Indian Journal of Pharmacy Practice., 2024; 17(2):122-127.
https://www.ijopp.org

Review Article

# Lyme Disease: The Threat of a Tick Born Illness

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**ABSTRACT**

Lyme disease, which is the most common vector born disease caused by the *Borrelia burgdorferi* and transmitted in the United States primarily by *Ixodes scapularis*. The major symptoms of the disease are Erythema migrans, fatigue, malaise, myalgia, headache and regional lymphadenopathy. The untreated Lyme disease can spread to heart and nervous system, which lead to potentially life-threatening neurologic and cardiac problems.[1] Lack of awareness and misdiagnosis is frequent which is the most common cause of failure of treatment. The study attempts to give a thorough knowledge and awareness about the Lyme disease by interpreting the clinical symptoms, pathophysiology, diagnostic criteria, potential therapies and prophylaxis.

**Keywords:** Lyme disease, *Borrelia burgdorferi*, Erythema migrans, *Ixodes scapularis*.

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**Received:** 04-02-2024;
**Revised:** 29-02-2024;
**Accepted:** 15-03-2024.

## INTRODUCTION

The most prevalent tick borne illness, known as Lyme disease, is brought on by the spirochete *Borrelia burgdorferi* and is spread by *Ixodes scapularis* and *Ixodes pacificus* ticks. *B. burgdorferi* is a gram-negative organism which is 10-30 micrometre long and 0.2-0.5 micrometre width.[1] Typically, Erythema Migrans (EM), a typical growing skin lesion, is the first sign of infection. Signs of atrioventricular block, migrating musculoskeletal discomfort, and widespread myocarditis. Acrodermatitis, polyneuropathy, chronic encephalopathy, and intermittent or persistent arthritis may appear months or years later. In a geographic group of kids in Lyme, Connecticut, who were initially diagnosed with juvenile rheumatoid arthritis in 1976, Lyme disease was discovered. Lyme disease, or Lyme borreliosis, was first identified in 1982 when *Borrelia burgdorferi* was isolated from *Ixodes scapularis* ticks and subsequently from Lyme disease patients.[2]

### Etiology

Lyme disease is caused by the meticulous microaerophilic bacteria *Borrelia burgdorferi*. *Borrelia burgdorferi sensu lato* is the aggregate name for 13 closely related species of *Borrelia*. The infection among people caused by 3 pathogenic genospecies-*Borrelia burgdorferi, Borrelia garnii, and Borrelia afzelii*. All three genospecies of *B. burgdorferi* are prevalent in Europe, with two species subsequently detected in Asia. *B. burgdorferi* is the exclusive source of infection in the United States. Male are predominant to acute Lyme disease and in an age group under 16 years or older than 30 years of age.[3]

### Epidemiology

The 13 recognized species of *Burgdorferi* are found in enzootic cycles involving 14 species of *I. ricinus* complex ticks throughout the eastern United States, ranging from Maine to Georgia, as well as in the midwestern states of Wisconsin, Minnesota, and Michigan. The primary vector in the eastern states of California and Oregon is *I. scapularis*. In Europe, the vector is *I. ricinus*, while in Asia; the vectors are *I. persulcatusis* in China, Japan, and Russia. An infections carried by vectors is now most common in Europe and the United States with Lyme disease. In 1982, the Centres for Disease Control and Prevention stated that while the initial number of infections was close to 300,000 per year, an additional 30,000 cases were reported each summer. The disease is most common in the centre of Europe and in Scandinavia. It is a rare disease in India, 3000-5000 people in India suffer from the disease.[4] In India, no specific species of ticks causing Lyme borreliosis have been identified.

### Pathophysiology

Through the tick and the mammalian host, the enzootic cycle is completed. As the organism shifts the spirochete expresses outer surface protein A (Osp A) in the tick's midgut and Osp C in the tick's salivary gland, both of which are necessary for infecting the mammalian host. *B. burgdorferi* transmission requires a tick attachment lasting at least 24 hr. The spirochete downregulates Osp C and upregulates the VIsE lipoprotein after being injected into human skin. A great deal of diversity occurs in the protein, which is essential for spirochetal survival.[5] After several days to weeks, *Burgdorferi* may move outside in the skin, causing an

