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Lyme Disease

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Introduction

Lyme disease is caused by the spirochete *Borrelia burgdorferi* and is a bacterial infectious disease that is spread by zoonotic transmission in which animals act as reservoir hosts and ticks are the primary vector or carrier and are considered arthropods. Transmission to humans may occur following the bite of an infected tick (Pearson, 2015). There are two major types of ticks: hard ticks (*Ixodidae*) and soft ticks (*Argasidae*). Hard ticks latch onto their hosts and feed for days, whereas soft ticks usually are found in animal nests (Juckett, 2013). The blacklegged tick (*Ixodes scapularis*) spreads the disease in the northeastern, mid-Atlantic, and north-central United States. The western blacklegged tick (*Ixodes pacificus*) spreads the disease on the Pacific Coast (CDC, 2016).

Ticks prefer humidity and places like woodland areas or long grass. Ticks are more active from late spring to early autumn, but will continue to search for food during mild winters in warmer areas. The seasonal pattern of tick bites is reflected in the incidence of Lyme disease which has its peak during summer. Once a tick has found a potential host, it will tend to crawl upwards to areas such as the back of knees, groin or around the hairline (Pearson, 2015).

It is important that primary caregivers are able to recognize signs and symptoms of Lyme disease quickly in order to keep the disease from becoming worse. It is a treatable disease, but it is challenging to diagnose especially in the early stages. Although Lyme disease is mostly associated with the Northeastern and Midwestern states, it can be found in other areas as well. According to the CDC (2015), the total 2015 confirmed cases of Lyme disease was reported to be 28,453. Pennsylvania, New Jersey, New York, Massachusetts, Maryland, and Connecticut were the highest reporting states in 2015 (CDC, 2016).

Disease Process

B. burgdorferi is connected to the life cycle of its tick vector. The tick's first meal is during their tiny larval phase during which they wait on the forest floor for a passing host such as a rodent, bird, or deer. The next life stage is the nymphal stage where they are no larger than a poppy seed. They must attach to another host in order to grow into an adult. Both nymphs and adults sit higher on vegetation, so they can only attach to larger animals (Levy, 2013). Lyme disease is most often caused by the bite of an infected nymph which is hard to detect because of its small size. *B. burgdorferi* is not passed from mother ticks to their offspring; every larva is born uninfected (Levy, 2013). Once a tick has attached to its host it feeds and becomes bloated and releases its saliva into the bite wound. It takes approximately 36-48 hours for the spirochete *B. burgdorferi* to migrate from the stomach of the tick to its salivary glands. It will eventually migrate out from the initial bite site throughout the body to different organs. If the tick is removed less than 24 hours from attachment, it is very unlikely to pass the bacteria onto the host (Wright, Riedel, Talwani, & Gilliam, 2012).

Erythema migrans, a distinctive skin lesion with a bulls-eye presentation, is the most common objective clinical manifestation of Lyme disease with as many as 90% of cases having the lesion (Nadelman, 2015). Although most infected patients will develop this lesion, not everyone will which can further perplex the primary care giver when attempting to diagnose the disease.

Signs and Symptoms

Lyme disease can have different stages with different symptoms in those stages. During the stages of early disease development of erythema migrans occurs most usually 7-14 days after tick detachment as mentioned previously. Approximately half of patients develop flu-like symptoms including fever, headache, myalgias, stiff neck, and fatigue without gastrointestinal or respiratory symptoms (Nichols & Windemuth, 2013).

If Lyme disease is not treated, early disseminated symptoms include neurologic manifestations that can include meningitis, Bell's palsy, cranial neuritis, and radiculoneuritis. Cardiac manifestations most commonly include atrioventricular block, but patients can experience symptoms of shortness of breath, palpitations, lightheadedness connected to atrioventricular block (Bockenstedt, & Wormser, 2014). Musculoskeletal symptoms such as migratory muscle and joint pain may be present in early untreated disseminated disease (Nichols & Windemuth, 2013). Arthritis is the most common late manifestation of Lyme disease and can occur in as much as 60% of patients, in whom infection was not treated at earlier stages, usually developing an average of six months after infection. Most patients present with oligoarticular inflammatory arthritis affecting one or more large joints, especially the knee. Children often present with more acute arthritis than adults (Bockenstedt, & Wormser, 2014).

