Rocky Mountain spotted fever (RMSF) is caused by a Gram-negative obligate intracellular bacteria, *Rickettsia rickettsii*, and it is transmitted to dogs and human beings by ticks. Dogs in the U.S. can also be infected with *R. montana*, *R. rhipicephali*, *R. belli*, and *R. akari*; however, *R. rickettsii* is the only *Rickettsia* known to be pathogenic in dogs. While ticks are the vectors, small mammals (mostly rodents) act as the reservoir host for *R. rickettsii*. RMSF is seen throughout the continental U.S., reflecting the host range of susceptible tick populations: the American dog tick (*Dermacentor variabilis*) in the eastern United States, and either the Rocky Mountain wood tick (*Dermacentor andersonii*) in the western United States and Canada, or the brown dog tick (*Rhipicephalus sanguineus*) in the southwestern United States. Despite its name, the highest prevalence of RMSF is in the Southeastern and south central United States. Most cases are diagnosed from April until October, coinciding with peak tick activity. Ticks must be attached and feeding for 6-20 hours before *Rickettsia* are transmitted. Transmission may also occur by ingestion of *Dermacentor* ticks or from contamination of a wound with tick feces or secretions.

Transmission does not occur directly between dogs and humans; however infected dogs are considered a sentinel for potential concurrent tick exposure and disease transmission to humans. In people, the overall incidence of rickettsial infections is increasing, with male Caucasian children less than 15 years old having the highest incidence of infection. People who live near wooded areas or areas with tall grass are also at increased risk. The main risk factor for dogs is spending time outdoors; however, young purebred dogs are overrepresented in some reports.

**Pathophysiology**

After infection, the incubation period for RMSF is approximately 1 week (range 2-14 days), as rickettsiae disseminate via the circulation and multiply within vascular endothelium and smooth muscle. Three main mechanisms of pathogenesis exist: 1) endothelial response to injury leading to promotion of a pro-inflammatory state and pro-thrombotic state, 2) microvascular thrombosis and endothelial injury causing oxidative stress leading to cell death, and 3) immune-mediated platelet destruction. A diffuse vasculopathy, perivascular inflammation, and microvascular thrombosis occur, especially within the brain, skin, gastrointestinal organs, heart, lungs, kidneys, and skeletal muscle. Vasculitis leads to increased vascular permeability and edema.

**Clinical manifestations of RMSF**

The earliest and most common signs of RMSF seen in dogs are nonspecific and include lethargy, anorexia, and fever. Lymphadenomegaly, rapid weight loss, and edema may also be noted on physical exam. Evidence of bleeding can also be seen as petechiae, melena, epistaxis, or hematuria. Recent history of tick exposure is suggestive, but not necessary, and was only reported in 17% of dogs in one study.

Ocular signs occur in up to 80% of RMSF cases in dogs, secondary to vasculitis, and can include: discharge, scleral injection, conjunctival injection, scleral/conjunctival/iridal/retinal hemorrhage, conjunctivitis, scleral petechiae, anterior uveitis, hyphema, and retinitis. Ocular signs are mostly bilateral, generally mild, and with proper treatment most ocular signs resolve in 2-5 days.

Dyspnea and other respiratory signs such as epistaxis are reported in up to 20% of canine RMSF cases. Dyspnea can be attributed to vasculitis causing pulmonary edema, hemorrhage, or could be secondary to anemia or neurologic dysfunction in some cases. A small study reviewing thoracic radiographs of dogs with RMSF found that a mild unstructured interstitial pattern was the most common abnormality.

Arthralgia and myalgia are less commonly seen in canine RMSF than in other tick-borne diseases but may be seen in up to 20% of cases.

Cutaneous lesions can occur on the face, ears, oral cavity, extremities, ventrum, vulva, scrotum, or prepuce, and include: edema, hyperemia, necrosis, petechiae, and ecchymosis. Discrete vesicles and erythematous macules can also occur on the buccal mucosa. Cutaneous necrosis is uncommon but can be severe and can occur weeks after proper therapy has been initiated and improvement in other signs has been seen. Necrosis occurs in the extremities and previously edematous regions. Necrosis may occur more in dogs that have a delay in treatment, and may be more severe in German shepherds and Springer spaniels. Histopathology has shown focal coagulative dermal necrosis, suggestive of ischemia from vascular occlusion, but direct immunofluorescence for *R. rickettsii* in the same biopsy tissue has been negative.

Neurologic dysfunction may occur in up to 43% of dogs with RMSF, and can be focal or generalized, including hyperesthesia, tremors, ataxia, paresis, vestibular disease, altered mental status, stupor, seizures, or coma. The most common neurologic manifestation is vestibular disease, usually central, and often with strabismus. Dogs with RMSF can also have meningitis progressing to encephalomyelitis. CSF analysis may show increased cell and protein counts, mostly neutrophils or pleomorphic, and CSF can be...
submitted for RMSF titer. Higher mortality rate has been reported for dogs with RMSF and neurologic dysfunction, but prognosis depends on type of neurologic disease manifested (many vestibular dogs recover fully).

