

Tickborne Diseases in the United States

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Infectious Diseases

NPAIHB ID ECHO



Objectives



Name the different diseases transmitted by ticks in the USA and their distribution



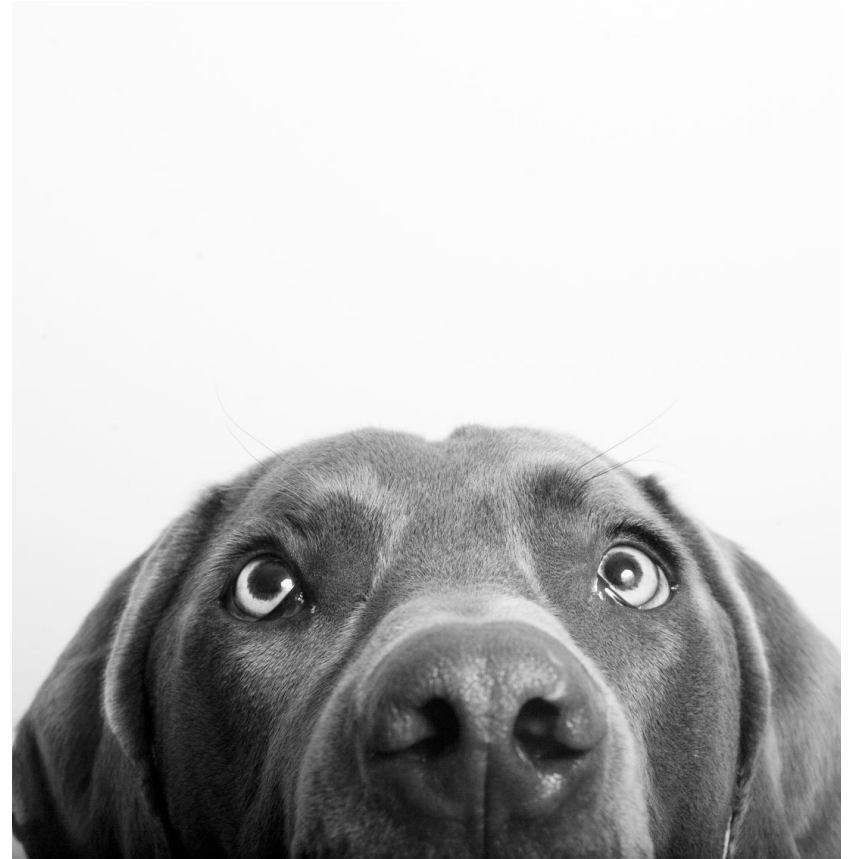
Explain the different diagnostic tools available for tickborne diseases.



Recognize the clinical presentation and treatment of the most common tickborne diseases in the USA

Why do Tickborne Diseases Make me TICK

- I have dogs
- I must know about them!! (I am an ID specialist)
- I lived in Oklahoma for 12 years
- Part of my family is scientifically vested in ticks
- The rest of my family seems to be a magnet for ticks



Luca and Mia trying to avoid ticks




Parasitology Research
<https://doi.org/10.1007/s00436-020-07005-7>

GENETICS, EVOLUTION, AND PHYLOGENY - SHORT COMMUNICATION



Epidemiological link between canine monocytic ehrlichiosis caused by *Ehrlichia canis* and the presence of *Rhipicephalus sanguineus sensu stricto* in Argentina

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Tick Basics



**Hematophagous
vectors**

Not the reservoir



> 900 species worldwide

9 tick species in the US
transmit diseases



**Have a defined/
dynamic geographical
distribution**



Tick Attack



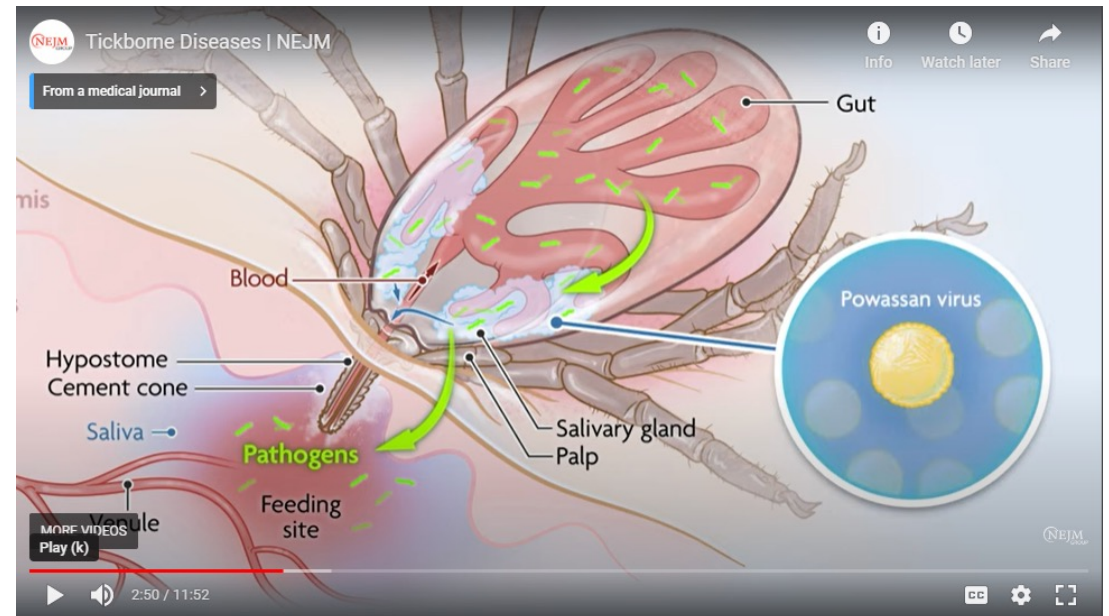
While questing, ticks hold onto leaves and grass by their third and fourth pair of legs.



**They hold the first pair of legs outstretched, waiting to climb on to the host.
When a host brushes the spot, it quickly climbs aboard.**

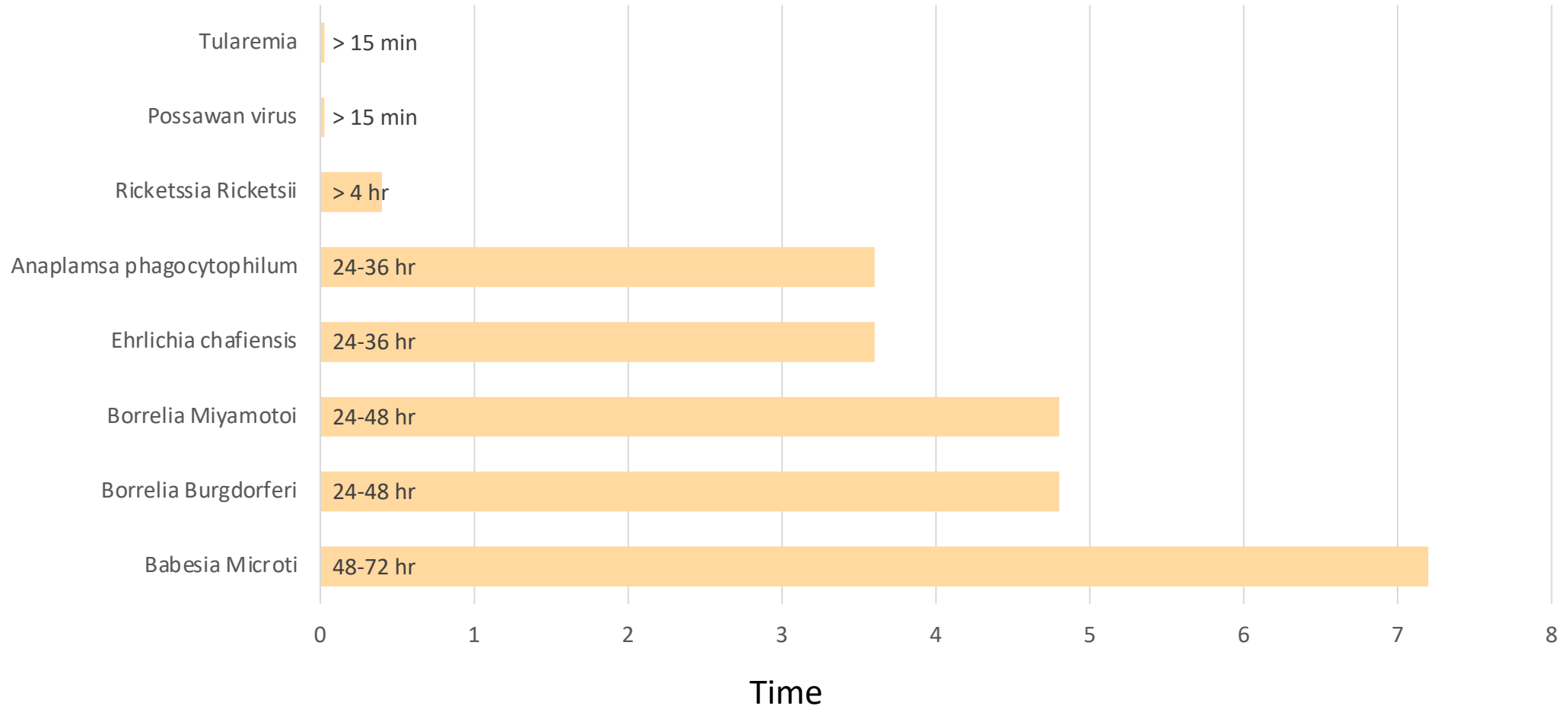
Ticks find their hosts by detecting animals' breath and body odors, or by sensing body heat, moisture, and vibrations. Some species can even recognize a shadow. In addition, ticks pick a place to wait by identifying well-used paths.

