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LYME DISEASE

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Lyme Disease or Lyme Borreliosis is a tick-borne disease cause by *Borrelia burgdorferi*.

In 1975, a cluster of children with juvenile rheumatoid arthritis was identified in Old Lyme, Connecticut. The investigation showed that the cause was an infection by a spirochete transmitted by ticks. A similar infection had been described in Sweden in 1909 and named erythema migrans (EM). Between 1920 and 1940, neurological abnormalities following EM were described in France, Sweden and Germany (Erythema migrans disease). All of these diseases were grouped together. Soon the spirochete responsible for Lyme disease was isolated from an Ixodes collected in an endemic area. The name *Borrelia burgdorferi* was adopted in 1984.

Epidemiology

Animal reservoir

B. burgdorferi is common in white tailed deer and feral mice (*Peromyscus leucopus* or white-footed mouse and other *Peromyscus* spp). Other mammals may be infected but play a lesser role in transmission for example, raccoons. Infected dogs develop a "lameness"; horses and cows may also become infected.

Infected Ixodes have been found in ground feeding migratory birds.

Ticks

B. burgdorferi is transmitted by ticks belonging to the genus Ixodes. The Ixodes genus consists of hard-bodied ticks (about one-third the size of the dog tick), which can harbor *B. burgdorferi*.

In the northeast and north central parts of the country, the vector is the deer tick, *Ixodes scapularis,* which has a two-year life cycle. In the northwest, *I. pacificus* is the most common vector.

The ticks acquire the infection through a blood meal, more than likely as a larva. They remain infected throughout their lifetime, throughout the different stages (larva, nymph, adult). Transovarial infection may occur but it does not seem to play a major role in sustaining the infection in nature, probably because the infected eggs do not survive very well.

The nymphal form is primarily responsible for transmission during the summer months. Adult females are implicated in transmission during early spring and fall. *B. burgdorferi* are generally found in the gut of unfed nymphs and adults. Infected nymphs produce saliva containing microorganisms within three days of attachment. Thus a minimum feeding time is necessary for transmission to take place. The smaller size and shorter feeding period of nymphs make them more effective transmitters.

The Lyme spirochete gains access to a human host at the site of an infected tick's bite. However, the organism is not transmitted to everyone bitten by an infected tick; in fact, most such bites do not infect humans. The likelihood of infection increases in proportion to the duration of the tick's feeding. Some people, because of low inoculum and/or host immune factors, may contain the infection.

Spirochetes have also been found in horseflies, deerflies and mosquitoes. There are a few cases of EM resulting from bites from these insects, but these remain rare occurrences.

Contact transmission has been demonstrated between mice. This type of transmission may help maintain the microorganisms in the small rodent reservoir.

Factors explaining the increase in Lyme disease are:

- Migration of population in unhabited areas
- Return of lands used for agriculture or industry in forests
- Suburban habitat next to preserve areas

Outdoor workers (foresters for example), hikers, campers, hunters are at higher risk of contacting the infection. Foresters were determined to be six-times more likely to be positive than blood donors from the same area.

The incubation period from tick bite to appearance of erythema migrans ranges from three to thirty-one days and typically is from seven to fourteen days. Late manifestations occur months to years later.

Clinical Description

Stage 1: Erythema migrans

Stage I is asymptomatic or begins with erythema migrans, which develops at the site of an infected tick bite. (Fewer than one-half of patients recall being bitten.) The rash appears alone or with fever, minor constitutional symptoms and regional lymphadenopathy. The characteristic maculopapular erythema expands centrifugally, beginning a few days to a few weeks after the bite. The outer border remains flat and bright red; the center usually, but not always, clears. Patients often describe the rash as feeling hot or burning and sometimes painful or pruritic. Even without treatment, manifestations of localized infection usually resolve over several weeks.

