped bacteria, and is characterized by it's yellow-brown hue. Normal flora yeast and bacteria can also be visualized from the surface of healthy skin and ears. Although there is variation based on body site and breed, in general it is believed that less than 1 type of each organism (rod, yeast or coccoid bacteria) per oil power field in the absence of inflammatory cells can be normal.

Abnormal findings include inflammatory cells (most commonly neutrophils, although eosinophils are common in many allergic conditions), nucleated keratinocytes, acantholytic keratinocytes, neoplastic cells and microorganisms. When examining cytology samples for microorganisms it is important to determine the type, relative numbers, and tissue (inflammatory) response.

The bacteria that are typically seen on cytology are coccoid or rod shaped, and rarely filamentous. Mycoplasma, rickettsia, L form bacteria and some spirochetes are too small to be seen with 100x in house microscope. Dif-Quik is the most commonly used stain, with the organisms staining a dark purple (basophilic) color. Coccoid bacteria from the skin and ears is most commonly Staphylococcus pseudintermedius, which is DIFFERENT from the Staphylococcus aureus that humans have. These coccoid bacteria

can be seen alone, in pairs, or in quads or clusters. It's harder to assume what a rod shaped bacteria is based on cytology, as Proteus, Pseudomonas and Corynebacteria can all look similar and can all be involved in infections. It is important to evaluate for inflammatory cells, especially neutrophils, to help determine if the immune system is mounting a response-this helps differentiate between infection and bacterial overgrowth. Neutrophils with the presence of intracellular coccoid bacteria taken from the skin is almost 100% indicative of a Staphylococcal pyoderma. If no bacteria are seen a bacterial skin infection can't be ruled out, because most infections are actually folliculitis, meaning the majority of the bacteria may be within the skin rather than on the surface. This does not apply to ears.

There is a bacterium that is often seen that is not pathogenic that can be alarming if not familiar with it. It is called Simonsiella and is a gram negative saprophyte that inhabits the oral cavity of a large number of mammals. They can be found on areas around the oral cavity, or on other locations if the pet has been licking that area excessively. This bacteria doesn't cause disease and doesn't require treatment, but it is an example of importance of recognizing normal bacterial flora.

Malassezia pachydermatis is the most common yeast organism seen on the skin and ears, although there are many other Malassezia organisms that can be found, as well as rarely Candida. Candida is not as much of a concern in pets as it is in people, and when it is pathogenic pseudohyphae will be present. As previously mentioned, Malassezia is part of the normal flora and it is not necessary pathogenic to see the occasional yeast organism on cytology. One research study found that on skin showing lesions greater than 1 yeast per oil power field (opf) was associated with certain diseases. There is no hard and fast rule for when the yeast is causing clinical symptoms or not, I make medical decisions whether to treat with an anti fungal shampoo or oral anti fungal based on their clinical symptoms and itch level.

Dermatophyte spores and hyphae can be seen on exfoliative or aspirational cytology in many patients with ringworm, although more easily in cats than dogs. The dermatophyte spores will appear as round spheres, surrounded by a capsule that looks like a clear halo. They are usually about double the size of coccoid bacteria. The hyphae are filamentous and don't always stain well-so look for the outline rather than the stain.

Although not often diagnosed in routine clinical practice, there are many fungal and protozoal organisms that be identified on cytology including Coccidioides, Cryptococcus, Sporothrix, Blastomyces and Histoplasma.

Ectoparasites are not commonly seen on cytology, but demodex and sarcoptes mites can rarely be found on routine cytology in severely affected cases.

Clinical cases will be used to exemplify the points above.

Pain:
Detection and Management

Wanda Gordon-Evans, DVM, PhD, DACVS, DACVSMR
Wisconsin Veterinary Referral Center
Waukesha, WI

Pain is defined as an emotional response to a stimulus. This is why it can be so variable and one of the reasons that people (and we assume animals) have different tolerances. There are not only medications that can exacerbate or ameliorate pain, but also environmental and situational aspects that can change the perception of pain.

For our animal patients, this can make determinations of pain much more difficult to identify and therefore treat. You may have heard owners say things like "he limps all the time at home and when he gets to the vet it stops". This may be from adrenaline or endogenous opioid release (similar to a runners high). Some animals may pace while others cower. There are multiple behavioral responses to pain. Cats may simply decrease activity rather than limp. We think of vocalization or crying for pain, but many dogs do not cry unless the pain is anticipated or startling. Crying may be difficult to determine if it is dysphoria (drug induced), anxiety, or pain. Aggression may or may not be related to pain as well.

To make it even more difficult, there are multiple types of pain that might elicit differing behaviors:

1. **Sharp vs throbbing**

This difference is commonly manifested in injury situations like cruciate rupture. Likely weight bearing produces a sharp component of pain, whereas, the joint effusion is likely more of a throbbing type pain. This is why many dogs will still want to be very active. If they have 3 good legs, then they do not have to put pressure on the limb preventing sharp exacerbations.

2. **Visceral vs orthopedic vs neurogenic**

Visceral pain may manifest itself in inappetence or vomiting vs orthopedic pain that changes ambulation in some way. Neurogenic pain can be tricky because they may be lame in a limb or not depending on the area of nerve pain. This can be some of the most severe pain.

3. **Deep vs superficial**

Deep pain is typically from viscera or bone level and travels slower and cannot be pinpointed as well as superficial pain. This is like the difference between a touching a hot stove or breaking a bone. You know precisely and specifically where it hurts with the burn (which is superficial nerve endings) vs with broken bones you can feel a general area not the specific break point.

4. **Acute vs chronic**

The distinction between acute and chronic pain is important because there are different consequences and treatments. Chronic pain can cause neurologic changes that allow other smaller stimuli to be perceived as more painful. Acute pain tends to be sharper.

5. **Anticipatory vs elicited**

Anticipatory pain can change behaviors permanently and elicited pain can help a veterinarian diagnose the cause. Dogs that anticipate pain are often aggressive or vocal prior to handling. Cats will sometimes develop litterbox aversion after an episode of feline lower urinary tract disease because they anticipate the pain during urination.

Because we can't speak to our patients, we have to use a combination of behavior and knowledge of their problem to advocate for pain management. There are several owner questionnaires that can be downloaded from the internet and used to help assess chronic pain. These include the Canine Brief Pain Inventory (CBPI), Liverpool Osteoarthritis in Dogs (LOAD) scale, and the Helsinki Chronic Pain Index (HCPI). These can also be used to determine if treatment is working.

For acute pain, it is much tougher to assign a score. There are scoring sheets like the Glascow Pain Score that can be used in a hospital situation for acute pain, but often times it is easier to use a scale of 1-10 much like in humans. The problem is that one person in your practice may have a different idea of what a 5 means compared to another. If there is only one person evaluating pain on an animal for its entire stay, this is not a big deal because trends are most important: Is the pain getting better or worse? However, if multiple people are evaluating, the patients, it is better to use more defined criteria unless everyone can train to have similar scoring.

There are many ways to treat pain both environmentally, with handling, and with medications. Environmental factors include temperature and bedding. Those dogs with severe injuries or neurologic dysfunction should be on thick, soft bedding. Cold temperatures without heat support can increase stiffness in arthritic joints or strained muscles. In contrast, post-surgical pets often enjoy ice packs applied to new incisions. For dogs with neck or back pain, moving slow can prevent guarding or anticipatory crying. Spreading support over a large area when carrying dogs with multiple areas of trauma, abdominal or back pain is also helpful. Walking after abdominal surgery is helpful to reduce ileus.

The main pain medications are separated into general categories. See the table below. Much about pain identification and treatment is common sense and empathy.

Categories	Mechanism	Examples
Opioids	mu agonist in brain (strongest)	morphine, hydromorphone, methadone, oxymorphone
	partial agonist or agonist/antagonist (less strong)	butorphanol, buprenorphine
NSAID	works as anti-inflammatory at the site and some effect in the spine or brain	carprofen, deracoxib, firocoxib, aspirin, robenacoxib, meloxicam, etodalac
NMDA Receptor Antagonist	prevents or reverses wind-up, dissassociates pain	ketamine, amantadine

Overview of Practical Avian Parasitology for Technicians

Cheryl Greenacre, DVM, DABVP (Avian, ECM)
University of Tennessee
Knoxville, TN

Protozoa

Giardia

Giardia has been reported in many orders of birds including Psittaciformes (cockatiel and budgie), Piciformes (toucan), Ciconiiformes (heron), Chadriformes (avocet), Passeriformes (shrike), and Falconiformes (kite). The cyst is ingested by the host and enters the GI tract.There are several methods of identifying the presence of Giardia including the zinc sulfate flotation test of feces to detect the cyst form, the direct saline smear of fresh feces to detect the motile trophozoites, or the ELISA test for Giardia antigen in feces (available at the University of Miami Diagnostic Lab). Clinical signs may be none to diarrhea and weight loss.Treatment for Giardiasis is metronidazole.

Trichomonas

Trichomonas has been reported in many orders of birds including Columbiformes, Galliformes, Falconiformes, Psittaciformes, and Passeriformes. Transmission is through ingestion of trophozoites, or through navel of neonates. Diagnosis is based on the presence of on a direct saline smear of fresh feces to detect the motile trophozoites. Clinical signs include whitish plaques in the oropharynx, esophogus, and crop, and anorexia, dysphagia, weight loss, and dyspnea. The plaques can sometimes spread and Trichomonas can invade deeper structures. Treatment for Trichomoniasis is metronidazole.

Histomonas

Histomonas has been reported in many orders of birds including Galliformes and Rheiformes. The trophozoite is ingested by the host via contaminated food, water, earthworms or within *Heterakis gallinariuim* eggs. Diagnosis is based on a concomitant *Heterakis* infection and pathognomonic green lesions on liver at necropsy. Clinical signs may be none to sulfur yellow feces, hepatomagaly, ascites, diarrhea and weight loss. Treatment for Histomoniasis is metronidazole and treatment for the *Heterakis* infection. Also, eliminate access to earthworms, and do not house chickens with turkeys.

Coccidia

Eimeria/isospora

Coccidia have been reported in probably all birds, but the genus and species of coccidia are very host specific. Eimeria is the most common coccidian of Galliformes and Columbiformes. Infection is by ingestion of oocysts. The presence of coccidian is best detected with the zinc sulfate flotation test of feces. Clinical signs may be none to diarrhea and weight loss. Treatment for coccidian is amprolium or sulfadimethoxine.

Cryptosporidium

Cryptosporidium has been reported in many orders of birds including Galliformes, Anseriformes, Psittaciformes and Passeriformes. Transmission is through ingestion or inhalation of sporulated oocysts. Because of the small size and low shedding rate of Cryptosporidium it is difficult to detect but a Sheather's sugar flotation test is best. An acid-fast stain can also be used to detect the organism. Clinical signs may involve GI tract, respiratory tract or urinary tract, especially in immunosuppressed birds. Treatment for Cryptosporidiosis in birds is not described.

Atoxoplasma

Atoxoplasma has been reported in many orders of birds including Passeriformes and Psittaciformes. Common examples include canaries and the Bali Mynah. The host becomes infected with Atoxoplasma through ingestion of oocysts. There are several methods of identifying the presence of Atoxoplasma including fecal float (best in adult), buffy coat smear (Romanowsky's stain to look for asexual stage in lymphocytes and monocytes), liver impression smear (Wright's stain) or PCR of feces. Clinical signs can be none to diarrhea, weight loss and signs of liver disease (dark spot of liver visible throught he skin over the coelomic cavity in neonates. Clinical signs are more severe in young and include death of fledgling birds, whereas adults can remain assymptomatic. Treatment attempts include diclazuril, toltraurazil or sulfachorpyridazine. Please see the Bali Mynah SSP website for new information on attempted treatments at: http://www.riverbanks.org/aig/new.htm

Toxoplasma

Toxoplasma has been reported in probably all birds, but most commonly in lory, lorikeet and rosella. Infection is by ingestion of sporulated oocysts from felid feces. Also, cockroaches can act as a mechanical vector. Diagnosis is based in identifying the organism in tissues at necropsy. Most bids are assymptomatic and may be reactivated later in the lungs, heart or liver and may show anorexia and weight loss. Treatment for toxoplamosis in birds is not described.

Sarcocystis

Sarsocystis has been reported in many orders of birds, but the definitive hosts include the Falconiformes and Strigiformes, whereas the intermediate hosts include the Psittaciformes (Old World), Passiformes and Columbiformes. The life cycle in the definitive host is by ingestion of bradyzoites in muscle tissue, whereas in the intermediate host it is by ingestion of sporocysts in opposum feces, which

may have been moved mechanically by a cockaroach. Usually the diagnosis is made at necropsy, grossly there are hemorrhagic lungs and on histopathology the parasite is identified in the lung tissue (or muscle tissue of definitive hosts). Clinical signs may be none to mild including diarrhea, neurological signs and weight loss, to severe including dyspnea and death in the intermediate hosts, especially in the winter months. There is no treatment for Sarcocystosis. Elimination of cockroaches in the aviary is a helpful preventative.

Hemoparasites

Plasmodium

Malaria is highly pathogenic in the canary, penguin and gyrfalcon. Plasmodium is spread by mosquito. Diagnosis is based on a blood smear stained with Wright's or similar stain displaying RBC's with a displaced nucleus. Clinical signs may be none to weakness and death. Treatment for malaria, if needed is with chloroquin.

Haemoproteus

Haemoproteus has been reported in many orders of birds butis most common in raptors and pigeons. Haemoproteus is spread by the hippobscid louse fly and the Culicoides mosquito. The number of circulating organisms increases with stress. Diagnosis is based on a blood smear stained with Wright's or similar stain displaying RBC's with a nucleus that is not displaced. Clinical signs may be none to weakness. Treat any underlying disease or other stressors.

Leukocytozoon

Leukocytozoon is significant in Galliformes and Anseriformes. Leukocytozoon is spread by the black fly. Diagnosis is based on a blood smear stained with Wright's or similar stain displaying WBC's with a nucleus that is displaced by the parasite.Clinical signs may be none to weakness. There is no specific treatment for Leukocytozooanosis.

Platyhelminths - The helminthes include the flukes (trematodes) and tapeworms (cestodes)

Liver flukes

Digenetic liver flukes are sometimes encountered in Old World Psittaciformes (cockatoos, African grey parrots, etc.). The eggs pass in feces of host and with warmth and moisture, a miracidium hatches out and bores into a a snail intermediate host. After penetrating the snail, the miracidium loses its ciliated coat and forms a sporocyst and produces cercaria,the final infective stage, which is either imbibed or ingested by the host. The cercaria enters the 2nd intermediate host, an arthropod, which is then ingested by the definitive host. The term metacercaria is used after cercaria have encysted on vegetation or inside the second intermediate host. After metacercaria are ingested it encysts in the definitive host's intestinal tract and the immature stage migrates to a predilected site. Diagnosis is based on visualization of the operculated fluke eggs on a fecal float. Clinical signs of infection by liver flukes includes hepatomagaly, depression and anorexia. Treatment for liver flukes is praziquantel.

Tapeworms:

The most common pet birds that are hosts to tape worms include African grey parrots, finches and cockatoos. The egg hatches after being swallowed by the intermediate host and the embryo penetrates the intestinal wall to migrate to a suitable place to grow. Then it forms a cyst (i.e. bladderworm) and develops hooks and then the intermediate host is ingested by the final host. Then proglottids develop after attachment. Diagnosis is based on visualization of the eggs on a fecal float.Clinical signs can be none to unthriftyness with diarrhea.Treatment of tapeworms is with praziquantel.

Nematodes

Ascarids

All species can be infected with ascarids that are usually species specific. Transmission is through ingestion of ova. Diagnosis is by identification of eggs on a fecal float. Clinical signs include none to anorexia, weight loss and death. Treatment is pyrantel pamoate, but to prevent repeat infection the eggs in the environment must be steamed or flamed.

Heterakis

The species most commonly affected by Heterakis are the Galliformes and Anseriformes (poultry and ducks).Transmission is by ingestion of embryonated ova. Diagnosis is based on a fecal float. At necropsy the presence of cecal nodules is highly suggestive. This nematode is associated with the disease Histomoniasis. Treatment of Heterakis is with pyrantel pamoate or fendendazole.

Syngamus

The most common host species for syngamus are Galliformes and Anseriformes. The life cycle is direct with earthworms acting as a transport host. The eggs are coughed up and swallowed and passed in the feces. The infective larva develop in the egg starting at about 3 days and hatch in 9 days when they are subsequently ingested by the host directly of by the host eating an earthworm or snail that ate the infective larva. The larva can live months to years in the snail. After ingested the larva are carried int eh blood stream to the lungs where they undergo ecdysis. Then males and females migrate to larger bronchi to permanently copulate, then migrate to the trachea at about 7 days post-infection. The eggs are shed 7-20 days later. Males are smaller at 2-6 mm, whereas females are larger at 5-20 mm long. Diagnosis is based on visualization of the eggs on a fecal float, of direct visualizationj of the paired male and female worms shaped like a red, 1 cm "Y" in the trachea of the bird. Clinical signs include coughing, blood at ricti, head shaking and dyspnea. Treatment is with thiabendazole or ivermectin, or they can be retrieved endoscopically.

Capillaria

Capillaria is a common parasite and has been reported in Falconiformes, Galliformes, Columbiformes, Psittaciformes (budgie, macaw) and Passeriformes (canary). Transmission is by ingestion of embryonated ova. Diagnosis is by identifying the bipolar ova on a fecal float. Clinical signs include none to diarrhea, weight loss, dysphagia and melena. Treatment for capillariosis is commonly with fenbendazole.

Filarid nematodes

Chandlerella

Chandlerella has been reported in Passeriformes and cockatoos. Transmission is throught to be via a mosquito. Diagnosis is by identification of microfialria on a Wright's stained blood smear. The organism was found in the heart (ventricles) of a Ducorp's cockatoo at necropsy. Clinical signs include none to possibly weakness. No treatment is reported for chandlerellosis or any microfilaremia in birds.

Pelicitus

Pelicitus has been reported in Amazon parrots and conures. Transmission is not known.

Diagnosis is by identification of eggs on aspiration of a SQ mass on a distal pelvic limb or direct visualization after surgical removal. Clinical signs include a SQ mass on a distal pelvic limb. Treatment is surgical removal.

Nematodes of the eye (thelazia, oxyspira, ceratospira, annulospira)

Spirurid nematodes

Various species of spiruriod nematodes are reported in certain species of birds including Tetrameres in Grakles, Microtetrameres in Kakas and Spiroptera in cockatoos. Transmission is probably through an insect intermediate host. Diagnosis is based on a fecal float, or identification of masses within the proventriculus and ventriculus. Clinical signs include none to weight loss and melena. Treatment is with ivermectin.

Mites

Knemidokoptes pili and laeris mites

Knemidokoptes pili is most commonly reported in Passerines such as canaries and finches, and Psittaciformes such as budgies and others. Transmission is via direct contact.Diagnosis of *K. pili* is based on typical pitted appearance to the legs and face of the bird and via visualization of the mite under the microscope after a tape prep or scrape of the affected area. *K. laeris* affects the feathers. Clinical signs include pitting of the surface tissue of the face and legs. Treatment is with topical ivermectin.

Sternostoma tracheocolum mites

Sternostoma is most commonly reported in finches, especially Lady Gouldian finches.

Diagnosis can be made by visualizing dark specks in the trachea during transillumination of the trachea on a physical examination. Typical clinical signs include dyspnea and a characteristic clicking sound with each breath. Treatment is with topical ivermectin.

Dermanyssus

Dermanyssus, also known as the red fowl mite, is most commonly reported in poultry.

Diagnosis can be made by identifying the mite under microscopy after a tape prep or skin scrape. Clinical signs may be none to pruritis and anemia. This mite feeds on the bird at night and is off the bird and in the environment and bedding during the day. When treating the bird for Dermanyssus, the environment and enclosure must be treated as well.

Ornithonyssus

Dermanyssus, also known as the white fowl mite, is most commonly reported in poultry.

Diagnosis can be made by identifying the mite under microscopy after a tape prep or skin scrape. Clinical signs may be none to pruritis. This mite spends its entire life on the bird.

Only the bird, and not the enclosure is treated for Ornithonyssus.

Video Lessons:
Be an Exam Room Hero

Sheila Grosidier, BS, RVT
Veterinary Management Consultants
Evergreen, CO

Take a moment and ask yourself these questions in regard to your veterinary practice:

- Are you certain that clients are being offered a consistent standard of care?
- Do team members have the tools and resources to meet the clients' needs?
- What future training do you see your team needing to best grow the business?
- How does your team best learn?
- What training have you specifically done in the past that has targeted client interaction on an individualized basis?

While there is little argument that costs are rising for training clinic team members, significant debate does exist over what methods of training will ensure consistency, enable the adoption of new skills, and create an environment that allows team members to coach themselves to achieve greater performance. When done correctly, recording employee/client interactions on video for one-on-one review can be one of the most valuable training tools available to change ineffective behavior into consistently productive client communication.

This article will cover a number of essential components that should be considered and implement in order to realise the full potential of video coaching in practice.

Communication

A 2005 survey of the American Management Association identified that more than half of employers use video surveillance as a way to decrease theft and violence[2], while only 16 per cent of those businesses use that information for evaluating employee performance.[3] While your practice may already be using video technology as a method of monitoring for theft-prevention or safety, video coaching differs in its ultimate aim, and these differences include how the information will be captured, what will be done with the video and how it can change your practice.

The success of this process will hinge on clear communication with your team members, assuring them that this will not be a covert operation but rather an openly acknowledged training tool for reviewing staff and client interactions and subsequent coaching for future performance. This is not about looking for mistakes; it’s about looking for ways to improve.

Each of us has had those moments when we replay a conversation with a client and wonder, ‘Could I have done something differently?’ Seeing the entire interaction can provide clear answers – after all, a picture is worth a thousand words. So remember that the team will need to be reassured that the main goal of filming is for those images to help them choose just the right words in order to communicate more effectively with clients in the future.

Rules for everyone

Because there may be some initial resistance from the team about being recorded on video, it's important to establish clear, steadfast rules that will be outlined and followed so as to reassure the team that this is a training tool to be used in a positive manner. Recording an exam will proceed only after the client has been advised. A consultation could begin, for example, by saying, ‘Ms. Jones, we are videotaping today for training purposes. Is that okay with you?’ Usually clients are glad to give consent, but if the client does not approve, then the camera is to be turned off. Signs must be posted to alert clients and remind team members that the practice is using video cameras, and that it is not a secret activity. While there may be a sense of natural apprehension at the onset of using video, over time, team members will likely have to be reminded that the video is running—it will become part of the landscape. Establish that the video will be used as a tool for training only, not as surveillance.

Setting up publicly

Implement a clear policy that outlines how the video will be recorded and evaluated to ensure maximum benefit to the employees as well as to the practice. To get the most out of the process, this should not be a one-time activity. Plan to evaluate it monthly and set goals with a timeline for each team member, then evaluate their success. A policy example can be found in Box 2.

---

[2] http://veterinaryteam.dvm360.com/firstline/article/articleDetail.jsp?id=622344

[3] http://www.nolo.com/legal-encyclopedia/workplace-cameras-surveillance-employer-rules-35730.html

One-on-one coaching

Be sure to have your team members assess themselves before their review with their supervisor. It is likely that the team members will readily pick up on how to improve and know what they need to do before the review. This will help them feel more confident ad supportive of your coaching over time. Reinforce this action; point out what they are doing on their own to improve and how that not only directly impacts the well-being of pets, client satisfaction and the health of the practice, but also enhances their skills. This is where an incentive program can accelerate results.

The rock star reel

Did you just watch Erin give a perfect explanation of why your pet needs to have a senior profile? Did you see how amazing Dr. Sanchez was in her response to an angry client? Videos are amazing tools for training new staff. Ask your team members if they would be comfortable sharing their expertise by showing how to perform at that star level in such special videos. Creating a collection of these interactions is incredibly instructive to new employees.

Positive and productive

Your team members will probably be concerned that this will be a negative experience that consists of looking for what they are doing wrong. Demonstrate that it's about building on their current skills and creating positive reinforcement. Start the discussion by asking them to identify what they did well and what they would do differently. Focus on the interaction, not the person. See Table 1 for additional recommendations to make coaching a positive experience.

Summary

To change ineffective behavior, the first step is to recognize that it is not working and clearly understand what will work. Video can dramatically depict how a team member is communicating with clients at that essential point: when they're in your exam room. Don't leave it up to chance; leave it up to training.

BOX 1: The benefits of using video for coaching in veterinary practice

- Team members can specifically review the actual interaction with each client, not simply go on what they remember about it.
- Video can be viewed and compared "back-to-back"? to see improvement over time.
- Team members can review an interaction multiple times focusing on things such as their body language, word choice, speech volume and cadence and find something different upon each viewing.
- See a complete visit from the client's perspective, not just the team member's part. Set up the camera to show the entire exam room.
- Find out what clients do in your exam room when you are not present, then think of what you could do to make this a productive time for them and you.

BOX 2: Example policies for team video coaching

- The practice utilizes video as an individual staff coaching tool to evaluate interactions with clients exclusively in the exam room.
- Recording will take place in identified exam rooms on specified dates and times. All exam room assistants or technicians, receptionists, kennel assistants, and veterinarians will be expected to participate, as the entire visit in the exam room will be recorded. The video camera is to be set up correctly so the entire room will be visible.
- All staff who greet clients and guide them into the exam room are to state that the visit is being recorded and request the client's permission (for example, "Mrs. Jones, for training purposes we are recording this on video today—is that okay?"). If the client declines, the video camera is to be turned off.
- Team members will have opportunity to review their video and pick which of the clips they would like to review with their supervisor. Each team member will use an evaluation checklist and submit it to the supervisor prior to the review. (See checklist examples in figures 1 and 2.)
- The supervisor will review the clip one-on-one with the team member and complete the checklist for comparison with the team member's checklist. An agreed-upon goal will be established for the next videotape session.
- An incentive will be included, for example, all team members who complete four video reviews in a 12-month period will receive a $100 bonus and be entered into an annual drawing for a paid day off at a spa.

Table 1: Positive coaching techniques

POSITIVE COACHING TECHNIQUES[4][5][6]	
DON'T	**DO**
Use general feedback ("Good job" or "Nice work") when reviewing video.	Be specific: "Your use of the pet's name was just right in your introduction."
Believe that change isn't possible.	Look for changes from one video to the next.
Make a long list of mistakes.	Use a 3-to-1 ratio—identify three positive attributes for each negative feedback component. This will help keep you from sounding too negative and provide an overall tone that reinforces what the team is performing well.
Think you have nothing to learn.	Get feedback from your team members. Ask them about the process, what is working, what they would change, and whether they like to mentor a team member in the future.
Sugarcoat criticism and confuse your team members on what you want them to do.	Stay specific to the example and not to the individual, then give a direct way to correct the issue (for example, "Next time, offer to review the medical care plan with the client prior to starting the services; this will prevent any issues with the bill after the services have been completed").
Fail to establish goals for the next video session.	Mutually identify with the team member two areas to focus on in the next video.