**DOI:** 10.5530/ijopp.17.2.20

erythema migrans lesion, and they may then spread to other organs via the blood or lymphatic systems. The spirochete's pathogenicity surface proteins bind to glycosaminoglycans, glycoproteins, integrins, and mammalian proteins. Certain borrelia strains have the ability to attach themselves to the complement regulator, thereby obtaining surface proteins (factor H) that shield them from complement-mediated lysis. By attaching to the vitronectic receptor on endothelial cells and the fibrinogen receptor on active platelets, the organism can more easily spread throughout the bloodstream. The host mounts both innate and adaptive immunological responses in an effort to manage and eradicate *Borrelia burgdorferi*, which leads to the spirochete's death through the action of macrophages and antibodies. *B. burgdorferi*, the enzootic infection, can only withstand this immunological process in the summer before it feeds back to larval ticks and repeats the cycle the next year. Without antibiotic medication, the body's immune system spread the infection broadly within a few weeks or months. However, in the absence of antibiotic therapy, the spirochete may continue to live for several more years in specific niches and seldom cause mild encephalopathy or arthritis.[3]

## Clinical signs and symptoms

During the first stage of early infection, a red macule or papulae at the site of the tick bite slowly develops into a huge annular lesion after 3 to 32 days of incubation.

**Early infection stage 2 (Disseminated infection):** In this case, the patient may experience a secondary annular skin lesion along with a fever, chills, myalgia, lymphadenopathy, a strong headache, and slight neck stiffness.

**Stage 3 of late infection:** In the US, 60% of patients who are not treated with antibiotics may get months-long arthritis. Large joints may be attacked by oligoarticular arthritis, and periarticular areas in a few minor joints may also be impacted. Joint fluid contains 500-110,000 WBCs, the majority of which are polymorphonuclear leukocytes.

**Post-Lyme syndrome:** More widespread or incapacitating symptoms may result from post-Lyme. They consist of extreme exhaustion, excruciating headaches, widespread musculoskeletal discomfort, stiffness, and joint soreness.[6] A schematic diagram showing development of Lyme disease (Figure1).

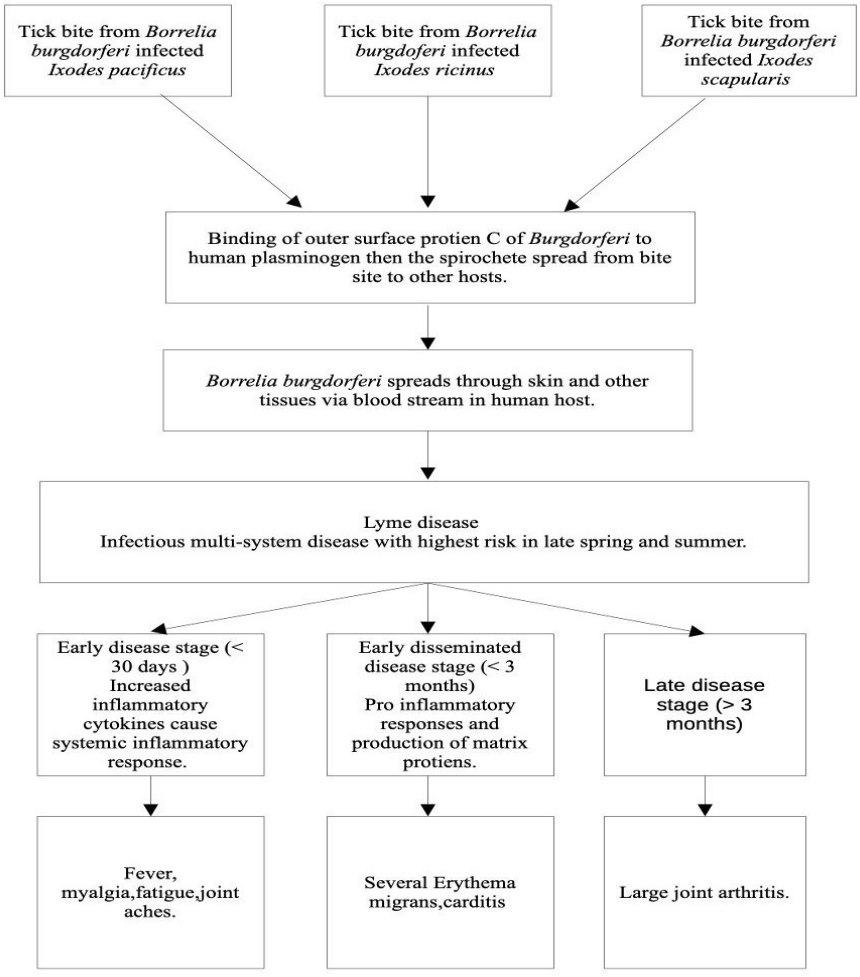


**Figure 1:** Pathophysiology of Lyme disease.

## Diagnosis

Enzyme-Linked Immuno Sorbent Assay (ELISA) was the first method used for serologic investigation of Lyme disease. Western blotting is then used to confirm positive results. The spirochete is identified during the first week of infection by the IgM and IgG responses.[1]

