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## **Transmission of the Lyme Disease Spirochete**

Lyme disease is the most prevalent tick-associated disease in the United States. Although only around 30,000 cases are reported annually, the Centers for Disease Control and Prevention (CDC) has recognized that this disease is greatly underreported and that there are actually about 300,000 human cases annually, mainly in northeastern, mid-Atlantic, and upper midwestern regions of the country. In 2012, 95% of Lyme disease cases were reported from 13 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, Virginia, and Wisconsin. The blacklegged tick, *Ixodes scapularis*, and sometimes referred to as the deer tick, is the most important species that transmits the bacterial (spirochete) disease agent, *Borrelia burgdorferi*.

The rise in deer populations and other associated hosts over several decades in and near forests is correlated with substantial increases in blacklegged ticks and corresponding amplification of the disease organism in nature. Although deer are important hosts for adult blacklegged ticks, they do not serve to infect ticks. White-footed mice are considered the chief reservoirs for the Lyme disease agent, although chipmunks, shrews, and some species of birds are also competent reservoirs. Larval and nymphal blacklegged ticks acquire the pathogen when they feed on these animals. The disease organism can then be passed from larvae to nymphs to adults during the developmental process. There is occasional [rare] passage of the disease agent from infected females to larvae (via the eggs), but this form of pathogen transmission is not considered to be epidemiologically significant.<sup>1</sup>

The length of time that a nymphal or adult female tick is attached to a host is an important factor in pathogen transmission. The nymphal tick, which is about the size of a poppy seed, is the most important stage for transmitting the disease organism. Most human infections are acquired during the months of May, June, and July when nymphs are most abundant. Not all ticks are infected. Depending on the site and other factors, infection rates are highly variable and generally range between 15% and 40% (Table 1). After several hours of attachment, the tick begins to ingest blood. This triggers multiplication of the spirochetes, which subsequently penetrate the mid-gut, disseminate through the tick via the hemolymph, migrate to the salivary glands, and are finally transmitted to the host. The spirochetes also change the expression of their outer surface proteins to permit the escape from the mid-gut, migration to the salivary glands, and infection of a mammalian host<sup>2</sup>. The most rapid arrival of infectious spirochetes to the salivary glands occurs 48-60 hours postattachment<sup>3-4</sup>. A nymphal tick feeds for approximately 4 days for full engorgement, while a female tick requires 5-7 days.

Several laboratory studies,<sup>5-7</sup> using mice as experimental hosts, have shown that infected ticks need to be attached for more than 24 hours to effectively transmit the Lyme disease pathogen. The probability of transmission increases with the duration of attachment (0% at 24 hours, 12% at 48 hours, 79% at 72 hours, and 94% at 96 hours<sup>6</sup>); therefore maximal transmission usually occurs between 48 and 96 hours post attachment. Most people who get Lyme disease acquire the infection from an undetected feeding tick. In summary, an infected, flat (unengorged) tick does not transmit the disease agent until after host blood is ingested.

**Table 1.** Number of nymphal and adult female blacklegged ticks, *Ixodes scapularis*, submitted for testing at The Connecticut Agricultural Experiment Station for the presence of the spirochete *Borrelia burgdorferi*, the causal agent of Lyme disease, and the percentage positive for *B. burgdorferi*.

Year	No. nymphs tested	% infected	No. adults tested	% infected
2005	3654	22.4	2184	36.1
2006	1032	16.0	1271	27.9
2007	620	36.8	767	32.7
2008	672	18.8	801	26.7
2009	763	41.4	1005	34.7
2010	558	35.1	686	29.3
2011	520	15.6	993	26.1
2012	327	15.9	644	21.3
2013	1017	30.6	609	33.3
Total	9163	25.0	8960	30.8

Early detection and prompt removal of attached ticks has been found to reduce the risk of infection and incidence of Lyme disease<sup>8</sup>. A pair of tweezers or forceps can be used to grasp the tick's mouthparts at the skin surface. Gentle pulling or twisting of the tick with steady pressure will dislodge it. The area of attachment can be cleaned with an antiseptic or rubbing alcohol. A single 200-mg dose of doxycycline given within 72 hours after an *I. scapularis* tick bite has been reported to prevent the development of Lyme disease.<sup>9</sup> However, studies on the prophylactic use of antibiotics following tick bite found the incidence of Lyme disease or development of erythema migrans (Lyme rash) in untreated individuals with a detected tick was less than 5%<sup>9-10</sup>.

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An original version of this fact sheet was composed by Dr. Louis A. Magnarelli, former Director of The Connecticut Agricultural Experiment Station.