Photo—Make the exam room easy to view

[4] http://smallbusiness.chron.com/simple-ways-build-trust-employees-11619.html
[5] http://bookboon.com/blog/2013/02/managers-read-these-8-tips-on-giving-the-right-feedback/
[6] http://www.inc.com/guides/2010/08/how-to-get-feedback-from-employees.html

Video Lessons:
Technician Tools that Really Work

Sheila Grosidier, BS, RVT
Veterinary Management Consultants
Evergreen, CO

Even pets are going electronic these days with an iPod program that will track medical information such as vaccinations, medications and upcoming appointments. So, why aren't you taking advantage of one of the strongest assets a veterinary practice can possess? Clients expect competency. Demonstrating your usage, understanding and ability to embrace technology for the benefit of their pet is vital. Whether you are concerned about team member productivity, implementing effective marketing programs, or placing your practice in an advantageous position online, it's time for you to click your way to success. Here are 8 compelling reasons why the technology superhighway should be your onramp to practice success!

Convert from paper files to electronic files

The costs of staying with paper files

- How much of your time is wasted in preparing files, filing, retrieving and looking for medical records?
- What other wonderful things our receptionists could be doing if they did not have to "play" with our files.
- Do you get a headache from trying to read your own (or someone else's) hand-writing in a record?
- What the actual cost of your files (paper and space to store the records)?
- What does it costs to write the same information over and over (time)?

Automation creates a WIN-WIN!

- Recruiting and keeping quality team members has become one of the most time consuming and frustrating challenges for practices.
- There is also frustrating for team members who want to have a balance between challenge and opportunity, and minimal redundant tasks.
- You as an owner want to maximize productivity. Your team members want to be engaged in activities that directly help pets live longer healthier lives.
- Reduce redundant tasks.
    - Take advantage of every opportunity to use team members where that personal interaction with the client and pet care cannot be realized any other way but with a team member.
    - Ask your team members to identify 10-12 tasks that they do during the day that take up the most amount of time, then consider how you could automate these tasks.
    - The savings on time, resources and quality of life are just some of the benefits you will all experience!

Create an online presence

First, look at your website

- Do you have a web site? If you do have a web site, are you proud of it?
- In today's era, web sites are no longer an option, but a necessity.
- What does your web site look like?
    - Professional image,
    - Pictures of your doctors and bios,
    - Virtual tour of your practice.

To be competitive in today's environment, it is imperative for a practice to have a shop site on their web site

- Select you shop site provider carefully.
- What products will you offer, and at what prices?
    - 3rd party inventory.

Make it convenient for clients

- After converting to an electronic medical record system, your veterinary software program should allow your clients to request an appointment via e-mail.
    - Available 24-7
    - Receptionist can review requests the following day and respond back to the client with a set appointment time.
- If you choose, clients can also access information about their pet -reminders that are due, medications the pet is on and even a "family album" of the pet's pictures.

Get some satisfaction

- Want to know what clients really think? Ask them!

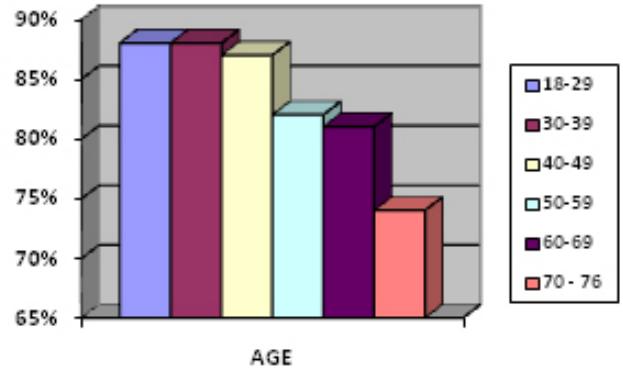
- Set up a survey online that encourages clients to share their insight about their recent visit to your practice.
- Why not send a link via email to all new clients to assure they will be back and tell others about their positive experience?
- Post some of those positive comments online and let the word spread…electronically!

The internet world opens a lot of new doors for you and your clients. You can either embrace it or watch as others embrace it. Along with technology advances come many opportunities to help improve the effectiveness of your practice, its communication with clients and its marketing of products and services. Your clients are going to the internet for answers as a general rule, be there and be their answer.

Elements your website needs to attract clients

- Appointment scheduling,
- Forms that can be downloaded and completed prior to appointments,
- Seasonal information for pets,
- Links to additional info and resources
- Prescription order portal,
- Upcoming event information,
- Option to email clinic with questions or requests,
- Product information
- Pet pictures

PERCENTAGE OF INTERNET USERS BY AGE



Next generation client demands = next generation reminders

- Reminders are the life blood of our practice.
- Many practices have up to 30% of their clients that have been seen in the past year that do not have future reminders linked to them in the system.
- Think of all the patients you see in one day or a week that have eye, ear or skin problems…
    - Did we ask them about their vaccination history?
    - Do we have a future reminder in the computer for an exam, fecal, heartworm or any vaccination?
- Contact to Connect
    - Most people do not clean out their 'snail mailbox' more often than every couple of days. On the other hand, most people check their email several times a day.
    - Email reminders can reinforce hard copy letter or postcard reminders at a fraction of the cost.
        - Add a link in your email reminder that directs your clients back to your website.
        - Clients will see complete, in-depth information about how important your recommendations are to the health of their pet.
        - This can be automated!

Ideas for using email to build your practice!

- Birthday Cards
- Client Satisfaction Surveys
- Medication Reminders
- Upcoming Lab Tests
- Lab Work Findings

- Seasonal Health Alerts
- New Pet Information
- Upcoming Education
- Target Marketing
- Appointment Follow-Up

List of automated reminders

- Vaccines
- Lab Tests
- Diets
- Medications
- Recommended Testing
- Flea/Heartworm Refills
- Chronic Medication Refills
- New Services
- Tests needed due to change in age or condition
- Grooming
- Boarding

Track your success

- What would you think of a doctor who made a diagnosis without doing a complete physical exam?
- Lack of client compliance with recommendations is a common topic of discussion among practice owners. How can you improve this?
- Many practice owners decide they want to put into place a program and process that will increase client visits, improve client transaction values and assure client service satisfaction. However, they do not know what their current status is in these components of the business.
- Wouldn't it be nice if you could turn on your computer and at a glance see how your practice is doing from a practice management point of view?
    - Veterinary Software
    - Graph and communicate with team!

Key indicators to track

- Per Client Transaction (ACT)
- Per Doctor Transaction (PCT)
- Number of New Clients (& where they originate)
- Number of Dentals/Recommendations
- Number of Senior Profiles/Recommendations
- Inventory Costs/Gross Revenue
- Staffing Costs/Gross Revenue

Are you ready to rev up your practice, electrify your clients electronically and leverage your team by reducing redundancy and increasing face to face time with clients? The proficiency of your practice will include embracing digital options throughout the practice. Start with these 8 options and you will see solid and lasting improvements to your practice.

Video Lessons:
Making the First 90 Days Count- in Any Job

Sheila Grosidier, BS, RVT
Veterinary Management Consultants
Evergreen, CO

10 ways to make new associates feel welcome

1. **R-e-s-p-e-c-t**

It's not just a word, it's what you do. Treat them with respect and model the behavior you expect from them with every employee. Part of respect is praise and feedback; let them know in public when they do well and in private when there's a concern.

2. **Leadership**

Associates want to know they are on the right path and there is a plan in the practice for moving forward. They want to belong to something bigger than themselves and know that someone they can trust is in charge.

3. **Empowerment**

Allow your Associates to make decisions and to share their ideas with you. While they may not always make the right decisions, they need to know you will support them when needed. Consider what you learned when you made a mistake and encourage them to make decisions.

4. **Make it fit**

Send the new associate out to lunch with different departments in the hospital; one day with the veterinary technicians, one day with the receptionists and then lunch with the kennel and exam room teams. Have them talk about the successes of the practice and how we make a difference in the lives of pets every day.

5. **Open it up**

Have an open house or reception and invite your best clients to meet the new associate. Nothing says welcome like clients who will tell your new employee how wonderful the practice is from the client's point of view.

6. **Expectations**

Ask them what their expectations are in an employer. Let them know clearly how they will be evaluated and the timeline for performance evaluations.

7. **Be proud**

Put an ad in the paper welcoming the new associate. Create a flyer that you can give to clients in the practice telling them about the wonderful addition to the practice. Post their picture and biography in the exam rooms.

8. **Mentor**

Assign a mentor, someone who can assist them, meet with them regularly and help them to integrate into the practice.

9. **Time**

Set up regular times to meet and talk about cases, comments, and concerns. Encourage the new associate to ask questions when they have them, but also make time so you can demonstrate your commitment to them; and remember, you can't change the tire at 40 mph, slow down and take the time to talk about it.

10. **Make sure there are no misunderstandings**

Everything should be put in writing, make sure you have an employment contract, job description and policy manual. Go over these with your new associate.

11. **Walk your talk**

Make sure you set the example, not only medically but in your actions. Be to meetings on time, treat other employees with respect, get to work on time. Remember that any successful business starts from the top.

Transfusion Medicine

Ari Jutkowitz, VMD, DACVECC
Michigan State University
East Lansing, MI

Anemia is a common problem in the emergent patient and may result from blood loss, hemolysis, or decreased erythrocyte production. Anemia may be detrimental to the critically ill patient when it causes a decrease in oxygen delivery to the tissues. In the following session, we'll review indications for blood transfusion in veterinary patients as well as guidelines for ensuring safe collection, storage, and delivery of blood products. This document is meant to serve as a reference for practitioners who wish to provide blood product support, but lack blood banking capabilities.

The transfusion trigger

For many years there has been an ongoing search for a universal "transfusion trigger", a set of conditions under which transfusion is considered to be indicated and for which no further justification is required. One of the earliest examples of a transfusion trigger was the "10/30 rule", first published by Adams and Lundy in 1942, which stated that presurgical patients should be transfused if their hemoglobin concentration was less than 10 g/dl or their hematocrit was less than 30%.[1]

More recently, concerns in human medicine about transmission of infectious diseases and a growing awareness of other risks associated with blood transfusion lead to a reassessment of transfusion practices. It was recognized during this time that healthy animals[2] and people[3] could tolerate very low hematocrits as long as intravascular volume was maintained. Furthermore, human patients who declined blood transfusion for religious reasons were also able to survive surgical procedures despite suboptimal hematocrits.[4] In recognition of these observations, the practice of transfusing to a target hematocrit has begun to give way in favor of risk to benefit analysis for the individual patient.

Risks of transfusion

Some of the more commonly cited risks of blood transfusion include fever (febrile non-hemolytic transfusion reactions), hypersensitivity reactions, and acute or delayed hemolytic reactions. These types of transfusion reactions are thought to occur in approximately 3% of veterinary patients receiving blood products. Disease transmission is another potential complication of blood transfusion, though the prevalence has not been reported in veterinary patients. Acute lung injury, microembolic disease, electrolyte and acid-base disturbances, and coagulopathy are other known risks. In addition to these well-recognized risks, there is also increasing evidence that blood transfusions may have significant immunosuppressive effects. In a landmark study of 1717 human patients admitted to an ICU trauma unit, patients receiving transfusions were 6 times more likely to develop nosocomial infections than those who did not receive blood products. Mortality in the transfused group was also twice that of the non-transfused group.[5] Similar findings of increased infection rates and mortality following transfusion have been documented in human patients undergoing surgery for penetrating abdominal trauma, fracture repair, gastrointestinal cancer, cardiac bypass, spinal surgery, and hip replacement. Although the association between blood transfusion and harmful effects such as immunosuppression, acute lung injury, and proinflammatory responses are still poorly understood, there is enough evidence at this time to warrant caution in their use.

Benefits of transfusion

The main goal of red blood cell transfusion is to reduce the morbidity and mortality associated with inadequate delivery of oxygen to the tissues. In order for this goal to be valid, it is important to establish (a) that anemia in fact contributes to morbidity, (b) at what level adverse effects are likely to occur, and (c) that transfusion in these patients is associated with improved outcome. In experimental models, healthy animals subjected to acute hemodilution were able to tolerate hematocrits as low as 10-15% as long as intravascular volume was maintained. Below hematocrits of 15% electrocardiographic changes consistent with ischemia began to appear, and at hematocrits of less than 10%, increased lactate production, myocardial depression, and death occurred.[2] Healthy human volunteers subjected to hemodilution were similarly able to tolerate hematocrits as low as 15% with no evidence of inadequate oxygen delivery. At the lowest hematocrits, many subjects complained of fatigue, but no other symptoms were reported.[3]

However, there is some evidence that even mild to moderate anemia may contribute to mortality in clinical patients. In a study of nearly two thousand human patients undergoing surgery who refused transfusions for religious reasons, risk of death was shown to increase as hematocrits decreased below 30%.[4] In this study, even mild anemia was associated with some increase in the risk of death, and patients with concurrent cardiovascular disease were much less tolerant of anemia than those without concurrent disease. Because no patient in this study received transfusions, the study was not able to show, however, that administration of transfusion would have resulted in an improved survival rate. In a follow-up study of transfused versus non-transfused patients undergoing hip surgery, at hematocrits of 24% or higher, the administration of blood transfusions was not shown to decrease mortality.[6] In another recent study, human ICU patients were randomized to restrictive (hematocrits maintained at > 21%) or liberal (hematocrits maintained at >30%)

transfusion strategies. Hospital mortality rates, multiorgan dysfunction scores, and cardiac complication rates all favored the restrictive transfusion strategy.[7] Benefits to liberal transfusion were only seen in patients with underlying cardiovascular disease.

From studies such as these, it seems clear that anemia is associated with poor outcome. However, it is less clear that transfusion in certain populations of patients will provide benefits in terms of improved tissue oxygen delivery and survival. We may be able to extrapolate that critically ill patients with hematocrits below 15% may benefit from transfusion, while those with stable blood volume and hematocrits greater than 24% are unlikely to benefit from transfusion. In between these values is a gray zone where some patients may benefit from transfusion and others will not.

When to transfuse?

Students frequently ask how low the hematocrit must fall before we decide to transfuse. Hopefully the point has been made by now that hematocrit levels alone should not serve as a transfusion trigger. However, they may still be used as a rough guideline for when to consider transfusion as a possible treatment. In *otherwise healthy patients*, current guidelines supports the safety of hematocrit levels as low as 18% as long as normovolemia is maintained.[8] Other factors to consider when deciding on the need for blood transfusion should include clinical signs of anemia, the rate of ongoing losses, the chronicity of the anemia, and the presence of co-morbidity that may limit the ability of the patient to compensate for their anemia.

Blood donor screening

Canine blood donors should be at least 25 kg (to donate ½ unit of blood or 225 ml), in good health and temperament, current on vaccinations, and not receiving any medications. At Michigan State University, donors are tested for all blood group antigens for which a commercial test is available, but at a minimum testing for 1.1 and 1.2 should be performed as these antigens are associated with acute hemolytic transfusion reactions in sensitized individuals. Infectious disease screening should include: Heartworm antigen, Babesia spp, Ehrlichia spp, Anaplasma, Mycoplasma, Brucella, and Leishmania. Trypanosoma and Bartonella should be considered in places where endemic.[9]

Feline blood donors should be at least 5 kg, strictly indoors, in good health, and current on vaccinations. Echocardiogram is strongly recommended for donor safety to rule out occult cardiomyopathy. Feline donors should be blood typed and screened for infectious disease as follows: FeLV, FIV, Mycoplasma, heartworm antibody, and Bartonella. Cytauxzoon and Ehrlichia should be considered in places where endemic.[9]

Blood collection and storage

Blood is collected from the jugular vein into a closed collection system following aseptic preparation of the skin. If the blood is to be administered immediately, it may be anticoagulated with heparin (625 u per 50 ml blood) or 3.5% sodium citrate (1 ml anticoagulant/9 ml blood). Because these anticoagulants lack preservatives, the blood collected in this fashion may not be stored for any length of time. CPDA-1 (14 ml anticoagulant/100 ml blood) is an anticoagulant with a preservative that increases red cell survival by serving as a substrate for synthesis of ATP. Packed red blood cells in CPDA-1 may be stored for 4 weeks 4^{o} C. The use of Adsol (an electrolyte solution containing adenine, saline, glucose, and mannitol) may further improve length of storage and post transfusion viability.

Typing and crossmatching

Blood typing should ideally be performed in all dogs to optimize allocation of resources (administering 1.1 positive blood to 1.1 positive recipients and reserving universal blood for 1.1 negative recipients) and to avoid sensitizing recipients to blood alloantigens. In an emergency, a dog that has never been transfused previously may safely receive transfusion without blood typing, because dogs lack naturally occurring alloantibodies. Dogs that have previously been transfused (5 or more days prior), that have had litters of puppies, or that have an unknown transfusion history should have a major crossmatch performed prior to transfusion to rule out incompatibility.

All cats have naturally occurring alloantibodies to foreign blood types.[10] Transfusion of type A blood to B cats results in a potentially fatal transfusion reaction. Transfusion of type B blood to type A cats may result in hemolysis and less severe transfusion reactions. Consequently, all cats must be blood typed prior to transfusion.

Recently, a new blood type (Mik), distinct from the AB blood group system, has been reported in cats. Most cats are positive for the Mik antigen. However, Mik-negative cats do exist, and possess naturally occurring Mik-alloantibodies. These cats may experience acute hemolytic transfusion reactions after receiving AB compatible blood. Given the clinical relevance of naturally occurring Mik alloantibodies, all cats should be crossmatched prior to transfusion, even if they have not previously received blood products.[11]

Administration

The optimal route of blood administration is intravenously, through the largest catheter diameter possible for the size of the patient. When large quantities of blood and fluids must be given rapidly in the face of exsanguination, 14 or 16 gauge over the needle catheters (Angiocath®, Becton Dickinson Infusion Therapy Systems Inc) can be used in the jugular veins.

Refrigerated blood products should ideally be warmed to room temperature prior to administration to avoid inducing hypothermia in the recipient. Cold blood also has a much higher viscosity than that of warmed blood and as a result cannot be given as quickly. Packed cells may be warmed by immersing the unit in a warm water bath at 37° C or by passing the coils of the transfusion tubing through a fluid heater or basin of warm water. Plasma may also be warmed in a warm water bath at 37° C. Care should be taken when handling plasma prior to warming as the plastic blood bag is fragile when frozen and susceptible to cracking.

Blood products should always be administered using a commercial blood administration set with an in-line filter (Baxter Healthcare Corp, Deerfield, IL) to remove blood clots and particulate debris. For small blood volumes administered to cats and small dogs by syringe, a pediatric 18 µm blood filter (Hemo-Nate Filter, Gesco International, San Antonio, Tx) may be placed between syringe and extension set.

Blood should not be administered with any fluid other than 0.9% sodium chloride. Calcium containing solutions such as lactated Ringer's (B. Braun Medical Inc, Irvine, CA), Normosol (Abbott Laboratories, Abbott Park, IL), or Plasmalyte (Baxter Laboratories, Deerfield, IL) may bind citrate and thus initiate coagulation. Hypotonic fluids like D5W or half-strength saline may result in red cell lysis as a result of osmotic fluid shifts. Concurrent administration of other drugs through the same catheter should also be avoided.

Volume and rate

The volume of blood to be transfused can be calculated as follows:

Transfusing 10 ml/kg of packed cells or 20 ml/kg of whole blood typically raises the PCV by approximately 10%.[12] In the setting of acute blood loss, PCV may not provide a reliable indicator of blood loss. In these cases, blood should be given to effect or in proportion to estimated losses.

Rates for blood transfusion are variable, depending on the degree of blood loss and the rate of ongoing losses. Ideally, the transfusion time for a unit of blood should not exceed 4 hours due to concerns about bacterial proliferation once the product has been warmed. An initial rate of 0.25 ml/kg for the first 30 minutes has been recommended while the patient is monitored for transfusion reactions. If no adverse effects are noted, the rate may then be increased to as much as 10-20 ml/kg/hr. However, in the setting of exsanguinating injury and imminent death, blood may be given as rapidly as possible.

Autotransfusion

Direct aspiration and reinfusion is easily accomplished using a 60 cc syringe and three-way stopcock. Using this method, blood may be aspirated from the thoracic or abdominal cavity into a blood collection bag or container and then reinfused through a micropore filter (Hemo-Nate Filter, Gesco International). Anticoagulants are generally not needed because blood has been sitting in contact with pleural or peritoneal surfaces for over one hour undergoes defibrination. However, with rapid hemorrhage there is insufficient time for defibrination, and CPD-A should be added at a dose of 7 ml per 50 ml blood. Direct aspiration and reinfusion can be very useful in cases like hemothorax secondary to rodenticide or trauma where evacuation of the chest cavity is needed and preservation of viable cells is desired.

Autotransfusion has a number of advantages and disadvantages that need to be taken into consideration prior to administration. The biggest advantage is a ready source of compatible blood that can be given quickly and inexpensively, without the need for warming, typing, crossmatching, or infectious disease screening. Disadvantages include the potential for hemolysis, coagulopathy, blood contamination, and acute lung injury. Autotransfused blood is subject to hemolysis as a result of prolonged contact with injured serosal surfaces and from mechanical trauma when suction systems are used. Coagulopathies may also be a concern because pleural or peritoneal contact activates the coagulation system, resulting in reduced platelet and clotting factor levels in autotransfused blood that may lead to dilutional coagulopathy when large volumes are reinfused. Additionally, because autotransfused blood may contain large amounts of FDPs, red blood cell fragments, activated leukocytes, platelets, and inflammatory mediators that may initiate coagulation, autotransfusion may exacerbate consumptive coagulopathies. Acute lung injury is another potential complication following autotransfusion, and is believed to result from microembolization of cellular aggregates, fat, and protein to the pulmonary vasculature. For this reason, the use of micropore filters (18 µm) has been recommended when autotransfused blood is administered. Because there is the potential for spread of neoplasia if the shed blood contains tumor cells, and for contamination with bacteria if GI perforation may have occurred, autotransfusion should not be used in these situations.

Monitoring of blood administration

Prior to administration of blood products, baseline values for PCV, total solids, and vital signs should be obtained and blood components should be checked carefully for signs of discoloration. During administration, vital signs should be rechecked initially every 15 minutes for the first half hour, then every 30 minutes thereafter to monitor for signs of transfusion reaction. A rise in body temperature of 1° C, the development of tachycardia, bradycardia, tachypnea, vomiting, urticaria, erythema, angioedema, or pigmenturia should prompt investigation into the possibility of transfusion reaction.

Conclusion

Blood transfusion is a valuable and potentially life-saving technique that should not be withheld in patients at risk. However, there is a growing body of evidence that transfusions may contribute to increased morbidity and mortality, and this perception has lead to a change in the way that transfusion requirements are assessed. By weighing the risks of transfusion against the potential benefits, by carefully screening blood donors, and by using appropriate precautions in the collection, storage, and administration of blood products, clinicians may be better able to optimize blood transfusion management in the emergent patient.

References

Adams RC, Lundy JS: Anesthesia in cases of poor surgical risk. Some suggestions for decreasing the risk. Surg Gynechol Obstet 1942;74:1011-1019.

Wilkerson DK, Rosen AL, Lakshman RS, et al: Limits of cardiac compensation in anemic baboons. Surgery 1998;103:665-670.

Weiskopf RB, Viele MK, Feiner J, et al. Human cardiovascular and metabolic response to acute, severe isovolemic anemia. JAMA 1998;279:217-221.

Carson JL, Duff A, Poses RM, et al: Effect of anaemia and cardiovascular disease on surgical morbidity and mortality. Lancet 1996;348:1055-1060.

Taylor RW, Manganaro L, O'Brien J, et al: Impact of allogenic packed red blood cell transfusion on nosocomial infection rates in the critically ill patient. Crit Care Med 2002;30:2249-2254.

Carson JL, Duff A, Berlin JA, et al: Perioperative blood transfusion and postoperative mortality. JAMA 1998;279:199-205.

Hebert PC, Wells G, Blajchman MA, et al. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. N Eng J Med 1999;340:409-417.

A report by the American Society of Anesthesiologists task force on blood component therapy. Practice guidelines for blood component therapy. Anesth 1996;84:732-747.

Wardrop KJ, Reine N, Birkenheuer A, et al. Canine and feline blood donor screening for infectious disease. J Vet Intern Med 2005;19:135-142.

Bucheler J, Giger U. Alloantibodies against A and B blood types in cats. Vet Immunol Immunopathol 1993;38:283-95.

Weinstein NM, Blais MC, Harris K, et al. A newly recognized blood group in domestic shorthair cats: The Mik red cell antigen. J Vet Intern Med 2007;21:287–292.

Stone MS, Cotter SM: Practical guidelines for transfusion therapy. In Kirk RW, Bonagura JD (ed): Kirk's Current Veterinary Therapy XI, Small Animal Practice. Philadelphia, PA, WB Saunders, 1992, pp 475-479.

Pain Management in the ER: The Fifth Vital Sign

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

The recognition and treatment of pain is an incredibly important part of the hospitalized veterinary patient's regimen. Patients that do not have their pain addressed might suffer longer hospitalization times or face increases in morbidity and mortality from pain. Pain is known to elicit a sympathetic response worsening or inciting shock states which promote decreased wound healing and decreased organ perfusion. The veterinary technician is invaluable in assessing and reporting findings to the veterinarian. The veterinary technician, in conjunction with the veterinarian, can discuss and implement a multi-modal approach to managing pain in critically ill patients.

