Lyme Disease and Tick Bite Prevention

The National Association of Pediatric Nurse Practitioners (NAPNAP) values our members and their commitment to pediatric health care. The Lyme disease (LD) pocket guide is both a practice tool and caregiver education resource!

Side A is designed as a clinician companion, providing you with exactly what you need to know to effectively care for children at risk for Lyme disease. Educating patients and their families is one of many strengths of the pediatric nurse practitioner, so when you're ready to educate, flip this pocket guide over to side B and share the information designed to help families become part of the health care team working to improve the outcome of children at risk for Lyme disease.

NAPNAP is proud to bring this practice tool to you. Our hope is that it becomes a tool you can rely on in daily practice.

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The NAPNAP staff associated with the development of content for this activity have disclosed no relevant financial relationships.

Acknowledgement of Support
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What Is Lyme Disease?

• Tickborne illness caused by the spirochete Borrelia burgdorferi
• Usually causes a local rash; if not treated, can disseminate to other sites over days to weeks

Diagnosing Lyme Disease

• Early infection with classic erythema migrans rash in Lyme disease endemic areas is a clinical diagnosis (i.e. laboratory testing not required); in all other cases diagnosis of Lyme disease should be supported by laboratory testing
• Serology is the mainstay of testing and is most useful for patients with suspected disseminated disease
• Culture or PCR of blood or CSF specimens generally not recommended due to poor sensitivity

Erythema Migrans Skin Lesions (photos next panel)

• May occur within 3 to 30 days of bite
• Flat to slightly raised erythematous expanding lesion, typically larger than 5 centimeters
• May not appear as classic bull’s-eye lesion or have central clearing
• One or multiple lesions may be present

DISCLAIMER

Participants have an implied responsibility to use the newly acquired information to enhance patient outcomes and their own professional development. The information presented in this activity is not meant to serve as a guideline for patient management. Any medications, diagnostic procedures, or treatments discussed in this publication should not be used by clinicians or other health care professionals without first evaluating their patients’ conditions, considering possible contraindications or risks, reviewing any applicable manufacturer’s product information, and comparing any therapeutic approach with the recommendations of other authorities.
Visual Examples: Erythema Migrans Skin Lesions


B. More than one rash: ©DermAtlas, Bernard Cohen. Used with permission;

C. Classic bull’s-eye lesion: James Gathany, http://phil.cdc.gov/phil

D. Skin of color: Brown Skin Matters, https://brownskinmatters.com/525
Lyme Disease Post-Exposure Prophylaxis (PEP)

START HERE

1. Where the tick bite occurred, are ticks likely to be infected with *Borrelia burgdorferi*? See Panel 2B
   - NO
   - YES

2. Was the tick removed within the last 72 hours?
   - NO
   - YES

3. Was the tick's body flat, or was it engorged with blood? See Panel 4A
   - FLAT
   - ENGORCED

4. Was the tick an *Ixodes* (blacklegged) tick? See Panel 1B
   - DEFINITELY NOT
   - YES / POSSIBLY / TICK UNAVAILABLE

5. Is doxycycline safe for the patient?
   - NO
   - YES

A single dose of doxycycline has been shown to reduce the frequency of Lyme disease after a high-risk tick bite and is generally safe for people of all ages, including young children.

Consider Prescribing PEP

Single dose of doxycycline (200 mg for adults or 4.4 mg/kg for children of any age weighing less than 45 kg)

PEP Not Indicated

**LD Risk Increases with Longer Tick Attachment**

- Ticks become increasingly engorged with blood the longer that they are attached
- Transmission of the *Borrelia burgdorferi* spirochete typically occurs after at least 24 hours of tick attachment; Lyme disease risk increases with longer tick attachment times
- Removing an attached tick as soon as possible is important to reduce risk of Lyme disease

### Wait & Watch Consider for Prophylaxis (Nymph)

<table>
<thead>
<tr>
<th>Unfed</th>
<th>Day 1.5</th>
<th>Day 2</th>
<th>Day 2.5</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
</table>

### Wait & Watch Consider for Prophylaxis (Adult female)

<table>
<thead>
<tr>
<th>Unfed</th>
<th>Day 1.5</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 7</th>
</tr>
</thead>
</table>

**Note:** These images are not actual size. Nymphal blacklegged ticks are approximately the size of a poppy seed, and adult blacklegged ticks are approximately the size of a sesame seed.

Lyme Disease Serology Testing

**FIRST TEST**
Enzyme Immunoassay (EIA) OR another test cleared by the FDA as a first test

If the first step is negative, no further testing is recommended.

