

Lyme borreliosis treatment

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ABSTRACT: Lyme borreliosis is the most common human tick-borne illness in the Northern Hemisphere. The causative agent is the spirochete *Borrelia burgdorferi* species complex, and the hard-shell ticks of the genus *Ixodes* is responsible for pathogen transmission from animals to humans. The incidence of the disease is increasing year by year and although lyme disease is not fatal, it can affect the skin, heart, nervous, and musculoskeletal system with an impairment of quality of life. The appropriate diagnosis of lyme disease should be promptly treated by antibiotics to prevent late stage of the disease. The choice of antibiotics depends on many factors such as the stage of the disease, the drug efficacy, adverse effects, type of delivery, duration of treatment, and cost. Treatment failure occurs as a result of many reasons, re-infection is possible. The recommended treatment schedule in the Czech Republic is presented.

KEYWORDS: acrodermatitis chronica atrophicans, *Borrelia burgdorferi*, borreliosis, borreliosis lymphocytoma, erythema migrans, treatment

Lyme borreliosis is the most common human tick-borne illness in the Northern Hemisphere (1). It has been known as an infectious disease since 1975, although clinical signs have been described since the beginning of the 20th century (2). Although lyme disease is not fatal, it can cause skin, musculoskeletal, neurologic, and cardiovascular manifestation that may be difficult to treat. The causative agent is the spirochete *Borrelia burgdorferi* species complex (3). Wild animals are the reservoir for *Borrelia* and the hard-shelled ticks of the genus *Ixodes* are responsible for transmission of pathogen to humans. The incidence of lyme borreliosis increases year by year. There were nearly twice as many reported cases of lyme borreliosis in 2006 compared to 1997 in the Czech Republic. The incidence is 42 cases per 100,000 inhabitants, and the number of cases per year in 2006 was higher in comparison to the number of cases of erysipelas (4).

B. burgdorferi is a thin, extracellular bacterium with a unique mode of motility belonging to the

family Spirochetaceae. It is named after the researcher Willy Burgdorfer, who first isolated the bacterium from a tick gut in 1982 (3). It is a spiral-shaped, two membrane bacteria, that has two flagellae, linear chromosome, and 21 plasmids that are extrachromosomal strands of DNA and allow *Borrelia* to adapt very rapidly to changes in the environment.

B. burgdorferi can be divided into several species. Genospecies *Borrelia burgdorferi* sensu stricto, *Borrelia Afzelii*, and *Borrelia garrinii* referred to as *B. burgdorferi* sensu lato are pathogenic and responsible for the clinical manifestation of lyme disease (5). *B. burgdorferi* sensu stricto is associated with arthritis and is the only pathogen of lyme disease in North America; *B. garinii* is associated with neurologic symptoms (6–8), and *B. afzelii* with chronic skin manifestation, acrodermatitis chronica atrophicans (ACA) (9). All of them occur in Europe, but *B. garinii* and *B. afzelii* are more prevalent (10) and the later two species occur in Asia. All can cause the pathognomic symptom of lyme borreliosis, erythema migrans (EM).

Ticks are the vectors of *B. burgdorferi*, *Ixodes ricinus* in Europe, *Ixodes persulcatus* in Euroasia and *Ixodes scapularis* in North America (9). *Ixodes* is infected by *Borrelia* when it feeds on infected

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animals. All forms of *Ixodes* ticks feed on humans: larval, nymph, and adult form, but those in the nymph form are most commonly found. The reservoir of *Borreliae* is wild animals, rodents, and birds. *B. burgdorferi* is transmitted as the tick is feeding, and the mechanism of spirochetal transmission is through saliva. *Ixodes* ticks are slow feeders and require several days to become fully engorged. That is the reason why early removal of ticks within 24 hours reduces the possibility of infection. Only 30–40% of patients are aware of a proceeding tick bite because of the small size of the nymph (1–2 mm). Ticks can transmit also other microbiologic agents, i.e., *Anaplasma phagocytophilum* causing human granulocytic anaplasmosis, *Babesia divergens*, and *Babesia microti* causing babesiosis.

