

Larval Tick Infestation: A Case Report and Review of Tick-Borne Disease

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GOAL

To understand larval tick infestation to better manage patients with the condition

OBJECTIVES

Upon completion of this activity, dermatologists and general practitioners should be able to:

1. Recognize the clinical presentation of larval tick infestation.
2. Manage and understand patients exposed to tick-borne disease.
3. Prevent tick-borne disease within the general population.

CME Test on page 47.

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Tick-borne disease in the United States continues to be a threat as people interact with their natural surroundings. We present a case of an 8-year-old boy with a larval tick infestation. Ticks within the United States can carry Lyme

disease, Rocky Mountain spotted fever (RMSF), ehrlichiosis, babesiosis, tularemia, tick-borne relapsing fever, and tick paralysis. These preventable diseases are treatable when accurately recognized and diagnosed; however, if left untreated, they can cause substantial morbidity and mortality. This article highlights the knowledge necessary to recognize, treat, and prevent tick-borne disease.

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Case Report

An 8-year-old boy presented to a pediatrician's office. The patient's father was concerned that his son had crabs. Because of the sensitivity of such a diagnosis, the pediatrician immediately



A



B

One 2- to 3-mm tick attached near the glans penis and multiple tiny ticks scattered on the penis and scrotum (A). Multiple 0.5-mm ticks attached to the patient's scrotum (B).

consulted the dermatology department for more expert identification of possible crab lice. The father reported that the family had spent the weekend at a farm. Approximately 24 hours after leaving the farm, the child started to complain of itching and bugs on his genitalia. The child and family members denied any sexual abuse or sexual contact. The child did not have a fever, rash, joint pain, headache, or other complaints or concerns. Overall, the child was feeling well. Physical examination of genitalia revealed one 2- to 3-mm tick near the glans penis and 40 to 50 ticks measuring 0.5 mm in diameter located on the shaft of the penis and scrotum (Figure). A single tick was plucked as it was running across the child's leg and was identified by the local public health department as a nymphal deer tick (*Ixodes dammini*).

Comment

Biology of Ticks—More than 800 species of ticks exist worldwide.¹ The 2 large families of ticks include hard ticks (Ixodidae) and soft ticks (Argasidae). Ixodidae ticks are the main disease vectors of concern in the United States (Table). Ixodidae genera include *Ixodes*, *Amblyomma*, and *Dermacentor*, each with important disease vectors.³ Hard ticks inhabit both open grassy and wooded environments, though competing arthropods may limit their range.^{3,4} In the southern United States, *Amblyomma* ticks were common in grassy areas. However, the introduction of imported fire ants, which forage for tick eggs, has limited *Amblyomma* ticks to wooded areas. The 2-year life cycle of ticks consists of 4 stages: egg, larva, nymph, and adult. Larvae (sometimes referred to as seed

