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Lyme disease: An Emerging Bacterial Zoonosis of Public Health Significance

Open Access **Review Article**

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Abstract

Tick is an arthropod vector that is known to transmit several zoonotic diseases that are responsible for significant morbidity and mortality in the susceptible hosts. Lyme disease (LD) is the most common tick-borne emerging disease caused by the genus Borrelia spirochete bacterium, Borrelia burgdorferi sensu lato, a bacterium from the Spirochaetaceae family. The reservoir hosts are defined as animals that infect a considerable number of ticks that feed on them. Humans and domesticated animals are incidental hosts. In endemic locations, members of Borrelia burgdorferi sensu lato complex cycle between tick vectors and wild animal reservoir hosts. Three-host hard ticks of the genus Ixodes transmit the organisms in this complex. Approximately half of patients with early illness have erythema migrans, a confined skin lesion. Lyme borreliosis is diagnosed by looking to this lesion. In animals, the symptoms generated by Borrelia burgdorferi sensu lato are poorly understood. Clinical indicators, epidemiology (i.e., a history of tick exposure in an endemic area), elimination of other diseases, laboratory data, and drug response are all used to make a Lyme disease diagnosis. Tick populations and human tick interactions have been targeted as strategic measures to lowering Lyme disease infection rates. In most jurisdictions, public health information that promotes Lyme disease awareness and provides advice on how to treat tick bites is the most effective strategy for avoiding the infection.

Keywords: Borrelia burgdorferi sensu lato; Emerging zoonosis; Erythema migrans; Lyme disease; Public health; Tick

Introduction

There are several zoonoses of multiple etiologies that are transmitted through ticks. Lyme disease (LD) also known as erythema chronicum migrans, Lyme arthritis, Lyme borreliosis, is an important emerging life threatening bacterial zoonosis of public health concern, and is reported from several regions of the world *[1]*. It is the most common tick-borne disease in the Northern Hemisphere's temperate zones *[2]*. Disease is caused by spirochete bacteria of the genus Borrelia, which are transmitted to humans via tick bites from the infected wildlife species. Lyme disease has become much more common over the last three decades, with more than 100,000 cases reported each year throughout the world *[3]*. People who come into direct contact with infected ticks in north-temperate woods, forested regions, and green spaces are at higher risk of contracting the disease *[2]*. It is an occupational disease of the forest workers, wildlife curators, hunters, campers, hikers, livestock handlers, veterinarians, and farmers *[1]*. Lyme disease is a potentially complex disease from a clinical standpoint of view *[4]*. With climate change, the extension of Lyme disease beyond its endemic foci is expected to accelerate. Tick survival and geographic distribution are likely linked to climatic variables and climate change (i.e., warming climate). Infected ticks dispersed by migratory birds could infect animal groups on new frontiers, introducing endemic infection cycles into newly established reproducing tick vector populations *[2]*. Climate change is anticipated to have an impact on human behavior, altering vector interactions and the transmission of diseases carried by vectors to humans *[5]*. During the early stages of the disease, when a distinctive rash typically aids in disease detection, Lyme disease in people is easily cured with antibiotics. People with untreated infections, on the other hand, can develop chronic arthritis, neurological symptoms, and other diseases. Lyme disease in farmed animals is still little understood, and there appears to be no characteristic rash. The disease appears to be best defined in dogs, with arthritis and nephropathy appearing to be the most common complications. Lyme disease-like symptoms have also been documented in other animals, including the horses and cattle *[6]*. So, the overall objective of this review is to promote awareness of this emerging vector-borne zoonosis of public health concern and strategies for minimizing the risk of infection.