Stage 2: Hematogenous dissemination

The main organs involved during the secondary spread are

CNS (meningo encephalitis)

Cardiovascular system (endocarditis, myocarditis, fibrinous pericarditis, vasculitis):

Stage II occurs days to weeks after infection with *B. burgdorferi* and consists of systemic flu- or meningitis-like symptoms (malaise and fatigue, headache, fever and chills, stiff neck, arthralgias, myalgias and anorexia), as well as acute cardiac and neurologic abnormalities. Possible physical findings include regional or generalized lymphadenopathy, signs of meningeal irritation, a malar rash, an erythematous throat, conjunctivitis and hepatosplenomegaly. Secondary erythema migrans lesions, annular and usually smaller than the primary lesion, develop in about fifty percent of cases, anywhere except on the palms and soles. Frank arthritis is rare.

The most common cardiac abnormality is self-limited, fluctuating atrioventricular (AV) block (first- to third-degree). Myopericarditis is rarer and usually mild. Cardiomegaly is unusual. Symptoms of cardiac involvement include lightheadedness, syncope, palpitations, chest discomfort and dyspnea. The electrocardiogram may show ST-T changes in addition to AV block.

Neurologic problems include meningoencephalitis, cranial neuritis and radiculoneuritis. Symptoms vary with the type of neurologic involvement and may include headache, stiff neck, photophobia, difficulty concentrating, poor memory, emotional lability, focal weakness, dysesthesias, dizziness, unilateral or bilateral facial palsy and earache. Although each of these manifestations may occur alone, their clustering strongly suggests Lyme disease, even without a history of erythema migrans.

Stage 3: Persistent infection

The two target systems of this stage are:

Recurrent migratory arthritis involving primarily the large joints
Chronic neurological involvement

Occurring weeks to months (and sometimes years) after the initial infection, stage III typically manifests as one or more attacks of mono-or oligoarthritis, each lasting several days to several months. The knee is the most frequently affected joint, with large effusions common. Patients complain of swelling, stiffness, and pain in affected joints, but generalized morning stiffness and prominent systemic symptoms are uncommon. The arthritis attacks often become less frequent and less severe over time. A minority of these patients develop chronic erosive arthritis.

Some patients present with symptoms of late persistent infection without having had manifestations of early disseminated infection.

Chronic Lyme synovitis histologically resembles rheumatoid arthritis. A distinctive obliterative vasculopathy, reminiscent of that seen in syphilis, can occur in synovium and other tissues. It remains unclear whether both early and late disease manifestations require the presence of viable *B. burgdorferi* organisms or whether a self-perpetuating immune response to past infection may continue to cause clinical disease. The preponderance of evidence supports the likelihood of persistent infection.

Peripheral Facial Palsy (PFP): Bell's Palsy

Aside from headache, the most common neurologic symptom associated with Lyme disease is peripheral facial palsy (PFP), occurring, according to one report, in eleven percent of patients with Lyme disease. There is evidence, however, that the incidence of Borrelia-associated PFP is much higher and that many cases of idiopathic facial paralysis, known as Bell palsy, are actually manifestations of undiagnosed Lyme borreliosis.

Laboratory Tests

Direct detection, antigen detection and culture are poor methods.

B. burgdorferi can be demonstrated by silver stains or immunofluorescence. Direct detection methods are not very sensitive because of the small numbers of microorganisms in tissues. PCR assays need to be highly sensitive for the same reason (small number of microorganisms). The draw back of this high sensitivity is the high rate of false positive. *B. burgdorferi* can be cultured on Barbour-Stoenner-Kelly medium.

B. burgdorferi is difficult to isolate from infected fluids: blood, CSF, pericardial or synovial fluids because of the low concentrations in these fluids. It has a more definite affinity for tissues rather than for body fluids. *B. burgdorferi* can be isolated from the infected tissues, for example at the periphery of the EM lesion.

Serology is widely available BUT must be interpreted with caution

An early IgM response develops and peaks at three to six weeks. Very rare cases (one or two percent) have had IgM persisting for over two to three years. An IgG response starts after several weeks and may persist for years, even after successful treatment. Therefore IgG antibodies are not useful to evaluate response to treatment.

