

Hidden dangers

Non-Lyme tick-borne diseases

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MOST PEOPLE don't realize that ticks are the most important arthropod vector in the United States.¹ (See *Tick talk.*) Why the lack of recognition? For starters, a tick bite is rarely felt and, except

for Lyme disease, very little information about tick-borne diseases is available for the general public.

Although Lyme disease seems to get all the attention, especially in the spring and summer, other common tick-transmitted diseases can be more harmful or even deadly to humans.² Obtaining a detailed health history and performing a thorough physical assessment can help nurses identify the possibility of a tick-transmitted disease early on. Zeroing in on a tick as a possible vector is essential because most tick-borne diseases cause nonspecific signs and symptoms that are difficult to sort out.

This article describes seven infections caused by ticks, including the causative pathogen, signs and symptoms, diagnosis, and treatment. It also details preventive measures.

Anaplasmosis

Caused by the bacterium *Anaplasma phagocytophilum*, anaplasmosis is a serious disease that can be fatal if not identified and treated. The chief tick vectors in the United States are the blacklegged tick (*Ixodes scapularis*) in the Northeast and Midwest, and the western blacklegged tick



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(*Ixodes pacificus*) in northern California.^{3,4} People at higher risk include those who are immunocompromised or who spend much of the summer in tick-infested areas.⁴

Signs and symptoms. The most common signs and symptoms, which are nonspecific, develop

within 3 weeks of exposure. Most patients who contract this disease have some combination of fever, headache, myalgia, malaise, chills, nausea, abdominal pain, cough, and confusion. These signs and symptoms are similar to those of ehrlichiosis and Rocky Mountain spotted

fever. Severe signs and symptoms include hemorrhage, renal failure, respiratory distress, and neurologic problems.⁴

Diagnosis. Anaplasmosis is difficult to diagnose because routine blood cultures don't detect the causative organism. Diagnosis is made based on clinical manifestations and can later be confirmed using specialized lab tests.⁴ Confirmatory lab tests include a polymerase chain reaction assay within 7 days of illness or an indirect immunofluorescence assay (IFA) to identify an increase in antibody titers within the first week of signs and symptoms, repeated between 2 and 4 weeks. Other tests, such as specific culturing for *A. phagocytophilum* or enzyme immunoassay, can be conducted at specialized labs.⁴

Treatment. Although anaplasmosis is difficult to identify and diagnose, its treatment is very straightforward. Doxycycline, the drug of choice, should be prescribed immediately if anaplasmosis is suspected (or amoxicillin for treatment of pregnant women or children under age 8). Clinicians shouldn't wait to start this antibiotic regimen until definitive lab test results are obtained. Patients should continue this course for at least 3 days after the fever subsides and until they show signs of clinical improvement.⁵

Babesiosis

Babesiosis is caused by microscopic parasites that infect the host's red blood cells (RBCs).⁶ In the United States, most infections are caused by *Babesia microti* parasites carried by the blacklegged tick.⁷ Although white-tailed deer are the most important hosts for this tick species, white-footed mice are the most common hosts of the *B. microti* protozoa.^{6,8} The most common areas of infection with babesiosis in the United States are the Northeast and upper Midwest, particularly Minnesota. Some people infected with babesiosis who have mild or no

Tick talk

Classified as arachnids, ticks are subdivided into two distinct families: the hard-shell tick of the Ixodidae family and the soft-shell tick of the Argasidae family.¹ Ticks are most commonly found in weed- and shrub-filled areas and along the edges of forests, where they remain until they can attach themselves to a passing host mammal. Ticks populate all 50 states and are responsible for almost 3,000 calls annually to the American Association of Poison Control Centers.²⁸

During spring, summer, and fall, their most active periods, ticks attach to humans during outdoor activities or following contact with animals, primarily dogs, that carry them indoors.²⁴



Blacklegged tick



Western blacklegged tick



Wood tick



Lone star tick



Dog tick



Bat tick

signs and symptoms donate blood because they don't realize they have an infection; the illness has been transmitted by blood transfusions in at least 100 cases.⁹

Signs and symptoms. Common manifestations of this infection include gradual onset of flulike signs and symptoms, such as fever, chills, night sweats, headache, myalgia, anorexia, nausea, and fatigue. It can also cause hemolytic anemia due to infection and destruction of the host's RBCs. Although many people infected with these parasites show no signs or symptoms, those who are immunocompromised, have undergone splenectomy, have kidney or liver disease, or are older adults are at increased risk for severe complications and death.^{6,7}