**NEGATIVE RESULT**

If the first step is positive or indeterminate (sometimes called “equivocal”), the second step should be performed.

**SECOND TEST**
Western blot assay OR another test cleared by the FDA as a second test

**POSITIVE OR EQUIVOCAL RESULT**

**NEGATIVE RESULT**

Overall Test Positive
The overall test result is positive only when the first and second tests are positive (or for some tests, equivocal).

Overall Test Negative
Consider alternative diagnoses.
Note that antibodies take several weeks to develop. Patients infected recently, including patients with erythema migrans, may test negative.

**Interpretation of LD Western Blot Results**

<table>
<thead>
<tr>
<th>IgM Bands</th>
<th>IgG Bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive IgM</td>
<td>Positive IgG</td>
</tr>
<tr>
<td>At least 2 of these 3 bands</td>
<td>At least 5 of these 10 bands</td>
</tr>
<tr>
<td>23/24, 39, 41 kDa</td>
<td>18, 23/24, 28, 30, 39, 41, 45, 58, 66, 93 kDa</td>
</tr>
</tbody>
</table>

The IgM Western blot is only useful if symptom onset was in the last 30 days. If symptoms have been present for more than 30 days, consider ONLY the IgG Western blot. This is because the IgM result is more prone to false-positive results than the IgG.

Doxycycline has traditionally been avoided in children <8 years of age, in pregnancy, and in breastfeeding women because of concern for staining of permanent teeth. This is primarily based on experience with older tetracyclines, not with Table 3. Drug Doses

<table>
<thead>
<tr>
<th>Drug Dosage for Adults</th>
<th>Dosage for Children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oral Regimens</strong></td>
<td></td>
</tr>
<tr>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>500 mg 3 times daily</td>
</tr>
<tr>
<td>Doxycyclineb</td>
<td>100 mg twice daily or 200 mg once dailyb</td>
</tr>
<tr>
<td>Cefuroxime axetil,c</td>
<td>500 mg twice daily</td>
</tr>
<tr>
<td>Alternative</td>
<td></td>
</tr>
<tr>
<td>Azithromycind</td>
<td>500 mg once daily</td>
</tr>
<tr>
<td><strong>Intravenous Therapy</strong></td>
<td></td>
</tr>
<tr>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>2000 mg once daily</td>
</tr>
<tr>
<td>Alternative</td>
<td></td>
</tr>
<tr>
<td>Cefotaximea</td>
<td>2000 mg three times daily</td>
</tr>
<tr>
<td>Penicillin Ga</td>
<td>18–24 million units divided every 4 hours</td>
</tr>
</tbody>
</table>

Regardless of the treatment regimen, complete response to treatment may be delayed beyond the treatment duration. Relapse may occur with any of these regimens; patients with objective signs of relapse may need a second course of treatment.

aDoses of some beta lactam antibiotics (amoxicillin, penicillin, cefuroxime, and cefotaxime) may require adjusted dosing for patients with impaired renal function.
bThere is increasing favorable information on the safety of short courses of doxycycline in young children, which should impact the risk to benefit ratio of using this antibiotic in patients with various manifestations of Lyme disease; see the General Principles and the individual treatment sections of this guideline for further discussion.
cThe oral suspension of cefuroxime is currently not available in the USA.
dBecause of concerns for lower efficacy, macrolide antibiotics including azithromycin are considered second line agents, and should be reserved for patients in whom other antibiotic classes are contraindicated.

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d The preferred IV agent is ceftriaxone. Cefotaxime and penicillin G are alternatives.

e Initial IV therapy is recommended for patients requiring hospital admission. Therapy can be completed orally for the same total 14-day duration. Patients with Lyme carditis who do not require hospital admission can be treated orally.

f Repeat IV therapy can be extended to 28 days if inflammation is not resolving.