Pain physiology and pathophysiology

Pain is typically thought of as an adaptive response to prevent injury. If you stick your arm over a fire, it hurts so you can pull away and minimize tissue damage. However, severe injury, or failure to treat pain can cause detrimental physiologic effects, beyond the positive effects of self-preservation. In the periphery, specialized nerves, called nociceptors, exist and transmit pain signals to the spinal cord and to the brain. The free nerve endings, which terminate in soft tissue, have various receptors that can be activated in response to thermal, chemical, or mechanical noxious stimuli. For example, an acid burn will stimulate different fibers than a laceration. The first step in the pain process is transduction, where nerve endings convert stimuli into electrical signals. The two main nerve fibers (each with separate ability to transmit various stimuli) are the A-delta and C fibers. The A-delta fibers tend to fire faster, sending quicker signals to the spinal cord. The C-fibers tend to have a slower ability to reach their threshold. Thus, pain that is felt immediately upon exposure to noxious stimuli (crushing, pinching, tearing) is transmitted through A-delta fibers. Pain that is felt with a bit of a pause, cold temperature, etc is transmitted across C-fibers. Another important point is that there are various A-delta and C nerve fibers contain endings that typically do not transmit pain signals (initially) but can be "woken up" and recruited in severe circumstances. The next step in the pain process is transmission; after the nociceptors have converted the stimulus to energy it is sent to the spinal cord for initial processing. The signal travels through the nerve fibers to the dorsal part of the spinal cord. As discussed earlier, C-fibers are 10x slower than A-delta fibers in their transmitting speed. After pain signals reach the spinal cord, modulation occurs. Here, the spinal cord either dampens or increases the pain signal according to various neurotransmitters or chemicals that are activated/deactivated in the spinal cord. The majority of pain signals that make it to the spinal cord and are sent on are mediated by glutamate, a neurotransmitter. Glutamate acts on the AMPA, KAI, and neurokinin (NK) receptors and stimulates a response by sending the signal up the spinal cord to the brain. The NMDA receptor (upon which ketamine exerts it's effects) is responsible for amplifying pain signals, whether they are incredibly strong or not. The NDMA receptor is thought to be important in prolonged/amplified pain states. A neurotransmitter called Substance P activates the NMDA receptor. Finally, GABA receptors, when activated, tend to inhibit signals from crossing into the spinal cord to be processed. There are other important neurotransmitters involved in modulation of signals in the dorsal horn of the spinal cord. These include: serotonin, norepinephrine, and opioid receptors. Serotonin, norepinephrine and opioid receptors, when activated, inhibit excitation of neurons, thus agonists of these drugs have analgesic properties. The last, and final, step of the pain pathway is perception. Perception occurs in multiple parts of the brain and is then perceived as an unpleasant sensation associated with real or perceived tissue damage. Pain can be categorized in various different ways: disease or anatomy related (pancreatic, etc), location (superficial, visceral, deep), duration (acute, chronic) or intensity (mild, moderate, or severe). These often require some objective input) from the patient, so categorizing these in veterinary patients can be challenging.

A few other important concepts in pain management in the acute patient include: Allodynia, sensititzation, windup, and referred pain. Allodynia refers to an exaggerated reaction to a stimulus that is normally not painful. This can occur due to an exaggerated pain response where the pain threshold of nociceptors is lowered. Sensitization and windup are the result of peripheral and central physiochemical changes that occur during tissue damage and the inflammatory response. Peripherally, inflammatory mediators and cells can reduce the threshold of normally high-threshold nociceptors, and awaken "sleeping" nociceptors causing an exaggerated pain response. Central sensitization (windup) occurs as another mechanism for an exaggerated pain response, and because this occurs in the spinal cord, can result in severe pain that lasts much longer than the initial tissue insult. Repeated signaling to the spinal cord activates excitatory neurotransmitters which activate various receptors (NMDA, notably) and secure open-channels for pain stimuli to pass through. It appears that central sensitization can be responsible for allodynia. Referred pain is pain in a body part that is not affected by tissue damage. This might occur in a limb that was not amputated (phantom limb pain), or pain in limbs where the source of the pain is in the abdomen, for example.

Pain pharmacology

Drugs used in the treatment of pain are best described by their effects on the pain pathway. Major classes of drugs used for pain in the acute setting include: opioids, NSAIDS, alpha-agonists, NMDA-antagonists, and local anesthetics.

Opioid medications act peripherally (transduction) and centrally (modulation) on opioid receptors. There appear to be three sub-types of receptors: mu, kappa, and delta. There are various types of opioid drugs including agonists, antagonists, and partial agonists/agonist-antagonist drugs. The below table summarizes these drugs.

Drug	Primary receptor	Secondary receptor	Level of pain appropriate for	Duration of action	Species	Routes to be administered
Morphine	Mu	NA	Moderate-Severe	Up to 4 hours	Cat, Dog	IV, IM, SQ-IV Can cause histamine release
Hydromorphone	Mu	NA	Moderate-Severe	Up to 4 hours	Cat, Dog	IV, IM, SQ
Oxymorphone	Mu	NA	Moderate-Severe	Up to 4 hours	Cat, Dog	SQ, IM, IV
Fentanyl	Mu	NA	Moderate-Severe	Single injection up to 30 minutes	Cat, Dog	IV- CRI
Buprenorphine	Mu (partial agonist)	NA	Mild-moderate	Up to 6 hours	Cat, Dog	SQ, IM, IV
Methadone	Mu	NMDA antagonist	Moderate-severe	2-6 hours	Cat, Dog	SQ, IM, IV
Butorphanol	Kappa	Mu	Mild-Moderate	1-6 hours (Dogs typically 1 hour or less)	Cat, Dog	SQ, IM, IV
Tramadol	Mu agonist	Serotonin/Norepinephrine reuptake inhibitor	Mild-moderate	Twice-four times daily dosing	Cat, Dog	PO
Naloxone	Mu antagonist		Reversal agent	NA	Cat, Dog	IV

The second class of important analgesic drugs are the non-steroidal anti-inflammatory drugs (NSAIDS). These drugs have a potent ability to slow/stop inflammatory processes which are responsible for pain signaling. Although tissue damage may exist, of the inflammatory cascade can be prevented, pain signals will not be transduced. NSAIDS work on transduction of pain, working locally to prevent cytokine release, cell recruitment, and other inflammatory signs. They do have some significant side-effects and their use in critical patients are limited. Examples include: carprofen, meloxicam, aspirin, etodolac, piroxicam, deracoxib, fibrocoxib, tepoxalin, and ketoprofen.

Next, alpha-agonists, such as dexmedetomidine, can act in the spinal cord to prevent modulation of pain signals through agonizing norepinephrine at the alpha-receptors in the dorsal horn. Alpha-agonists tend to have severe cardiopulomonary effects, even at low doses, and so their use in critical patients is also limited. However, they remain an important part of the pain arsenal in dealing with anesthetic delirium, or as a continuous rate infusion for sedation with desired analgesic effects.

Local anesthetics are the next major class of analgesic drug to discuss. These drugs, ending in -caine, are Na-channel blockers. Influx of Na+ ions into the neuron is responsible for the creation of an action potential in the nerve. The action potential propagates and the signal travels along the neuron to the spinal cord. Blocking Na+ influx would stop the action potential and prevent transmission of the painful stimulus. Examples include: lidocaine, bupivicaine, proparacaine, and tetracaine. A summary of these drugs is found below.

Drug	Duration of action	Routes administered	Notes
Lidocaine	60-120 minutes	Local, SQ/Intradermal, IV	Can provide effective adjunctive analgesia as a CRI Reduce dosages in cats****
Bupivicaine	180-480 minutes	Intrathecal, Intrapleural, NOT IV	Only to be used
Proparacaine	Variable	Topically (ocular)	

Finally, the adjunct drug that might be used in analgesia in the critically ill is ketamine. Ketamine functions as an NMDA-antagonist, preventing or stopping exaggerated pain signals from passing through these channels to the brain (windup). Ketamine does not have analgesic properties on it's own. Rather, it seems to potentiate the effects of other drugs (opioids notably) by blocking NMDA-receptors and lowering the needs for the other analgesic drug (opioid) by itself.

Assessment of pain

Assessing pain in small animals in the ICU can be somewhat difficult. There has been alot of research into physiologic and behavioral responses to pain. This research has allowed the veterinary professional to better assess and categorize pain states in animal patients. While it might seem somewhat intuitive that a patient who was hit by a car and growls is painful, the veterinary community didn't always see things that way. The best recommendation is to implement a comprehensive pain scale in the hospital and use that when assessing pain in your patients. A commonly used chart is the Colorado State University pain scales found here:

- Canine: ivapm.evetsites.net/refid.20468/refDownload.pml
- Feline: ivapm.evetsites.net/refid.20467/refDownload.pml

Behaviors associated with pain can be found in the following charts

Canine pain behaviors		
Anxiety	Decreased desire for interaction	Submissiveness
Reluctance to move	Whimpering/Howling/Growling	Guarding
Aggression	Anorexia	Self-mutiliation

Feline pain behaviors		
Hiding	Decreased desire for interaction	Hissing/spitting
Reluctance to move	Excessive licking/grooming	Attempting to escape
Lack of grooming/unkempt coat	Tail flicking	Crouching

Vitals alone (blood pressure, heart rate) have been found to be poor predictors of pain. Many animals with normal vital signs are in pain. Approaches to a patient for a pain assessment might include:

- Observation of the animal in the cage
- Observing the patient interacting with another staff member
- Taking vital signs: HR, RR, Temp, Mentation, BP
- Attempting to elicit a painful response: palpating incision or limb/organ affected
- Observing quality of life: eating/drinking, coat, ambulation

Once the assessment is complete, the decision is made to institute analgesic therapy or modify current therapy, if it is inadequate.

Treatment of pain

Treating a patient with acute pain involves a multi-modal approach. The first step is to assess the pain and make judgments as to the level of pain, location, and analgesic therapy that is appropriate. This involves thinking of where the pain occurs, what stimuli is causing it, and if there is a windup component.

Options for treating pain in the ICU include: injections of analgesic medications, continuous rate infusions of analgesic medications, use of local anesthetic blocks near site of pain, epidural injection and catheter placement, transdermal patches, continuous infusion of analgesics into pain site ("soaker catheters), and non-allopathic interventions such as acupuncture and/or physical therapy.

An example of a multi-modal approach to analgesia in a thoracotomy patient:

- Pre-medication:
  - Hydromorphone (pure u opioid) + Midazolam
- Induction:
- Fentanyl (pure u opioid) + Lidocaine (Na-channel blocker) + Ketamine (NMDA antagonist) + Midazolam
  - Intra-operatively:
  - Fentanyl + Lidocaine + Ketamine CRI
  - Intercostal block (local anesthesia)
- Post-operatively:
  - Bupivicaine infusion into thoracostomy tube
  - FLK CRI
  - +/- NSAID

Critical Care Patient Monitoring

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

Critical care monitoring essentials

1. Check all invasive tube sites for inflammation:
    a. Catheters: peripheral, central, urinary
    b. Feeding tubes: Gastrostomy, Jejunostomy
    c. Chest tubes
    d. Abdominal drains
2. Use latex gloves when dealing with immunosuppressed patients, or invasive devices
3. Wash hands between each patient
4. Use appropriate disinfectants for appropriate contact time
5. Perform regular physical exams on patients (TPR plus!)
    a. Temperature
    b. Pulse, HR, Evaluation of pulse quality, palpation of distal/femoral pulses
    c. Respiration rate, character, auscultation
    d. Auscultation of heart
    e. Abdominal palpation
    f. Palpation for edema, chemosis
    g. Evaluation of mentation, eyes, ears, nose
    h. Evaluation of integument for bruising, scald, redness/swelling
6. Check data from prior exams (will catch temperature changes, HR increases, etc)

A wonderful model to follow when evaluating critical patients is Kirby's Rule of 20, written and developed by Dr. Rebecca Kirby. It is available for public access at: www.animalemergencycenter.com/images/rule of 20.pdf

1- Fluid Balance**	2- Oncotic Pull**	3- Glucose**
4- Electrolytes**	5- Oxygenation and ventilation**	6- Mentation**
7- Blood Pressure**	8- HR, Rhythm, Contractility**	9- Albumin**
10- Coagulation**	11- RBC/Hgb concentration**	12- Renal function**
13- Immune status, Abx dosage, WBC count	14- GI motility/mucosal integrity**	15- Drug dosages/metabolism
16- Nutrition**	17- Pain control**	18- Nursing care/patient mobilization**
19- Wound care/bandage care**	20- Tender loving care**	

Monitoring the critical patient

Blood gases

More important than metabolic acid-base information in the mechanically ventilated patient would be understanding the oxygenation/ventilation information provided by an arterial blood gas. Traditional blood-gas machines report a partial pressure of oxygen and carbon dioxide delineated with an "a" in the subscript if arterial. Thus, the P_aO_2 and P_aCO_2 are the partial pressures of dissolved oxygen and carbon dioxide in arterial blood. The carbon dioxide level is closely related to alveolar ventilation and directly corresponds to ventilatory rate or tidal volume. Hypercarbia indicates hypoventilation and hypocarbia indicates hyperventilation. CO2 can also be elevated in cases of severe lung disease (alveolar flooding). Normal Co2 is typically 35-45 mmHg.

Interpreting oxygenation indices is slightly tricker. If normal PaO2 is 80-100mmHg on room air, what should the PaO2 be when a patient is receiving 100% oxygen? 60% oxygen? The PaO2 should always be roughly 5 times the inspired oxygen content (FiO2). So a patient breathing 100% oxygen should have a PaO2 of 500mmHg or so. A patient on 60% oxygen should have a PaO2 of around 300mmHg. Now if one receives a blood gas report indicating sub-normal PaO2, how do we know if it is hypoxemia and clinically significant? The PaO2/FiO2 ratio gives a quick estimate of lung function and can be used on patients breathing FiO2's >21%. The traditional measure of lung function is the Alveolar-Arterial (A-a) oxygen gradient, but can only be reliably used on patients breathing 21% oxygen. If the patient's PaO2/FiO2 is <300 (no units) than the patient can be considered at risk or demonstrating clinical signs of acute lung injury. If the patient's PaO2 is <200 the patient is at risk or showing signs of Acute Respiratory Distress Syndrome (ARDS).

The last piece of information to discuss is the relationship between saturation of oxygen at the level of hemoglobin (SO2 or SaO2 if arterial) and the dissolved oxygen tension (PaO2). The oxyhemoglobin dissociation curve gives us this information.

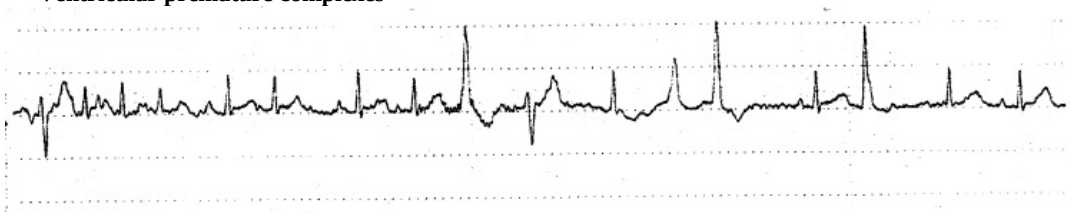
Monitoring devices employed in veterinary ICU include: EKG, Blood pressure (non-invasive or invasive), end-tidal Co2 monitoring (capnography), temperature, and pulse oximetry. Understanding each of these is essential to properly administering effective nursing. A in-depth discussion of each of these monitoring devices is beyond the scope of this presentation. Only an overview will be presented.

Parameter	Normal Range	Acidosis	Alkalosis
pH	7.35-7.45	< 7.35	> 7.45
HCO_3	18-24 mmol/L	< 18	> 24
pCO_2	34-45 mmHg	> 45 mmHg	< 35 mmHg
P_aO_2	80-100 mmHg	Hypoxemia: <80 mmHg room air	

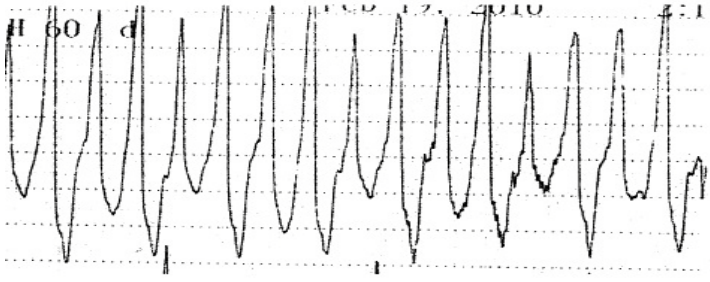
ECG

Electrocardiography measures electrical conduction in the heart. The heart rate reported by the ECG should always be double checked with auscultation or a manual pulse rate. Cardiac arrhythmias can certainly occur in critically ill patients and can contribute to worsening organ perfusion or cardiac arrest. Common cardiac arrhythmias include:

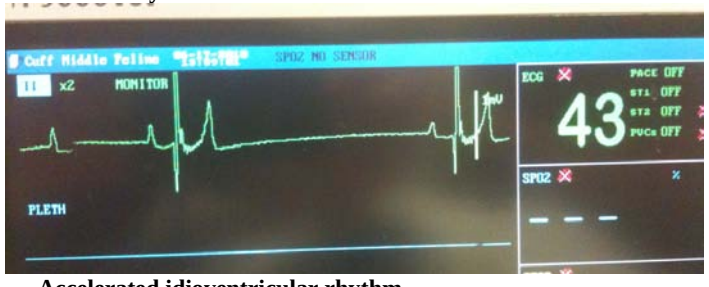
Ventricular premature complexes



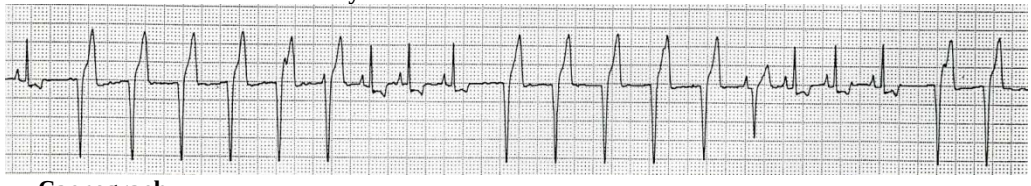
Ventricular tachycardia



Sinus bradycardia



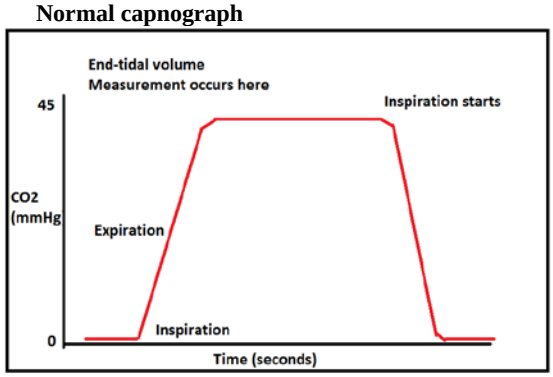
Accelerated idioventricular rhythm



Capnography

Capnography (more specifically end-tidal CO2 measurement) reports the CO2 in the patient's endotracheal tube at the very last part of their breath (end-tidal volume). This most closely approximates alveolar CO2 and is fairly accurate. It tends to underestimate alveolar CO2 so normals are about 3-5mmHg lower than arterial measurement of CO2. Mainstream and side-stream options are available. The small T-connector that is placed at the end of the patient's ET tube contributes to additional mechanical deadspace. Constant CO2 measurement can be of great importance in a ventilated patient, not only indicating appropriateness of ventilator settings but also can indicate impending disaster such as barotrauma or cardiac arrest.

Normal capnograph

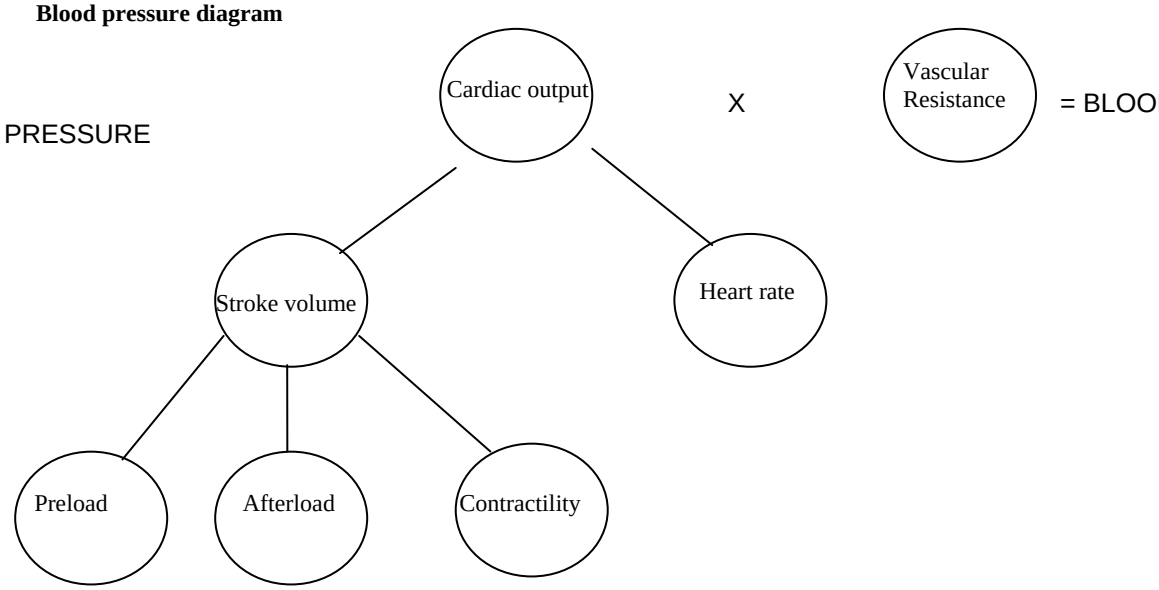


Normal ET-CO_2 should be: 30-40 mmHg (Approximately 5 mmHg lower than pCO_2)

Blood pressure

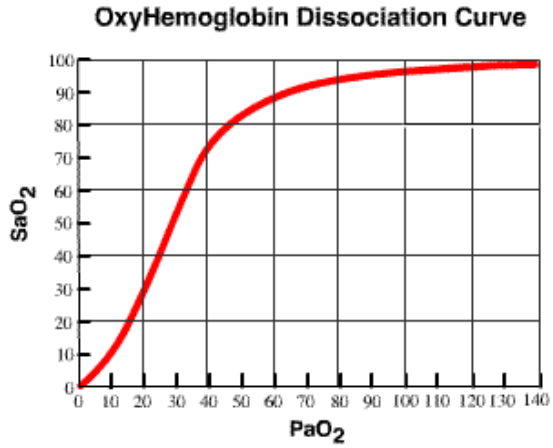
Blood pressure is the measurement of pressure within the arterial system and is affected by heart rate, stroke volume, and systemic vascular resistance. Bradycardic or tachycardic patients may be hypotensive, hypovolemic patients or patients with heart failure may be hypotensive, or patients with vasodilation or vasoconstriction may also have blood pressure abnormalities. It is a very important parameter to measure in ventilated patients as PEEP increases intrathoracic pressure and may decrease venous return and if the patient does not have pre-existing heart disease, septic and SIRS inflammatory mediators can induce cardiomyopathy, causing hypotension and decreased organ perfusion. Non-invasive blood pressure is typically measured using Doppler technology or an oscillometric model. It is important to note that studies have validated the Doppler and invasive (arterial catheter) methods of blood pressure monitoring in the critically ill, but not oscillometric models. Arterial catheter placement has advantages in the mechanically ventilated patient in that you can measure direct arterial blood pressure and sample for arterial blood gases. The advantages of direct arterial blood pressure include: second-to-second readings, direct measurement of MAP (not calculated), and an arterial waveform.

Blood pressure diagram



Pulse oximetry

Discussed mainly above in the blood gas section. Pulse oximetry is a non-invasive measurement of hemoglobin and if kept normal, assumes oxygen is traversing the blood-gas barrier in the lungs. However, because only slight changes in pulse oximetry can relate to larger changes in PaO2 it must be used with caution.



Central venous pressure (CVP)

Central venous pressure is the pressure measured in the cranial vena cava (sometimes caudal vena cava as well) and indirectly estimates the volume of blood in the right ventricle during diastole. This approximates preload, or the volume of blood available to be ejected during a cardiac cycle. Assuming normal cardiac anatomy, contractility, and no pleural/pericardial disease, the CVP estimates "vascular volume" without the extravascular effects of blood pressure, such as vasoconstriction, or changes in cardiac output. Thus, a low CVP will be present in a hypovolemic patient, and a high CVP in a hypervolemic patient. A patient in hemorrhagic shock may have a "normal" or "acceptable" blood pressure, but should have a low CVP. CVP measurement can occur easily with a jugular catheter (placed cranial to the right atrium) and a water manometer.

References available upon request

Traumatic Brain Injury Management: Not Just the Head Needs Treating

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

Traumatic brain injury, or (TBI) formerly termed head trauma, refers to direct injury to the cerebral cortex and brainstem as the result of trauma. This term is technically more correct as a patient could experience head trauma and not necessarily suffer any neurologic consequences. TBI often occurs in the course of blunt trauma such as being kicked or hit by a car, but can also occur as a result of penetrating trauma. This syndrome involves two steps, a primary injury and then sequelae caused by the neurologic response to that injury. The veterinary technician is very important in nursing the patient with head injuries and TBI and there are many nursing interventions that can affect outcome and care.

Pathophysiology

A discussion of TBI must begin with a review of normal homeostatic mechanisms in the cranium maintaining cerebral perfusion. One must remember that the skull is a fixed compartment that contains brain tissue (parenchyma), cerebrospinal fluid (CSF) and blood. An increase in the volume of any of those three things must correspond to a reduction in volume in another to maintain the same intracranial pressure. This is called the Monroe Doctrine. Cerebral perfusion is regulated by the cerebral perfusion pressure (CPP), which is given by the mean arterial pressure (MAP) minus the intracranial pressure (ICP). This relationship demonstrates that when there is a threat to the perfusion of the brain the MAP or ICP will respond accordingly. In an example, if a patient's ICP increases for some reason, the CPP will drop, so the MAP will compensate by increasing. This systemic hypertension is often paired with bradycardia (similar to the effects of dexmedetomidine) and is called the Cushing's reflex. This is often indicative of impending brain herniation, where part of the brain is pushed out of the foramen magnum (the opening at the back of the skull) and compromises the brainstem which can lead to death.

Cerebral blood flow (CBF, related to CPP) is relatively constant over a range of MAP's from 50-150 mmHg. Similar to renal blood flow, the body can autoregulate CBF and maintain it over a range of MAP's as a protective mechanism. CBF is compromised at MAP's less than 50 and greater than 150, and patients with TBI lose the ability to autoregulate regardless of their MAP. CBF is controlled by several factors including: partial pressure of oxygen in the blood (PaO2), partial pressure of carbon dioxide in the blood (PaCO2), MAP, and other metabolic factors. During TBI, the brain becomes dependent on MAP to maintain a constant CBF and so hypotension can drastically affect the blood flow to the brain, and thus cerebral perfusion worsening injury. Additionally, the role of ventilation and CO2 is important in brain physiology. Elevations in the PaCO2 (from hypoventilation) cause cerebral vasodilation, increased CBF and increased ICP. Decreased PaCO2 (from hyperventilation) also causes detrimental effects including vasoconstriction and a decrease to the CPP. Keeping the PaCO2 in a normal range by controlling ventilation can be a neuroprotective measure.