## Treatment

### *Antibiotic Therapy*

Despite certain limitations, such as neurologic problems, third-degree atrioventricular heart block, and arthritis, antibiotics are used to treat Lyme disease. Adult patients without clinical evidence of neurologic disease are provided either cefuroxime axetil 500 mg twice daily for 28 days, or doxycycline 100 mg twice daily, or amoxicillin 500 mg 3 times each day. Cefuroxime axetil 30 mg/kg per day in two separate doses, with a maximum of 500 mg per treatment, and amoxicillin 50 mg/kg per day in three divided doses were administered to children. Doxycycline 4 mg/kg per day in two separate doses, with a maximum of 100 mg per dosage, is recommended if the patient is older than 8 years old.[7]

Late neurologic Lyme disease: Adult patients should get intravenous ceftriaxone treatment for two to four weeks if they have late neurologic disease that affects the central or peripheral nervous system. An intravenous dose of penicillin G or cefotaxime is an alternative. Unless relapse is demonstrated by trustworthy objective measures, retreatment is not advised. Children with late neurologic Lyme disease are also administered ceftriaxone Figure 2.[7]

## Chronic Lyme disease

Like chronic fatigue syndrome or fibromyalgia, post-Lyme syndrome, often known as chronic Lyme disease, can occasionally cause severe disability.[6] Patients with post-Lyme syndrome were treated with IV ceftriaxone for 30 days, then oral doxycycline for 60 days in a large population research. In contrast, no discernible difference was seen between another group receiving IV and oral placebo treatment.

