



LYME DISEASE

Lyme disease is an infection caused by the *Borrelia burgdorferi* bacteria and is transmitted by ticks.

LYME DISEASE was recognized in Sweden as long ago as 1908. It was first identified in the United States in 1975, after a mysterious outbreak of arthritis among the residents of Lyme, Connecticut. Since then, reports of Lyme disease have increased dramatically, and the disease has become an important public health problem in some areas of the United States. Lyme disease is an infection caused by *Borrelia burgdorferi*, a member of the family of corkscrew-shaped bacteria known as spirochetes and is transmitted by ticks.



DISEASE TRANSMISSION

Ticks infected with *Borrelia burgdorferi* transmit Lyme disease. In the Northeast, the tick most commonly associated with the disease is the blacklegged tick, *Ixodes scapularis*. Some closely related ticks (i.e. *Ixodes pacificus* and *I. ricinus*) have been identified as transmitting the disease in other parts of the United States and the world.

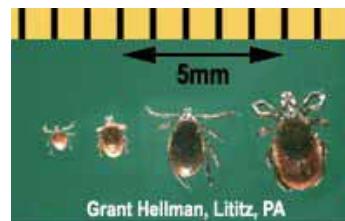


Ixodes scapularis



Borrelia burgdorferi

The larval and nymphal stages of the tick are no bigger than a pinhead (less than 2 mm). Adult ticks are only slightly larger. Research in the eastern United States has indicated that, generally, ticks transmit Lyme disease to humans during the nymphal stage, probably because nymphs are rarely noticed on a person's body due to their small size. Thus, the nymphs typically have ample time to feed and transmit the infection (ticks need at least 24 to 36 hours to transmit the infection).



Ixodes scapularis life stages



Engorged Female Tick

Ticks search for host animals from the tips of grasses and shrubs and transfer to animals or persons who brush against vegetation. They usually attach themselves in areas that are more hidden or hairy, such as the groin, armpits, and scalp. However, ticks can attach under watch bands and waistbands, and in many other body locations. Ticks feed on blood by inserting their mouthparts into the skin of a host animal. They are slow feeders: a complete blood meal can take 3 to 5 days.

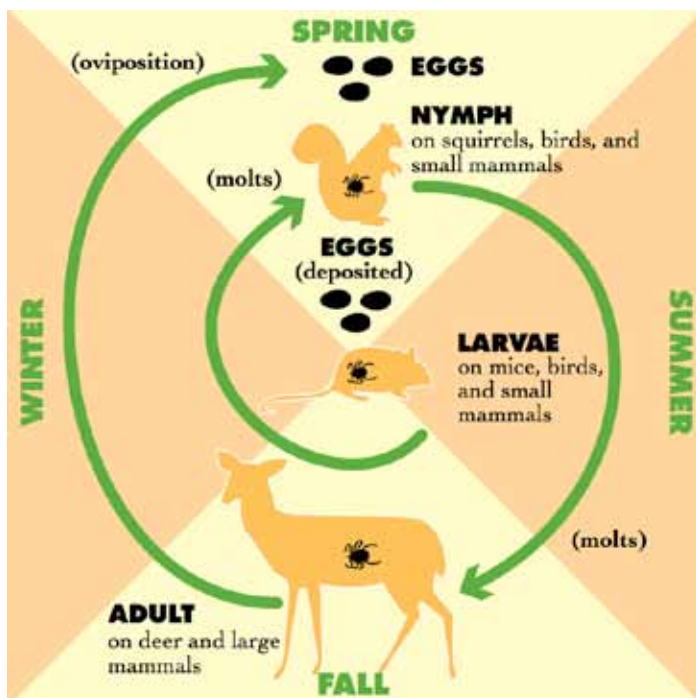
Although in theory Lyme disease could spread through blood transfusions or other contact with infected blood or urine, no such transmission has been documented. There is no evidence that a person can get Lyme disease from the air, food or water, from sexual contact or directly from wild or domestic animals. There is no convincing evidence that insects such as mosquitoes, flies, or fleas can transmit Lyme disease.