Clinical symptoms

Lyme disease is a progressive disease that occurs in three stages: early localized stage, early disseminated stage, and late disseminated stage. Clinical picture of lyme disease differs in North America and in Europe and it is the result of genetic differences between species of *B. burgdorferi* (1,11). In 14 (the range can be from 1 to 180 days) days after tick bite, an expanding erythematous patch appears at the site of tick bite. Erythema migrans (FIGS. 1 and 2) is more than 5 cm in diameter and slowly expands. The character of the lesion can be homogenous, annular, or target like. Erythema migrans is the pathognomic sign of lyme borreliosis. Untreated EM can persist for weeks and months. On the other hand, it can disappear spontaneously during some weeks. The infection can also proceed asymptotically. Some patients complain



FIG. 1. Lymphocytoma borreliensis on the left mamilla (left, upper part).



FIG. 2. Erythema migrans under the knee (right, upper part).



FIG. 3. Lymphocytoma borreliensis on the ear lobe (right, košer part).

of flu-like symptoms as headache, arthralgias, fatigue. This stage is the early localized stage.

Borrelial lymphocytoma (BL, lymphocytoma borreliensis) is a rare cutaneous manifestation of lyme borreliosis that is diagnosed in up to 3% of patients with lyme borreliosis in Europe (FIG. 3). It appears after 3 weeks (2 days to 6 months) near a tick bite (12). It presents as a red to bluish papule or nodule with a diameter of up to a few centimeters typically localized usually on the ear lobe in children, on the nipple–areola mammae in adults (12) or on other localization such as the scrotum. This lesion can appear in any stage of lyme borreliosis. It is very common among children and rare in adults. Borrelial lymphocytoma can be the only manifestation of the disease or it can be accompanied by other lyme disease symptoms most frequently by EM, but concomitant ACA can be also observed (12). The duration of untreated BL takes several months to more than one year.

After weeks, *Borreliae* hematogenously spread, causing general signs and symptoms with involvement of other organs. Multiple EM, neurologic signs, carditis, and arthritis are typical for the second disseminated stage of lyme borreliosis. Multiple EM are secondary lesions. They are smaller and tend to be more uniform than solitary EM. Neurologic involvement includes Bell's palsy–neuritis affecting the peripheral seventh nerve, meningitis, meningoradiculitis. Arthritis is seen as an intermittent, inflammatory mono- or oligo-arthritis mostly of large joints. Cardiac involvement manifests as an atrioventricular conduction defect.

The late stage of lyme disease can manifest usually weeks or months and even years after contact with the spirochetal infection. This third stage is characterized by arthritis and synovitis of large joints such as the knee, chronic neurologic manifestation with peripheral neuropathy, and CNS disorders as dementia or transverse myelitis. Some changes can be irreversible. Cutaneous manifestations spread months to years in untreated lyme disease. Acrodermatitis chronica atrophicans (FIG. 4) localized on the limbs is the typical cutaneous manifestation of late stage in European patients (cases in America are very rare). It occurs as bluish red skin changes over the distal part of the upper and lower extremities. Swelling occurs at the beginning, and skin atrophy in progress. Fibrotic nodules can develop above the joints and are typical. Other cutaneous disorders such as morphea, lichen sclerosus et atrophicus, and granuloma annulare seem to have a spirochetal origin.

Diagnosis of lyme disease

Clinical diagnosis of an early stage of lyme borreliosis is based on the presence of expanding erythematous



FIG. 4. Acrodermatitis chronica atrophicans (left, košer part).

macula. The presence of EM is pathognomic. Laboratory tests help assess infection in patients with atypical skin lesions or when erythema disappears. Enzyme-linked immunosorbent assay (ELISA) or indirect fluorescent antibody assay (IFA) detecting IgM and IgG antibodies to *B. burgdorferi* are the first step test recommended. Interpretation of serologic results should be made with caution as the presence of antiborrelial antibodies indicates that the infection by the spirochete has occurred, but does not indicate the presence of active infection. On the other hand, a negative result of serologic test does not exclude an infection. In EM, the present authors expect increased levels of IgM antibodies in the first 4 weeks after onset of disease, followed by increased levels of IgG antibodies. In ACA, the high level of IgG antibodies is expected. Sera from patients with treponemal infections (syphilis) cross-react significantly with *Borrelia* infection, and the sera of some patients with lyme disease give a false-positive Fluorescent treponemal antibody absorption test (FTA-ABS) test result. Autoimmune diseases and herpetic infections can give false-positive results too. The use of immunoblots has increased the specificity of serologic testing for lyme disease and is useful for verification of positive ELISA or IFA results. Polymerase chain reaction detects the presence of *B. burgdorferi*-specific segments of DNA in patient specimens – blood, cerebrospinal fluid (CSF), urine, synovial fluid, and skin. The polymerase chain reaction method must be carefully controlled to avoid false-positive results, because this method is highly sensitive. The best results are obtained from the skin, but they do not distinguish between dead and viable spirochetal organism. *Borrelia* organisms are microaerophilic and can be cultured in vitro in BSK (Barbour, Stoenner, and Kelly) medium from skin, blood, CSF and synovial fluid. It has long generation time 7–20 hours. It takes several weeks to obtain the cultivation result and therefore, *Borrelia* isolation does not belong to routine tests.

