

Lyme Disease in Dogs

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Revised: May 15, 2024

Published: December 06, 2003

[See the article summary below.](#)

The infection known today as Lyme disease (named after the Connecticut town of Lyme) has been around for at least a century; public awareness and confusion did not occur until the late 1980s. Media exposure to this infection virtually exploded, leaving most of the general public with some basic knowledge and concern about this infection as it pertains to themselves and their dogs. The canine experience of



This spirochete is the agent of Lyme disease.
Photo by CDC

Lyme disease is very different from that of a human infection.

Human Lyme Disease vs. Canine Lyme Disease

After exposure to the Lyme organism, 90% of humans will ultimately develop symptoms, but only about 5% of dogs will experience the disease.

The first lesson to be learned about Lyme disease infection is that, as mentioned, it manifests completely differently in man's best friend compared with the human experience. After being bitten by a tick that has transmitted *Borrelia burgdorferi*, 90% of humans will develop a rash and flu-like symptoms. In the next few weeks, 60% of infected people develop joint pain, with 15% of infected people



Ixodes scapularis is the main carrier of the *Borrelia burgdorferi*. Photo by USDA.



This is the characteristic skin rash shown by humans shortly after *Borrelia burgdorferi* infection. Dogs only rarely exhibit a similar rash with Lyme disease. Photo by CDC.

developing actual neurologic abnormalities associated with Lyme disease and 5% of people developing a heart rhythm disturbance called “A-V block. At this same point in the infection timeline, dogs have yet to develop any symptoms at all, and 95% of infected dogs never will.

In humans, Lyme disease presents with

the potential for serious long-term illness, while this is a possibility for only a small number of dogs.

When canine illness does occur, it does not begin to manifest for weeks to months after infection, at which point arthritis signs are noticed.

Sometimes, there is a fever. Most canine Lyme patients respond rapidly to a simple course of proper antibiotics, but some unlucky dogs develop associated kidney disease, so some related screening tests will be recommended for dogs testing positive for Lyme disease infection.

Heart and neurologic issues are exceedingly rare.

The *Borrelia burgdorferi* organism is well suited to live in the canine body without causing trouble. Most exposed dogs harbor the organism uneventfully. Still, it is important not to discount Lyme disease in dogs completely or an easily eliminated cause of chronic joint disease may be overlooked, especially in dogs of the Northeast U.S.

The infected dog’s most serious long-term potential is glomerular disease. This is a type of kidney damage that occurs when the immune system is stimulated over a long time by a latent infectious organism or



The larva (bottom right), nymph (bottom left), and adult female (top). Photo by CDC

other immune stimuli in hiding. This is a more insidious problem for which specific testing is needed (see below).

The Tick and Its Control

An organism that serves to transport and deliver an infectious organism from one host to another is called a vector. The vector of Lyme disease in the Northeastern United States is the deer tick, *Ixodes scapularis*. The female tick lays a clump of approximately 2,000 eggs in the spring. A small six-legged larva hatches and attaches to a host as soon as it is able. Since the larva is small, it typically can only reach a small host, usually a white-footed mouse.

If the mouse carries the Lyme disease spirochete, the baby tick will become infected when it drinks the mouse's blood. The tick won't get sick, but it will carry the Lyme organism with it throughout its life.

When the larva is full of blood, it will drop off the host and lie dormant until the following spring, about a year later. At this point, the larva molts and becomes a nymph. The nymph is a bit larger and may select another mouse as a host or may approach a larger game such as a dog or human. The nymph feeds for three to five days and when it is full it drops off and remains dormant until late summer. It then molts into an adult tick. When the nymph is feeding, it may infect its host with the Lyme spirochete. If the nymph was not already infected from its larval stage, it may become infected now during its spring feeding.

The adult tick seeks a larger host, hence its name the deer tick; however, with man encroaching upon the range of the deer, there are often plenty of dogs or humans for the tick to attack. The adult ticks mate on their new host, feed, and transmit the Lyme spirochete if they are carrying it. The male tick remains attached through the winter but the female, once engorged with the host's blood, drops off, hides under leaves and other debris through the winter, and in spring lays her eggs for the two-year cycle to begin again.

This process of transmitting *Borrelia burgdorferi* from the tick to the new mammal host requires a minimum of 48 hours, which means that if the tick is removed within 48 hours of attachment, the spirochete cannot be transmitted and the host will not get the disease.

Tick control on the host is an effective means of preventing infection. There are numerous effective tick control products available in assorted formats including chewable treats, collars, and topical spot-on treatments. All of these [products](#) either kill the tick or cause it to drop off before the 48-hour deadline.

On the west coast of [the United States](#), there is far less Lyme disease than in the east, although the northern coast of California is considered to have moderate risk. This is because the Lyme vector in these areas is primarily *Ixodes pacificus*, a tick whose nymphal and larval stages strongly prefer to feed on reptiles rather than mammals. Reptile blood has natural anti-*Borrelia* factors that kill the Lyme spirochete and prevent further transmission.

There are several subspecies of *Borrelia burgdorferi* in different parts of the world, so Lyme disease is not unique to the United States.

