

Targeting Lyme



disease

Did you know that deer ticks can live for up to 2 years and are able to survive in the winter? During the winter months, ticks can be active when temperatures increase to 35° F or higher. Learn how to protect your patients year round.

By Amanda Perkins, MSN, RN

Lyme disease is the most common arthropod-borne illness found in the United States, seen throughout America and in more than 60 countries worldwide. It's caused by the bacterial spirochete *Borrelia burgdorferi*, which is transmitted to humans through a tick bite, traveling through the bloodstream and establishing itself in the body. Once a person is infected, Lyme disease can be difficult to detect because it can affect any body system, causing a wide variety of symptoms.

The ticks responsible for the transmission of Lyme disease are deer ticks, western black-legged ticks, and black-legged ticks (see *Ticks responsible for Lyme disease*). Ticks are members of the arachnid family and can be as small as 2 mm or less. They're so small that they can be difficult to feel or see when they're on a person.

In this article, you'll learn about the transmission, signs and symptoms, diagnosis, treatment, and prevention of Lyme disease, including your role in prevention and treatment.

The tick

There are approximately 850 tick species worldwide. Of those, 82 of them can be found in the United States and are known to cause 10 major diseases. The majority of American Lyme disease cases occur along the eastern coast and in the upper Midwest states (see *Lyme disease in the United States*).

Many people consider ticks insects, but they're actually arachnids. With the exception of one stage of development—the larval stage—ticks have eight legs like spiders. When in the larval stage, ticks have six legs, instead of eight. In addition to being arachnids, ticks are also parasites, requiring the consumption of blood to survive.

Ticks move through four stages of development: egg, larva, nymph, and adult. They need to feed in each stage of development or they'll die. After feeding in each stage, the ticks will enter a dormant period as it prepares to enter the next stage of development. Ticks are born uninfected with Lyme disease, but have the opportunity to contract it in each stage of development. After feeding on an infected host, the tick is able to pass on Lyme disease to humans. Once a tick has been infected with Lyme disease, it's able to continue passing along the disease for the remainder of its life, which can last up to 2 years.

In many cases, Lyme disease is transmitted by ticks in the nymph stage because they're very small and much harder to detect than adult ticks. Additionally, due to the small size of the tick in the nymph stage, the bite is usually not felt, making detection more difficult. Adult ticks are much bigger than those in the nymph stage and are more likely to be discovered and removed before they've been attached long enough to transmit Lyme disease.

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Ticks responsible for Lyme disease



Deer tick



Black-legged tick



Western black-legged tick

PHOTO BY CDC / JAMES GATHANY

Ticks that carry Lyme disease may be found in the following locations:

- wooded areas
- the border between wooded areas and lawns
- tall grass
- under leaves and plants
- around stone walls
- around woodpiles
- on animals, such as dogs, cats, horses, and birds.

Ticks are typically found in areas where the animals they feed on are located. Generally, ticks thrive and will be more active in

cooler, damp environments. They tend to be less active in hot, dry environments.

Transmission

In order to understand how Lyme disease is transmitted, you need to understand the chain of infection, which consists of the following six components:

- infectious agent/disease
- reservoir
- portal of exit
- mode of transmission
- portal of entry
- susceptible host.

For an infection such as Lyme disease to occur, the chain of infection must remain intact. If any of the links in the chain are broken, a person won't contract Lyme disease.

Infectious agent/disease

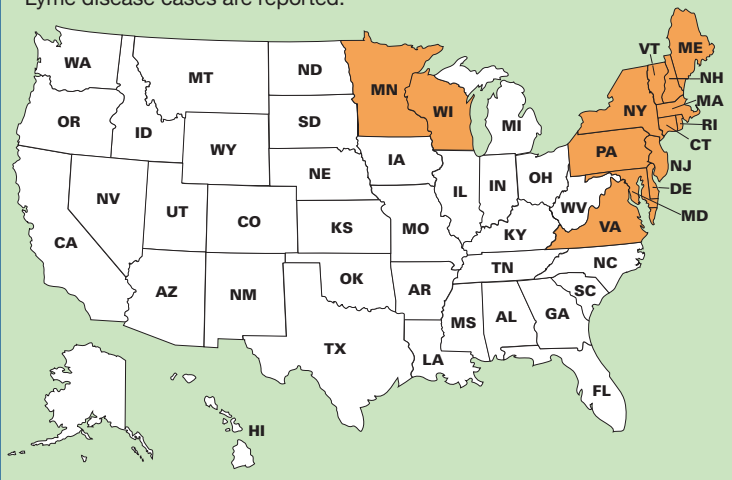
The infectious agent/disease in the chain of infection is the microorganism that causes the disease. In the case of Lyme disease, the infectious agent/disease is *B. burgdorferi*.