LIFE CYCLE OF THE BLACKLEGGED TICK

For Lyme disease to exist in an area, at least three closely inter-related elements must be present in nature: the Lyme disease bacteria, ticks that can transmit them, and mammals (such as mice and deer) to provide food for the ticks in their various life stages. Ticks that transmit Lyme disease can be found in temperate regions that may have periods of very low or high temperature and a constant high relative humidity at ground level.

Knowing the complex life cycle of the ticks that transmit Lyme disease is important in understanding the risk of acquiring the disease and in finding ways to prevent it.

The life cycle of these ticks requires 2 years to complete. Adult ticks feed and mate on large animals, especially deer, in the fall and early spring. Female ticks then drop off these animals to lay eggs on the ground. By summer, eggs hatch into larvae.



Larvae feed on mice and other small mammals and birds in the summer and early fall and then are inactive until the next spring when they molt into nymphs.

Nymphs feed on small rodents and other small mammals and birds in the late spring and summer and molt into adults in the fall, completing the 2-year life cycle.

Larvae and nymphs typically become infected with Lyme disease bacteria when they feed on infected small animals, particularly the white-footed mouse. The bacteria remain in the tick as it changes from larva to nymph or from nymph to adult. Infected nymphs and adult ticks then bite and transmit Lyme disease bacteria to other small rodents, other animals, and humans, all in the course of their normal feeding behavior.

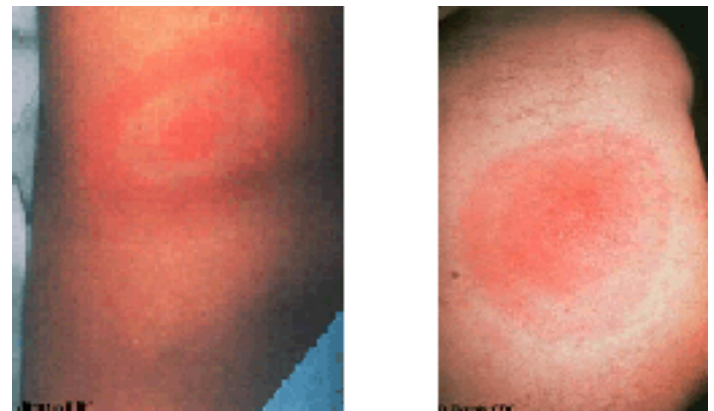
SYMPTOMS, DIAGNOSIS AND TREATMENT

Early Lyme Disease

The early stage of Lyme disease is usually marked by one or more of the following symptoms and signs:

- Fatigue
- Chills and fever
- Headache
- Muscle and joint pain
- Swollen lymph nodes
- a characteristic shin rash called erythema migrans

Erythema migrans is a red circular patch that appears usually 3 days to 1 month after the bite of an infected tick at the site of the bite. The patch then expands, often to a large size. Sometimes many patches appear, varying in shape, depending on their location. Common sites are the thigh, groin, trunk, and the armpits. The center of the rash may clear as it enlarges, resulting in a bulls-eye appearance. The rash may be warm, but it usually is not painful. Not all rashes that occur at the site of a tick bite are due to Lyme disease, however. For example, an allergic reaction to tick saliva often occurs at the site of a tick bite. The resulting rash can be confused with the rash of Lyme disease. Allergic reactions to tick saliva usually occur within hours to a few days after the tick bite, usually do not expand, and disappear within a few days.



Examples of erythema migrans

Late Lyme Disease

Some symptoms and signs of Lyme disease may not appear until weeks, months, or years after a tick bite:

- Arthritis is most likely to appear as brief bouts of pain and swelling, usually in one or more large joints, especially the knees.
- Nervous system abnormalities can include numbness, pain, Bell's palsy (paralysis of the facial muscles, usually on one side), and meningitis (fever, stiff neck, and severe headache).
- Less frequently, irregularities of the heart rhythm occur.
- In some persons the rash never forms; in some, the first and only sign of Lyme disease is arthritis, and in others, nervous system problems are the only evidence of Lyme disease.

