Tick-borne Infections

Wei Li Adeline Koay, MBBS, MSc, FAAP  
Attending, Infectious Diseases  
Children’s National Medical Center, Washington DC

Kari Simonsen, MD, FAAP  
Professor and Vice Chair of Pediatrics  
Chief, Division of Pediatric Infectious Diseases  
University of Nebraska Medical Center, Omaha NE
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Objectives

- Overview of tick-borne infections
- Epidemiology of tick-borne infections
- Transmission of tick-borne infections
- Prevention of tick-borne infections and removal of ticks
- Case presentation and differential diagnoses
- Common questions about tick-borne infections
General Overview

- Different tick species transmit different infectious agents.
- Most infections occur in the spring or summer.
Geographic Distribution of Ticks

Life Cycle of the Blacklegged Tick

How Does Infection Occur?

- Attachment/feeding time required for transmission of infection to occur is variable.
  - Risk of Lyme disease approaches 100% when infected nymphal ticks in highly endemic areas feed for >72 hours
  - 12–24 hours for anaplasmosis to transmit
- The tick attaches to the host by anchoring its mouthparts firmly to the skin.
- The tick injects a mixture of chemicals and saliva during the feeding process. Saliva is injected alternately with blood uptake during the tick bite.
- The infectious agents that reside in the gut of the tick travel to the salivary glands and eventually to the host.

Two adult female deer ticks (*Ixodes scapularis*) that can transmit *Borrelia burgdorferi* to humans. The engorged tick on the right demonstrates increased size from a blood meal. Both are magnified for this photograph.


Prevention of Tick-borne Infections

- **Avoid** tick-infested areas (i.e., hike in center of trails).
- Locate play equipment in sunny, dry areas away from forest edges.
- **Use pesticides** targeting ticks on property or pets to reduce tick populations.
- Wear appropriate **protective clothing**.
- Consider treating clothing and gear with permethrin.
- Check for and safely remove ticks.
- **Use repellents** on skin.
## Repellents for Use on Skin

<table>
<thead>
<tr>
<th>Product</th>
<th>Concentration</th>
<th>Duration of protection from ticks</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEET</td>
<td>5%</td>
<td>May not protect against ticks</td>
<td>• 20–30% most appropriate for infants and young children</td>
</tr>
<tr>
<td></td>
<td>24%</td>
<td>Average of 5 hours</td>
<td>• &gt;50% does not appear to provide a meaningful increase in protection time</td>
</tr>
<tr>
<td></td>
<td>≥40%</td>
<td>≥10 hours</td>
<td></td>
</tr>
<tr>
<td>Picaridin</td>
<td>5%</td>
<td>3–4 hours</td>
<td>Less experience than with DEET, but no serious toxicity reported</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>8–12 hours</td>
<td></td>
</tr>
<tr>
<td>Oil of lemon eucalyptus (OLE) or PMD</td>
<td>8–10% PMD</td>
<td>Up to 2 hours</td>
<td>Not recommended if &lt;3 years old</td>
</tr>
<tr>
<td></td>
<td>30–40% OLE</td>
<td>6 hours</td>
<td></td>
</tr>
<tr>
<td>IR3535</td>
<td>7.5–20%</td>
<td>2–10 hours</td>
<td></td>
</tr>
<tr>
<td>2-Undecanone</td>
<td>7.75%</td>
<td>Up to 2 hours</td>
<td></td>
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</tbody>
</table>

Inspection for Ticks

- Inspect body, clothing, and equipment used during and after possible tick exposure.
- Pay special attention to exposed body parts (head, neck, behind ears) and areas of tight clothing (axillae, groin, sock/belt line).
- After potential tick exposure, remove clothes as soon as possible, as they may harbor crawling ticks.
- Bathing within 2 hours of coming indoors can help locate ticks.
- Place dry clothing in dryer on high heat for at least 10 minutes to remove humidity to kill unattached ticks on clothes.
Tick Removal

- Remove tick from skin as soon as discovered.
- Fine-tipped forceps or tweezers are recommended.
- Grasp tick close to skin.
- Gently pull straight out without twisting.
- Take care not to break mouthparts as the tick is removed. If mouthparts remain, avoid cutting or digging to remove small remnants.
- Clean used forceps or tweezers.
- Wash bite site with soap and water.

