TICKBORNE DISEASES OF THE UNITED STATES

A Reference Manual for Healthcare Providers

Fifth Edition, 2018

U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

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TICK ID

BLACKLEGGED TICK *Ixodes scapularis*

WHERE FOUND Widely distributed across the eastern United States.

TRANSMITS *Borrelia burgdorferi* and *B. mayonii* (which cause Lyme disease), *Anaplasma phagocytophilum* (anaplasmosis), *B. miyamotoi* disease (a form of relapsing fever), *Ehrlichia muris eauclairensis* (ehrlichiosis), *Babesia microti* (babesiosis), and Powassan virus (Powassan virus disease).

COMMENTS The greatest risk of being bitten exists in the spring, summer, and fall in the Northeast, Upper Midwest and mid-Atlantic. However, adult ticks may be out searching for a host any time winter temperatures are above freezing. All life stages bite humans, but nymphs and adult females are most commonly found on people.

LONE STAR TICK *Amblyomma americanum*

WHERE FOUND Widely distributed in the eastern United States, but more common in the South.

TRANSMITS *Ehrlichia chaffeensis* and *E. ewingii* (which cause human ehrlichiosis), *Francisella tularensis* (tularemia), Heartland virus (Heartland virus disease), Bourbon virus (Bourbon virus disease), and Southern tick-associated rash illness (STARI).

COMMENTS The greatest risk of being bitten exists in early spring through late fall. A very aggressive tick that bites humans. The adult female is distinguished by a white dot or "lone star" on her back. The nymph and adult females most frequently bite humans.

Allergic reactions associated with consumption of red (mammalian) meat have been reported among persons bitten by lone star ticks.

AMERICAN DOG TICK *Dermacentor variabilis*

WHERE FOUND Widely distributed east of the Rocky Mountains. Also occurs in limited areas on the Pacific Coast.

TRANSMITS *Francisella tularensis* (tularemia) and *Rickettsia rickettsii* (Rocky Mountain spotted fever).

COMMENTS The greatest risk of being bitten occurs during spring and summer. Adult females are most likely to bite humans.

BROWN DOG TICK *Rhipicephalus sanguineus*

WHERE FOUND Worldwide.

TRANSMITS *Rickettsia rickettsii* (Rocky Mountain spotted fever). Primary vector for *R. rickettsii* transmission in the southwestern United States and along the U.S.-Mexico border.

COMMENTS Dogs are the primary host for the brown dog tick in each of its life stages, but the tick may also bite humans or other mammals.

GROUNDHOG TICK *Ixodes cookei*

WHERE FOUND Throughout the eastern half of the United States.

TRANSMITS Powassan virus (Powassan virus disease).

COMMENTS Also called woodchuck ticks. All life stages feed on a variety of warm-blooded animals, including groundhogs, skunks, squirrels, raccoons, foxes, weasels, and occasionally people and domestic animals. Photo courtesy of Steve Jacobs, PSU Entomology

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GULF COAST TICK *Amblyomma maculatum*

WHERE FOUND Southeastern and mid-Atlantic states and southern Arizona.

TRANSMITS *R. parkeri (R. parkeri* rickettsiosis), a form of spotted fever.

COMMENTS Larvae and nymphs feed on birds and small rodents, while adult ticks feed on deer and other wildlife. Adult ticks have been associated with transmission of *R. parkeri* to humans.

ROCKY MOUNTAIN WOOD TICK *Dermacentor andersoni*

WHERE FOUND Rocky Mountain states.

TRANSMITS *Rickettsia rickettsii* (Rocky Mountain spotted fever), Colorado tick fever virus (Colorado tick fever), and *Francisella tularensis* (tularemia).

COMMENTS Adult ticks feed primarily on large mammals. Larvae and nymphs feed on small rodents. Adult ticks are primarily associated with pathogen transmission to humans.

SOFT TICK *Ornithodoros* spp.

WHERE FOUND Throughout the western half of the United States, including Texas.

TRANSMITS *Borrelia hermsii, B. turicatae* (tick-borne relapsing fever [TBRF]).

COMMENTS Humans typically come into contact with soft ticks in rustic cabins. The ticks emerge at night and feed briefly while people are sleeping. Most people are unaware that they have been bitten. In Texas, TBRF may be associated with cave exposure.

O. hermsi tick, before and after feeding. Photo taken by Gary Hettrick RML, NIAID.

WESTERN BLACKLEGGED TICK *Ixodes pacificus*

WHERE FOUND In the Pacific Coast states.

TRANSMITS *Anaplasma phagocytophilum* (anaplasmosis), *B. burgdorferi* (Lyme disease), and very likely *B. miyamotoi* (*Borrelia miyamotoi* disease, a form of relapsing fever).

COMMENTS Larvae and nymphs often feed on lizards, birds, and rodents, and adults more commonly feed on deer. Although all life stages bite humans, nymphs and adult females are more often reported on humans.

TICKS THAT COMMONLY BITE HUMANS

Blacklegged Tick *(Ixodes scapularis)*

adult female | adult male | nymph | larva

Lone Star Tick *(Amblyomma americanum)*

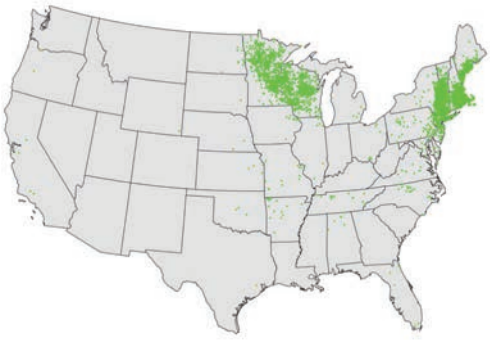
Dog Tick *(Dermacentor variabilis)*

NOTE: Relative sizes of several ticks at different life stages.

Engorged female *Ixodes scapularis* tick. Color may vary.

OVERVIEW OF
TICKBORNE DISEASES

SELECTED TICKBORNE DISEASES REPORTED TO CDC, U.S., 2016



ANAPLASMOSIS

BABESIOSIS

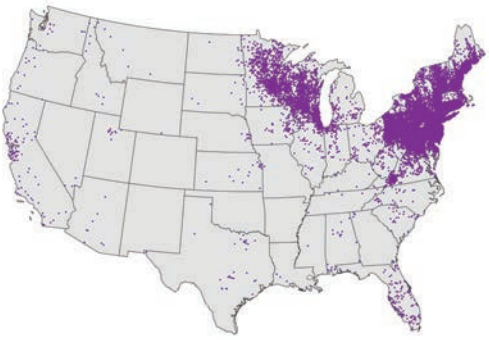
NOTE: Each dot represents one case. Cases are reported from the infected person's county of residence, not necessarily the place where they were infected.

NOTE: In 2016, no cases of tickborne illness were reported from Hawaii. In 2016, Alaska reported 6 travel-related cases of Lyme disease and 1 case of tularemia.

NOTE: During 2016, babesiosis was reportable in Alabama, Arkansas, California, Connecticut, Delaware, Illinois, Indiana, Iowa, Louisiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.

FOR INFORMATION ABOUT REPORTING TICKBORNE DISEASE CASES OR QUESTIONS ABOUT TESTING, CONTACT YOUR STATE OR LOCAL HEALTH DEPARTMENT.

EHRLICHIOSIS



LYME DISEASE

SPOTTED FEVER RICKETTSIOSIS (INCLUDING ROCKY MOUNTAIN SPOTTED FEVER)

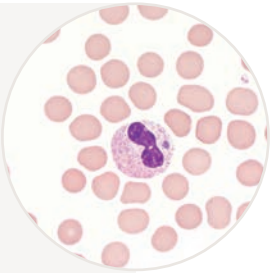
TULAREMIA

NOTE: Anaplasmosis and ehrlichiosis were not reportable in Colorado, Idaho, New Mexico, Alaska, Hawaii in 2016.

NOTE: Spotted fever rickettsiosis was not reportable in Alaska and Hawaii in 2016.

ANAPLASMOSIS

AGENT: *Anaplasma phagocytophilum*



Anaplasmosis was formerly known as Human Granulocytic Ehrlichiosis (HGE), and *A. phagocytophilum* was *Ehrlichia phagocytophilum*.