The pathophysiology of traumatic brain injury involves two events: a primary injury and a secondary injury. The primary injury is the direct injury or trauma to the cranium, face, or neck that occurs right at the time of trauma. Several types of primary injury exist including: concussion, laceration, and contusion. A concussion is a type of primary TBI characterized by a loss of consciousness and is not associated with any histopathologic findings of the brain parenchyma. Contusions involve direct blunt trauma to the brain parenchyma (a "bruise) and can cause damage and microhemorrhage. Laceration is a very severe form of primary injury and is characterized by disruption in the continuity of brain tissue.

Secondary injury occurs after primary injury and involves a cascade of events that worsens the primary injury. These include such things as excitatory neurotransmitter release, hypoxia, hypotension, etc. These are usually divided into intracranial and exracranial insults. Intracranial insults include: excitatory neurotransmitter release (glutamate), ischemia, depletion of ATP, reactive oxygen species formation, accumulation of intracellular Na and Ca ions, nitric oxide release, and lactic acidosis. Extracranial secondary insults include: hypotension, hypoxemia, SIRS, hyper or hypoglycemia, hyper or hypocapnea, hyperthermia (hypothermia is often neuroprotective), and any electrolyte or acid-base imbalance.

Initial stabilization and treatment

On physical exam patients with TBI may present in a shock state and have evidence of trauma to their head and neck. Any patient with history of, or clinical signs of trauma to their head and neck should be assumed to have TBI. Level of consciousness is a simple indicator of brain perfusion. The below chart summarizes various LOC's:

Level of Consciousness	Description
Alert	Appropriately responds to stimuli
Depressed/Obtunded	Quiet without stimulation but can be roused with verbal stimuli
Stuporous	Unconscious but can be roused with noxious/painful stimuli
Comatose	Unconscious/unrousable

The modified Glasgow coma scale has been shown to predict survival in dogs with head trauma. The scale is below:

SCORE	Motor activity
6	Normal gait, normal spinal reflexes
5	Hemiparesis, tetraparesis, decerebrate activity
4	Recumbent, intermittent extensor rigidity
3	Recumbent, constant extensor rigidity
2	Recumbent, constant extensor rigidity with opisthotonus
1	Recumbent, hypotonia of muscles, depressed or absent spinal reflexes
	Brainstem reflexes
6	Normal PLR's and oculocephalic reflexes
5	Slow PLR's and normal to reduced oculocephalic reflexes
4	Bilateral unresponsive miosis, normal to reduced oculocephalic reflexes
3	Pinpoint pupils, reduced to absent oculocephalic reflexes
2	Unilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes
1	Bilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes
	Level of consciousness
6	Occasional periods of altertness and responsive to environment
5	Depressed/obtunded
4	Semicomatose- responsive to visual stimuli
3	Semicomatose- responsive to auditory stimuli
2	Semicomatose- responsive to noxious stimuli
1	Comatose
TOTAL:	OUT OF 18

Treatment should involve assessing the ABC's, dealing with life-threatening injuries (hypotension, hemorrhage, etc) and instituting neuroprotective or neurospecific therapies. After the ABC assessment, patients should have their blood pressure normalized, as best as possible, to ensure adequate cerebral perfusion as well as other the perfusion of other major organ systems. Initial diagnostics can be performed including a minimum database (PCV, Glucose, TP, BUN, Blood gas, electrolyte) and screening radiographs. CT imaging can be performed in institutions that have access to a CT scanner. Although not specifically mentioned, analgesic therapy is important in any trauma patient. Analgesics should be administered immediately after physical exam and not withheld for continued neurologic assessments. The hallmark of treating these patients is typically through medical therapy.

Decreasing ICP

This can be achieved through avoiding the jugular veins for venipuncture and slightly elevating the patient's head to use gravity to ensure draining of the jugular veins. Avoid coughing at any time, or during intubation is essential, and Elizabethan collars/leashes should be avoided or used sparingly to minimize compression of the neck.

Fluids

Older approaches to fluid therapy in the head trauma patient favored a hypotensive/hypovolemic resuscitation strategy to minimize extravasation of fluids into the cerebral parenchyma. However, current practice emphasize the importance of maintain euvolemia and normotension to maintain CPP. Crystalloid and colloid therapy are the mainstays to treat shock states in small animals. Many veterinary clinicians advocate for the use of hypertonic saline by itself, or in combination with a colloid. Hypertonic saline has advantages in that it uses a low volume to achieve great increases in intravascular volume, and functions as an osmotic diuretic to relieve cerebral edema. Additionally, in combination with a colloid a huge increase in blood pressure can be seen with relatively little volume used. Crystalloid fluids should follow after this initial resuscitation period.

Diuretics

Treating cerebral edema involves drawing fluid from the cerebral interstitium and mobilizing it into the vasculature for excretion. This is typically achieved with Mannitol, while it can also be achieved with hypertonic saline. In addition to its osmotic properties Mannitol causes an increase in plasma volume, decreases blood viscosity and can cause cerebral vasoconstriction and reduce ICP. Mannitol has been recommended as a bolus vs. an infusion initially.

Oxygenation/ventilation

Oxygen therapy is indicated in most TBI patients. Hypoxemia should be avoided and so oxygen can be safely recommended to be routinely administered. Non-invasive oxygen supplementation (flow by, cage) should be used over more invasive methods (tight fitting face mask, nasal cannula). Intubation and mechanical or manual ventilation should be used in the comatose hypoventilating

patient. Controlling ventilation is important in the TBI patient if they do not seem to be ventilating appropriately. CO2 should be monitored if possible using a venous/arterial blood gas, or end-tidal CO2 if the patient is intubated. PaCO2 should be maintained in a normal range or even slightly hypocapnic, around 30-40 mmHg. Hypocapnea below 30 mmHg and hypercapnea above 40-45 mmHg should be avoided as it is detrimental to cerebral blood flow and perfusion.

Seizure prophylaxis

Seizure activity can occur in TBI patients in the acute period or even potentially days to months after the incident. There was some though to benefit for prophylactic seizure treatment, but it appears that current thoughts recommend treating seizures involve treating seizures aggressively when they occur with standard anticonvulsants.

Steroids

Many human studies have found a negative impact on mortality with steroid administration in TBI. Steroids are now contraindicated in the treatment of TBI in human patients. Therefore, recommendations in veterinary medicine follow human guidelines and recommend against administering corticosteroids to a patient with TBI in efforts to reduce cerebral edema.

Glucose control

Hyperglycemia has been found to be a negative prognostic indicator in TBI and might indicate continued secondary injury. However, the routine use of insulin therapy in TBI patients isn't currently recommended until further studies can be published. If hyperglycemia persists, it is probably reasonable to administer insulin to achieve normoglycemia.

Nursing care

Nursing the TBI patient is very involved and can have a huge impact on the care of the patient. A typical nursing plan would include:

Reducing intracranial pressure

Avoid jugular venipuncture, keep head elevated, avoid coughing, avoid use of collars or E-collars.

Monitoring vital signs

HR, RR/effort, subjective assessments of tidal volume, MM/CRT, Pulse quality, BP, temperature, PaCO2, BG.

Recumbent care

Head elevated, turning often, PROM, eye care.

Neurologic assessments

LOC, PLR's, mGCS scores, pain scores

Conclusion

Patients with traumatic brain injury can present in life-threatening or devastating conditions but with intensive nursing care and recover and are often very rewarding cases to treat. Nursing the TBI patient involves understanding the pathophysiology of injury, secondary complications, treatment approaches, and avoiding making the situation worse.

Critical Care Nursing: Tales from the Trenches

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

Dealing with emergencies often involves life-saving procedures and team efforts to bring patients back from the brink of death. This lecture will present two cases from admit to discharge and show how the veterinary critical care team can jump into action and deal with the most complicated and critical cases.

Case 1

- Signalment: 2y MI Yorkshire Terrier
- Presenting complaint: Hit by car
- Physical exam: HR: 40 BPM, RR: Apneic, MM- Gray, Large laceration across thorax
- Treatment summary
    - IV Catheter and fluid bolus
    - Intubation/CPR
    - Open chest CPR
    - Chest tube placement/suture of thorax
    - Analgesic medication
    - Jugular catheter placement
    - Urinary catheter placement
    - Sedation/Intermittent Positive pressure ventilation
    - Weaned from IPPV- oxygen cage
    - 2 days of intensive care
    - Pelvic fracture repair
    - Discharge 8 days later

Case 2

- Signalment: 2y MN DSH
- Presenting complaint: ADR, Diarrhea
- Physical exam: HR 60 BPM, Cyanotic, Apneic
- Treatment summary
    - IV Catheter- fluid bolus
    - ECG
    - Blood gas
    - Administration of insulin, calcium, dextrose
    - Intubation/CPR
    - Recovery from CPR
    - Urinary catheter placement
    - 1 day later- nasogastric tube placement
    - Urinary output monitoring
    - Peritoneal dialysis
    - Jugular catheter placement
    - Preparation for hemodialysis transfer
    - 2 days ICU treatment
    - Surgery for bilateral ureteroliths
    - Discharge 6 days post-op

Gut Drugs:
GI Pharmacology

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

Drugs used in the treatment of various gastrointestinal diseases are used almost every day in the veterinary hospital. These drugs have a complicated method of action, and their pharmacology is essential for the veterinary technician to understand. In addition, they are fun and interesting! And they actually fix the problem! Diseases such as gastrointestinal foreign body, pancreatitis, gastritis, and liver diseases cause life-threatening side effects such as vomiting, diarrhea or ulcer formation. The patient wholly benefits when the detrimental syndromes like vomiting and diarrhea are alleviated! The pathophysiology of vomiting, ulcer formation, and diarrhea will be discussed. The classes of drugs to be addressed in this lecture are: prokinetic drugs, anti-emetic drugs, emetic drugs, antacid drugs, and some anti-diarrheal drugs.

Vomiting

Vomiting is the active expulsion of contents from the stomach and proximal duodenum. It is a forceful process, with some referring to cat vomiting as "violent." It can result in discomfort, pain, and large fluid losses if not controlled. The emetic center, in the brain, controls the vomiting reflex. It receives input from a variety of sources including: the chemoreceptor trigger zone (CRTZ), vestibular system, peripheral sensory receptors, and other CNS receptors. The CRTZ represents an important entity in the pathway of vomiting. It is not entrenched in the blood-brain barrier (tight gap junctions preventing toxins from entering the brain) and thus is susceptible for circulating emetic-inducing substances. The CRTZ is stimulated by dopamine, serotonin (5-HT3 receptors), histamine (H1) and alpha-2 adrenergic stimulation. This explains the use of Xylazine as an emetic in cats. Vestibular input also arrives to the emetic center via the CRTZ. Peripheral receptors providing input to the emetic center are found throughout the body, but are mainly found in the GI tract. These receptors respond to pain, inflammation, distension, and rapid changes in electrolyte/water content (osmolality). In addition, there are several known toxins that affect the CRTZ. Notably, uremic toxins can cause stimulation of the CRTZ and thus, vomiting.

Anti-emetics

Anti-emetics work in a variety of ways. Those included in this class are: Phenothiazines, Metoclopramide (Reglan®), Peripheral 5-HT3 serotonin antagonists, Opioids, Antihistamines, and Anticholinergics.

Phenothiazines

Phenothiazines such as Chlorpromazine exhibit anti-dopaminergic effects and a2 receptor antagonist effects. Thus, they block vomiting centrally at the CRTZ and emetic centers. They are not thought of as first-line anti-emetics and are not used much anymore. They have significant cardiovascular side effects including vasodilation, which can cause hypotension.

Metoclopramide

Metoclopramide is an anti-dopaminergic and anti-serotonergic drug which blocks signaling to the CRTZ. It is also an anticholinergic, giving rise to its prokinetic properties. Metoclopramide increases lower esophageal sphincter tone, thereby preventing gastroesophageal reflux. It also stimulates peristalsis. Metoclopramide has a short half life and is more effective administered as a CRI. It also can cause neurologic side effects including hyperactivity and tremors. These are seen most often in cats.

5-HT3 antagonists

Ondansetron (Zofran®) and Dolasetron (Anzemet®) block neurotransmission of serotonin receptors in the GI tract. They also have some central ability to block CRTZ neurotransmission to the emetic center. These are powerful anti-emetics and have increased efficacy in chemotherapy induced emesis. There are few commonly observed side effects. Ondansetron has the added benefit of SID dosing.

Opioids

Opioids are anti-emetics, although Hydromorphone is associated with vomiting. They are not used often for anti-emesis.

Antihistamines

Antihistamines can have anti-emetic effects by blocking H1 receptors in the CRTZ. Meclizine and Diphenhydramine can be used to control motion sickness induced vomiting. They are not effective in cats because vestibular signals bypass the CRTZ in cats and travel directly to the emetic center.

Anticholinergics are not worth mentioning because they have very little anti-emetic properties and may cause ileus and predispose to aspiration.

Emetics (central acting)

Apomorphine is an opioid drug with dopaminergic antagonism causing stimulation of the CRTZ. It is typically used in dogs. It comes in tablet or compounded form for parenteral injection. Sedation can occur as a side effect

Xylazine is an α_2 adrenergic agonist that can induce emesis in cats. It is used a doses much lower than the sedative doses and thus should not cause many complications. However, the α_2 agonist class are known for potent cardiovascular side effects such as vasonconstriction and reflex bradycardia.

Ulcer formation

Acid is secreted into the gastric and duodenal lumen via the parietal cells. There are several receptors on the parietal cell influencing acid secretion. The input of Gastrin, an endocrine hormone, Histamine (H_2), and muscarinic acetylcholine receptors occur in a step-wise fashion with all inputs creating the highest level of acid secretion. When engaged the H/K/ATP-ase pump is activated and pumps H+ protons into the gastric lumen. The stomach has several defense mechanisms that protect it from the highly acidic gastric fluid within the lumen. First there is a hydrophobic mucous layer which exists in a gel form. It traps bicarbonate ions and prevents H^+ ions from travelling through it. Second, bicarbonate is constantly secreted into the gastric mucous to help neutralize H^+ ions travelling towards gastric tissue. Finally, gastric blood flow is maintained by prostaglandins which help assist in vasodilation and increased blood flow to the epithelial tissue. Because of the increased blood flow, there is increased gastric cell turnover, leading to increased numbers of healthy cells, with old cells being constantly replaced by new ones.

Gastric ulcers form as the mucous layer breaks down, blood flow to the stomach decreases, and H^+ activity increases. As the protective mechanisms fail, gastric necrosis occurs from decreased blood flow and exposure of epithelial cells to acid. Blood supply under the epithelial tissue can be exposed and rupture, causing GI hemorrhage. This hemorrhage can be significant. In veterinary medicine diseases/conditions associated with ulceration include: NSAID use, hepatic disease, corticosteroid use, neurologic/IVDD, Uremia, Mast cell tumors, gastrinomas, neoplasia, GI disease, hypoadrenocorticism, and pancreatitis. There is a syndrome of critical patients reported called stress-related mucosal disease. In human studies, clinically significant GI bleeding did not occur, but stress ulcer prophylaxis did help prevent bleeding episodes.

Antacids

These drugs work by blocking acid input from parietal cells into the gastric lumen. Thus they cause an elevation in gastric pH.

H_2 receptor antagonists

H_2 receptor antagonists, such as famotidine, ranitidine, and cimetidine, block histamine input to the parietal cell. They block one pathway of signaling involved in acid secretion. Famotidine is the most potent, followed by ranitidine and cimetidine. As cimetidine is a weak antacid its use has fallen out of favor. It also inhibits the CP450 metabolism system in the liver, potentially preventing effective metabolism of drugs that use this pathway. Ranitidine and cimetidine exhibit some weak prokinetic activities, which make them weak anti-emetics, if emesis is the result of reflux or ileus. However, they are generally considered safe drugs.

Proton pump inhibitors (PPI's)

Proton pump inhibitors (such as omeprazole and pantoprazole) irreversibly inhibits Na/K/ATPase pump which pumps H^+ protons into the gastric lumen. These are highly effective antacids. However, they take 3-5 days to exert maximum antacidity. They only work on active proton pumps, so inactive pumps, which begin work as others are inactivated, work for some time until the PPI binds to them. However, they are superior to H_2 antagonists. In a study done at the University of Guelph, patients receiving various antacid medications were studied. On day 2, 30% of patients receiving famotidine had a gastric pH >4. 45% of patients receiving omeprazole had a gastric pH >4. On day 6, 48% of patients receiving famotidine and 52% of patients receiving omeprazole had a gastric pH >4. Additionally, PPI's are ineffective at inhibiting gastric acid production overnight, and current recommendations call for combining H2 antagonists and PPI's for superior gastric acid control.

Miscellaneous

Additional anti-ulcer medications include the gastric coating agent, Sucralfate, and the cytoprotective agent, Misoprostol (Cytotec®). Sucralfate is a mixture of sucrose and aluminum hydroxide. After ingestion, the sucrose and aluminum hydroxide dissociate. The aluminum hydroxide becomes a paste in the acidic stomach, and coats areas of erosion. This prevents further damage from occurring. Sucralfate also binds to and inactivates bile acids and pepsin. Sucralfate has other properties such as: binding of epidermal growth factor, increasing prostaglandin synthesis, and stimulating nitric oxide formation, a potent vasodilator. Sucralfate works best in an acidic environment, but does not require it. Co-administration of an H2 blocker and sucralfate provides no therapeutic benefit. Misoprostol is an analogue of PEG_1. It enhances mucosal blood flow. This action stimulates bicarbonate secretion, mucous production, and epithelial cell turnover. It also binds to the prostaglandin receptor on the parietal cell to inhibit the Na/K/ATPase pump. It can stimulate uterine contraction, so is not to be handled by women of child-bearing age.

Motility disorders

Motility in the GI tract functions to mix and break down material, coordinate pyloric and duodenal contraction, and relaxation after ingestion of a meal. There are two types of motility. Rhythmic motility is caused by contractions of the circular muscle layer and increases resistance to flow. These segmented movements allow for GI transit time for digestion and absorption of nutrients. Peristalsis occurs when there are longitudinal muscle contractions and these move food forward. Regulation of motility is governed by the parasympathetic nervous system. Acetylcholine is the primary neurotransmitter involved in signaling muscle contraction. Adrenergic stimulation inhibits gastrointestinal transit. Motility disorders, including gastric transit disorders, can predispose a patient to gastric ulceration, regurgitation and aspiration. In addition, these patients are nauseous and do not want to eat. Critically ill patients often suffer from ileus, which can be caused by nervous system, metabolic, electrolyte, or infectious causes and derangements. Prokinetic therapy helps move things along.

Prokinetic drugs

The prokinetic drugs of mention are: metoclopramide, cisapride, and erythromycin. *Metoclopramide* enhances the release of acetylcholine and thus increases lower esophageal sphincter tone, increases strength and timing of gastric contractions, and has some duodenal motility effects as well. It does not work on the distal small intestine or colon. Some concern exists in administering metoclopramide to patients who have not had GI obstruction ruled out. Prokinesis may cause an intussception or GI perforation. *Cisapride* is rarely used in critical care, but stimulates the distal small intestine and colon. It also increases lower esophageal sphincter tone and promotes gastric emptying. It is 8 times more potent than metoclopramide. It only exerts local GI effects, as it does not pass the blood-brain barrier. However, it cannot be given parenterally. Finally, *Erythromycin* is somewhat of a novel prokinetic. It is chemically a marolide antimicrobial drug, but has some effects on motility at low doses. It is a motilin agonist. In cats it increases lower esophageal sphincter tone. It causes increased gastric, duodenual, jejuna, and ileal contractions. The prokinetic dose is 1/10 the antimicrobial dose. It has relatively few side effects and is typically used if other prokinetics do not work.

Diarrhea

Diarrhea is a multi-faceted syndrome caused by increased fecal volume and expulsion. There are two forms of diarrhea, large bowel and small bowel. Small bowel diarrhea occurs in the small intestinal segments, and large bowels indicates disease of the colon. Small bowel diarrhea is characterized by large volume diarrhea. There is minimal straining (tenesumus), and rarely hematochezia. Weight loss is often a common clinical finding. Decreased fecal volume, tenesmus, hematochezia, increased frequency, and mucousy stools are indicative of large bowel diarrhea. There are four general types of causes for diarrhea. Secretory, osmotic, hypermotility, and inflammatory types exist. Secretory diarrhea refers to excess secretion, and decreased absorption, of certain nutrients, like anions. Osmotic diarrhea exists when large molecules (sugars, etc) are present in the intestinal lumen and pull water content into the GI tract. Hypermotility diarrhea exists when there is decreased GI transit time. Finally, inflammatory diarrhea occurs with inflammatory diseases leaking protein in the bowels. Diarrhea can be very uncomfortable and cause significant fluid nutritional deficits include hypovolemia and dehydration, hypoproteinemia, and electrolyte derangements.

Anti-diarrheal drugs

The drugs covered in this class are sulfasalazine, tylosin, and metronidazole. *Sulfasalazine* is a colonic anti-inflammatory drug. It is two parts (a sulfapyridine and a salicylic acid) bound together. Bacteria of the colon cleave the bond and allow the drug to take effect. The salicylic acid portion (mesalamine) probably has local anti-inflammatory effects. It is a sulfa drug and thus can cause KCS. *Tylosin* is a macrolide antibiotic used in diarrhea. If tylosin solves the diarrhea component, it is typically termed “Antibiotic-Responsive Diarrhea” or enteritis. *Metronidazole* is an antibiotic with primarly gram-negative and anti-protozoal properties. It is effective in giaridasis and also have local anti-inflammatory effects. It has typically minimal side effects if used at proper doses. Higher doses may cause neurologic signs including vestibular syndromes.

Table 1- GI drug formulary

Drug	Route	Frequency	Dose	Indication
Metoclopramide	IV, SC, PO	PO/SC: q6-8h IV: CRI best/24h	PO/SC: 0.1-0.4mg/kg CRI: 1-2mg/kg/d	Vomiting, Ileus
Ondansetron	IV	6-12h	0.1-0.2mg/kg	Vomiting
Dolasetron	IV	SID	0.5mg/kg	Vomiting
Apomorphine (Dogs)	IM. IV, Conjunctival	Once	IM: 0.04mg/kg IV: 0.03mg/kg Conjunctival: Portion of tablet	Emesis
Xylazine (Cats)	IM	Once	0.44mg/kg	Emesis
Famotidine	SC, IV, PO (IV in cats	12-24h	0.5mg/kg	Hyperacidity

	considered a low risk-idiosyncratic rxn)			
Ranitidine	PO, IV	12h	1-2mg/kg	Hyperacidity, Ileus
Omeprazole	PO	24h	0.5-1mg/kg	Hyperacidity
Pantoprazole	IV	24h	Dogs: 0.7-1mg/kg	Hyperacidity
Sucralfate	PO	8h	Dogs: 0.5-1g Cats: 0.25-0.5g	Hyperacidity, Esophagitis
Misoprostol	PO	8h	Dogs: 1-5ug/kg	NSAID OD
Cisapride	PO	8h	Dogs: 0.5mg/kg Cats: 0.1-1mg/kg	Megacolon, Ileus
Erythromycin	IV, PO	8h	0.5-1mg/kg (IV off label on dogs/cats, Labeled in horses)	Ileus
Sulfasalazine	PO	8-12h (24h in cats)-Caution b/c contains salicylates	Dogs: 20-30mg/kg Cats: 10-20mg/kg	Diarrhea
Tylosin	PO	12h	10-20mg/kg	Diarrhea
Metronidazole	PO, IV	8-12h	Dogs/Cats (PO): 15-25mg/kg Dogs/cats (IV): 10-15mg/kg	Diarrhea, Sepsis

All doses are for dog and cat unless otherwise specified-Plumb's Veterinary Drug Handbook, 6th edition

References available upon request.

Understanding Endocrine Testing

David Liss, BA, RVT, VTS (ECC, SAIM), CVPM
Platt College
Los Angeles, CA

The endocrine system is complex and sometimes poorly understood. Although veterinary technicians are often involved with preparing and submitting endocrine tests and caring for patients with endocrinopathies, it may be difficult to understand what is happening in affected patients. Understanding endocrine testing can greatly enhance a technician's role in helping to manage endocrinopathies.

Thyroid Disorders: Hypothyroidism and hyperthyroidism

The thyroid gland, pituitary, and hypothalamus form part of a feedback loop that helps the body regulate thyroid hormone levels. The hypothalamus secretes thyrotropin-releasing hormone, which stimulates the pituitary to release thyroid-stimulating hormone (TSH). TSH signals the thyroid gland to release thyroid hormones, with the major ones being triiodothyronine (T_3) and thyroxine (T_4).

Hypothyroidism

Hypothyroidism—low levels of circulating thyroid hormones—can cause clinical signs. Hypothyroidism is reportedly the most common canine endocrinopathy. It is also rarely recognized in feline patients. Hypothyroidism is typically caused by thyroid gland failure, in which the gland atrophies (or is attacked by the immune system), causing a decrease in T_3 and T_4 production. Rarely is hypothyroidism caused by a pituitary or hypothalamic condition.

In patients suspected of having hypothyroidism, concentrations of the following hormones are typically tested: total T_3, total T_4, free T_3, free T_4, TSH, and anti-thyroid autoantibody hormone. Because total and free T_3 concentrations are not typically used for diagnosing hypothyroidism, they have been excluded from this discussion.

The total T_4 concentration is typically used as a screening test, meaning that if the level is low, further testing is needed. Because the total T_4 concentration refers to both bound (to proteins) and unbound (biologically available) portions of the total amount of T_4, other factors can affect its measurement. Patients that are critically ill or undergoing certain drug therapies can have a low total T_4 concentration but a normal biologically active free T_4 concentration. Thus, if a patient has a low total T_4 concentration on routine blood work, follow-up tests should be performed.

The free T_4 test correlates highly with clinical illness but should be performed only if measurement is by equilibrium dialysis, which is more accurate for detecting hypothyroidism than the total T_4 test.

The TSH level can also be measured. If the thyroid gland is not functioning and circulating thyroid hormone levels are low, the TSH level should be high. However, the accuracy of the TSH assay for detecting hypothyroidism is quite low. Although the TSH level would be expected to be high if hypothyroidism is present, this level can often be high, low, or normal.

Therefore, hypothyroidism cannot be diagnosed based on a TSH level alone, and errors may occur when the free T_4 and TSH levels are interpreted together; however, a low free T_4 level combined with a high TSH level is highly predictive of hypothyroidism.

