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INTRODUCTION TO TICK BORNE DISEASES

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Learning Objectives

1. Discover the current geographic distribution of various tick-borne diseases as well as the common vectors (Anaplasmosis, Alpha-Gal, Lyme, Powassan, Ehrlichiosis, Babesiosis, etc).
2. Recognize the presentation of various tick-borne diseases.
3. Review treatment protocols for various tick-borne diseases.
4. Review the current literature and understanding of Post Treatment Lyme Disease Syndrome.
    - **NOTE - Doxycycline pediatric dosing - where adult dose is 100mg the pediatric equivalent is 2.2mg/kg up to 100mg.**

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Ticks in the United States: Overview

Major Disease Vectors

Over a dozen tick species transmit diseases in the US. Three species cause most infections in humans.

- Blacklegged tick (Ixodes scapularis)
- Lone Star tick (Amblyomma americanum)
- American dog tick (Dermacentor variabilis)

Species of interest: Ixodes pacificus

Preferred Habitats

Ticks thrive in specific environmental conditions. They prefer areas with:

- Dense woodland underbrush
- Tall grass meadows
- Brushy transition zones
- High humidity microenvironments

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Geographic Distribution of Ticks

Ixodes scapularis (Blacklegged Tick)

Dominant in Northeast and Upper Midwest. Expanding westward and south due to climate change.

Amblyomma americanum (Lone Star Tick)

Prevalent in Southeast and South-central regions. Steadily advancing northward.

Dermacentor variabilis (American Dog Tick)

Widespread across Eastern and Central US. Adapting to suburban environments.

Expansion Factors

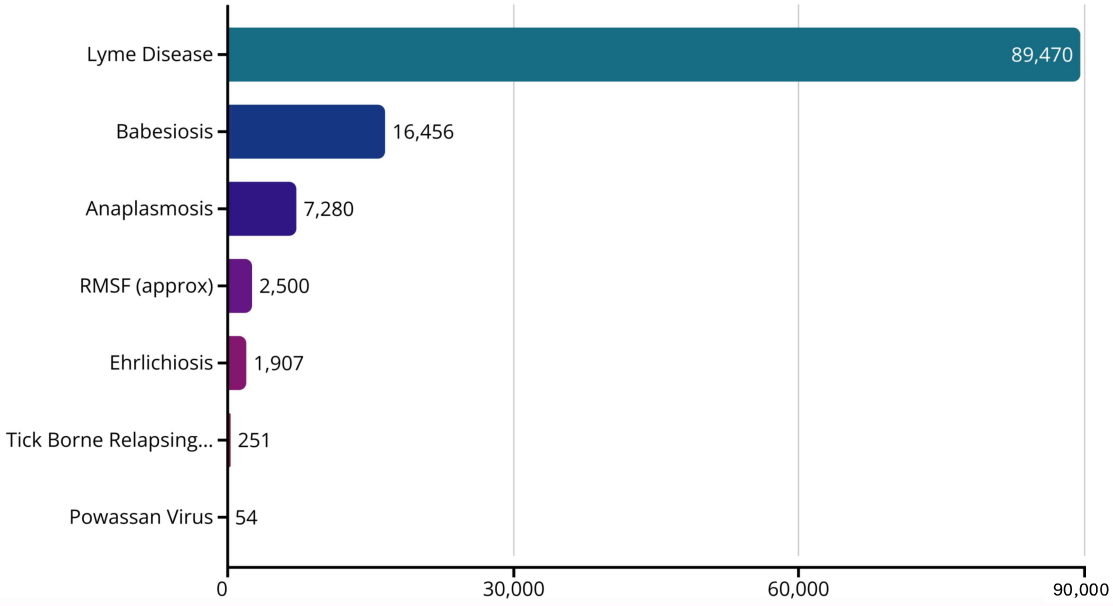
Climate warming, wildlife movement, and changing land use drive tick migration.