Severe and life-threatening illness is less common with anaplasmosis compared to other rickettsial diseases, such as Rocky Mountain spotted fever (RMSF) or *E. chaffeensis* ehrlichiosis. While the case-fatality rate among patients who seek care for the illness is <1%, predictors of a more severe course include advanced age, immunosuppression, comorbid medical conditions, and delay in diagnosis and treatment.

WHERE FOUND

Anaplasmosis is most frequently reported from the Upper Midwest and northeastern United States in areas that correspond with the known geographic distribution of Lyme disease and other *Ixodes scapularis*-transmitted diseases. Due to the common vector, co-infection with *A. phagocytophilum* and *B. burgdorferi, Babesia microti,* or Powassan virus is possible; illness may be marked by a more severe course or incomplete response to treatment.

A. phagocytophilum is typically transmitted by the bite of an infected tick, but may also be associated with blood product transfusions.

INCUBATION PERIOD

5–14 days

SIGNS AND SYMPTOMS

- Fever, chills, rigors
- Severe headache
- Malaise
- Myalgia
- Gastrointestinal symptoms (nausea, vomiting, diarrhea, anorexia)
- Rash (<10%)

The Signs and Symptoms list presents symptoms commonly seen with anaplasmosis. However, it is important to note that few people will develop all symptoms and the number and combination of symptoms varies greatly from person to person.

CONFIRMATION OF THE DIAGNOSIS IS BASED ON LABORATORY TESTING, BUT ANTIBIOTIC THERAPY SHOULD NOT BE DELAYED IN A PATIENT WITH A SUGGESTIVE CLINICAL PRESENTATION.

GENERAL LABORATORY FINDINGS

Typically observed during the first week of clinical disease:

- Mild anemia
- Thrombocytopenia
- Leukopenia (characterized by relative and absolute lymphopenia and a left shift)
- Mild to moderate elevations in hepatic transaminases

Visualization of morulae in the cytoplasm of granulocytes during examination of blood smears is highly suggestive of a diagnosis; however, blood smear examination is insensitive and should never be relied upon solely to rule anaplasmosis in or out.

LABORATORY DIAGNOSIS

- Detection of DNA by PCR of whole blood. This method is most sensitive during the first week of illness; sensitivity may decrease after administration of tetracycline-class antibiotics.
- Demonstration of a four-fold change (typically rise) in IgG-specific antibody titer by indirect immunofluorescence antibody (IFA) assay in paired serum samples. The first sample should be taken within the first week of illness and the second should be taken 2 to 4 weeks later.
- Immunohistochemical (IHC) staining of organism from skin, tissue, or bone marrow biopsies.

NOTE: Antibody titers are frequently negative in the first 7–10 days of illness. Acute antibody results cannot independently be relied upon for confirmation.

NOTE: IgM antibodies are less specific than IgG antibodies and are more likely to generate false positives. IgM results alone should not be used for laboratory diagnosis.

TREATMENT

Anaplasmosis, ehrlichiosis, and spotted fever group rickettsioses are treated with doxycycline. **Clinical suspicion of any of these diseases is sufficient to begin treatment. Delay in treatment may result in severe illness and even death.** The regimens listed below are guidelines only and may need to be adjusted depending on a patient's age, medical history, underlying health conditions, pregnancy status, or allergies. Consult an infectious disease specialist in cases of pregnancy or life-threatening allergy to doxycycline.

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Doxycycline	100 mg twice per day, orally or IV	100 mg/dose	Patients with suspected anaplasmosis infection should be treated with doxycycline for 10–14 days to provide appropriate length of therapy for possible co-infection with Lyme disease.
Children weighing <100 lbs. (45.4 kg)	Doxycycline	2.2 mg/kg per dose twice per day, orally or IV	100 mg/dose	

NOTE: Use doxycycline as first-line treatment for suspected anaplasmosis in patients of all ages. The use of doxycycline to treat suspected anaplasmosis in children is recommended by both the CDC and the American Academy of Pediatrics Committee on Infectious Diseases. Use of antibiotics other than doxycycline increases the risk of patient death. At the recommended dose and duration needed to treat anaplasmosis, no evidence has been shown to cause staining of permanent teeth, even when multiple courses are given before the age of eight.

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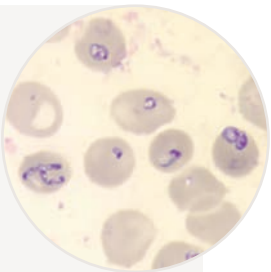
BABESIOSIS

AGENT: *Babesia microti* and other *Babesia* species



Babesiosis is caused by parasites that infect red blood cells. Most U.S. cases are caused by *B. microti,* which is transmitted by *Ixodes scapularis* ticks, primarily in the Northeast and Upper Midwest. *Babesia* parasites also can be transmitted via transfusion, anywhere, at any time of the year. In March 2018, FDA approved the first *B. microti* blood donor screening tests. Congenital transmission has also been reported.

Babesia infection can range from asymptomatic to life threatening. Risk factors for severe babesiosis include asplenia, advanced age, and impaired immune function. Severe cases can be associated with marked thrombocytopenia, disseminated intravascular coagulation, hemodynamic instability, acute respiratory distress, renal failure, hepatic compromise, altered mental status, and death.

WHERE FOUND

Babesiosis is most frequently reported from the northeastern and Upper Midwestern United States in areas where *B. microti* is endemic. Sporadic cases of infection caused by novel *Babesia* agents have been detected in other U.S. regions, including the West Coast. In addition, transfusion-associated cases of babesiosis can occur anywhere in the country.

INCUBATION PERIOD

1–9+ weeks

SIGNS AND SYMPTOMS

- Fever, chills, sweats
- Malaise, fatigue
- Myalgia, arthralgia, headache
- Gastrointestinal symptoms, such as anorexia and nausea (less common: abdominal pain, vomiting)
- Dark urine
- Less common: cough, sore throat, emotional lability, depression, photophobia, conjunctival injection
- Mild splenomegaly, mild hepatomegaly, or jaundice may occur in some patients

Not all infected persons are symptomatic or febrile. The clinical manifestations, if any, usually develop within several weeks after exposure, but may develop or recur months later (for example, in the context of surgical splenectomy).

GENERAL LABORATORY FINDINGS

- Decreased hematocrit due to hemolytic anemia
- Thrombocytopenia
- Elevated serum creatinine and blood urea nitrogen (BUN) values
- Mildly elevated hepatic transaminase values

LABORATORY DIAGNOSIS

- Identification of intraerythrocytic *Babesia* parasites by light-microscopic examination of a peripheral blood smear; or
- Positive *Babesia* (or *B. microti*) polymerase chain reaction (PCR) analysis; or
- Isolation of *Babesia* parasites from a whole blood specimen by animal inoculation (in a reference laboratory)

NOTE: If the diagnosis of babesiosis is being considered, manual (nonautomated) review of blood smears should be requested explicitly. In symptomatic patients with acute infection, *Babesia* parasites typically can be detected by blood-smear examination, although multiple smears may need to be examined. Sometimes it can be difficult to distinguish between *Babesia* and malaria parasites and even between parasites and artifacts (such as stain or platelet debris). Consider having a reference laboratory confirm the diagnosis and the species. In some settings, molecular techniques can be useful for detecting and differentiating among *Babesia* species.

SUPPORTIVE LABORATORY CRITERIA

- Demonstration of a *Babesia*-specific antibody titer by indirect fluorescent antibody (IFA) testing for total immunoglobulin (Ig) or IgG.

NOTE: Antibody detection by serologic testing can provide supportive evidence for the diagnosis but does not reliably distinguish between active and prior infection.

TREATMENT

Treatment decisions and regimens should consider the patient's age, clinical status, immunocompetence, splenic function, comorbidities, pregnancy status, other medications, and allergies. Expert consultation is recommended for persons who have or are at risk for severe or relapsing infection or who are at either extreme of age.

For ill patients, babesiosis usually is treated for at least 7–10 days with a combination of two medications—typically, either atovaquone PLUS azithromycin; OR clindamycin PLUS quinine (this combination is the standard of care for severely ill patients). The typical regimens for adults are provided in the table below.