A two test approach, sensitive EIA or IFA followed by Western Blot confirmation is the preferred approach. EIA, IFA alone or ImmunoBlot alone (particularly IgM) do produce false positives. A combination of both is the best solution to reduce false positives. A positive IgM with negative EIA is more than likely a false positive result.

False positive result from rheumatoid arthritis, systemic lupus erythematosus and treponemal infections. False-positive results of serological tests for Lyme disease have been reported in cases of recent primary infection with varicella-zoster virus, Epstein-Barr virus and cytomegalovirus and herpes simplex virus (HSV) type 2.

About 5% of a normal population has false positive IgM Western Blots.

The following may be found in Lyme disease serology testing:

- False negative serologic tests during acute disease
- False negative due to early antibiotic treatment
- True Positive results in infected but asymptomatic individuals
- False positive results in rheumatoid arthritis, systemic lupus erythematosus and treponemal infections.

Serodiagnosis early in the infection is insensitive because the specific immune response in Lyme disease develops slowly. Only thirty to forty percent of patients with EM are seropositive in acute phase sera and sixty to seventy percent are positive by convalescence two to four weeks later.

After the first four to six weeks of infection, ninety percent or more of patients have an elevated IgG response to the spirochete.

During the first month of infection, both IgM and IgG responses to the spirochete should be determined, preferably in both acute and convalescent serum samples. After that time, the great majority of patients have a positive IgG response and a single test is usually sufficient. In persons with illness persisting longer than one month, a positive IgM test alone is likely to be a false-positive result. According to the current criteria adopted by the Centers for Disease Control and Prevention (CDC),

- **an IgM Western blot is considered positive if two of the following three bands are present: 23, 39 and 41 kD**; however, a combination of the 23- and the 41-kD bands may still be a false-positive result.
- An IgG blot is considered positive if five of the following ten bands are present: 18, 23, 28, 30, 39, 41, 45, 58, 66 and 93 kD.

Overdiagnosis of Lyme disease is a major problem. In one study at a university-based referral clinic, only 339 (43%) of 788 patients were found to have -- or have had -- Lyme disease. False-positive test results are a major problem; they are more common than false-negative results in late disease. Excessive reliance on serologic tests, as well as failure to consider alternative diagnoses, contributes to overdiagnosis.

A recent position paper by the American College of Physicians urges clinicians to determine the pretest probability of Lyme disease before ordering serologies; to perform Western blotting in the case of indeterminate serologic results; also to not regard a positive result as an indication for automatic antibiotic therapy if the pretest probability of disease is low. In fact, if the pretest probability of Lyme disease is low, a positive test result is more likely a false-positive than a true-positive.

Chronic Lyme Disease

A large proportion of diagnoses of chronic Lyme disease cases are overdiagnosed as demonstrated by studies carried out at Lyme disease referral centers. Patients present with fatigue, myalgias, arthralgias, sleep disturbances, memory deficits and depression. Many fulfill criteria for fibromyalgia or chronic fatigue syndrome.

Common problems contributing to the over-diagnosis of Lyme Disease include 1-the use of serologic testing in clinical situations in which the pre-test probability of Lyme disease was low, 2-misinterpretation of test results and 3-use of non-validated methods and criteria for interpretation of

laboratory results. (Chronic Lyme disease: A review. Marques A, 2008. Infectious Disease Clinics of North America 22: 341-360). An example of over-diagnosis of Lyme disease is the following: In placebo controlled studies of post-Lyme disease syndromes, only one to ten percent of individuals volunteering were found to be eligible, others were not because their Lyme disease past infection could not be confirmed.

Chronic Lyme disease includes several different patient populations:

1-Patients with obvious manifestations of late Lyme disease: arthritis, encephalo-myelitis, peripheral neuropathy

2-Patients who have post-Lyme disease syndrome

3-Patients with unspecific signs and symptoms of unclear cause who received this diagnosis based on unproven or unvalidated lab tests and clinical criteria

4-Patients with a well-defined illness not related to Lyme disease

Follow up studies of patients with EM who received appropriate antibiotic treatment show that:

-Persistent or intermittent subjective symptoms are observed after treatment: thirty-three percent after three weeks, twenty-five percent after three months, ten to twenty percent after twelve months.