Tick-Borne Disease

Disease	Causative Agent	Vector	Diagnostic Criteria	Treatment
Lyme disease	<i>Borrelia burgdorferi</i>	<i>Ixodes scapularis</i> (deer tick)	Clinical signs and symptoms; history of tick bites in endemic area; laboratory tests not usually necessary; serologic tests can confirm diagnosis but results may be negative early in disease course	Prophylaxis (not recommended unless criteria met ³): single 200-mg dose of oral doxycycline for adults and 4 mg/kg (max, 200 mg) for children ≥ 8 y Early Lyme disease in adults or children ≥ 8 y: oral doxycycline 100 mg 2 \times daily for 10–21 d (adults) or oral doxycycline 4 mg/kg daily divided into 2 doses (max, 100 mg per dose)(children ≥ 8 y); oral amoxicillin 500 mg 3 \times daily for 14–21 d; or oral cefuroxime axetil 500 mg 2 \times daily for 14–21 d Early Lyme disease in children < 8 y: oral amoxicillin 50 mg/kg daily divided into 3 doses (max, 500 mg per dose) or oral cefuroxime axetil 30 mg/kg daily divided into 2 doses (max, 500 mg per dose)
Rocky Mountain spotted fever	<i>Rickettsia rickettsii</i>	<i>Dermacentor variabilis</i> (dog tick), <i>Dermacentor andersoni</i> (wood tick), <i>Amblyomma americanum</i> (Lone Star tick)	Clinical signs and symptoms; history of tick bite in endemic area; direct immunofluorescence assay	Adults: doxycycline 100 mg every 12 h given orally or IV for 5–7 d; chloramphenicol is an alternative Children ≤ 8 y: oral doxycycline 1–2 mg/kg per dose 2 \times daily (max, 100 mg per dose)
Ehrlichiosis HME and HGE	HME, <i>Ehrlichia chaffeensis</i> ; HGE, <i>Anaplasma phagocytophilum</i>	HME, <i>A. americanum</i> (Lone Star tick); HGE, <i>I. scapularis</i> (deer tick)	Clinical signs and symptoms; history of tick exposure; laboratory test results include leukopenia, thrombocytopenia, anemia, elevated hepatic transaminase levels; <i>E. chaffeensis</i> or <i>A. phagocytophilum</i> antibodies detected by indirect immunofluorescence assay	Symptomatic adults or children ≥ 8 y: oral doxycycline 100 mg 2 \times daily for 10 d or oral rifampin 300 mg 2 \times daily for 7–10 d Children < 8 y: oral doxycycline 4 mg/kg daily divided into 2 doses (max, 100 mg per dose) or oral rifampin 10 mg/kg 2 \times daily (max, 300 mg per dose)

Babesiosis	<i>Babesia microti</i>	<i>Ixodes dammini</i> (nymphal deer tick)	Clinical signs and symptoms; history of tick bite; laboratory test results include thrombocytopenia, anemia, hemoglobinuria, elevated hepatic transaminase levels; visualization of intracellular protozoa in red blood cells with so-called Maltese cross pattern stained with Giemsa; serologic tests and PCR assay also possible	Adults: oral atovaquone 750 mg every 12 h and oral azithromycin 500–1000 mg on day 1 and 250 mg once daily thereafter, or clindamycin 300–600 mg IV every 6 h or 600 mg orally every 8 h plus oral quinine 650 mg every 6–8 h Children <8 y: oral atovaquone 20 mg/kg every 12 h (max, 750 mg per dose) and oral azithromycin 10 mg/kg once on day 1 (max, 500 mg per dose) and 5 mg/kg once daily (max, 250 mg per dose) thereafter, or clindamycin 7–10 mg/kg IV or orally every 6–8 h (max, 600 mg per dose) plus oral quinine 8 mg/kg every 8 h (max, 650 mg per dose)
Tularemia	<i>Francisella tularensis</i>	<i>D variabilis</i> (dog tick), <i>D andersoni</i> (wood tick), <i>A americanum</i> (Lone Star tick)	Clinical signs and symptoms; history of exposure to tick bite, wild rabbits, or rodents; culture of organism from skin lesion, inflamed lymph node, sputum; biopsy results show stellate abscesses within palisading granulomas in ulceroglandular form; serologic tests demonstrating agglutinating antibodies to <i>F tularensis</i>	Streptomycin sulfate 0.5 mg IM every 12 h for 7–14 d or gentamicin sulfate 3–5 mg/kg daily divided into 3 doses given IM or IV for 7–14 d (dosage may need to be modified in patients with renal insufficiency)
Tick-borne relapsing fever	Spirochete within <i>Borrelia</i> genus	<i>Ornithodoros</i> genus (soft tick)	Clinical signs and symptoms; history of tick bite; visualization of spirochetes on peripheral blood smear with Giemsa or Wright stain (seen during febrile episode); laboratory test results include leukocytosis and thrombocytopenia	Oral doxycycline 100 mg 2× daily for 5–10 d, or oral erythromycin 500 mg 4× daily for 5–7 d
Tick paralysis	Neurotoxin secreted in tick saliva	<i>D variabilis</i> (dog tick), <i>D andersoni</i> (wood tick)	Clinical signs and symptoms of acute, ascending, flaccid paralysis; locating an attached tick on the patient	Prompt removal of the tick will lead to resolution of symptoms