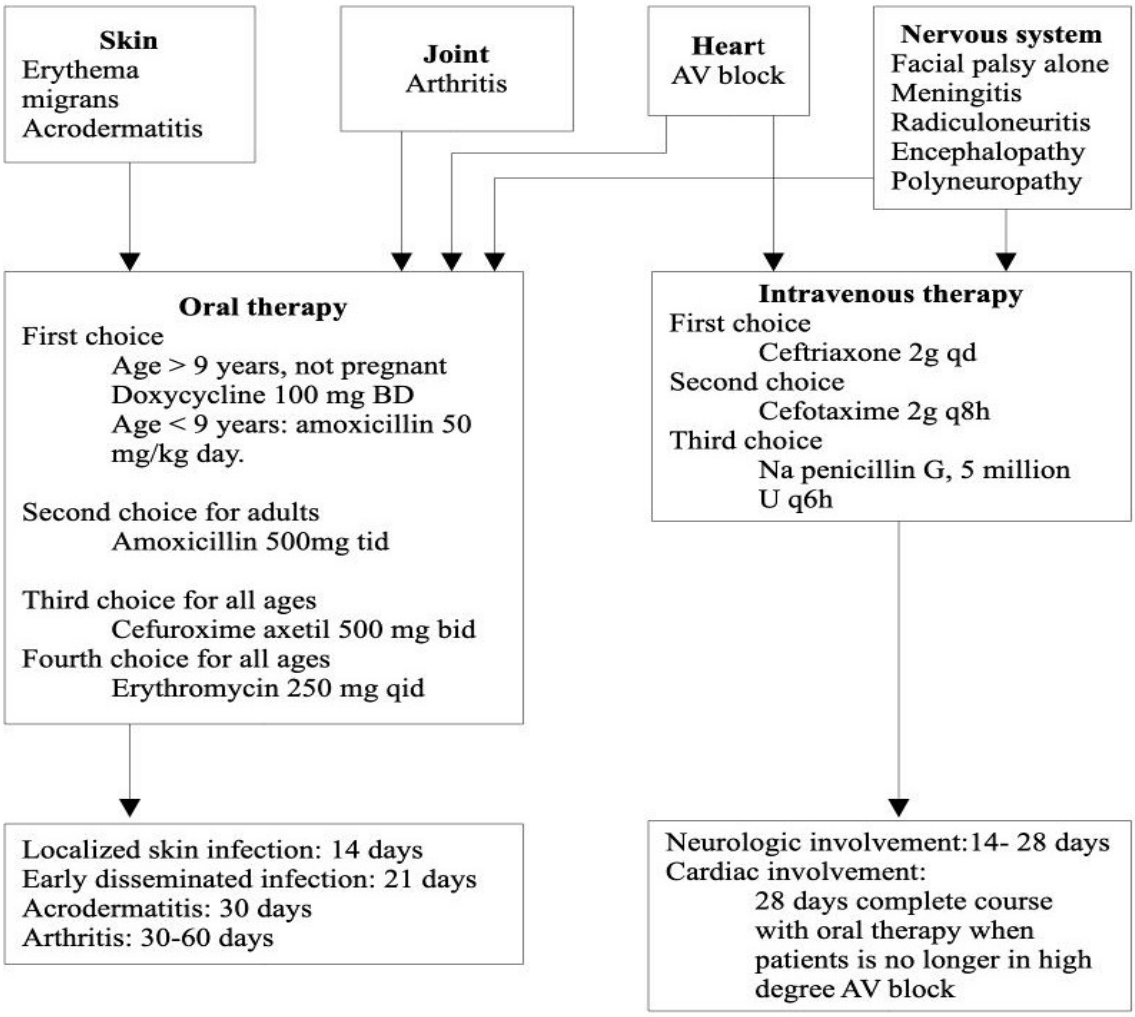


**Figure 2:** Treatment chart for Lyme disease.

## Prevention of tick bites

Avoiding tick-infested areas is presently the best way to prevent infection with *B. burgdorferi* and other illnesses transmitted by *Ixodes*. If it is inevitable for you to come into contact with *I. scapularis* or *I. pacificus* ticks, there are a few things you may do to lessen the likelihood that the ticks will attach and spread the infection. Regular visual examination of the skin and clothing can assist in identifying ticks before they adhere, enabling removal before the spread of infection. Ticks that are attached should be extracted right away, ideally with fine-tip forceps. Only topical disinfection of the area is advised if a portion of the tick's mouth parts are still entrenched in the skin, as attempts to remove them could harm the skin and is not necessary given the risk. Wearing protective clothes, such as long sleeve shirts tucked into pants and long pants tucked into socks, may hinder tick attachment by making it take longer for ticks to locate exposed skin, making it easier to identify and remove them. As a common-sense precaution to improve the capacity to detect and remove ticks prior to attachment, wearing light-coloured clothes that contrasts with the tick is frequently favoured. When applied topically to the skin or clothing, tick and insect repellents containing N, N-diethyl-3-methylbenzamide (DEET) offer further protection, however reapplication may be necessary for optimal efficacy.

| Treatment regimen | Drug | Alternative |
|---|---|---|
| **Early-localised and early-disseminated Lyme borreliosis** | | |
| Erythema migrans | T.Doxycycline 100 mg Twice daily.<br>T. Amoxicillin 500 mg Three times daily.<br>T.Phenoxymethylpenicillin 500–1000 mg TID | T. Azithromycin 500 mg OD |
| Meningitis or radiculopathy | Ceftriaxone 2 g once daily intravenously.<br>Cefotaxime 2 g every 8 h intravenously. | Cefotaxime 2 g every 8 h IV<br><br>Penicillin G 18–24 million units intravenously per day divided into six daily doses. |
| Cardiac disease | T.Doxycycline 100 mg Twice daily.<br>T. Amoxicillin 500 mg Three times daily.<br>T.Phenoxymethylpenicillin 500–1000 mg TID<br>OR<br>Ceftriaxone 2 g once daily intravenously.<br>Cefotaxime 2 g every 8 h intravenously. | T. Azithromycin 500 mg OD<br>OR<br>Cefotaxime 2 g every 8 h IV<br><br>Penicillin G 18–24 million units intravenously per day divided into six daily doses. |
| **Late Lyme borreliosis** | | |
| Arthritis without neurological disease | T.Doxycycline 100 mg Twice daily.<br><br>T. Amoxicillin 500 mg Three times daily.<br>T.Phenoxymethylpenicillin 500–1000 mg TID | T. Azithromycin 500 mg OD |
| Antibiotic-refractory arthritis | Symptomatic treatment with non-steroidal anti-inflammatory drugs and corticosteroids. | |
| **Post-Lyme borreliosis syndrome** | Symptomatic treatment as required. | |