Reactivation and Inoculation of Pathogens

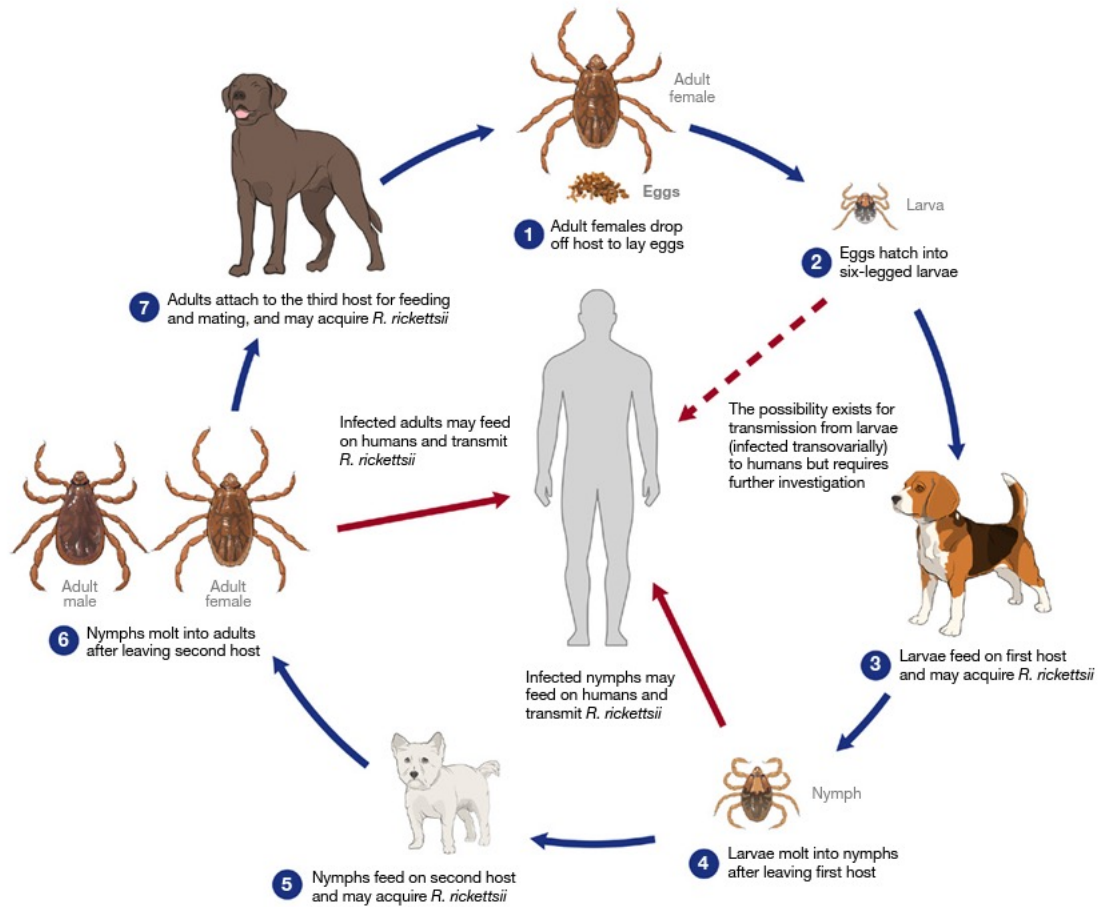


Some ticks will attach quickly, others will wander, looking for places like the ear, or areas where the skin is thinner. Small amounts of saliva from the tick may also enter the skin of the host animal during the feeding process.

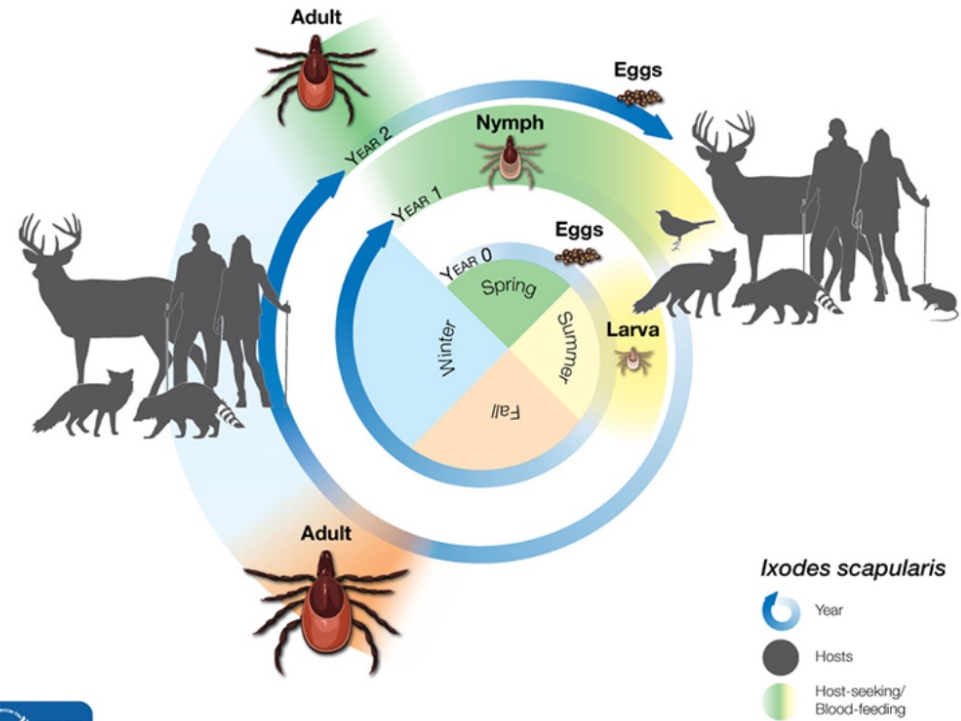
Approximate Reactivation Time of Tickborne Diseases



Life cycle of *Rhipicephalus sanguineus* and the transmission of *Rickettsia rickettsii* (the causative agent of Rocky Mountain Spotted Fever)



Images are not drawn to scale. *R. sanguineus* can maintain *R. rickettsii* between life stages. Humans, as well as dogs, may become infected when bitten by a tick infected with *R. rickettsii*.



The lifecycle of *Ixodes scapularis* ticks generally lasts two years. During this time, they go through four life stages: egg, larva, nymph, and adult. After the eggs hatch, the ticks must have a blood meal at every stage to survive. Blacklegged ticks can feed from mammals, birds, reptiles, and amphibians. The ticks need a new host at each stage of their life.



Ticks that Transmit Diseases to Humans in the US

BLACKLEGGED TICK
Ixodes scapularis



LONE STAR TICK
Amblyomma americanum



AMERICAN DOG TICK
Dermacentor variabilis, D. similis



BROWN DOG TICK
Rhipicephalus sanguineus



WESTERN BLACKLEGGED TICK
Ixodes pacificus



GROUNDHOG TICK
Ixodes cookei



GULF COAST TICK
Amblyomma maculatum



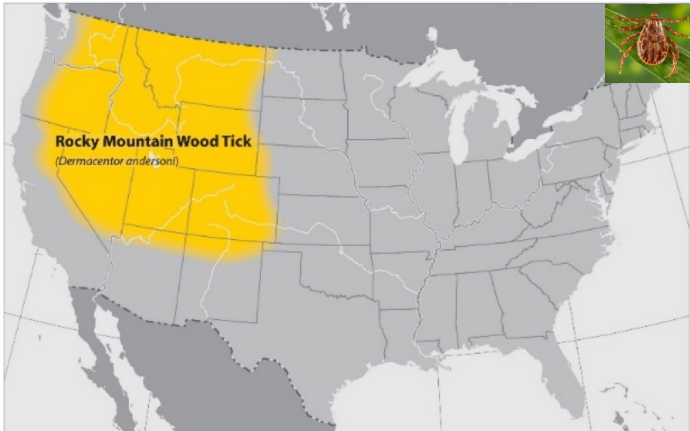
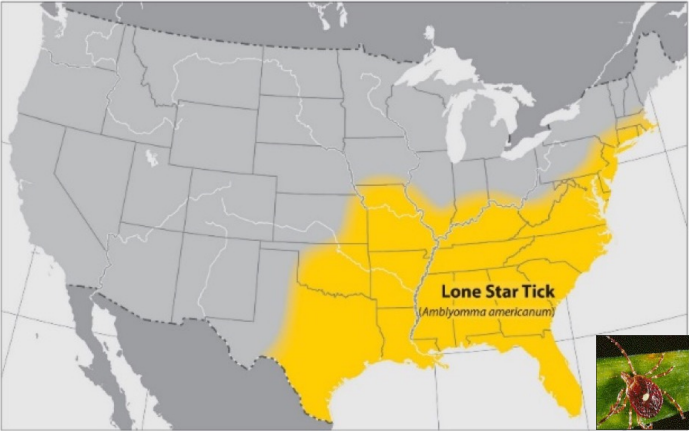
ROCKY MOUNTAIN WOOD TICK
Dermacentor andersoni



SOFT TICK
Ornithodoros spp.