Ixodes scapularis

Amblyomma americanum

Dermacentor variabilis

Major Tick-Borne Diseases in the US



STARI and Alpha Gal not reportable so not tracked

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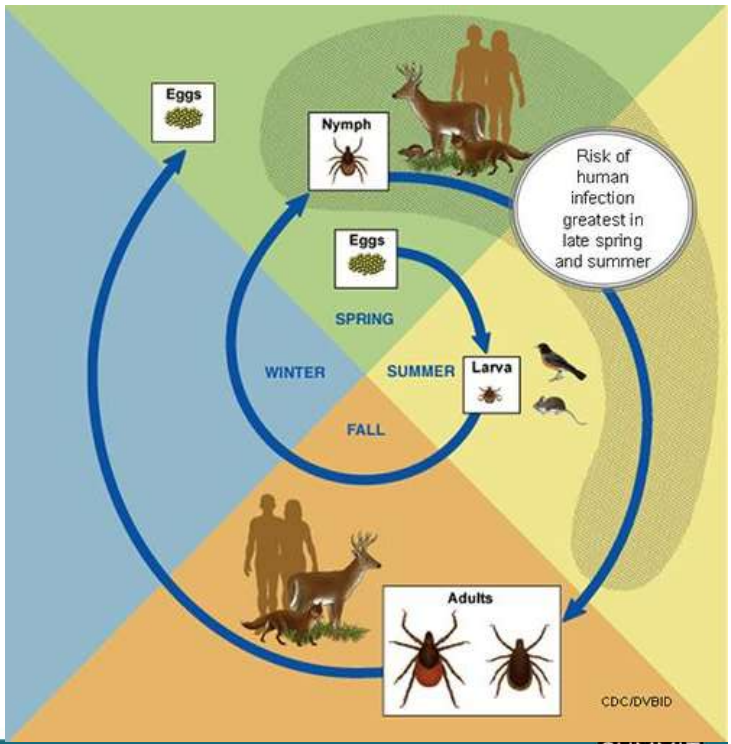
Lifecycle of a tick (Ixodes and Amblyomma)



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Poll: WHICH OF THESE IS A COMMON HOST FOR LYME DISEASE?

Lyme Hosts

Eastern US Host

White-Footed Mouse serves as the most common host in the Eastern United States

Western US Host

Grey Squirrel is the predominant host for ticks in the Western United States

Non-Susceptible

Western Fence Lizard does not become infected

Lyme Disease: Historical Timeline

Lyme disease has a relatively recent medical history, despite likely affecting humans for centuries.

1970s Discovery

First identified as a distinct condition in Lyme, Connecticut after unusual arthritis outbreak in children.

1981-1982 Bacterial Identification

causative spirochete isolated - officially named Borrelia burgdorferi in 1982 (now B burgdorferi sensu stricto)

Expanding Knowledge

Over 20 species identified in B. burgdorferi sensu lato complex worldwide (several shown to cause various diseases)

B. mayonii identified in 2013 as causative agent of Lyme in Minnesota and Wisconsin region

Lyme Disease: Vectors and Endemic Areas

Pathogens

Borrelia burgdorferi (ss), Borrelia mayonii, Borrelia afzelii, Borrelia garinii

(note - Borrellia bissettii has been shown to cause borrellia lymphocytoma)

Primary Vectors

Ixodes scapularis (East and Midwest US) and Ixodes pacificus (West US)

Ixodes ricinus (castor bean tick - Europe) and Ixodes persulcatus (Baltic countries and Finland)