AGE CATEGORY	DRUG		DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Prescribe together	Atovaquone	750 mg orally every 12 hours	N/A	7–10
		Azithromycin	On the first day, give a total dose in the range of 500–1000 mg orally; on subsequent days, give a total daily dose in the range of 250–1000 mg*	1000 mg per day	7–10
	OR				
	Prescribe together	Clindamycin**	300–600 mg IV every 6 hours OR 600 mg orally every 8 hours**	N/A	7–10
		Quinine**	650 mg orally every 6–8 hours	N/A	7–10

* The upper end of the range (600–1000 mg per day) has been used for adults who are immunocompromised.

** The standard of care for patients with severe babesiosis (e.g., with parasitemia levels ≥10% and/or organ-system dysfunction) is quinine plus clindamycin; typically, the clindamycin is administered intravenously. Such patients also might require or benefit from exchange transfusions, vasopressor therapy, mechanical ventilation, or dialysis.

NOTE: Most persons without clinical manifestations of infection do not require treatment. However, consider treating persons who have had demonstrable parasitemia for more than 3 months.

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BORRELIA MIYAMOTOI DISEASE

AGENT: *Borrelia miyamotoi*

WHERE FOUND

Borrelia miyamotoi disease, sometimes called hard tick relapsing fever, has been reported as the cause of human infection in the Upper Midwest, the Northeast, and the mid-Atlantic states, in places where Lyme disease occurs. Unlike Lyme disease, which is most common in June and July, *Borrelia miyamotoi* infection occurs most commonly in July and August and may be spread by larval blacklegged ticks.

INCUBATION PERIOD

Days to weeks, specific ranges are unknown

SIGNS AND SYMPTOMS

- Fever
- Chills
- Fatigue
- Severe headache
- Arthralgia/myalgia
- Dizziness, confusion, vertigo (uncommon)
- Rash (uncommon)
- Dyspnea (uncommon)
- Nausea, abdominal pain, diarrhea, and anorexia (uncommon)

GENERAL LABORATORY FINDINGS

- Leukopenia
- Thrombocytopenia
- Elevated hepatic transaminase values

LABORATORY DIAGNOSIS

- Diagnosis relies on signs and symptoms coupled with:
  1. Polymerase chain reaction (PCR) tests that detect DNA from the organism; or
  2. Antibody-based tests

  Tests are available from a limited number of CLIA-approved reference laboratories.
- Recent studies indicate that the C6 peptide ELISA test (a first-tier test for Lyme disease) may be positive in patients infected with *B. miyamotoi*.

TREATMENT

To date, there are no comprehensive studies to evaluate treatment regimens, but in published case series, patients were successfully treated with antibiotics and dosages used for Lyme disease (page 26).

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Chowdri HR, Gugliotta JL, Berardi VP, et al. *Borrelia miyamotoi* infection presenting as human granulocytic anaplasmosis: a case report. *Ann Intern Med* 2013 Jul 2;159(1):21-7.

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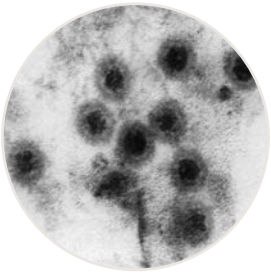
COLORADO TICK FEVER (CTF)

AGENT: Colorado tick fever virus

WHERE FOUND

The geographic range of Colorado tick fever virus includes the Western United States, primarily Colorado, Utah, Montana, and Wyoming. Although rare, the virus can also be transmitted from person-to-person via blood transfusion.



INCUBATION PERIOD

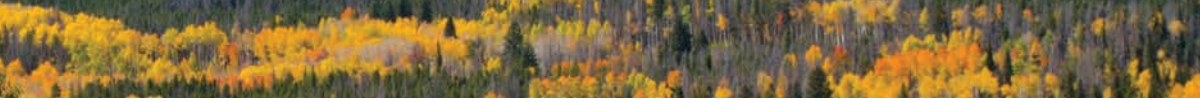
1–14 days

SIGNS AND SYMPTOMS

- Fever, chills, headache, myalgias, and lethargy
- ~50% of patients have a biphasic illness with symptoms remitting after 2 to 4 days, but then recurring 1 to 3 days later.
- Conjunctival injection, pharyngeal erythema and lymphadenopathy may be present.
- Maculopapular or petechial rash in <20% of patients
- Prolonged convalescence characterized by weakness and fatigue is common in adults.
- Life-threatening complications and death are rare and usually associated with disseminated intravascular coagulation or meningoencephalitis in children.

GENERAL LABORATORY FINDINGS

- Leukopenia
- Moderate thrombocytopenia



LABORATORY DIAGNOSIS

- Culture and RT-PCR during first 2 weeks of illness
- Serologic assays (e.g., IgM-capture EIA, indirect fluorescent antibody, and plaque-reduction neutralization) on convalescent samples. IgM antibodies usually do not appear until 14–21 days after illness onset.

TREATMENT

No specific antiviral treatment is available. Patients with suspected CTF should receive supportive care as appropriate. Patients with confirmed CTF should defer blood and bone marrow donation for at least 6 months after recovery.

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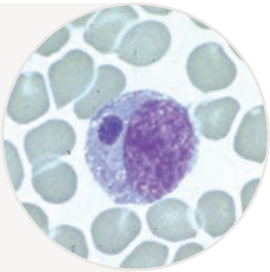
EHRLICHIOSIS

AGENTS: *Ehrlichia chaffeensis, Ehrlichia ewingii, Ehrlichia muris eauclairensis*

E. chaffeensis can cause fatal illness, whereas no deaths have been reported for *E. ewingii* or *E. muris euclairensis* ehrlichiosis.

Incidence of *E. chaffeensis* enhrlichiosis generally increases with age, however, case-fatality rates are highest among children aged <10 years and adults aged ≥70 years.



WHERE FOUND

Ehrlichiosis is most frequently reported from the southeastern and south-central United States, from the East Coast extending westward to Texas. The areas from which most cases are reported correspond with the known geographic distribution of the lone star tick (*Amblyomma americanum*), which is associated with transmission of both *E. chaffeensis* and *E. ewingii*. Three states (Oklahoma, Missouri, Arkansas) account for 35% of all reported *E. chaffeensis* infections. Since 2009, >115 cases of ehrlichiosis caused by *E. muris eauclairensis* have been identified in patients in the Upper Midwest. The tick responsible for transmitting this new subspecies of *Ehrlichia* is *Ixodes scapularis,* and the clinical presentation is generally similar to those associated with infections caused by *E. chaffeensis* and *E. ewingii.*

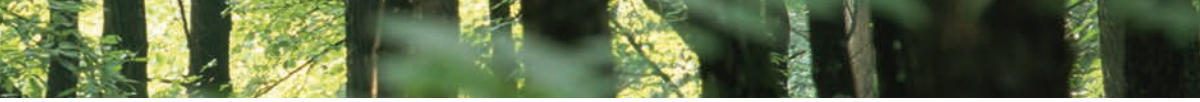
INCUBATION PERIOD

5–14 days

SIGNS AND SYMPTOMS

- Fever, chills
- Headache
- Malaise
- Muscle pain
- Gastrointestinal symptoms (nausea, vomiting, diarrhea, anorexia)
- Altered mental status
- Rash (more commonly reported among children)

The Signs and Symptoms list presents symptoms commonly seen with ehrlichiosis. However, it is important to note that few people will develop all symptoms, and the number and combination of symptoms varies greatly from person to person.



CONFIRMATION OF THE DIAGNOSIS IS BASED ON LABORATORY TESTING, BUT ANTIBIOTIC THERAPY SHOULD NOT BE DELAYED IN A PATIENT WITH A SUGGESTIVE CLINICAL PRESENTATION.

GENERAL LABORATORY FINDINGS

Typically observed during the first week of clinical disease:

- Thrombocytopenia
- Leukopenia (absolute)
- Anemia (generally occurs later in illness than thrombocytopenia or leukopenia)
- Mild to moderate elevations in hepatic transaminases

During the acute stage of illness, morulae can be detected in about 20% of patients. *E. chaffeensis* most commonly infects monocytes, whereas *E. ewingii* more commonly infects granulocytes. The target cell of *E. muris eauclairensis* has not yet been identified.

LABORATORY DIAGNOSIS

- Detection of DNA by PCR of whole blood. This method is most sensitive during the first week of illness and sensitivity can decrease after administration of tetracycline-class antibiotics.
- Demonstration of a four-fold change (typically rise) in IgG-specific antibody titer by indirect immunofluorescence antibody (IFA) assay in paired serum samples. The first sample should be taken within the first week of illness, and the second should be taken 2 to 4 weeks later.
- Immunohistochemical (IHC) staining of organism from skin, tissue, or bone marrow biopsies.