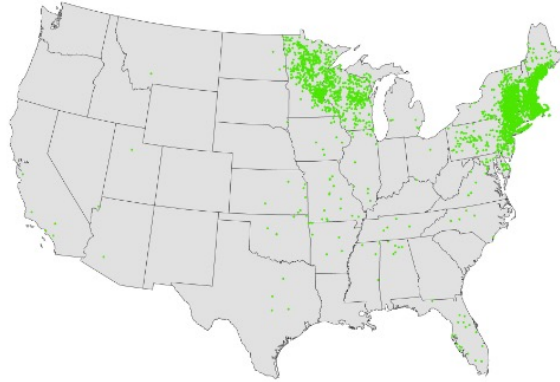


Range Maps of Ticks that Bite Humans in the U.S.



Selected Tickborne Diseases Reported to CDC, U.S., 2018

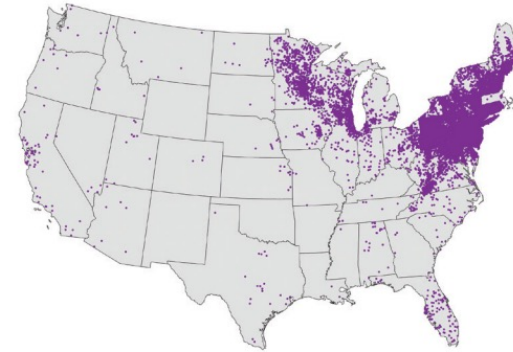
For information about reporting tickborne disease cases or questions about testing, contact your state or local health department.



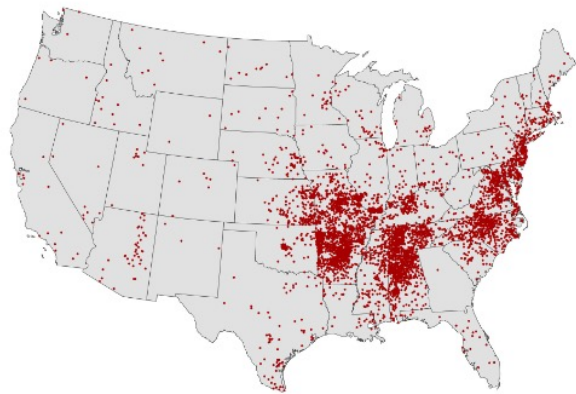
ANAPLASMOSIS



BABESIOSIS



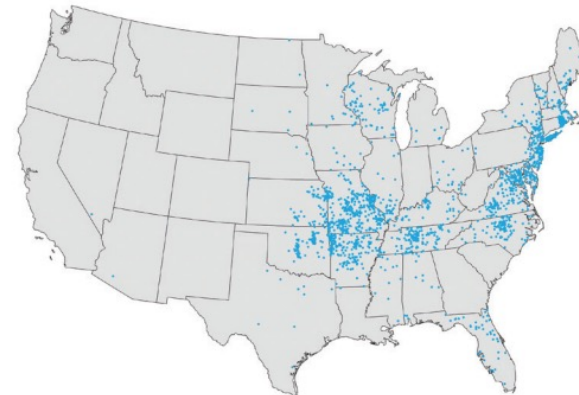
LYME DISEASE



SPOTTED FEVER RICKETTSIOSIS (INCLUDING
ROCKY MOUNTAIN SPOTTED FEVER)



TULAREMIA



EHRlichiosis

Disease, Agent and Ticks

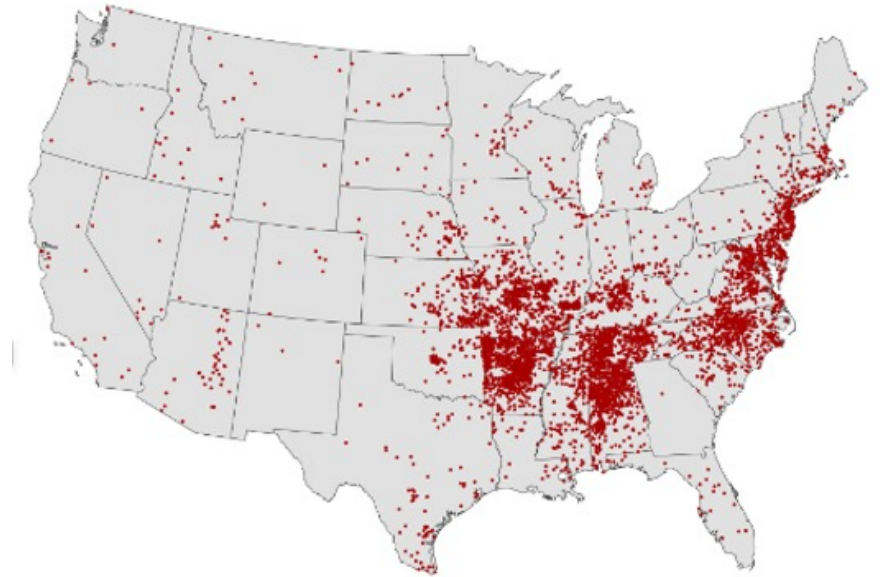
Disease	Agent	Tick
Rocky Mountain Spotted Fever (RMSF)	Rickettsia rickettsii	American dog tick, Brown dog tick Rocky Mountain wood tick,
Colorado Tick Fever	Colorado tick fever virus	Rocky Mountain wood tick
Ehrlichiosis	Ehrlichia chaffeensi, Ewingi and Wisconsin	Lone Star Tick
Tularemia	Franciscella tularensis	Brown Dog tick, Rocky Mountain wood tick Lone star tick
Southern Tick Associated Rash Illness (STARI)	Borrelia lonestari ?	Lone Star tick
Rickettsia Parkeri Rickettsiosis	Rickettsia Parkerii	Gulf coast tick
Tick Borne Relapsing fever	Borrelia hermsii	Soft tick
Anaplasmosis	Anaplasma phagocytophilum	Blacklegged tick
Babesiosis	Babesia microti	Blacklegged tick
Lyme Disease	Borrelia burgdorferi	Blacklegged tick
Powassan virus disease	Powassan virus	Groundhog Tick

Tick Distribution Does Not Match the Burden of Tickborne Diseases



ABOUT THIS MAP: This map is not meant to represent risks for a specific tick-borne disease, because disease transmission is influenced by multiple factors beyond mere tick presence. This map has been designed to answer the question "What ticks should I be concerned about at a regional scale?" Please consult a local public health authority or USDA Agricultural Extension Office to determine more specific information at the state, county, or municipal level. Background data for this map is from the US National Atlas.

National Center for Emerging and Zoonotic Infectious Diseases
Division of Vector-Borne Diseases



SPOTTED FEVER RICKETTSIOSIS (INCLUDING
ROCKY MOUNTAIN SPOTTED FEVER)