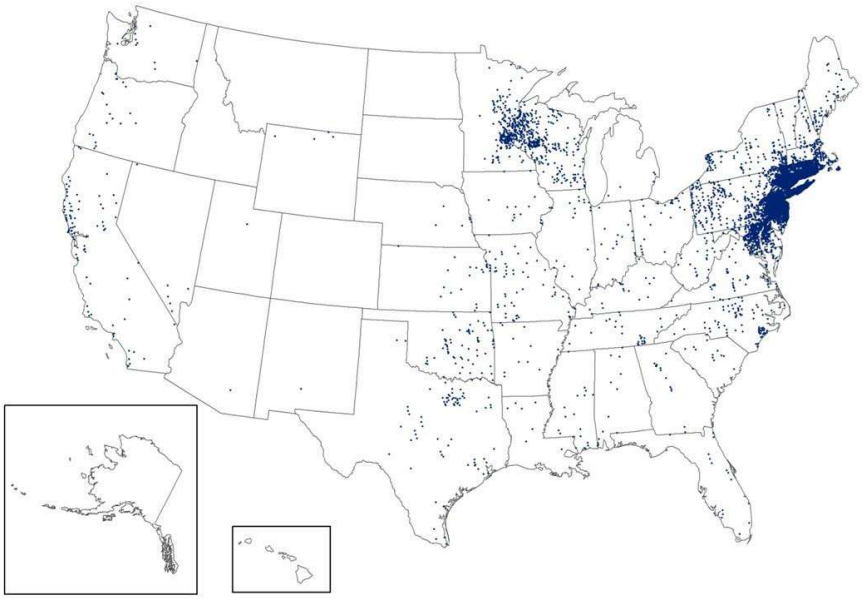
US Historic Endemic Regions

Northeast, Mid-Atlantic, Upper Midwest, West Coast

Expanding Territory

Moving into Southern Appalachia and Canada

Lyme Disease: 1995



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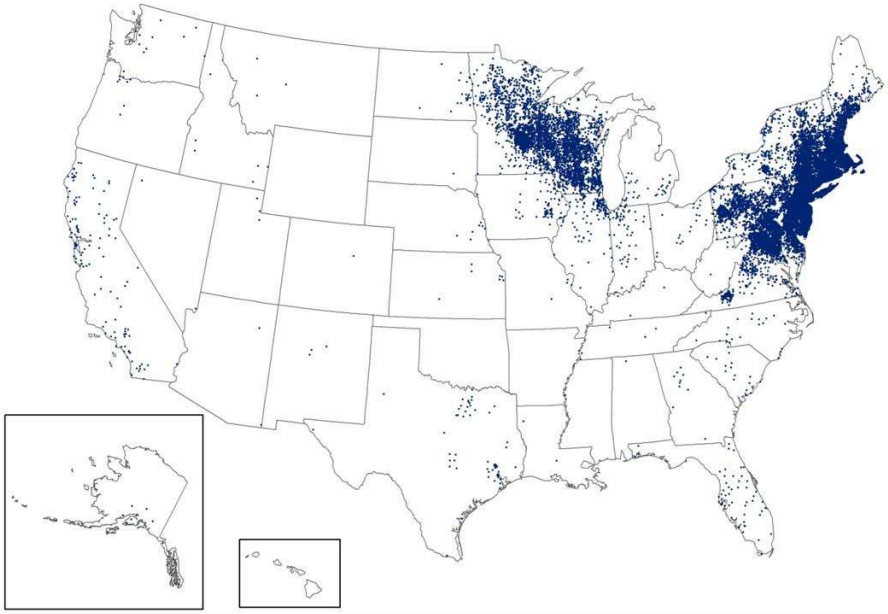
Lyme Disease: 2010