Underlying Pathophysiology

•The spirochetes may avoid the immune response by decreasing expression of surface proteins that are targeted by antibodies, inactivating key immune components such as complement, and hiding in the extracellular matrix which may interfere with the function of immune factors (Nadelman et al., 2012).

•The spirochetes spread to other tissues by entering capillary beds (Bockenstedt, & Wormser, 2014).

•Inflammation begins when dendritic cells and macrophages respond to Lyme borrelia by pattern-recognition receptors.

•Once these toll-like receptors are stimulated they produce proinflammatory cytokines, including interleukin-1 β , tumor necrosis factor α , IL-6, and type I interferons (Bockenstedt, & Wormser, 2014).

•Once the immune system is triggered, local production of CXCL13, a B-cell-attracting chemokine produced by monocytes in response to *B. burgdorferi* outer surface proteins is increased (Halperin, 2014).

•The anti-inflammatory cytokine IL-10 is also produced. The balance between proinflammatory and anti-inflammatory cytokines may determine the efficiency with which cells respond at infected sites and therefore the clinical presentation of the disease (Bockenstedt, & Wormser, 2014).

•If untreated, the bacteria could persist in the body for months or even years, despite the production of *B. burgdorferi* antibodies by the immune system.

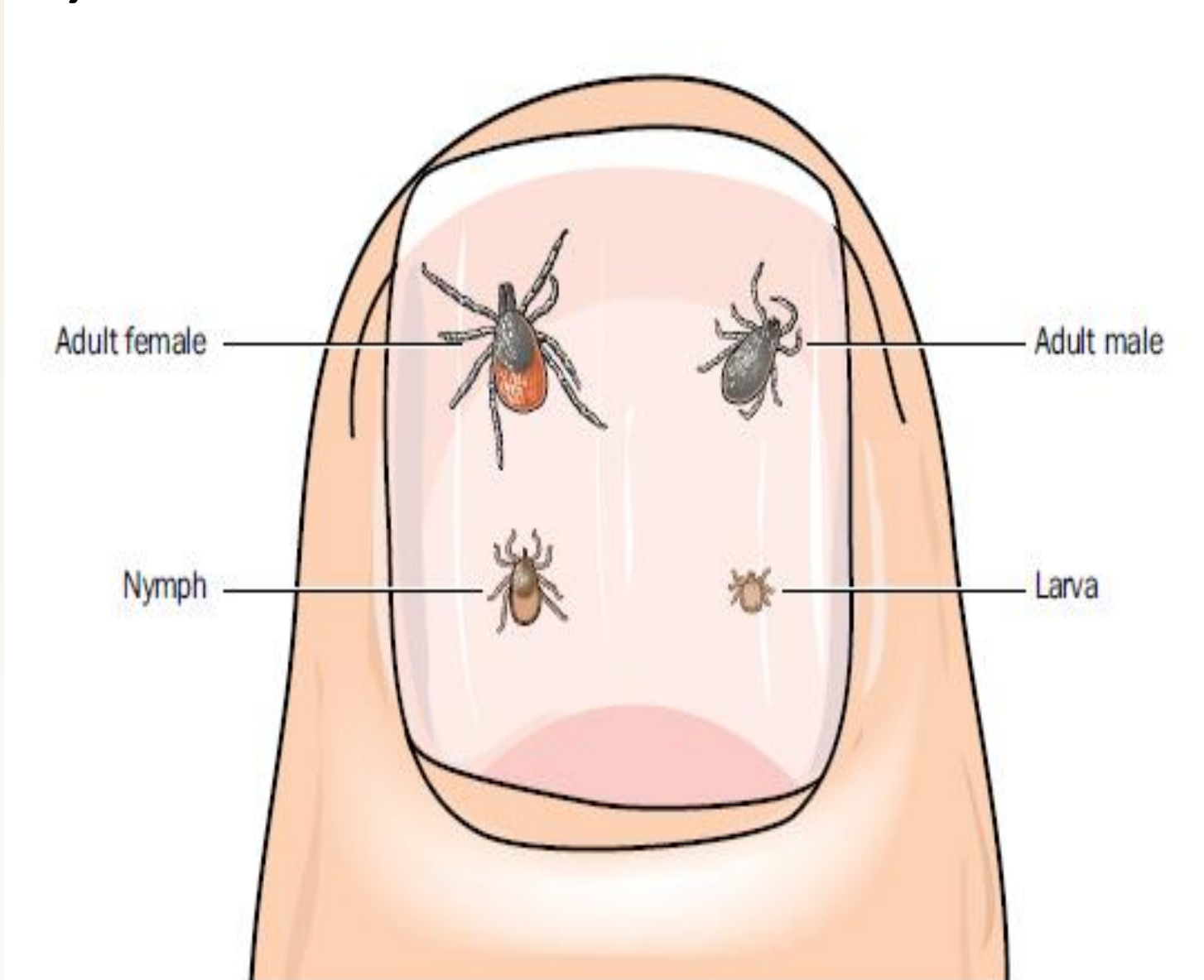


A classic erythema migrans rash in a patient with Lyme disease (Wright et al, 2014).

Significance of Pathophysiology

Whether Lyme disease becomes severe or not is based on how quickly it is diagnosed and treated. Because patients will have varying degrees of symptoms, it is important for clinicians to diagnose carefully. Serology is insensitive in early Lyme disease with half of patients having erythema migrans having negative serology on presentation (Nadelman, 2015). Many experts recommend doxycycline as the preferred agent for oral treatment once diagnosed with Lyme disease (Wright, Riedel, Talwani, & Gilliam, 2012). If the patient with Lyme disease is exhibiting neurological, cardiac, or in a few cases refractory Lyme arthritis, then it is appropriate that the patient receive intravenous regimens. In highly endemic areas, people bitten by nymphal or adult *scapularis* ticks that are estimated to have been attached for longer than 36 hours should be offered doxycycline prophylaxis if they are not contraindicated (Nadelman, 2015).