Reservoir

The reservoir is the place where the microorganism resides. When it comes to Lyme disease, the reservoir is the tick. Ticks feed on animals infected with Lyme disease, such as mice and deer. After feeding on the infected animal, the tick becomes the reservoir and is then ready to infect humans.

Lyme disease in the United States

The following 14 states are the location in which 95% of all American Lyme disease cases are reported.





Portal of exit

The portal of exit is the area in which the microorganism leaves the reservoir. With Lyme disease, the portal of exit is the tick's feeding tube.

Mode of transmission

The mode of transmission is the way in which the microorganism is transferred from one carrier (tick) to another (human). Lyme disease is directly transmitted to humans through tick bites. Ticks can attach to any part of the body and, in many cases, will attach in hard-to-see locations, such as the scalp or groin. Typically, a tick must be attached to a human for 36 to 48 hours before *B. burgdorferi* can be transmitted.

Portal of entry

The portal of entry is the opening in which the microorganism is able to enter the host's body. With Lyme disease, the tick bites a human, creating an opening in the skin through which the microorganism can be transferred. When the tick finds a susceptible host, in this case a human, the tick will grasp the skin and cut it, allowing for the insertion of the tick's feeding tube. In some instances, the tick's feeding tube will have barbs on it, making removal more difficult. Additionally, some ticks are able to secrete a cement-like substance once they've inserted the feeding tube, keeping it in place.

Susceptible host

The susceptible host is the individual at risk for contracting an infection; in this case, Lyme disease. Anyone can be a susceptible host, but those most at risk for Lyme disease are individuals who spend time in wooded areas where ticks are more commonly found.

Signs and symptoms

Lyme disease is a multisystem disease with a variety of symptoms that can mimic those associated with other diseases, making diagnosis difficult. The following stages occur with Lyme disease and each has its

own associated symptoms:

- early localized stage (3 to 30 days after the tick bite)
- early disseminated stage (days to weeks after the tick bite)
- late disseminated stage (months to years after the tick bite).

Early localized stage

In the early localized stage, erythema migrans, or the bull's eye rash, may develop. According to the CDC, the classic bull's eye rash that's associated with Lyme disease is seen in 70% to 80% of Lyme disease cases (see *Picturing bull's eye rash*). Typically, the rash will develop at the site of the tick bite, but may also be seen in other areas of the body. The bull's eye rash starts out small and will expand over the course of a few days, up to 12 inches in diameter. It's characterized by a central red/pink spot surrounded by a clear ring, which is surrounded by a red/pink ring. Please note that in dark-skinned patients, the rash may look like a bruise. It may be warm when palpated, but typically causes no pain or discomfort.

In addition to, or in the absence of, the bull's eye rash, patients may complain of the following symptoms:

- flu-like symptoms
- fatigue
- chills
- fever
- headache
- nausea
- sweating
- muscle pain
- joint pain
- swollen lymph nodes.

key points

- In most cases, ticks must be attached for 36 to 48 hours before Lyme disease can be transmitted.
- Symptoms of Lyme disease may mimic those associated with other diseases.
- The classic bull's eye rash is seen in 70% to 80% of all cases.
- The stages associated with Lyme disease are early localized, early disseminated, and late disseminated.
- The best way to prevent Lyme disease is to eliminate or reduce exposure to ticks. Prevention is key!
- Instruct patients to conduct a full body check after spending time outside.
- When removing a tick, use tweezers or a tick removing tool and pull the tick straight up and out of the skin.

Picturing bull's eye rash



PHOTO BY CDC

Early disseminated stage

The early disseminated stage develops in untreated cases as a result of the infection spreading from the site of the tick bite to other areas of the body. Signs and symptoms associated with the early disseminated stage of Lyme disease may appear, disappear, and then reappear again. The signs and symptoms typically seen in this stage include:

- rashes on various areas of the body
- Bell's palsy (loss of facial muscle tone)
- meningitis with associated headaches and neck stiffness
- pain and swelling in the joints
- pain interfering with sleep
- sore throat
- vision changes
- Lyme carditis with associated heart palpitations and dizziness.