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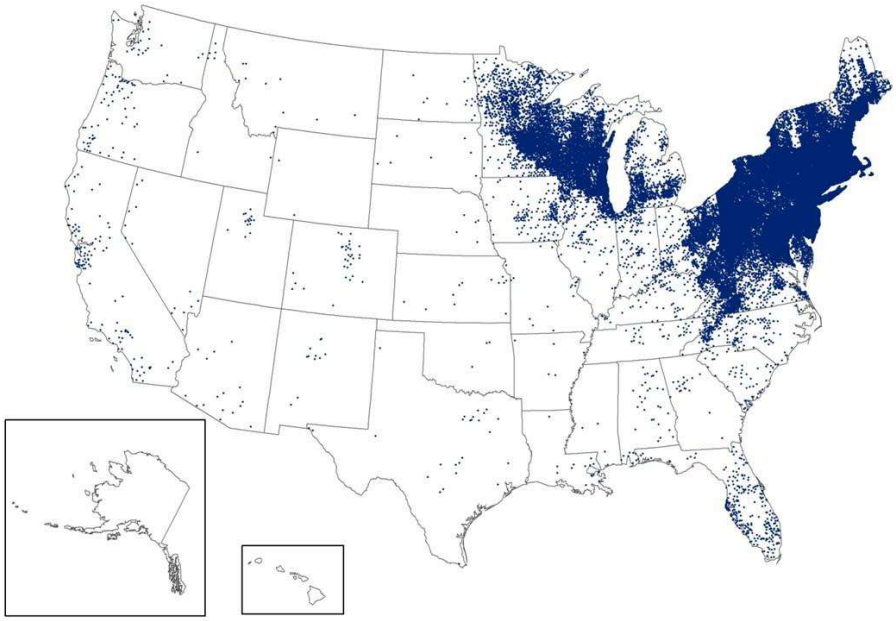
Lyme Disease: 2023



Lyme Disease: Clinical Presentation

1 **Early Localized:**

Erythema migrans rash appears in 70-80% of cases (7-30 days after bite with 7-14 days being most common)

Fever, chills, fatigue, headache, brain fog, lymphadenopathy, myalgias/arthalgias, etc

"Summer cold" (though Covid has changed this somewhat)

2 **Early Disseminated:**

EM Rash spread

Weakness/Numbness or other neuropathic s/s

Palpitations

Facial Palsy (responsible for up to 25% of Bell's Palsy cases)

3 **Late Disseminated:**

True arthritis (may mimic septic arthritis on exam)

Severe headaches/vertigo

New onset heart block, other EKG changes

Sleep disturbances, polyneuropathies, concentration issues

4 **Post Treatment Lyme Disease Syndrome:**

Prolonged fatigue, brain fog, myalgias/arthralgias following appropriate treatment of lyme disease

Lyme Disease: Diagnosis

Diagnosis:

Two-tier testing

- Elisa followed by WB
- 2 step Elisa

High rate of false negative in first 6 weeks of illness (approx 60-70% sensitivity in early disease)

Antibiotic use shown to decrease sensitivity (by as much as half in some studies)

PCR of blood/serum inconsistent results

PCR of CSF option for neuroborreliosis

Difficult to culture (requires special medium and factors to slow growth of other bacteria)

Lyme Disease: Treatment

NOTE - I do not recommend ILADS approach - feel it is important to know what they recommend as your patients will know about them

NOTE 2 - Approximately 30% of patients experience Jarisch-Herxheimer Reaction to treatment

EARLY (Localized or Disseminated)

IDSA

Doxycycline 100 mg BID 10 days

Alt Cefuroxime 500mg BID for 14 days

Amox 500mg TID for 15 days

Azithromycin 500mg daily for 5 days

CDC

Doxycycline, amoxicillin, or cefuroxime for 10-14 days

Alt: ´Cefuroxime 500mg BID for 14-21 days

´Amoxicillin 500mg TID for 14-21 days

Azithromycin, clarithromycin or erythromycin may be used

ILADS

Antibiotics 4-6 weeks minimum (Doxycycline, Cefuroxime or 3 weeks of Azithromycin)

Extend therapy for ongoing symptoms

Lyme Disease: Treatment

Neuroborreliosis

IDSA

Mild (facial palsy):

Doxycycline 100mg BID 14-21 days

Severe (polyneuropathy, meningitis):

Doxycycline 100mg BID 14-21 days OR

Ceftriaxone 2gm IV daily 14-21 days

CDC

Ceftriaxone 2g IV daily for 10-28 days

Alternative: Cefotaxime 2g q8hr or Penicillin G 3-4 million U IV every 4 hours

Doxycyline 200mg PO BID may be suitable

ILADS

Same as above

Retreat if symptoms return

Consider adding IV ceftriaxone or penicillin (NOT substituting)