Diagnosis. The signs and symptoms of babesiosis are similar to those of malaria. Clinical findings in infected patients often include hepatosplenomegaly and jaundice. Lab test results are likely to indicate hemolytic anemia with thrombocytopenia, reticulocytosis, proteinuria, and elevated liver enzymes, serum creatinine, and blood urea nitrogen.⁸

The *B. microti* parasite is difficult to distinguish from malarial parasites using only a blood smear. The diagnosis can be confirmed by combining a detailed history of recent travel with additional lab confirmation using Wright-Giemsa stain on thin blood smears.⁷

Treatment. Two treatment regimens are available for symptomatic patients infected with babesiosis. The first treatment plan developed includes clindamycin and quinine administered over a 7- to 10-day period. This combination, still used today for severely ill patients, frequently causes tinnitus, vertigo, and gastrointestinal distress.^{6,8} A more recently developed treatment combination, atovaquone and azithromycin given over 7 to 10 days, is now most commonly used. It adequately treats this parasitic infection without causing the adverse reactions of the

other combination. Higher levels of azithromycin are prescribed for immunocompromised patients.⁸

Ehrlichiosis

Also known as human monocytic ehrlichiosis, ehrlichiosis is a range of bacterial infections caused by *Ehrlichia chaffeensis*, *Ehrlichia ewingii*, and *Ehrlichia muris-like* bacteria.¹⁰ Research about this infection is ongoing, and our understanding of ehrlichiosis is constantly evolving. The *E. chaffeensis* and *E. ewingii* species are most common in the Southeast and South Central United States, while the *E. muris* species is most commonly identified in Wisconsin and Minnesota.^{1,10}

Signs and symptoms. Clinical manifestations differ from patient to patient, but generally include fever, headache, chills, malaise, myalgia, nausea, vomiting, diarrhea, confusion, arthralgia, and conjunctival injection. Although about 60% of children and 30% of adults present with a rash, it isn't a definitive sign for diagnosing the disease. The rash can be maculopapular, petechial, or erythrodermic, but whatever the form, it's not pruritic. Severe signs and symptoms include respiratory distress and hematologic complications. The chief neurologic complication is meningoencephalitis.^{10,11}

Diagnosis. As with anaplasmosis, the initial diagnosis of this disease is based on the patient's history and signs and symptoms while other diagnoses are ruled out. Antibody titers may be negative in the early stages of the disease, but routine blood tests, such as a complete blood cell count, may identify thrombocytopenia and leukopenia, and serum liver enzymes may be elevated.^{1,10} Definitive diagnosis is made with serologic tests, particularly the IFA, to detect the significant increases in immunoglobulin G and immunoglobulin M.¹

Treatment. Doxycycline is the accepted treatment for all forms of ehrlichiosis. Patients should continue antibiotic therapy until at least 3

days after the fever subsides and the patient demonstrates clinical improvement.¹¹

Rocky Mountain spotted fever (RMSF)

This serious and life-threatening illness is caused by the *Rickettsia rickettsii* bacteria that infect the endothelial cells that line blood vessels. The most common tick-borne rickettsial disease in the United States, RMSF can be fatal even in healthy young people if not treated quickly.¹² RMSF has been found throughout the lower 48 states except for Vermont and Maine. The Rocky Mountain designation is misleading: More than 60% of cases are reported in Oklahoma, Tennessee, Arkansas, Maryland, Virginia, and South Carolina. The number of reported cases continues to increase each year.^{12,13}

Signs and symptoms. Initial signs and symptoms include a sudden onset of fever, malaise, and a severe headache, often described by patients as the worst they've ever experienced. Many patients report myalgia, anorexia, abdominal pain, nausea, and vomiting. The classic clinical triad that suggests a RMSF infection (headache, fever, and rash) is observed in only 3% of patients in the first 2 to 5 days of illness.^{12,13} After 2 weeks, the triad appears in 60% to 70% of patients.¹² The rash, which is usually characterized as "small, flat, pink, non-itchy spots," is most commonly seen on the wrists, forearms, and ankles but often spreads to include the trunk and sometimes the soles of the feet and palms of the hands during this early period.¹³ In the following days, this rash changes, becoming purple and petechial. This warning sign of disease progression occurs in 35% to 60% of patients with RMSF.¹³ Many patients with RMSF go undiagnosed over the course of multiple visits due to the nonspecificity of early signs and symptoms.

