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Lyme Disease in Dogs

Profile

Definition

Lyme disease, also called Lyme borreliosis, is a bacterial infection that occurs primarily in dogs and humans. The causative agent, *Borrelia burgdorferi*, is transmitted by ticks.

Systems. Musculoskeletal joints are commonly affected. Kidney disease (Lyme nephritis) has been reported.

Genetic Implications. There are no reports of genetic associations with Lyme disease in dogs.

Incidence/Prevalence. Up to 90% of dogs in endemic areas may be exposed to *B. burgdorferi*. An estimated 5% to 10% of seropositive dogs develop clinical disease.¹

Geographic Distribution.

Cases in dogs follow the same distribution as human cases in the U.S. with the vast majority occurring in the northeast, the upper Midwest and the far west (Figure 1).² However, cases may be seen in any region due to travel.

Signalment

Species. Clinical disease is found in dogs and occasionally other domestic animals such as horses and cattle.

Cats may be exposed but natural disease has not been demonstrated.

Breed Predilection. Any dog exposed to *B. burgdorferi* may become infected. Labrador and golden retriever dogs show a higher prevalence for Lyme nephritis than other breeds.³

Age and Range. Experimental infection of adult dogs with *B. burgdorferi* did not cause clinical signs. Young puppies (6 to 26 weeks of age) were more likely to develop disease experimentally. After natural exposure, dogs of any age may be infected.¹

Gender. No difference has been reported.

Causes

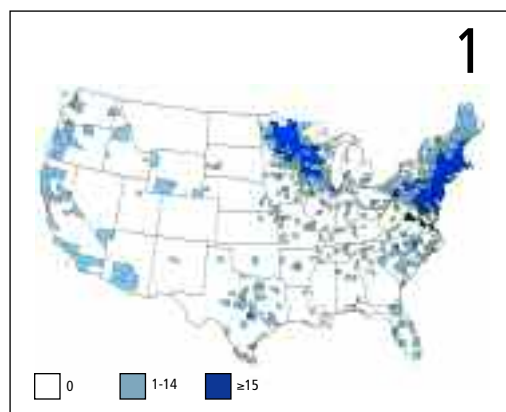
B. burgdorferi is transmitted by *Ixodes* ticks, primarily *I. scapularis* in the northeast and

Midwest and *I. pacificus* in the west.¹ Tick larvae and nymphs feed on small mammals, while adult ticks feed on deer and larger mammals. Infected nymphs and adult ticks can attach to dogs and transmit the bacterium while feeding. Studies suggest that *B. burgdorferi* is transmitted after 36 to 48 hours of attachment. Thus, finding a small, flat, nonengorged *Ixodes* tick on a dog indicates a very low risk of infection (Figure 2).⁴

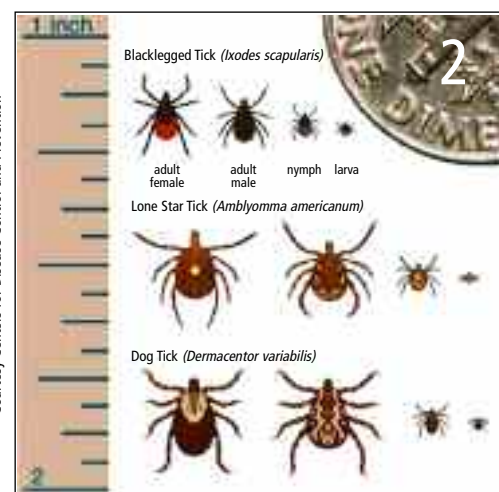
Risk Factors

Dogs living in endemic areas, especially the northeast, are at the highest risk (Figure 3). In some regions of Connecticut, New York, Rhode Island, and surrounding areas, 50% to 90% of *I. scapularis* ticks are infected with *B. burgdorferi*.⁵

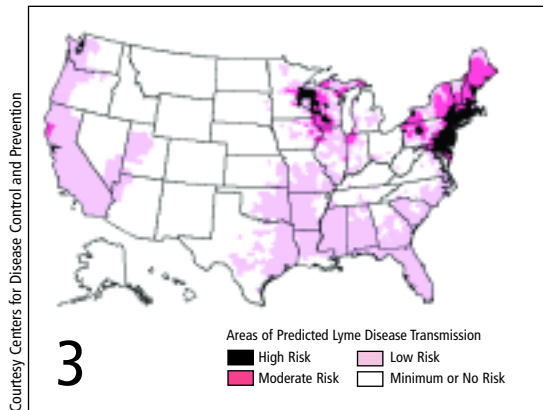
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Geographic distribution of Lyme disease in humans (2004)



Relative sizes of *Ixodes* and other common dog ticks



Risk of Lyme disease in humans by geographic location

Pathophysiology

The bacteria proliferate locally in the skin at the site of tick attachment. However, skin lesions are rarely observed in dogs. The bacteria then spread and may localize in joints, connective tissues, the nervous system, kidneys, and other organs. Innate and adaptive immune responses lead to the production of proinflammatory cytokines and antibodies, but *B burgdorferi* may evade host immunity and persist extracellularly in tissues. Clinical disease is primarily a result of the immune response.¹

Signs

History. Owners may report decreased appetite, lethargy, and lameness.