To assess the correct diagnosis of cutaneous manifestations, the histopathologic examination of skin biopsy is needed. It applies especially in BL and ACA suspected lesions.

The diagnosis of EM is usually based on clinical picture when the lesion is typical and there is a history of attached tick. In case of nontypical EM, serologic tests can help as well as the further clinical development of erythematous lesion. The diagnosis of BL and ACA is based on increased level of IgG antiborrelial antibodies and histopathologic examination of the skin specimen.

Treatment

Lyme disease is treated by antibiotics. The aim of antibiotic treatment is to cure the presenting disease manifestation, to prevent the spreading of bacteria, and thus to prevent later stage of the disease. *B. burgdorferi* sensu lato strains are susceptible in vitro against doxycycline, amoxicillin, azithromycin, cefuroxime axetil, benzylpenicillin (14–17), and phenoxymethylpenicillin (18). Those antibiotics are widely used in the treatment of lyme borreliosis.

Doxycycline is a broad-spectrum semisynthetic antibiotic of the tetracycline family. It exhibits good intra- and extracellular penetration with bacteriostatic activity on many bacteria. It has also an antiinflammatory activity. Doxycycline is rapidly absorbed by the digestive tract and excreted by the kidney. It has a long biological half time and penetrates well into the tissue. The penetration to CSF is low. The more frequent side effects are digestive problems with vomiting and diarrhea as a result of the irritation of the mucous membrane. The other side effect is phototoxicity that is dose dependent. The patient should not sun bathe during the treatment. Various cutaneous side effects were described too. Doxycycline is contraindicated also in pregnancy and during lactation because of the possibility of causing dental stains and bone growth inhibition of the fetus. Doxycycline should not be given to children under 9 years of age because of decreased growth rate and tooth discoloration. It is not recommended to combine doxycycline treatment with a course of retinoids. It is not necessary to reduce the dose in renal failure. The advantage of doxycycline therapy is its therapeutic effect on a possible co-infecting ehrlichial and rickettsial species. Doxycycline is the most effective in the early stage of the disease and in prevention of the chronic stage of lyme disease.

Amoxicillin is a broad-spectrum penicillin antibiotic with bactericide activity. It reaches high plasmatic and tissue concentration after oral administration. Its advantage is that it may be used in pregnancy, it is also suitable for children under 9 years of age and for patients allergic to doxycycline. The disadvantage of amoxicillin from the point of treating lyme borreliosis is that it does not treat co-infecting disorders such as ehrlichiosis and babesiosis. Penetration of amoxicillin into perivascular space is probably sufficient. It is recommended to adjust dose in patients with renal impairment.

Benzylpenicillin is a penicillin G with bactericide activity, good tolerance, and low resistance during

therapy. It is administered intravenously, and excretion occurs in the kidney. Benzylpenicillin penetrates well into the skin, kidney, and mucous membrane, but badly into muscles, bones, nerve tissue, and brain. The penetration to CSF is low, but it is increased in meningitis. Benzylpenicillin does not penetrate into cells. The allergic reactions and risk of phlebitis when administered to peripheral venous are the most frequent side effects.

Azithromycin is a macrolide antibiotic with bacteriostatic activity. It shows good extracellular and intracellular distribution. The concentration in tissues is much higher than in plasma. The penetration to CSF is low. Azithromycin is absorbed in small intestine and excreted by the kidney. Because of long biological half time and high accumulation in tissue, azithromycin is excreted by urine even on the fourth day after the administration. Hepatic impairment and hypersensitivity are the main contraindications. The increase in neurotoxicity and nephrotoxicity may occur when administered with cyclosporine. The advantage is once-daily dosing and a possible usage during pregnancy.