-These symptoms are: fatigue, arthralgias, myalgias, headaches, neck stiffness, paresthesias, sleeplessness, irritability, memory and concentration deficits.

-Post Lyme disease syndrome is associated with severe initial disease and delayed initiation of treatment.

Large cohort studies showed no difference on physical examination and neuro-cognitive tests between former Lyme disease patients and age-matched controls (Shadick NA 1999. Musculo-skeletal and neural outcomes in patients with previously treated Lyme disease. (Annals Internal Med 131: 919-926).

There are four randomized placebo controlled double blinded studies of antibiotic treatment in post Lyme disease syndrome patients and none showed any sustained benefit from treatment.

Chronic pain is fairly common in the population at large. In a survey of 3,664 persons twenty-five years or older, forty-four percent reported having experienced musculo-skeletal pain (lower back, shoulder, neck, knee) that had lasted more than three months (Picaret HS 2003. Pain 102:167-178). In another study of 2,300 subjects, fifteen percent reported some chronic widespread pain and eight percent reported chronic fatigue (Aggawal VR 2006. "The epidemiology of chronic syndromes that are unexplained." Int. J. Epidemio. 35: 468-476).

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Caution Regarding Testing for Lyme Disease

The CDC and the Food and Drug Administration (FDA) have become aware of commercial laboratories that conduct testing for Lyme disease by using assays whose accuracy and clinical usefulness have not been adequately established. These tests include urine antigen tests, immunofluorescent staining for cell wall--deficient forms of *Borrelia burgdorferi* and lymphocyte transformation tests. In addition, some laboratories perform polymerase chain reaction tests for *B. burgdorferi* DNA on inappropriate specimens such as blood and urine or interpret Western blots using criteria that have not been validated and published in peer-reviewed scientific literature. These inadequately validated tests and criteria also are being used to evaluate patients in Canada and Europe, according to reports from the National Microbiology Laboratory, Public Health Agency of Canada; the British Columbia Centre for Disease Control, Canada; the German National Reference Center for Borreliae; the Health Protection Agency Lyme Borreliosis Unit of the United Kingdom.

In the United States, the FDA has cleared seventy serologic assays to aid in the diagnosis of Lyme disease. Recommendations for the use and interpretation of serologic tests have been published previously (*1*). Initial testing should use an enzyme immunoassay (EIA) or immunofluorescent assay (IFA); specimens yielding positive or equivocal results should be tested further by using a standardized Western

immunoblot assay. Specimens negative by a sensitive EIA or IFA do not need further testing. Similar assays and recommendations are used in Canada (*2*). In the European Union, a minimum standard for commercial diagnostic kits is provided by Conformité Européene (CE) marking; application and interpretation guidelines appropriate for Europe have been published (*3,4*).

Health-care providers are reminded that a diagnosis of Lyme disease should be made after evaluation of a patient's clinical presentation and risk for exposure to infected ticks and, if indicated, after the use of validated laboratory tests. Patients are encouraged to ask their physicians whether their testing for Lyme disease was performed using validated methods and whether results were interpreted using appropriate guidelines.

References

CDC. Recommendations for test performance and interpretation from the Second National Conference on Serologic Diagnosis of Lyme Disease. MMWR 1995;44:590--1.
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Wilske B, Zöller L, Brade V, et al. MIQ 12 Lyme-Borreliose. Qualitätsstandards in der mikrobiologisch-infektiologischen Diagnostik. Munich, Germany: Urban & Fischer Verlag; 2000;1--59. Guidelines available in English at http://nrz-borrelien.lmu.de/miq-lyme/index.html.
Robertson J, Guy E, Andrews N, et al. A European multicenter study of immunoblotting in serodiagnosis of Lyme borreliosis. J Clin Microbiol 2000;38:2097--102.