Lyme Disease: Treatment

Cardiac Lyme

IDSA

Mild:

-Doxycycline 100mg PO BID for 14-21 days OR

Amox 500mg TID 14-21 days OR

Cefuroxime 500mg BID 14-21 days

Severe:

-Ceftriaxone 2g IV daily for 14-21 days

CDC

Asymptomatic:

-Doxycycline 100mg PO BID for 14-21 days

Symptomatic:

-Ceftriaxone 2g IV daily for 14-21 days

-Alternative: Cefotaxime 2g q8hr or Penicillin G 3-4 million U IV every 4 hours 14-21 days

-Cardiac Monitoring

-Consider temporary pacing

ILADS

Same as above

Lyme Disease: Treatment

Lyme Arthritis

IDSA

Initial:

-Doxycycline 100mg PO BID for 28 days OR

Amox 500mg TID 28 days OR

Cefuroxime 500mg BID 28 days

Persisitent:

-Ceftriaxone 2g IV daily for 14-28 days

CDC

Initial:

-Doxycycline 100mg PO BID for 28 days OR

Amox 500mg TID 28 days OR

Cefuroxime 500mg BID 28 days

Persisitent:

-Ceftriaxone 2g IV daily for 14-28 days

ILADS

Same as above

Continued antibiotics, adjunctive therapies

Postexposure Prophylaxis for Lyme Disease

CDC/IDSA Approach	ILADS Approach
• Single 200mg dose of doxycycline within 72 hours of removal • Endemic area • Ixodes tick or unidentified tick • Engorged • Contraindicated in pregnancy, relative contraindication in children <8 years • DO NOT WAIT FOR TICK TESTING	• Doxycycline 100mg BID for minimum of 20 days • All Ixodes bites with evidence of feeding • Alternative antibiotics for pregnant women/young children

Prophylaxis efficacy data: CDC's single-dose approach shows ~87% effectiveness in preventing EM rash when criteria are met. ILADS cites concerns about persistent infection despite prophylaxis.

Post-Treatment Lyme Disease Syndrome (PTLDS)

Definition & Prevalence

Persistent symptoms for >6 months after appropriate antibiotic therapy.

Affects approximately 10-20% of patients treated for Lyme disease.

Symptoms include fatigue, pain, cognitive difficulties, and sleep disturbance.

Hypothesized Mechanisms

- Persistent infection (controversial)
- Post-infectious immune dysregulation
- Tissue damage from initial infection
- Concurrent conditions unmasked by infection

Management Approaches

Extended antibiotics not recommended by IDSA/CDC guidelines.

Symptom-based supportive care is current standard.

Consider multidisciplinary approach with pain specialists, neurologists, and rheumatologists.

Research continues on novel therapies.

Babesiosis

Pathogen

- Babesia microti protozoa
- Note - some early evidence to suggest that Babesia odocoilei may also cause disease

Primary Vector

- Ixodes ticks (second meal same as Lyme)
- Note - vertical transmission has been reported

US Geographic Distribution

- Northeast and upper Midwest

Symptoms

Most infections believed to be asymptomatic

Symptoms include fever, chills, sweats, headache, body aches, loss of appetite, nausea, fatigue

Can cause a hemolytic anemia, DIC and hypotension in some patients

Can be life-threating for asplenic, immunocompromised, or patients over 50

Babesiosis

Diagnosis

- Antibody serology
- Peripheral smear showing pleomorphic rings within RBCs (seen better with Giemsa-staining)
- May also see extracellular rings of parasite
- NOTE - often misdiagnosed as malaria in malaria-endemic regions

Treatment

Mild disease - treat 7-10 days minimum

- Atovaquone 750mg PO BID PLUS
  - NOTE - take with food - preferably fatty meal
- Azithromycin 500mg PO first day then 250mg PO daily
  - NOTE - 1000mg first day followed by 500mg daily often used in immunocompromised patients

Babesiosis

Treatment

Alternatives:

- Clindamycin 600mg PO TID OR
- Quinine 650mg PO TID

Severe Disease - treat until all symptoms resolve and blood smear negative then switch to PO for additional 7-10 days

- Atovaquone 750mg PO BID PLUS
- Azithromycin 500mg IV daily

Alternatives:

- Clindamycin 600mg IV QID OR
- Quinine 650mg PO TID

Considerations:

- Severe hemolytic anemia or parasite burden may benefit from exchange transfusion
- Pressors and dialysis may be required for severe disease

Anaplasmosis

Pathogen

Anaplasma phagocytophilum (note - this was previously Ehrlichia equi)

Primary Vector

Ixodes ticks (documented in scapularis but believed to also spread in pacificus)

US Geographic Distribution

Northeast/Upper Midwest

Symptoms

Fever, severe headache, malaise, myalgias, GI symptoms 20% of cases

Elevated LFTs, leukopenia thrombocytopenia

May develop renal failure, respiratory failure, neuropathies, meningoencephalitis, focal paralysis, DIC, rhabdomyolysis, and non-DIC hemorrhage

Anaplasmosis

Diagnosis

PCR testing on whole blood is gold standard during the first week of symptoms

Serology can be helpful in later disease

- IgG IFA (IgM is worthless) - should be repeated in 2 weeks to ensure rising (stable or declining may suggest past disease)
- Can cross-react with Ehrlichia species thus often run both together

Blood smear may show morulae in cytoplasm of granulocytes - not pathopneumonic

Immunostaining of bone marrow biopsy can show A. phagocytophilum (note - biopsy is NOT done to diagnose Anaplasmosis - but if done to eval cytopenias in an endemic area, consider asking for this testing)

Treatment

Doxycycline 100mg BID until fever resolves plus 3 days or minimum 5-7 days

If doxycycline allergy - recommend admission for rapid desensitization and treatment with doxycycline

Alternative - rifampin has been using successfully in pregnant women

Fever typically subsides within 24-48 hours of initiating antibiotic treatment

- Failure to defervesce suggests alternative diagnosis (RMSF or Borrelia)

Rocky Mountain Spotted Fever (RMSF)

Pathogen

Rickettsia rickettsii, an obligate intracellular bacterium that invades vascular endothelium.

Primary Vectors

- Dermacentor variabilis (American dog tick)
- Dermacentor andersoni (Rocky Mountain wood tick)
- Rhipicephalus sanguineus (Brown dog tick)

US Geographic Distribution

Despite its name, highest incidence occurs in Southeastern and South-central states.

- Oklahoma
- North Carolina
- Tennessee
- Arkansas

Rocky Mountain Spotted Fever: Clinical Features

Typically begins 3-12 days after tick bite

Children account for less than 6% of RMSF cases but 22% of fatalities

Days 1-4: Early Illness

Abrupt onset of high fever, severe headache, and myalgias

GI Symptoms are common (may be misdiagnosed as appendicitis or acute abdomen)

Days 2-4: Rash Emergence

Maculopapular rash begins on wrists and ankles

Spreads centrally to trunk and sometimes to the palms and soles

Often associated with edema of eyes and back of hands

90% of RMSF cases have rash but less than 50% show in the first 3 days

Days 5+: Late Illness

Rash turns petechial (petechiae are an indication of severe disease)

- May progress to soft tissue necrosis requiring amputations or grafts

Vascular damage leads to multi-organ involvement

- Altered mental status and pulmonary edema are common

Complications include ARDS, encephalitis, coagulopathy, and shock.

Mortality reaches 20-30% without prompt treatment.