Patients with an autoimmune component to hypothyroidism (autoimmune thyroiditis) can have elevated levels of thyroid hormone antibodies, which can be measured as a high thyroglobulin autoantibody titer. An elevated T_3 or T_4 autoantibody titer results in a high thyroglobulin autoantibody titer. If a patient has a slightly low total T_4 level and a low free T_4 level, measurement of antithyroid antibodies is indicated. However, these parameters are not routinely measured because the presence of thyroglobulin autoantibodies does not change the approach to treatment.

Hyperthyroidism

Hyperthyroidism is common in cats. Affected patients often have cachexia, hyperactivity, polyuria, polydipsia, polyphagia, hypertension, tachycardia, thyroid "slip" which is a palpable thyroid nodule. This thyroid nodule is typically a benign adenoma, however adenocarcinoma's are possible. These neoplasias cause heightened production of thyroid hormones. Most hyperthyroid cats have an elevated total T_4 level; however, this level may be in the middle to high range of normal. Therefore, testing the total T_4 level is somewhat useful for screening, but additional testing is often required to confirm clinical suspicion. As in dogs, testing the free T_4 level can confirm a normal (within reference range) total T_4 level in cats. Therefore, in cats, hyperthyroidism is indicated by either an elevated serum total T_4 level or a "normal" total T_4 level and an elevated free T_4 level.

Guidelines to Thyroid Tests					
	T_3 Level	Total T_4 Level	Free T_4 Level	TSH Level	Autoantibodies
Hyperthyroid	NA	Elevated or normal	Elevated	Decreased	Not present
Hypothyroid	NA	Decreased or normal	Decreased or normal	Normal to increased	Present if there is lymphocytic thyroiditis
Sick euthyroid	NA	Decreased or normal	Normal	Normal	Not present

Adrenal disorders

The adrenal glands are part of the interconnected hypothalamus, pituitary, and adrenal system, which is called the hypothalamic-pituitary-adrenal, or HPA, axis. The HPA axis functions to ultimately produce cortisol. Each part of the axis, down to the adrenal glands, secretes a hormone that triggers release of another hormone from a different area within the HPA axis. When cortisol is secreted, the body reacts by ceasing to produce the previous hormones. The hypothalamus secretes corticotropin-releasing hormone (CRH), which stimulates the pituitary to secrete corticotropin (also known as adrenocorticotropic hormone). In turn, corticotropin stimulates the adrenal glands to secrete steroids. The major steroids in the body are cortisol (an endogenous glucocorticoid) and aldosterone (an endogenous mineralocorticoid). When levels of endogenous steroids increase, their predecessor hormones decrease; this is called a negative feedback loop. When the cortisol level is high, CRH is inhibited and the corticotropin level decreases. Conversely, when the cortisol level is low, CRH is secreted and the corticotropin level increases.

Hypoadrenocorticism

Hypoadrenocorticism (also known as Addison disease) usually results from immune-mediated destruction of the adrenal glands. Clinical signs appear as affected patients become deficient in not only cortisol (a natural glucocorticoid) but also aldosterone (a natural mineralocorticoid). Rarely, dogs develop secondary Addison disease due to failure of the pituitary to secrete corticotropin, resulting in adrenal failure. In addition, hyperadrenocorticism patients receiving antiadrenal therapy can develop iatrogenic Addison disease. Adrenal dysfunction can be detected by measuring how well the adrenal glands respond to stimulation; therefore, the corticotropin stimulation test (also known as the adrenocorticotropic hormone [ACTH] stimulation test) is performed to diagnose this disorder.

Corticotropin is released from the pituitary during times of stress. When synthetic corticotropin or a gel form of corticotropin is administered, it stimulates the adrenal glands to produce cortisol. This response can be measured in an assay. Diagnosis of Addison disease involves measurement of an inappropriately low response to corticotropin stimulation. This definitively diagnoses hypoadrenocorticism because affected patients with a low basal cortisol level have no reserve when forced to respond to corticotropin stimulation.

Hyperadrenocorticism

Hyperadrenocorticism (also known as Cushing disease) involves overproduction of glucocorticoids and mineralocorticoids in the body. It is a complicated disease that can be caused by steroid therapy, a pituitary adenoma, or a functioning adrenal adenoma or adenocarcinoma. Most cases involve pituitary-dependent hyperadrenocorticism (PDH); fewer cases involve adrenal-dependent hyperadrenocorticism (ADH).

Several approaches may be used to test for hyperadrenocorticism. The differences are due to disagreement regarding which test should be used first and which tests should be used for confirmation. These tests have different sensitivity and specificity, so some are arguably better screening tests and others are better for confirming a result.

It may be beneficial to distinguish between PDH and ADH because a unilateral adrenal tumor may be surgically excised. The corticotropin stimulation test detects adrenocortical reserve and, therefore, sometimes reveals an elevated basal cortisol level and an exaggerated poststimulation cortisol level. Eighty-five percent of dogs with PDH have exaggerated postcorticotropin results, while 55% of dogs with ADH have the same results.

Diagnosis of hyperadrenocorticism not only relies on excess cortisol production but also must show decreased sensitivity to exogenous glucocorticoid administration. When Cushing disease is suspected, a spontaneously obtained resting cortisol level is not diagnostic because many factors can elevate a single cortisol measurement. The primary test used to investigate the ability of the adrenal system to manage exogenous steroid administration is the low-dose dexamethasone suppression test (LDDST), which uses the potent steroid dexamethasone at a dose that elicits a diagnostic response without affecting the laboratory machine measurement of cortisol, as dexamethasone does not cross-react with the assay. In a healthy dog, because the corticotropin system is based on negative feedback, administration of exogenous glucocorticoids suppresses the corticotropin system, resulting in lowered cortisol measurements. However, in an affected patient, the “low” dose of steroids fails to suppress the hypothalamic-pituitary-adrenal axis,

resulting in elevated cortisol measurements. Therefore, LDDST results showing failure to suppress (i.e., the cortisol level is elevated) at 4 and 8 hours after administration are diagnostic of hyperadrenocorticism. This test is fairly accurate for diagnosing hyperadrenocorticism. In 65% of cases, the LDDST can differentiate between PDH and ADH through observation of the response (i.e., the cortisol level) at 4 and 8 hours after administration. In patients with pituitary-dependent hyperadrenocorticism, cortisol production is temporarily suppressed after exogenous dexamethasone is administered. Thus, some suppression can be detected at 4 hours after administration, but the cortisol level (i.e., escape level) is exaggerated again at 8 hours.

A noninvasive option to help diagnose hyperadrenocorticism is the urinary cortisol:creatinine ratio (UCCR) test. This test reflects several hours of cortisol production even though the UCCR sample is collected from one urination. This test is highly sensitive making it a good screening test. Patients with normal UCCR values (ref range: <13 normal) are unlikely to have hyperadrenocorticism. Typically, the client collects the UCCR sample by free catch at home. This can eliminate falsely elevated test results due to the stress of a veterinary visit. It is recommended to collect two samples on two consecutive mornings, with the second sample collected on the day of the veterinary appointment. The results are analyzed and averaged. An elevated urinary cortisol concentration in relation to the creatinine concentration suggests hyperadrenocorticism, but this should be confirmed with another test, such as the LDDST or corticotropin stimulation test. Stress or concurrent infection can raise the patient's cortisol level, resulting in false-positive results. The UCCR test does not differentiate between PDH and ADH. Because test results from two consecutive days are averaged, diagnosis may be missed in patients with mildly elevated cortisol levels.

If initial diagnostic tests confirm a diagnosis of hyperadrenocorticism but are not definitive for differentiating between PDH and ADH, a high-dose dexamethasone suppression test (HDDST) can be used. This test administers 10 times more dexamethasone than the LDDST. The HDDST works on the premise that a high level of dexamethasone suppresses the corticotropin system in the presence of a pituitary-dependent tumor, based on negative corticotropin feedback, but does not suppress the corticotropin system in the presence of an adrenal tumor. With this test, if suppression is seen (i.e., cortisol levels are decreased from the baseline at 4 and 8 hours after administration), a diagnosis of PDH can be made. However, suppression does not occur in 25% of cases; therefore, if suppression is not detected at 4 or 8 hours, the test cannot differentiate between PDH and ADH. The preferred method for differentiating between ADH and PDH is visualization of the adrenal glands by abdominal ultrasonography.

The plasma corticotropin level can also be used to differentiate between PDH and ADH. Patients with pituitary tumors have elevated corticotropin levels because their pituitary oversecretes corticotropin. Patients with adrenal tumors have decreased corticotropin levels due to negative feedback mechanisms. The plasma corticotropin level test is expensive and difficult to perform because of the requirements for sample handling. However, this test can be useful as a final laboratory test.

	Test	Results Indicative of Hyperadrenocorticism	Basal Cortisol Level	Poststimulation Cortisol Level
Pituitary Dependent	UCCR test	Elevated cortisol level in relation to creatinine level		
	Corticotropin (ACTH) stimulation test	Possibly elevated basal cortisol level; elevated post-stimulation cortisol level	Possibly elevated	Elevated: exaggerated response
	LDDST	Possibly elevated basal cortisol level; elevated poststimulation cortisol level	Possibly elevated	Elevated at 4 and 8 h
	HDDST	Possibly elevated basal cortisol level; elevated poststimulation cortisol level; suppression evident only if PDH is present	Possibly elevated	Possibly elevated
	Corticotropin level test	Possibly elevated level		
Adrenal Tumor	UCCR test	Elevated cortisol level in relation to creatinine level		
	Corticotropin stimulation test	Possibly elevated basal cortisol level; elevated poststimulation cortisol level	Possibly elevated	Elevated: exaggerated response
	LDDST	Possibly elevated basal cortisol level; elevated poststimulation cortisol level	Possibly elevated	Elevated at 4 and 8 h
	HDDST	Possibly elevated basal cortisol level; elevated poststimulation cortisol level	Possibly elevated	Elevated
	Corticotropin level test	Low level		

References available upon request

Clinical Pathology and the Exotic Pet: Where do I Stick the Needle and What's with all those Nucleated Cells?

Mark Mitchell, DVM, PhD, DECZM
University of Illinois
Urbana, IL

Exotic animals are stoic by nature, and have evolved to mask their illness to avoid predation. This behavior can create a clinical challenge for the veterinarian. In some cases, an animal that appears clinically normal may have a terminal illness. Hematology can be used to evaluate these species to characterize their true physiological status and aid in disease diagnosis.

When working with small species, it is important to determine the volume of blood that can be safely collected from the patient. The blood volume of a reptile is approximately 5-8% of its body weight, while in birds and mammals it is 10%. In general, 1% of the total blood volume can be safely collected, which is approximately 0.5-0.8-ml/ 100-gr for the reptile, or 1 ml/100-gr for a bird or mammal.

Blood samples are routinely collected from the ventral coccygeal vein, ventral abdominal vein or jugular vein in lizards. The ventral coccygeal vein is located on the ventral midline of the tail between the coccygeal vertebrae. Anesthesia is not required for this procedure. The preferred site of venipuncture is 1/4 to ½ the distance between the vent and tip of the tail. Care should be taken to avoid the hemipenes in male lizards. The venipuncture site should be cleaned with an appropriate disinfectant to remove any excess organic debris. A 22 to 25-gauge needle fastened to a 3-ml syringe should be used to collect the sample. The length of the needle will vary with the size of the animal. A long needle (1.5-2") is often required to collect samples from adult male iguanas. The needle should be inserted perpendicular to the skin and directed towards the caudal vertebrae. Gently apply negative pressure as the needle-syringe makes contact with the caudal vertebrae. A large volume of blood can be collected from this site. The ventral abdominal vein is located on the ventral midline within the body cavity. The venipuncture site should be cleaned with an appropriate disinfectant to remove any excess organic debris. A 22-25-ga needle fastened to a 3-ml syringe should be used to collect the sample. The needle should be inserted at approximately a 15-30^{o} angle. Negative pressure should be applied once the needle is inserted. The phlebotomist should not be overly aggressive with this technique, as it may result in laceration or damage to the viscera. The jugular vein can be used to collect large volumes of blood from lizards. To locate the jugular vein, draw an imaginary line between the shoulder and tympanum. The phlebotomist will not be able to visualize the jugular, but the jugular vein is a sizable blood vessel. The venipuncture site should be cleaned with an appropriate disinfectant to remove any excess organic debris. A 25-ga needle fastened to a 3-ml syringe may be used to collect the sample.

Blood samples are routinely collected from the jugular vein, subcarapacial (azygous) vein, dorsal coccygeal sinus, or brachial vein of chelonians. Chelonians are the one group of reptiles that may require sedation to collect a blood sample. A dissociative agent (e.g., ketamine) or propofol may be used to effectively restrain the chelonian. A 22-25-ga needle fastened to a 3-ml syringe can be used to collect blood samples at any of the prescribed sites. The venipuncture sites should be aseptically prepared to remove any excess organic debris. The jugular vein is generally located on the lateral aspect of the neck approximately at the level of the tympanum. The subcarapacial vein lies dorsally over the cervical vertebrae and should be approached by inserting the needle at a 45^{o} angle over the cervical vertebrae in an anterior-posterior direction. The brachial vein is located on the posterior aspect of the forelimb at the level of the biceps tendon and can be used to collect blood from unsedated tortoises. The needle should be inserted perpendicular to the posterior aspect of the elbow and negative pressure applied immediately after penetrating the skin. The brachial vein is closely associated with lymphatics. The dorsal coccygeal sinus is located on the dorsal midline of the tail. The tail should be extended and the needle inserted on the dorsal midline in a cranial direction. Again, this site is closely associated with the lymphatics and a mixed sample may be collected.

Blood samples are routinely collected from the heart and ventral coccygeal vein of snakes. Cardiocentesis is the preferred method, and can be used to collect large volumes of blood. This procedure is routinely performed on snakes over 100 grams without sedation. Position the animal in dorsal recumbency and visualize the heart beat, which should be located approximately 1/3-1/4 the distance from the animal's head. The venipuncture site should be cleaned with an appropriate disinfectant to remove any excess organic debris. The heart should be isolated between the index finger and thumb to prevent movement. A 22-25-ga needle fastened to a 3-ml syringe may be used to collect the sample. The length of the needle will vary with the size of the snake. Insert the needle at a 45^{o} angle between the two ventral scales over the distal point of the beating heart (ventricle). Begin to apply negative pressure once the needle is inserted. Blood will fill the syringe corresponding to the heartbeat. The ventral coccygeal vein is located on the ventral midline of the tail. Collection of blood from this site is usually only possible in snakes greater than 4-6 feet in length. A 22-25-ga needle fastened to a 3-ml syringe can be used to collect the sample. The venipuncture site should be cleaned with an appropriate disinfectant to remove any excess organic debris. The collection site should be approximately 1/3 to 1/4 the distance from the anal plate. In male snakes, care

should be taken to avoid the hemipenes. Insert the needle at a 45^{o} angle between two ventral scales to the point of the vertebra. The needle may need to be "walked" along the vertebrae to collect the sample.

Blood samples are typically collected from the jugular, basilic or medial metatarsal veins of birds. A 25-26 gauge needle fastened to a 3-ml syringe can be used to collect samples from these sites. In mammals, the jugular, cranial vena cavae, saphenous, femoral or cephalic veins can be used to collect a sample. Needle size will depend on animal size (20-26 gauge needles).

Blood samples should be placed into appropriate collection tubes immediately after collection. Hematological samples may be placed into ethylenediaminetetraacetic acid (EDTA) or lithium heparin. Blood for plasma chemistry analysis may be placed into a lithium heparin vial. The plasma chemistry samples should be centrifuged immediately to separate the cells from the plasma. If the blood cells are not separated from the cell fraction, than glucose levels may be lower than normal, and phosphorus and potassium levels higher than normal.

The complete blood count routinely includes a packed cell volume (PCV), total white blood cell count, and a differential white cell count. The PCV can be used to assess general health and hydration status. In general, a reptile hematocrit should be 20-40, mammal hematocrit 30-55, and a bird hematocrit 40-55. Anemia in wildlife has been attributed to acute blood loss, chronic infections, malnutrition and toxicities. The erythron of an anemic animal should be evaluated to estimate prognosis.

Complete blood cell counts in reptiles and birds cannot be processed using an automated cell counter because of the presence of nucleated red blood cells and thrombocytes. The two most common manual techniques used to perform a white blood cell count for these species are using phloxine B stain and Natt Herricks stain. Reptile and bird blood cells are fragile and susceptible to damage when blood smears are made. Mixing 1 drop of 22% bovine albumin (Gamma Biologicals, Inc, Houston, TX, 77092) and 5 drops of blood prior to making a smear appears to stabilize the cell membranes and improve cell visualization.

The primary white blood cells of reptiles and birds are the heterophil, lymphocyte, monocyte, eosinophil, and basophil; mammals have a neutrophil instead of a heterophil. The azurophil is a cell considered to be similar to the monocyte and is generally found in reptiles. The heterophil is associated with the acute inflammatory response. Monocytes are common finding in chronic inflammatory responses. In general, the function of the other white blood cells is considered to be similar to those described for mammals. The reptile and avian thrombocyte is nucleated and similar in appearance to the lymphocyte. In general, the thrombocyte has an irregular nucleus and membrane margins, whereas the lymphocyte has an acentric nucleus and a well-defined cell membrane.

Pediatric and Reproductive Emergency Room Pearls

Garret Pachtinger, DVM, DACVECC
Veterinary Specialty and Emergency Center
Levittown, PA

Pediatric and reproductive emergencies are common in both general practice and the emergency room setting and can be both extremely rewarding for the small animal practitioner. This lecture will focus on evaluation, diagnosis, and treatment of both the pediatric and reproductive emergency patient.

Neonatal / pediatric emergencies

Unfortunately, just like cats are not small dogs, at times neonates and pediatrics are not just tiny adult dogs or cats either! There are significant differences in the diagnosis, monitoring, and treatment of neonates and pediatric patients compared to adult patients. For this reason, it is important that veterinarians become familiar with normal physical examination, hematological, biochemical, and radiographic values for this age range.

In veterinary medicine, the term neonate is typically used from birth to 2 weeks of age and the term pediatric refers to patients between 2 weeks and 6 months of age.

Neonatal / pediatric history

Common historical comments from the owners at the time of presentation include frequent crying, lack of/ineffective nursing, failure to gain weight, lethargy, and weakness.

Neonatal / pediatric examination

The neonate / pediatric examination is at times a challenge based on their small size. A pediatric stethoscope is preferred for auscultation. Several important differences will be emphasized as compared to adult patients.

- The rectal temperature at birth is lower than adult patients, 95–98.6°F. This temperature gradually increases to adult temperature (100-102.5°F) over 4 weeks.
- A physiologic heart murmur may be ausculted up until 12 weeks of age without a primary cardiac defect / concern. If the murmur is louder than expected or persists past 12 weeks, it is important to consider congenital disease. Other pathology that may result in a neonatal/pediatric murmur includes fever, sepsis, or anemia.
- Elevated heart rates in neonates (200 bpm in the normal neonatal puppies and 250 bpm in kittens) is common and decreases to more normal resting heart rates at approximately 4 weeks of age. The decrease happens as parasympathetic tone increases during that time.
- Neonatal respiratory rates are often increased as compared to adult patients. Neonates have a smaller tidal volume and increased pulmonary interstitial fluid, thus leading to a mild increase in both respiratory rate and effort.

Neonatal / pediatric clinicopathologic data

The neonate / pediatric bloodwork results can be quite normal, but differ considerably compared to adult patients. It is important to recognize these common differences so further testing and/or treatment is not instituted without need.

- The hematocrit (HCT) in neonatal puppies and kittens is lower than adult patients, reported to be 25-30% in the first 4 weeks of life, increasing to normal starting at 4-6 weeks of age.
- Neonates normally have a mild increase in bilirubin (0.5mg/dl; normal adult range 0–0.4)
- Alkaline phosphatase is often markedly elevated (ALP; 3845 IU/L, normal adult range 4–107)
- γ-glutamyltransferase likewise is also quite elevated normally (GGT; 1111 IU/L, normal adult range 0–7).
- Blood urea nitrogen (BUN), creatinine, albumin, cholesterol and total protein are lower in neonates compared to adults.
- Calcium and phosphorous are higher in neonates.
- Urine is isosthenuric in neonates as they do not yet have the ability to concentrate and dilute urine.

Neonatal / pediatric imaging

Radiographically, there are several anatomical differences as compared to the adult patient.

- The thymus is located in the cranial thorax on the left side. According to Miller's Anatomy the thymus "is relatively large at birth, grows rapidly during the first few postnatal months so that it reaches its maximum development before sexual maturity, or between the fourth and fifth postnatal months, just before the shedding of the deciduous incisor teeth. The thymus begins to involute with the changing of the teeth. Although the process is rapid at first, the organ does not atrophy completely even in old age." If this same opacity is seen in an adult patient, as compared to being normal in a neonate/pediatric patient, this would more likely represent pulmonary disease or a mediastinal mass.

- Pulmonary parenchyma has increased water content and appears more radiodense in neonates.
- Neonates have a mild increase in heart size as compared to adults.
- Neonates and pediatrics do not have prominent costochondral mineralization giving the appearance of the liver more cranial, sitting under the rib cage.
- Neonates and pediatric patients have decreased abdominal detail due to lack of fat as well as a normal, small volume abdominal effusion

Neonatal / pediatric venous access and alternatives

Intravenous (IV) access is the preferred route for fluid and medication administration and when possible, should be performed. In the event an IV catheter cannot be placed, placement of an intraosseous catheter is a reasonable alternative. Fluid or drugs administered by this route are rapidly absorbed into the circulatory system. The most common sites for intraosseous access include the trochanteric fossa of the femur, the greater tubercle of the humerus, the wing of the ilium and crest of the tibia. The author's preferred site for IO catheter placement is the proximal femur. The author commonly uses an 18–22 gauge hypodermic needle. Similar to an IV catheter, an IO catheter can should be placed in an area that is prepared in a sterile manner. When placing an IO catheter, the needle inserted into the bone parallel to the long axis of the bone. Following placement, the clinician should gently aspirate, then flush with saline to assure patency. The catheter is secured with a bandage, suture, or tape preparation. Intravenous access should be attempted as soon as possible following IO catheter placement, ideally within 2 hours to reduce the risk of complications from the IO catheter such as infection, inflammation, or even fracture.

Neonatal / pediatric fluid therapy

Neonates have a higher percentage of total body water, a greater surface area to body weight ratio, a higher metabolic rate, more permeable skin, decreased renal concentrating ability, and decreased body fat as compared to adults. For these reasons, neonates have higher fluid requirements and must be treated accordingly.

- Shock boluses of isotonic crystalloids are slightly higher in neonates, 30–40 mL/kg in puppies and 20–30 mL/kg in kittens as compared to adults.
- Maintenance rates of isotonic crystalloids are also slightly higher, reported to be 80–100 mL/kg/day.

It is important to keep the fluids warm due to the concern for hypothermic changes with large volume of potentially cool fluids in neonates and pediatrics.

Neonatal / pediatric supplementation

Hypoglycemia is common in these patients due to a combination of factors including inefficient hepatic gluconeogenesis, decreased liver glycogen stores, decreased intake, and loss of glucose in the urine as urinary glucose reabsorption does not normalize until approximately 3 weeks in puppies. Gastrointestinal losses such as vomiting, diarrhea, as well as lack of intake also can exacerbate hypoglycemia in neonates.

Critically ill neonates may require a dextrose bolus of 12.5% dextrose IV or IO (0.1 to 0.2 mL/100 g), followed by a constant-rate infusion of 1% to 5% dextrose in a balanced electrolyte solution to prevent rebound hypoglycemia.

Neonatal / pediatric temperature regulation

Neonates have a greater surface area-to-volume ratio, impaired shivering reflex and decreased vasoconstrictive ability as compared to adults and for this reason have an increased risk for hypothermia. Hypothermic patients should be rewarmed accordingly.

Neonatal / pediatric nutrition

If there is a concern for insufficient nutrition, often nursing from the bitch or queen, nutritional supplementation is recommended via alternatives such as bottle-feeding and tube feeding. Tube feeding is performed using a small suction catheter or a 5-Fr red rubber catheter for neonates under 300grams and an 8–10 Fr for larger neonates. It is important to confirm proper placement prior to milk administration due to the risk for placement in the trachea and subsequent pneumonitis or pneumonia. Puppies are expected to double their weight within 10 days of birth and gain 5–10%/day. Nursing kittens should also double their weight within the first 10 days of life and normal kittens gain 10–15 g/day.

Postpartum emergencies

Dystocia

Dystocia is defined as the inability to expel fetus from the uterus and birth canal at the expected time of parturition. This is an emergency that requires immediate attention to reduce both the risk of morbidity and mortality to the mother and fetus. Common causes for dystocia include a pelvic obstruction, an oversized fetus, fetal malpresentation, or fetal death. If possible, an attempt should

be made to manually remove the fetus if protruding from the vaginal vault. This is performed with a water-based sterile lubricant and gentle traction wearing sterile gloves. Instruments that may injure the mother or fetus should be avoided if possible.

For patients with dystocia it is also important to correct any fluid, electrolyte, calcium, and glucose imbalances. Oxytocin is commonly used, but important to understand the risks and why dosing currently is likely far less than what veterinarians used years ago. Excess dosing of oxytocin can lead to tetanic and unproductive uterine contractions, placental separation and fetal hypoxia. It is also important to identify obstructive dystocia, closed cervix, fetal distress, placental separation, uterine disease, an/or uterine rupture prior to administration of oxytocin. If ruled out, oxytocin can be considered at 1–5 IU SC or IM repeating in 20-30 minutes if ineffective. Calcium gluconate 10% as well as dextrose supplementation can also be considered if electrolyte support is a concern.

Uterine prolapse

Uterine prolapse may be seen during birthing or commonly within 48 hours following birthing when the cervix is open. Due to the risk of infection, trauma and necrosis, immediate therapy is warranted. If appreciated early in the process, digital manipulation can be attempted, replacing the uterus while the patient is under general anesthesia. If not found immediately, uterine tissue swelling prevents successful digital manipulation and additional therapy may be needed. Hyperosmotic fluids such as 50% dextrose or mannitol may decrease tissue swelling and assist with replacement. In more severe cases, an episiotomy or abdominal surgery are needed to manually reduce the prolapse. If infection or necrosis is identified, ovariohysterectomy is indicated.

Retained placenta

Placentas should pass within 15 minutes of each puppy or kitten. Retained placentas carry the risk for metritis. Clinical signs of a retained placenta and subsequent metritis include a foul smelling discharge, fever, vomiting, anorexia, and lethargy. While an astute owner may report the failure of the placenta to pass, this can also be confirmed via ultrasound. Treatment with antibiotics, oxytocin, or PGF2a can be considered.