***Borrelia burgdorferi*: The Spirochete and Its Detection**

The spirochete that causes Lyme disease cannot live outside the body of a host. It must live within either a mammal or a tick.

In the mammal's body, the spirochete is especially adept at binding to connective tissue. If you are doing additional reading on this organism, you will encounter references to the spirochete's surface proteins called Osp (Osp stands for outer surface protein). Different Osps are expressed depending on whether the spirochete is attached to the tick midgut (OspA, OspB, and OspD) or the mammal's connective tissue (OspC). By modifying its Osps, the spirochete can change its presentation to the mammalian host's immune system thus escaping immune destruction. In addition to changing Osps, the spirochete can

change its presentation to the mammalian host's immune system, thus escaping immune destruction. In addition to changing Osps, the spirochete can change its shape into at least three different forms and can hide within cellular folds. The Lyme spirochete is a master of disguise and camouflage.

This camouflage presents an enormous diagnostic challenge: if the actual host's immune system can't even find the organism, how are we supposed to detect it?

Antibody Levels

A dog with symptoms of Lyme disease ideally should have a test to confirm or rule out Lyme disease. Since it is almost impossible to culture the Lyme spirochete, efforts have centered on the detection of antibodies against the Osps. The problems encountered with this method are:

- In a Lyme endemic area, as many as 90% of the dogs will have antibodies against the Lyme spirochete. Most exposed dogs never get sick but almost all of them will develop antibodies and these antibodies persist for years.
- How do we tell the dogs that have an active infection from those that have been exposed and are not sick from their exposure? (In other words, is our sick dog sick because of his Lyme disease infection, or is the Lyme infection incidental and he's sick from something else?).
- Vaccine has been available for Lyme disease for decades. How do we distinguish antibodies generated by the vaccine from those generated by natural infection?
- How do we distinguish antibodies generated by similar organisms (*Leptospira*, for example, or harmless other *Borrelia* species)?

The solution to some of these problems has come about in the form of the “C6 Antibody test.” This is an immunological test for antibodies against the “C6 peptide,” a very unique section of the *Borrelia burgdorferi* surface antigens. It is only displayed by the organism after transmission into the mammal host's body.

As the spirochete changes its configuration to escape the host's immune system, the C6 peptide remains constant and always detectable. The vaccine does not contain the C6 peptide so vaccinated dogs will not test positive. Dogs with other infections will not erroneously test positive. Furthermore, this test is simple enough to be available as an in-house test kit that can be run in most veterinary hospitals, with results in approximately 10 minutes.

This still does not address distinguishing active infection from exposure. Dogs will test C6 positive within 3-5 weeks of infection. They stay positive for over a year. Putting together a clinical diagnosis based on the test results and symptoms of the pet remains in the realm of the veterinarian in charge.

Testing Apparently Healthy Dogs

The American College of Veterinary Internal Medicine Consensus Statement on Lyme disease recommends testing any dog living in or recently visiting a Lyme endemic area for C6 antibodies. In areas where Lyme disease is common, this is typically done as part of the annual wellness visit along with heartworm testing. The idea is to identify infected dogs and then screen them for urinary protein loss to catch the diagnosis of Lyme Nephritis early. Since dogs do not generally get sick from their Lyme *Borrelia* infection, most experts do not recommend treating dogs for Lyme disease simply because they are positive for C6 antibodies but owners should be aware of the potential for Lyme disease symptoms in the future.

Treatment and Its Goals

Which of these dogs get sick and which do not? Does the dog with joint pain, fever, and a positive C6 test need medication? This is where the news is particularly good.

Treatment of Lyme disease utilizes a two to four-week course of [doxycycline](#) or its cousin minocycline. [Oral amoxicillin](#) or injectable cefovecin (Convenia®) can also be used as effective alternatives.

If Lyme disease is a consideration, many veterinarians simply prescribe the medication. An obvious improvement is seen within 48 hours. Furthermore, most tick-borne infections capable of causing joint pain, fever, and signs similar to Lyme disease generally all respond to doxycycline so a simple course of medication covers several types of infection.

Complete elimination of the Lyme spirochete is not a reasonable expectation with treatment; the organism is simply too good at hiding. The goal instead is to bring the patient into what is called a premunitive state, or when the immune system is in a protective mode. This is the state that 90% of infected dogs achieve when they get infected but never get ill: the organism is in their bodies latently but is not causing active infection or disease.

Glomerular Disease (Lyme Nephritis)

Discussing a particularly serious complication of *Borrelia burgdorferi* infection is important: Lyme nephritis. While this occurs in a small portion of infected dogs, the consequences to the kidneys are frequently severe. While, as noted, a good 90 percent of dogs infected with *Borrelia burgdorferi* never get sick, some infected dogs are harmed by the long-time presence of an infectious organism in their bodies. The immune system is constantly active in its attempt to remove the invading spirochete, and over the years these complexes of antibodies may deposit in the kidney and cause damage that can be severe. This group of dogs will likely require medication for their kidney disease: antibiotics, treatments to reduce protein loss in urine, and potentially immune suppressive therapy. It has been recommended that dogs with positive *Borrelia burgdorferi* antibody levels be regularly screened for

significant protein loss in their urine with a test called a “urine protein to creatinine ratio” so as not to miss these patients while their disease is still treatable.