May result in lifelong sequelae from organ failure

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Rocky Mountain Spotted Fever (RMSF)

Diagnosis

Serology - IgG IFA - repeat 2-10 weeks later showing 4 fold seroconversion

IgM is less reliable due to cross-reactivity with other infections

PCR can be helpful if done on a skin biopsy - not reliable on serum or whole blood

- NOTE - send fresh non-frozen tissue - do NOT send in formalin if you want PCR done

Treatment

Start treatment immediately - do NOT wait for results

Doxycycline 100mg PO BID until fever resolves plus 3 days - minimum of 5-7 days

- **EVEN IN PREGNANCY**
- **ALL CHILDREN REGARDLESS OF AGE**
- **EVEN IN ALLERGIC PATIENTS**

Chloramphenicol works...sort of...but significantly higher mortality rate than doxycycline and significantly higher rate of sequelae

NOTHING ELSE HAS SHOWN ANY SUCCESS

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Ehrlichiosis

Pathogen

Ehrlichia chaffeensis, Ehrlichia ewingii, or Ehrlichia muris eauclairensis

Rarely Ehrlichia canis (usually affect dogs but can infect humans)

Primary Vectors

Lone Star tick (Amblyomma americanum)

Black Legged and Western Black Legged (Ixodes scapularis and I. pacificus)

American Dog Tick (Dermacentor variabilis)

Regional Distribution

South-central/Southeastern most prevalent

Symptoms

Fever, chill, severe headache, myalgias, GI symptoms, confusion

1 in 3 develop rash

- More common with E. chaffeensis and in children - develops 5 days after fever

Can progress to meningoencephalitis, respiratory failure, DIC, organ failure and death

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Ehrlichiosis

Diagnosis

PCR on whole blood in first week of symptoms and before antibiotics

- Do not withhold antibiotics if high clinical suspicion

Serology: IgG IFA in first 2 weeks of symptoms and again 2-10 weeks later with 4 fold increase

- IgM serology unreliable

Peripheral smear may show morulae

- Monocytes with E. chaffeensis
- Granulocytes with E. ewingii
- Target cell unknown for E. muris eauclairensis

Treatment

Doxycycline 100mg BID until 72 hours after fever resolves or a minium of 5-7 days

Rifampin appears effective against E. chaffeensis in lab setting but has yet to show effectiveness in humans

- Has not been tested against other species

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Tick Borne Relapsing Fevers

Pathogens

Various Borrelia species (B hermsii, B. turicatae, B. miyamotoi, etc)

Primary Vectors

Soft bodied ticks (Ornithodoros) for B hermsii and turicatae

Hard ticks for B miyamotoi (primarily Ixodes species)

Regional Distribution

Soft tick - Primarily west coast extending as far east as Texas

Hard tick - Primarily in the northeast/midatlantic regions and pacific coastal states

Symptoms

Fever, headache, chills, myalgias, dizziness, nausea, vomiting, eye pain/redness, vision changes

NOTE - Soft tick Replasing fever lives up to the name...after initial illness, cycle of 2-4 days of fever followed by 5-8 days afebrile is observed

Hard tick relapsing fever does NOT have that pattern and often resolves without intervention

Infection during pregnancy can cause pregnancy loss or premature birth

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Tick Borne Relapsing Fevers

Diagnosis

Primarily clinical - no testing widely available yet

Treatment

Not well established - for now, same guidelines as Lyme as these are also Borrelia species

NOTES

In Malaria endemic regions, this is often misdiagnosed as Malaria

There is also a louse-borne relapsing fever - different Borrelia species

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Powassan

Pathogens

- Powassan Virus (lineage 1 and lineage 2 based on tick/symptoms)
  - lineage 2 also called deer tick virus
  - NOTE - lineage 1 identified in 2022

Primary Vectors

- Ixodes ticks
  - cookei (groundhog tick) - lineage 1
  - marxi (squirrel tick) - lineage 1
  - scapularis (deer tick) - lineage 2
  - NOTE - lineage 2 has been identified in Amblyomma tick species and Dermacentor tick species - unclear if concentration is high enough to cause disease in humans

US Geographic Distribution

- Northeast and upper Midwest

Also reported in Russia and related to tick-borne encephalitis seen in Europe and Asia

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Powassan

Symptoms

Asymptomatic or mild febrile illness (often included vomiting)