Abbreviations: max, maximum; IV, intravenously; HME, human monocytic ehrlichiosis; HGE, human granulocytic ehrlichiosis; PCR, polymerase chain reaction; IM, intramuscularly.

^aThe Infectious Diseases Society of America does not recommend antimicrobial prophylaxis unless the following criteria are met: (1) the attached tick is identified as a nymph or adult *Ixodes scapularis* tick and is estimated to have been attached for at least 36 hours based on the degree of blood engorgement of the tick; (2) prophylaxis can be started within 72 hours of tick removal; (3) ecologic information indicates that the local rate of *Borrelia burgdorferi* infection of these ticks is 20% or greater; and (4) treatment with doxycycline is not contraindicated.²

ticks) measure from 0.5 to 0.8 mm in diameter and often are difficult to recognize because of their small size.^{4,5} Nymphs are approximately 1.5 mm in diameter and adults can be 5 mm in diameter. Both the nymphs and adults are 8 legged, while larvae have 6 legs.^{3,4} A blood meal is consumed during each stage of a tick's life cycle.⁶

Studies have reviewed the importance of the duration of tick attachment and its relationship to disease transmission.^{7,8} It has been shown that maximal transmission of *Borrelia burgdorferi* occurred following 48 to 72 hours of tick attachment. However, transmission of *Ehrlichia phagocytophila* from infected *Ixodes scapularis* nymphs occurred within 24 hours of tick attachment.⁷ Another study focused on the length of time *I scapularis* ticks fed on human hosts before being detected and removed, and compared the duration of attachment for nymphs and adult female ticks.⁸ Results showed the attachment time significantly increased with age of the host ($P < .05$). The mean attachment duration for adult female ticks was 28.7 hours compared with 48 hours for the nymphs. This disparity was attributed to the larger size of the adult female ticks and therefore the greater likelihood of recognition and earlier removal.⁸ Thus, prompt detection and removal of ticks are important to prevent disease transmission.⁷⁻⁹

Lyme Disease—Lyme disease is the most common tick-borne illness in the United States.³ It is most commonly seen in patients residing in the north-eastern, Midwestern, and north central states. Lyme disease is transmitted through the bite of the *I scapularis* (deer tick) and the illness is caused by the spirochete *B burgdorferi*.^{10,11} The tick bite often is painless and patients commonly are unaware that they have been bitten. The tick must be attached to the skin for at least 36 hours for the transmission of the spirochete to effectively occur. The incubation period typically is 1 week following the tick exposure but can take as long as 16 weeks.³

Lyme disease has various clinical presentations. Eighty percent of patients initially present with the classic rash erythema migrans, described as an erythematous, annular, round, well-demarcated plaque with central clearing extending up to 70 cm in diameter.^{3,11,12} The rash may present with constitutional symptoms such as low-grade fever, myalgia, arthralgia, and fatigue. Within weeks to months, the patient can manifest musculoskeletal and neurologic complaints such as facial paralysis, peripheral neuropathy, and asymmetric oligoarticular arthritis. Later in the disease, cardiac involvement including atrioventricular block can occur.^{3,11} In the late stage of the disease, patients also can develop localized scleroderma-like lesions and

acrodermatitis chronica atrophicans, which has been recognized in Europe.³

Early recognition and diagnosis is paramount in the treatment of Lyme disease. Because the diagnosis is mainly clinical, treatment must rely on a high index of suspicion. Serologic tests can be useful to confirm a diagnosis, but the results often are negative early in the course of disease.^{12,13}