Vaccination: Lyme Disease Vaccination

The object of vaccination is to prevent infection in dogs vaccinated before any exposure to Lyme spirochetes. A series of two vaccines is given with one dose 2-4 weeks apart followed by annual boosters. Some experts recommend a 6-month booster before going to the annual booster schedule. Dogs living or visiting Lyme areas will definitely need tick prevention and vaccination should be considered for additional protection.

Virtually all the vaccines act by blocking OspA. Basically the tick drinks in the vaccinated host's blood full of anti-OspA antibodies. The *Borrelia* organism needs OspA to effectively move into the tick's mouth parts for transmission to the host but with the tick's belly full of OspA antibodies, OspA is blocked and the spirochete is quarantined inside the tick.

Several types of vaccines have been marketed, and all of them are effective:

Killed Whole Bacterin

The killed whole spirochete vaccine uses intact dead spirochetes injected into the host. By using the entire spirochete, the host is exposed to parts of the organism that are not useful in immunization and has more potential to lead to vaccine reactions.

Recombinant OspA Vaccine

The next type of vaccine is felt to be superior in preventing reactions and that is the recombinant vaccine against OspA. This vaccine generates antibodies specifically against OspA, the surface protein the spirochete uses to attach to its tick host. When the tick bites and sucks blood full of Anti-OspA antibodies, the spirochete's migration sequence is blocked and the spirochete is prevented from even exiting the tick. The vaccine utilizes DNA for OspA cloned into a harmless virus so that the entire Lyme spirochete is not used; only the OspA DNA is used.

OspA and OspC Vaccine

The third type of vaccine targets both OspA, as above, and OspC. OspC is the surface protein the *Borrelia* organism expresses inside the dog. The idea is that the OspC antibodies target *Borrelia* organisms that make it inside the dog's body, theoretically providing enhanced protection.

Recombinant OspA plus Chimerized OspC Vaccine

This vaccine has all the advantages of the OspA attack and the advantages of recombinant technology. Taking things a step further is the Chimerized OspC portion. The idea here is that *Borrelia burgdorferi* expresses OspC in the dog's body, and generating antibodies against OspC enables the immune system to find the organism wherever it is hiding. The problem is that OspC is not one protein; there are many forms of OspC. Chimerizing OspC means taking seven versions of OspC and binding pieces together into one protein clump.

In this way, the immune system can be directed against multiple versions of OspC rather than only one.

Should Healthy Dogs That Test Positive Still Get Vaccinated?

Prevention of Lyme disease in the dog is based on the following principles: Vaccination, Education, and Tick control. Hopefully, we have covered all of this in this article.

This is a controversial subject and every veterinarian will have a perspective. Here are the pros and cons:

Argument For Vaccination

- Vaccines work by preventing new *Borrelia* organisms from entering the host. Whether or not a given dog develops actual symptoms of Lyme disease (nephritis in particular) will depend on how many organisms the dog has to deal with. Vaccination will minimize the number of organisms in the dog's body by preventing the entry of new organisms.

Argument Against Vaccination

- The idea that more organisms = more chance of disease is still theoretical.
- Unnecessary vaccine, especially if a "whole cell" vaccine is used, increases the chance of vaccination reaction.
- Some experts feel a 2-week course of antibiotics should be given to a positive dog before vaccination to reduce the load of organisms and reduce the chance of vaccination reaction. This practice is not likely to have side effects but any medication has that potential.

Dogs that are Lyme positive and sick (including having urinary protein loss) should not be vaccinated for Lyme disease.

When it comes to prevention, there is nothing controversial about tick control. It is crucial in Lyme-endemic areas to use tick-controlling products.

Lyme disease is a regional problem. For more guidance regarding this infection in your area, or areas where you will be traveling, see your veterinarian.

Additional Links

[CDC](#)

[AVMA](#)

In Summary:

- Lyme disease in dogs is quite different than in humans.
- 95% of infected dogs never will show symptoms.
- Weeks to months after infection, there may be signs of joint pain or a fever.
- Most serious long-term potential complication affects the kidneys - called [glomerular disease](#) or Lyme Nephritis.
- If the tick is removed before it has been attached for 48 hours, your dog cannot get Lyme disease. It takes 48

hours for the bacteria to transmit.

- It is recommended that any dog living in or recently visiting a high-risk area have a C6 antibody test to identify those dogs to monitor for future Lyme disease signs. That test is typically done during a wellness appointment, just like heartworm testing.
- Treatment usually consists of the antibiotic [doxycycline](#) or minocycline.
- Prevention includes vaccines and dedicated tick control.
- Many effective vaccines are available, each with its advantages and disadvantages. Vaccination prevents more of the organism from entering but the idea that more organism equals more chance of disease is still being researched. Your veterinarian will have advice as to which is best for your dog. [Back to top](#)

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