In many cases, the signs and symptoms associated with the early disseminated stage will resolve on their own, but it's important to remember that the disappearance of signs and symptoms doesn't correlate with the resolution of Lyme disease.

Late disseminated stage

If not treated, Lyme disease will continue to progress and may cause long-term, irreversible complications. When untreated, approximately 60% of individuals with Lyme disease will progress to the late disseminated stage. In this stage, the affected individual will suffer from exacerbations and remissions of arthritis, with associated joint pain and stiffness. In many cases, the large joints such as the knees are affected. In approximately 5% of untreated cases, chronic neurologic symptoms, such as shooting pain, numbness, and tingling of the hands and feet, will develop. In addition, some individuals may experience problems with short-term memory, mood changes, and difficulty concentrating (see *Lyme disease and children*).

Diagnosis

The diagnosis of Lyme disease is based on a history of being bitten by a tick, signs and symptoms, and, in some cases, blood tests. The CDC recommends that blood tests not be conducted unless signs and symptoms are present. It's important to note that within the first month of infection, blood tests may be inaccurate and treatment should be based on the history of a tick bite, as well as signs and symptoms of Lyme disease, and not a positive blood test. Early on, blood tests are inaccurate because the body hasn't had enough time to develop a measurable antibody response. Later in the course of the disease, blood tests are more reliable; however, tests for Lyme disease are never 100% accurate.

When signs and symptoms of Lyme disease are present after the first month of infection, or if a recurrence of symptoms develops, it's recommended that enzyme-linked immunosorbent assay (ELISA) and Western blot tests be utilized to assist with diagnosis. In many cases, it's recommended that an ELISA test be ordered initially to detect Lyme disease and the Western blot test be ordered after a positive ELISA to

confirm the diagnosis. Be aware that some healthcare providers are moving away from ELISA tests. Western blot tests utilize electricity to separate antigens into bands. The resulting bands look very similar to bar-codes and are specific for each person tested. The bands from the suspected case will be compared with those from a confirmed case of Lyme disease. The more similar the bands, the more likely the diagnosis.

Additional tests that may be ordered when diagnosing Lyme disease include polymerase chain reaction (PCR), antigen detection testing, and culture testing. PCR is a useful test because it multiplies a portion of Lyme bacterial DNA, allowing for easier detection. Antigen testing utilizes fluids, such as blood or urine, to test for the presence of Lyme protein. Culture testing is new and requires further validation, but has shown positive results. It's important to note that no test is definitive; with each of these tests, there's a possibility of false-positive results.

Treatment

Treatment of Lyme disease is typically initiated after signs and symptoms have presented. Early treatment is important; patients who are treated within the first few weeks of infection are typically cured and response to treatment is rapid. Treatment initiated after the first few weeks of infection may still yield a cure; however, the longer the delay in treatment, the more difficult the road to recovery. Treatment in the late stages of Lyme disease may take months to years for the dissipation of symptoms to occur.

The three antibiotics that are most commonly utilized for the treatment of Lyme disease are doxycycline, amoxicillin, and cefuroxime. In the majority of cases, oral antibiotics are just as effective as I.V. antibiotics and have fewer complications. I.V. antibiotics are typically reserved for more severe cases involving the neurologic and/or cardiac system. Doxycycline isn't recommended for pregnant women, lactating women, and

Lyme disease and children

Of all new Lyme disease cases, 25% are diagnosed in children, especially between the ages of 5 and 14. It's estimated that 200 children become infected with Lyme disease each day. Lyme disease detection may be difficult in children because they may not be able to fully explain their signs and symptoms. Additionally, signs and symptoms in children can mimic other medical and behavioral problems. It's important to be aware of Lyme disease in children because they're low to the ground, play on the ground, and play with pets, all of which can increase exposure to ticks.

Common signs and symptoms of Lyme disease in children include:

- complaints of feeling tired even when they appear to be sleeping enough
- difficulty sleeping (sleeping too much, trouble falling asleep, night terrors, or anxiety)
- headaches (migraine and nonmigraine)
- upset stomach (nausea and abdominal pain)
- fevers and chills
- complaints of body aches
- joint and muscle pain
- dizziness
- sensitivity to noise, light, sound, and touch
- difficulty concentrating, paying attention, or making decisions
- problems with short-term memory
- difficulty with schoolwork (feeling overwhelmed and dropping grades)
- confusion
- behavioral changes
- mood swings
- difficulty maintaining social relationships.