According to the 2006 Infectious Diseases Society of America (IDSA) treatment guidelines, antimicrobial prophylaxis is not recommended unless all of the following circumstances exist: (1) the attached tick is identified as a nymph or adult *I scapularis* tick and is estimated to have been attached for at least 36 hours based on the degree of blood engorgement of the tick; (2) prophylaxis can be started within 72 hours of tick removal; (3) ecologic information indicates that the local rate of *B burgdorferi* infection of these ticks is 20% or greater; and (4) treatment with doxycycline is not contraindicated.² In the presence of these conditions, a single 200-mg dose of oral doxycycline can be used in adults and 4 mg/kg (maximum, 200 mg) in children 8 years and older. If a patient presents with manifestations of early Lyme disease, such as erythema migrans, the IDSA recommends oral doxycycline 100 mg twice daily for 10 to 21 days or oral amoxicillin 500 mg 3 times daily for 14 to 21 days. Oral cefuroxime axetil 500 mg twice daily for 14 to 21 days also is an acceptable therapeutic alternative. For children younger than 8 years, oral amoxicillin 50 mg/kg daily (divided into 3 doses; maximum, 500 mg per dose) or oral cefuroxime axetil 30 mg/kg daily (divided into 2 doses; maximum, 500 mg per dose) should be used. For patients 8 years and older, oral doxycycline 4 mg/kg daily (divided into 2 doses; maximum, 100 mg per dose) is preferred.² In a study of the duration of antibiotic therapy for early Lyme disease, Wormser et al¹⁴ showed that either extending doxycycline treatment from 10 to 21 days or adding a dose of ceftriaxone at the start of the 10-day course of doxycycline did not enhance the efficacy of treatment in patients with erythema migrans. For patients presenting with manifestations of late Lyme disease, it is best to consult the 2006 IDSA guidelines and treat the patient according to the presenting symptoms.²

Rocky Mountain Spotted Fever—Rocky Mountain spotted fever (RMSF) is the second most common as well as the most lethal tick-borne disease in the United States.^{3,15} The disease is most commonly seen in southeastern, western, and south central states. Despite the name, actual cases in the Rocky Mountain regions are rare.¹³ The disease is transmitted by a variety of ticks including the *Dermacentor*

variabilis (dog tick) in the southeastern states, the *Dermacentor andersoni* (wood tick) in the western states, and the *Amblyomma americanum* (Lone Star tick) in the south central states.¹⁶ The illness is caused by *Rickettsia rickettsii*, a gram-negative coccobacillus known to disrupt membrane channels, leading to characteristic small vessel vasculitis.^{3,17} Transmission may occur within 6 hours of tick attachment, though it has been noted to take more than 24 hours.¹³ The disease is more likely to affect children than adults. The incubation period is 5 to 9 days following the tick bite.^{12,13}

Most patients present with an acute onset of fever, chills, headache, and myalgia. Rash commonly appears following the development of fever, though it may never occur in at least 10% of patients; thus, the presence of fever and a headache in an endemic area is sufficient reason to start treatment. The rash begins as a blanching maculopapular eruption on the wrists, ankles, and forearms, involving the palms and soles. The rash progresses in a centripetal fashion, covering the thighs, trunk, and face, and develops more petechial, purpuric, and ecchymotic features.³ If untreated, the disease can progress to respiratory distress, renal dysfunction, hepatosplenomegaly, lymphadenopathy, mental status change, seizure, and possible coma.^{3,13}

As with Lyme disease, diagnosis of RMSF is based on clinical suspicion and history of a tick bite. Direct immunofluorescence assays identifying *R. rickettsii* are possible; however, immediate treatment and recognition are critical for improved morbidity and mortality outcomes.³

