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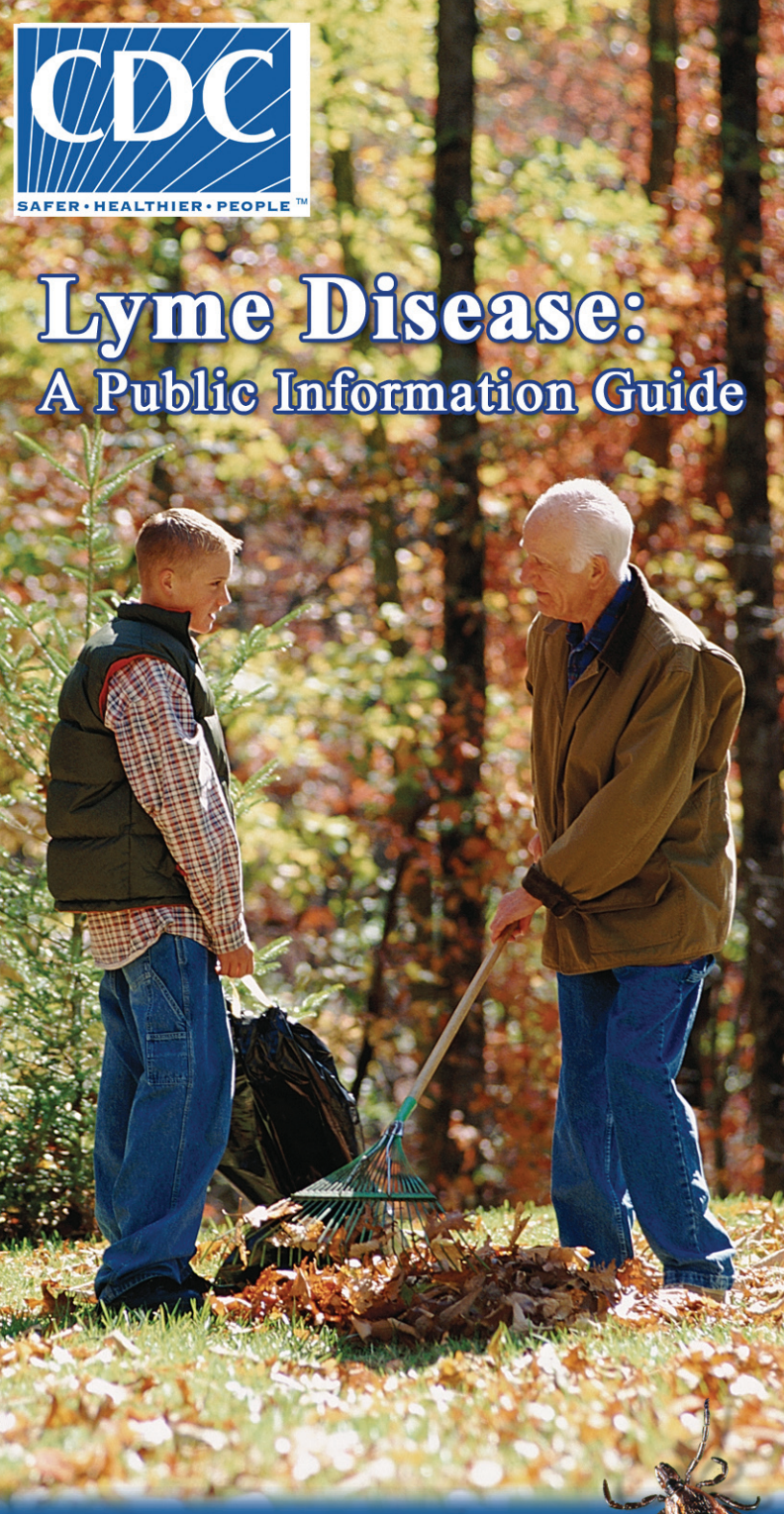
Lyme Disease:
A Public Information Guide