NOTE: Antibody titers are frequently negative in the first 7–10 days of illness. Acute antibody results cannot independently be relied upon for confirmation.

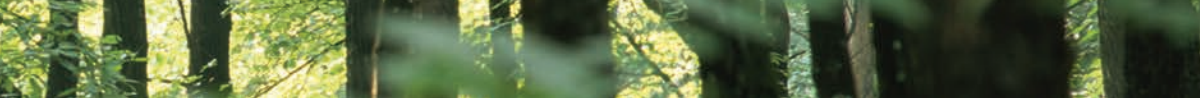
NOTE: IgM antibodies are less specific than IgG antibodies and are more likely to generate false positives. IgM results alone should not be used for laboratory diagnosis.

TREATMENT

Anaplasmosis, ehrlichiosis, and spotted fever group rickettsioses are treated with doxycycline. Clinical suspicion of any of these diseases is sufficient to begin treatment. **Delay in treatment may result in severe illness and death.** The regimens listed below are guidelines only and may need to be adjusted depending on a patient's age, medical history, underlying health conditions, pregnancy status, or allergies. Consult an infectious disease specialist in cases of pregnancy or life-threatening allergy to doxycycline.

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Doxycycline	100 mg twice per day, orally or IV	100 mg/dose	Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Minimum course of treatment is 5–7 days.
Children weighing <100 lbs. (45.4 kg)	Doxycycline	2.2 mg/kg per dose twice per day, orally or IV	100 mg/dose	

NOTE: Use doxycycline as first-line treatment for suspected ehrlichiosis in patients of all ages. The use of doxycycline to treat suspected ehrlichiosis in children is recommended by both the CDC and the American Academy of Pediatrics Committee on Infectious Diseases. Use of antibiotics other than doxycycline increases the risk of patient death. At the recommended dose and duration needed to treat ehrlichiosis, no evidence has been shown to cause staining of permanent teeth, even when multiple courses are given before the age of eight.



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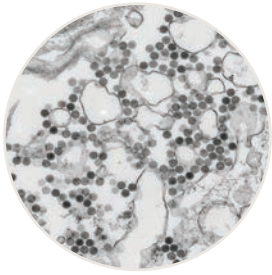
HEARTLAND VIRUS DISEASE

AGENT: Heartland virus



WHERE FOUND

As of 2017, more than 30 cases of Heartland virus disease have been reported from states in the Midwest and the South.

INCUBATION PERIOD

Specific ranges are unknown; most patients report a tick bite in the 2 weeks prior to illness.

SIGNS AND SYMPTOMS

- Fever
- Fatigue
- Decreased appetite
- Headache
- Arthralgia
- Myalgia
- Nausea
- Diarrhea

GENERAL LABORATORY FINDINGS

- Leukopenia
- Thrombocytopenia
- Mild to moderate elevation of liver transaminases

BOURBON VIRUS DISEASE

As of 2017, a limited number of Bourbon virus disease cases have been identified in the Midwest and southern United States. Some people who have been infected later died. Scientists continue to investigate possible symptoms caused by this new virus. Symptoms of people diagnosed with Bourbon virus disease included fever, tiredness, rash, headache, body aches, nausea, and vomiting. General laboratory findings included leukopenia and thrombocytopenia.

LABORATORY DIAGNOSIS

There is no routine testing available for Heartland virus infections. However, protocols are in place to allow people to be tested for evidence of Heartland virus RNA and IgM and IgG antibodies. Contact your state health department if you have a patient with an acute illness that may be compatible with Heartland virus disease.

TREATMENT

Treatment of Heartland virus disease is supportive. Many patients diagnosed with the disease have required hospitalization. With supportive care, most people have fully recovered; however, a few older individuals with medical comorbidities have died.

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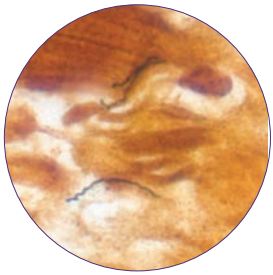
LYME DISEASE

AGENT: *Borrelia burgdorferi, B. mayonii*

WHERE FOUND

Lyme disease is most frequently reported from the Upper Midwestern and northeastern United States. Some cases are also reported in northern California, Oregon, and Washington. In 2015, 95% of Lyme disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin.



INCUBATION PERIOD

3–30 days

SIGNS AND SYMPTOMS

*LOCALIZED STAGE**

- Erythema migrans (EM)—red ring-like or homogenous expanding rash; classic rash not present in all cases. See examples on following pages.
- Flu-like symptoms—malaise, headache, fever, myalgia, arthralgia
- Lymphadenopathy

**During the localized (early) stage of illness, Lyme disease may be diagnosed clinically in patients who present with an EM rash. Serologic tests may be insensitive at this stage. During disseminated disease, however, serologic tests should be positive.*

DISSEMINATED STAGE

- Multiple secondary annular rashes
- Flu-like symptoms
- Lymphadenopathy

Rheumatologic Manifestations

- Transient, migratory arthritis and effusion in one or multiple joints
- Migratory pain in tendons, bursae, muscle, and bones
- Baker's cyst
- If untreated, arthritis may recur in same or different joints

Cardiac Manifestations

- Conduction abnormalities, e.g., atrioventricular node block
- Myocarditis, pericarditis

Neurologic Manifestations

- Bell's palsy or other cranial neuropathy
- Meningitis
- Motor and sensory radiculoneuropathy, mononeuritis multiplex
- Subtle cognitive difficulties
- Encephalitis, encephalomyelitis, subtle encephalopathy, pseudotumor cerebri (all rare)

Additional Manifestations

- Conjunctivitis, keratitis, uveitis
- Mild hepatitis
- Splenomegaly

LYME DISEASE OR STARI?

An erythema migrans-like rash has also been described in humans following bites of the lone star tick, *Amblyomma americanum.* This condition has been named Southern Tick-Associated Rash Illness (STARI). Although the rash may be accompanied by flu-like symptoms, long-term sequelae have not been reported. Because the cause of STARI is unknown, diagnostic blood tests are not available.

Lone star ticks can be found from central Texas and Oklahoma eastward across the southern states and along the Atlantic Coast as far north as Maine.

It is not known whether antibiotic treatment is necessary or beneficial for patients with STARI. Nevertheless, because STARI resembles early Lyme disease, physicians often treat patients with the same antibiotics recommended for Lyme disease.

GENERAL LABORATORY FINDINGS

- Elevated erythrocyte sedimentation rate
- Mildly elevated hepatic transaminases
- Microscopic hematuria or proteinuria
- In Lyme meningitis, CSF typically shows lymphocytic pleocytosis, slightly elevated protein, and normal glucose.

LABORATORY DIAGNOSIS

- Demonstration of diagnostic IgM or IgG antibodies in serum. A two-tier testing protocol is recommended—EIA or IFA should be performed first; if positive or equivocal, it is followed by a Western blot.
- Isolation of organism from a clinical specimen
- In suspected Lyme meningitis, testing for intrathecal IgM or IgG antibodies may be helpful.

NOTES ON SEROLOGIC TESTS FOR LYME DISEASE

- Serologic tests are insensitive during the first few weeks of infection. During this stage, patients with an EM rash may be diagnosed clinically. While not necessary, acute and convalescent titers may be helpful in some cases.
- In persons with illness > 1 month, only IgG testing should be performed (not IgM). A positive IgM test alone is not sufficient to diagnose current disease.
- Due to antibody persistence, single positive serologic test results cannot distinguish between active and past infection.
- Serologic tests cannot be used to measure treatment response.
- Enzyme immunoassay (EIA) and immunofluorescence assay (IFA) tests have low specificity and may yield false-positive results. They may cross-react with antibodies to commensal or pathogenic spirochetes, some viral infections (e.g., varicella, Epstein-Barr virus), or certain autoimmune diseases (e.g., lupus).

NOTE: Coinfection with *B. microti* and/or *A. phagocytophilum* should be considered in patients who present with initial symptoms that are more severe than are commonly observed with Lyme disease alone, especially in those who have high-grade fever for more than 48 hours despite appropriate antibiotic therapy or who have unexplained leukopenia, thrombocytopenia, or anemia. Coinfection should also be considered in patients whose erythema migrans skin lesion has resolved but have persistent flu-like symptoms.