Doxycycline is the antibiotic of choice, regardless of the patient's age. A 100-mg dose should be administered orally or intravenously every 12 hours for 5 to 7 days and for 24 hours following the absence of the fever.^{3,6,13} The pediatric dosage (children aged ≤ 8 years) is 1 to 2 mg/kg per dose twice daily (maximum, 100 mg per dose).⁶ Chloramphenicol is an alternative therapy, but it has fallen out of favor because of its potential for side effects and inferior effectiveness compared with doxycycline.¹⁸

Ehrlichiosis—Two subtypes of ehrlichiosis have been reported in the United States: human monocytic ehrlichiosis (HME) caused by *Ehrlichia chaffeensis*, and human granulocytic ehrlichiosis caused by *Anaplasma phagocytophilum*. In the United States, HME mainly affects the mid-Atlantic, southeastern, and south central regions, as well as California, and is transmitted by *A. americanum* (Lone Star tick). Human granulocytic ehrlichiosis is seen mainly in the upper Midwestern and northwestern United States and is transmitted by *I. scapularis* (deer tick).^{3,12}

In contrast to Lyme disease and RMSF, ehrlichiosis mainly affects adults. The incubation period is approximately 7 to 10 days following the tick bite. Patients present with fever, chills, headache, myalgia, malaise, and gastrointestinal tract complaints.^{3,6} Maculopapular rash may accompany the symptoms in one-third of patients with HME but is rare in patients with human granulocytic ehrlichiosis.⁶ The rash can be difficult to distinguish from RMSF.^{3,12} Abnormalities revealed by results of laboratory tests can include leukopenia, thrombocytopenia, anemia, and elevated hepatic transaminase levels. The clinical spectrum of disease can range from subclinical to fatal in 3% of patients.³

Diagnosis is established through clinical suspicion, history of tick exposure, and classic laboratory test results. The presence of antibodies to either *E. chaffeensis* or *A. phagocytophilum* as detected by indirect immunofluorescence assays also can assist with the diagnosis.³

Treatment is recommended only in symptomatic patients.² According to IDSA treatment guidelines, adult patients are treated with oral doxycycline 100 mg twice daily for 10 days. To minimize the risk of treatment toxicity for children, the IDSA panel recommends the treatment course be modified according to disease severity, the child's age, and the presence or absence of coinfection with *B. burgdorferi*. The recommended dosage of oral doxycycline in children younger than 8 years is 4 mg/kg daily (divided into 2 doses; maximum, 100 mg per dose). Children 8 years and older can be given the 10-day course of doxycycline. For adults or children 8 years and older with contraindications to doxycycline, oral rifampin 300 mg twice daily may be given for 7 to 10 days; children younger than 8 years may be given 10 mg/kg twice daily (maximum, 300 mg per dose).²

Babesiosis—Babesiosis is a malarialike disease caused by the intraerythrocytic protozoa *Babesia microti*.^{3,6} In the United States, babesiosis is the only tick-borne disease caused by a protozoan.¹² Transmission occurs by the larvae of the *I. dammini* tick, and most cases occur in the northeastern states. The incubation period typically is 1 week, but an asymptomatic infection may persist for years in young adults.^{3,12}

The classic clinical presentation is similar to other tick-borne disease and includes high fever, drenching sweats, myalgia, malaise, and hemolytic anemia. Children usually have a milder course of disease than adults, and the illness is more prevalent in asplenic and immunocompromised patients.³ Babesiosis closely resembles falciparum malaria and often is only distinguishable by the results of a peripheral blood smear.^{3,12} Abnormalities revealed by

laboratory test results include thrombocytopenia, anemia, hemoglobinuria, and elevated hepatic transaminase levels. Diagnosis of babesiosis is achieved by visualizing intracellular protozoa in red blood cells on a Giemsa-stained peripheral blood smear with the presence of clinical symptoms.^{2,3} The classic appearance of the so-called Maltese cross, or a tetrad of cells on the blood smear, is considered diagnostic. Serologic testing and polymerase chain reaction assay are other diagnostic tools.¹²