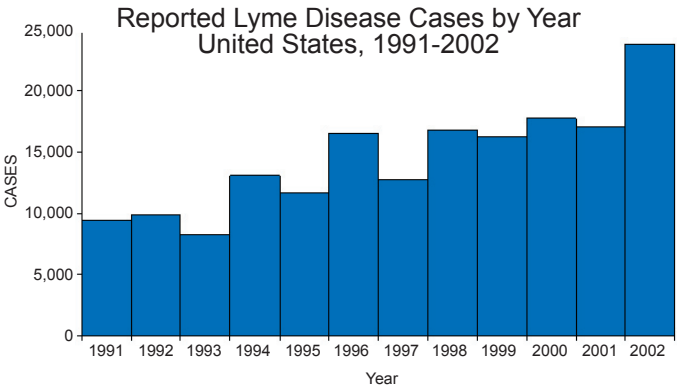


Centers for Disease Control and Prevention

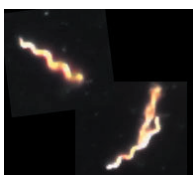
DEPARTMENT OF HEALTH AND HUMAN SERVICES

LYME DISEASE

Lyme disease was first recognized in the United States in 1975, after an unusual outbreak of arthritis near 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.



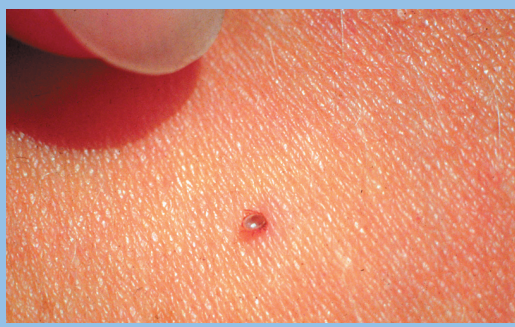
How ticks spread the disease



Lyme disease is an infection caused by the corkscrew-shaped bacterium *Borrelia burgdorferi*, a member of the family of spircohetes.

The Lyme disease bacterium, *Borrelia burgdorferi,* is spread through the bite of infected ticks. The black -legged tick (or deer tick, *Ixodes scapularis*) spreads the disease in the northeastern and north-central United States, and the western black-legged tick (*Ixodes pacificus*) spreads the disease on the Pacific Coast. These ticks are usually found in wooded areas and have complex life cycles. In some regions, black-legged ticks can spread other diseases in addition to Lyme disease, including babesiosis and anaplasmosis (formerly known as ehrlichiosis). In general, ticks need to be attached for 36 to 48 hours before they can transmit the Lyme disease bacterium.

Most humans are infected through the bites of immature ticks called nymphs. Nymphs are tiny (less than 2 mm) and difficult to see; they feed during the spring and summer months.



(Used with permission of Durland Fish)

Ticks can attach to any part of the human body but are often found in hard-to-see areas such as the groin, armpits, and scalp. In most cases, the tick must be attached for 36-48 hours or more before the Lyme disease bacterium can be transmitted. Shown is an attached *Ixodes* nymph.

Adult ticks can also transmit Lyme disease bacteria, but they are much larger and may be more likely to be discovered and removed before they have had time to transmit the bacteria. Adult *Ixodes* ticks are most active during the cooler months of the year.

***Ixodes* ticks are much smaller than the common dog and cattle ticks. In their larval and nymphal stages, they are no bigger than a pinhead. Adult *Ixodes* ticks are larger, about the size of a small apple seed. Left to right: Adult Female, Adult male, nymph, larva**

photo by John Montenieri

Ixodes ticks search for host animals from the leaf litter of the forest floor or from the tips of grasses and shrubs. Ticks crawl on to animals or persons as they brush against them; ticks cannot jump or fly. Ticks found on the scalp usually have crawled there from lower parts of the body. Ticks feed on blood by inserting their mouth parts (not their whole bodies) into the skin of a person or animal. *Ixodes* ticks are slow feeders: a complete blood meal can take several days. As they feed, their bodies slowly enlarge.

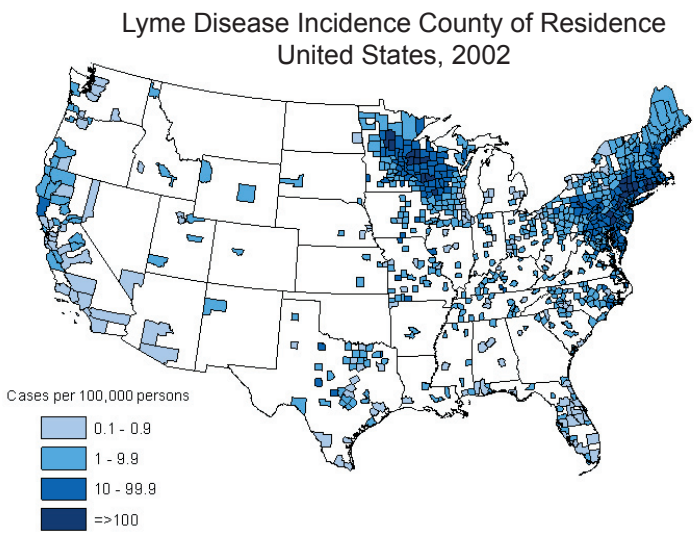
Although in theory Lyme disease could be spread through blood transfusions or other contact with infected blood, there are no known cases of this happening. There is no definitive evidence that a person can get Lyme disease from the air, food, or water; from sexual contact; from insects such as mosquitoes, flies or fleas; or directly from wild or domestic animals.