TREATMENT

Treatment regimens listed in the following table are for localized (early) Lyme disease. See references for treatment of patients with disseminated (late) Lyme disease. These regimens are guidelines only and may need to be adjusted depending on a person's age, medical history, underlying health conditions, pregnancy status, or allergies. Consult an infectious disease specialist for the most current treatment guidelines or for individual patient treatment decisions.

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Doxycycline	100 mg twice per day, orally	N/A	10-21*
	Cefuroxime axetil	500 mg twice per day orally	N/A	14–21
	Amoxicillin	500 mg three times per day orally	N/A	14–21
Children	Amoxicillin	50 mg/kg per day orally, divided into 3 doses	500 mg per dose	14–21
	Doxycycline	4 mg/kg per day orally, divided into 2 doses	100 mg per dose	10–21*
	Cefuroxime axetil	30 mg/kg per day orally, divided into 2 doses	500 mg per dose	14–21

* Recent publications suggest the efficacy of shorter courses of treatment for early Lyme disease.

NOTE: For patients intolerant of amoxicillin, doxycycline, and cefuroxime axetil, the macrolides azithromycin, clarithromycin, or erythromycin may be used, although they have a lower efficacy. Patients treated with macrolides should be closely observed to ensure resolution of clinical manifestations.

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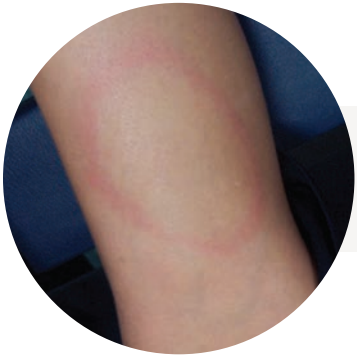
LYME DISEASE

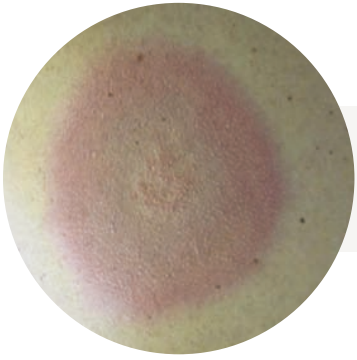
ERYTHEMA MIGRANS RASHES

The erythema migrans (EM) rash occurs in 70–80% of patients with Lyme disease. EM rashes expand slowly over a few days after which they may develop a "bull's-eye" appearance consisting of a red ring with central clearing. However, EM may take alternate forms—solid lesions, blue-purple hues, and crusted or blistering lesions have all been documented. The rash is not painful or pruritic, but it may be warm to the touch. If early localized Lyme disease is not treated, patients may develop multiple secondary circular rashes as spirochetes disseminate throughout the body.



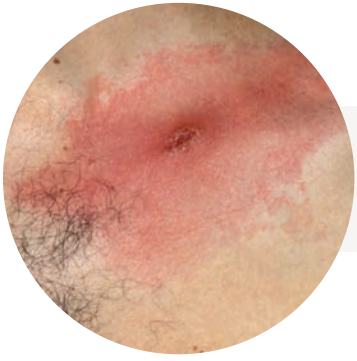
CLASSIC EM—CIRCULAR RED RASH WITH CENTRAL CLEARING THAT SLOWLY EXPANDS

Photo courtesy of Taryn Holman.



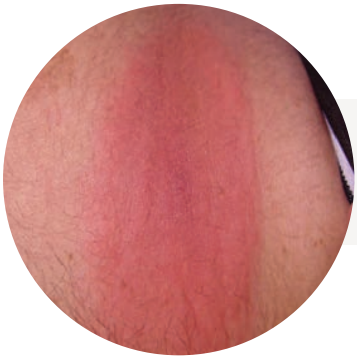
BLUISH HUE WITHOUT CENTRAL CLEARING

Photo courtesy of Yevgeniy Balagula.



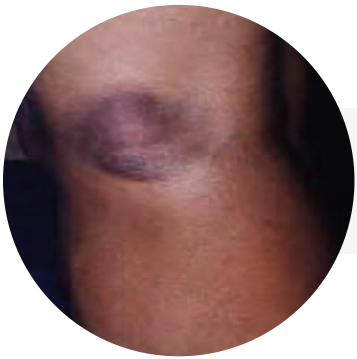
RED, EXPANDING LESION WITH CENTRAL CRUST

Photo courtesy of Bernard Cohen.



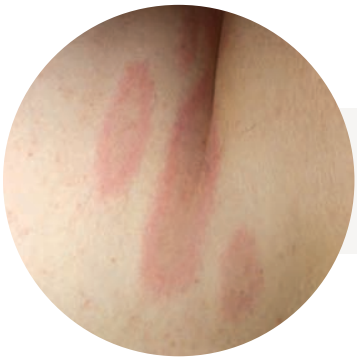
RED, OVAL-SHAPED PLAQUE ON TRUNK

Photo courtesy of Alison Young.



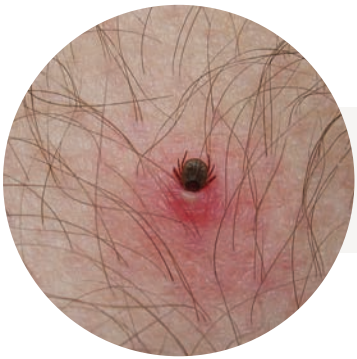
PURPLE LESION ON BACK OF KNEE

Photo courtesy of New York State Department of Health.



EARLY DISSEMINATED LYME DISEASE—MULTIPLE RED LESIONS WITH DUSKY CENTERS

Photo courtesy of Bernard Cohen.



TICK BITE WITH MILD ALLERGIC REACTION

Not an erythema migrans. Allergic reactions typically appear within the first 48 hours of tick attachment and are usually <5 cm in diameter.

Special thanks to DermAtlas for providing many photographs.

POWASSAN VIRUS DISEASE

AGENT: *Powassan virus*

WHERE FOUND
Cases have occurred primarily in northeastern states and the Great Lakes region.

INCUBATION PERIOD
1–4 weeks

SIGNS AND SYMPTOMS
- Fever, headache, vomiting, and generalized weakness
- Usually progresses to meningo encephalitis. May include meningeal signs, altered mental status, seizures, aphasia, paresis, movement disorders, or cranial nerve palsies.

GENERAL LABORATORY FINDINGS
- CSF findings include lymphocytic pleocytosis (neutrophils can predominate early), normal or mildly elevated protein, and normal glucose.

LABORATORY DIAGNOSIS
- Primarily through testing available at CDC and selected state health departments; limited commercial testing.
- Measurement of virus-specific IgM antibodies in serum or CSF. Cross-reaction with other flaviviruses (e.g., West Nile, dengue, or St. Louis encephalitis viruses) can occur; plaque reduction neutralization tests should be performed to confirm the diagnosis.
- RT-PCR may detect viral RNA in acute CSF specimens or tissues, but the sensitivity is unknown and this method should not be used to rule out the diagnosis.

TREATMENT
No specific antiviral treatment for Powassan virus disease is available. Patients with suspected Powassan virus disease should receive supportive care as appropriate.

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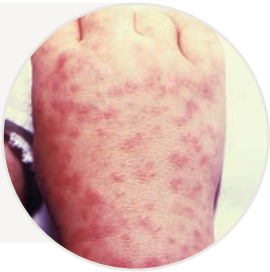
ROCKY MOUNTAIN SPOTTED FEVER (RMSF)

AGENT: *Rickettsia rickettsii*

RMSF is most often transmitted by the American dog tick in the Eastern, Central and Western United States; by the Rocky Mountain wood tick in the Rocky Mountain states; and by the brown dog tick in the Southwestern United States, along the U.S.-Mexico border. RMSF can be rapidly fatal if not treated within the first 5 days of symptoms. Before tetracycline antibiotics were available, case fatality rates ranged from 20–80%.



WHERE FOUND

Although RMSF cases have been reported throughout most of the contiguous United States, five states (North Carolina, Oklahoma, Arkansas, Tennessee, and Missouri) account for over 60% of RMSF cases. RMSF has become increasingly common in certain areas of Arizona over the last several years; between 2003 and 2016, over 360 cases and 21 fatalities occurred.