Patient Case Discussion

- 7-year-old female, previously healthy
- Initial symptoms: fevers, headaches, neck pain, rash that started on thighs and later emerged on feet, arms, and face
- Later: generalized weakness, worsening headaches, loss of consciousness, edema of feet and hands
- Social history:
  - Lives in a trailer in PA
  - Barn with cows close by
  - Rat problem at home
- Significant findings on exam:
  - Neurological: nystagmus, nuchal rigidity, clonus
  - Skin: diffuse petechial rash
Rocky Mountain Spotted Fever (RMSF)

Caused by: *Rickettsia rickettsii*

- **Vectors:**
  - American dog tick
  - Rocky Mountain wood tick
  - Brown dog tick

- **Incubation:** 1 week (3–12 days)


Rocky Mountain Spotted Fever (RMSF)

- Clinical manifestations:
  - Fever, myalgia, headache, photophobia, nausea, gastrointestinal symptoms
  - Rash: Begins within first 6 days of symptoms as erythematous macules. Starts on wrists and ankles, appears within hours on trunk, then distally to palms and soles.
  - Hepatomegaly and splenomegaly (10–20%)
  - Meningeal signs
- Labs: thrombocytopenia, hyponatremia, elevated transaminases
- Prognosis:
  - If untreated, lasts ~3 weeks with multi-system involvement; 20–80% mortality rate
Rocky Mountain Spotted Fever (RMSF)

- **Diagnosis**
  - Detection of DNA by polymerase chain reaction (PCR) of whole blood or serum
  - Serology:
    - Indirect fluorescent antibody test (IFA)
    - Fourfold or greater rise in antigen-specific immunoglobulin G (IgG) between acute and convalescent sera obtained 2 to 6 weeks apart confirms diagnosis
    - Cross-reactivity with other antibodies to the spotted fever group rickettsiosis can be seen

- **Treatment**
  - Doxycycline is the treatment of choice in any age.
  - Treatment delay after day 5 of illness is associated with increased risk of mortality and morbidity.
  - Treat for at least 3 days after defervescence and clinical improvement.
Lyme Disease
Caused by *Borrelia burgdorferi* (and other closely related species)

- Vectors:
  - Deer tick (blacklegged tick)
  - Western blacklegged tick

- Incubation: 11 days (range 3–32 days)

Lyme Disease: Clinical Manifestations

- Early localized stage:
  - Erythema migrans (70–80%)
  - Constitutional symptoms

- Early disseminated stage:
  - Erythema migrans
  - Constitutional symptoms
  - Cranial nerve palsies (common: CN VII)
  - Meningitis (lymphocytic)
  - Carditis (including atrioventricular [AV] block)

- Late manifestations:
  - Lyme arthritis
    - Mono- or pauciarticular inflammatory arthritis

- Other manifestations: ophthalmic conditions (conjunctivitis, keratitis, uveitis, optic neuritis)
Lyme Disease: Diagnosis and Labs

- Labs:
  - Leukopenia, anemia, thrombocytopenia, or abnormal transaminases should raise concern for co-infection.

- Diagnosis:
  - Two-tier serologic assay
    - Initial enzyme-linked immunosorbent assay or immunofluorescent antibody test
    - If positive or equivocal, do Western blot
    - Western blot tests for 3 IgM and 10 IgG antibodies
      - Need 2 IgM or 5 IgG bands to be considered positive
  - Suspected meningitis
    - Intrathecal Lyme IgM or IgG
    - Concurrently measure total cerebrospinal fluid (CSF) IgG and serum IgG
Lyme Disease: Treatment

- A patient with erythema migrans who lives in an endemic area should be treated for Lyme disease without testing.

- Early localized disease, arthritis, carditis, meningitis:
  - Doxycycline, amoxicillin, or cefuroxime
  - May use intravenous ceftriaxone for carditis or meningitis and persistent arthritis after first course of therapy

- Facial palsy: doxycycline is the treatment of choice.

- Duration of treatment:
  - Early localized disease: 10 days (doxycycline), 14 days (amoxicillin or cefuroxime)
  - Arthritis: 28 days
  - Facial palsy, meningitis, carditis: 14 days
# Anaplasmosis and Ehrlichiosis

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<thead>
<tr>
<th></th>
<th>Anaplasmosis</th>
<th>Ehrlichiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causal agent</td>
<td>Anaplasma phagocytophilum</td>
<td>Ehrlichia chaffeensis</td>
</tr>
<tr>
<td>Vectors</td>
<td>Blacklegged tick</td>
<td>Lone star tick</td>
</tr>
<tr>
<td></td>
<td>Western blacklegged tick</td>
<td>Blacklegged tick</td>
</tr>
<tr>
<td>Incubation (days)</td>
<td>5–21</td>
<td>5–14</td>
</tr>
</tbody>
</table>

Anaplasmosis and Ehrlichiosis

- **Clinical manifestations:**
  - Acute, systemic, febrile illness
  - Fever, severe headache, malaise, myalgia, nausea
  - Variable symptoms: arthralgia, vomiting, diarrhea, cough, confusion, rash (rare)
  - Severe manifestations: acute respiratory syndrome, encephalopathy, hemorrhage, renal failure