The risk of exposure to ticks is greatest in the woods and in the edge area between lawns and woods. But ticks can also be carried by animals into lawns and gardens and into houses by pets. Campers, hikers, outdoor workers, and others may be exposed to infected ticks in wooded, brushy, and grassy places. People living in houses built in heavily wooded areas where infected ticks are common may also be at higher risk for exposure.

Geographic distribution

Lyme disease is distributed over a wide geographic area in northern temperate regions of the world. In the United States, most infections occur in the following areas:

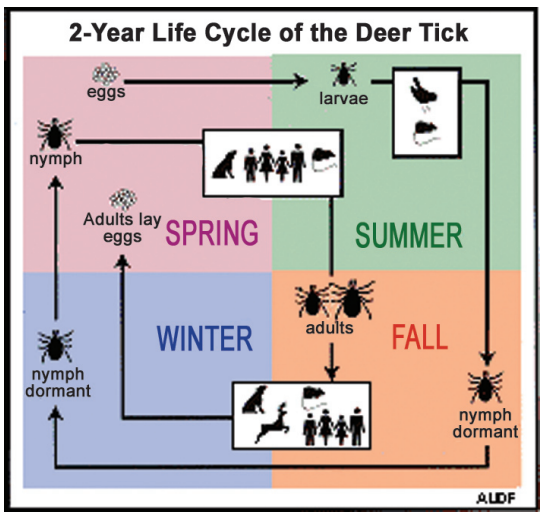
- Northeast, from Maryland to Maine
- North-central states, mostly in Wisconsin and Minnesota
- West Coast, particularly northern California



For Lyme disease to exist in an area, three elements must be present in the natural environment: 1) animals that are infected with Lyme disease bacteria, 2) ticks that can transmit the bacteria, and 3) animal hosts (such as mice and deer) that can provide food for the ticks in their various life stages. Ticks that transmit Lyme disease bacteria can be found in temperate regions that have a constant high relative humidity at ground level.

Life cycle of Lyme disease ticks

Knowing the complex life cycle of the ticks that transmit Lyme disease bacteria can help in understanding the risk of getting the disease and how to prevent it.



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The complete life cycle of *Ixodes* ticks requires 2 years. Tick **eggs** are laid in the spring, and hatch as larvae in the summer. **Larvae** feed on mice, birds, and other small animals in the summer and early fall. The larvae may become infected with Lyme disease bacteria when feeding on these animals. Once a tick becomes infected, it stays infected for the rest of its life and can transmit the bacteria to other hosts. After this initial feeding, the larvae usually become inactive until the following spring, when they change into nymphs. **Nymphs** seek blood meals in order to fuel their growth into adults.

Nymphs feed on small rodents, birds, and other small mammals in late spring and early summer. Nymphs will also feed on humans, and if previously infected with the Lyme disease bacterium, they can transmit the disease to humans. Nymphs molt into adult ticks in the fall. In the fall and early spring, **adult ticks** feed and mate on large animals, such as deer. Adult female ticks will sometimes also feed on humans. In spring, adult female ticks lay their eggs on the ground, completing the 2-year life cycle.

Lyme disease in domestic animals

Domestic animals may become infected with Lyme disease bacteria and some of these (dogs, for instance) may develop arthritis. Domestic animals can carry infected ticks into areas where people live. Studies to determine whether pet owners have an increased risk of Lyme disease have been inconclusive. Veterinary tick control products may be helpful to reduce the presence of ticks on pets.