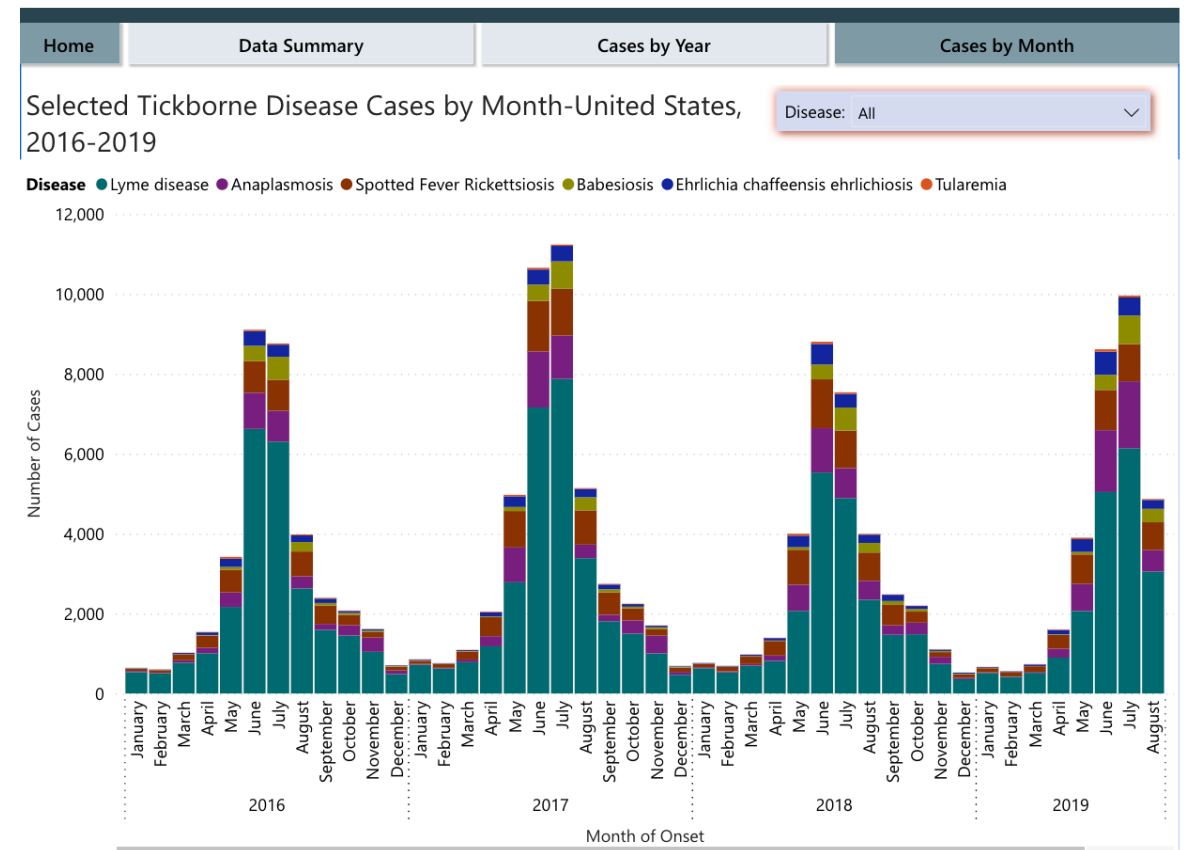
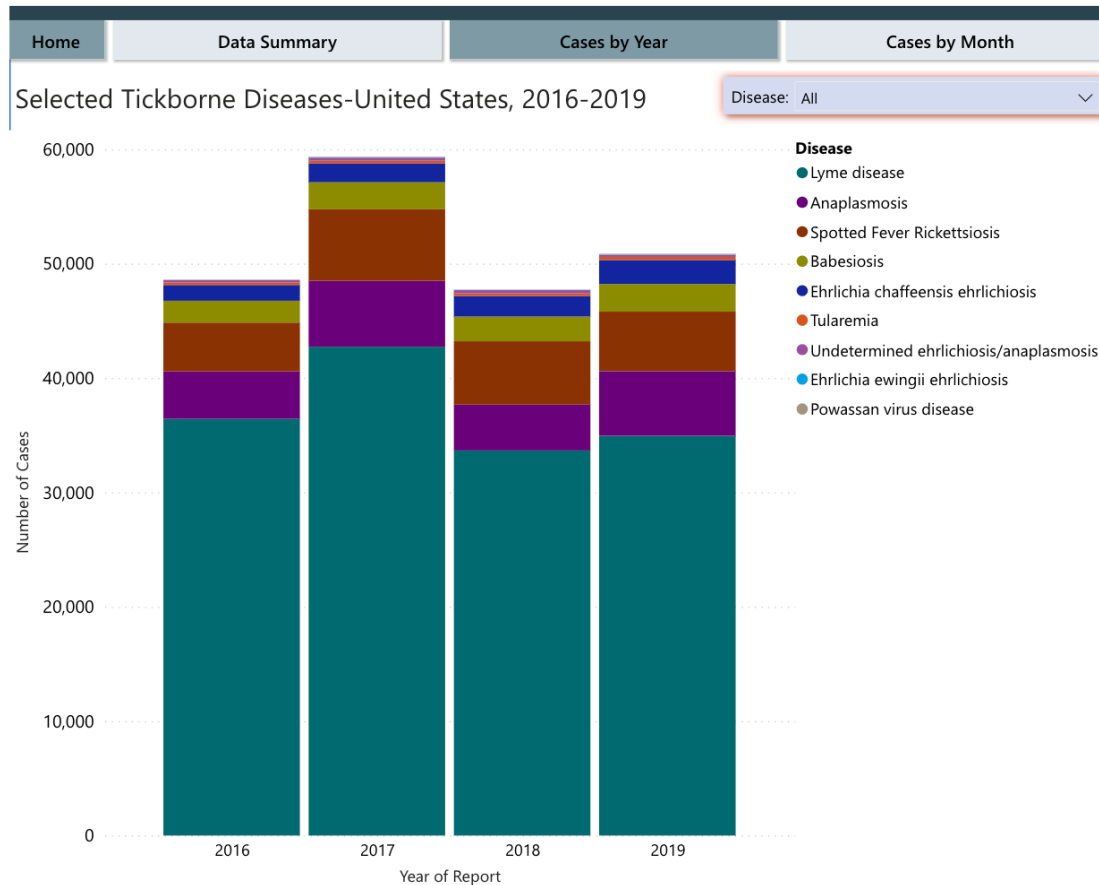
Where found: Worldwide.

Transmits: [Rocky Mountain spotted fever](#) (in the southwestern U.S. and along the U.S.-Mexico border).

Comments: Dogs are the primary host, but the tick may also bite humans or other mammals.



Tickborne Diseases Cases Per Year and by Month

<https://www.cdc.gov/ticks/data-summary/index.html>



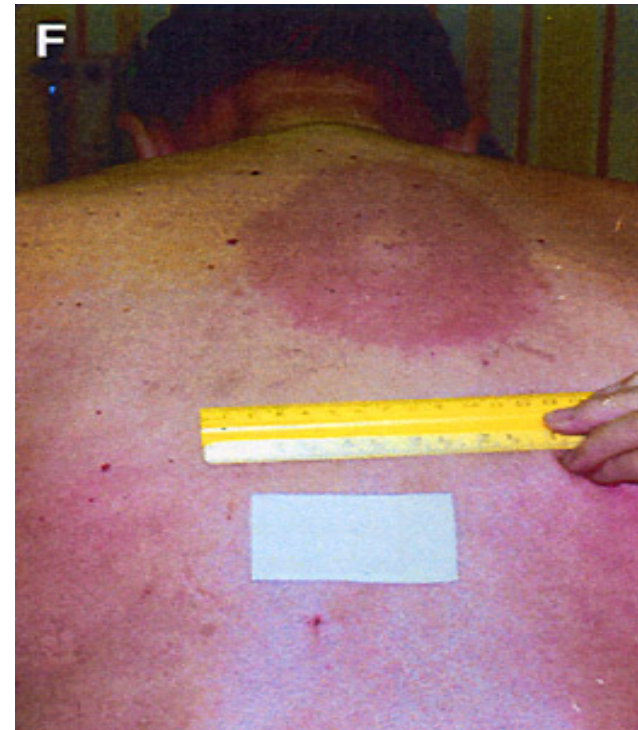
Nationally cases are stable, there are changes in regions in term of frequency

Possible Tickborne Diseases Originating in New Mexico

Tick	Headshot	Where Found	Transmits	Comments
BROWN DOG TICK <i>Rhipicephalus sanguineus</i>		Worldwide	<ol style="list-style-type: none"> 1. <i>Rickettsia rickettsii</i> (Rocky Mountain spotted fever) 	<ul style="list-style-type: none"> • Primary vector for <i>R. rickettsii</i> transmission in the southwestern U.S. and along the U.S.-Mexico border. • 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.
ROCKY MOUNTAIN WOOD TICK <i>Dermacentor andersoni</i>		Rocky Mountain states.	<ol style="list-style-type: none"> 1. <i>Rickettsia rickettsii</i> (Rocky Mountain spotted fever) 2. <i>Francisella tularensis</i> (tularemia) 3. <i>Colorado tick fever virus</i> (Colorado tick fever) 	<ul style="list-style-type: none"> • Adult ticks feed primarily on large mammals. • Larvae and nymphs feed on small rodents. • Adult ticks are primarily associated with pathogen transmission to humans.

Clinical case

- A 42-year-old male who lives in El Paso, Texas, presents with 4 days of fever, malaise and a bull's eye rash in his back. He has traveled to Massachusetts 6 months ago for a professional meeting and was not outdoors during his travel. His PE is only remarkable for the rash, otherwise normal.
- Labs reveal WBC 2800, Platelets 130,000, LFT's (ALT 88, AST 68). Rest is normal. What is the most likely diagnosis?



What is the most likely diagnosis?

- A. Lyme disease (*Borrelia burgdorferi*)
- B. Rocky Mountain Spotted Fever (*Rickettsia rickettsii*)
- C. Human Monocytic Ehrlichiosis (HME)
- D. Southern Tick Associated Rash Illness (STARI)

Key Factors to Early Diagnosis of Tick-Borne Illnesses

Know

- your local epidemiology

Ask about

- exposure history

Recognize

- the clinical presentation

Understand

- the limitations of the laboratory diagnosis

Have

- a low threshold to treat

Tick Borne Diseases: Key Clinical Messages

Asses for risk factors

- Tick exposure
- Contact with dogs
- Travel to areas with known disease in previous 2-4 weeks

Red flags

- Persistent High fever
- Suttle lab abnormalities
- Failed initial treatment
- Patient is toxic or looks sick

Treat based on level of clinical suspicion

- Next day follow-up if treatment not initiated immediately

Clinical Presentation of Tickborne Diseases



Symptoms

Fever
Muscle aches
Fatigue
Malaise
Headaches
Gastrointestinal symptoms



History (need to figure out probability)

Where and when have you been?
What have you been doing?
What prevention methods did you use?
Time of symptom onset
Progression and nature of symptoms

Clinical Presentation “Influenza in the Summer”

Disease	Anaplasmosis	Ehrlichiosis	RMSF	Rickettsia parkeri	Babesiosis
Initial Symptoms	Fever/Chills Headache Myalgia	Fever/Chills Headache Myalgia	Fever Headache Myalgia	Fever Headache Myalgia	Fever/Chills Headache Myalgia
	Malaise GI symptoms Rash (<10%)	GI symptoms Malaise Rash AMS	Rash GI symptoms Edema around eyes and on the back of hands	Rash	Malaise Arthralgia GI symptoms Dry cough, Sore throat, Photophobia Conjunctival injection
Incubation Period	5-14 days	5-14 days	1-4 days	2-10 days	1-4 weeks

Physical Exam



VITALS



SKIN EXAM
(RASH AND TICKS)



MOUTH
(TULAREMIA)



LYMPH NODES
(TULAREMIA)



HEART
ENDOCARDITIS
(TULAREMIA) OR
MYOCARDITIS
(EHRlichiosis) OR
A-V BLOCK
(LYME)

Skin Exam

Lyme Disease:

- 80% of with early Lyme disease have erythema migrans
- Serology only positive 50 % of the time

Rocky Mountain Spotted Fever (RMSF):

- Rash is present in 80 % after 2-5 days of illness
- May be confused with syphilis.
- Later petequeial or purpuric in 50% of the cases