Children may be misdiagnosed, delaying treatment. Common misdiagnoses include:

- juvenile arthritis
- attention deficit hyperactivity disorder
- oppositional defiant disorder
- phobias
- anxiety
- allergies
- food sensitivities.

children under age 8. Amoxicillin and cefuroxime are the two antibiotics utilized for these patients. The typical duration of antibiotic administration is 10 to 21 days.

In some cases, patients may experience residual fatigue, pain, or joint and muscle aches after treatment. When this occurs, it's known as post-treatment Lyme disease syndrome. In a small number of cases, this can last for 6 months or more. The cause is unknown, but may be related to bodily damage that has occurred as the result of Lyme disease.

Prevention

When caring for patients, you'll want to educate them about prevention. The best way to prevent Lyme disease is to eliminate or reduce exposure to ticks. If an exposure occurs, the next best way to prevent Lyme disease is to locate the tick(s) and remove it quickly (see *Patient teaching: How to remove a tick*). Encourage your patients to avoid tick-prone places such as wooded or grassy areas because they're at risk for picking up ticks when hiking or spending time in these areas. Activities to avoid include playing in leaves, leaning against tree trunks, moving firewood, and sitting on rock walls. Teach your patients that when walking in wooded or grassy areas, they should try to stay in the middle of trails.

Additionally, encourage your patients to utilize a tick repellent, such as DEET or

permethrin, when spending time in tick-prone areas. Clothing pretreated with permethrin can also be purchased that lasts up to 70 washes while still maintaining effectiveness, making it perfect for camping or long trips. When educating your patients about DEET and permethrin, keep in mind that DEET repels ticks and is safe to apply to the skin, whereas permethrin kills ticks, but isn't safe for skin application. Always encourage patients to read labels carefully before applying any chemicals to their bodies or their children's bodies and/or clothing.

Teach your patients that when outside in potentially tick-infested areas, they should pay attention to how they dress. Dressing for prevention is important, including shoes, socks, long pants, and long-sleeve shirts. Tucking pants into socks and shirts into pants will make it more difficult for ticks to find available areas for attachment. Wearing light-colored clothing assists in the detection of dark-colored ticks. Clothing that's made of smooth material is also helpful because it's more difficult for ticks to climb. Long hair should be tied back because ticks can easily climb it.

Instruct your patients to complete a full body check after spending time outside and bathe within 2 hours to assist in the detection and removal of ticks. Washing and drying clothes may also be helpful because washing may remove ticks and they'll die in the dryer because they're intolerant to heat. In addition to body and clothing checks, educate your patients about the importance of checking all gear and pets after returning home.

Preventing tick exposure at home can be accomplished through landscaping strategies, such as:

- remove tall grass and brush from around the home
- place a 3-foot wide barrier of woodchips or gravel in between lawns and wooded areas; these barriers can also be placed around patios and play equipment
- keep lawns mowed and raked

Patient teaching: How to remove a tick

Understanding how to remove a tick properly is essential because incorrect removal can increase the chances of developing a tick-borne disease, such as Lyme disease. When removing a tick, **don't**:

- burn the tick or place a hot match on it
- apply any substance to the tick
- grasp, squeeze, or twist the body of the tick
- squeeze the tick with your fingers.

Attempting any of the maneuvers listed above may cause the tick to inject substances into the person's body, potentially causing an infection. Additionally, the improper removal of a tick can cause the mouth pieces to break off in the skin.

To properly remove a tick, follow these steps:

- use fine-tipped tweezers or a tick removing tool (available in drug stores)
- grasp the tick close to the skin; the closer to the skin, the better
- pull the tick straight up and out of the skin using steady pressure; avoid jerking movements
- after removal, apply antiseptic to the skin and wash your hands thoroughly
- monitor the site of the bite
- monitor for signs and symptoms of Lyme disease for 30 days
- contact a healthcare provider if signs and symptoms are present.

In some instances, a person may want to keep the tick until speaking with a healthcare provider. If so, the tick should be saved, preferably alive, in a plastic bag. If disposing of the tick, place it in alcohol and then put it into a sealed plastic bag or flush it down the toilet, according to the CDC.

- keep common areas, such as children's play areas and patios, away from yard edges and trees
- remove clutter from lawns
- remove stone walls, woodpiles, and bird feeders from lawns
- spray lawns with pesticides.

Bull's eye!

You can play an important role in Lyme disease prevention by educating yourselves and your patients. In those cases in which Lyme disease isn't prevented, you can assist your patients with early recognition so that treatment is promptly initiated, preventing long-term complications. ■

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