Metritis

Clinical signs of metritis include anorexia, depression, lethargy, fever, and foul smelling vaginal discharge. Diagnosis of metritis is based not only on history and examination findings, but often confirmed via abdominal ultrasound. Additional diagnostic findings that can aid in the diagnosis include a complete blood count (leukocytosis with left shift) as well as a deep vaginal swab for culture and sensitivity.

Hypocalcemia

Commonly referred to as eclampsia, hypocalcemia is a fairly common condition in bitches, notably small breed patients, 2–3 weeks after delivery. It is uncommon in cats, but can occur. Signs of hypocalcemia include tremors, panting, stiffness, pacing, salivation and restlessness. As it progresses the patient may exhibit worsening signs including tetany, hyperthermia, tachycardia, and seizure behavior. The treatment of choice is 10% calcium gluconate; administered slowly with the patient monitored on ECG. The dose range is 0.22-0.44mg/kg administered slowly IV until signs improve. Other signs such as dehydration or hypoglycemia should be treated accordingly. Oral calcium treatment (500 mg TID per 20 lbs) as well as vitamin D (10,000-25,000 IU) should be continued throughout the rest of lactation with the recommendation of removing the puppies from the bitch and supplemented with milk replacer, at minimum for 12-24.

Mastitis

Mastitis is the term documenting inflammation of the mammary gland, commonly associated with infection. The most common bacteria isolated include *Staphylococcus* sp. and *Streptococcus* sp. Clinical signs may be localized to one gland or throughout multiple glands. The glands affected are often warm to the touch, painful, firm, and erythematous. Diagnosis is based on clinical signs, history, cytology of milk confirms, and ideally culture and sensitivity. Broad spectrum antibiotics that achieve good concentration in milk (cephalexin or clavamox).

References

Biddle D, Macintire D. Obstetrical emergencies. Clin Tech Small Anim Pract 2000;15(2):88-93

Davidson AP. Obstetrical monitoring in dogs. Vet Med 2003;6: 508.

Davidson AP. Dystocia management. In: JD Bonagura, ed. Kirk's Veterinary Therapy XIV. WB Saunders Co, Philadelphia, PA, in press.

Davidson A. Postpartum disorders in the bitch, queen & neonates. Western Veterinary Conference 2008.

Feldman EC, Nelson RW. Periparturient diseases. In: Veterinary Reproduction and Endocrinology. Philadelphia, WB Saunders, 1996.

Johnston SD, Root Kustritz MV, Olson PNS. The neonate - from birth to weaning. In: Johnston SD, Root Kustritz MV, Olson PNS, eds. Canine and Feline Theriogenology, 1st edition. Philadelphia: WB Saunders; 2001:146–167.

Johnston SD, Root Kustritz MV, Olson PN. Canine and Feline Theriogenology. Philadelphia: WB Saunders Co, 2001

Macintire DK. Reproductive emergencies, Atlantic Coast Veterinary Conference 2006

Smith FO. Postpartum diseases. Vet Clin North Am Small Anim Pract. 1986;16(3):521-524

Wallace MS. Management of parturition and problems of the periparturient period of dogs and cats. Sem Vet Med Surg (Small Anim) 1994;9(1).

Digital Imaging:
Is it Time to Make the Switch?

Anthony Pease, DVM, MS, DACVR
Michigan State University
East Lansing, MI

Diagnostic imaging has seen a huge technology shift in the last 10 years. Modalities that were not accessible to the small animal patient, such as magnetic resonance imaging, are now considered the modality of choice for neurologic examinations. This technology shift has caused a lot of confusion as well as questions about what modalities are used for which diseases and why. The purpose of this article is to explain the different modalities including conventional radiography, ultrasound, nuclear medicine, computed tomography and magnetic resonance imaging, their uses and the pros and cons of each.

Radiography is the oldest and widest used diagnostic imaging modality available. Since its discovery by Wilhelm Conrad Roentgen on November 8, 1895, several changes have been made. These changes include the use of screens to minimize patient dose while increasing the efficiency of information transfer from the x-rays to film. In addition, automatic processors were invented to speed the development of the film to generate an image. Computed radiography (CR) and digital radiography (DX) have been created to optimize contrast resolution and create a virtual image that can be stored in a computer, rather than on a shelf by creating a digital image. These modalities can be further divided into direct and indirect imaging. Direct imaging occurs when the x-ray photon directly strikes a detector to create an image. This will provide the greatest spatial resolution for digital images, but it is still less than screen-film combinations. Indirect imaging is when the x-ray photon interacts with a phosphor in the screen to transform the x-ray photon into light. The light can then expose the imaging plate with greater efficiency and minimal loss of resolution.

The choice of which system to buy will be guided by your needs as a practitioner. Digital, indirect radiography such as a charged coupling device, is inexpensive but provides a rapid digital image. This system generally comes with an x-ray table and a large device that works similar to a digital camera. Other forms of indirect and direct digital radiographic systems may have an imaging plate but are considerably more expensive. In exchange, for the added expense more detail and better imaging quality is obtained. Computed radiography is an indirect cassette based system much like conventional radiographs. When the cassette is exposed it is placed in a reader to generate the image. This can take around 45-60 seconds, but is mildly less expensive (depending on the number of cassettes required) and more versatile than most DX systems.

The main thing to avoid is the high-pressure salesperson talking of resolution. People will use the terms megapixels, pixel depth, and even line pairs per millimeter. The thing to remember is that all digital systems (with the exception of digital mammography) will have less spatial resolution than most film screen combinations. That said, it is not the spatial resolution we care about. Spatial resolution, the ability to see to objects of similar opacity next to each other, is not as importance as contrast resolution. Contrast resolution is the ability to see two structures of slightly different opacities next to each other. This is where digital imaging (direct and indirect) is superior. Because it is possible to adjust the grey scale on the images after exposure, the ability to identify small fragments, areas of mineralization or nodules within the lungs, is far greater with digital imaging modalities compared to conventional film. The choice of which vendor and technology is right for your clinic is difficult and it is recommended that you seek help from a board certified radiologist or advice from colleagues who have the system you are interested in, to guide your purchase choice.

The main benefit of digital is the change from the fee per image that we have grown accustom. Since there is no inherent charge for the images and since cost for storage of digital images is minimal, a three view radiographic study can become the norm rather than the exception. With the fee per image that we use to perform, the main problem is our diagnoses were limited by the client's ability to pay. A single lateral projection was all we could perform on a vomiting dog if the owner had cost constraints. Now, we can take 3 radiographs or even 9 radiographs with the digital radiographic system in the same time it took us to run 1 normal film through a processor. Also, gone are the days of repeat radiographs due to technique. This is eliminated using digital or computed radiography.

Radiography is the method of choice for rapid evaluation of the skeletal system and the thorax. Pulmonary edema can only be evaluated with radiography (be it computed tomography, digital radiography or conventional) and fractures, though seen with ultrasound and nuclear medicine, can best be evaluated with some form of radiographic technique. In addition, radiography can be used to give an overview of the abdomen. Unlike ultrasound, which will be discussed next, radiographs can help look at large gas filled structures that are not easily evaluated with ultrasound. Examples include gastric dilation with volvulus and mechanical obstructions. It is possible to identify these with ultrasound as well, but radiography remains faster and easier to make the diagnosis.

The idea of changing over to digital imaging is a daunting one, but much like when we switched to e-mail from regular mail, it is a necessary transition. No one uses a pen and paper much and tablets, iPads, smartphones and laptops are the norm in most hospitals. Computed or digital radiography provides innumerable benefits compared to conventional imaging, the best of which is access to specialists 24 hours a day for advice and guidance. Switching to digital means you will never be alone!

Making the Move from Technician to Lead Technician

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

Many veterinary technicians are elevated into a leadership position based on the exceptional skills they possess on a daily basis. However, fellow team members also wanted that position, and now resist the new role their counterpart is trying to fill. Attendees will learn how to develop RESPECT from fellow team members and overcome the resistance that can be felt for years if not dealt with.

A common scenario that occurs in practices throughout the United States is the advancement of a long time team member into a leadership role. Of course this seems absolutely logical; internal team members are familiar with the practice's policies and procedures. This person may have some of the skills needed to excel in this leadership position. However, the one skill most lack is the ability to overcome the resistance of fellow team members who also wanted to be elevated into a leadership position. Let us look at a few details to help the suffering leader to overcome obstacles and build respect from the team.

First and foremost, those being elevated, as well as those who were not, must realize that a leader is no one without their team, and a team needs a leader to help provide the vision to achieve goals. No leader is hero without the team; and no team achieves goals without leadership. With that being said, every organization must have a mission, vision and values statement which helps provide guidance to the entire team. If every team member is living and breathing the mission and vision, then the road to a positive environment built with respect for one another is being paved. If a practice does not have a Mission, Vision or Values statement established – no fear! The new leader is here to save the day!

Create a mission, vision and values statement

A mission, the vision and the values (MVVs) of a hospital are core competencies that must be integrated in every practice. MVVs set the structure, creating a positive culture, and goals that help define team member expectations. Without these, team members have no direction; they simply show up to work and complete the tasks assigned to them. Owners make it day to day, with no clear light at the end of the tunnel, and managers struggle to implement successful goals and policies to increase value in the hospital. The mission and vision should be evaluated every couple of years, ensuring that they are still in alignment with the beliefs of the owner.

Utilize the team to help establish the MVVs. Of course, the owners opinion is critical in the development of these, but so is the teams. If team members do not feel apart of this, they will not buy into it, they will resist it, and will in fact, will rebel against it. Seek team members opinions and implement it, then they will hold themselves accountable.

Leadership

Leadership, not just management, is vital to the success and growth of a practice. Leadership is influence. Leaders motivate team members into action, and inspire them to be the best that they can be. They guide through effective communication, and create an environment that facilitates teamwork.

Leadership is about character, behavior and actions (actions speak louder than words!). Every leader must look in the mirror; are the characteristics and behaviors that one is striving for (within the team) exhibited day in and day out (by oneself)? Through these characteristics, leaders compel individuals to pursue the mission, value and goals of the leader.

Exceptional leaders create environments where team members are empowered to communicate openly, voice their concerns, and make changes where necessary to produce an improved service. Inhibiting this environment can be detrimental.

Veterinary practice is a team business. A team is a simple concept: a group of individuals with different skills and attributes, which contribute the positive culture of the hospital. Effective leaders build teams that allow the business to succeed at all levels, including providing excellent patient and client care and maintaining a friendly and cohesive work environment, all while being able to create and maintain a profit for the practice. Leaders invite creative thinking from team members, and integrate this creative thinking into daily conversations. Creative thinking facilitates productive, problem solving team members that are not afraid to move outside the box.

Delegation/empowerment

Team members who are elevated into positions of leadership soon realize there are many responsibilities that come with the promotion. Too often, these newly emerging leaders feel it is their responsibility to get all tasks done themselves, and if they delegate, it will how signs of weakness or the inability to handle the job. The fact is: leadership is more than a one-person job; it is a team job. Therefore, effective leadership includes delegations and empowering team members to aid in the completion of tasks. Mangers can oversee tasks, and provide assistance to those in which the tasks have been delegated. When we choose not to delegate, tasks get completed late and often lack in completeness. This breeds disrespect from fellow team members, and stirs the pot for gossip. Develop respect by delegating and empowering the team, and make them feel proud (and accountable) for their contributions.

Training and continuing education

Every team member needs training in the veterinary practice. This starts the first day of employment and continues through the last day (which can be 5 years, 10 years, even 15 when we have a well managed team). Phase training must be implement to ensure potholes are not created in the road we are paving. Ask team members to help create this phase training program (cover all position AND lengths of employment) and gain respect by asking them to help implement it. They can train and be accountable for their new team member. In addition, they will understand the need for continuing education, even in seasoned team members.

Leveraging

Who does what in the hospital? All team members drive passive income (DVMs drive active income), so be sure each team member is completing the tasks that they have the capabilities to do. Does a team member seem disengaged? Ask why and what responsibilities they could take on that would ignite the passion again. Leveraging team members drives income, client retention, and team member respect.

Recognition

Team members receive energy through recognition. Team members should be recognized for a job well done as soon as it is warranted. Many team members only hear of mistakes they have made and the necessary corrections and never hear about the excellent quality of work they produce. Positive situations need to be recognized and brought to the attention of all team members so they can all benefit.

Don't give up with the first failure. Developing respect comes with overcoming adversity and having resilience. Being an outstanding leader comes with time, patience, and many mistakes. A respected leader accepts criticism well and builds character and moral values based off the criticism. In addition, the leader takes the fall for the team when applicable and gives all recognition to the team for successes.

Technician Accountabilities that Enhance Productivity

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

Veterinary team members can drive approximately 50% of the practice revenues, yet often don't realize how much they actually contribute, or ***can*** contribute. The team drives client compliance, client retention and referrals. Attendees will be exposed to 6 tools and scenarios that help drive practice productivity, which can be taken back into the practice and used immediately.

When practice income is analyzed, it can be broken down into two segments; active and passive income production. Veterinarians that diagnose, prescribe and perform surgery produce active income. Passive income is produced by the remainder of the team (receptionists, kennel assistants, veterinary assistants, veterinary technicians) through appointment booking, client education, treatments of hospitalized patients, generating radiographs and performing dental prophylaxis procedures, just to name a few. A well-managed practice with a strong performing team can produce 50% of the income; however, veterinary technicians must excel at communication, client education, and have leadership abilities (leading clients) in order to drive this income.

Communication

Communication is essential to the success of the veterinary hospital. Team members must be able to communicate clearly with each other, as well as educate clients with clear and concise information. Team members must communicate clearly regarding treatment plans, ensuring that patient care is a priority. These treatment plans must then be communicated clearly to clients, making sure they understand the importance of the recommended care. Excellent communication will increase team member satisfaction, client compliance and client retention.

A message is composed of three parts: verbal, paraverbal and nonverbal. The verbal component of the message includes the words that are chosen to relay the message, and is responsible for 7% of the message. The enunciation of words and the tone of voice used to relay the message is the paraverbal component and contributes to 38% of the message. The remaining 55% of the message is the nonverbal component, and refers to the body language displayed while talking to another person or persons. Most people think that the words chosen to relay a message play the largest component of a message, when in fact, the body language portrayed dominates. If a listener is confused about the message being sent, they will respond more so to the body language being demonstrated than the words being spoken (actions speak louder than words!).

Client education

Client education is obviously a piece of communication, as education will not occur without communication. However, the way we educate clients can make or break a relationship that drives production.

There are several learning styles that have been identified, three of which apply to the veterinary setting: visual, verbal and tactile. Visual learning involves the use of pictures, images and spatial learning. Verbal utilizes words, both in speech and writing. Tactile uses hands and a sense of touch.

Since we cannot identify which client learns by which style, it is important to incorporate a small amount of each into our educational plan. Consider the items available to you in the practice to educate clients: manufacture brochures, client education handouts, models and videos. We must always send home information with the client; therefore, we must verbally review written materials. Most of the written materials will have pictures or images included, so we have covered the verbal aspect and a bit of the visual. Now include the use of models (many models are available for free from manufactures, or they can be purchased in the exhibit hall). Let the clients feel and touch as you verbally explain the service or procedure. Third, show a short video (watch it with the client, don't walk out of the room). As a final touch, email the video to the client (you may also ask if they would like the client handout emailed to them; if it is on their smartphone, they can review it anytime!).

Clients must hear a message three times to absorb the information; these methods address the different learning styles and repeat the message(s) subtly. Clients must understand a procedure and the value of it, or they will decline the service. In fact, 8 out 10 clients will decline a service not due to money, but because they are confused or do not understand the need.

Positive culture

Positive cultures generate a harmonious environment; team members enjoy working with one another, respect flows through the team, and clients build strong and loyal relationships. When a negative culture exists, clients "feel" it. It is cold when they enter the practice, team members snap at each other, and the employee turnover rate is exceptionally high. Due to these 3 simple factors, client trust and bonding rates drop and compliance falls, both having a direct relation to driving referrals and increasing the number of active clients.

Team members must stop gossip, facilitate teamwork and respect all team members to help drive a positive culture.

Leveraging staff

The veterinarian's job description is rather simple: diagnose, prescribe and perform surgery. Therefore, when veterinarians are trimming nails, expressing anal glands, filling medications and taking radiographs, the income production will likely drop. In addition, when team members are unable to perform the functions they have been trained to do, team member satisfaction decreases and the turnover rate increases.

Team members must perform duties that their position specifies. If team members are lacking in the skills needed to complete tasks, continuing education should be sought, whether online or at an event. Often, team members must step up and show their enthusiasm to learn and complete these tasks.

Continuing education

Veterinary technicians never quit learning. There are always new drugs, equipment, or emerging diseases. In addition to these hard skill enhancers, team members should also learn soft skills that enhance their personal and professional lives. Soft skills include (but are not limited to) communication, customer service, and leadership. Continuing education ignites passion and decreases the risk of burnout.

LEADership

Every team member is a leader. They may not be a practice or office manager, but they do lead client's everyday. In addition, the actions that each leader emits can persuade a client to accept recommendations being made, or can make them reject any recommendation being made. Actions speak louder than words, and those with confident, respected actions will drive income through the roof.

Becoming the Indispensable Team Member

Heather Prendergast, RVT, CVPM
Synergie, LLC
Las Cruces, NM

We can all be replaced…. *or can we?* If you left the practice, would you be rehired (in an instant)? Yes, technically, we *can* be replaced, however, creating shoes that are hard to fill is always a desirable trait. What do you bring to the exam room table, or perhaps the better question is, what are you not bringing to the table? Attendees will learn how they can become the superstar of the hospital, and inspire others to do the same.

Mission, vision and values of the practice

Identify the mission, vision and values of the practice. Live and breathe these statements day in and day out, with every client, every time. If your practice does not have a mission, step up and ask leadership if you can lead the development of one. A mission defines *why* you come to work everyday. It provides guidance and structure for the practice. What is the vision of the practice? Where will the practice be, and what does the owner *want* in 2 years, 5 years, and 10 years? If you do not know what the vision is, how can you help obtain these goals? Determine what the vision is, and contribute to achieving those goals everyday. What are the core values of the hospital? Compassion, empathy, accountability, or respect? Team members must exhibit these values 100% of the time, to *both* clients and team members.

Client service orientation

Every team member must be customer service oriented. This is a service-oriented industry, and therefore, every client must be satisfied with your performance every time. Do clients know your name? Do they ask for you when they call or come into the practice? Do you provide such stellar service that they compliment you to others? These are great questions you can ask yourself, before asking for a raise. Team members that positively influence clients through education drive client compliance through the roof. Start with wearing a name tag or have your name inscribed on your scrubs. Second, look professional! Never wear stained and wrinkled scrubs. How is a client ever to take you serious, when you look "frumpy"? Next, evaluate your communication platform.

Communication

Communication is they key to success, and must occur with both team members and clients. Evaluate the words you use on a daily basis. Are they professional, and do they communicate respect? Is your enunciation of words clear or do you include slang in your vocabulary? Does your tone of voice convey respect or does it degrade the listener? Before answering these questions, it is strongly encouraged to record your conversations over a period of days and evaluate them. Knowing you are recording your conversations is going to subconsciously change the communication pattern (until it is forgotten about); once forgotten, then you can truly evaluate yourself.

Pay attention to key phrases you may be saying, but completely unaware of. Consider these three words: "*I don't know*". Now consider the negative effect that these 3 simple words can have on a person asking a question. Most commonly, the tone of voice used when uttering these words is negative. It may add to the message that you are lazy and unwilling to find an answer; perhaps you are too busy, or you simply don't care. Regardless, the end result is the same; a negative message has just been conveyed. Rather than stating, "I don't know", reply with, *"that is a great question, let me find an answer for you!"* The tone of voice changes, resulting in a positive message to the person asking the question. This applies to both team members and clients.

Evaluate yourself for the nonverbal language that is exhibited. Nonverbal communication dominates the message being sent, accounting for 55% of the message, while words contribute 7%, and enunciation and tone of voice contribute 38%. Do you stand tall, walk with a peppy step and portray a positive self-image? Facial expressions subconsciously communicate our true internal feelings. Are your facial expressions communicating a positive or negative message? If your practice has security cameras, ask management to view those recordings and evaluate yourself for positive and negative nonverbal cues you may be exhibiting.

Respect for one another

Every client and team member deserves respect. Each person has different strengths and weaknesses; you may be great with treating patients while another team member is incredible when it comes to client entertainment. There is no need to publicly ridicule a person for a weakness that they posses, however this is often the case in the practice setting. On the flip side of the coin, rarely do team members compliment fellow team members on strengths they exhibit. Be the first in your hospital to compliment others for their strengths, while evaluating your own. What weaknesses can you improve, in order to gain the respect of others?

Respect for one another develops a positive team culture and an incredible team dynamic. Teams that work well together have higher client satisfaction, client retention and client compliance, in addition to increased team moral. Ask yourself if you are breaking down this phenomenal dynamic, or contributing positively, day in and day out.

Respect for one another is not sharing gossip; it is being the person to stop the gossip from flowing through the hospital. Do not talk about other team members unless it is a positive statement; likewise, never talk about clients to other clients. Gossip results in a toxic workplace, and a toxic employee.

Learning motivation

How motivated are you to learn new concepts and apply them to the practice? Take a good look in the mirror before answering this question. We may say we are the motivated learner, but the answer most often heard when trying to implement new concepts in the practice is "*we have done it this way for years, why do we have to change?"* Now ask, do you eagerly accept change and apply yourself, or does your 'nonverbal communication' suggest otherwise?

Now consider personal education. What steps are you taking to improve your value to the practice? Do you take courses online or at a local community college? Have you considered taking your career to the next step (approved veterinary assistant, a credentialed veterinary technician, a veterinary technician specialist or a CVPM)? It is not necessarily the practices role to push you to improve yourself. Take the first step and become a life long learner, and enhance your value.

Influential personality

Being an influence on others can have two outcomes: positive or negative. In the veterinary practice, we influence both team members and clients, and if either is negative, it affects the other. If we have a negative effect on team members, clients "see and hear" it. If we have a negative effect on clients, team members "see and hear" it. A positive influential personality is exhibited by a person that is professional, speaks with a positive tone of voice, carries themselves with pride and is willing to take a few extra minutes to educate (both clients and team members). Being a positive influence on others is contagious and leads to a positive team culture.

Work ethic

If management were to rate you on work ethic, would it be strong, mediocre, or poor? Work ethic, as defined by Wikipedia is a value based on hard work and diligence. It is also a belief in the moral benefit of work and its ability to enhance character. A strong work ethic includes being reliable, having initiative and pursing new skills. Breaking this down further, being reliable includes accountability. Are you on time or early for your shift or required meeting, every time? Are you accountable for your actions, or do you consistently blame others (*actions do speak louder than word*s)? Having a mediocre work ethic is unacceptable, it must be strong, and include motivation, passion, and ambition.

Resilience

Resilience is the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress - such as family and relationship problems, serious health problems or workplace and financial stressors. It means "bouncing back" from difficult experiences. It is behaviors, thoughts and actions that can be learned and developed by any team member. Consider how you respond to adversity in the work place, including constructive coaching, difficult clients and the loss of patients. Does your 'nonverbal communication' indicate you are angry, in a bad mood or offended? A resilient team member takes the adversity, builds a positive response and implements change to compliment the situation at hand. This resilience builds confidence in character, enhances communication and problem solving skills. Every person experiences adversity in life; it is your choice how you chose to deal with the event.

Empowerment

Do you possess the soft skills described above, and allow leadership to delegate tasks to you? More often than not, leadership does not delegate as they should due to the lack of soft skill qualities in team members. Increase your value to the practice by accepting skills that can be delegated. Before asking for these tasks, analyze yourself for *accountability*: can you accept tasks and complete them with 100% by the due date? *Resilience*: can you accept constructive criticism to improve the task, realign yourself and bring back a new and improved task? *Work place ethic*: do you give 100% all the time (or do you just "look" busy?) *Influence:* can you positively affect fellow team members with your newly delegated task, or will you negatively affect others with an "I am better than the" attitude? *Learning:* are you willing to learn in order to enhance the effectiveness of the task, or will you just complete the task? How can this task help achieve the vision of the practice? All soft skills tie into successful delegation, which results in an empowered employee.

Listening skills

How well we listen often dictates the outcome of the message being given. In today's society, we often finish sentences for others, anticipate what the next question is going to be, or have preconceived ideas of what the result of the conversation should be. The result is misunderstood messages, assumptions and sometimes, an intense conflict. Good listeners give their full attention to the person that is speaking (either clients or fellow team members). Eye contact is made, and preconceived thoughts and opinions are placed aside. It is important to listen to not only the words that are being said, but the nonverbal component as well. Identify if the speaker is closed

off or upset (closed, folded arms – protecting the core cavity), happy and engaged (facial expressions), stressed or annoyed (facial expressions and hand gestures). Enhanced listening skills build professionalism, integrity and value.

Organization

Not all team members have a ‘desk space’ to keep organized, and that is often how others judge the organizational skills of a team member. However, a desk space is not the only thing that can be organized. Consider organized *thoughts*. Team members that have an organized thought pattern have an increased ability to conceptualize, problem solve and make a sound judgment. They also have an increased ability to positively persuade others and complete tasks, whether delegated or not. Organization is a soft skill that can be built, enhanced and managed on a daily basis.

How Anthropomorphism, Communication, and Learning Theory Change Patient Perceptions of Common Procedures (Parts 1 and 2)

Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP
Leader Dogs for the Blind
Bloomfield Hills, MI

Anthropomorphism

Anthropomorphism occurs when humanlike characteristics are given to real or imagined nonhuman things. Some of the characteristics may include physical appearance where animals or objects are believed to look humanlike, emotional states where animals or objects are perceived to be uniquely human or have human like motivations. Anthropomorphism does not include behavioral descriptions of observable actions, therefore it is important describe objective actions that occur in a given situation rather than assuming what the motivation may be. Anthropomorphism is also not limited to non-human animals; it can be casts onto an object or a particular situation, for example: "my car loves to go fast, she's got a real attitude" or "my computer hates cooperating with me." At times, these assumptions may not always be inaccurate; however more information regarding a particular situation should be gathered in order to be certain.

So why do we anthropomorphize? Because it allows us to better understand, sympathize, control, predict or act on a situation that we can relate to. It may also occur when we are lacking social connection with other humans so we may compensate by creating humans out of non-human things. It is a way of coping with momentary or chronic loneliness. That being said all anthropomorphism isn't bad. Often it enhances the human-animal bond and strengthens the connection between people and their pets. It can create friends and family during times of depression and may offer a since of security when it is needed most.