Etiology

Lyme disease is caused by Borrelia burgdorferi sensu lato complex, which belongs to the Spirochaetaceae family. This complex has more than a dozen identified genospecies (genomic groups), but only a few of them appear to be harmful in humans or domesticated animals. Borrelia burgdorferi sensu stricto, B. garinii, B. afzelii, and the newly discovered species B. spielmanii are all known to cause Lyme disease in humans. Based on their isolation from Lyme disease patients in Europe and Asia, and/or research in laboratory animals, B. bissettii, B. lusitaniae, and B. valaisiana may also be pathogenic *[6]*. Borrelia burgdorferi sensu lato (B. burgdorferi s.l.) has been

divided into eight serotypes, with serotype 1 corresponding to B. burgdorferi sensu stricto, serotype 2 relating to B. afzelii, and serotypes 3 to 8 corresponding to B. garinii. B. andersonii, B. carolinensis, and B. americana, which are found in North America, and B. japonica, B. tanukii, B. turdi, and B. sinica, which are found in Asia, are Geno-species in B. burgdorferi s.l. complex that is not known to cause disease. In wild animals, several new genospecies (including B. carolinensis and B. americana) have recently been discovered. In serological tests, various Borrelia species that cause relapsing fever and other illnesses can cross-react with B. burgdorferi s.l. *[7]*.

Species Affected

Borrelia burgdorferi s.l. reservoir hosts are defined as animals that infect a considerable number of ticks that feed on them. The main reservoir hosts have been identified as rodents. Birds and other vertebrates, on the other hand, may be able to operate as vectors in situations where the major reservoir hosts are unavailable. The role of birds as reservoirs of Lyme disease has been debated. Domesticated animals and humans are incidental hosts, infected after being bitten by ticks. Ticks may be infected with B. burgdorferi s.l. by dogs and wild carnivores, but they are not considered reservoir hosts *[6]*.

Transmission

Lyme disease is transmitted by three-host hard ticks of the genus Ixodes. Tick bites are most common in May-July and September-October each year, while they can occur at any time throughout the growth season *[8]*. When a tick is ready to feed, it goes onto tall grass or foliage and attaches itself to mammals and birds that pass by *[9]*. The tick then looks for a safe spot to puncture the skin with its hypostome (barbed proboscis) and tap a blood artery; the "bite" is firm but not painful. The armpits, navel, groin, and hairline are among the most popular human regions *[10]*. Once attached, the tick's abdomen swells like a coffee bean as blood is sucked over several hours. The spirochete, if present, is only passed to the host during the later stages of a blood meal (typically>24 hours). Because of their abilities to elude detection, nymphs are more likely to transmit infection *[11]*.

Clinical Signs

Humans

Early and late Lyme borreliosis are defined by the Asbrink and Hovmark categorization system. Approximately, half of patients with early infection have erythema migrans (EM), a confined skin lesion. Lyme borreliosis is diagnosed by this characteristic lesion. The EM generally occurs 3 to 30 days after the tick bite, but not later than 3 months, and is most commonly found on the lower limbs (approximately 54%) and trunk (approximately 29%). The lesion grows in size, eventually developing a central clearing and attaining a diameter of nearly 5 cm. It is mentioned that atypical erythemas with vesicles or without a central clearing is occasionally seen. Borrelial lymphocytoma, a bluish-red lump that commonly appears on the ear lobe or nipple during months or years of infection, is another extremely unusual skin lesion *[12]*. When a patient is not treated during the EM phase, or when EM is absent, the disease might advance to the disseminated stage and impact other organs *[13]*. The condition is known for affecting the musculoskeletal system. This form develops several weeks to years following a tick bite, but most commonly after six months. In nearly 60% of patients, pain is limited to migratory muscle, big joint, and bone discomfort in the first several weeks after infection. Arthritis with effusion, affecting a big joint, is a common symptom (very often a knee joint). It is commonly asymmetrical and accompanied by joint edema without erythema, with remissions and relapses lasting many weeks, which might result in joint dysfunction. Even if EM is still present, central nervous system (CNS) involvement can occur, and neurological signs and symptoms are highly variable *[14]*.