INCUBATION PERIOD

3–12 days

SIGNS AND SYMPTOMS

EARLY (1–4 DAYS)

- High fever
- Severe headache
- Malaise
- Myalgia
- Edema around eyes and on the back of hands
- Gastrointestinal symptoms (nausea, vomiting, anorexia)

LATE (5 DAYS AND BEYOND)

- Altered mental status, coma, cerebral edema
- Respiratory compromise (pulmonary edema, ARDS)
- Necrosis, requiring amputation
- Multiorgan system damage (CNS, renal failure)

RASH

- Typically appears 2–5 days after onset of symptoms; approximately 10% of RMSF patients never develop a rash.
- Decision to treat should not be based on presence of rash.

Early Rash

- Maculopapular: Small, flat, pink, non-itchy spots (macules) initially appear on the wrists, forearms, and ankles then spread to the trunk and sometimes palms and soles.

Late Rash

- Petechial: Red to purple spots (petechiae) are usually not seen until day 6 or later after onset of symptoms.
- Petechial rash is considered a sign of progression to severe disease. Every attempt should be made to begin treatment before petechiae develop.

Confirmation of the diagnosis is based on laboratory testing, but antibiotic therapy should not be delayed in a patient with a suggestive clinical presentation. Antibiotics are more likely to prevent fatal outcome from RMSF if started within the first 5 days of symptoms.

GENERAL LABORATORY FINDINGS

- Thrombocytopenia
- Elevated hepatic transaminases
- Hyponatremia

NOTE: Laboratory values are often within normal limits in early illness.

LABORATORY DIAGNOSIS

- Demonstration of a four-fold change (typically rise) in IgG-specific antibody titer by indirect immunofluorescence antibody (IFA) assay in paired serum samples. The first sample should be taken within the first week of illness and the second should be taken 2 to 4 weeks later.
- Detection of DNA in a skin biopsy specimen of a rash lesion by PCR assay or in an acute phase whole blood specimen. Additionally, new pan-*Rickettsia* and *R. rickettsii*-specific PCR assays are available at some local and state health departments.
- Immunohistochemical (IHC) staining of organism from skin or tissue biopsy specimen.

NOTE: Antibody titers are frequently negative in the first 7–10 days of illness. Acute antibody results cannot be independently relied upon for confirmation

NOTE: IgM antibodies are less specific than IgG antibodies and are more likely to generate false positives. IgM results alone should not be used for laboratory diagnosis.

TREATMENT

Anaplasmosis, ehrlichiosis, and spotted fever group rickettsioses are treated with doxycycline. Clinical suspicion of any of these diseases is sufficient to begin treatment. **Delay in treatment may result in severe illness and even death.** The regimens listed below are guidelines only and may need to be adjusted depending on a patient's age, medical history, underlying health conditions, pregnancy status, or allergies. Consult an infectious disease specialist in cases of pregnancy or life-threatening allergy to doxycycline.

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Doxycycline	100 mg twice per day, orally or IV	100 mg/dose	Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Minimum course of treatment is 5–7 days.
Children weighing <100 lbs. (45.4 kg)	Doxycycline	2.2 mg/kg per dose twice per day, orally or IV	100 mg/dose	

NOTE: Use doxycycline as the first-line treatment for suspected RMSF in patients of all ages. The use of doxycycline to treat suspected RMSF in children is recommended by both the CDC and the American Academy of Pediatrics Committee on Infectious Diseases. Use of antibiotics other than doxycycline increases the risk of patient death. At the recommended dose and duration needed to treat RMSF, no evidence has been shown to cause staining of permanent teeth, even when multiple courses are given before the age of eight.

REFERENCES

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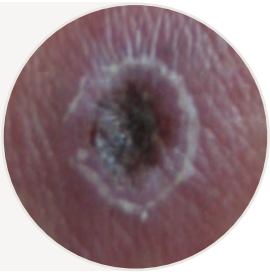
RICKETTSIA PARKERI RICKETTSIOSIS

AGENT: *Rickettsia parkeri*

R. parkeri is closely related to *R. rickettsii,* the causative agent of Rocky Mountain spotted fever (RMSF). *R. parkeri* rickettsiosis and RMSF have similar signs and symptoms, including fever, headache, and rash, but also typically include the appearance of an inoculation eschar (seen at right) at the site of tick attachment. Eschar is not common in cases of RMSF.



WHERE FOUND

R. parkeri rickettsiosis is transmitted by Gulf Coast ticks in the southeastern and mid-Atlantic states, as well as parts of southern Arizona.

INCUBATION PERIOD

2–10 days

SIGNS AND SYMPTOMS

R. parkeri rickettsiosis is characteristically less severe than RMSF and almost always associated with an inoculation eschar (ulcerated, necrotic lesion) at the site of tick attachment.

Several days after an eschar appears, the following can develop:

- Fever
- Headache
- Rash (sparse maculopapular or papulovesicular eruptions on the trunk and extremities)
- Muscle aches

NOTE: *R. parkeri* rickettsiosis can be difficult to distinguish from RMSF and other spotted fevers, especially during early stages of these diseases. Eschars are uncommonly identified in persons with RMSF.

GENERAL LABORATORY FINDINGS

- Mildly elevated hepatic transaminases
- Mild leukopenia
- Mild thrombocytopenia, less common

CONFIRMATION OF THE DIAGNOSIS IS BASED ON LABORATORY TESTING, BUT ANTIBIOTIC THERAPY SHOULD NOT BE DELAYED IN A PATIENT WITH A SUGGESTIVE CLINICAL PRESENTATION.

LABORATORY DIAGNOSIS

- Detection of rickettsial DNA by PCR in eschar swab, whole blood, or skin biopsy.
- Demonstration of a four-fold change (typically rise) in IgG-specific antibody titer by indirect immunofluorescence antibody (IFA) assay in paired serum samples. The first sample should be taken within the first week of illness and the second should be taken 2 to 4 weeks later.

NOTE: Species-level testing for *R. parkeri* is not commercially available. RMSF antibody tests are available commercially and often cross-react.

NOTE: IgM antibodies are less specific than IgG antibodies and are more likely to generate false positives. IgM results alone should not be used for laboratory diagnosis.

NOTE: Acute antibody results cannot independently be relied upon for confirmation.

TREATMENT

See Rocky Mountain spotted fever treatment on page 34.

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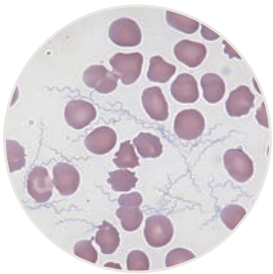
TICKBORNE RELAPSING FEVER (TBRF)

AGENT: *Borrelia hermsii, B. turicatae*



WHERE FOUND

TBRF occurs most commonly in 14 western states: Arizona, California, Colorado, Idaho, Kansas, Montana, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming. Most cases occur in the summer when people vacation and sleep in rustic cabins. However, TBRF can also occur in the winter months when fires started to warm a cabin activate ticks resting in the walls and woodwork. In Texas, TBRF may be associated with cave exposure.

INCUBATION PERIOD

~7 days, followed by recurring febrile episodes that last ~3 days and are separated by afebrile periods of ~7 days.

SIGNS AND SYMPTOMS

- Headache
- Myalgia
- Chills
- Nausea, vomiting
- Arthralgia
- Facial palsy (rarely)

COMMON FINDINGS ON ROUTINE LABORATORY TESTS

- Normal to increased white blood cell count with a left shift
- Mildly increased serum bilirubin
- Mild to moderate thrombocytopenia
- Elevated erythrocyte sedimentation rate
- Slightly prolonged prothrombin time (PT) and partial thromboplastin time (PTT)

LABORATORY DIAGNOSIS

- Organisms are best detected in blood (by microscopy or culture) obtained while a person is febrile.
- Observation of *Borrelia* spirochetes in smears of peripheral blood
- Serologic testing is appropriate for convalescent samples drawn 10–14 days post-illness onset.

TREATMENT

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Tetracycline	500 mg four times per day, orally	N/A	10
	Erythromycin	500 mg four times per day, orally	N/A	10
	Ceftriaxone*	2 g per day, IV	N/A	10–14
Children weighing <100 lbs. (45.4 kg)	Erythromycin	12.5 mg/kg four times per day, orally	2g/day	10

*For CNS involvement

NOTE: When initiating antibiotic therapy, all patients should be observed during the first 2–4 hours of treatment for a Jarisch-Herxheimer reaction.

