Lyme Disease

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Etiologic agent
*Borrelia burgdorferi* (1)

Reservoir
Lyme disease is a zoonosis; the reservoir for the *B. burgdorferi* are animals like rodents or deer (2).

Transmission
*B. burgdorferi* is transmitted via infected blacklegged ticks of the *Ixodes* species. The bacteria can be transmitted by both immature and adult ticks, but most disease results from a bite by immature ticks called nymphs, since they are tiny and thus difficult to see (1).

General characteristics
*Borrelia burgdorferi* are classified as gram-negative bacteria. They are pleomorphic so have the ability to change morphology as a response to environmental conditions (3). However, they are typically found as a spirochete that move via axial filaments. The bacteria can be up to 30 microm long, but only .2-.3 microm wide, thus can only be viewed under a darkfield microscope. (4)

Key tests for identification
The test for Lyme disease is two-tiered. Both steps can be done with same blood sample and need to both be positive to confirm that someone has Lyme disease (5).

- The first step is an enzyme immunoassay or immunofluorescence assay. If negative, no further testing is needed and alternative diagnosis is considered; or a new test is performed 30 days later if the patient still presents signs/symptoms of Lyme disease (5).
- If first test is positive or equivocal, a Western blot test is performed. If also positive, the disease is confirmed (5).

Signs & symptoms (CDC)
The signs and symptoms a patient with Lyme disease presents are divided into early and late signs. Early signs occur 3-30 days after a bite, and include fever, chill, fatigue and joint pain. Most noticeable on the body in an erythema migrans (EM) rash, characterized by its ‘bulls-eye’ appearance. It can increase up to 30cm diameter in size and feel warm to the touch, but rarely causes itchiness or pain. Late signs show up days to months after a bite and include additional EM rashes and facial palsy. The patient can also experience Lyme carditis, dizziness and shortness of breath (6). When untreated, people may develop neurological issues and have about a 60% chance of developing Lyme arthritis. (7).

Historical
The disease inherits its name from Lyme, Connecticut, where an outbreak of rheumatoid arthritis occurred in 1975 (6,4). The disease was recognized that year by Dr. Allen Steere who
suggested transmission via arthropod vectors due to rural location and seasonal summer/early fall onset of the disease. The etiological agent was discovered by Willy Burgdorferi in 1982, when he isolated the *Borrelia* spirochete genus from the gut of *Ixodes* ticks. Thus, the name *Borrelia burgdorferi* was given to the bacteria. Since its discovery, reports of Lyme disease have risen and it is now the most prevalent tick-transmitted disease in the U.S. (6)

**Virulence factors**
Research shows that *B. burgdorferi* do not have actual virulence factors, but their effects on humans are caused by the bacteria attempting to reproduce and survive (8). The flagellar arrangement in *B. burgdorferi* is along the length of the cell body and under the outer membrane - in this way the flagella may be hidden from the host defense systems and therefore not act as an antigen. Additionally, the structure of the spirochete helps bacteria to penetrate host tissues and let them swim in more viscous medium than other bacterial species (8). However, there are some outer membrane proteins (Osps), namely Osp A and Osp B, that are believed to play some part in virulence by allowing the bacteria to latch on to host cells (4).

**Control/treatment**
Currently antibiotics are the only effective treatment for Lyme disease (9,10). Oral treatments are short course and include doxycycline and amoxicillin. If patients develop neurological symptoms they may require intravenous antibiotics like ceftriaxone or penicillin (10). Successful treatment can resolve the disease in about 3 to 4 weeks (9).

**Prevention/Vaccine info**
There are currently no vaccines available for humans in the U.S. An antigenic vaccine which used the outer surface protein A was developed (licensed as LYMErix). However, it was taken off the market in 2002 due to the incidence of Lyme disease continuing to rise and the reduced sales of the vaccine (11). Currently, developing vaccines are focusing on eliminating *B. burgdorferi* from animal reservoirs (11) and using tick saliva (12). However, the most effective prevention is by taking precautions to avoid getting bitten by blacklegged ticks. This includes avoiding wooded/grassy areas especially during summer months, spraying insect repellent that works against ticks on exposed skin, and by wearing clothing that covers as much skin as possible (13).

**Local cases/outbreaks**
There are approximately 300,000 cases of Lyme disease in the U.S. every year, but the majority are concentrated in the Northeast and upper Midwest regions. Only 14 states contain over 96% of all cases of Lyme disease reported to the CDC. The disease account for more than 90% of all reported vector-borne illnesses in the U.S. overall (14).

**Global cases or outbreaks**
Lyme disease is also the most common tick-borne bacterial disease in the world, and are common in the forest of Asia, in north-west, central and eastern Europe, in addition to the cases reported in the U.S. (15).
References

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