Animals

In animals, the symptoms generated by B. burgdorferi s.l. are poorly understood. A large number of infections appear to be asymptomatic. Fever, lameness/ stiffness, with or without joint swelling, and decreased milk output have all been linked to acute Lyme illness in cattle. The skin on the ventral udder was noted to have erythema, warmth, edema, and hypersensitivity. There have also been reports of laminitis, persistent weight loss, uveitis, and abortion. In the case of horses' Low-grade fever, arthritis with intermittent or shifting lameness and swollen joints, myalgia, prolonged weight loss, and myalgia have all been linked to B. burgdorferi s.l. infection. There have also been reports of neurological signs and skin lesions, as well as rare eye signs (uveitis), heart disease, hepatitis, laminitis, and abortion *[6]*. Arthritis, kidney illness (Lyme nephritis), cardiac failure, and neurological symptoms have all been linked to B. burgdorferi in infected dogs. Lameness and arthritis, particularly of the carpal joints, are the most usually documented syndromes in dogs. Lameness can affect one or more joints, and it might be intermittent or move from leg to leg. The implications of infection in cats are little understood. Although surveys show that 5-47 per cent of cats are seropositive, no examples of naturally occurring illness have been reported. Experimental infections have yielded mixed results: cats in one study remained asymptomatic, while in another, they developed fever, lethargy, stiffness, and arthritis *[10]*.

Diagnosis

A diagnosis of Lyme disease is usually based on the clinical signs, epidemiology (i.e., a history of exposure to ticks in an endemic area), and elimination of other diseases, laboratory data and response to antibiotics. The diagnosis is usually presumptive rather than definitive. The standard blood test measures antibodies for Borrelia, but is often negative in the first weeks after infection. A more reliable result is obtained if the test is repeated at a later stage, as the spirochete starts to disseminate *[8]*. Clinical indicators, epidemiology (i.e., a history of tick exposure in an endemic area), elimination of

other diseases, laboratory data, and drug response are all used to make a Lyme disease diagnosis. Rather than being conclusive, the diagnosis is frequently presumptive. The conventional blood test for Borrelia antibodies measures antibodies; however it is frequently negative in the first few weeks following infection *[8]*. If the test is performed later, when the spirochete begins to spread, a more reliable result is obtained. Unless a biopsy sample is taken from the erythema migrans at an early stage of infection, Borrelia culture has proven unsuccessful in diagnosing. Neurological testing may be needed to examine memory impairment and nerve abnormalities, as well as to rule out other possible diseases *[15]*. Serology is the most common method of laboratory confirmation, and many seropositive animals never show clinical indications. With the exception of data related to the damaged system, the CBC, blood chemistry, autoimmune panels, and radiographs are all normal (s). Spirochetes are rarely found in the joint fluid of chronically ill dogs, which usually consists of a purulent discharge with neutrophils as the most numerous cells. The volume of joint fluid in acute instances is frequently too little to sample. Specific monoclonal antibodies or nucleic acid detection with polymerase chain reaction (PCR) can confirm that they are B. burgdorferi s. l. The geno-species can also be identified via PCR *[16]*.

Treatment

Humans

Antibiotics are the primary line of treatment for Lyme disease in the majority of individuals *[15]*. In patients above the age of eight, a treatment of doxycycline for 14-21 days is suggested for localized or disseminated infection, except in pregnant women *[17]*. Oral antibiotics are often effective in treating Lyme arthritis, although a small percentage of individuals require intravenous antibiotic therapy. Lyme arthritis cannot respond to oral or intravenous antibiotics in a small percentage of individuals; in these circumstances, anti-inflammatory medicines are recommended *[15]*. Intravenous treatment may be required if neurologic involvement is present. Antibiotic treatment for 21 days is usually sufficient for early disease, but 30 days may be required in more severe instances or for later symptoms *[10]*.