NOTE: Acute respiratory distress syndrome requiring intubation has occurred in several patients undergoing TBRF treatment.

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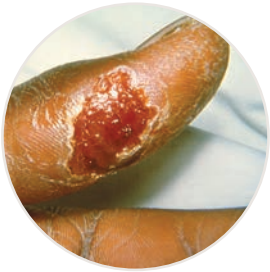
TULAREMIA

AGENT: *Francisella tularensis*

WHERE FOUND

Naturally occurring tularemia infections have been reported from all states except Hawaii. Ticks that transmit tularemia to humans include the dog tick *(Dermacentor variabilis),* the wood tick *(D. andersoni),* and the lone star tick *(Amblyomma americanum).* Other transmission routes include deer fly bite, inhalation, ingestion, and through skin contact with infected animals.



INCUBATION PERIOD

3–5 days (range 1–21 days)

SIGNS AND SYMPTOMS

- Fever, chills
- Headache
- Malaise, fatigue
- Anorexia
- Myalgia
- Chest discomfort, cough
- Sore throat
- Vomiting, diarrhea
- Abdominal pain

(ULCERO) GLANDULAR

- Localized lymphadenopathy
- Cutaneous ulcer at infection site (not always present)

OCULOGLANDULAR

- Photophobia
- Excessive lacrimation
- Conjunctivitis
- Preauricular, submandibular, or cervical lymphadenopathy

OROPHARYNGEAL

- Severe throat pain
- Exudative pharyngitis or tonsillitis
- Cervical, preparotid, and/or retropharyngeal lymphadenopathy

PNEUMONIC

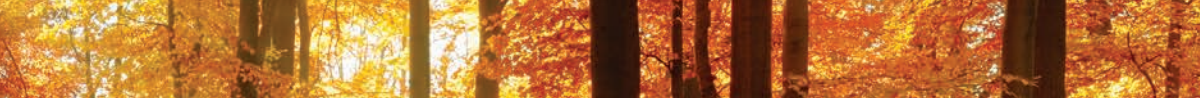
- Non-productive cough
- Substernal tightness
- Pleuritic chest pain
- Hilar adenopathy, infiltrate, or pleural effusion may be present on chest X-ray

TYPHOIDAL

- Characterized by any combination of the general symptoms (without localizing symptoms of other syndromes)

NOTE:

The clinical presentation of tularemia will depend on a number of factors, including the route of inoculation.



GENERAL LABORATORY FINDINGS

May be normal or elevated:

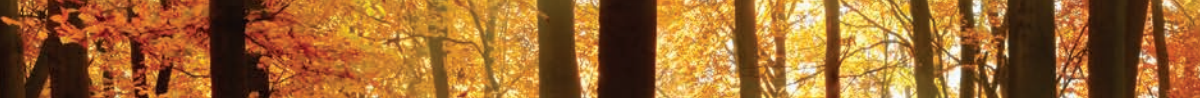
- Leukocyte count and sedimentation rate
- Thrombocytopenia
- Hyponatremia
- Elevated hepatic transaminases
- Elevated creatine phosphokinase

May be present or not present:

- Myoglobinuria
- Sterile pyuria

LABORATORY DIAGNOSIS

- Isolation of *F. tularensis* from a clinical specimen; or four-fold or greater change in serum antibody titer to *F. tularensis* antigen between acute and convalescent specimens.
- Detection of *F. tularensis* in a clinical specimen by direct immunofluorescence assay (DFA) or polymerase chain reaction (PCR) assay; or single positive antibody titer to *F. tularensis* antigen.



TREATMENT

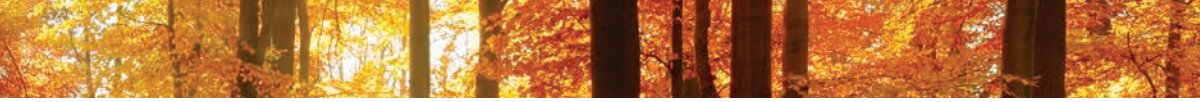
The regimens listed below are guidelines only and may need to be adjusted depending on a patient's age, medical history, underlying health conditions, pregnancy status or allergies. Consult an infectious disease specialist for the most current treatment guidelines or for individual patient treatment decisions.

AGE CATEGORY	DRUG	DOSAGE	MAXIMUM	DURATION (DAYS)
Adults	Streptomycin	1 g IM twice daily	2 g per day	Minimum 10
	Gentamicin*	5 mg/kg IM or IV daily (with desired peak serum levels of at least 5 mcg/mL)	Monitor serum drug levels	Minimum 10
	Ciprofloxacin*	400 mg IV or 500 mg PO twice daily	N/A	10–14
	Doxycycline	100 mg IV or PO twice daily	N/A	14–21
Children	Streptomycin	15 mg/kg IM twice daily	2 g per day	Minimum 10
	Gentamicin*	2.5 mg/kg IM or IV 3 times daily**	Monitor serum drug levels and consult a pediatric infectious disease specialist	Minimum 10
	Ciprofloxacin*	15 mg/kg IV or PO twice daily	800 mg per day	10

* Not a U.S. FDA-approved use, but has been used successfully to treat patients with tularemia.
** Once-daily dosing could be considered in consultation with a pediatric infectious disease specialist and a pharmacist

NOTE: Gentamicin or streptomycin is preferred for treatment of severe tularemia. Doses of both streptomycin and gentamicin should be adjusted for renal insufficiency.

NOTE: Chloramphenicol may be added to streptomycin to treat meningitis.



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TICKBORNE DISEASES ABROAD

AFRICAN TICK BITE FEVER (ATBF)

AGENT: *Rickettsia africae*

African tick bite fever (ATBF) is the most commonly diagnosed rickettsial disease among returning international travelers. ATBF is transmitted by *Amblyomma hebraeum* and *A. variegatum* ticks. Travel-associated cases of ATBF often occur in clusters with exposure during activities such as safari tours, game hunting, and bush hiking.

WHERE FOUND

Sub-Saharan Africa, Caribbean (French West Indies), and Oceania

INCUBATION PERIOD

Typically 5–7 days but may be as long as 10 days

SIGNS AND SYMPTOMS

ATBF is typically a mild-to-moderate disease; no known deaths are attributable to infection with *R. africae*. ATBF is almost always associated with an inoculation eschar (see *R. parkeri* rickettsiosis) at the site of tick attachment. Multiple eschars are described in approximately 20–50% of patients with ATBF.

Several days after eschar(s) appear, the following can develop:

- Fever
- Headache
- Myalgia
- Regional lymphadenopathy
- Rash (generalized with maculopapular or vesicular eruptions)

GENERAL LABORATORY FINDINGS

- Similar to other *Rickettsia,* see *R. parkeri* rickettsiosis.

LABORATORY DIAGNOSIS

Confirmation of the diagnosis is based on laboratory testing, but antibiotic treatment should not be delayed pending laboratory confirmation.

- ATBF can be confirmed using IFA or detection of Rickettsial DNA by PCR of eschar swab, skin biopsy, or whole blood. See *R.parkeri* rickettsiosis.
- ATBF can be confirmed by comparing acute and convalescent (taken 4–6 weeks following illness onset) samples for evidence of seroconversion in IgG antibodies.

TREATMENT

See RMSF treatment.

LYME DISEASE (EUROPE AND ASIA)

AGENT: *Borrelia afzelii, B. garinii, B. burgdorferi* sensu stricto

Outside North America, Lyme disease is transmitted through the bite of infected *Ixodes ricinus* and *I. persulcatus* ticks.

WHERE FOUND

In Europe, endemic from southern Scandinavia into the northern Mediterranean countries of Italy, Spain, Portugal, and Greece and east from the British Isles into central Russia. Incidence is highest in Central and Eastern European countries. In Asia, infected ticks occur from western Russia through Mongolia, northeastern China, and Japan; however, human infection appears to be uncommon in most of these areas.

INCUBATION PERIOD

3–30 days

SIGNS AND SYMPTOMS

In contrast to North America, Lyme disease can be caused by several different species of *B. burgdorferi* and may have somewhat different symptoms. The erythema migrans rash (EM) may last longer but have less associated inflammation than the EM produced by U.S. strains.