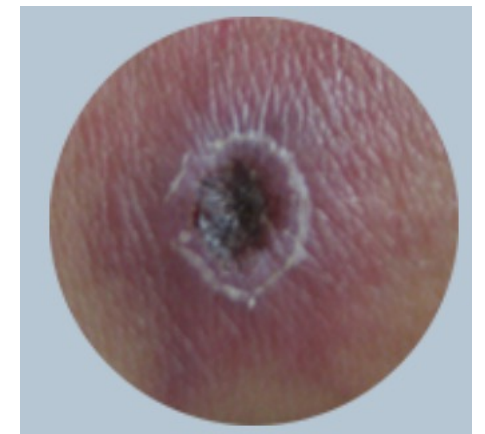
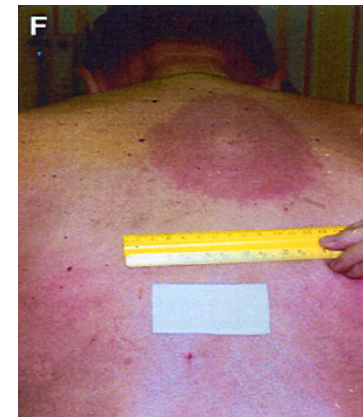
Southern Tick Associated Rash Illness (STARI)

- Similar rash to Lyme

Rickettsia parkeri rickettsiosis

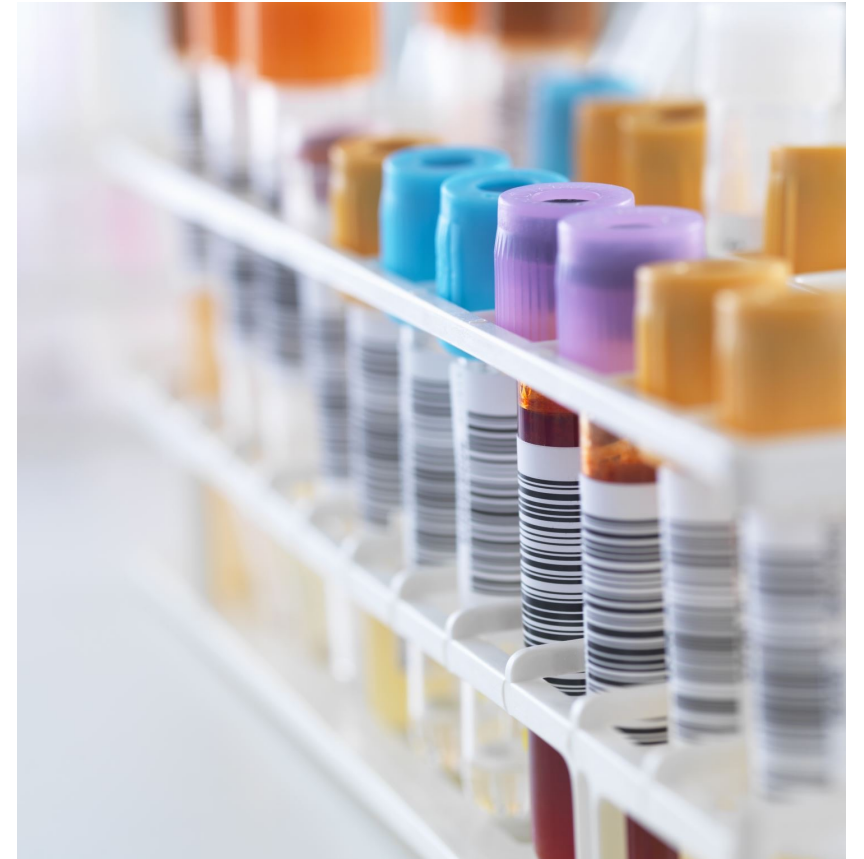


small pink macules in ankles and wrists and sometimes in palms and soles)



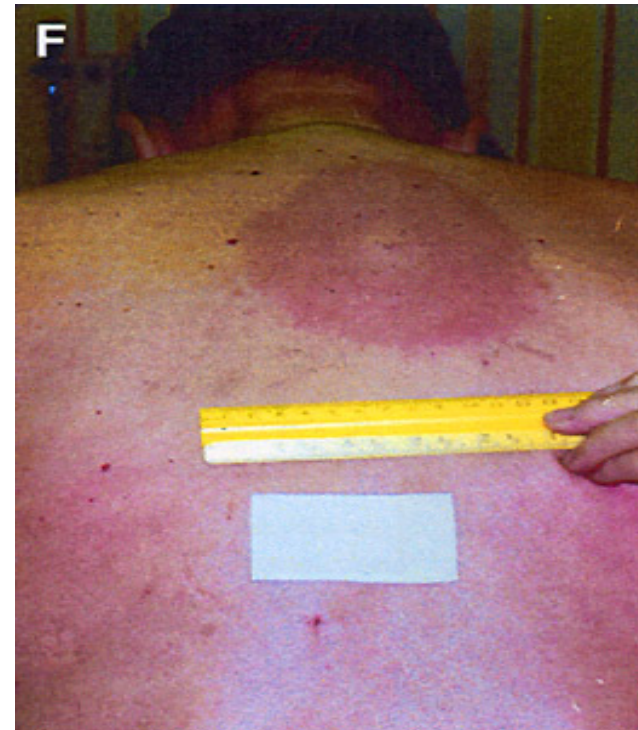
TBD: Laboratory Workup

- **CBC and LFT's**
 - Leucopenia/Thrombocytopenia
 - Elevated LFT's
- **Confirmatory Tests**
 - PCR
 - Serology (4-fold titer increase)
 - Histopathology/culture
- **Testing the tick is not warranted**
 - Negative tick does not exclude bites from other infected ticks
 - Positive test does not warranty that transmission occurred
 - Rate of transmission for Lyme for example
 - 20 - 40 % of ticks may be infected but transmission is ~2%



Clinical case

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What is the most likely diagnosis?

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- B. Rocky Mountain Spotted Fever (*Rickettsia rickettsii*)
- C. Human monocytic Ehrlichiosis
- D. Southern Tick Associated Rash Illness (STARI)

- Lyme disease is not present in Texas
- RMSF has a maculopapular rash and generally has leukocytosis
- Ehrlichiosis may have a rash, but it is not a “bulls' eye rash”

Southern tick –associated rash illness (STARI)

Variable	STARI	Lyme
Etiology	Borrelia Lonestari ?	Borrelia Burgdorferi
Vector	Lone Star Tick	Black Legged Tick
Hx of tick bite	86 %	20 %
Time to lesion	6.1 days	10.4 days
Other symptoms	19 %	76 %
Multiple skin lesion	5 %	27 %
Size	8.3 cm	16.4 cm



Rocky Mountain Spotted Fever

Rickettsia rickettsii

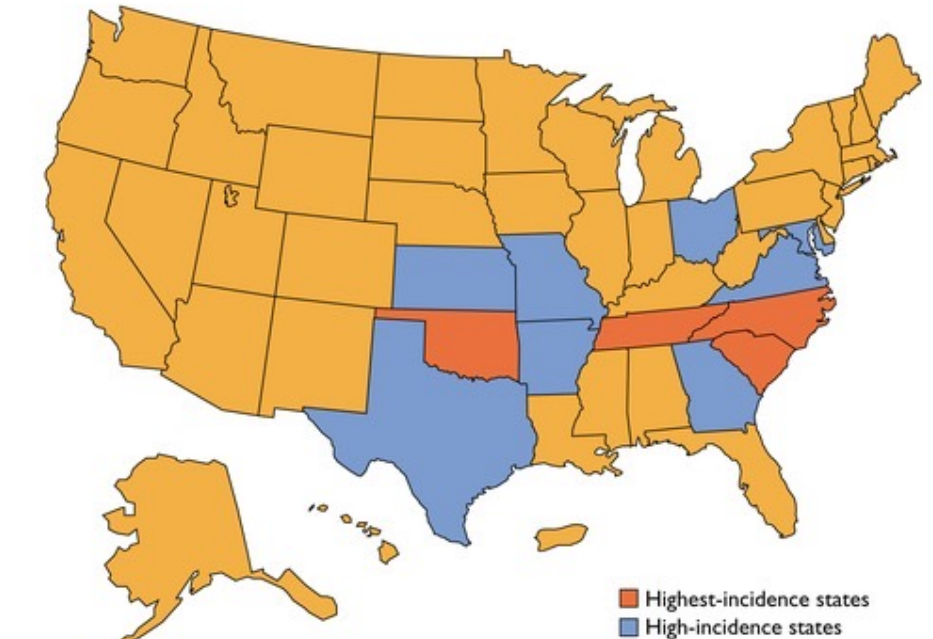
- Obligate intracellular bacteria
- Transmitted by the **American dog tick** in the Eastern, Central and Western US; **Rocky Mountain wood tick** in the Rocky Mountain states; **brown dog tick** in the Southwestern US.
- More than 50 % of patients do not report a tick bite
- Incubation Period 3-12 days

The most severe rickettsiosis in the US

- Mortality rates as high as 25 % in untreated cases
- Most deaths occur first 8 days of illness

Diagnostic Challenge

- Symptoms are like other febrile illnesses
- Decision to treat is based on clinical diagnosis