Treatment

Institute antibiotic treatment in patients with definite or strongly suspected early localized or disseminated infection; it is not necessary to perform an antibody test first. Patients with early infection generally respond very well to oral antibiotics, started promptly and given for three weeks. **Doxycycline** 100 mg bid is considered the drug of choice for adults and children aged nine years and older. It achieves some cerebrospinal fluid penetration and is also effective against Ehrlichia. Alternatives are amoxicillin 500 mg tid, alone or with probenecid; cefuroxime axetil 500 mg bid; also erythromycin (possibly less effective). Young children and pregnant or lactating women should not take tetracycline. Antibiotic treatment shortens the duration of erythema migrans and systemic symptoms, although residual fatigue and arthralgias may persist for weeks to months.

Some cases of refractory early infection and all cases of early disseminated infection with CNS involvement or late persistent infection require parenteral antibiotic therapy. A typical regimen is ceftriaxone 2 g daily, intravenously, for fourteen to twenty-eight days. The benefits of this regimen are its demonstrated efficacy, good cerebrospinal fluid penetration and once- or twice-daily dosing schedule. Before considering parenteral therapy, some investigators treat chronic arthritis with a one-month course of oral doxycycline or amoxicillin. The optimal parenteral regimen remains uncertain. A "latent" period of several months may separate completion of antibiotic therapy and maximal neurologic or rheumatologic improvement. Some patients with refractory arthritis may need to undergo synovectomy.

Although the vast majority of patients with late Lyme disease respond to antibiotic therapy, prevention and prompt treatment of early disease remain paramount.

Surveillance

Lyme disease is a condition reportable within five business days.

Case Definition

This surveillance case definition was developed for national reporting of Lyme disease; it is not intended to be used in clinical diagnosis.

Clinical presentation

A systemic, tick-borne disease with protean manifestations, including dermatologic, rheumatologic, neurologic, and cardiac abnormalities. The best clinical marker for the disease is *erythema migrans* (EM), the initial skin lesion that occurs in 60% to 80% of patients.

For purposes of surveillance, EM is defined as a skin lesion that typically begins as a red macule or papule and expands over a period of days to weeks to form a large round lesion, often with partial central clearing. A single primary lesion must reach greater than or equal to 5 cm in size across its largest diameter. Secondary lesions also may occur. Annular erythematous lesions occurring within several hours of a tick bite represent hypersensitivity reactions and do not qualify as EM. For most patients, the expanding EM lesion is accompanied by other acute symptoms, particularly fatigue, fever, headache, mildly stiff neck, arthralgia, or myalgia. These symptoms are typically intermittent. The diagnosis of EM must be made by a physician. Laboratory confirmation is recommended for persons with no known exposure.

For purposes of surveillance, late manifestations include any of the following when an alternate explanation is not found:

> Musculoskeletal system. Recurrent, brief attacks (weeks or months) of objective joint swelling in one or a few joints, sometimes followed by chronic arthritis in one or a few joints. Manifestations not considered as criteria for diagnosis include chronic progressive arthritis not preceded by brief attacks and chronic symmetrical polyarthritis. Additionally, arthralgia, myalgia, or fibromyalgia syndromes alone are not criteria for musculoskeletal involvement.
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> Nervous system. Any of the following, alone or in combination: lymphocytic meningitis; cranial neuritis, particularly facial palsy (may be bilateral); radiculoneuropathy; or, rarely, encephalomyelitis. Encephalomyelitis must be confirmed by demonstration of antibody production against *Borrelia burgdorferi* in the cerebrospinal fluid (CSF), evidenced by a higher titer of antibody in CSF than in serum. Headache, fatigue, paresthesia, or mildly stiff neck alone, are not criteria for neurologic involvement.
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> Cardiovascular system. Acute onset of high-grade (2nd-degree or 3rd-degree) atrioventricular conduction defects that resolve in days to weeks and are sometimes associated with myocarditis. Palpitations, bradycardia, bundle branch block, or myocarditis alone are not criteria for cardiovascular involvement.

