Quick background

LYME DISEASE: most common vector-borne disease in the US

VECTOR: ticks
- *Ixodes scapularis* (AKA blacklegged or deer tick)

PATHOGEN: *Borrelia burgdorferi*

1. (CDC MMWR, 2013; Steer et al. 2004)

History of Lyme

1976
The seasonal and geographic distribution, and the associated skin lesion suggested a "virus with a "biting insect." 

Douglas S. Lloyd, M.D., M.P.H., Health Commissioner:
Patients had an unusual skin lesion before the onset of joint symptoms.

History of Lyme

1909 Swedish dermatologist Arvid Afzelius described an EM lesion following the bite of a sheep tick. He named the lesion erythema migrans (EM).

1970 Wisconsin dermatologist Rudolph Scrimenti recognized an EM lesion in a patient after recalling description of the rash in European literature. This was the first documented case of EM in the United States.

1980 NYS HD Epidemiologist Jorge Benach provided Willy Burgdorfer, researcher at Rocky Mountain Biological Laboratory, collections of Deer ticks (Ixodes scapularis) from a known Lyme-endemic area.

1980 While examining the ticks for Rickettsia, Willy noticed “poorly stained, rather long, irregularly coiled spirochetes” in 60% of the ticks. He realized that the spirochetes might be the “long-sought cause of EM and Lyme disease.”

1980 Coordinating with Alan Barbour of U-Texas, Willy was able to isolate the spirochetes from patients with Lyme disease. The spirochete was named Borrelia burgdorferi in his honor.


Ticks will embed their mouthparts in the skin, and may be difficult to detect due to their small size. Prompt removal of ticks is preventative for Lyme disease as studies have shown it takes >36 hours for efficient B. burgdorferi transmission to occur.

People come into contact with ticks while working or recreating in wooded areas or areas with shade and vegetation, which is the preferred habitat for Blacklegged ticks.

Lyme bacteria

Ecology of Lyme disease

Lyme disease is maintained in nature through a cycle of infection between Blacklegged ticks and small mammals.
U.S. Lyme disease biogeography

Reported Cases of Lyme Disease – United States, 2001

Public health significance

- In 2013, Lyme disease was the 5th most commonly reported notifiable disease in the U.S.
- Approximately 3.4 million LD tests nationwide in 2008 from 7 large commercial laboratories
  - Cost estimates for laboratory services of $492 million
  - Estimate 288,000 LD cases/year
- 2005-2010 Truven Health MarketScan Commercial Claims and Encounters Database analyzed
  - Estimate 329,000 LD cases/year


Public health significance

CDC Estimate:

(approx. 10x underreporting)
288,000 - 329,000 cases annually

First detection of ticks, pathogen, and cases: Michigan’s UP late ’80s, early ’90s

Blacklegged ticks and risk for Lyme disease are emerging in Michigan

Tick populations are affected by:
- Local temperature
- Precipitation
- Soil type
- Drainage
- Host species
- Land use/ cover

What is a tick?
- Ticks are more closely related to spiders and mites than insects
- They must feed on blood to complete their life cycle
- Ticks feed on a variety of animals from small and medium sized mammals, to birds and lizards
- It is generally within the enzootic, or tick/animal cycle that tick borne diseases are maintained
- There are two major families of ticks
  - Argasidae – Soft ticks
  - Ixodidae – Hard ticks
How do ticks sense their environment?

- Unlike insects, ticks have no antennae.
- Unlike insects or spiders, hard ticks have 2 simple eyes or no apparent eyes.
- Ticks sense their environment with sensory organs on their legs and palps.
- They can detect heat, CO₂, movement, and other ticks.

How do ticks find their prey?

- The ticks that concern us in human health in the U.S. find their prey by "questing".
- Ticks climb onto vegetation to await a passing animal, often along animal and man-made trails.
- They may also crawl short distances in response to CO₂.
- Ticks DO NOT jump, fly, or drop onto people from trees.