Animals

Lyme disease in horses has been treated with antibiotics or antibiotics coupled with anti-inflammatory drugs. Treatment directed targeting the afflicted organ system, as well as symptomatic treatment, may be required. Antibiotics such as amoxicillin or tetracycline derivatives frequently help dogs with acute Lyme arthritis (e.g., doxycycline). Acute instances are normally treated for two weeks, whereas dogs with chronic intermittent arthritis are usually treated for four weeks; however, clinical investigations have yet to determine the best treatment length and dose. Lyme nephropathy in dogs may require longer-term antibiotic treatment. Angiotensin-converting enzyme inhibitors, low-dose aspirin, omega-3 fatty acids, nutritional therapy, anti-hypertensive medications, fluids, and immune-modulators may be used as adjunctive treatment in canine Lyme nephropathy, although the best treatment is still unknown *[16]*.

Prevention and Control

Tick populations and human tick interactions have been targeted as strategic measures to lowering Lyme disease infection rates. Some authorities have attempted to spray acaricides over regions of vegetation with high tick populations. Other research has focused on certain host mammals, such as rats and deer. Attempts to cull deer populations have also been made in some parts of New England. In most situations, these measures have proven to be both costly and ineffectual in lowering the number of infected ticks and the risk of Lyme disease infection *[18]*. Local habitat modification, such as removing vegetation from near buildings, cutting larger walkways, and reducing tall leafy plants from public access locations, may be of more practical value *[19]*. A vaccination was available for a short time, however it was discontinued in 2002 *[20]*. In most jurisdictions, public health information that promotes Lyme disease awareness and provides advice on how to treat tick bites is currently the most effective technique for avoiding infection. Avoiding known tick locations, covering exposed skin, wearing suitable clothing, and using acaricides sprays are all examples of personal preventive methods. If you work or visit a tick-infested location, you should check your entire body for ticks on a frequent basis. Ticks should be checked on youngsters by responsible adults; pets should also be checked because they can bring ticks into a vehicle or into the home *[8]*. Employers must be aware of the dangers to employees who operate in woodlands and green spaces and take appropriate precautions, such as providing current health information and training. When a tick is discovered attached to the skin, prompt removal is successful in preventing Lyme disease in the vast majority of cases *[2]*. Ticks can be safely removed with a tick removal tool, tweezers, or cotton thread. Gentle traction to draw the tick away from the skin without twisting is the best method *[8]*. This reduces the possibility of a tick regurgitating its stomach contents into the lesion or the hypostome becoming detached in the incision *[20]*. The transfer of the spirochete from an infected tick should be prevented if the tick is removed within 24 hours after the bite *[21]*. Increasing anxiety about access to green space is at odds with public health messages supporting woods walks for mental and physical wellness. As a result, high-quality information and educational materials must be targeted, particularly in key regions and to those groups of people who are most at risk of being bitten by an infected tick *[2]*. Reassurance about the numerous benefits of exercise should be offered, as well as appropriate information regarding Lyme disease prevention. Many holiday destinations where Lyme disease is endemic, particularly in New England, central Europe, and Scandinavia, require travel advice *[20]*.

Conclusion and Recommendation

Lyme disease is an emerging zoonotic disease, which is transmitted by bite of the ticks. In Europe and North America,

disease is becoming more widespread. It can be a difficult sickness to diagnose and treat, especially if treatment is delayed. Any person who falls ill after being bitten by a tick should seek medical help right away. The erythema migrans rash is a prominent symptom of the illness in humans; however it is not always present. Animals, such as cattle, dog, cat, and horse are also affected by the disease, which is mostly asymptomatic and manifests as arthritis, abortion, neurologic symptoms, and skin lesions. The mainstay of treatment is short-term antibiotic medication. Simple precautions can significantly reduce the risk of infection. However, a public health strategy to Lyme disease management is required in order to promote good health messages regarding outdoor exercise as well as best practices for avoiding infection. Based on the above conclusions, the following recommendations were forwarded

a. It is emphasized to create public awareness about the mode of transmission, prevention and control of the disease.
b. It is highly imperative for avoiding known tick locations and using acaricides sprays for personal prevention.
c. Strategic control of the tick should be strengthened.

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Contribution of The Authors

Both Authors contributed equally. They read the final version, and approved it for publication.

Conflict of The Interest

The authors declare that they do not have conflict of interest.

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