- **Labs:**
  - Anemia, thrombocytopenia, leukopenia
  - Hyponatremia, elevations in hepatic transaminases
  - CSF pleocytosis with lymphocyte predominance, increased protein

- **Prognosis:**
  - Symptoms last 1 to 2 weeks without treatment
  - Fatigue can last for weeks
  - Fatal infections have been reported (1–3% case fatality for ehrlichiosis; <1% for anaplasmosis)
Anaplasmosis and Ehrlichiosis

- **Diagnosis**
  - Detection of DNA by PCR of whole blood
  - Peripheral blood smear to look for morulae (not sensitive)
  - Serology:
    - IFA test
    - Fourfold or greater rise in antigen-specific IgG between acute and convalescent sera obtained 2 to 4 weeks apart

- **Treatment**
  - Doxycycline is treatment of choice regardless of age
  - Duration: 7–14 days (or at least 3 days after defervescence)
Babesiosis
Caused by: *Babesia microti*

- **Primary reservoir host:**
  - White-footed mouse

- **Vectors:**
  - Blacklegged tick

- Can also be transmitted by blood transfusion

- **Incubation:**
  - 1 to 5 weeks after a tick bite

Babesiosis

- **Clinical manifestations:**
  - Can develop within several weeks after exposure, and can recur months later
  - Fever, malaise, myalgia, arthralgia, headache, gastrointestinal symptoms, dark urine
  - Less common: cough, sore throat, emotional lability, photophobia
  - Mild splenomegaly and hepatomegaly, jaundice

- **Labs:**
  - Hemolytic anemia, thrombocytopenia
  - Mildly elevated transaminases
  - Elevated serum creatinine and blood urea nitrogen

- **Prognosis:**
  - If untreated, lasts for weeks or months
  - Potentially fatal in people who are asplenic, immunocompromised, elderly
  - Asymptomatic people can have persistent low level parasitemia
Babesiosis

- **Diagnosis**
  - Blood smear (tetrad Maltese-cross)
  - Babesia DNA by PCR

- **Treatment**
  - Patients without clinical manifestations do not require treatment unless they have had parasitemia for >3 months
  - Mild disease: atovaquone and azithromycin for 7–10 days
  - Severe disease: clindamycin and quinine, intravenous for 7–10 days
  - Severely immunocompromised patients:
    - Treat for at least 6 weeks
    - Need negative blood smears for ≥2 weeks prior to discontinuing therapy

Case conclusion

- CSF: white blood cell 32 (79% neutrophils); red blood cell 2; 198 protein; 43 glucose

- Tests:
  - CSF: negative bacterial and viral studies
  - **Serum RMSF IgM and IgG both positive**
  - Serum *R. typhi* IgG detected; IgM negative
  - Anaplasma, Ehrlichia PCR and serology negative
  - Babesia smear and serology negative

- Completed a course of doxycycline
Common Questions about Tick-borne Infections
What is “chronic Lyme disease”?

- No definition for “chronic Lyme disease”
- Refers to patients with chronic, unexplained symptoms characterized by pain and fatigue, with perceived cognitive difficulties*
- No evidence of persistent infection with *B. burgdorferi*
- Long term antibiotics not beneficial and potentially harmful
- Should consider alternative diagnoses

Should I save the tick I found on my child and send it for testing?

- Testing ticks removed from animals or humans for infectious pathogens is discouraged.
- It can be expensive.
- It does not provide adequate information about risk of infection in a human.
Is antimicrobial prophylaxis for Lyme disease indicated?

- In general, chemoprophylaxis is not recommended routinely.

- Chemoprophylaxis with a single dose of doxycycline to prevent Lyme disease can be considered under certain circumstances.
  - Tick has been attached ≥36 hours
  - Tick is engorged
  - In highly endemic areas of the eastern mid-Atlantic states for Lyme disease where 30–50% of blacklegged ticks harbor *B. burgdorferi*

- In such cases, prophylaxis has been shown to be effective if given within 72 hours.
Conclusion

- Many tick-borne diseases can infect humans and cause disease.
- Several tick species transmit tick-borne diseases and have different geographic distributions.
- Symptoms can be similar among different tick-borne infections.
- Diagnosis can be difficult.
- Treatment needs to be prompt in several of these infections.
References

- Where references are not listed on each slide, information in this webinar was obtained from:
  

- Relevant chapters:
  
  - Prevention of Mosquitoborne and Tickborne Infections (pp 195–200)
  - Rocky Mountain Spotted Fever (pp: 697–700)
  - Lyme Disease (pp: 515–523)
  - Ehrlichia, Anaplasma and Related Infections (pp: 323–328)
  - Babesiosis (pp: 235–237)
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