Cefotaxime is a broad-spectrum third-generation cephalosporin. It is administered intravenously and has bactericide activity. Its analog is ceftriaxone. They differ in pharmacokinetics. Ceftriaxone has a long biological half time that is advantageous for long generation time of *B. burgdorferi* and its ability for regeneration of *B. burgdorferi*. It has a good penetration to tissues, CSF, and synovial fluids as well. The prolonged prothrombin time in patients with the risk of bleeding is one of the side effects. Once-daily dosing is the advantage. Ceftriaxone is highly recommended for neurologic, cardiac, and articular manifestations during the second and third stages of lyme disease.

Cefuroxime axetil is a second-generation cephalosporin related to penicillin. Hypoprothrombinemia and alcohol intolerance are the main side effects. Cefuroxime can be used in pregnancy. For cost reasons, it is an alternate drug.

Various antibiotic treatment regimens are used in clinical practice. There are many studies evaluating the different durations of different antibiotics or their combination for treatment of patients with lyme disease (17,19–22). The stage of the disease, presence of associated neurologic symptoms and other factors such as duration of symptoms, allergies, age, and pregnancy status should be considered at the beginning of the treatment. It is advisable to consult specialists in patients with cardiac, neurologic, or rheumatologic manifestations. The selection of antibiotics might take in consideration

the drug efficacy, adverse effects, administration, duration of treatment, taste (when administered to children), cost, and influence on bacterial resistance. Antibiotic treatment should be accompanied with probiotics to minimize adverse effects (23). In about 15% of patients, Jarish-Hexheimer reaction appears within the first 24 hours of antibiotic treatment. Jarish-Hexheimer reaction includes fever, shivering, weakness, cephalgia, and myalgia. Worsening of Lyme borreliosis symptoms is probably caused by reactive components released from dying spirochetes. In case of worsening or persisting symptoms during the treatment of Lyme borreliosis, the possible co-infection has to be considered. *Anaplasma phagocytophilum* causing human granulocytic ehrlichiosis can be a coinfecting pathogen. *A. phagocytophilum* is an intracellular bacteria that causes an acute non-specific febrile illness characterized by high fever, malaise, severe headache, myalgias, and/or arthralgias in patients with exposure to tick within the last 3 weeks. Laboratory tests show leukopenia, thrombocytopenia in blood count, elevation of serum hepatic transaminase, higher erythrocyte sedimentation rate and elevated C-reactive protein. The disease can have mild or even asymptomatic course. *A. phagocytophilum* infection can be proved by serologic tests, PCR, and by light microscopy (the presence of morulae in granulocytes in peripheral blood smear). The drug of choice for treatment is doxycycline and rifampicin. Doxycycline should be considered the drug of choice for patients from endemic areas wherein exposure to both pathogens may have occurred (24).

Treatment of EM

The aim of the treatment is to prevent later manifestation of Lyme disease. The treatment is therefore indicated also to patients with spontaneous disappearance of EM, although in this case positive serologic tests are needed. The treatment of

typical EM is recommended to start immediately (Table 1). The drug of choice is doxycycline. If doxycycline cannot be used, i.e., because of allergy or during summer time, amoxicillin is the alternative. Azithromycin is recommended as a second-line choice for patients who are allergic to tetracycline and penicillin. But there are reported more treatment failures of azithromycin compared to amoxicillin (25). For solitary EM, oral antibiotic treatment for 14–21 days provides the effective therapy. The present authors prescribe longer course of antibiotic treatment to patients with longer history of EM, with extracutaneous clinical symptoms or when EM does not disappear in 14 days. Some patients with EM may have hematogenous dissemination with the absence of symptoms (26). Patients with the involvement of central nervous system should be treated with intravenous antibiotics.

Treatment of BL

A 14–21-day course of oral antibiotics (doxycycline, amoxicillin, cefuroxime axetil) is recommended for BL without accompanying symptoms (Table 1). According to the European Union Concerted Action on Lyme Borreliosis, the treatment can be extended to 21–30 days because of the longer pretreatment duration of BL. Azithromycin is not recommended for the treatment of BL (27). The lymphocytoma regresses more slowly after antibiotic treatment than EM, the median is 3–4 weeks (12). The speed of regression depends on the duration of BL before institution of therapy (12,28).

Treatment of multiple EM

Parenteral therapy should be used in case of symptoms of disseminated Lyme borreliosis. Ceftriaxone or penicillin G given intravenously for 2–3 weeks should be administered in multiple EM, neurologic involvement, and carditis (Tables 2 and 3).