RMSF: Symptoms Day 1

Abrupt onset of headache, fever Myalgia and malaise

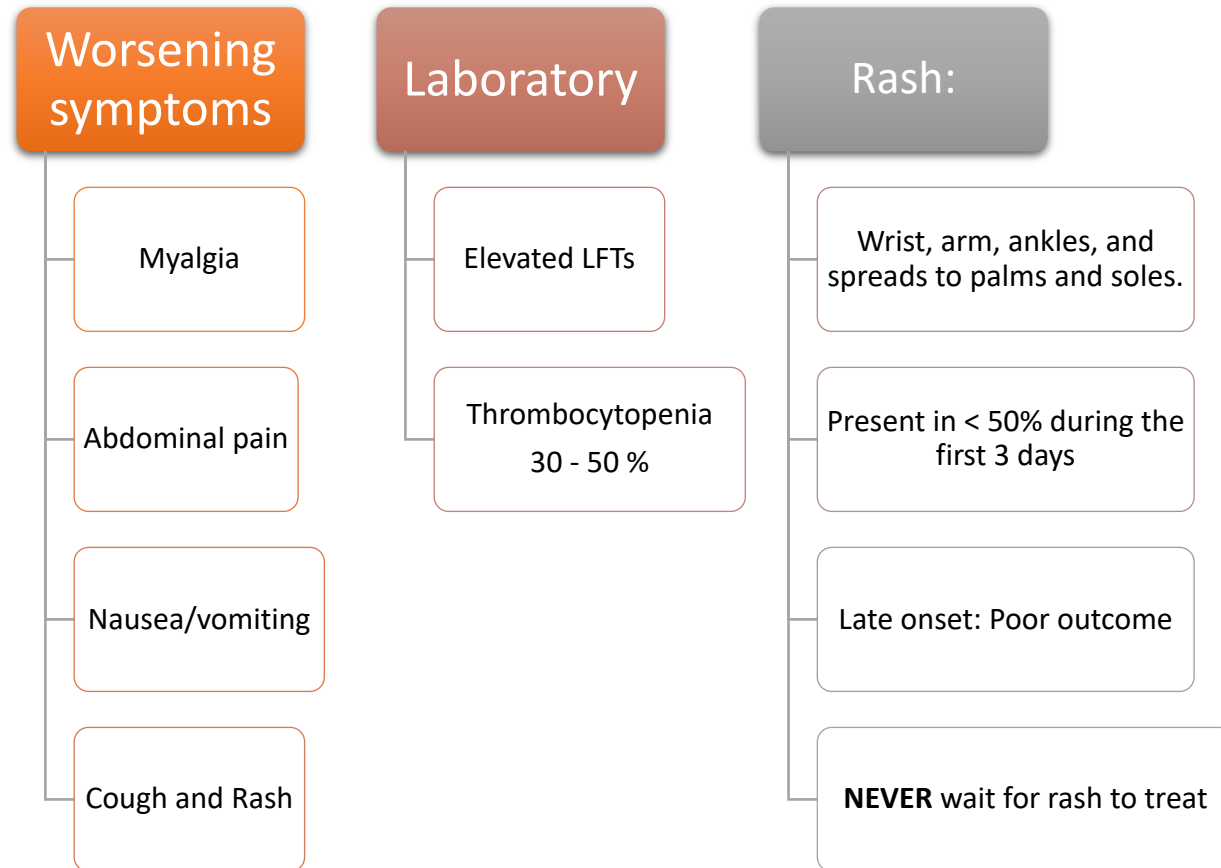
Children less likely to report headache

- But more likely to experience periorbital edema or edema of dorsum of the hand

WBC and Platelet count:

- Normal at early stages

RMSF: Symptoms Day 2-4



Small flat pink macules

RMSF: Symptoms Day 5-7

High fever

Worsening abdominal pain

Worsening respiratory status

Rash petechial and widespread

Worsening thrombocytopenia, elevated LFTs,
hyponatremia



Example of a later-stage rash in an RMSF patient.

RMSF: Symptoms Beyond day 7



This is what you do not want to see

- Diffuse damage to the endothelium:
 - Diffuse purpura and necrosis of digits
 - Septic shock, renal failure
 - Pulmonary and cerebral edema
- Those who survive
 - Persistent neurologic deficits
 - Amputations
 - Permanent organ damage

Therapeutic Delay and Mortality in Cases of Rocky Mountain Spotted Fever

Table 1. Factors associated with failure to initiate therapy for Rocky Mountain spotted fever at the first physician visit.

Factor	Percent of patients not treated at first visit	Univariate OR	P value	Multivariable OR (95% CI)	P value
Rash at first visit					
Absent	89.5	10.0	.001	8.7 (2.7, 28.1)	.001
Present	46.0				
First Visit					
Early	81.2	1.7	.001	4.0 (1.1, 14.0)	.04
Late	48.0				
Season					
Low incidence	92.3	6.5	.007	11.8 (2.0, 69.5)	.007
High incidence	64.7				
Race					
Nonwhite	80.4	2.3	.09
White	64.6				
Sex					
Male	75.4	1.5	.4
Female	67.6				
Age					
>30 y	73.0	1.1	.9
≤30 y	71.9				

- Patients with RMSF who received antirickettsial therapy within 5 days of the onset of symptoms were significantly less likely to die than were those who received treatment after the 5th day of illness (6.5% vs. 22.9%, respectively; $P < .03$).
- Ninety percent of patients were seen by a physician during this 5-day period
- < 50% received treatment before day 6.

RMSF: Laboratory Diagnosis

Four-fold or greater rise in IgG antibody titer in convalescent serum

- between acute (first week) and convalescent (2-4 weeks later)
- A positive serology during the first week can not confirm RMSF and a negative serology does not rule it out
- IgM has many false positives

PCR:

- In blood or tissue PCR >90 % sensitivity in late disease
- Early in infection Rickettsia circulate in low numbers (a negative PCR does not rule RMSF out)
- Pathogen specific

Skin biopsy

- With Immunofluorescence staining is highly specific, 70 % sensitivity

Decision to treat on clinical suspicion

- Post Exposure Prophylaxis is not recommended and may confound presentation

RMSF: Key Clinical Messages



Rapidly progressive disease with non-specific clinical findings during early illness



Doxycycline is the drug of choice for treating people of all ages

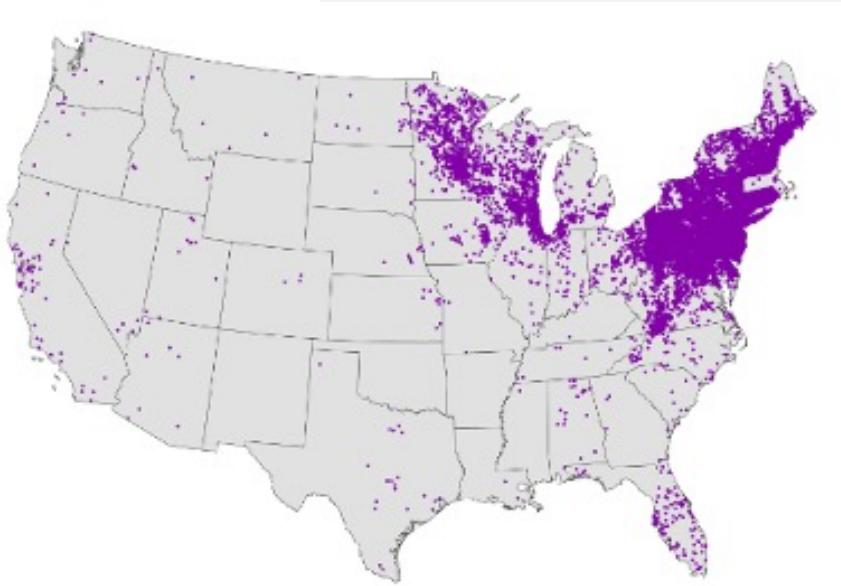


Tx is most effective at preventing death and severe disease when started within 5 days of illness



Never wait for the rash, serology or PCR results to begin treatment

Lyme Disease: Geographic Distribution



LYME DISEASE

Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, Washington D.C., West Virginia, and Wisconsin

Most frequently reported from the upper midwestern, northeastern, and mid-Atlantic states (*Ixodes scapularis*).

- Some cases are also reported from northern California, Oregon, and Washington, where it is spread by *Ixodes pacificus* ticks.

The geographic area of risk is expanding to include neighboring states.

Lyme Disease: Clinical Stages

Early localized disease

- Erythema migrans (EM), with or without constitutional symptoms.
- Serology may be negative

Early disseminated disease

- **Multiple EM lesions** (days to weeks after infection) **and/or**
- **Neurologic and/or cardiac findings** (weeks to months after infection).
- Some patients may not have a history of early localized Lyme disease.

Late Lyme disease

- Intermittent or persistent arthritis, and/or
- Mild encephalopathy or polyneuropathy.
- May develop months to a few years after the initial infection.

Early Localized Disease

Incubation period

- 3-30 days

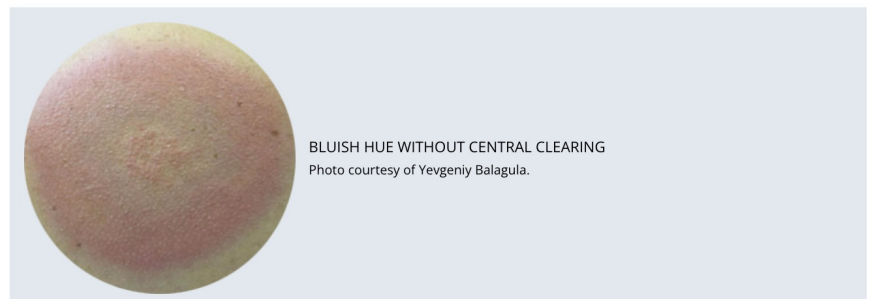
Erythema migrans (EM)

- Red annular or homogeneous rash at the site of tick bite
- Expands gradually over several days to >5 cm in diameter
- Central clearing may develop as the rash expands, resulting in a “target” or “bull’s-eye” appearance
- Occurs in 70-80% of infected persons.

