Little Bite, Big Disease: Recognizing and Managing Tickborne Illnesses

Clinician Outreach and Communication Activity (COCA) Call
May 24, 2016
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Objectives

At the conclusion of this session, the participant will be able to:

- Review the geographic distribution of Lyme disease, Southern tick-associated rash illness (STARI), Rocky Mountain spotted fever, ehrlichiosis, anaplasmosis, and other emerging tickborne diseases.
- Define the symptoms of Lyme disease, STARI, Rocky Mountain spotted fever, ehrlichiosis, anaplasmosis, and emerging tickborne diseases.
- Identify the serologic tests used to diagnose Lyme disease, Rocky Mountain spotted fever, ehrlichiosis, anaplasmosis, and emerging tickborne diseases.
- Describe the appropriate use of antibiotics in treating Lyme disease, STARI, Rocky Mountain spotted fever, ehrlichiosis, anaplasmosis, and emerging tickborne diseases.
TODAY’S PRESENTER

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TODAY’S PRESENTER

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Leading Tickborne Diseases in the U.S.

- Lyme disease (*Borrelia burgdorferi*)
- Rocky Mountain spotted fever (*Rickettsia rickettsii*)
- Ehrlichiosis (*Ehrlichia chaffeensis*, others)
- Anaplasmosis (*Anaplasma phagocytophilum*)
- Babesiosis (*Babesia microti*)

For information on other tickborne diseases, visit [www.cdc.gov/ticks](http://www.cdc.gov/ticks)
Selected Tick Vectors

Transmit pathogens that cause the following diseases:

- Lyme disease
- Anaplasmosis
- Babesiosis
- Powassan virus disease
- *Borrelia miyamotoi* disease
- Ehrlichiosis
- STARI
- Tularemia
- Rocky Mtn. Spotted Fever
- Tularemia
Diseases are reported to CDC by county of residence. Each dot represents one case. The county where the disease was diagnosed is not necessarily the county where the disease was acquired.

- **Lyme disease**
- **Rocky Mountain spotted fever**
- **Anaplasmosis**
- **Ehrlichiosis**
- **Babesiosis**
- **Tularemia**
Lyme Disease

- Caused by spirochete *Borrelia burgdorferi* (and newly discovered *Borrelia mayonii*)
- Occurs in areas of North America, Europe, and Asia
- ~30,000 cases reported annually in US
- Transmitted in US by blacklegged ticks
Reported Lyme Disease Cases, 2014

Diseases reported to CDC by county of residence. Each dot represents one case. The county where the disease was diagnosed is not necessarily the county where the disease was acquired.
Erythema Migrans (EM)

- 70-80% of cases
- ~7-14 days after tick bite
- Expands over days
- Rarely painful
- Distinguish from allergic reaction
Atypical EM Presentations

Disseminated and Late Lyme Disease

- Facial palsy
  - Summer months
  - May be bilateral
- Meningitis
- Arthritis
  - Intermittent
  - Oligoarticular
- Late-stage neurologic
  - Peripheral neuropathy
Two-Tiered Testing for Lyme Disease

**First Test**
- Enzyme Immunoassay (EIA)
  - OR
  - Immunofluorescence Assay (IFA)
  
  **Positive or Equivocal Result**

  **Negative Result**

**Second Test**
- Signs or symptoms ≤ 30 days
  - IgM and IgG Western Blot
- Signs or symptoms > 30 days
  - IgG Western Blot ONLY

Consider alternative diagnosis

OR

If patient with signs/symptoms consistent with Lyme disease for ≤ 30 days, consider obtaining a convalescent serum
### Sensitivity of Two-Tiered Serologic Testing

<table>
<thead>
<tr>
<th>Lyme Disease Stage</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM rash (acute)</td>
<td>38</td>
</tr>
<tr>
<td>EM rash (convalescent)</td>
<td>67</td>
</tr>
<tr>
<td>Early neurologic</td>
<td>87</td>
</tr>
<tr>
<td>Late neurologic</td>
<td>100</td>
</tr>
<tr>
<td>Arthritis</td>
<td>97</td>
</tr>
</tbody>
</table>

**Specificity of two-tiered testing is generally ≥ 95%**

**Bottom line:**
- Good in later stages of disease
- Testing of patients with EM and exposure in an endemic area is not generally necessary