Hepatopathies are reported in human cases of RMSF, but information regarding liver involvement is scarce in the veterinary literature. In human cases of RMSF, hepatic lesions are described as having inflammation and vasculitis of the portal triad with large mononuclear cells, neutrophils, and rickettsial organisms. There is no hepatocellular necrosis. Hyperbilirubinemia is likely from a combination of mild cholestasis from inflammation, edema, and hemolysis.

Intact dogs can develop orchitis, scrotal edema, hyperemia, and epididymal pain related to RMSF. Orchitis induced by RMSF can mimic testicular neoplasia and torsion and can be differentiated using ultrasound.

**Diagnostic testing**
The most typical laboratory abnormalities in dogs with RMSF include thrombocytopenia, moderate leukocytosis, hypoalbuminemia, and elevated ALP activity. This is similar in human beings with RMSF who commonly have thrombocytopenia and mild liver enzyme activity elevations. Dogs with pulmonary signs can have radiographic evidence of a mild unstructured interstitial pattern. Diagnosis is based on tick exposure, consistent clinical presentation, and serology results, and treatment should be started while serology is pending. The indirect immunofluorescence assay (IFA) is used in dogs and human beings to detect IgM and IgG antibodies. IgM antibodies can be detected 1 week after clinical signs appear and decline after 2 months. An IgM single titer of 1:64 or greater with consistent exposure and clinical signs is diagnostic for RMSF. However, the serologic gold standard for diagnosis involves a 4-fold increase in IgG titer from the acute initial phase to the convalescent phase 3 weeks later. IgG antibodies can be detected 2-3 weeks after infection but titers can remain elevated long-term; thus a single IgG titer is only indicative of exposure. Cerebrospinal fluid analysis can identify antibodies in patients with CNS signs. PCR may be useful during acute infections before dogs have seroconverted and to confirm active infection in seropositive dogs.

**Treatment**
There are 3 documented effective antibiotics for canine RMSF: doxycycline, enrofloxacin, and chloramphenicol. Doxycycline (5mg/kg PO BID for 7-14 days for dogs) is the treatment of choice, due to its efficacy and coverage against other tick-borne infections with which the dog may be co-infected. Co-infection cases may require 3-4wks of treatment. With the challenges of acquiring doxycycline in the current market, minocycline can also be used (7.5mg/kg PO BID), although research to confirm efficacy for RMSF in dogs is lacking. Enrofloxacin (5mg/kg PO BID for 7-14 days for dogs) works well if dogs cannot tolerate doxycycline, or if parenteral antibiotics are needed and you do not have access to injectable doxycycline. Enrofloxacin should be avoided in growing animals and clinicians should use caution or ideally avoid enrofloxacin in CNS cases (especially seizuring dogs). Enrofloxacin is not effective against *E. canis* and other tick-borne diseases. Steroid therapy is not typically required (or recommended) for successfully treatment RMSF in dogs, but it may be needed in rare cases with a severe immune-mediated component (ITP) or strong inflammatory component (meningitis or ocular cases). Prednisone has been shown to have no detrimental effects when given in combination with doxycycline to dogs with RMSF. Most patients show rapid response to appropriate antimicrobial therapy within 48 hours if treated early in the course of disease; however this disease can be fatal in both human beings and in dogs if not recognized and treated promptly.

**Public health considerations:**
RMSF has been considered the most prevalent and severe human rickettsial disease in the United States. Manifestations of human RMSF include: fever, rash, headache, fatigue, joint and muscle pain, nausea, and decreased appetite. Rash is the most common clinical finding, occurring in 85-90% of infected human beings, and beginning on the extremities, especially the palms and soles. Signs can rapidly progress if undiagnosed, and multi-systemic vasculitis can lead to gangrene, shock, acute respiratory distress, thrombotic stroke, and death. Human mortality is reported to be 2-10%. Dogs bring ticks in closer proximity to their owners, and dogs can be sentinels for disease, often becoming infected and sick before their owners. Therefore, client education about how RMSF is acquired and prevented is important to protect the family members as well. Prevention of RMSF includes limiting exposure to and removal of ticks after each exposure, as well as using tick repellants, sprays, and veterinary approved products. Veterinarians can also inform clients of clinical signs that are seen with RMSF infection in people, and vets should always suggest that clients contact their physician with any concerns about human illness or infection. Reporting cases of RMSF to local or state health authorities is recommended but not required.

**Selected references**


Mikszewski JS, et al. CNS dysfunction associated with RMSF infection in 5 dogs. JAAHA 2005;41:259-266.