Physical Examination. Common signs include fever (103° to 105° F), intermittent or shifting-leg lameness, joint swelling, and lymph node enlargement.

Pain Index

Affected dogs may not exhibit clinical signs. Some dogs may display mild to moderate limb/joint discomfort and pain on palpation.

Dx Diagnosis

Definitive Diagnosis

B burgdorferi can be cultured from affected areas including skin (site of tick attachment), and collagen-rich connective tissues such as muscle fascia and synovium. Organisms also may be cultured from blood or plasma, cerebrospinal fluid, and synovial fluid. Special media and long incubation times (2 to 4 weeks) are necessary. Culture techniques are limited in

clinical cases by low sensitivity (especially if antibiotics have been given), expense, delayed results, and invasive nature of tissue sampling.⁶

PCR analysis may be performed on similar specimens. The sensitivity in human studies is 10% to 80%, depending on the samples. False positives may occur because nucleic acid is detected from both live and dead organisms. Techniques have not been standardized among laboratories and PCR is not a widely accepted diagnostic tool.⁶

Serology is the most common diagnostic method used by clinicians. Antibodies to various proteins associated with *B burgdorferi* can be detected by ELISA, IFA, and Western blot. Currently available serologic tests do not diagnose Lyme disease—they only indicate exposure and seroreactivity.^{1,5,6} Vaccination with *B burgdorferi* stimulates antibody production, which causes false positive results on most ELISA and IFA tests. However, one commercial ELISA test detects antibodies to the C₆ peptide, which does not cross-react with antibodies from other infections or with those in vaccinated dogs (SNAP 3Dx, SNAP 4Dx, Lyme Quant C₆ Test; IDEXX, www.idexx.com).

A positive antibody response occurs 3 to 5 weeks after infection. In a study of 8 experimentally infected dogs, 4 untreated dogs maintained high C₆ levels for 69 weeks while the antibody level in 4 treated dogs started declining 20 weeks after infection and reached baseline after 45 weeks.⁷ Studies in humans have reported conflicting results: some patients experience a 4-fold or greater decline in C₆ level within 6 months of treatment while high levels persist in other patients for up to 15 years despite antibiotics.⁷⁻⁹ At this time, serology cannot be recommended as an accurate indicator of disease status or response to treatment in humans or dogs.

Differential Diagnosis

Lameness may result from other causes of arthritis including bacterial (septic) or immune-mediated polyarthritis, lupus, rheumatoid arthritis, degenerative joint disease, or other tick-borne disease (ehrlichiosis, anaplasmosis, Rocky Mountain spotted fever). Trauma (eg, sprain, strain) and neurologic problems such as intervertebral disk disease often cause lameness. Painful limbs and joints can also result from myositis, panosteitis, neoplasia, osteomyelitis, hypertrophic osteodystrophy, or hypertrophic osteopathy.⁵

Ixodes ticks may be coinfecting with other organisms such as *Anaplasma phagocytophilum* and/or *Babesia microti*, which can complicate diagnosis and management.⁵

Laboratory Findings/Imaging

In both experimental and clinical cases, routine blood analysis (CBC, chemistry profile) is normal. Urine may be collected for analysis, especially to screen for proteinuria. However, proteinuria alone is not diagnostic of Lyme nephritis.¹

CBC = complete blood count; ELISA = enzyme-linked immunosorbent assay; IFA = immunofluorescent antibody test; PCR = polymerase chain reaction

Radiographs of affected joints may reveal a nonerosive polyarthritis, and fluid analysis of joint effusions typically shows a nonspecific neutrophilic inflammation.^{1,5}

Postmortem Findings

Lyme disease is a nonfatal infectious disease, with the possible exception of Lyme nephritis. Membranoproliferative glomerulonephritis, tubular necrosis and regeneration, and diffuse interstitial lymphoplasmacytic inflammation are commonly reported. A causal relationship between *B burgdorferi* infection and nephritis has not yet been proven.^{3,10}



Treatment

Inpatient or Outpatient

Uncomplicated cases of Lyme disease are managed on an outpatient basis. Dogs with suspected Lyme nephritis may need in-hospital treatment if renal insufficiency or failure is present.

Activity

Exercise restriction is useful until lameness resolves.

Nutritional Aspects

Dogs may be transiently anorexic but nutritional support is rarely needed. Cases of suspected Lyme nephritis with significant proteinuria may benefit from reduced-protein diets.

Alternative Therapy

Acupuncture, homeopathy, and herbal remedies may be used by alternative medicine practitioners to treat Lyme disease or Lyme nephritis. No research has been published to support alternative therapies.