Bacon et al. JID 2003; 187:1187–99
Additional Tests: Questionable Utility

- Single-tier Western blot tests without a previous EIA
- In-house criteria for interpretation of Western blots
- Capture assays for antigens in urine
- Tests for “cystic forms” of *B. burgdorferi*
- Lymphocyte transformation tests
- Quantitative CD57 lymphocyte assays
- Novel culture techniques

More info on [www.cdc.gov/Lyme](http://www.cdc.gov/Lyme)
Concerns Regarding a New Culture Method for *Borrelia burgdorferi* Not Approved for the Diagnosis of Lyme Disease

Christina Nelson, MD, Sally Hojvat, PhD, Barbara Johnson, PhD, Jeannine Petersen, PhD, Marty Schriever, PhD, C. Ben Beard, PhD, Lyle Petersen, MD, Paul Mead, MD (Author affiliations at end of text)

In 2005, CDC and the Food and Drug Administration (FDA) issued a warning regarding the use of Lyme disease tests whose accuracy and clinical usefulness have not been adequately established (1). Often these are laboratory-developed tests (also known as “home brew” tests) that are manufactured and used within a single laboratory and have not been cleared or approved by FDA. Recently, CDC has received inquiries regarding a laboratory-developed test that uses a novel culture method to identify *Borrelia burgdorferi*, the spirochete that causes Lyme disease. Patient specimens reportedly are incubated using a two-step pre-enrichment process, followed by immunostaining with or without polymerase chain reaction (PCR) analysis. Specimens that test positive by immunostaining or PCR are deemed “culture positive” (2). Published methods and results for this laboratory-developed test have been reviewed by CDC. The review raised serious concerns about false-positive results caused by laboratory contamination and the potential for misdiagnosis (3).

CDC recommends that laboratory tests cleared or approved by FDA be used to aid in the routine diagnosis of Lyme disease. A complete searchable list of such tests is available online (4).

When laboratory testing is indicated, CDC recommends two-tier serologic testing for the diagnosis of Lyme disease. Two-tier testing consists of an FDA-cleared enzyme immunoassay (EIA) that, if positive or equivocal, is followed by an FDA-cleared immunoblot test, commonly known as a “Western blot” test. Results are considered positive only when both the EIA and Western blot are positive (5). Culture and PCR of clinical specimens are recommended only in certain rare circumstances (6).

CDC encourages researchers to work with FDA to develop new or improved tests for the diagnosis of Lyme disease. As with any diagnostic test, it is critical that new tests for Lyme disease have adequate analytical and clinical validation to avoid misdiagnosis and improper treatment of patients.

1. Division of Vector-Borne Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC; 2. Division of Microbiology Devices, Office of In Vitro Diagnostics and Radiological Health, Center for Devices and Radiological Health, FDA (Corresponding author: Christina Nelson, wje1@cdc.gov, 970-225-4259)

References
Prognosis

- Most patients treated with antibiotics recover completely.
- In patients with persistent or recurrent joint swelling, re-treatment with a second 4-week course may be needed.
- Some patients – particularly those diagnosed with later stages of disease – may have persistent symptoms of fatigue, muscle aches, reduced concentration.

  - Preferred term for this is Post-treatment Lyme Disease Syndrome (PTLDS).
  - Placebo-controlled trials have not shown a sustained benefit of extended antibiotic treatment.
Prevention – Talk About It!

- Avoid tick habitat
- Use DEET and wear permethrin-treated clothing
- After being outdoors:
  - Tumble clothes in the dryer on high heat for 5-10 min
  - Shower within 2 hrs – washes away unseen nymphs
- Daily tick checks – remove attached ticks ASAP
- Treat pets appropriately for ticks year-round

Antibiotic prophylaxis for patients with a tick bite

Single dose of doxycycline for prevention of Lyme disease when all of the following conditions are met:

- Highly endemic area
- Attached tick identified as an adult or nymphal *I. scapularis*
- Tick attached for > 36 hours based on engorgement or history
- Prophylaxis can be started within 72 hrs. of tick removal
- Doxycycline treatment is not contraindicated

Dose = 200 mg po x 1 for adults

From: The Clinical Assessment, Treatment and Prevention of Lyme disease, human granulocytic anaplasmosis and babesiosis: Clinical practice guidelines from the Infectious Diseases Society of America; CID; 2006
Emerging Tickborne Diseases