How do ticks feed?

- Ticks will search the host for an appropriate attachment site.
- Typically the hairline, behind the ears, armpits, groin, behind knees, waistline.
- Chelicerae, which are like saws will begin to pierce the skin.
- Hypostome is guided through into the wound.
- Cement is rapidly secreted to create firm attachment to the host.
- Salivary compounds are secreted to create a "feeding lesion" or hematoma in the dermis.
- Includes antihistamines and anticoagulants.
Ticks are common in Michigan

**Dermacentor variabilis** (American dog tick or wood tick)
- Found in wooded and brushy habitats
- Most common tick in Michigan
- Oval scutum with white markings, brown abdomen
- Adults commonly bite and are active from early spring through the end of summer
- Vector: Rocky Mountain spotted fever

**Ixodes scapularis** (blacklegged tick)
- Common in wooded and brushy habitats
- Smaller size than *D. variabilis*
- Rounded, black scutum, red or gray abdomen
- Adults and nymphs will readily bite people.
- Adults: April – July, October – November
- Nymphs: May – August
-Vectors: Lyme disease, anaplasmosis, babesiosis, deer tick virus, *Ehrlichia muris*-like

**What is the Blacklegged tick life cycle?**

- **Spring**
  - Egg
  - Larvae

- **Early Summer**
  - Nymph

- **Next Spring/Summer**
  - Adult

- **Fall/Next Spring**
  - Egg

**Immature ticks feed primarily on small mammals. These mammals are the primary reservoir of Lyme disease**

**People become unwilling participants by recreating or working in tick infested habitats**

**White-tailed deer do not cycle the disease**

**Blacklegged tick nymphs**

Nymphs are the stage most responsible for the majority of Lyme disease illness in the United States. This is due to:
- Small size
- First infectious stage
- Active during peak outdoor recreation periods in the NE and Upper Midwestern U.S.
Not all ticks are infected

- Only blacklegged ticks transmit Lyme disease
- Only two stages of blacklegged ticks transmit Lyme disease

<table>
<thead>
<tr>
<th>Stage</th>
<th>Infection Rate</th>
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<tbody>
<tr>
<td>Adult Female</td>
<td>36-40%</td>
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<tr>
<td>Nymph</td>
<td>9-15%</td>
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</tbody>
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B. burgdorferi infection rate

Who does tick-borne disease affect?

Anyone working or recreating in forested or forest-edge habitats, including:

- Man-made trail systems
- Trails used by animals
- Campgrounds
- Brushy or grassy areas near buildings or yards
- Wooded river banks

Lyme disease “re”emergence

- Reforestation
- Overabundant deer
- Increased numbers of ticks
- Expansion of suburbia into wooded areas
- Increased exposure opportunities
- Changes in diagnostic, surveillance, and reporting practices
Tick habitat suitability model

Parameters
- Forest type
- Soil type
- Land cover
- Soil texture
- Bedrock

Environmental risk determination

UP Tick Survey 2015

Isis Arnooe, 2015
MI cases have increased over time

Lyme disease cases by year, Michigan 2002-2015

Lyme disease by age group, 2002-2015

Lyme disease by gender
Race & ethnicity of Lyme disease cases

- White: 85%
- American Indian or Alaskan Native
- Black or African American
- Asian
- Unknown

Reported Lyme disease cases in Michigan: 2015 EPI Curve

Clinical Manifestations of Confirmed Lyme Disease Cases--US, 2001-2010

Emerging & Zoonotic Infectious Diseases Section
Michigan Department of Health & Human Services
September, 2016
70% of infected persons have Erythema migrans (EM) rash

- Begins at the site of a tick bite after a delay of 3 to 30 days
- Expands gradually
- “Bull’s-eye” appearance

70% of infected persons have Erythema migrans (EM) rash

Other symptoms 3 to 30 days after tick bite include:

- Fever
- Chills
- Headache
- Fatigue
- Muscle and joint aches
- Swollen lymph nodes
Weeks to months after infection

