衞生防護中心
Centre for Health Protection

Scientific Committee on Vector-borne Diseases

Prevention of Lyme Disease in Hong Kong

Purpose

Lyme disease is the most common human tick-borne infectious disease in the northern hemisphere (1). The disease predominately occurs in temperate regions of Europe, North America and Asia. It is estimated that there are about 85 500 cases annually, including 65 500, 16 500 and 3 500 cases in Europe, North America and Asia respectively (2). This paper aims to review the global situation of Lyme disease, assess its potential risk to Hong Kong and highlight relevant preventive and control measures.

The Causative Agent

2. Lyme disease is a tick-transmitted bacterial infection caused by *Borrelia burgdorferi* (*B. burgdorferi).* It is a gram-negative, microaerophilic spirochete which belongs to the genus Borrelia. It is a slow growing, fastidious organism which requires a complex liquid medium and an optimal temperature of 33-35 °C for growth (3). The protoplasmic cylinder of the organism is firstly surrounded by a cell membrane, followed by flagella and finally by an outer membrane which is only loosely associated with the underlying structures. *Borrelia* species are longer and more loosely coiled than the other spirochetes (4).

3. *Borrelia* species causing Lyme disease are collectively known as *Borrelia burgdorferi sensu lato* (*B. burgdorferi sl*). Five pathogenic genospecies are identified in Europe. *Borrelia afzelii (B. afzelii)* and *Borrelia garinii (B. garinii)* are more common than *Borrelia burgdorferi sensu stricto (B. burgdorferi ss*), *Borrelia bavariensis (B.*

bavariensis) and *Borrelia spielmanii (B. spielmanii)*. In North America, *B. burgdorferi ss* is the major causative agent of Lyme disease (5), whereas *B. garinii* and *B. afzeii* are dominant in Northern Asian countries (6-11) (Table 1).

The Vector

4. The vectors of Lyme disease are a number of closely-related, hard bodied and blacklegged *ixodid* ticks, which are distributed in various geographic regions (Table 1). Transmission of *B. burgdorferi* to humans in Europe is primarily through the ticks *Ixodes ricinus* (12). The two principal vectors of Lyme disease in the United States (US) are populations of adult *Ixodes scapularis* and *Ixodes pacificus* (13). *Ixodes persulcatus*, which is less frequently found in Europe, is known to be the common vector in northeastern China, Russia and Far East Asia including Japan (7, 8, 11). *Ixodes granulatus* and *Haimaphysails bispinosa* are predominant in the southern regions of China (7, 9, 14).

Table 1. Distribution of genospecies of *B. burgdorferi sl* and vectors of Lyme disease in different regions.

Geographic distribution		**Common Arthropod vector(s)**	**Common etiologic agent(s)**
US (13)	North–eastern, North-central and Pacific Coast of United States	*Ixodes scapularis, Ixodes pacificus*	*B. burgdorferi ss*
Europe (12)	--	*Ixodes. ricinus*	*B. garinii (Eurasian-type) , B. afzelii*
China (7, 9, 14)	Northern	*Ixodes persulcatus*	*B. garinii (Asian-type), B. garinii (Eurasian-type) , B. afzelii*
	Southern	*Ixodes granulatus, Haimaphysails bispinosa*	
Japan (7, 8, 11)	--	*Ixodes persulcatus*	*B. garinii (Asian-type)*

5. These ticks are commonly found in the woods and in the edge area between lawns and woods. It can be carried by animal onto lawns and into houses by pets. In endemic areas, people like campers, hikers, outdoor workers and others who may be exposed to infected ticks in wooded, brushy, and grassy places are at a greater risk of contracting the disease. In addition, people living in houses built in wooded area where infected ticks are common are also at a great risk of exposure (13).

The Host

6. Besides human beings, the reservoir-competent hosts include many common species of small and medium-sized mammals, such as mice, rats, squirrels, hares, rabbits and ground-feeding bird species (17-19). The ticks infected with *Borrelia* can stay in the competent reservoir hosts and transmit the spirochetes to both the hosts and other uninfected ticks (15).

Transmission Cycle between the Causative Agent and Vector

7. *Borrelia* may be acquired by ticks through co-feeding transmission (15). A tick can get the spirochete from feeding on an infected host, when feeding very close to an infected tick on the same host, or from the site where an infected tick has recently finished its blood meal. Once infected, competent tick species retain the pathogen even between moults. It effectively transmits the pathogen to the next feeding stage and/or to the host (12).