STARI

- Rickettsia parkeri (rickettsiosis)
- E. ewingii
- Ehrlichia muris-like
- Heartland virus
- Borrelia miyamotoi
- Borrelia mayonii

- Colorado tick fever
- Rocky Mountain spotted fever (RMSF)
- Tularemia
- Babesiosis
- Powassan disease
- Lyme disease
- Anaplasmosis
- 364D rickettsiosis
- E. chaffeensis
Southern tick-associated rash illness (STARI)
- Rash indistinguishable from Lyme disease EM
- May be accompanied by fatigue, fever, headache, muscle and joint pains
- Follows bite of lone star tick, *Amblyomma americanum*

Also known as Master’s disease

Cause of STARI is not known
Southern Tick-associated Rash Illness (STARI)

Life stages of lone star tick
(Amblyomma americanum)
Treatment of STARI

- It is not known whether antibiotic treatment is necessary or beneficial for patients with STARI.

- STARI has not been linked to arthritis, neurologic disease, or chronic symptoms.

- Nevertheless, because STARI resembles early Lyme disease, physicians will often treat patients with oral antibiotics.

Borrelia miyamotoi

- Relapsing fever spirochete
- Detected in *I. scapularis* ticks in CT in 2001
- First report of human infection in 2011 (Russia)
- First report of human infection in U.S. in 2013
- Until very recently, 4 cases reported
  - All >60 years old and 2 immunocompromised
- Present in approximately 2% (up to 10.5%) of *Ixodes* spp. ticks in U.S.

Wormser and Pritt, 2015
Borrelia miyamotoi

- Human blood samples from May 2013 – Oct 2014
  - 11,515 samples tested (*B. miyamotoi* DNA in 0.8%)
  - 97 patients positive by 2 PCR assays (genus, species) → Clinical data on 51 patients

- Onset in July/August

- Most patients experienced fever (96%), headache (96%), myalgia (84%), malaise (82%), and arthralgia (76%)

- Hospitalized (24%); Immunocompromised – ?

Molloy *et al.* 2015
Borrelia mayonii: An Emerging Tickborne Pathogen

Elizabeth Schiffman, MPH, MA
Vectorborne Disease Program
Minnesota Department of Health
Lyme Disease

- Disease caused by bacteria in the *Borrelia burgdorferi* sensu lato (Bbsl) complex
  - In United States, *Borrelia burgdorferi* sensu stricto
  - In Europe, *Borrelia afzelii*, *Borrelia garinii*, and *Borrelia burgdorferi*
- The Bbsl complex does not include the relapsing fever group of *Borrelia* (e.g., *B. hermsii*, *B. miyamotoi*)
Lyme Disease Diagnosis

- Based on clinical presentation and a history of exposure to blacklegged ticks in an area where Lyme disease is endemic
- Serology
  - Two-tiered approach recommended, using FDA-approved tests
  - Not needed for early Lyme disease with single erythema migrans (EM) rash
  - Important for disseminated infections or illness without EM rash
Lyme Disease PCR Test

- Commercial assays are available to test blood, CSF, synovial fluid, and tissue
- Considered an adjunct test rather than for routine diagnostics
- Advantage of direct detection in acute illness – no need to wait for antibodies to develop
- Major disadvantage is low sensitivity
  - Blood is positive in only 50% of acute cases with EM
  - CSF is positive only 1/3 of patients with early neuroborreliosis
Index Case – June 2013

- 10-year-old male from northwestern Minnesota
- Presented with fever, headache, neck pain, myalgia, nausea/vomiting, and diffuse rash (not typical EM)
- Spent the week prior in Spooner, WI
- Patient was hospitalized for 4 days
- Treated with ceftriaxone for 1 day, followed by 21 days of amoxicillin
- Complete recovery
Diffuse Macular Rashes
PCR Melting Temperature Analysis
Additional Cases Identified

- PCR on whole blood positive
  - 11-year-old male from WI in July 2013
  - Retrospective review also identified a 65-year-old male from ND (exposure in MN) from July 2012
- Synovial fluid specimen from Mayo Clinic Eau Claire
  - 21-year-old woman from WI in June 2013
- Two additional cases in 2014
Sequence Analysis of Atypical *oppA1* PCR Products

- ND121 (patient 1)
- ND132 (patient 2)
- WI133 (patient 3)
- MN14-1539 (patient 5)
- MN14-1420 (patient 6)
- EC10N1 (tick, Eau Claire, WI, 2010)
- CP12150 (tick, Barron County, WI, 2012)