Table 1. Treatment of EM and borrelial lymphocytoma

Drug	Dose/day (mg)	Children dose/day	Route	Duration (days)
Doxycycline	2 × 100	from 9 y. 2–4 mg/kg	oral	14–21
Amoxicillin	3 × 1000	50 mg/kg	oral	14–21
Azithromycin ^a	2 × 500 1st day 1 × 500 next days	1 × 20 mg/kg 1st day 1 × 10 mg/kg next days	oral	5–10
Cefuroxim axetil ^a	2 × 500	30–40 mg/kg	oral	14–21

^aIn case of penicillin and doxycycline allergy.

^bTreatment of borrelial lymphocytoma can be prolonged up to 28 days.

Table 2. Treatment of neuroborreliosis, multiple EM

Drug	Dose/day	Children dose/day	Route	Duration (days)
Ceftriaxone	1 × 2 g	50–100 mg/kg	i.v.	14–21
Cefotaxime	3 × 2 g	100 mg/kg	i.v.	14–21
Penicillin G	4 × 5 m.u.	0.25–0.5 m.u./kg	i.v.	14–21
Doxycycline ^a	2 × 100–200 mg	from 9 y. 2–4 mg/kg	oral	14–28

^aIn case of penicillin and cefalosporin allergy.

Table 3. Treatment of Lyme carditis

Drug	Dose/day	Route	Duration (days)
Ceftriaxone	1 × 2 g	iv	14–21
Penicillin G	4 × 5 m.u.	iv	14–21
Cefotaxime	3 × 2 g	iv	14–21

Table 5. Treatment of ACA

Drug	Dose/day	Route	Duration (days)
Doxycycline	2 × 100 mg	Oral	21–28
Amoxicillin	3 × 1000 mg	Oral	21–28
Ceftriaxone	1 × 2 g	iv	14–21
Penicillin G	4 × 5 m.u.	iv	14–21
Cefotaxime	3 × 2 g	iv	14–21

Doxycycline, amoxicillin, and ceftriaxone are recommended for arthritis (Table 4). The clinical outcome is to be evaluated 6–12 months after antibiotic therapy (22).

Treatment of ACA

Antibiotic treatment of ACA improves inflammatory changes and leads to regression of fibrotic nodules. Atrophic changes of skin belong to irreversible changes that do not improve even after successful treatment with eradication of *Borrelia*. Therapeutic effect of doxycycline and/or amoxicillin as first-line antibiotics (used in the treatment for 3–4 weeks) and ceftriaxone and/or penicillin G used in case of neurologic symptoms (for 2–4 weeks), are recommended to evaluate several months up to 6 months after finishing the therapy (Table 5). Sometimes it is necessary to repeat the course of antibiotic treatment because of no efficacy during the first course or because of the presence of extracutaneous manifestations.

Treatment of post-lyme disease syndrome

It is not well understood why some patients develop symptoms that include fatigue, neurocognitive dysfunction such a depression, mood and attention disturbances or pain after receiving standard antibiotic course for the treatment of lyme disease. Very often, prolonged courses of oral and parenteral antibiotics are ordered, believing that persistent infection with *B. burgdorferi* is responsible. The study of patients with post-treatment chronic lyme disease with those symptoms showed no evidence of persisting *Borrelia* infection, and additional antibiotic therapy was not more beneficial than administering placebo (29). On the other hand, some other studies show that patients can benefit from longer re-treatment (30). The term “post-lyme disease syndrome” reflects the postinfectious origin of this condition. The etiopathogenesis of those chronic symptoms is not understood, and the effective therapy does not exist. Symptomatic therapy is an obvious choice.

Table 4. Treatment of lyme arthritis

Drug	Dose/day	Children dose/day	Route	Duration (days)
Doxycycline	2 × 100 mg	from 9 y. 2–4 mg/kg	Oral	21–28
Amoxicillin	3 × 500–1000 mg	50 mg/kg	Oral	21–28
Ceftriaxon	1 × 2 g	50–100 mg/kg	iv	14–21
Cefotaxime	3 × 2 g	100 mg/kg	iv	14–21

Children

Cutaneous manifestations of Lyme borreliosis in children include mainly EM and BL, as ACA is very rare during childhood (31). Clinical studies of the antibiotic treatment of children under 15 years of age who had solitary EM showed comparable efficacy and comparable appearance of minor and major manifestations of Lyme borreliosis, regardless of antibiotic used. Amoxicillin, azithromycin, phenoxymethyl penicillin is recommended. Cefuroxime has more side effects (19) (FIG. 3). Children with multiple EM can suffer from meningitis without obvious clinical sign and symptoms of CNS involvement in up to 25% of cases. It is recommended to treat such children intravenously with ceftriaxone (32,33) (FIG. 4). Children are treated in the same principles as adults, but the present authors do not use doxycycline in children under 8 years of age, the doses should be reduced by weight, and the maximal dose for children is the recommended dose for adults.