8. There are three stages in the life cycle of ticks, namely the larva, nymph and adult stage. The whole cycle lasts for about 2 years (Figure 1) (13). Eggs of ticks laid in spring are hatched as larva in summer. Between summer and early fall, larvae feed on mice, birds, and other small animals and they may get infected if these animals carry *Borrelia*. The larvae then become inactive and they move into the nymph stage in following spring.

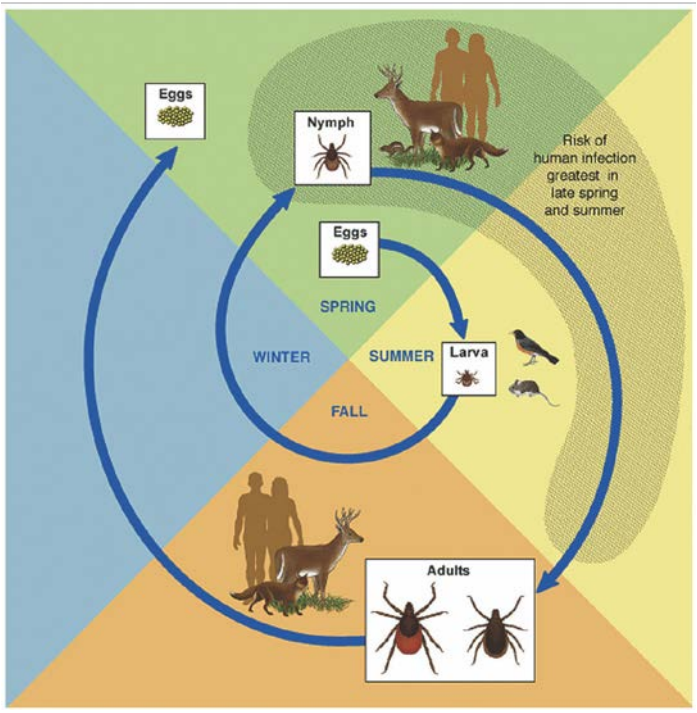

Figure 1. Life cycle of vector (Source: Lyme Disease: A Public Information Guide, CDC,2011)(13)

9. Nymphs feed on small rodents, birds, other small mammals as well as human beings in late spring and early summer. Nymphs moult into adult ticks in the fall, which can transmit *Borrelia* to humans while feeding if they have been previously infected. Between meals, the larvae and nymphs remain in leaf litter until moultings are complete. As the ticks cannot jump or fly, they seek hosts by "questing" or climbing up grass stems or onto the edge of leaves, and extending their forelegs in response to thermal and chemical cues. Once the ticks attach on hosts, they feed on blood by inserting their mouth parts into the skin of targeted human or animal. Their bodies slowly enlarge during the feeding process. As *Ixodes* ticks are slow feeders, a complete blood meal can take several days (13).

Clinical Presentation and Management

10. Lyme disease is an inflammatory disorder affecting multiple systems, caused by an immune response to the pathogenic species of *Borrelia*. The incubation period is usually about 3 to 32 days.

11. *B. burgdorferi* infection can be asymptomatic (16). Approximately 80% of people infected with *B. burgdorferi* develop an early skin rash of localised inflammation, the erythema migrans (EMs) or "bull's eye rash", within 30 days of exposure (16). A typical EM is usually greater than 5 cm in diameter (17, 18). This erythematous rash is commonly found over the thighs, groin, trunk and armpits (13). The rash gradually expands from the site of a tick bite and it usually feels warm to the touch but is rarely itchy or painful (19). Some patients may also have systemic flu-like illness without significant respiratory symptoms such as fever, fatigue, headache and muscle or joint pain (12).

12. Some signs and symptoms may not appear until weeks, months, or years after a tick bite and the disease can involve multiple systems. Clinical presentations of nervous system involvement include numbness, pain, nerve paralysis (such as facial palsy), and meningitis. Arthritis is most likely to appear as brief bouts of pain and swelling, usually in one or more large joints, especially the knees. Rarely, carditis and arrhythmia may occur (13, 20). Multiple EMs lesions may also appear following haematogenous spread to other areas of skin (21).

13. The mortality rate of Lyme disease is low. There was only one death out of the 96 068 cases reported in the US from 1999 to 2003 (22).

14. Early treatment with antibiotics stops the course of the disease and reduces the incidence of developing late stage complications. It is believed that even patients with late stage Lyme borreliosis can benefit from antibiotics, despite that clinical recovery may be incomplete if severe tissue damage had occurred prior to the treatment (23).

15. Reinfection of Lyme disease has been documented after successfully treated early infection. There is no evidence of person to person transmission thus far but individuals undergoing treatment for Lyme disease with antibiotics should not donate blood as the bacteria can survive in the blood products (24, 25).