LABORATORY CONFIRMATION

Not all tests in the United States will reliably detect infection with European/Asian *Borrelia* species. Providers who suspect internationally-acquired Lyme disease should request testing using a C6 ELISA assay as a stand-alone diagnostic test.

TREATMENT

See Lyme disease treatment.

TICKBORNE ENCEPHALITIS (TBE)

AGENT: Tick-borne encephalitis virus

TBE is transmitted through the bite of infected *Ixodes ricinus* and *I. persulcatus* ticks.

WHERE FOUND

Endemic in focal areas of Europe and Asia, extending from eastern France to northern Japan and from northern Russia to Albania. The highest disease incidence has been reported from western Siberia, Slovenia, and the Baltic States. Asian countries with reported cases or virus activity include China, Japan, Kazakhstan, Kyrgyzstan, Mongolia, and South Korea. TBE may also be acquired by ingestion of unpasteurized dairy products from infected goats, sheep, or cows.

INCUBATION PERIOD

8 days (range, 4–28 days)

SIGNS AND SYMPTOMS

TBE disease often presents with mild illness but can follow a more severe, biphasic course:

- First phase: nonspecific febrile illness with headache, myalgia, and fatigue. Usually lasts for several days and may be followed by an afebrile and relatively asymptomatic period. Up to two-thirds of patients recover without any further illness.
- Second phase: central nervous system involvement resulting in aseptic meningitis, encephalitis, or myelitis. Findings include meningeal signs, altered mental status, cognitive dysfunction, ataxia, rigidity, seizures, tremors, cranial nerve palsies, and limb paresis.

LABORATORY CONFIRMATION

During the first phase of the illness, TBE virus or viral RNA can sometimes be detected in serum samples by virus isolation or RT-PCR. However, by the time neurologic symptoms are recognized, the virus or viral RNA is usually undetectable. Therefore, virus isolation and RT-PCR should not be used to rule out a diagnosis of TBE. Clinicians should contact their state or local health department, CDC's Division of Vector-Borne Diseases (970-221-6400), or CDC's Viral Special Pathogens Branch (404-639-1115) for assistance with diagnostic testing.

TREATMENT

There is no specific antiviral treatment for TBE; therapy consists of supportive care and management of complications.

SELECTED TRAVEL-ASSOCIATED TICKBORNE INFECTIONS

DISEASES AND ETIOLOGIC AGENTS	GEOGRAPHIC LOCATION AND ADDITIONAL RISK FACTORS
Mediterranean spotted fever (also known as boutonneuse fever)	Europe (Mediterranean basin), Middle East, Indian subcontinent, and Africa. Caused by *Rickettsia conorii,* symptoms include fever, headache, muscle pain, eschar (usually single), and rash. It is typically a moderately severe illness, and can be fatal.
Crimean-Congo hemorrhagic fever *CCHF virus*	Asia, Africa, and Europe. May also be acquired by contact with infected blood or saliva or inhalation of infected aerosols.
Omsk hemorrhagic fever *Omsk hemorrhagic fever virus*	Southwestern Russia. May also be acquired by direct contact with infected muskrats.
Kyasanur Forest disease	Southern India, Saudi Arabia (aka Alkhurma disease in Saudi Arabia). Typically associated with exposure while harvesting forest products.

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TICK BITES/PREVENTION

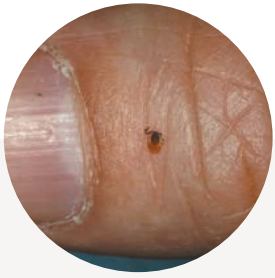
Ticks are generally found near the ground, in brushy or wooded areas. They can't jump or fly. Instead, they climb tall grasses or shrubs and wait for a potential host to brush against them. When this happens, they climb onto the host and seek a site for attachment.

PREVENTION

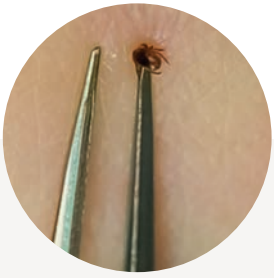
1. Use Environmental Protection Agency (EPA)-registered insect repellents containing DEET, picaridin, IR3535, oil of lemon eucalyptus, para-menthane-diol, or 2-undecanone. Treat clothing and gear, such as boots, pants, socks and tents with products containing 0.5% permethrin. Additional repellent options are available. For more information, see http://cfpub.epa.gov/oppref/insect/.
2. Treat dogs and cats for ticks as recommended by a veterinarian.
3. Check for ticks daily, especially under the arms, in and around the ears, inside the belly button, behind the knees, between the legs, around the waist, and on the hairline and scalp.
4. Shower soon after being outdoors.
5. For tips on "tick-safe" landscaping for blacklegged ticks, see www.cdc.gov/lyme/prev/in_the_yard.html.

TICK REMOVAL

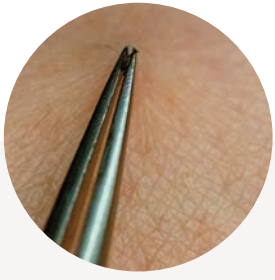
1. Use fine-tipped tweezers to grasp the tick as close to the skin's surface as possible. The key is to remove the tick as soon as possible. Avoid folklore remedies such as using nail polish, petroleum jelly, or heat to make the tick detach from the skin.
2. Pull upward with steady, even pressure. Don't twist or jerk the tick; this can cause the mouth-parts to break off and remain in the skin. If this happens, remove the mouth-parts with clean tweezers. If you are unable to remove the mouth parts easily, leave them alone and let the skin heal.
3. After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol, an iodine scrub, or soap and water.



Embedded tick



Tick removal, step 1
Photo courtesy of Mike Wren, NY State Department of Health



Tick removal, step 2
Photo courtesy of Mike Wren, NY State Department of Health

TICK BITE PROPHYLAXIS

Antibiotic treatment following a tick bite is not recommended as a means to prevent anaplasmosis, babesiosis, ehrlichiosis, Rocky Mountain spotted fever, or other rickettsial diseases. There is no evidence this practice is effective, and it may simply delay onset of disease. Instead, persons who experience a tick bite should be alert for symptoms suggestive of tickborne illness and consult a physician if fever, rash, or other symptoms of concern develop.

The Infectious Disease Society of America (IDSA) does not generally recommend antimicrobial prophylaxis for prevention of Lyme disease after a recognized tick bite. However, in areas that are highly endemic for **Lyme disease,** a single dose of doxycycline may be offered to adult patients (200 mg) who are not pregnant and to children older than 8 years of age (4 mg/kg up to a maximum dose of 200 mg) when all of the following circumstances exist:

a. Doxycycline is not contraindicated.

b. The attached tick can be identified as an adult or nymphal *I. scapularis* tick.

c. The estimated time of attachment is ≥36 h based on the degree of tick engorgement with blood or likely time of exposure to the tick.

d. Prophylaxis can be started within 72 h of tick removal.

e. Lyme disease is common in the county or state where the patient lives or has recently traveled, (i.e., CT, DE, MA, MD, ME, MN, NH, NJ, NY, PA, RI, VA, VT, WI).

Tularemia prophylaxis is recommended only in cases of laboratory exposure to infectious materials:

- Doxycycline (100 mg orally BID X 14 days) is generally recommended for prophylaxis in adults.
- Ciprofloxacin (500 mg orally BID) is not FDA-approved for prophylaxis of tularemia but has demonstrated efficacy in various studies, and may be an alternative for patients unable to take doxycycline.

For more information, please contact:

Centers for Disease Control and Prevention
Division of Vector-Borne Diseases
3156 Rampart Road, Fort Collins, CO 80521

Telephone: 1-800-CDC-INFO (232-4636)
TTY: 1-888-232-63548

Contact: www.cdc.gov/cdc-info/
Web: www.cdc.gov/ticks

Based on "Tickborne Diseases in Massachusetts: A Physician's Reference Manual," produced by collaboration between MDPH, Nancy Shadick, MD, MPH, and Nancy Maher, MPH of the RBB Arthritis and Musculoskeletal Diseases Clinical Research Center at Brigham and Women's Hospital and Dennis Hoak, MD, of Martha's Vineyard Hospital.

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