### Table 4. Treatment of Specific Manifestations of Lyme Disease

<table>
<thead>
<tr>
<th>Disease Manifestation</th>
<th>Route</th>
<th>Medication</th>
<th>Duration, days (range)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythema migransb</td>
<td>Oral</td>
<td>Doxycycline</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amoxicillin or cefuroxime axetil</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Azithromycin</td>
<td>7 (range: 5–10)</td>
</tr>
<tr>
<td>Meningitis or radiculopathy</td>
<td>Oral</td>
<td>Doxycycline</td>
<td>14–21</td>
</tr>
<tr>
<td></td>
<td>IVd</td>
<td>Ceftriaxone</td>
<td>14–21</td>
</tr>
<tr>
<td>Cranial nerve palsy</td>
<td>Oral</td>
<td>Doxycycline</td>
<td>14–21</td>
</tr>
<tr>
<td>Carditis</td>
<td>Oralf</td>
<td>Doxycycline, amoxicillin, or cefuroxime axetil</td>
<td>14–21</td>
</tr>
<tr>
<td></td>
<td>IVg</td>
<td>Ceftriaxone</td>
<td>14–21</td>
</tr>
<tr>
<td>Arthritis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial treatment</td>
<td>Oral</td>
<td>Doxycycline, amoxicillin, or cefuroxime axetil</td>
<td>28</td>
</tr>
<tr>
<td>Recurrent or refractory arthritis</td>
<td>Oral</td>
<td>Doxycycline, amoxicillin, or cefuroxime axetil</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>Ceftriaxone</td>
<td>14f</td>
</tr>
<tr>
<td>Acrodermatitis chronica atrophicans</td>
<td>Oral</td>
<td>Doxycycline, amoxicillin, Or cefuroxime axetil</td>
<td>21–28</td>
</tr>
<tr>
<td>Borreliac lymphocytoma</td>
<td>Oral</td>
<td>Doxycycline, amoxicillin, or cefuroxime axetil</td>
<td>14</td>
</tr>
</tbody>
</table>

Abbreviation: IV, intravenous.

aRanges are given where different durations have been studied, and the optimal duration remains uncertain.
bThis recommendation applies both to solitary and multiple erythema migrans.
cBecause of concerns for lower efficacy, macrolide antibiotics including azithromycin are considered second line agents, and should be reserved for patients in whom other antibiotic classes are contraindicated. Azithromycin has not been sufficiently studied for manifestations of Lyme disease other than erythema migrans.
dThe preferred IV agent is ceftriaxone. Cefotaxime and penicillin G are alternatives.
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Table 3. Drug Doses

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<tr>
<td>Amoxicillin&lt;sup&gt;a&lt;/sup&gt;</td>
<td>500 mg 3 times daily</td>
<td>50 mg/kg divided 3 times daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td>Doxycycline&lt;sup&gt;b&lt;/sup&gt;</td>
<td>100 mg twice daily or 200 mg once daily&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.4 mg/kg divided twice daily (maximum 200 mg daily)</td>
</tr>
<tr>
<td>Cefuroxime axetil&lt;sup&gt;*,c&lt;/sup&gt;</td>
<td>500 mg twice daily</td>
<td>30 mg/kg divided twice daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td>Alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azithromycin&lt;sup&gt;d&lt;/sup&gt;</td>
<td>500 mg once daily</td>
<td>10 mg/kg once daily (maximum 500 mg per dose)</td>
</tr>
<tr>
<td><strong>Intravenous Therapy</strong></td>
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<tr>
<td>Preferred</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>2000 mg once daily</td>
<td>50–75 mg/kg once daily (maximum 2000 mg per dose)</td>
</tr>
<tr>
<td>Alternative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefotaxime&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2000 mg three times daily</td>
<td>150–200 mg/kg divided 3–4 times daily (maximum 6000 mg daily)</td>
</tr>
<tr>
<td>Penicillin G&lt;sup&gt;e&lt;/sup&gt;</td>
<td>18–24 million units divided every 4 hours</td>
<td>200 000–400 000 units/kg divided every 4 hours (maximum 18–24 million units daily)</td>
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Presentations of Disseminated Lyme Disease

**Lyme Carditis**
Lyme carditis typically presents as atrioventricular nodal block. Varying degrees of heart block can occur, which can progress to or fluctuate between complete heart block. Pericarditis and myocarditis can also occur. Symptoms may include:
- dyspnea
- palpitations
- syncope
- chest pain
- exercise intolerance
- edema

An ECG does not need to be performed routinely on all patients with Lyme disease. However, an ECG should be performed urgently for any patient with suspected Lyme carditis.

**Lyme Arthritis**
Marked swelling primarily affecting large joints, most commonly the knee. This is the most common presentation of late Lyme disease in children. Predictors of Lyme arthritis include:
- known history of tick bite
- isolated knee involvement
- lack of fever

Lyme arthritis can be difficult to differentiate from septic arthritis. Predictors of septic arthritis may include:
- absolute neutrophil count $\geq 10k$ cells/mm$^3$
- ESR $\geq 40$ mm/hour
- hip involvement
- pain with short arc motion

*Image used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/lyme/signs_symptoms/index.html*
Presentations of Disseminated Lyme Disease

Cranial Neuritis
Cranial neuritis usually involves the facial nerve (CN VII) and less often, the trigeminal (CN V), oculomotor and abducens (CN III, VI), and vestibulocochlear nerves (CN VIII). When the cranial nerves are affected, facial palsy can occur on one or both sides of the face.