Signs and symptoms of Lyme disease

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

- a characteristic skin rash, called erythema migrans
- fatigue
- chills and fever
- headache
- muscle and joint pain
- swollen lymph nodes

Erythema migrans is a red circular patch that appears at the site of the tick bite, usually within 3 days to 1 month after the bite of an infected tick. The patch then grows larger. Sometimes many patches appear, varying in shapes and sizes. Common sites are the thighs, groin, trunk, and armpits. The center of the rash may clear as it enlarges, resulting in a "bull's-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. An allergic reaction to tick saliva

photo by N.Y. Medical College

often occurs at the site of a tick bite and may be confused with the "bull's-eye" rash of Lyme disease. Allergic reactions to tick saliva usually appear within hours to a few days after the tick bite, usually do not expand, and disappear within a few days.

Late Lyme Disease: Some signs and symptoms 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 symptoms can include numbness, pain, nerve paralysis (often of the facial muscles, usually on one side), and meningitis (fever, stiff neck, and severe headache).
- Rarely, irregularities of the heart rhythm may occur.
- Problems with memory or cognition, fatigue, headache, and sleep disturbances sometimes persist after treatment.

Different people exhibit different signs and symptoms of Lyme disease. Some people never develop a bull's eye rash. Some people only develop arthritis, and for others nervous system problems are the only symptom of Lyme disease.

Diagnosis

Many of the symptoms of Lyme disease are similar to those of other diseases. The fever, muscle aches, and fatigue of Lyme disease can 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. Other infections, arthritis, or neurologic diseases can also be misdiagnosed as Lyme disease.

Diagnosis of Lyme disease should take into account the following factors:

- History of possible exposure to ticks in areas where Lyme disease is known to occur.
- Signs and symptoms of the illness.
- The results of blood tests used to detect whether the patient has antibodies to the Lyme disease bacterium (*Borrelia burgdorferi*).

Laboratory tests for Lyme disease must be interpreted in relation to a person's recent medical history, and signs and symptoms. Both false-positive (the test results read positive, but the patient is not infected with Lyme disease-causing bacteria) and false-negative test results (the results read negative, but the patient is infected with Lyme disease-causing bacteria) may occur.

Currently, a two-stage testing process to measure the body's production of antibodies to the Lyme disease bacterium is recommended:
(1) an enzyme-linked immunosorbent assay (ELISA) or indirect immunofluorescence assay (IFA), followed by
(2) a Western immunoblot of samples that tested positive or equivocal by ELISA or IFA.

These tests do not detect an infection until the body begins to produce measurable levels of antibodies to the Lyme disease bacterium, usually 2-4 weeks after the bite of an infected tick. Therefore, while these tests are good for identifying Lyme disease in patients with late-stage symptoms such as arthritis, they may be falsely negative in patients with erythema migrans (rash).

Treatment and prognosis

Several antibiotics are effective for treating Lyme disease. These are usually given by mouth but may be given intravenously in more severe cases. Patients treated with antibiotics in the early stages of the infection usually recover rapidly and completely. Most patients who are treated in later stages of the disease also respond well to antibiotics. A few patients may have persistent or recurrent symptoms and may require a second 4-week course of antibiotic treatment. Longer courses of antibiotics have not been shown to be beneficial in patients who have been previously treated and have chronic symptoms. Varying degrees of permanent damage to joints or the nervous system can develop in patients with late Lyme disease. Typically these are patients in whom Lyme disease was unrecognized in the early stages or for whom the initial treatment was inadequate. Lyme disease is rarely fatal.

Lyme disease and pregnancy

Prevention and early diagnosis of Lyme disease are important during pregnancy. Rarely, Lyme disease acquired during pregnancy may lead to infection of the placenta and may possibly lead to stillbirth. Studies of women infected during pregnancy have found that there are no negative effects on the fetus when the mother receives appropriate antibiotic treatment for her Lyme disease.

Prevention

There are several approaches to Lyme disease prevention, including personal protection, tick control, post-exposure antibiotics, and early diagnosis and treatment.

Personal protection from tick bites

You can decrease the chances of being bitten by a tick with a few precautions.

Avoid tick-infested areas! This is especially important in May, June, and July. Many local health departments and park or extension services have information on the local distribution of ticks. If you are in tick infested areas, walk in the center of trails to avoid contact with overgrown grass, brush, and leaf litter at trail edges.

Use insect repellent! *Spray insect repellent containing a 20-30% concentration of DEET* on clothes and on exposed skin; use 10% DEET for children. You can also treat clothes (especially pants, socks, and shoes) with permethrin, which kills ticks on contact. Permethrin can also be used on tents and some camping gear. Do not use permethrin directly on skin. Always follow the manufacturer's instructions when applying any repellents.