Unspecific General Symptoms”

- Fever, chills, malaise, fatigue, headache, myalgia, arthralgia

Lymphadenopathy

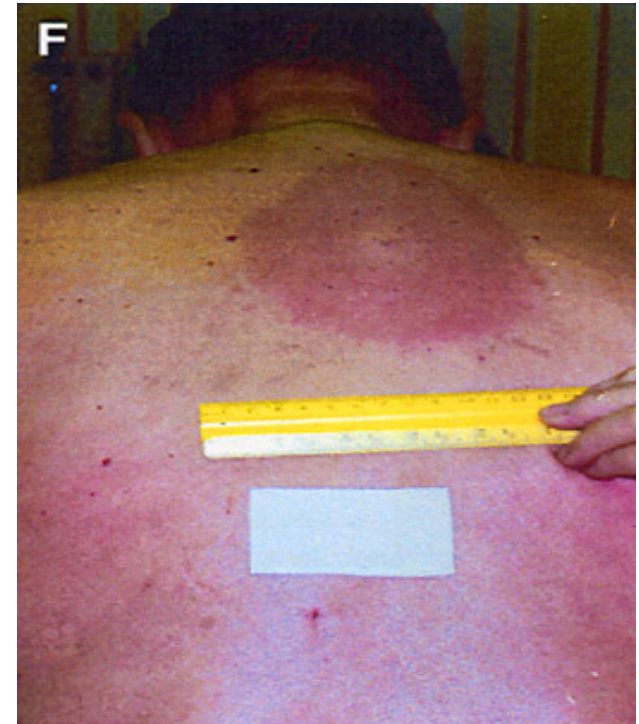


Not Erythema Migrans



TICK BITE WITH MILD ALLERGIC REACTION

Not erythema migrans. Hypersensitivity reactions typically appear within the first 48 hours of tick attachment, are often itchy and are usually <5 cm in diameter. Localized tick bite reactions can occur following bites from any tick species.



Southern Tick Associated Rash Illness (STARI)

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.

<https://www.cdc.gov/ticks/tickbornediseases/lyme.htm>

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DESCRIPTION OF LYME DISEASE STANDARD TWO-TIERED TESTING AND SUGGESTED REPORTING AND INTERPRETATION TABLE

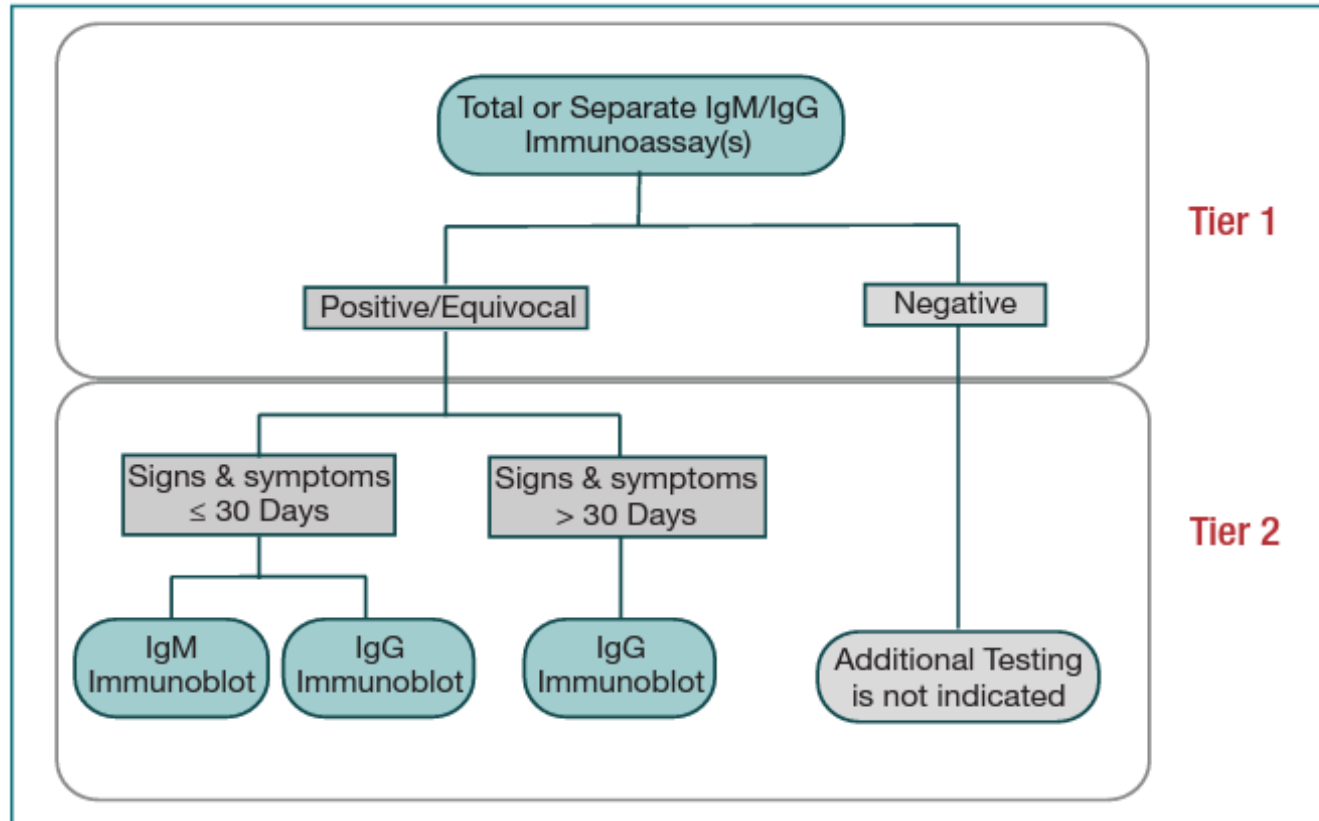


Figure 1: Standard Two-Tiered Testing (STTT)

- The STTT begins with an immunoassay detecting IgM or IgG antibodies to *B. burgdorferi*.
- Either an enzyme immune assay (immunoassay) or, newer generation (e.g., lateral flow, fluorescence and chemiluminescence) assays available on other platforms can be performed.
- If the immunoassay(s) are negative, no further testing is necessary.
- If the total IgM/IgG immunoassay, or either one or both of the first tier IgM and IgG immunoassays are positive or equivocal, reflex testing by immunoblot is required.
- For samples collected from patients with symptoms lasting 30 days or less, both IgM and IgG specific anti-*B. burgdorferi* immunoblots should be performed and interpreted to guide clinical decisions.
- For samples collected over 30 days post symptom onset, only the anti-*B. burgdorferi* IgG immunoblot should be performed or interpreted.

Antibiotic prophylaxis following tick bite

- Prophylaxis with a single dose of doxycycline 200 mg can be offered to nonpregnant adults and children (4.4 mg/kg) who meet **ALL** the following criteria after a tick bite
 - Attached tick identified as an adult or nymphal *Ixodes scapularis* tick (deer tick)
 - Tick is estimated to have been attached for ≥ 36 hours (by degree of engorgement or time of exposure)
 - Prophylaxis is begun within 72 hours of tick removal
 - The bite occurs in a highly endemic area
 - Doxycycline is not contraindicated



Clinical case

- A 39-year-old male who lives in Portland, Oregon visited Tahlequah, Oklahoma 1 week ago. He presents with fever, headache and myalgias. PE: is normal.
 - Labs reveal WBC 2400, Platelets 95,000, LFT's (ALT 321, AST 340). Lab technician reports "weird inclusions in the monocytes). **What is the most likely diagnosis?**
- A. Lyme Disease (*Borrelia burgdorferi*)
 - B. Hepatitis A
 - C. Ehrlichiosis (*Ehrlichia chaffiensis*)
 - D. American Boutonneuse Fever (*Rickettsia parkerii*)

Human Monocytic Ehrlichiosis



Lone Star Tick

E. chaffeensis

- 80% Hx of tick exposure

Signs and symptoms

- Fever, HA, malaise, myalgias, arthralgias
- May have rash
- 70 % are males

Mortality 3 %

Diagnosis

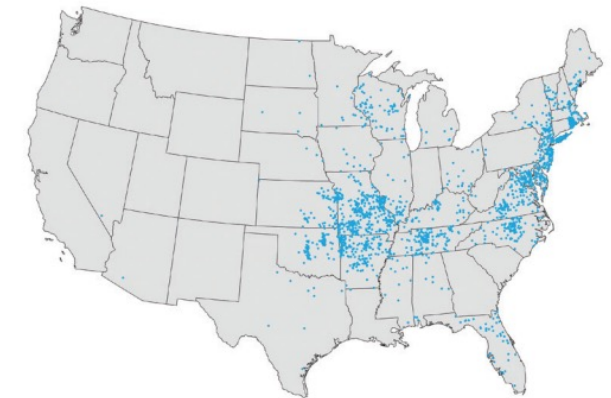
- Leucopenia, thrombocytopenia, increased LFT's
- 4-fold antibody increase in convalescent serum
- PCR
- Morulae in monocytes