- B. bissetii DN127 (CP002746)
- *B. americana* BAA-1877
- B. burgdorferi B31 (AE000783)
- B. burgdorferi WI91-23 (NZ_ABW02000031)

- B. garinii BgVir (CPU03151)
- B. valaisiana VS116 (NZ_ABCY02000001)

- B. afzelii HLJ01 (CP003882)
- B. spielmani A14S (NZ_ABKB02000003)
Dark Field Microscopy and Cultures
Phylogenetic Analysis

- 8 housekeeping genes: 
Multi-Locus Sequence Analysis (MLSA)

- 8-gene MLSA performed
- Previously used for defining Bbsl genospecies
- Highest pairwise similarity was to *B. burgdorferi* (94.9 to 95.2%)
  - Threshold for separating genospecies = 98.3% similarity
  - Results confirmed that this is a novel Bbsl genospecies
- Proposed name is *Borrelia mayonii*
Patient Samples Analyzed

Patients: All states
Nov. 2003 – Sept. 2014 100,545 specimens

Patients: All states

No B. mayonii positives

Patients: All states

Patients: 44 states (not MN, WI, ND) 24,786 specimens

No B. mayonii positives

Patients: MN, WI, ND 9,197 specimens

6 B. mayonii positives
Clinical Features of Patients (n=6)

- Ages ranged from 10 to 67 years; 4 male, 2 female
- 2 patients had a known tick bite, but all reported exposure to ticks or tick habitat in Minnesota or Wisconsin
- 5 presented with an acute febrile illness
- 3 had potential neurologic involvement (confused speech, profound somnolence, visual difficulties)
- 4 had rash – only 1 was suggestive of an EM
- 1 had arthralgia
Patient Outcomes

- 2 of 6 patients were hospitalized
- All were treated with antibiotics recommended for treatment of Lyme disease
- 5 patients recovered completely, while 1 reported residual joint pain
Patient Exposure and Residence Locations

[Map showing risk zones and case locations]
### Routine Serologic Testing Results

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Days from Illness Onset to Specimen Collection</th>
<th>Bb EIA-whole cell</th>
<th>Bb EIA-C6</th>
<th>Bb IgM Immunoblot Result (number of bands detected/possible bands)</th>
<th>Bb IgG Immunoblot Result (number of bands detected/possible bands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>N/A</td>
<td>Positive</td>
<td>Positive (2/3)</td>
<td>Negative (1/10)</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>N/A</td>
<td>Equivocal</td>
<td>Negative (0/3)</td>
<td>Negative (0/10)</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>N/A</td>
<td>Positive</td>
<td>Positive (3/3)</td>
<td>Negative (2/10)</td>
</tr>
<tr>
<td>3</td>
<td>104</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative (0/3)</td>
<td>Negative (4/10)</td>
</tr>
<tr>
<td>4</td>
<td>266</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative (1/3)</td>
<td>Positive (5/10)</td>
</tr>
<tr>
<td>5(^1)</td>
<td>3</td>
<td>Negative</td>
<td>Positive</td>
<td>Negative (0/3)</td>
<td>Negative (0/10)</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive (2/3)</td>
<td>Negative (2/10)</td>
</tr>
<tr>
<td>6(^1)</td>
<td>1</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative (0/3)</td>
<td>Negative (1/10)</td>
</tr>
</tbody>
</table>

\(^{1}\) Specimen source was plasma rather than serum.
Tick Collection

- *Ixodes scapularis* ticks collected
  - 2 sites in Wisconsin (2009-2010, 2013-2014)
  - 4 sites in Minnesota (2014-2015)
- PCR testing performed for both *B. burgdorferi* and *B. mayonii*
  - Wisconsin ticks – Mayo Laboratories
  - Minnesota ticks – Minnesota Department of Health Public Health Laboratory
### Tick Testing Results, 2009 - 2015

<table>
<thead>
<tr>
<th>Region</th>
<th><em>I. scapularis</em> ticks</th>
<th><em>Borrelia mayonii</em></th>
<th></th>
<th><em>Borrelia burgdorferi</em></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults</td>
<td>Nymphs</td>
<td></td>
<td>Adults</td>
<td>Nymphs</td>
</tr>
<tr>
<td>Minnesota</td>
<td>14/855 (1.6)</td>
<td>2/203 (1.0)</td>
<td></td>
<td>374/855 (43.7)</td>
<td>50/203 (24.6)</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>15/465 (3.2)</td>
<td>4/193 (2.1)</td>
<td></td>
<td>162/465 (34.8)</td>
<td>33/193 (17.1)</td>
</tr>
</tbody>
</table>