Laboratory Diagnosis (21, 26)

16. A two-tiered approach is usually applied. It includes the sensitive enzyme immunoassay (EIA) or indirect immunofluorescence assay (IFA) as an initial screening test. If the result is negative, the length of infection must be considered for interpretation since antibody response can take some weeks to develop. It may also be abrogated if the patient receives early treatment. Further immunoblot (Western blot) tests are indicated for any positive screening result (Figure 2).

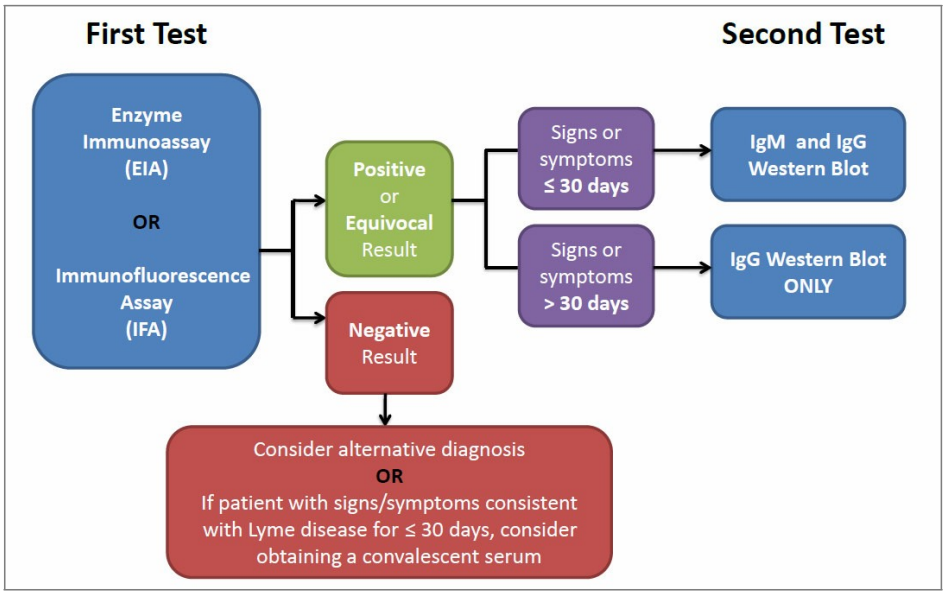

Figure 2. Two-tiered testing for Lyme disease
(Source: Two-tiered testing decision tree, Laboratory Testing, CDC, 2011)

Global Epidemiology

Situation in United States (US)

17. In US, Lyme disease is a notifiable disease. For surveillance purpose, a case is classified as ***Confirmed*** if: i.) a case of EM with a known exposure, or ii.) a case of EM with laboratory evidence of infection and without a known exposure or iii.) a case with at least one late manifestation that has laboratory evidence of infection. Any other case of physician-diagnosed Lyme disease that has laboratory evidence of infection is classified as ***Probable***. Exposure is defined as having been (less than or equal to 30 days before onset

of EM) in wooded, brushy or grassy areas (i.e., potential tick habitats) in a county in which Lyme disease is endemic. A history of tick bite is not required (17).

18. Lyme disease is the fifth most commonly reported notifiable disease in the US in 2009 (27). It was first recognised in 1975, after an unusual outbreak of arthritis among children living near Lyme, Connecticut. Since then, reports of Lyme disease had increased dramatically and this was made to be notifiable in 1991. The disease became the most common vector-borne illness in US. In 1992 – 2006, approximately 248 000 cases were reported, the annual number of reported cases increased 101% in 15 years from 9 908 cases in 1992 to 19 931 cases in 2006. The highest incidence appeared in children aged from 5 to 14 years and the male-to-female ratio was roughly 1:1. Cases were reported in all months but the majority had onset of symptoms in June and July. EM was reported in more than 65% of patients, compared with 32% of patients with arthritis. Neurologic symptoms were also reported in 12% of cases (28).

19. In 2010, more than 22 500 confirmed and 7 500 probable cases were reported in the US. The distribution was highly focused in north-eastern and north-central states. The majority of cases (93%) were reported from 10 states (Connecticut, Delaware, Massachusetts, Maryland, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island and Wisconsin) (29) (Figure 3).