- Pain and swelling in the large joints
- Facial or Bell's palsy
- Shooting pains that may interfere with sleep
- Severe headaches and neck stiffness due to meningitis
- Heart palpitations and dizziness

Early disseminated stage

If not appropriately treated:

- Intermittent bouts of arthritis, with severe joint pain and swelling
- Chronic neurologic complaints:
  - Shooting pains
  - Numbness or tingling in the hands or feet
  - Problems with short-term memory

Late disseminated stage

Some symptoms may persist even after treatment

- Muscle and joint pains
- Cognitive defects
- Sleep disturbance
- Fatigue

called Post-treatment Lyme disease Syndrome
The most important factors in preventing Lyme disease are:

1. Knowing where ticks can be encountered
2. Preventing tick bites
3. Removing ticks promptly if they do bite
4. Seeking prompt medical care if illness occurs after exposure to ticks

Key driver: increase and spread of blacklegged ticks

Established tick populations:
≥ 6 ticks or 2 life stages in a single year
Preventing tick bites

- Wear light-colored clothing with a tight weave so ticks can be spotted easily.
- Wear closed-toe shoes, long pants, and a long sleeved shirt. Tuck pant legs into socks or boots and shirt into pants.
- Check clothes and any exposed skin frequently for ticks.
- Avoid sitting directly on the ground, fallen logs, or stone walls.

Personal protective measures

**EPA-approved skin repellents:**
- DEET
- Picardin
- Oil of lemon eucalyptus

**EPA-approved clothing repellent:**
- Permethrin

Preventing tick bites

- Remove ticks from your clothes before going indoors.
- To kill ticks that you may have missed, wash your clothes with hot water and **dry them** using high heat for at least one hour.
- Perform daily tick checks after being outdoors, even in your own yard. Inspect all parts your body carefully, including your armpits, scalp, and groin.
Removing blacklegged ticks promptly can help prevent Lyme disease!

Probability of Lyme disease transmission by blacklegged tick nymphs over time

What should I do if I’m bitten by a tick?

- If a tick is attached to you, use fine-tipped tweezers or similar tool to grasp the tick at the surface of your skin.
- Pull the tick straight up and out. Don’t twist or jerk the tick—this can cause the mouth parts to break off and stay in the skin. If this happens, remove the mouth parts with tweezers if you can. If not, leave them alone and let your skin heal.
- Clean the bite and your hands with rubbing alcohol, an iodine scrub, or soap and water.
- You may get a small bump or redness that goes away in 1-2 days, like a mosquito bite. This is not a sign that you have Lyme disease.

How to remove a tick?

- Use tweezers and just pull out from closest point of attachment to body and try not to leave mouthparts in, which could lead to a secondary infection.
- Then wash area with soap & water and apply antiseptic.
At the end of the day, also check your dog, cat, and horse companions!

Tick ID and Testing!

Expert tick identification is available at a number of state agencies. Place the tick in a small vial containing a damp piece of tissue or piece of grass and submit it to the appropriate agency, following the guidelines for tick identification and testing found at: www.michigan.gov/lyme.

This service is free to the public for ticks removed from residents in Michigan.

When to see your doctor

See a doctor if you develop a fever, a rash, severe fatigue, facial paralysis, or joint pain within 30 days of being bitten by a tick. Be sure to tell your doctor about your tick bite. If you have these symptoms and spent time outdoors where Lyme disease is common, it is important to get treatment right away.
The future?

- Likely that Michigan will see increased tick populations, and increased Lyme disease risk
- Other pathogens associated with blacklegged ticks, such as Anaplasma and Babesia will also increase
- Michigan agencies (MDNR, MDHHS) will need to continue educating the public regarding tick-bite and tick-borne disease prevention
- Borrelia mayonii recently discovered in WI and MN, is more virulent than B. burgdorferi.

More resources available online

- www.michigan.gov/lyme
- www.cdc.gov/lyme