1. Minnesota ticks tested were from 2014-2015.
2. Wisconsin ticks tested were from 2009-2010 and 2013-2014.
Unique Features of *B. mayonii*

- Disease only identified in patients from the upper Midwest
  - Not detected in nearly 25,000 blood samples from other parts of the US
- Based on initial findings, seems to cause more severe disease than *B. burgdorferi*
- Rashes more diffuse than classic EM presentation
- Organism found primarily in whole blood
  - Historically, <0.1% of blood positive for *B. burgdorferi*
Summary

- Still much to learn about this newly identified species of *Borrelia* – unclear how common Lyme disease associated with *B. mayonii* really is, but research indicates it recently emerged.

- Both Minnesota and Wisconsin are considered high-incidence states for Lyme disease, and have several endemic tickborne diseases.

- Risk for tickborne diseases is highly seasonal – late spring through mid-summer is period of highest risk.

- Tickborne diseases, including *B. mayonii*, should be considered in patients presenting with febrile illness after outdoor exposures in the upper Midwest.
Acknowledgements

- Bobbi Pritt and colleagues at Mayo Clinic
- Division of Vectorborne Diseases, Centers for Disease Control
- Minnesota Department of Health Vectorborne Disease Program
- Minnesota Department of Health Public Health Laboratory
- Wisconsin Department of Health Services Vectorborne Program
- University of Wisconsin – Madison
- North Dakota Department of Health
Tickborne Rickettsial Diseases

- Nonspecific early clinical signs make them difficult to diagnose
- Some are rapidly progressing and may be fatal
- Increasing incidence

But...

- Are all treated with doxycycline
- Use similar laboratory methods for diagnostic confirmation
**Rickettsia rickettsii**: Rocky Mountain spotted fever

- Gram-negative intracellular bacterium, endothelial cells
- Transmitted by *Dermacentor variabilis*, *Dermacentor andersoni*, and in some areas *Rhipicephalus sanguineus*
- Causes widespread vasculitis and multi-system organ failure
- Rapidly fatal, yet difficult to diagnose in early stage of illness (>20% case fatality rate in untreated cases)
Incidence of Spotted Fever Rickettsiosis, 2000-2013

### RMSF: Early Clinical Manifestations (Days 1-4)

<table>
<thead>
<tr>
<th>Day 1-2: Fever, headache, myalgia (<em>may be responsive to pain/fever meds</em>)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 2-4: May develop respiratory signs (cough) and/or gastrointestinal signs (nausea, vomiting, abdominal pain)</td>
</tr>
<tr>
<td>Day 2-4: Faint maculopapular rash (variable)</td>
</tr>
</tbody>
</table>
Initial Rash of RMSF

- Small (1-5 mm), blanching, pink macules, 2 to 4 days after onset of fever
- First appears on wrists, ankles, forearms, spreads centrally
RMSF: Late Clinical Manifestations (Day 5 or Later)

- Worsening systemic illness (cough, dyspnea, arrhythmias, hypotension, severe abdominal pain)
- Petechial rash may develop
- Thrombocytopenia, hyponatremia, elevated liver enzymes (AST, ALT) usually present
- Onset of neurologic signs (photophobia, altered mental status, seizures)
- Death
Petechiae on palms or soles typically do not appear until after 5th day of illness and indicates advanced disease
Gangrene

Cerebral edema

Pulmonary edema

Myocarditis

Photos courtesy of Dr. Chris Paddock and Dr. Gerardo Alvarez Hernandez
Risk Factors for Fatal Outcome

- Delayed onset or absence of rash
- Age <10 years or ≥60 years
- Chronic conditions with signs/symptoms that overlap with RMSF (i.e. alcoholism, chronic lung disease)
- Glucose-6-phosphate dehydrogenase deficiency
- Off-season onset (colder months, first and last cases of the year)
- Delay in administration of effective therapy (doxycycline)
Other Pathogenic Tickborne Spotted Fever Rickettsioses

- *Rickettsia parkeri* rickettsiosis:
  - Transmitted by *A. maculatum*
  - Southeastern United States
  - Eschar-associated, febrile illness, no fatal cases