The IDSA recommends that all patients with symptomatic babesiosis be treated with antimicrobial agents to minimize the likelihood of complications. The guidelines suggest treatment with a combination of atovaquone plus azithromycin or clindamycin plus quinine for 7 to 10 days, the latter recommended for severe disease. It is recommended that adults be treated with oral atovaquone 750 mg every 12 hours and oral azithromycin 500 to 1000 mg on day 1 and 250 mg once daily thereafter. For children younger than 8 years, oral atovaquone 20 mg/kg every 12 hours (maximum, 750 mg per dose) and oral azithromycin 10 mg/kg once on day 1 (maximum, 500 mg per dose) and 5 mg/kg once daily (maximum, 250 mg per dose) thereafter. The recommended dosage of clindamycin for adults is 300 to 600 mg intravenously every 6 hours or 600 mg orally every 8 hours and quinine 650 mg orally every 6 to 8 hours. Children younger than 8 years should receive clindamycin 7 to 10 mg/kg either intravenously or orally every 6 to 8 hours (maximum, 600 mg per dose) and quinine 8 mg/kg orally every 8 hours (maximum, 650 mg per dose).²

Tularemia—Tularemia, also known as rabbit fever, is a recognized form of tick-borne disease in the United States. Tularemia is caused by *Francisella tularensis*, a small, fastidious, gram-negative rod bacterium.^{19,20} Although 4 subspecies of tularemia have been discovered, 2 are of clinical concern in the United States: *F tularensis* subsp *tularensis* (type A), the virulent strain; and *F tularensis* subsp *holarctica* (type B), a less virulent strain.^{3,19,20} Type A has been isolated to North America, while type B occurs across the entire northern hemisphere.²⁰ Tularemia is transmitted to humans through ingestion, inoculation, or inhalation. Wild rabbits, rodents, and ticks are the primary reservoirs. The ticks known to transmit *F tularensis* are *D variabilis* (dog tick), *D andersoni* (wood tick), and *A americanum* (Lone Star tick).¹² The incubation period of tularemia is 3 to 5 days following inoculation.

Onset of tularemia usually presents with fever, chills, headache, and myalgia. However, clinical manifestations of tularemia are divided into various

forms, including ulceroglandular, oropharyngeal, oculoglandular, typhoidal, and respiratory, depending on the subspecies causing the disease and the route of transmission.²⁰ Other forms may include skin ulcers, sore throat, pleural effusions, gastrointestinal tract complaints, regional painful lymphadenopathy, pneumonia, acute respiratory distress, and pericarditis. The ulceroglandular form is the easiest to recognize and is the most common. It is classically identified as a papule at the site of the tick bite that rapidly progresses into a slow-healing ulcer with colorless exudate.^{3,20} The severity of the illness caused by tularemia varies from mild clinical findings to rare cases of fatal septic shock and respiratory failure.

Diagnosis of tularemia is established mainly through clinical suspicion and examination. Culture of the organism is possible from the skin lesions, inflamed lymph nodes, or sputa, though all 3 are dangerous because the organism is highly infectious; therefore, extreme caution should be used when handling tissue or culture specimens. Biopsy results from the ulceroglandular form demonstrate stellate abscesses within palisading granulomas. Tularemia is a potential biologic weapon and extreme caution should be used when handling infected tissue and culture media.¹² Confirmation of diagnosis can be made using serologic tests that demonstrate agglutinating antibodies to *F tularensis*.