Anthropomorphism has both positive and negative qualities when it pertains to better understanding animal behavior because it may have an impact on how we react to a given situation. It could also lead to a behavioral miss-diagnosis and thus inappropriate treatment may be issued. This can be problematic when pet owners inadvertently and/or unknowingly apply inappropriate actions and/or labels to companion pets. While there is no doubt that pet dogs and cats are intelligent we may overestimate that animal's mental complexity and true motivation for behavior. Therefore anthropomorphism should be avoided when pet owners, trainers, veterinarians and other animal professionals are attempting to better understand why a particular behavior is occurring. For example: many common canine behaviors such as aggression, mounting and pulling on a leash are described as the dogs attempt to become alpha however this assumption could be detrimental when it comes to treating the problem. Instead we as veterinary and animal professionals should rely on scientific facts to make decisions or a formal veterinary diagnosis before proceeding. It is important to assess the environment and context in which the problem behavior occurs in, minimize assumptions of the pet's emotional state and most importantly watch closely for signs of canine communication.

Communication

Canine communication eliminates "guessing" and anthropomorphism of assumed emotional states. For many of us it's easy to detect when a dog is happy and relaxed but what do fearful dogs look like? A relaxed, happy dog will have a soft appearance to their body, similar to puppies. They are more apt to bounce, bow, wiggle and jump. They should be social and highly willing to interact. The tail should be found in a relaxed neutral position or typical position for their breed and possibly wagging. Tail wagging in some cases can be difficult to interpret because it will not always indicate that the dog is happy, as we will discuss later. Other things to note will be the position of the ears, mouth and eyes. All should appear soft, the eyes should be bright not squinting or furrowed eye brows and the pupils should remain small. Happy dogs are generally easy to identify; however the signs that are somewhere between happy and relax to phobic with the possibility of aggression can be a little more difficult to sort. The signs of stress and anxiety that are found in the middle may be referred to as preliminary anxiety signs. There are several excellent articles and pictorials that have been designed to improve ability to read canine body language in a simplified manner (see the Ladder of Aggression by: Kendal Shepherd or Body Language of Fear and Aggression by: Sophia Yin). When assessing body language you will want to continue to watch the eyes, ears, body posture and tail for information. Although some changes can be subtle more often than not, they exist and most animals do their best to display them. The changes in body language may also be referred to as distance increasing signals. That is the animal's way of saying "no thank you," "I've had enough," or "I don't want to be in this situation." It is our job to read those signals and honor them. Some signs of stress and anxiety may include an overall tensing of the body, and a crouched or ducking position. Remember that dogs are highly dependent on body language to communicate, signs such as turning their head away, turning their body away, backing up and trembling can be displayed by the dog in an anxiety causing situation. Another sign to watch for is the wet dog shake also referred to as the full body shake. This is an anxiety sign that is thought to be offered as the dogs stress level is decreasing. Keep a close watch on the ears and eyes for information too. One clear anxiety sign that we get from the eye is something that is referred to as "whale eye." Whale eye is where the sclera or white part of the eye becomes more prominent. It is demonstrated by a moon shaped appearance in the lateral or medial aspect of the sclera. Whale eye is most typically observed as the dog turns his head away.

In certain breeds this sign may be difficult to appreciate do to variations in confirmation or the amount of facial hair that covers the eyes. The ears can also offer a lot of information depending on their position. Ears that are low or flattened indicate signs of stress and concern. Again, depending on the confirmation, ear position may vary, so while ears do give us a lot of information they should not be assessed alone. The mouth also says a lot about how a dog is feeling. Yawning, lip licking, whether it s a quick tongue flick or a full mouth swipe, and tightly held lips are good measures of anxiety. Some of these behaviors occur very quickly and can be difficult to catch in action so it is important to watch the dog closely for noticeable changes in behavior. Lastly, take a look at the tail for additional information. As mentioned previously, tail wagging isn't always happy, in fact this could be one of the most misunderstood body language signs; that's why it is so important to assess the whole body not just one section. Typically a fast wag, similar to a windmill or a propeller that involves the entire body is indicative of a happy relaxed dog. Wagging that is slow and cautious with the tail held low is a little more concerning and may mean that the dog is unsure about the present situation. Rolling over exposing the belly is often misinterpreted as well. While some dogs do enjoy a good belly rub, for others this is truly a distance increasing signal. If the limbs including the tails are tightly close to the body this may not be the best time to rub the dog's belly. A spread eagle dog with loosely relaxed limbs is more likely to enjoy the belly rubbing interaction. The events leading up to the dog rolling over can also lend some information as to how the dog is feeling and whether this is a solicitation for a belly rub or way of saying "stay back." Again, remember to assess the whole dog, not just one aspect. If possible spend 5-10 seconds before approaching the dog to note subtle signs of communication. In some settings it will not be practical for medical staff to avoid interactions with fearful dogs, but learning their signs of stress will give you a different perspective for their present state of mind and allow you to consider a different approach. What can you do to decrease the signs of stress and anxiety? Increase distance between the dog and anxiety causing stimuli, use motivators to create a positive association, prevent, prevent, prevent and follow guidelines of scientific based learning theory.

Learning theory

Training is the process of modifying the behavior of an animal, either for it to assist in specific activities, undertake in particular tasks, or for it to participate effectively in contemporary domestic life. The basic paradigm of reinforcement and punishment is a breakdown of all training techniques; it gives a scientific explanation of how particular techniques are applied. When discussing learning theory 'positive' and negative are used as mathematic terms that imply an addition or a subtraction of a consequence. The terms 'reinforcement" and 'punishment' are often paired with the terms positive and negative to fully define the behavior technique. Reinforcement is used as a consequence to increase behavior; whereas a punishment is used as a consequence decrease a behavior. Positive Reinforcement (+PR) is likely one of the most popular terms; however its definition may not be fully understood. Simply, positive reinforcement can be explained as when a behavior offered results in receiving a desirable reward *or* added consequence. What is used for reinforcement? Adding something the animal finds motivating to strengthen or increase the frequency of a behavior. Giving the dog a treat for sitting in order to increase the probability that the dog will sit again is a good example of how positive reinforcement works.

Positive reinforcement can be further broken down into two separate techniques; classical conditioning and operant conditioning. Classical conditioning can be used to alter an animal's emotional response to a stimulus (ex: a response that is independent of voluntary control). Classical conditioning may also be known as Pavlovian conditioning; with this technique we are then able to take something that has no meaning to the animal, pair it with a reward, and teach the animal to have a conditioned emotional response, or a pleasant association with the stimulus. Common examples of classical conditioning are a dog's response when they see the leash; they assume it means a walk. Another example is a can opener. By itself the can opener has no meaning, however because it routinely opens cans of food, which then results in the animal being fed, thus the can opener becomes the conditioned stimulus. The application of this technique can then be used in behavior modification for everyday pets. A possible application would be to introduce a new puppy to a cage for the first time. If every time the puppy makes contact with the cage on his own, he is then rewarded, he will quickly make the association that the crate is indicative of a positive reward. Counter-conditioning takes classical conditioning to the next level. It is the process whereby an animal is trained to perform a behavior or response that is incompatible with the response that is to be eliminated when presented with the problem-evoking stimulus. In other words when a stimulus is present that the animal already has a negative association with it is then presented with something that is more appealing and desirable then the behavior that is normally offered. For this to be accomplished it will be important to first determine motivators for the animals and rank them from low to high levels. Depending on how negative the association is with the stimulus, the level of the motivator should be increased. Response substitution is considered a branch of counter conditioning; it uses a conditioned response such as a previously taught behavior to control the undesired behavior. The new behavior should be incompatible with the undesirable behavior, easy and enjoyable for the pet to offer. Dogs who are fearful of men are good subjects for the counter conditioning technique. In this application whenever the dog see's a man who would normally trigger the dog to have a negative response, they are presented with a highly desirable reward (from the trainer or owner and not the man), they may then be asked to complete an easy and well known behavior on cue such as sit. This sequence should continue while the man is present and discontinue when he is gone.

Thus, the presence of the man then becomes the predictor of a reward and a positive association is formed. Desensitization is often used in conjunction with counter conditioning; it is where an animal is gradually exposed to situations or stimuli that would previously bring on an undesirable behavior, but at a level so low that there is no negative response. It can be used to improve emotional perception towards any sound, item or situation. It is a slow process that yields long term positive results; however at intense levels accidental sensitization may occur.

Operant conditioning is the primary method by which training of dogs is achieved. It is dependent on a voluntary behavior being offered, and then it is followed by a reward. There are three primary methods that are used with operant conditioning which include shaping, capturing and luring. Shaping is defined as a force free method of training. It focuses on successive approximation, by deciding what your ideal final behavior should look like then slowly rewarding behaviors along the way until the end result is achieved. A conditioned reinforcer such as clicker can be helpful for shaping behaviors but it not necessary. If a conditioned reinforcer is not used then rewards are given alone to mark the desired behavior. It is Important to increase criteria as the desired behavior is achieved or decrease the criteria to help the learner if they are struggling. Shaping is a great training method to teach increasingly complex tasks however it can at times be a slow process. Capturing is another force free method of training. The focus in this training method is put on behaviors that occur naturally such as sit, down, lying on a side or cocking a head. Rewards can be given alone to mark the desired behavior or a conditioned reinforcer such as clicker can be used to accelerate the training process. Luring is likely the most popular method of positive reinforcement/ operant conditioning; it is the process that most trainers and pet owners gravitate to. Luring uses coaxing, prompting or guiding to achieve the behavior while still being a force free method of training. One downfall of luring is that the learner may catch on quickly but then may become dependent on the lure in this case it is best if the prompts or lure is faded out quickly. Like shaping and capturing a conditioned reinforcer can be used to mark the desired behavior.

Negative Reinforcement (-NR) is the process of removing something unpleasant to increase the frequency of the desired behavior or removing something the animal will work to avoid to strengthen or increase the frequency of a behavior. Heeling is traditionally taught using this method; corrections are given when the dog is in any other place but heel, removal of the unpleasant strengthens the desired behavior. Negative Punishment (-NP) is the process of taking away something the animal will work for to suppress (lessen the frequency of) a behavior. For example if dog jumps on you to get attention, by turning your back or leaving the room, you apply negative punishment by removing the attention they want.

Positive Punishment (+PP) is the process where the behavior that is offered results in receiving an undesirable consequence. Adding something the animal will work to avoid suppressing or lessening the frequency of a behavior is the basis for positive punishment. Common examples of positive punishment include yelling, spanking, shock collar (any kind), and assorted “booby traps.” It can be any action taken to interrupt or discontinue a behavior; it can be verbal, physical or any action that the learner perceives is unpleasant. Positive punishment is the most common type of training used, although it can be difficult for clients and animal professionals to be good at punishment. Punishment must be strong enough to be effective, for some animals this may be hard to achieve. Unintentionally; positive punishment could cause intense fear which may generalize and could lead to aggression. In order to be effective the punishment also must occur while the animal is performing an undesirable behavior and the immediate rewards may outweigh the future possibility of punishment. It can accidentally strengthen the undesired behavior or suppress other behaviors, thus leaving the underlying emotional state of the animal untreated. Punishment may lead to poor association and poor bond with the family or handlers. It teaches an animal what you don’t want it to do but fails to teach it what you expect of it.

Is some punishment ok? Yes, however the timing must be precise, the punishment must be consistent while not being too aversive. Some automatic punishment tools such as a Scat Mat can be used to extinguish an undesirable behavior but this method should only be implemented for non-fear based behaviors. Automatic punishment tools are also known as remote punishment devises or environmental punishment. Most importantly this process does not directly involve human interaction; instead the environment is rigged so that an unpleasant consequence occurs when the undesired behavior occurs.

10 Things Technicians Can do to Improve Animal Behavior

Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP
Leader Dogs for the Blind
Bloomfield Hills, MI

As veterinary professionals it is our duty to prevent or treat illness. In fact many of us chose this profession to better the lives of the animals that we are surrounded by. As the field of veterinary medicine continues to grow we continue develop new diagnostic techniques and treatment methods. With these developments it is only natural that our knowledge for our patient's mental health and well being expands too. Naturally we see patients that require our attention and we jump into action, whether they are in need of a preventative vaccine or to be prepped for a more in depth procedure. However, no matter how urgent the medical concern is, it is also important to remember the emotional needs of the patient as well. Learning to assess the emotional status of the patient will then allow you to prevent or treat stress as it occurs in a veterinary setting.

1. Know the statistics

Behavior problems continue to be the leading cause of relinquishment and euthanasia of pets in the United States; which research shows leads to approximately 224,000 pets being euthanized each year. For this reason it becomes integral for veterinary technicians to have a solid understanding of animal behavior. Bad behavior costs the veterinary hospital time and money due to the amount of staff that needs to care for a single patient and the risk for potential injury for employees. Another study reports that dogs and cats that were fearful, hyperactive, noisy, soiled or damaged the house, or escaped frequently were much more likely to be turned in to shelters. A separate study revealed that most dogs will leave their original home by their second birthday whether these dogs are re-homed or euthanized these occurrence will result in lost revenue for the hospital. A study by AAHA revealed that as many as 90% of dog owners noted one or more behavior problems that they would like to improve. This research suggests that we as veterinary professionals are not doing our part to help decrease these statistics. While so much focus is being put into the potential revenue lost, it may be more important to us these statistics to potentially make behavior profitable by adding services to the hospital that teach clients and their pets to prevent or improve problematic behavior.

2. Be an advocate for low stress handling

Veterinary visits are rarely enjoyable, and though there is often a treat made available upon checking check out at the end of the visit, it is typically not enough to make of the other unpleasant events worth being there. As a veterinary professional it is imperative to be constantly mindful of how stressful veterinary appointments and hospitalization can be. Therefore one of the most important low stress handling tools is having compassion and patience for the fearful patient. It is easy to become frustrated with patients that are difficult to handle and require more time. They may be reacting out of fear of previous negative experiences, or they may feel painful, defensive and vulnerable. It is our job as veterinary professionals to protect them, calm them and ultimately ease their pain. While working with any patient, staff should try using minimal restraint, minimal force while adding motivational elements to achieve the desired task. Becoming rough or aggressive with patients will likely not teach them to behave better, especially if the unwanted behavior you are seeing is manifested by fear. Try to stay calm, offer a soothing touch to patients that are frightened, treat all patients as you personally would wanted to be treated as a patient or how you would want another veterinary professional to handle your pet. Remember that actions such as growling and snapping are information and you should use that information to re-asses your approach and make that patient feel more comfortable. Avoid the "I can't let him get away with that" mentality, pursuing this thought process will likely make the patient more aroused and leave you feeling stressed or frustrated. Be proactive rather than reactive, these types of approach will likely yield better results. If you only implement low stress handling techniques on the worse patients, or wait until they are explosive and impossible to control, your rate of success will be poor. Remind yourself to start when the patient's anxiety level is minimal, this approach will give you a much higher success rate.

3. Label records and take notes

Now that all of the appropriate tools have been gathered to calm the apprehensive patient it is now time prepare the staff and the exam rooms. Start by determining the best way to label patient charts, in a manner that is easy to locate. It should describe in detail what concerns the patient may have in a professional and respectful manor. For example, avoid charting that this patient "hates men" instead it would be more appropriate to log "fearful of men" or "works best with women." By changing your wording, you can also change the emotional response you or other staff members will have with this patient. Remembering that it is important to have compassion for the fearful patient it will be your job to make the patient's trip to the veterinary hospital as pleasant as possible and ultimately successful. It will also be imperative to log what techniques or procedures have worked in the past and the ones that have not worked as well. Note, if this dog has someone in particular it works best with or does best in a particular area in the hospital. Demonstrating that your behavior logging system is easily implemented can impress clients and can teach them about having enjoyable experiences at your hospital, which will make them more likely to return. Notes about the animal's behavior should also be

made in the appointment book when the client is scheduled to come in. It would be a good idea to be prepared for that patient before they enter the building. If the patient is known to be reactive in the lobby, whether it is to other dogs or people you should recommend to the client that the dog wait in their car until their name is called, the patient should be brought in through a back a side door and escorted directly to their exam room. If the client were available to, it would also be ideal if this patient were scheduled at a time of the day when there is less traffic in the hospital.

4. Teach life skills to puppy owners

Socialization is a term that often gets over used yet underutilized. It may be term that is mentioned a lot but not completely understood however it plays an integral role in the prevention of behavior problems. Proper socialization could be considered a vaccination for behavioral problems later in pet's life, just as important as anti-viral vaccinations. One common thought is that puppies should not begin the socialization process (going classes, interacting with adult dogs, being introduced to new environments, etc.) before begin completely vaccinated. Traditionally, puppies complete their initial vaccination series around 16 weeks of age, incidentally, dogs are best able to form new relationships with those of their own species and other species and adapt to stimuli in their environment (habituation) during their socialization period, commonly considered to be between 4-14 weeks of age. So, if puppies are kept isolated during this period they may have a more difficult time being comfortable in new environments and around multiple species in the future. If they have not been properly socialized with people and other pets by the end of this period, they are likely to be fearful, defensive and potentially aggressive when exposed to them at a later age. How to appropriately introduce puppies to new people, places and things is the key to quality socialization. Socialization is more than just introductions, it's an art and a science. Although exposure is important, having a positive and pleasant experience makes the socialization enjoyable to the puppy. If the puppies are introduced to novel people places and things, and their experience is negative, then there is the possibility that the will learn to develop a negative association. Early and adequate socialization and programs of positive training can go a long way in preventing behavior problems and improving bonding between humans and dogs. While the first three months is the most important socialization period in a puppy's life, owners of puppies that have passed this milestone are strongly encouraged to continue to socialize their puppies to as many people, pets, and locations as is practical. However, owners of puppies displaying fear should seek veterinary guidance. The fact is more pets are likely to die because of behavior problems than of infectious disease such as parvovirus or distemper: so teaching your clients the importance of proper socialization is critical. Before the socialization process begins, the veterinary team set new families up for success by assisting them when they are selecting a new pet.

5. Teach life skills to kitten owners

Preventative behavioral care for puppies is far easier to remember to address than it often is for kittens; however addressing the behavioral needs for kittens is just as important. Teaching clients techniques to make husbandry such as nail trimming, grooming, medication administration, confinement and traveling will last cats a lifetime. These skills can be taught to kittens in a fun low stress manner that is enjoyable for the cat and its family. Administering medication to an adult cat can be a stressful event for both the cat and its owners. There are however several methods that can decrease the stress to make the medication giving process a pleasant experience. The duration that a cat may require medication can vary from just a few doses to life long. Long term medication administration can be especially stressful because of the frequent unpleasant interactions. Physical restraint and manual manipulation may not be unpleasant for all cats; but for many cats this interaction with its owner on a daily basis may deteriorate their bond, causing the cat to want to interact with its owner less or cause stress to manifest into other undesirable behaviors. There are easy solutions to make giving medication a hands-free process or if needed, the physical manipulation low stress. Being proactive and teaching kittens to take medication prior to needing it can set them up for a lifetime of success. Start by offering the kitten a variety of foods that include both hard and soft textures so that if medication needs to be hidden in food later on the cat is already keen to eat a variety of textures. Just as it was important to introduce kittens to novel foods early on in life it is just an important to expose them to physical handling, restraint and manipulation. When any of these techniques are practiced they should be done out of context prior to the cat actually needing to be medicated. Start by gathering a variety of dry cat food kibbles, crunchy and soft cat treats and pieces of real tuna or chicken. Use one hand to cup the kittens head and upper jaw. The index finger on the second hand will be used the open the cats mouth by placing the finger by the opening of the mouth, just under the cats nose but just above the lower incisors. The index finger will be used to open the cat's mouth while the other hand is holding the cats head in place. Now, drop a piece of the higher value food into that cat's mouth and release his restraint. The cat may seem unsure after this first interaction but with several more repetitions the kitten will quickly form a positive association with this process. It is recommended that each time the kitten is restrained and falsely medicated a variety of the pre-selected treats are being given. Teaching a new kitten to be comfortably confined while traveling is another skill that can be appreciated more as the cat ages. Cats that are fractious and too frightened to go into a cat carrier may result in missing out on veterinary care because of the owners desire to avoid this stressful interaction. This is not only the case for routine care, but treatment for early onset or less serious illness may be delayed in order to avoid having to place the cat in a carrier. Making the cat carrier a more permanent fixture in the home and a interactive part of the kittens environment will eliminate

the initial alarm and fear when the cat typically is presented and approached with a carrier, simply because the carrier will already be familiar to them. The door of the carrier should remain open so that the kitten has access to the inside. Toys, treats and soft bedding should be placed inside of the carrier so that the kitten is encouraged to seek this location out. Pet safe heated beds can also be placed inside of the carrier to introduce another valuable element. As it becomes more obvious that the kitten has deemed the carrier their sanctuary then it would be appropriate for the owner to begin closing and latching the door, then eventually picking it up and moving short distances. Lastly short travels in the car can be implemented but owners should remain mindful of the kittens comfort level while doing so. It the kitten shows signs of stress then earlier stages of the training process should be revisited before proceeding.

6. When to refer and who to refer to

Recommendations for behavior problems are readily available because animal behavior affects every animal owner. Behavior can be a conversation starter, it can be the one thing you have in common with an unfamiliar person, and it can be what builds the bond or breaks down the bond between a pet and their family. For that reason, when families begin to experience behavior problems with their pets it is very important to assist them in finding the appropriate help to remedy the problem. Sending a dog with behavior problems to the wrong person can be as dangerous as not recommending any treatment. Not all trainers and behaviorist are the same. Veterinarians are often the first professionals who are asked for help in improving a undesirable behavior. The veterinary technician can then help advise the owner which professional would be most appropriate to assist the family. Behavior professionals can include trainers, veterinarians, veterinary technicians, and veterinary technicians specialized in behavior, Board Certified Veterinary Behaviorist or a Certified Applied Animal Behaviorist. Clients may need additional help differentiating between each of these professionals, and selecting the right individual for the job. Dog trainers can be a good resource to help owners with their dogs. However, there are no licensing or experience requirements to be a trainer, meaning that there is no oversight of trainers or assurances that a trainer is using appropriate methods with each individual animal. In addition, there is no experience or licensing requirement for someone to call themselves pet behavior counselor or dog behaviorist. Therefore, owners must be careful when choosing trainers for their pets. Trainers can be very helpful in the role of preventing behavior problems. Hosting classes such as puppy socialization, puppy kindergarten and variety of levels of obedience and specialty training classes can assist clients with teaching manners and avoiding nuisance behaviors like jumping, pulling on a leash and basic commands. If the problem is well-defined and does not pose a safety concern, the veterinarian may refer the client to a trainer. If the problem is complicated, they may feel the pet needs a higher level of expertise such as a Board Certified Veterinary behaviorist or a Certified Applied Animal Behaviorist. Often the term “behaviorist” gets used very casually and it may be difficult to discern what the credentials of a behaviorist are. A Board Certified Veterinary Behaviorist is one that has a degree in veterinary medicine; they also have completed a behavior residency under a mentor, and passed board certification. Because they have extensive experience in animal behavior they are able to diagnosis and prescribe treatment for problems including, separation anxiety, aggression, inappropriate elimination, generalized anxieties, stereotypic disorders, cognitive dysfunction and several other problems in a variety of species. The veterinary behaviorist can fully evaluate the pet, both medically and behaviorally, and is trained to recognize where an underlying medical condition may either cause or contribute to a behavior problem. A certified Applied Animal Behaviorist (CAAB) is another professional that can assist pet owners with many of the same behavioral problems. CAAB's have two to five years of formal postgraduate academic education in the field of applied animal behavior resulting in the attainment of master’s degree (MS/MA) or a doctoral degree (PhD). It is important to remember that CAAB’s may not necessarily be veterinarians, so they are unable to prescribe medications for behavioral treatments. Than can however, be very helpful working closely with a veterinarian to obtain solutions to many behavior problems. The veterinary technician can be valued addition to a general practitioner or a Board Certified Veterinary Behaviorist. Technicians can assist the doctors by taking a detailed history and after a diagnosis and treatment plan is made, they can help the family implement and follow through with the techniques.