Late Disease and Pregnancy

In rare cases, Lyme disease acquired during pregnancy may lead to infection of the fetus and possibly to stillbirth, but adverse effects to the fetus have not been conclusively documented. The Centers for Disease Control and Prevention (CDC) maintains a registry of pregnant women with Lyme disease to advance the understanding of the effects of Lyme disease on the developing fetus.

Diagnosis

Lyme disease is often difficult to diagnose because its symptoms and signs mimic those of many other diseases. The fever, muscle aches, and fatigue of Lyme disease can easily be mistaken for viral infections, such as influenza or infectious mononucleosis. Joint pain can be mistaken for other types of arthritis, such as rheumatoid arthritis, and neurologic signs can mimic those caused by other conditions, such as multiple sclerosis. At the same time, other types of arthritis or neurologic diseases can be misdiagnosed as Lyme disease.

Diagnosis of Lyme disease should take into account:

- History of possible exposure to ticks, especially in areas where Lyme disease is known to occur.
- Symptoms and signs.
- The results of blood tests used to determine whether the patient has antibodies to Lyme disease bacteria

These tests are most useful in later stages of illness, but even then they may give inaccurate results. Laboratory tests for Lyme disease have not yet been standardized nationally.

Treatment and Prognosis

Lyme disease is treated with antibiotics under the supervision of a physician. Several antibiotics are effective. Antibiotics usually are given by mouth but may be given intravenously in more severe cases. Patients treated in the early stages with antibiotics usually recover rapidly and completely. Most patients who are treated in later stages of the disease also respond well to antibiotics. In a few patients who are treated for Lyme disease, symptoms of persisting infection may continue or recur, making additional antibiotic treatment necessary. Varying degrees of permanent damage to joints or the nervous system can develop in patients with late chronic Lyme disease. Typically these are patients in whom Lyme disease was unrecognized in the early stages or for whom the initial treatment was unsuccessful. Rare deaths from Lyme disease have been reported.

Preventive Antibiotic Treatment

Antibiotic treatment to prevent Lyme disease after a known tick bite may not be warranted. Physicians must determine whether the advantages of using antibiotics outweigh the disadvantages in any particular instance. If antibiotics are not used, physicians should alert patients to the symptoms of early Lyme disease and advise them to return for reevaluation if symptoms occur. Recent studies on the prophylactic value of single-dose doxycycline for the prevention of Lyme disease indicate that a 200-mg dose administered within 72 hours of tick removal can prevent disease in 87% of test subjects. However, it is worth noting that several prior controlled treatment trials found no benefit in prophylaxis.

EPIDEMIOLOGY

Wooded, brushy places are common blacklegged tick habitats. Campers, hikers, outdoor workers, and others who frequent wooded, brushy, and grassy places are commonly exposed to ticks, and this may be important in the transmission of Lyme disease in some areas. Because new homes are often built in wooded areas, transmission of Lyme disease near homes has become an important problem in some areas of the United States. The risk of exposure to ticks is greatest in the woods and garden fringe areas of properties, but ticks may also be carried by animals into lawns and gardens.

Lyme disease has a wide distribution in northern temperate regions of the world. In the United States, the highest incidence occurs in:

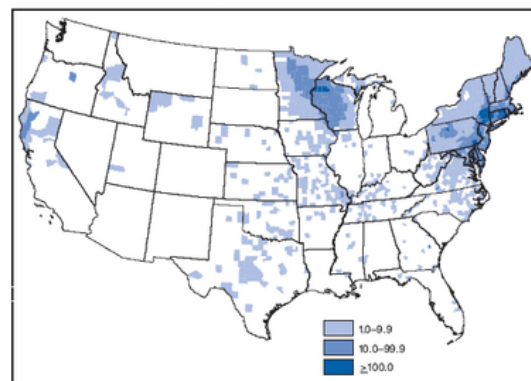
- Northeast, from Massachusetts to Maryland
- North-central states, especially Wisconsin and Minnesota
- West Coast, particularly northern California

Reported Cases of Lyme Disease -- United States, 2007



In Pennsylvania, the majority of the Lyme disease cases originate in the southeastern counties surrounding Philadelphia. Additionally, residents in the counties of Butler, Cameron, Clearfield, Elk, McKean, Monroe and Pike are also at higher risk.