Treatment includes streptomycin sulfate 0.5 mg intramuscularly every 12 hours for 7 to 14 days.^{3,12,20} Gentamicin sulfate also is an effective therapeutic option at a dosage of 3 to 5 mg/kg daily (divided into 3 doses) intramuscularly or intravenously for 7 to 14 days. If the patient has renal insufficiency, dosage requirements should be adjusted in adults.²⁰

Tick-Borne Relapsing Fever—Tick-borne relapsing fever has been recognized for more than 100 years. This disease is transmitted by a soft tick genus known as *Ornithodoros* and is most often encountered west of the Mississippi River. The illness is caused by a spirochete within the *Borrelia* genus. The incubation period is approximately 1 week following tick exposure.³

Initial presentation of symptoms includes fever (temperature, >40°C) with an irregular pattern, chills, headache, myalgia, arthralgia, and fatigue. Additional associated symptoms are a macular rash at the end of a febrile episode, conjunctival injection, hepatosplenomegaly, epistaxis, and meningal signs.⁶ The initial febrile period spontaneously resolves within 3 days and is followed by an afebrile period, after which the fever will relapse. Each relapse of the fever becomes progressively more mild than the preceding episode.

The diagnosis of tick-borne relapsing fever can be made by visualizing the spirochetes on the peripheral blood smear with a Giemsa or Wright stain. Detection is most likely if the smear is taken during a febrile episode. Leukocytosis and thrombocytopenia may be observed on laboratory test results.

The treatment of choice is oral doxycycline 100 mg twice daily for 5 to 10 days. As an alternative therapy, erythromycin 500 mg orally 4 times daily for 5 to 7 days can be used. Penicillin G also has been proven to be effective. A Jarisch-Herxheimer reaction has been noted in some patients following initiation of therapy. Administering acetaminophen before and after antibiotic therapy may help decrease the severity of this reaction.^{3,12}

Tick Paralysis—Tick paralysis is a toxin-mediated illness that typically occurs in children and can cause substantial morbidity and mortality if not appropriately recognized.³ In the United States, most cases have been reported in the Rocky Mountains and northwestern states.^{21,22} In animals, tick paralysis is caused by 43 different species of ticks, though *D variabilis* and *D andersoni* are the only ticks substantially associated with human tick paralysis in the United States.³ Because these ticks tend to attach to the scalp, they often are not identified and are most commonly found postmortem.

Paralysis occurs 4 to 7 days following tick attachment. It is characterized as an acute, ascending, flaccid paralysis that often is confused with neurologic disorders, Guillain-Barré syndrome, botulism, and myasthenia gravis. The paralysis is thought to be caused by a neurotoxin that is secreted in the tick saliva during the feeding process²³ and causes a pre-synaptic neuromuscular blockade.^{22,23} If the tick is not removed, dysarthria, dysphagia, and death from respiratory failure in 10% of patients is possible.²²

Prevention—Prevention of tick exposure is the optimal way to decrease the amount of tick-borne disease seen in the United States. By applying *N,N*-diethyl-*m*-toluamide (or DEET) to exposed skin, treating clothing with permethrin, and wearing protective clothing while walking through grassy vegetation, individuals can minimize their tick exposure. *N,N*-diethyl-*m*-toluamide often is found in over-the-counter insect repellents and can be applied to the skin. Sustained-release formulas are preferred; efficacy plateaus at a 30% concentration of these formulations. Permethrin is an acaricide that is available as a spray. It should be applied to clothing and remains stable through many cycles of laundry.²⁴ Garments pretreated with permethrin also are available.

Prompt removal of an attached tick is critical to the prevention of tick-borne disease. Vertical

traction with blunt forceps near the site of attachment can be effective. Various tick removal devices are available that are slipped under the tick to allow traction without tearing the body of the tick. It is advised to discourage patients from removing ticks with isopropyl alcohol, fingernail polish, petroleum jelly, or hot matches, or in chlorine swimming pools.^{12,14,23}

Conclusion

Tick-borne disease continues to be a problem commonly encountered in the United States. With many people regularly enjoying the outdoors and spending more time exploring their surroundings, it is important for practitioners to recognize the signs and symptoms of tick-borne disease. Tick-borne disease within the United States includes Lyme disease, RMSF, ehrlichiosis, babesiosis, tularemia, tick-borne relapsing fever, and tick paralysis. With prompt removal and treatment, disease prognosis is generally good.

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