Laboratory evidence

For the purposes of surveillance, the definition of a qualified laboratory assay is (1) a positive culture for *B. burgdorferi*, (2) two-tier testing interpreted using established criteria [1], or (3) single-tier IgG immunoblot seropositivity interpreted using established criteria [1-4].

Exposure

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.

Disease endemic to county

A county in which Lyme disease is endemic is one in which at least two confirmed cases have been acquired in the county or in which established populations of a known tick vector are infected with *B. burgdorferi.*

Case classification

Confirmed: a) a case of EM with a known exposure (as defined above), or b) a case of EM with laboratory evidence of infection (as defined above) and without a known exposure or c) a case with at least one late manifestation that has laboratory evidence of infection.

Probable: any other case of physician-diagnosed Lyme disease that has laboratory evidence of infection (as defined above).

Suspected: a) a case of EM where there is no known exposure (as defined above) and no laboratory evidence of infection (as defined above), or b) a case with laboratory evidence of infection but no clinical information available (e.g. a laboratory report).

Lyme disease reports will not be considered cases if the medical provider specifically states this is not a case of Lyme disease, or the only symptom listed is "tick bite" or "insect bite."

References

1. Centers for Disease Control and Prevention. Recommendations for test performance and interpretation from the Second National Conference on Serologic Diagnosis of Lyme Disease. MMWR MMWR Morb Mortal Wkly Rep 1995; 44:590–1.
2. Dressler F, Whalen JA, Reinhardt BN, Steere AC. Western blotting in the serodiagnosis of Lyme disease. J Infect Dis 1993; 167:392–400.
3. Engstrom SM, Shoop E, Johnson RC. Immunoblot interpretation criteria for serodiagnosis of early Lyme disease. J Clin Microbiol 1995; 33:419–27.
4. Centers for Disease Control and Prevention. Notice to readers: caution regarding testing for Lyme disease. MMWR Morb Mortal Wkly Rep 2005; 54:125–6.
5. Centers for Disease Control and Prevention. Lyme Disease — United States, 2003–2005. MMWR Morb Mortal Wkly Rep 2007; 56:573–6.

Investigation

The purpose of investigation is to identify cases, to confirm the diagnosis, to identify high risk areas of the state, and to provide information to the communities involved.

- Upon receipt of a report of a case of Lyme disease, contact the physician and/or hospital to confirm the diagnosis.
- Verify whether diagnosis has been confirmed by blood test. If not, it is important to try and obtain a serum specimen at least three weeks from the onset of symptoms and/or the skin lesion (EM). Patients with suspected Lyme disease who have already developed systemic manifestations (such as arthritis, carditis, or meningitis) may be tested immediately. Obtain the physician's permission and explain the importance to the patient. The physician may agree to draw the blood himself and make arrangements for the public health nurse to pick up the specimen from his office.
- Check the patient's history for exposure to ticks (i.e., travel history, hunting, camping, etc.).

Immunization

A Lyme disease vaccine was licensed by the U.S. FDA in 1998, for persons fifteen to seventy years of age. This vaccine seems safe and effective. Decisions about the use of this vaccine should be based on an assessment of a person's risk as determined by activities and behaviors relating to tick exposure in endemic areas. This vaccine should be considered an adjunct to, not a replacement for, the practice of personal protective measures against tick exposure and the early diagnosis and treatment of Lyme disease. Recommendations for the use of Lyme disease vaccine are as follows:

The vaccine should be considered for administration to the following persons who are fifteen years of age or older:

- Those who reside, work, or recreate in geographic areas of high or moderate risk and whose activities result in frequent or prolonged exposure to vector ticks.
- Those who visit geographic areas of high risk during the peak Lyme disease transmission season and whose activities result in frequent or prolonged exposure to vector ticks.

The vaccine may be given to persons who reside, work, or recreate in geographic areas of high or moderate risk and whose activities result in some, but neither frequent nor prolonged, exposure to vector ticks. However, the benefits of vaccine for these persons compared with those of personal protective measures and early treatment of Lyme disease are unclear.