Figure 1. The three life stages of the tick, against a human thumbnail, (Pearson, 2015).



Implications for Nursing/Future Research

It is important for clinicians to be aware that Lyme disease can cause post infectious complications such as Lyme arthritis following a Lyme disease course. Even though other infections can trigger autoimmunity, Lyme disease is uniquely characterized by joint manifestations in its late infectious and post infectious stages which along with *B. burgdorferi* antibodies, can persist for years after resolution of infection (Arvikar, Crowley, Sulka, & Steere, 2016). This can cause diagnostic confusion, and delay diagnosis and initiation of appropriate anti-inflammatory therapies. When it is found that the patient has Lyme disease-associated autoimmune responses after antibiotic treatment, disease-modifying antirheumatic drugs or DMARDs, rather than additional antibiotic treatment are called for (Arvikar, Crowley, Sulka, & Steere, 2016). It is important to teach patients the importance of preventing tick bites by spraying clothes with permethrin, a synthetic insecticide, or DEET-containing repellants on clothes, socks, and shoes as well as exposed skin. Tucking pants into socks, wearing hats, and performing a daily tick check also reduce exposure (Juckett, 2013).

An effective vaccine was developed for Lyme disease, but is no longer available due to not enough people being vaccinated and therefore being cost prohibitive. There is some interesting research being conducted concerning an oral vaccination for wild white-footed mice, a common host for *B. burgdorferi*. Richer et al, (2014) found a significant reduction of infection of nymphal ticks after 3 years. The authors argue that implementation of a long-term public health measure could substantially reduce the risk to human exposure to Lyme disease (Richer, Brisson, Melo, Ostfeld, Zeidner, & Gomes-Solecki, 2014).

Conclusion

Lyme disease is a challenging illness to diagnose correctly. Different patients will present with different signs and symptoms of the disease. Some may have the characteristic erythema migrans rash, but others will not. Vague symptoms like muscle soreness or fatigue and headache can further complicate the diagnosis process. With untreated disease, the most common sites of involvement are the joints, nervous system, and cardiovascular system. Lyme disease is treatable, but some patients struggle with a post Lyme disease syndrome.

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