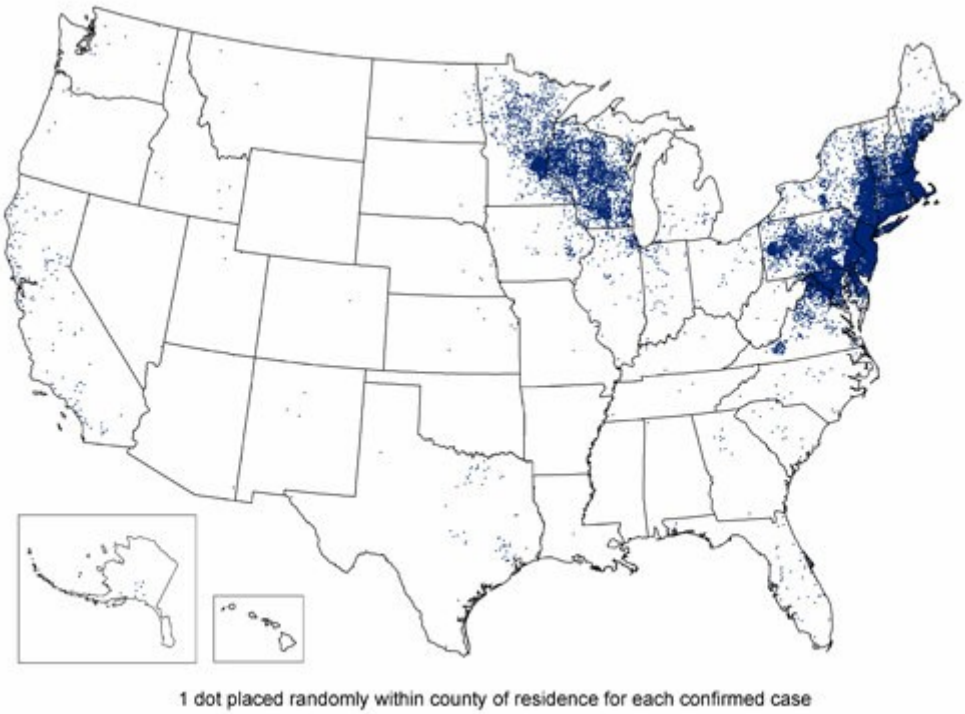

Figure 3. Reported Cases of Lyme Disease—United States, 2010 (Source: Lyme disease- NIOSH fast facts, CDC, 2011)(29)

Situation in Europe

20. Lyme disease occurs across Europe, with a distribution closely matching that of the common vectors (12). The incidence of Lyme disease had been increasing markedly in some European countries in the past decades. Its geographical distribution was expanding, especially towards higher altitudes and latitudes. Nevertheless, Lyme disease is not a statutory notifiable disease in most of the countries in Europe (11, 23, 34). Surveillance statistics based on epidemiological studies estimated that approximately 65 500 cases of Lyme disease occurred annually in Europe from 1987 to 2006 (30). The incidence rates of the disease were geographically unevenly distributed across the European countries. A serological study indicated that the level of antibodies to *B. burgdorferi sl* was highest in residents of northern and central countries and lowest in those in the southern countries (2, 12). There is a focal pattern of distribution related to the suitability of tick habitats. More than 100 cases per 100 000 population per year were recorded in some hotspots. These included part of Slovenia, Germany and Austria, the Baltic coastline of southern Sweden, and some Estonian and Finnish Islands(2).

21. In UK, although Lyme disease is not statutorily notifiable by medical practitioners, over 6 000 cases had been reported since introducing the enhanced laboratory surveillance in 1997 to 2009, The annual incidence rates for laboratory-confirmed cases increased steadily from 0.38 per 100 000 total population for the period 1997 – 2000, to 0.64 in 2002, and to 1.79 cases per 100 000 total population in 2009. Since 2000, an average of 15% of cases have been imported from US, France, Germany, Scandinavia and other northern and central European countries. Most of these cases were travellers. The remaining cases predominantly acquired the disease in the UK. Cases have been reported from most counties in England and Wales (31).

Situation in Asia

22. In China, the first case of Lyme disease was reported in the forest region of Heilongjiang Province in 1986 (32) in the literature. It was described that this disease was widely distributed in China, particularly in Northeast region and Inner Mongolia. It was roughly estimated that the incidence was over 10 000 annually in China (33). Previous seroprevalence studies indicated that this disease had occurred in the forest areas of more than 26 provinces and autonomous regions (33).

23. The literature also reported that the distribution of disease varied geographically across different regions in China. Seroprevalence of antibodies to *B. burgdorferi* was the highest (over 10%) in the population of mountainous areas. In forest area such as Southern region of Qinling forest area, the seroprevalence was relatively lower (ranged from 5 to 10%). The prevalence is the lowest (below 5%) in flatlands (9). This disease was more commonly

diagnosed in summer season from April to August in Northeast forest area, coinciding with the tick activities. Few cases were also observed beyond this period. All ages and sexes were susceptible but higher attack rate appeared in young adults. Occupation of patients was usually related to forestry workers and other workers exposed to forest (33).