The vaccine is not recommended for the following:

- Those who reside, work, or recreate in areas of high or moderate risk but who have minimal or no exposure to infected ticks.
- Persons who reside, work, and recreate in geographic areas of low or no risk.
- Children younger than fifteen years of age until data about the safety and immunogenicity of this vaccine in this age group are available and the FDA has approved the product for use in this age group.

Persons with a history of Lyme disease

Immunization should be considered for persons with a history of Lyme disease who are at continued high risk. However, persons with antibiotic treatment–resistant Lyme arthritis should not be immunized because of the association between this condition and immune reactivity to rOspA (recombinant outer surface protein A) vaccine. Persons with chronic joint or neurologic illness related to Lyme disease, as well as those with second- or third-degree atrioventricular block, were excluded from the phase three safety and efficacy trial and, thus, the safety and efficacy of Lyme disease vaccine for such persons is unknown.

Simultaneous administration with other vaccines

The safety and efficacy of the simultaneous administration of rOspA vaccine with other vaccines have not been established. Administration of rOspA vaccine should not interfere with the administration of routinely recommended immunizations. If rOspA vaccine is to be given concurrently with other vaccines, each should be administered in a separate syringe at a separate site.

Persons with immunodeficiencies

Data are lacking on the safety and efficacy of rOspA vaccines in persons with immunodeficiencies. General guidelines for administration of inactivated or subunit vaccines should be followed.

Vaccine use during pregnancy

Because the safety of rOspA vaccine administered during pregnancy has not been established, immunization of women known to be pregnant is not recommended. A vaccine pregnancy registry has been established by SmithKline Beecham Pharmaceuticals. If a pregnant woman is immunized, health care professionals are encouraged to register this immunization by calling 800-366-8900, extension 5231.

Chemoprophylaxis.

The risk of infection with *B. burgdorferi* after a recognized deer tick bite, even in highly endemic areas, is sufficiently low that prophylactic antimicrobial treatment after a tick bite is not indicated routinely. In addition, animal studies indicate that transmission of *B. burgdorferi* from infected ticks usually requires a prolonged duration (>36 hours) of attachment. Analysis of ticks to determine whether they are infected is not indicated because the predictive values of such tests for human disease are unknown.

Prevention

Tick bite prevention:

Specific measures for prevention are as follows:

- Physicians, parents, and children should be aware that ticks transmit diseases.
- Tick-infested areas should be avoided whenever possible.
- If a tick-infested area is entered, clothing that covers the arms, legs and other exposed areas should be worn, pants tucked into boots or socks and long-sleeved shirts buttoned at the cuff. In addition, permethrin (a synthetic pyrethroid) can be sprayed onto clothes to decrease tick attachment. Permethrin should not be sprayed onto skin.
- Tick and insect repellents that contain DEET applied to the skin provide additional protection but require reapplication every one to two hours for maximum effectiveness. While there have been rare reports of serious neurologic complications in children resulting from the frequent and excessive application of DEET-containing insect repellents, the risk is low when they are used properly. DEET should be applied sparingly according to product label instructions and not applied to a child's face, hands, or skin that is irritated or abraded. After the child returns indoors, treated skin should be washed with soap and water.
- Persons should inspect themselves and their children's bodies and clothing daily after possible tick exposure. Special attention should be given to the exposed hairy regions of the body where ticks often attach, including the head and neck in children. Ticks should be removed promptly. For removal, a tick should be grasped with a fine tweezers close to the skin and gently pulled straight out without twisting motions. If fingers are used to remove ticks, they should be protected with tissue and washed after removal of the tick. Care should be taken to avoid squeezing the body of the tick.
- Maintaining tick-free pets also may reduce tick exposure. Daily inspection of pets and removal of ticks are indicated.

Blood Donation. Patients with active disease should not donate blood because spirochetemia occurs in early Lyme disease. Patients who have been treated for Lyme disease can be considered for blood donation.

Hospital precaution and isolation: Standard precautions