FIGURE 2. Average rate* of Lyme disease, by county of residence† — United States, 1992–2006‡



* Per 100,000 population.

† County of residence was available for 98.1% of cases reported during 1992–2006.

‡ During 2003, Pennsylvania reported 4,722 confirmed cases and 1,008 suspected cases.

Ticks submitted to the Department of Entomology, PSU, since 1988 indicate that the blacklegged tick is increasing in range and abundance within Pennsylvania. Data obtained from the Pennsylvania Department of Health indicates that the areas of greatest risk of acquiring Lyme disease closely coincide with the PSU tick distribution data.

DISEASE PREVENTION

Tick Control

Removing leaves and clearing brush and tall grass around houses and at the edges of gardens may reduce the numbers of ticks that transmit Lyme disease. This is particularly important in the eastern United States, where most transmission of Lyme disease is thought to occur near the home.

Applying acaricides (chemicals that are toxic to ticks) to gardens, lawns, and the edge of woodlands near homes may be advisable in some situations. Various organophosphate, synthetic pyrethroid, and carbamate active ingredients are effective acaricides however, consideration should be given to impacts on non-target organisms. All applications must adhere to the label instructions. A licensed professional pest control expert should supervise application to residential properties.

A relationship has been observed between the abundance of deer and the abundance of deer ticks in the eastern United States. Reducing and managing deer populations in geographic areas where Lyme disease occurs may reduce tick abundance. Removing plants that attract deer and constructing physical barriers may help discourage deer from coming near homes.

The chances of being bitten by a tick can be decreased with a few precautions:

- Avoid tick-infested areas, especially in May, June, and July (many local health departments and park or extension services have information on the local distribution of ticks).
- Wear light-colored clothing so that ticks can be spotted more easily
- Tuck pant legs into socks or boots and shirt into pants.
- Tape the area where pants and socks meet so that ticks cannot crawl under clothing.
- Spray insect repellent containing DEET on clothes and on exposed skin other than the face, or treat clothes (especially pants, socks, and shoes) with permethrin, which kills ticks on contact.
- Wear a hat and a long-sleeved shirt for added protection.
- Walk in the center of trails to avoid overhanging grass and brush.

After being outdoors, remove clothing and wash and dry it at a high temperature; inspect body carefully and remove attached ticks with tweezers, grasping the tick as close to the skin surface as possible and pulling straight back with a slow steady force; avoid crushing the tick's body. In some areas (Pennsylvania), ticks (saved in a sealed container) can be submitted to the local health department or Penn State Cooperative Extension office for identification.

LYME DISEASE AND DOGS

Most dogs, even though they have been exposed to *Borrelia burgdorferi*, never exhibit any signs of Lyme disease. In certain highly endemic areas of New York and New Jersey dogs exhibit almost a 90% rate of exposure as evidenced by serosurvey. However, only about 4% of the dogs exhibit signs of Lyme disease including lameness, poor appetite and fever. Treatment of these animals with antibiotics typically results in rapid recovery.

A few dogs can develop lesions on the kidneys (Lyme nephropathy) and may not respond to antibiotic treatment. Interestingly, dogs susceptible to this condition may not be protected by the Lyme vaccines currently available. In fact, there are concerns that the vaccine may possibly sensitize a genetically predisposed individual to having a more intense immune-mediated reaction to Lyme antigens, or the vaccine may add to antigen-antibody complex deposition in tissues (Meryl P. Littman, VMD, DACVIM, University of Pennsylvania).

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