**Figure 3:** Treatment Regimen.

## Prophylaxis

### *Primary options for management*

Taking into account the individuals who discovered and extracted the attached tick, the available treatment alternatives were treating with antimicrobials for everyone, just those thought to be more susceptible to Lyme disease (such as those who removed an adult or nymphal *I. scapularis* or *I. pacificus* tick after at least 36 hr of attachment), only those who experienced erythema migrans or other clinical signs and symptoms of a tick borne infection, and all individuals who seroconverted from a negative to a positive test result for serum antibodies to *B. burgdorferi*. Parenteral antibiotic therapy is utilized for neurologic disorders (apart from facial palsy) in the United States. Treatment options for neurologic involvement include IV ceftriaxone for 14-28 days, IV cefotaxime, or IV penicillin G. Lyme disease vaccination should be considered for persons aged 15-70 years and have frequent or prolonged exposure to tick- infested habitats (Figure 3).[8]

## Late Lyme disease

Treatment options for late-stage Lyme disease manifestations, including arthritis, encephalopathy, encephalomyelitis, and peripheral neuropathy, include oral and parenteral antimicrobial regimens. The erythema migrans will go away on its own without antibiotics. Oral antibiotics such as Cefuroxime axetil, Amoxicillin, Doxycycline, and Phenoxymethyl penicillin are very effective in halting the spread of later sequelae. Ceftriaxone is the parenterally administered antibiotic of choice for treating Lyme borreliosis; cefotaxime and penicillin are other options. Parenteral antibiotics are recommended as the first line of treatment for cardiac Lyme borreliosis and for patients with Late Lyme borreliosis. Effectively managing the delayed complications while reducing the negative effects is the intended result.[8]

Patients with uncomplicated seventh nerve palsy have been successfully treated with Amoxicillin. Most cases of Lyme arthritis were seen in people with untreated Lyme disease. It typically reacts well to antibiotic therapy. Parenteral antibiotic treatment for those who do not show any clinical response can be used to treat the condition again if it is not resolved. Patients with high grade atrioventricular block and those with cardiac borreliosis symptoms should be admitted and closely watched. Treatment for acrodermatitis chronica atropicans, which appears years after the original infection, entails weeks of oral or parenteral antibiotic therapy.[8]

## Prognosis

Early in the course of the disease, treatment response is optimal. Even though treatment received later is successful, recovery time may extend.

## Reinfection

Following antibiotic therapy, reinfection results as EM. In these situations, the immune system is insufficient to shield the body from further infection. On the other hand, individuals who experience a prolonged protective immunity against the spirochete over several months are unlikely to re-infect.[6]

# CONCLUSION

Lyme disease is an illness caused by borrelia bacteria. Humans usually get Lyme disease from the bite of a tick carrying the bacteria. If Lyme disease is not treated, it can cause more serious symptoms that include the heart, joints, and brain system. The complexity of the illness and the rise in tick-borne infection rates highlight the need for more study, education, and preventative actions. The need to treat Lyme illness immediately is further underscored by the possible long-term effects, including chronic symptoms and complications. Innovative research, public health campaigns, and education programs are crucial in stopping the spread of Lyme disease and lessening its effects on both individuals and communities.

# CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

# SUMMARY

The abstract and introduction lay the foundation for a comprehensive examination of Lyme disease, focusing on its symptoms, etiology, epidemiology, pathophysiology, diagnosis, treatment, and prevention. Lyme disease is caused by the *Borrelia burgdorferi* bacterium and transmitted by Ixodes ticks, mainly in the United States. Symptoms include erythema migrans, fatigue, malaise, myalgia, headache, and regional lymphadenopathy. If untreated, Lyme disease can spread to the heart and nervous system, leading to potentially life-threatening neurologic and cardiac problems. The study aims to increase understanding and awareness of Lyme disease by exploring clinical symptoms, pathophysiology, diagnostic criteria, potential therapies, and prophylaxis. The article highlights the complexity of the illness and the importance of research, education, and preventative measures in tackling Lyme disease and reducing its impact.

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**Cite this article:** Nath AS, Ajith B. Lyme Disease: The Threat of a Tick Born Illness. Indian J Pharmacy Practice. 2024;17(2):122-7.