Treatment

- Doxycycline



Morulae



EHRlichiosis

Human Granulocytic Anaplasmosis



**Black legged Tick
(Deer Tick)**

Anaplasma phagocytophilum

- 50-80 % Hx of tick exposure

Signs and symptoms

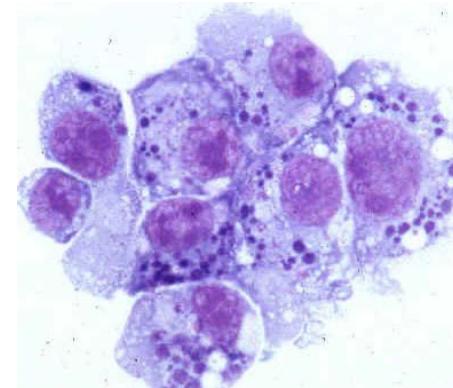
- Fever, HA, malaise, myalgias, arthralgias

Mortality

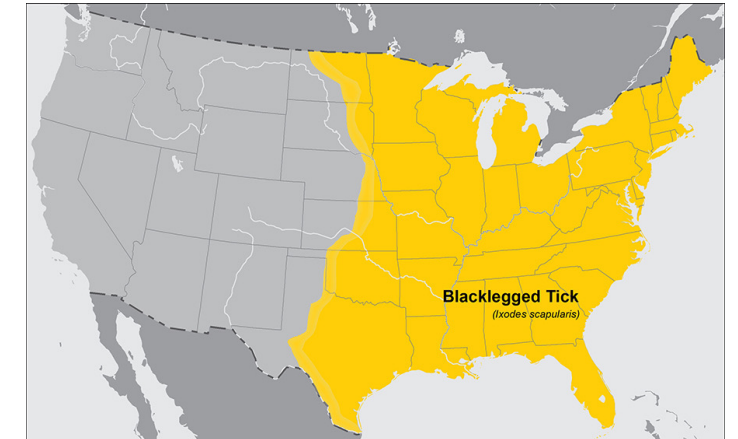
- 0.5-1.0 % (50 % in HIV + patients)

Diagnosis

- 4-fold antibody increase in convalescent serum
- PCR
- Morulae in neutrophils (20%)



Morulae in neutrophils



ANAPLASMOSIS

Clinical case

- A 39-year-old male who lives in Portland, Oregon visited Tahlequah, Oklahoma 1 week ago. He presents with fever, headache and myalgias. PE: is normal.
 - Labs reveal WBC 2400, Platelets 95,000, LFT's (ALT 321, AST 340). Lab technician reports "weird inclusions in the monocytes). **What is the most likely diagnosis?**
- A. Lyme Disease (*Borrelia burgdorferi*)
 - B. Hepatitis A
 - C. Ehrlichiosis (*Ehrlichia chaffiensis*)**
 - D. American Boutonneuse Fever (*Rickettsia parkerii*)

Tularemia

Francisella tularensis

General	<i>Ulceroglandular</i>	<i>Oculoglandular</i>	<i>Oropharyngeal</i>	<i>Pneumonic</i>	<i>Typhoidal</i>
<ul style="list-style-type: none"> Fever, chills Headache Malaise, fatigue Anorexia Myalgia Chest discomfort, cough Sore throat Vomiting, diarrhea Abdominal pain 	<ul style="list-style-type: none"> Localized lymphadenopathy Cutaneous ulcer at infection site (not always present) 	<ul style="list-style-type: none"> Photophobia Vision impairment/loss Conjunctivitis Regional lymphadenopathy 	<ul style="list-style-type: none"> Severe throat pain Exudative pharyngitis or tonsillitis Regional lymphadenopathy 	<ul style="list-style-type: none"> Non-productive cough Substernal tightness Pleuritic chest pain Hilar adenopathy, infiltrate, or pleural effusion may be present on chest X-ray 	<ul style="list-style-type: none"> Characterized by any combination of the general symptoms without the localizing symptoms of other syndromes May have infiltrates in chest radiograph in the absence of respiratory symptoms

Incubation period 3–5 days (range 1–21 days)

Multiple routes of acquisition beyond ticks

Ticks: Brown Dog tick, Rocky Mountain wood tick Lone star tick

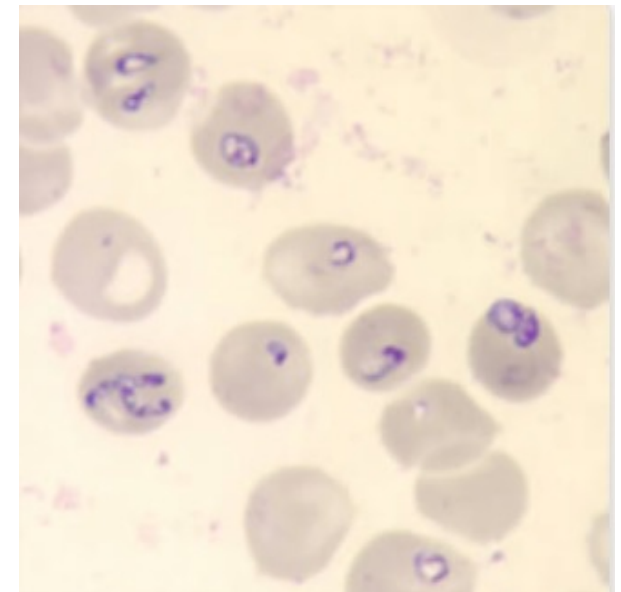
Blood cultures and serology is helpful for diagnosis

Babesiosis

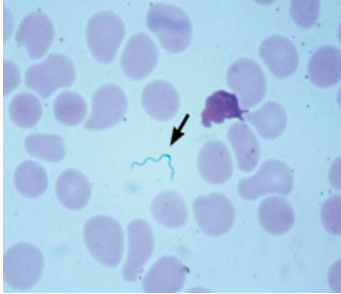
- **Agent:** *Babesia microti* (protozoan)
- **Vector:** Blacklegged tick (also transmitted by blood transfusion and vertical transmission)
- **Symptoms:**
 - Fever, chills, sweats, headache, body aches, loss, nausea, or fatigue, hemolytic anemia
 - More severe immunocompromised hosts
- **Diagnosis:** PCR, 4-fold increase in IgG, Pathology
- **Treatment:**
 - Azithromycin/Atovaquone
 - Clindamycin/Quinine sulfate



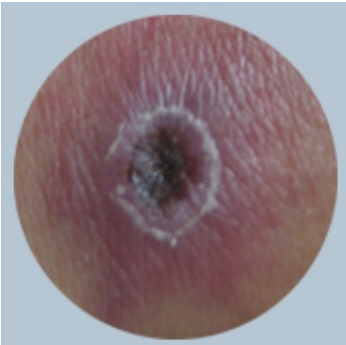
BABESIOSIS



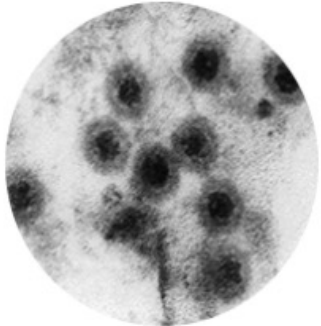
Less frequent tick-borne illnesses



- **Tickborne relapsing fever**
 - Western states only (25 cases per year)
 - Soft tick
 - *Borrelia hermsii*
 - Fever is relapsing, can be severe with ARF, ARDS
 - Postexposure prophylaxis with doxycycline works



- **American Boutonnesse Fever**
 - Gulf coast states
 - Gulf coast tick
 - *Rickettsia Parkeri*
 - Fever, headache myalgias, mild LFT elevation, leukopenia, thrombocytopenia
 - PCR in eschar swab, whole blood, or skin biopsy, four-fold rise in IgG-specific antibody titer



- **Colorado Tick Fever**
 - Colorado, Utah, Montana, Wyoming
 - Rocky mountain wood tick
 - Colorado Tick Fever virus
 - Meningoencephalitis in children
 - PCR, four-fold rise in IgG specific antibody titer

Disease, Agent and Treatment

Disease	Agent	Treatment
Rocky Mountain Spotted Fever	<i>Rickettsia rickettsii</i>	Doxycycline
Colorado Tick Fever	Colorado tick fever virus	Supportive
Ehrlichiosis	<i>Ehrlichia</i>	Doxycycline
Tularemia	<i>Francisella tularensis</i>	Doxycycline/Ciprofloxacin Aminoglycosides
Southern Tick Associated Rash Illness	<i>Borrelia lonestari</i> ?	Doxycycline/Amoxicillin/cefuroxime
Rickettsia Parkeri Rickettsiosis	<i>Rickettsia Parkerii</i>	Doxycycline
Tick Borne Relapsing fever	<i>Borrelia hermsii</i>	Penicillin/Doxycycline
Anaplasmosis	<i>Anaplasma phagocytophilum</i>	Doxycycline/rifampin
Babesiosis	<i>Babesia microti</i>	Azithromycin/Atovaquone Clindamycin/Quinine sulfate
Lyme Disease	<i>Borrelia burgdorferi</i>	Doxycycline/Amoxicillin/cefuroxime
Powassan virus disease		Supportive

Tick Borne Diseases (TBD) Summary



Flu like illness in the summer think TBD

Fever, myalgias, headache in a critically ill patient in the USA is doxycycline deficient until proven otherwise



Travel and exposure hx in the previous 4 weeks are critical information



-Diagnosis is clinical, do not wait for the rash, PCR or serology

-Low WBC or platelets : think TBD



If you order a diagnostic test for TBD empirically treat the patient