24. In Japan, Lyme disease was classified as Category IV infectious disease under the Infectious Diseases Control Law in 1999. Doctors are required to notify Ministry of Health of any diagnosed cases. From April 2006 to 2010, 49 cases were reported, with an incidence rate of 0.008 per 100 000 population. About 84% of the cases were acquired locally and the male to female ratio was 1.6:1. Among the local cases, nearly half of the patients were aged over 60 and most cases were diagnosed in summer season. No case was reported in winter season from December to March. About half of the cases were acquired in Hokkaido, 12% in Nagano and the rest cases were acquired in other regions such as Kanagawa, Niigata, Gifu and Fukuoka respectively. Around 16% of cases were imported from other countries, which included US, Germany, and the Switzerland (11).

Situation in Hong Kong

25. In Hong Kong, Lyme disease is not a statutory notifiable disease. No confirmed human case has been reported to the Department of Health (DH).

Prevention of Lyme Disease in Hong Kong

Preventive Measures for Travellers to Endemic Countries

26. Prevention and control of Lyme disease mainly rely on individual and community measures to reduce the probability of tick bite (34). Workers in high-risk occupations, long-term residents of endemic area or visitors to tick-infested areas are advised to avoid tick habitats especially in seasonal period (13). If it is not possible, risk of tick bite can be minimised by wearing light-coloured protective clothing with long trousers that tucked into socks and long sleeves clothes. Use of insect repellents can also decrease the risk of tick bites and Borrelia transmission.

27. Since ticks do not have a high probability of transmitting Borrelia until 12-24 hours after beginning to feed, prompt removal of ticks is one of the most effective ways of avoiding Borrelia infection (12, 35). Attached ticks should be removed using tweezers if available, by seizing and pulling steadily upwards on the mouthparts without twisting. The attachment site should be disinfected to reduce pyrogenic infection. The site should also be monitored for 4 to 6 weeks after the bite for signs of EM (21). After visiting the tick-infested areas, taking a shower and performance of thorough check for ticks are recommended.

28. Currently, licensed vaccine for Lyme disease is no longer available in the market as it has been withdrawn since 2002 (13, 30).

Disease Diagnosis and Investigation

29. When a doctor reports a suspected case of Lyme disease, the Centre for Health Protection (CHP) will conduct epidemiological investigation and arrange laboratory test for diagnosis confirmation. The Public Health Laboratory Services Branch of the CHP provides laboratory capacity for diagnosing Lyme disease in the form of serological tests for IgM and IgG against *Borrelia burgdorferi*. Acute and convalescent clotted blood specimens should be obtained for serological tests.

30. The exposure and travel history would be explored to determine the source of infection. The CHP will also inform the Food and Environmental Hygiene Department (FEHD) to implement vector control measures.

Vector Surveillance and Control

31. The Pest Control Advisory Section (PCAS) of FEHD is responsible for the control of pests that cause vector-borne diseases. Prompt investigation and vector control measures will be carried upon notification by the CHP. Meanwhile, tick control measures will be conducted based on the places visited by the patient during infectious period.

32. *Ixodes granulatus* is one of the main species transmitting *B. burgdorferi sl* in Southern China (9). This tick was last recorded in Hong Kong in the year 2008. Although serological had not been done to ascertain the presence of *B. burgdorferi sl* in this vector, the risk of the disease in local setting cannot be excluded.

Public Health Education

33. Avoidance of tick bite is effective in preventing the disease. The CHP (36) and FEHD (37) provide guidelines to the public on preventing tick-borne diseases. In addition, hotline of the FEHD is also available for phone enquiry on relevant preventive measures in rural areas. Other sources of useful education materials such as fact sheets on tick-borne diseases are available on the CHP website. Global news on Lyme disease outbreaks and health tips for travellers are continuously updated in the website of Travel Health Service of DH.

Conclusion

34. Lyme disease is a vector borne disease commonly found in temperate regions. Although no confirmed cases have been reported to the DH, Hong Kong is still receptive to the disease due to the presence of *Ixodes*

granulatus, which is one of the vectors for transmitting *B. burgdorferi sl*, in the community. The Government will remain vigilant in the prevention of Lyme disease through on-going surveillance, effective tick control measures, prompt laboratory diagnostic capacity and appropriate public health education.

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