7. Build a behavior tool box

Being prepared for a reactive or aggressive patient will partially influence whether or not your experience and interaction were successful. Building a behavior tool box is like building a crash cart to assist in low stress handling. If there is a patient scheduled with a known history of aggression at the veterinary hospital, or it is determined that the patient you are working with is fractious and has the potential to have a negative experience, stop and prepare tools before continuing with the procedure. The tools used in each situation will vary from patient to patient. Ideally you should have a designated area in the hospital for your “behavior toolbox” this will save time and eliminate staff searching for necessary items when needed. Towels and blankets are one of the easiest tools to use when implementing low stress handling. They can be used to swaddle a patient, cover their head to decrease visual arousal or warmed to add comforting support. Muzzles are the most basic safety tools that should be added to the behavior toolbox. While the standard blue or black nylon veterinary or grooming muzzle can be helpful, it’s not the only muzzle you should reach for. A cage muzzle, also known as a basket muzzle, and an Air Muzzle should be added to your supply. Each of these muzzles are designed to prevent bites but should be implemented at different times and for each unique situation. The nylon muzzle is designed to fit snuggly around the

snout, and extend to or past the tip of the nose. They should be used only for limited portions of time, no more than 5 minutes. Due to the fit of the muzzle, it may restrict airflow and prevent proper ventilation by panting. If your patient is requiring to be muzzled for a longer period of time, then a cage muzzle or Air Muzzle will be a better option. A nylon muzzle should never be left on a patient while unattended or be used to prevent barking. The basket type muzzle can be implemented during procedures that will likely take longer than 15 minutes. This form of muzzle may be ideal for a non-aggressive patient that is being hospitalized and has attempted to chew his bedding, IV line and/ or bandage material. Cage muzzles come in various is sizes. A Calming Cap, by Thundershirt® is a hidden gem and a "must have" in a veterinary hospital. The Calming Cap is made from a sheer nylon material and is designed to cover the eyes of a fearful or fractious dog. The Calming Cap has elastic trim around the mouth opening that can conform to a variety of dogs and can easily be used in conjunction with a standard veterinary muzzle or basket muzzle. The goal of this product is to decrease visual stimuli by essentially filtering the dog's vision through the sheer fabric panel. The applications for this product are seemingly limitless. They can be used during any standard veterinary procedure such as a physical exam or nail trim. Calming Caps make excellent tools for patients that are being induced for an sedation or anesthetic procedure. Having the cap in place as they are falling asleep encourages their ability to relax; the same applies as they are waking up from anesthesia. The cap will decrease light and stimuli in the surrounding area allowing them to recover calmly and smoothly. The Calming Cap is also a great tool for hospitalized patients that are stressed by their stay, or aroused by other pets passing their kennel. For best results the Calming caps should be implemented proactively. A head halter is a tool that can be used to improve many unwanted canine behaviors. In general a head halter's abilities extend beyond controlling unwanted pulling or settling of an unruly dog. An experienced staff member can implement it in the veterinary hospital. This tool has been designed to assist in restraining an aroused patient by controlling its head (similar to the rationale of a horse's head halter). A head halter will not only assist with restraint but it can also calm the patient just by wearing it. If the restrainer has better control, the dog is kept calm, and there is less confrontation. The patient will ultimately have a better experience at the veterinary hospital. The head halter can also provide an opportunity to reinforce desirable behaviors by releasing tension on the mouth and by offering favored food treats if the dog is sufficiently motivated. Peanut butter, squeeze cheese and other soft, highly desirable, easy to administer foods are also "must haves" in the veterinary hospital. Although many of the patients seen in the veterinary practice may be too anxious to eat, they may be more motivated to do so if the food is somewhat rare, novel and highly desirable. Combining the peanut butter with a long handled wooden spoon makes the perfect set of behavior modification tools. The long handle allows the food to be offered to a fearful dog at a safe distance and the spoons can easily be sanitized after each use. By using food during the veterinary exam, dogs can be lured or shape-trained into performing more desirable behaviors. They can be quietly taught to sit, lie down, settle or even offer a paw to perform a procedure, all the while enjoying a favored food, being rewarded for good behavior and steadily decreasing their anxiety. Using food rewards each time a patient is brought to the hospital will teach them to have a positive association with all that is involved. If you find that patients are too anxious to take food during a procedure that's ok; instead try the sandwich technique. The sandwich technique is where positive pleasant things such as food and toys are offered prior to and directly after a procedure. So while the procedure itself was not enjoyable everything before and after was pleasurable and more likely to stand out in the patients mind. Lastly, canine and feline pheromone products can also be very helpful tools in low stress patient care. CEVA Sante Animale produces Adaptil and Feliway for cats. Any of the products can be used to comfort canine or feline patients in situations that may cause them to be apprehensive or fearful. The spray can be used for situations that include: traveling by car, trips to the veterinary hospital or any other new or potentially challenging situation. It can be applied directly to bedding, inside cages, indoor kennels or in the car. Veterinary staff can spray their clothing to calm the patients they restrain. Wait approximately 15 minutes for the product to become active after spraying 8-10 pumps. It will stay concentrated in the environment for 1-2 hours, although each animal may respond differently. Reapply as needed. The diffuser's make a great addition to hospital exam rooms or in the hospital kennel area. It can then be diffused at a constant level to comfort patients that are spending long periods of time in your practice. The items kept in the behavior toolbox should be regularly inventoried, checked for damaged and restocked or replaced as needed.

8. Continuing education

Much like other areas of veterinary medicine, behavior is ever changing. Behaviorists continue to research new theories, strategies, medications and techniques to improve animal behavior and to prevent behavioral problems from occurring. Continuing education for behavior is becoming more and more available. The American Veterinary Medical Association, the National Association for Veterinary Technicians in America and the Society of Veterinary Behavior Technicians are excellent resources for staying current with behavior topics. Food and drug companies are also good resources; they often make continuing education meetings and programs available either at national conferences or through online resources. Websites such as clickertraining.com offer a wealth of information; however researching behavior on the internet may provide inaccurate information. Caution should be used when reviewing any website to ensure the authors have desirable credentials.

9. Watch your language

The words that we choose to express how we feel about a particular patient or in a given situation may have an impact on our behavior. This becomes especially problematic when veterinary professionals inadvertently and/or unknowingly apply inappropriate actions and/or labels to companion pets; these are considered some of the negative results of anthropomorphism. For example; if a canine patient is vocalizing in a kennel and biting at the bars of the cage while he is being hospitalized it is easy to label this dog "annoying" or "a jerk" however if we look at the situation closer and analyze the dogs behavior from a medical stand point we may have a better understanding for the motivation of his behavior. Likely if he is hospitalized he is ill in some way; he may be painful or uncomfortable in some way. The dog may not have a history of being kenneled previously therefore is concerned about the confinement. The patient may have previous hospitalization experiences that were unpleasant or he may be frightened simply because he is surrounded by unfamiliar people. No matter what the reason is it is likely that the dog is not motivated to "annoy" the staff or to make the veterinary staff have a bad day. If you feel like your patient is attempting to annoy you, you may be motivated to react in a different way, such as yelling at the patient or scolding them for their behavior. If you feel that the patient is fearful or painful you are more likely to take appropriate steps to make them more comfortable. If you find yourself feeling frustrated because of a patient's behavior; remember to assess the environment and context in which behavior is occurring in. You should watch closely for signs of canine communication and most importantly minimize quick assumptions of the pet's emotional state.

10. Don't be afraid to talk about behavior

It should be our goal as veterinary professionals that we improve the behavioral health and well being of our patients so that the rate of relinquishment and euthanasia due to behavior problems can be decreased. By opening up the lines of communication it will set clients up for success and ultimately allow them to have a better relationship with their pet. Many common behavioral problems can be prevented, avoided or caught and treated at an early stage with proper client education. Although it may not always feel comfortable to make behavioral recommendations to a co-worker or a pet owner the long term benefits will outweigh the short term uncomfortable conversation. Find opportunities to begin sharing your education with individuals that may not have the same set of experiences or education that you have. When a client calls and enquires about a good breeder or postings for available puppies, take the time to discuss pre-selection counseling with them; encourage them to set the up an appointment for this service. If a you see a co-worker struggling with a fractious patient offer to help and demonstrate an alternative technique to better manage their behavior. While seeing a patient for a routine nail trim discuss options with the client on what exercises they can do at home to decrease stress for future nail trims. With each experience the conversations should become easier; clients and coworkers will likely feel more comfortable approaching you with future questions and concerns.

Behavior Therapies:
From Natural Supplements to Pharmaceuticals

Melissa Spooner, LVT, VTS (Behavior), BS, KPA-CTP
Leader Dogs for the Blind
Bloomfield Hills, MI

An anxiolytic is defined as any drug or supplement used to treat chronic or acute anxiety. Medications or natural supplements used as anxiolytics can be helpful adjuncts for behavior modification if the animal's fearful or anxious behavior is so intense that it interferes with learning or other normal activities. Though both nutraceuticals and pharmaceuticals play important roles in animal behavior, it is important to understand the different options and how they can most effectively be implemented into a behavior modification plan. The information offered in this presentation should act as a guide, outline or overview of possible applications in a clinical setting.

Over the last five years there has been an increased desire to treat medical issues using natural remedies and alternative medicine. This desire has slowly moved from the human to veterinary world. It is the goal for many pet owners to improve their pet's medical or behavioral status without altering their pet's personality negatively. It is also hoped that natural supplements are a healthier choice and will cause less harm to the body. Nutraceutical Medicine is defined as the use of micronutrients, macronutrients, and other nutritional supplements as therapeutic agents. Communication on the potential risks and benefits from the use of these compounds within the context of a valid veterinarian/client/patient relationship is important. Continued research and education on the use of nutraceuticals in veterinary medicine is advised.

Adaptil® by Ceva formerly known as DAP is a synthetic version of a pheromone that is excreted from bitches that are nursing their offspring. Adaptil assists new born puppies to search for, orient and bond to their mother. The pheromone elicits a soothing and calming response to the puppies, however it is thought that the pheromone in the synthetic form can be beneficial for dogs at any age. Adaptil is available as a veterinary Over the Counter (OTC) product. As of today, Adaptil can be found in three different forms; a spray, plug in diffuser and disposable collar. Each works slightly differently. The rate of onset and the longevity varies with each product. Because the rate of onset is generally fairly short (15-30 minutes) depending on the product it can be classified as a situational anxiolytic that can be used on an as needed basis. While the Adaptil collar and diffuser last for four consecutive weeks, the spray can be used as needed in a specific location and should last for several hours before needing to be re-applied.

Rescue Remedy is another natural supplement that has both oral and topical applications. It is often selected as a first form of treatment by many pet owners because of it availability and longevity. The ingredients of Rescue Remedy include Impatiens, Star of Bethlehem, Cherry Plum, Rock Rose and Clematis. This is an alcohol based product and the company suggests that some pets may be sensitive to alcohol, in which case, Rescue Remedy should be diluted before it is administered, or the alcohol-free Rescue Remedy should be selected as an alternative. Similar to many of the other behavior targeted nutritional supplements, Rescue Remedy can be used for pets that experience anxiety during visits to the vet, separation anxiety, noise phobias such as thunderstorms and fireworks, excessive barking, hissing or being kenneled. Shock, trauma, obsessive cleanliness, mistreatment, constant licking, and self-mutilations are listed as aliments that can be treated by Rescue Remedy. The solution can be given to pets orally, in their food or water bowl. Rescue Remedy can also be rubbed directly on an animal's nose, ear or paw. It can be used for an immediate calming effect in any stressful situation.

Harmonease contains natural extracts of Magnolia officinalis and Phellodendron amurense combined in a chewable tablet. Harmonease helps dogs to overcome stressors such as noises and fear causing situations. The intent of Harmonease is to decrease anxiety without causing lethargy, which is a desirable state for maximum learning. Harmonease has been evaluated in kenneled dogs and shown to stop stereotypical behaviors, such as lick granulomas, spinning and cowering within five days of administration. Dosing directions are recommended once daily as follows; for dogs up to 50 lbs, give ½ tablet and for dogs over 50 lbs give 1 tablet. For noise phobia, administration is recommended 7 days before the anticipated event and throughout the necessary period of time. As with any anxiolytic, Harmonease should be used under the guidance of a veterinarian and in conjunction with a behavior modification plan.

Anxitane is a product from Virbac which sole ingredient is Suntheanine brand L-Theanine in a neurologically active chewable form. Anxitane promotes relaxation in pets exhibiting nervousness, anxiety or response to environmentally induced stress. This nutraceutical targets undesirable behaviors such as fear on walks, people and other animals. It also improves anxiety or stress associated with change in family situation or environment, episodic fear such as; noise phobias grooming, car travel and veterinary visits. The goal of this supplement is to significantly reduce stress related reactions; however Virbac recommends that this product should not be used for patients with severe phobias, separation anxiety or aggression. One reason that this product may be selected over some of the other options is due to its highly palatable form, a poultry flavored tablet, which makes administration to both dogs and cats very easy. There are also no known interactions with other therapeutics. It is recommended that Anxitane is used for no less than 60 days to fully assess the effectiveness and so that maximum results can be observed. Anxitane is available in two different sizes; small (50mg) for dogs and cats under 22lbs which is administered ½ tablet every 12 hours, and medium/large (100mg) for dogs

22.1-55lbs, the dose is ½ every 12 hours and dogs that exceed 55.1 lbs should be given 1 full tablet every 12 hours. The tablets are scored and can be easily divided to achieve the desired dose.

Composure is a nutritional supplement by Vetri-Science, which combines three natural ingredients. Similar to Anxitane, Composure contains Suntheanine brand L-Theanine, which is a naturally occurring amino acid found in green tea and it has been researched extensively for its ability to reduce stress, anxiety and unwanted behavior. It helps the body to produce other calming amino acids such as Dopamine, GABA and Tryptophan and helps bring certain neurotransmitters into better balance. Studies done on L-Theanine showed that dogs reduced anxiety-related behavior without adverse effects or drowsiness; dogs were alert, playful and calmer than expected given their situations, which are the desirable effects when utilizing an anxiolytic. L-Theanine also promotes calming and relaxation and reduces irritability and low mood states. The second ingredient is Colostrum Calming Complex, which is an isolated form of colostrum proteins, which have a calming effect on animals. These bioactive proteins have been found to support cognitive function and support stress reduction. The Colostrum Calming Complex works synergistically with the L-Theanine in this formula to promote relaxation and cognition in dogs. Lastly, Thiamine helps manage stress and reduces irritability. Thiamine (Vitamin B1) has been shown to affect the central nervous system to help calm and soothe anxious animals. A lack of Thiamine can cause mental confusion, muscular weakness, muscle spasms, nervousness, and weight and appetite loss during periods of stress. The Composure formula is available in two forms; a suspension and palatable bite sized chews. Recommended directions for the suspension in cats is ¼ teaspoon twice daily. Dogs under 25 lbs ¼ teaspoon twice daily, 26 - 49 lbs ½ teaspoon twice daily, 50 - 75 lbs ¾ teaspoon twice daily and 76 lbs and over 1 teaspoon twice daily. Recommended directions for the chews are for pets up to 25 lbs 1 chew daily, 26-50 lbs 1 chew daily, 51-100 lbs 2 chews daily, over 100 lbs 3 chews daily. Both forms of Composure can be used either as needed for immediate support or on a daily basis for on-going support. During times of increased stress it is safe to double or triple the directed amount.

Novifit also by Virbac, is targeted towards a slightly different area of behavior. Its active ingredients are S-Adenosyl-L-Methionine-Tosylate Disulfate also known as SAMe. Novifit is designed to support cognitive function of aging dogs and cats. These tablets help to control behavioral disorders related to brain aging such as disorientation, changes in social interactions with people and other pets, changes in sleep-wake cycles and loss of housetraining skills. They are a highly pure and stable form of SAMe (NoviSAMe) presented in an enteric-coated tablet. As a nutraceutical, it is a first line treatment of behavioral problems associated with cognitive decline for both dogs and cats. Novifit is available in three different sizes; small (100mg) for dogs and cats under 22lbs, medium (200mg) for dogs 22.1-44lbs, and large (400mg) for dogs 44.1-88lbs. The tablets can be given once a day in food, but should not be crushed or divided up into smaller pieces.

Not all behavior problems will demonstrate the desired level of improvement by using a natural supplement as therapy. Instead they may require a prescribed short term or long-term pharmaceutical anxiolytic. Some problems such mild noise phobias (thunderstorm & fireworks), activity or location specific (veterinary hospitals or grooming visits) anxieties may need only to be treated on an as needed basis. Using a short-term medication may efficiently treat this diagnosis. Under the supervised care of a veterinarian, a patient's anxiety status can be thoroughly assessed and the appropriate method of treatment can be determined.

Alprazolam and Diazepam are in the same drug category called Benzodiazepines. Benzodiazepines are anxiolytic medications with rapid onset of action that last for a few to several hours depending on the specific drug and the species. They are frequently used as augmenting agents for SSRIs or SNRIs in the treatment of anxiety disorders but also can be prescribed as a standalone drug. Benzodiazepines are metabolized by the liver and excreted into the urine. They should be used for situational anxiety because of the short duration of onset. Although Alprazolam and Diazepam are in the same family, there are significant differences between the drugs so they may be selected for different reasons. Alprazolam, which is the generic for Xanax is available in both tablet and suspension form. It is often prescribed to improve symptoms related to noise phobia, separation anxiety or generalized anxiety. Alprazolam is most likely to be effective when given 30-60 minutes before the occurrence of the earliest stimuli that elicits a fear response, and may remain in the system for 2-4 hours. Dosing recommendations are 0.02-0.1mg/kg every 6-8 hours for dogs and 0.02-0.05mg/kg for cats as needed for anxiety. If a patient has been receiving Alprazolam daily for several weeks, discontinuation should be gradual, and conducted over a period of at least one month. Diazepam (Valium) has been used in many areas of veterinary medicine. Diazepam has a CNS depressant effect that results in calming, sedative, skeletal muscle relaxation and anticonvulsant effects. Although Diazepam is available in multiple forms, oral administration is the preferred route for improvement of behavior problems. The drug reaches full levels at 30-120 minutes after administration and may last 2-3 hours. Dosing recommendations are 0.5-2mg/ kg every 6 hours for dogs and 0.2-0.5mg/kg every 8-12 hours for cats as needed for anxiety. Previously Diazepam was the drug of choice used to treat cats for spraying, anxiety motivated inappropriate elimination, general anxieties and fear related aggression, however after it was determined that it was more likely to cause hepatopathy, it's use was decreased. Similar to Alprazolam, patients receiving long-term daily treatment with Diazepam should be gradually weaned before completely discontinued. All of the drugs in the benzodiazepine category are controlled substances with the potential for human abuse. When drugs in this category are prescribed they should be monitored closely. If medications in this class are going to be prescribed over a long period of time only a limited amount of medication should be dispensed as needed, and when additional refills are requested, the previous

amount dispensed, previous date issued and the doctor's directions should be compared closely. Benziodiazepines are generally safe drugs to use with minimal side effects. The side effects reported most often are lethargy, hyperactivity and ataxia. Benzodiazepines have the possibility to cause disinhibition, or fearful animals could become more aggressive. For this reason it is important to monitor the patient closely while this medication is in use, and appropriate behavior modification should be implemented along with any behavior medication. Fulminant hepatic failure associated with oral administration of Diazepam was reported in some feline patients so blood work should be done on cats to check liver values. Hyperphagia may also be reported in both dogs and cats but in some cases that is a side effect that may be considered desirable at times.

Acepromazine falls under the antipsychotic drug category. It is a tranquilizer that causes decreased motor function and reduced awareness of external stimuli. Patients that are prescribed Acepromazine will appear sedated and possibly lethargic, which can be beneficial in some areas of behavior treatment. Classical antipsychotics can calm anxious patients and may be considered for pets that are destructive to themselves or their surroundings. Acepromazine also has an antiemetic effect so it may be recommended for dogs that experience car ride anxiety characterized by nausea or vomiting. However, there is some concern whether or not Acepromazine makes an appropriate behavior modification drug. Since it causes sedation, it may limit the animal's ability to learn and repeat desired behaviors in difficult situations. Ataxia, hypotension, decreased seizure threshold, and bradycardia are all possible side effects that may occur after administration of this drug. Any patient that is prescribed Acepromazine should be monitored closely. Recommended doses for Acepromazine is 0.5-2mg/kg orally every 8 hours or as needed for dogs and 1-2mg/kg orally as need in cats.

Situational anti-anxiety supplements or medications may not always be suitable in every case. Patients that experience ongoing anxiety, extreme phobias or when quality of life is severely impacted by their behavior may require long term drug therapy. There are several drug classes to choose from when selecting the appropriate drug for the patient.

SSRIs selectively block the reuptake of serotonin back into the presynaptic neuron. Consequently they increase the levels of serotonin in the synapse. Fluoxetine has been used most commonly in the treatment of behavior problems in companion animals, particularly those with anxiety disorders, such as separation anxiety and aggression, however it may be utilized to decrease reactivity, vigilance and compulsive disorders. Fluoxetine is a Selective Serotonin Reuptake Inhibitor (SSRI) generic for Prozac or Reconcile, a veterinary brand name. Drugs such as Fluoxetine found in the SSRI category are intended as long term anxiolytics, because they may be used over several months, years or lifelong. When Fluoxetine is prescribed it should be explained as a commitment to the client. Improvement from this medication may take 4-6 weeks from the start date to asses, and it is important for clients to have appropriate expectations of the drug. Using a veterinary brand name drug such as Reconcile can have several advantages over choosing the generic version. One important advantage is the palatability of the tablet, which is made from beef flavoring and can ease administration to an already anxious animal. The second advantage is the extensive research that has been completed to fully understand the effects, expectations and benefits of the medication. The company also offers veterinary education and support to prescribers. Despite the many positive aspects of using Fluoxetine it does have several side effects that both prescribers and veterinary staff should be aware of. Lethargy and decreased appetite are most often observed though they are generally transient and reported during the first 1-4 weeks of treatment. Vomiting, diarrhea, changes in urinary frequency, insomnia and sedation are also possible side effects. Dosing the medication every other day for the first 7-10 days can lessen side effects. Food may delay its absorption by 1-2 hours, so it may be most effective if given on an empty stomach. The combination of Fluoxetine and MAOIs can result in serious and sometimes fatal drug interactions. These two medications should never be given together. However, combing an SSRI with a benzodiazepine may enhance the drugs to achieve a better effect. Recommended dosing of Flouxetine is 0.5-2mg/kg once daily. Paroxetine is another SSRI used to treat anxieties involving social interactions; it is very similar to Fluoxetine. Dosing recommendations are 0.5-1mg/kg orally 1-2 times daily. Side effects include sedation, increased anxiety, animals seeming withdrawn, loss of appetite and the possible lowering of seizure threshold. Urine retention and constipation are also possible side effects. It may have the advantage of being more calming and therefore more preferable for some anxiety disorders. It is less likely to lead to agitation and insomnia compared to Fluoxetine. Paroxetine has a much shorter half-life than Fluoxetine. After the desired level of behavioral improvement is achieved the patient should slowly be weaned off of the SSRI, over a 4-6 week period. If medical side effects are observed that suggest interference from the medication, it can be safely stopped abruptly.

Another major class of drugs used for long-term behavior therapy is Tricyclide Anti Depressants, which block the reuptake of norepinephrine, dopamine, and serotonin into the presynaptic terminal. They effectively increase the level of neurotransmitter in the synapse. They are commonly used in dogs to manage behavior problems ranging from aggression to urine marking, repetitive behaviors, and separation anxiety. In cats, TCA's can be used to treat certain forms of aggression, urine spraying, excessive vocalization and grooming. Clomipramine and Amitriptyline are well known drugs in this category. Clomipramine, also known as Clomicalm, is one of two drugs licensed in the United States used to improve separation anxiety, (the other is Reconcile). Clomipramine is unique from other TCA's because it is the most selective inhibitor of serotonin reuptake. There is wide dose range offered for Clomipramine. Recommended doses for cats is 0.125-1mg/kg and dogs 0.5-2mg/kg divided every 12 hours depending on the diagnosis. Amitriptyline, (Elavil), may be used for diagnosed separation anxiety and generalized anxiety in both dogs and cats. Because of its sedative, ant-anxiety, anti-histaminic effects as well as its potential improvement for chronic pain it may be useful in

some self-traumatic disorders such as early stages of ALD-type lesions in dogs. Typical dosing for Amitriptyline is 50-150mg per day which is likely divided into 12 hour doses. For both Clomipramine and Amitriptyline, behavioral improvement will take 2-4 weeks to assess and if the desired improvements are not observed by 6-8 weeks, the dose may need to be increased. Potential side effects include cardiac arrthymias and seizures. Urinary retention and dry mouth may also occur during therapy. Amitriptyline is also notoriously known for being very bitter tasting, it can be difficult to mask in food and both dogs and cats may become disagreeable to taking it. Both Clomipramine and Amitriptyline should be slowly weaned before they are discontinued so that the undesired behavior problems do not reoccur.

Most psychoactive medications are used off-label for animals. Only a few medications, such as Fluoxetine (Reconcile, Lilly) and Clomimpramine (Clomicalm, Novartis Animal Health), are indicated for specific use in dogs.

Another class of drugs that is important to be aware of is Azapirones. Azapirones are described as anxioselective instead of anxiolytics because they do not cause sedation, which may occur during treatment with other classes. Similar to some of the TCAs and SSRIs, Buspirone can be used to treat generalized anxiety, inappropriate elimination, (specifically feline urine spraying), separation anxiety and some forms of aggression. A veterinarian may choose to treat with Buspirone when the patient's anxiety is decreased as it can often make them friendlier and more likely to seek attention. The prescriber should be aware that inhibition could lead to aggression. However, the desired effects may not be achieved by using Buspirone alone. Often Buspirone may be combined with SSRIs or TCAs in order to have an optimal effect. Azapiriones should not be combined with Monoamine Oxidase Inhibitors, (MAOI's), because of the potential for toxicity. Dosing for Buspirone for dogs is 0.5-2mg/kg every 8-24 hours. The feline dose varies slightly. It can be prescribed as 2.5-7.5mg/ cat every 12 hours or 0.5-1mg/kg every 12 hours. The rate of onset is shorter than other long-term behavior therapy drugs and behavioral improvement can typically be observed in 1-4 weeks.

Prior to starting any new behavior medications it is always recommended that baseline blood work be performed. It is important to understand how the drug that is being prescribed is metabolized and excreted and select appropriate blood work accordingly. An extensive chemistry panel and complete blood count are usually recommended. Depending on the prescribing physician, signalment and history of the patient, additional blood work may be indicated. Age, history and current health status of the patient may also determine how often blood work is repeated. Schedule guidelines for blood work can be as follows: 1-3 years old, once yearly, 4-9 years old, every 6 months, and 10 years and above every 3 months. The prescribing physician should ideally perform a physical exam at regular scheduled intervals. Depending on the reason for the patient being on behavior medications, an observational physical exam may be the only reasonable option. An observational physical exam will allow the physician to assess the patient from a comfortable distance. Gate, body condition score, skin, coat and neurologic status can all be assessed in this manner, however it should be the long term goal of the veterinary staff and client that patient be desensitized for physical exam at future medical visits. Grouping multiple medical procedures together for patients that are fractious during veterinary visits, such as blood draws, vaccinations, nail trims and physical exams, may prove to be easier for the patient to cope with. This will assist in decreasing the amount of "negative" veterinary interactions, although some patients may do better if the procedures are scheduled on separate visits.

Veterinary technicians can play a very important role assuring that multiple medications or other treatments are not prescribed where contraindicated. Patients that are being treated by various doctors run the risk of two or more medications being recommended simultaneously when they should not be paired together. It will be the job of the veterinary technician to work closely with clients on obtaining a complete behavior and medical history and reporting your findings to the veterinarian. The owner should be encouraged to list all medications that the patient may be taking. This list should include the medication strength, frequency, when it was started, last dose given or any medications that have been discontinued recently. Any nutraceutical or over the counter medications that are being administered should be included in this list. This drug list should be updated anytime medications are added or altered and anytime the patient is seen at the hospital. If possible, an alert should be made in the patient's chart in both digital and hard copies. Fluorescent stickers are an inexpensive yet effective method of alerting all veterinary staff that the patient is taking a medication that may be contraindicated with other medications. As with children, all medications should be stored in tamper proof containers that are out of reach. Due to several behavior medications now being made highly palatable for the patient, they should be kept were family pets do not have access to them.

Concerns arise when SSRIs, MAOs or TCAs are combined with other medications or supplements that may cause excess serotonergic activity at the central nervous system (CNS) and peripheral serotonin receptors. This is a potentially life-threatening adverse drug reaction that known as Serotonin Syndrome, may occur following therapeutic drug use, inadvertent interactions between drugs, or overdose of particular drugs. The most serious cases result when an SSRI are combined with an MAO inhibitor, which decreases serotonin metabolism, and a serotonin receptor agonist, such as Buspirone, a TCA which is a non-selective serotonin reuptake inhibitor, or Meperidine, Tryptophan or Dextromethorphan. There is still much to be learned about how Serotonin Syndrome effects animals, we do know that it has the potential to be fatal and precautions should be taken to avoid this possibility.