- *Rickettsia species 364D* rickettsiosis:
  - Transmitted by *D. occidentalis*
  - All cases have been reported out of California
  - Eschar-associated, febrile illness, no fatal cases
  - Rash not reported in few described cases

Ehrlichiosis

- Most commonly caused by *Ehrlichia chaffeensis* in United States
- Obligate intracellular bacteria which infect the peripheral blood leukocytes
Incidence of *Ehrlichia chaffeensis*, 2000-2013

Reported cases per million persons per year
- 0
- 0–5
- 5–20
- 20–20
- >60

NOTE: Incidence based on national surveillance data, 2000-2013
Symptoms—Ehrlichiosis

- Fever / chills
- Headache / malaise
- Muscle pain
- Nausea / vomiting / diarrhea
- Confusion
- Rash
  - In up to 60% of children, less than 30% of adults
- Thrombocytopenia, leukopenia and elevated liver enzymes

Severe clinical presentation may include multiple organ failure, septic shock, or respiratory failure.
Other Ehrlichial Species

- **Ehrlichia ewingii**
  - Primarily reported out of Missouri, Arkansas, Indiana
  - 51 cases between 2008-2012
  - Transmitted by *A. americanum*

- **Ehrlichia muris eauclairensis**
  - First case confirmed in 2011
  - 38 cases to date
  - Suspected transmission by *I. scapularis*
  - Wisconsin and Minnesota
Anaplasmosis

- Caused by *Anaplasma phagocytophilum*
- Obligate intracellular bacteria which infect the peripheral blood leukocytes (predilection for granulocytes)
Incidence of Anaplasmosis, 2000-2013

NOTE: Incidence based on national surveillance data, 2000-2013
Symptoms—Anaplasmosis

- Fever / chills
- Headache/ malaise
- Muscle pain
- Thrombocytopenia, leukopenia, elevated liver enzymes and mild anemia
- Gastrointestinal symptoms
- Rash is uncommon

Severe clinical presentations may include respiratory failure, peripheral neuropathies, renal failure or toxic-shock-like syndrome.
Treating Rickettsioses—A Race Against Time

- Doxycycline is most effective treatment of RMSF and other rickettsial diseases in patients of all ages.
- Treatment should be initiated early in patients of all ages with suspected rickettsial disease, before diagnosis confirmed.
- Rapid treatment can prevent death and disability.
Doxycycline Tooth Staining Study

- Short term doxycycline use does not:
  - Darken shade of teeth
  - Cause visible staining of teeth
  - Increase risk of enamel hypoplasia

- Doxycycline can be safely administered to children without fear of tooth staining at dose and duration recommended for rickettsial diseases

Confirming a Rickettsial Infection

- Treatment decisions must be made by clinical suspicion
- Do not base treatment decisions on (or wait for) confirmatory test results
- Laboratory test selection will depend on level of disease progression, the suspected agent, and specimen availability
Testing Options

- **PCR of whole blood, skin, or tissue**
  - Sensitive for ehrlichiosis and anaplasmosis during acute illness
  - Generally insensitive for RMSF during acute illness until late in disease progression
  - Eschar swabs or biopsy sensitive specimens for detection of *R. parkeri* and *R. species 364D*

- **Serology (IFA)**
  - Requires both an acute and a convalescent sample to be interpretable
  - May be difficult to interpret due to cross-reactivity and antibody persistence

- **IHC of skin or tissue**

- **Microscopy for detection of morulae**
  - For ehrlichiosis and anaplasmosis only
Early symptoms are non-specific but can progress rapidly.

Early treatment with doxycycline is the best way to prevent severe disease, disability, and death.

Do not wait on confirmatory diagnostic test results to make a treatment decision.
Thank you

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Updated guidelines on treatment, diagnosis and management of tickborne rickettsial diseases:

http://www.cdc.gov/mmwr/volumes/65/rr/rr6502a1.html?m=s_cid=rr6502a1_w
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- **Using the Webinar System**
  - “Click” the Q&A tab at the top left of the webinar tool bar
  - “Click” in the white space
  - “Type” your question
  - “Click” ask

- **On the Phone**
  - Press Star (*) 1 to enter the queue
  - State your name
  - Listen for the operator to call your name
  - State your organization and then ask your question
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Please email us questions at coca@cdc.gov

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