Neuroinvasive disease can present as aseptic meningitis or encephalitis

- 10% of neuroinvasive cases are fatal and 50% will have long-lasting sequelae

Diagnosis

- Serum of CSF IgM (may need to send to CBC or state health department)
- Positive IgM should be sent for confirmatory PRNT testing
- RT-PCR on serum, CSF or tissue is option - low sensitivity

Treatment

- Supportive - no specific treatment
- Cannot donate blood for 4 months after resolution of symptoms

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STARI (Southern Tick-Associated Rash Illness)

Pathogen

- Currently unknown - thought to have been Borrelia lonestari but studies do not support this

Primary Vector

Lone Star tick

Symptoms

EM-like rash, myalgias, headache

Treatment

Currently no treatment is recommended - appears self-limited

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Poll: Which of these is safe for someone with alpha-gal?

Alpha Gal

Cause

Lone Star tick bite - galactose-α-1,3-galactose

Allergic reaction to "mammal" - can be delayed

Symptoms

- **Skin:** Hives, itching, flushing, swelling of the face or lips
- **Gastrointestinal:** Nausea, vomiting, abdominal pain, diarrhea
- **Respiratory:** Shortness of breath, wheezing, cough
- **Cardiovascular:** Dizziness, fainting, low blood pressure
- **Other:** Fatigue, muscle aches, joint pain

Treatment

Avoid triggers:

- Mammal and mammal products (red meat, dairy, gelatin, etc)
- Glycerin
- Magnesium stearate
- Carrageenan

Time

Soliman Auricular Allergy Treatment acupuncture

Live Content Slide

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Poll: Which method of chemical tick prevention is safe for kids between 2 months and 3 years old?

Tick Bite Prevention and Awareness

Chemical Protection

- DEET (20-30%) on exposed skin
- Permethrin for clothing/gear (retreat as necessary)
- Picaridin, IR3535, OIL, PMD or 2-undecanone proven alternatives to DEET
- NONE on babies less than 2 months old, no OLE or PMD on children less than 3 years
- Essential oil formulations of OLE (and various other essential oils) have not been rigorously tested on ticks though does show some benefit against mosquitos

Clothing Barriers

- Light-colored, long sleeves/pants
- Tuck pants into socks
- Hat for head protection

Environmental Controls

- Yard maintenance (mowing, leaf removal)
- Create tick barriers (gravel, woodchips)
- Reduce wildlife habitats near homes
- Avoid tall grass and underbrush

Post-Exposure

- Thorough body checks (especially warm and hairy areas)
- Shower within 2 hours (friction helps - so washcloth or loofa)
- Proper tick removal technique

Summary and Key Takeaways

Ticks Are Gross

And their area is expanding and with it the regions of disease

What we learned in medical school and residency is outdated information

Early Recognition is Crucial

Prompt diagnosis (often clinical) and treatment prevent serious complications

Maintain a high index of suspicion for any "summer flu"

Ongoing Research

More studies needed for PTLDS, emerging diseases, and treatment options

Prevention Focus

Prevention is far better than treatment

Educate patients and be consistent with your own prevention

Summary: Treatment Protocols

First-Line Agent

Doxycycline (100mg BID) for most tick-borne infections (exceptions babesiosis and powassan)

Duration

Disease specific (sort of)

- 10-14 days for Lyme
- Until fever resolves plus 3 days (minimum 5-7 days) for Anaplasmosis, Ehrlichiosis, RMSF
- If co-infection with lyme is likely, do full 10 day course

Pediatric Considerations

Doxycycline is recommended for kids of all ages

- Most effective for this infections
- Risks from Doxycycline shown to be significantly less than previously believed

Special Cases

- Pregnancy - still use Doxy for RMSF - may be other options for other infections
- For most tick borne disease, fever responds within 72 hours of starting antibiotics - prolonged fever suggests alternate diagnosis or co-infection

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Social Q&A for Introduction to Tick-Borne Diseases

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QUESTIONS?

Contact Information

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Sources (or at least some of them)

- Cdc.gov (multiple pages)
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