Wear protective clothing! Long pants and long sleeves help keep ticks off your skin. Light-colored clothing will help you spot ticks more easily. You can even tuck pant legs into socks or boots and shirt into pants to keep ticks on the outside of clothing. Tape the area where pants and socks meet so that ticks cannot crawl under clothing.

Ticks can get a ride indoors on your clothes. After being outdoors, wash and dry clothing at a high temperature to kill any ticks that may remain on clothing.

Repellent use

Tick removal

Perform daily tick checks! Always check for ticks after being outdoors, even in your own yard. Because ticks must usually be attached for at least a day before they can transmit the bacteria that cause Lyme disease, early removal can reduce the risk of infection. Inspect all body surfaces carefully, and remove attached ticks with tweezers. Avoid crushing the tick's body. DO NOT use petroleum jelly, a hot match, nail polish, or other products. Grasp the tick firmly and as closely to the skin as possible. With a steady motion, pull the tick's body away from the skin. Do not be alarmed if the tick's mouthparts remain in the skin. Cleanse the area with an antiseptic.

Tick Control

Landscaping to create Tick-Safe Zones! "Tick-Safe Landscaping" techniques should be considered for homes, parks, fields, and recreational areas. *Ixodes* ticks need the higher humidity levels of the woodland to survive; they die quickly in drier environments. Increasing exposure to sun and air by removing leaf litter and clearing tall grass and brush around houses and at the edges of lawns will reduce the numbers of ticks that transmit Lyme disease. Laying down wood chips or gravel where lawns and recreational areas butt up against wooded areas can reduce the number of ticks on grassy areas by creating a drying barrier.

photo by K. Stafford, Connecticut Agricultural Experiment Station

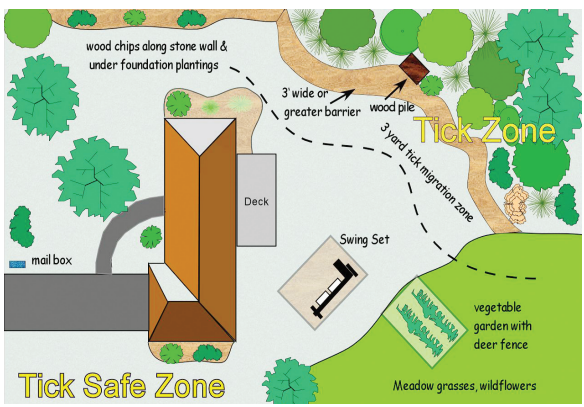

diagram by K. Stafford, Connecticut Agricultural Experiment Station

Chemical control! The use of pesticides to control tick populations is another highly effective option. Pesticide application to residential properties should be supervised by a licensed professional pest control expert and should be conducted when nymphal *Ixodes* populations are at their local peaks.

Discourage Deer! A relationship exists between the abundance of deer and the abundance of *Ixodes* ticks in the eastern United States. Tick populations do not decrease substantially unless deer are eradicated or severely reduced. Removing plants that attract deer and constructing physical barriers may help discourage tick-infested deer from coming near homes. Lists of deer-resistant plantings are available from garden centers, nurseries, or local extension agents.

Post-exposure Antibiotics

Recent studies have examined the value of giving antibiotics to prevent Lyme disease after a known tick bite. While giving antibiotics for tick bites is not routinely practiced, it may be beneficial in some cases, depending on disease presence in the local area and duration of tick attachment. Physicians must determine whether the advantages of using antibiotics outweigh the disadvantages in any particular instance.

Early Diagnosis and Treatment

The early diagnosis and proper treatment of Lyme disease are important strategies to avoid the costs and complications of infection and late-stage illness. As soon as you notice a characteristic rash or other possible symptoms, consult your health care provider.

For the Guidelines of the Infectious Diseases Society of America, see the CDC website www.cdc.gov/ncidod/dvbid/lyme/IDSA_2000.htm

Lyme disease vaccine

A vaccine for Lyme disease has been developed but is no longer available. The vaccine manufacturer discontinued production in 2002, citing insufficient consumer demand.

Lyme disease research

Research continues to address the following concerns:

- Where ticks are most likely to be and how best to protect against them.
- Which chemicals and other alternative strategies are best for controlling ticks in each kind of habitat.
- Ways of making diagnostic tests more accurate.
- How to improve antibiotic treatment.
- How Lyme disease bacteria cause chronic disease of the joints and nervous system and how to prevent these complications.

For more information about Lyme disease:

Web site: http://www.cdc.gov/ncidod/dvbid/lyme/index.htm

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