Lyme Meningitis
Presentation is similar to enteroviral and other aseptic meningitis. This may include:
- fever
- headache
- photosensitivity
- neck stiffness or pain
- CSF lymphocytic pleocytosis

The presence of the following increases likelihood of Lyme meningitis:
- co-occurrence of facial nerve palsy
- mononuclear cell predominant CSF pleocytosis

Radiculoneuritis
This presentation is rare in children, but if present, may include:
- numbness
- tingling
- “shooting” pain
- weakness in arms or legs

Image used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/lyme/signs_symptoms/index.html
How Many People Get Lyme Disease?

• Estimated 476,000 people in the US are diagnosed and treated for Lyme disease each year

Where Does Lyme Disease Occur?

• Most cases occur in Northeastern, mid-Atlantic and North Central states
• Sometimes, cases occur along the North Pacific coast

How is Lyme Disease Transmitted?

• Blacklegged ticks attached for at least 24 hours
• The deer tick (blacklegged tick) spreads the infection in Northeastern, mid-Atlantic and North Central states

• The Western blacklegged tick spreads the infection along the North Pacific coast

Used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/lyme/index.html
Each dot represents one case of Lyme disease and is placed randomly in the patient's county of residence. The presence of a dot in a state does not necessarily mean that Lyme disease was acquired in that state.

Used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/lyme/datasurveillance/maps-recent.html
Tick and Mosquito Repellents

Higher concentration corresponds to how long you are protected, not how well you are protected.

DEET (N, N-diethyl-m-toluamide)
- Safe and effective for children aged 2 months and older
- 10-30% concentration effective for 3 to 5 hours

Picaridin
- Safe and effective for children aged 2 months and older
- 10% concentration effective for 2 to 3 hours
- Similar to a natural compound found in black pepper plants

Oil of Lemon Eucalyptus
- Safe and effective for children aged 3 years and older
- 30% concentration effective for 4 hours
- Sourced from the gum eucalyptus tree

IR 3535
- Safe and effective for children aged 2 months and older
- 20% concentration effective for 2 to 3 hours

Permethrin
- Applied to clothing and gear - do NOT apply to skin
- Safe and effective for toddlers, children and teens
- 0.5% concentration
- Effective for multiple washes

For more information regarding Tick and Mosquito Repellents...
Additional Tick Bite Prevention Strategies

• Avoid tall grass and brushy areas when possible
  – Ticks don’t fly or jump, they wait for a host to brush up against them
  – Mow yards regularly, keep tall grasses and bushes away from busy yard areas

• Check your child’s body, and your own, for ticks after being outdoors

• Tumble dry clothes on high heat for 10 minutes to kill ticks on clothing; if the clothes require washing first, hot water is recommended

• Shower soon after spending time outdoors to help wash off unattached ticks

• Examine gear such as clothing, boots, bags and tents after being outdoors

• Outdoor/indoor pets should be checked for ticks as well, even if they are on a tick medication or have been vaccinated to protect against Lyme disease; talk to your veterinarian about tick prevention products for your dog

SCAN HERE
For more information regarding Prevention Strategies...
Full Body Tick Check

*Check ALL parts of the body, with careful inspection of these areas.*

Image used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/lyme/prev/on_people.html

**To use the Tick Bite Bot:**
A tool to assist people in removing attached ticks and seeking health care, if appropriate, after a tick bite.
Removing a Tick

• Use clean, fine-tipped tweezers to grasp the tick as close to the skin’s surface as possible

• Pull upward with steady, even pressure. Don’t twist or jerk the tick; this can cause the mouth-parts to break off and remain in the skin. If this happens, remove the mouth-parts with tweezers. If you cannot remove the mouth easily with tweezers, leave it alone and let the skin heal.

• After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol or soap and water

• Never crush a tick with your fingers. Dispose of a live tick by:
  – Putting it in alcohol
  – Placing it in a sealed bag/container
  – Wrapping it tightly in tape
  – Flushing it down the toilet

Used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/ticks/pdfs/FS_TickBite-508.pdf
Other Tickborne Diseases Reported to CDC

- Anaplasmosis
- Ehrlichiosis
- Rocky Mountain Spotted Fever
Note: Ticks can transmit diseases other than Lyme disease. An overview of tickborne diseases in the US, including maps where these diseases are reported, can be found at: https://www.cdc.gov/ticks/tickbornediseases/overview.html

Maps used with permission: Centers for Disease Control and Prevention, https://www.cdc.gov/ticks/