

While the infection we know today as Lyme disease (named for the Connecticut town of Lyme) has been around for at least a century, public awareness and confusion did not really occur until the late 1980s. Media exposure of this infection virtually exploded, leaving most of the general public with some basic knowledge and concern about this infection as it pertains to themselves as well as to their dogs. The canine experience of Lyme disease is very different from the human infection and we hope to sort out confusion here.

### **Human Lyme Disease vs. Canine Lyme Disease**

The first lesson to be learned about the 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*, 80 percent of humans will develop a rash and/or flu-like symptoms. In the next few weeks, joint pain ensues with 15 percent of people developing neurologic abnormalities associated with Lyme disease and five percent 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 90 percent of infected dogs never will.

Weeks to months after infection, about 60 percent of people will experience intermittent arthritis attacks and five percent will develop chronic neurologic manifestations. In humans, Lyme disease has the potential for serious long-term illness.

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. In dogs, heart and neurologic issues are exceedingly rare, plus the symptoms of canine Lyme disease generally respond rapidly to an inexpensive course of proper antibiotics (see below for details).

The *Borrelia burgdorferi* organism is fairly 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 lest you overlook an easily eliminated cause of chronic joint disease, especially in dogs of the Northeast U.S.

A dog's most serious long-term potential regards 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 other immune stimulus. This is a much 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 is carrying the Lyme disease spirochete, the larva can get infected at this point.

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 host or may approach larger game such as a dog or human. The nymph feeds 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.

The adult tick seeks a larger host, hence its name the deer tick. However, the feeding tick is basically a blood-sucker. It must keep its host's blood from clotting in order to continue sucking so it is able to regurgitate assorted enzymes to keep the blood flow liquid and smooth. It is during this regurgitation process that the Lyme spirochete is brought up from the tick's mid-gut to its mouthparts.

**This process of transmitting *Borrelia burgdorferi* from tick to 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 prior to 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 prefers to feed on reptiles rather than mammals. Reptile blood has natural anti-*Borrelia* factors that kill the Lyme spirochete and prevent further transmission.

A [color-coded map](#) searchable by zip code can show the prevalence of Lyme disease in any U.S. area.

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 is able to change its presentation to the mammalian host's immune system thus escaping immune destruction. In addition to changing Osps, the spirochete is able to 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 is able to hide within cellular folds. The Lyme spirochete is a master of disguise and camouflage.

**This camouflage presents an enormous diagnostic challenge: if the 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 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 active infection from those that have been exposed and are not sick from their exposure?

- 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 these problems has come about only recently in the form of the C6 test. This is an immunological test for antibody against the C6 peptide, a unique section of the one of the *Borrelia burgdorferi* surface antigens. As the spirochete changes its configuration to escape the host's immune system, the C6 peptide remains constant and always detectable. 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 to three to five weeks of infection. They stay positive for over a year.

#### 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. [Amoxicillin](#) can also be used as an effective alternative. If Lyme disease is a consideration, many veterinarians simply prescribe the medication. 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 actually covers several types of infection.

Eradication 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. 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.

#### Glomerular Disease (Lyme Nephritis)

It is important to discuss a particularly serious complication of *Borrelia burgdorferi* infection: 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 in fact 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 which 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: Yes or No?

The object of vaccination is to prevent infection in dogs vaccinated before any exposure to Lyme spirochetes. This means it is only helpful for dogs not yet exposed such as puppies and dogs from non-endemic areas travelling to endemic areas. Annual boosters continue the vaccine-based immunity

There are several types of vaccine that have been marketed.

#### 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 may lead to vaccine reaction. The recombinant vaccines are preferred.

#### 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 but also 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 as well as 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 where ever it is hiding. The problem is that OspC is not one protein; there are many forms of OspC. The chimerized OspC used in the vaccine takes pieces from seven different versions of OspC and binds them into an amalgamation. In this way, the immune system can be directed against multiple versions of OspC rather than only one.

Vaccination against the Lyme organism remains controversial. Understand both sides of the argument so you can decide if you want to use one.

#### Argument Against Vaccination

Lyme disease in dogs is an infection for which over 90 percent of infected dogs will never get sick and the five to ten percent that do get sick can be easily treated with a safe, inexpensive course of antibiotics. This situation would seem to indicate that vaccination is simply not worth the expense.

Vaccination of dogs already exposed and housing the organism is controversial. Visit with your veterinarian about this vaccine for your pet.

#### Argument for Vaccination

We vaccinate ourselves for the flu, an infection that is for most people more of a nuisance than a life-threatening event, and think nothing of it. Vaccination is about preventing infection; just because an illness is not life-threatening does not mean that we shouldn't prevent it with vaccine. Furthermore, in a non-endemic area, Lyme disease is not going to be a cause of arthritis that most veterinarians will consider. Treatment is only simple if you perform the treatment, but in an area where there is little Lyme disease, this treatment may easily be omitted. Why not just prevent the infection outright from the beginning if the dog is going to travel to a tick endemic area?

If we allow our dogs to readily become infected with the Lyme organism, do they not become a potential source for human infection through their ticks? We try to minimize the deer and mice in our vicinity and we want to keep company with the family dog, but who wants a reservoir of Lyme spirochete in their home?

As for the kidney disease, we do not know what spirochete antigens are implicated in this condition. The recombinant vaccine exposes the patient only to one spirochete antigen (OspA) and prevents introducing the spirochete into the mammal's body. Vaccination, at least with the recombinant vaccine, may prevent this syndrome.

**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.