Pregnancy and lactation

Erythema migrans is the most frequent cutaneous manifestation of LB that the present authors see in pregnant and lactating women. The Infectious Diseases Society of America recommends to treat these patients as nonpregnant patients with the exception that doxycycline should be avoided (34). Some other authors recommend treatment of pregnant patients with intravenously administered antibiotics (ceftriaxone, benzylpenicillin) for 14 days during all three trimesters of pregnancy (35). The present authors use a 14-day-course of benzylpenicillin (5 MU every 6 hours) given intravenously followed by amoxicillin (1 g three times daily) given orally for another 14 days for those pregnant women who experienced a tick bite or suffer from EM during the first trimester. Pregnant women with the manifestation of EM and/or a tick bite in the second and third trimester are treated with oral antibiotics.

In sum, skin manifestations of Lyme disease respond promptly to appropriate antibiotic therapy. Early manifestations, such as EM, respond more quickly than BL and later manifestations, ACA. Both, IgM and IgG antiborrelial antibodies start to decrease during the time after the antibiotic treatment, but they may persist for months to years without any sign of disease activity (13). Failures in antibiotic treatment have been reported

with all antibiotic regimens used in the treatment of Lyme borreliosis (21,25). The reason can be an inappropriate antibiotic, according to the stage of the disease, and inappropriate duration of treatment, persistence of Borreliae in the tissue (36), persistence of atypical forms of spirochetes – cysts, irreversible tissue damage caused by borrelial infection, immunopathologic changes following eradication of agent, misdiagnosis, or even re-infection (37). Re-infection is characterized as EM that appears at the different localization than original EM lesion. In contrast, relapse (recurrence) is characterized as EM lesion localized at the same site as the original one. The present authors expect the appearance of the relapsing erythema within a few weeks with persisting increased levels of antiborrelial antibodies. After the antibiotic treatment, recurrent episodes of Lyme disease seem to be caused by re-infection rather than by relapses (38). One study shows that treatment failure is associated with treatment delay (39). The follow-up of patients after treatment is necessary to disclose both, the relapse and late complications. The present authors recommend to follow up the patients for 2 years after the treatment. The follow-up includes evaluation of clinical status and providing serologic tests ELISA and immunoblots every 3 months during the first year and every 6 months during the second year.

Prophylaxis treatment

Patients with the history of attached ticks that were removed are encouraged to observe the site where the tick was attached. A routine use of antimicrobial prophylaxis and serologic testing is not recommended. The Infectious Disease Society of America recommends administering a single dose of doxycycline for adult and children above 9 years of age only when all the following circumstances exist: (a) the attached tick had been reliably identified as an adult or nymph *I. scapularis* that had been attached for more than 36 hours on the basis of the degree of engorgement of the tick with blood, (b) the prophylaxis can be started within 72 hours after the tick removal, (c) local rate to infection of these ticks with *B. burgdorferi* is more than 20%, and (d) doxycycline treatment is not contraindicated (33). This is assessed for America. In Europe, this approach is not entirely effective, as prophylaxis failure after administering 200 mg of doxycycline after tick bite has been described (40). It is reasonable to consider a 10-day

course of amoxicillin for pregnant women with tick bites.

The prevention of lyme borreliosis includes limited outdoor activity in endemic areas to avoid tick bites, using tick repellents, wearing light long sleeves shirts and trousers tucked into shoes, frequent skin inspection for early detection, and correct removal of ticks.

Conclusion

The diagnosis of lyme disease should be based on assessment of clinical signs and symptoms together with the evaluation of laboratory tests, the exception is EM. Antibiotic treatment is recommended in all stages of lyme disease to prevent late complications according to the stage. It should start promptly as the therapy is most effective early in the course of the disease. Although lyme disease is not fatal, it can cause impairment of quality of life.

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