Client Education

Clients should be advised of effective measures to prevent exposure to ticks. Careful

daily examination of the hair coat may reveal ticks, although *Ixodes* are tiny and easy to overlook. Acaricides such as fipronil (Frontline; Merial, www.merial.com),¹¹ amitraz (Preventic; Virbac, www.virbac.com),¹² and permethrin (K9 Advantix; Bayer, www.bayer.com), are generally effective when used according to label directions. Environmental tick control involves keeping grass and vegetation mowed and constructing tick barriers on property edges.¹³ Clients should also be advised that it is rare for *Ixodes* ticks to be transferred from dogs to humans. However, humans and dogs may become infected from the same environment.¹⁴



Medications

Drugs/Fluids

The drug of choice is doxycycline at 10 mg/kg Q 24 H.^{1,5} Amoxicillin at 11 to 22 mg/kg Q 8-12 H may be used, especially in very young puppies, to avoid potential enamel staining in developing teeth. Clinical improvement often occurs within 1 to 2 days of starting therapy, as lameness and fever rapidly resolve. The appropriate duration of treatment for affected dogs is unknown, but 30 days is commonly suggested.

Antibiotic therapy is unlikely to clear all *B burgdorferi* organisms. Experimental studies have documented persistence (positive culture, isolation, or PCR) even in treated dogs. Antibody titers often stay positive for weeks to months, or they may drop initially and then rise again after 6 months.^{1,5}

Contraindications/Precautions/Interactions

Vomiting or other gastrointestinal disturbances are occasionally seen with doxycycline or amoxicillin therapy. Administration with food may reduce the risk.



Follow-Up

Patient Monitoring

Clients should be advised to watch for improvements in lameness and appetite. As laboratory work is typically unremarkable in Lyme disease, follow-up testing is usually not necessary. Acute and convalescent antibody titers may help with diagnosis. Clinicians may wish to repeat Lyme serology after treatment and clinical resolution. However, antibody titers often remain elevated due to persistence of low levels of organisms and/or immunologic memory. Previously exposed dogs that continue to test positive do not need additional treatment unless clinical signs or other evidence of Lyme disease recur. Patients with Lyme nephritis are monitored similarly to dogs with other forms of glomerulonephropathy.

Prevention

In addition to avoiding tick exposure and using appropriate acaricides, vaccination may be useful in endemic areas. Both whole-cell bacterins and recombinant vaccines are available. Two vaccinations 2 to 3 weeks apart are recommended initially in puppies. Lyme vaccines may be combined with other routine canine vaccines, following product label instructions for minimum ages. A recent study showed that a third vaccination (3 vaccines 2 to 3 weeks apart) resulted in higher antibody levels than 2 vaccines, but the clinical significance is unknown.¹⁵ Annual revaccination is currently recommended, as long-term immunity studies have not been published.

Vaccination has not proven to be 100% effective in preventing Lyme disease. One clinical study of a whole-cell bacterin in an endemic area suggested 78% efficacy.¹⁶ Another small study of a recombinant vaccine indicated 100% efficacy with a 1-year

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challenge.¹⁷ The value of vaccines in preventing Lyme nephritis is unknown, as some affected dogs had a history of vaccination. Adverse effects associated with Lyme vaccination, especially whole-cell bacterins, have been reported but appear to be rare.

Clients may ask if antibiotics should be given if ticks are found on their dog. Because dogs are often exposed but not infected, prophylaxis with antibiotics is not recommended.

Complications

Exposure to *B burgdorferi* is most often not associated with clinical signs and complications are rare. The persistence of positive antibody titers complicates interpretation of post-Lyme-disease syndromes in both humans and dogs. Coinfections with other tick-borne diseases may explain cases of "chronic Lyme disease" or failure to respond to treatment.

In General

Relative Cost

- Treatment and follow-up care for uncomplicated cases: \$
- Diagnostic workup for suspected Lyme disease: \$\$
- Diagnostic workup and treatment of complicated Lyme nephritis: \$\$\$\$-\$\$\$\$\$

Cost Key

\$ = < \$100	\$\$\$\$ = \$500-1000
\$\$ = \$100-250	\$\$\$\$\$ = > \$1000
\$\$\$ = \$250-500	



at a glance

- Drug of choice: Doxycycline 10 mg/kg Q 24 H for 30 days
- Alternative drug: Amoxicillin 11 to 22 mg/kg Q 8-12 H for 30 days
- If oral medication not tolerated or severe disease: Ceftriaxone (Rocephin; Roche, www.roche.com) 25 mg/kg IV Q 12 H for 14 to 30 days

Prognosis

Both treated and untreated dogs generally recover from *B burgdorferi* exposure and infection without complications.^{1,5} Cases of Lyme nephritis have been uniformly fatal within weeks to months after diagnosis.³

Future Considerations

More studies are needed to demonstrate a causal link between *B burgdorferi* and glomerulonephritis and to investigate genetic predisposition. Improvements in diagnostic testing for actual organisms instead of antibody response to infection would be useful. Vaccination of seropositive dogs is controversial, and prospective challenge studies would help answer questions about vaccine efficacy. Veterinarians should monitor the environment as tick and host ranges may increase in the future due to climate change. ■

See Aids & Resources, back page, for references, contacts, and appendices.