Diagnosis. An initial diagnosis must be based on patient history and clinical manifestations because the

signs and symptoms vary widely among patients and are difficult to differentiate from those of other diseases. Lab studies may demonstrate thrombocytopenia, hyponatremia, and elevated liver enzymes, which are all predictors of RMSF. Because antibodies aren't detectable immediately, a definitive diagnosis can't be made with serologic studies until the disease has progressed for 7 to 10 days. The dearth of specific signs and symptoms and definitive diagnostic data often causes misdiagnosis or a delay in treatment for this deadly disease.¹²

Treatment. Luckily, the best treatment modality is straightforward and commonly used for other tick-borne diseases. Patients with RMSF respond to the same dosages of doxycycline prescribed for patients with anaplasmosis and ehrlichiosis. Patients should continue this course until at least 3 days after the fever subsides and the patient improves.¹³

Southern tick-associated rash illness (STARI)

STARI is most commonly identified by the red bulls' eye rash that resembles

the rash associated with Lyme disease. Generally found in the Southeast and South Central United States, it's also known as *Masters disease*. STARI occurs after a bite of the lone star tick (*Amblyomma americanum*).¹ Research into this disease is still relatively new, and the disease process and causative agent aren't well understood.

Signs and symptoms. Besides the bulls' eye rash around the bite, fatigue is reported by most patients. The bulls' eye rash is smaller than that associated with Lyme disease.¹⁴

Diagnosis. No recognized lab tests or serologic data can be used to definitively diagnose STARI. Instead, a diagnosis of STARI is based on the characteristic rash and the patient's geographic location. Case studies have shown that the rash associated with STARI responds to the typical course of antibiotics such as doxycycline.^{15,16}

Treatment. Although the origin of the disease is little understood, a course of oral doxycycline is prescribed by many clinicians as an effective primary treatment for STARI.^{15,16}

Tick-borne relapsing fever (TBRF)

Most common in the Western United States, TBRF is often contracted by people staying in rustic cabins throughout the Cascades and the Rocky, San Bernardino, and Sierra Nevada mountains. People who've recently explored caves or accessed the crawl spaces beneath buildings are also susceptible to this disease. The most common tick vectors for TBRF are two species of the Argasidae family of ticks, *Ornithodoros hermsi* and the *Ornithodoros turicata*. The disease is caused by the *Borrelia* bacteria.¹⁷

Signs and symptoms. Manifestations of TBRF, which generally appear after a 7-day incubation period, begin with recurring febrile episodes above 102.5° F (38.9° C) that last about 3 days and are separated by afebrile periods of about 7 days.¹⁷ Up to four febrile episodes can occur.

Signs and symptoms associated with the febrile episode include any combination of myalgia and arthralgia, chills, headache, nausea, vomiting, anorexia, nonproductive cough, rash, eye pain, photophobia, confusion, and dizziness.¹⁷ The febrile phase generally ends in crisis that includes hypertension and tachycardia lasting for 30 minutes, followed by diaphoresis, hypotension, and a decrease in body temperature.¹⁷ More severe neurologic signs and symptoms of TBRF, which usually occur with the second febrile episode, include delirium, facial palsy, meningismus, and radiculopathy.¹⁷

Diagnosis. Besides finding the typical signs and symptoms, clinicians can reach a diagnosis of TBRF by using blood smears to detect *Borrelia* spirochetes after Wright-Giemsa staining.¹⁷

Treatment. The accepted treatment for TBRF is doxycycline or tetracycline for 7 to 10 days. Erythromycin for 10 days is effective for patients who can't take tetracycline.

Within 2 hours of starting antibiotic therapy, roughly 50% of patients experience a Jarisch-Herxheimer reaction.^{17,18} Patients should be monitored carefully for typical manifestations of this reaction, which include high fever, chills, rigors, hypotension, headache, tachycardia, hyperventilation, vasodilation, flushing, myalgia, skin lesions, and extreme anxiety.¹⁷

Tularemia

Caused by the bacterium *Francisella tularensis*, tularemia can be transmitted by handling infected animals such as rabbits, muskrats, and even household cats, but the most common method of transmission is through the bite of an infected deer fly or tick.¹⁹ Three ticks are known to transmit tularemia: the dog tick (*Dermacentor variabilis*), the wood tick (*D. andersoni*), and the lone star tick. Most occurrences of this disease are reported in the Midwest.¹⁹ Forms of tularemia include

Removing ticks: Ignore the folklore²⁹

An Internet search of "proper tick removal" yields almost two million hits describing methods of tick removal, from old-time remedies to the latest gadget. This is the only method for removing a tick recommended by the CDC:

1. Using fine-tip tweezers held parallel to the skin, grasp the tick nearest the site of attachment and as close to the skin as possible.
2. Pull the tick upward with gentle, slow, and consistent pressure. This takes some effort because ticks secrete a cement-like liquid to hold them at the site of the bite, and their pincers are covered with small barbs.
3. After the tick has been safely removed from the skin, disinfect the site with rubbing alcohol or soap and water.

ulceroglandular, glandular, oculo-glandular, pharyngeal (oropharyngeal), typhoidal, and pneumonic disease. Ulceroglandular disease is the most common form of tularemia while pneumonic disease is considered the most deadly form.^{19,20}

Signs and symptoms. After an incubation period of 3 to 5 days, tularemia causes nonspecific signs and symptoms, including fever of acute onset, malaise, chills, and headache. An ulcer develops at the site of the bite, then transforms into a single inflamed pustule. The lymph nodes that drain this papulo-ulcerative lesion can become enlarged by 30% or 40% of their normal size.²⁰

Diagnosis. The diagnosis is usually confirmed serologically by detecting antibodies to *E. tularensis* using a tube agglutination or microagglutination assay. A diagnostic increase in antibody titer generally doesn't occur until 2 to 4 weeks after the onset of the disease so serologic testing doesn't help clinicians make immediate treatment decisions.¹⁹

Treatment. Streptomycin, gentamicin, doxycycline, and ciprofloxacin are most effective for treating patients with tularemia.¹⁹ Dosing for each drug is individualized based on the patient's clinical status and response to treatment.

An ounce of prevention

Now that the seriousness of diseases caused by tick bites has been established, let's address prevention. The best way to guard against tick-borne disease is to systematically check clothing and exposed skin for ticks at least twice daily when spending time outdoors. (See *Removing ticks: Ignore the folklore.*) Identifying common sites of tick attachment is also essential. Studies show that the most common sites of attachment on humans are the legs, feet, stomach, and groin, followed by the chest, shoulders, hips, head, and finally, the arms.²¹

Resources for additional information

Book

The CDC offers a wealth of information on these tick-borne diseases through many different forums. *Yellow Book: CDC Health Information for International Travel* discusses a wide variety of travel-related diseases, but also includes a useful discussion of prevention techniques and tick-borne diseases both within the United States and abroad.

Website

Even more useful is the CDC's in-depth discussion of each tick-borne disease within its website, with many useful pictures to assist in tick ID. Find these at <http://www.cdc.gov/ticks>.

Smartphone apps

Want to take the knowledge with you? There's an app for that! Try these free smartphone applications.

- **Lyme disease tick map.** Authored by the American Lyme Disease Foundation, this app informs the user about prevention and recognition of Lyme disease, as well as how to identify and remove ticks.
- **Tick ID.** Developed and published by North Carolina State University's College of Agriculture and Life Sciences, this app assists the user in identification and removal of ticks, as well as offering links to resources for additional information.

Choosing proper clothing for the outdoors is essential. Wearing long pants and long-sleeved shirts, tucking shirts into a belted waistband, and tucking pant legs into socks are outstanding preventive measures.²² Wearing smooth, loose-fitting clothing also helps to prevent ticks from attaching.

Using repellents that contain 20% or more DEET is moderately effective in reducing tick bites when used in conjunction with proper clothing.²³ DEET repellents should be applied to exposed skin areas, such as the wrists and neckline, avoiding the hands, eyes, and mouth, especially for children.^{23,24} Because the effectiveness of DEET deteriorates after about 2 hours, reapplication is recommended.²⁵

Permethrin, which is toxic to ticks, is approved by the U.S. Environmental Protection Agency (EPA) for use on clothing only.²⁶ It's the active ingredient for most commercially available clothing-based repellents.²⁷

Ethyl butylacetylaminopropionate (IR3535) is approved by the CDC and the EPA for use on the skin. Pi-

caridin is also approved by the CDC and EPA.²⁷

Plant-based products include oil of lemon eucalyptus and a product derived from portions of wild tomato.²⁶

All of these products are effective against ticks, and, when used with twice daily visual checks and proper clothing choices, act as a substantive barrier to tick bites. (See *Resources for additional information.*)

Growing field

An understanding of tick-borne diseases and their effects on patients is a valuable addition to every nurse's skill set. Include patient education on how to prevent tick bites for all at-risk individuals as part of health teaching. It's also important to keep up with continuing research to provide the best care to patients affected by tick-borne diseases. ■

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