Update on Lyme disease and other tick-borne disease in North Central US and Canada

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Tick season is here!
Today’s objectives:

- To review the most common ticks in Michigan and Ontario and the diseases they carry.
- To explore the ecology of tick-borne pathogens
- To provide an update on the state of tick-borne disease in North America
What are the top ticks that people contact in Michigan?

American Dog Tick (Wood Tick)
Blacklegged Tick (Deer Tick)
Lone Star Tick (Turkey Tick)

Honorable mentions: Woodchuck tick, Brown Dog tick
Which ticks transmit which diseases?

American Dog Tick

Diseases/pathogens: Rocky Mountain spotted fever, tularemia
Blacklegged tick

Diseases/Pathogens: Lyme disease, human anaplasmosis, human babesiosis, hard tick relapsing fever, Powassan virus encephalitis, ehrlichiosis

Goto: http://www.tickencounter.org/tick_identification
Lonestar Tick

Diseases/pathogens: Human monocytic ehrlichiosis, Rocky Mountain spotted fever, tularemia, Heartland virus, canine granulocytic ehrlichiosis (*E. ewingii*, humans, too), and meat allergy.

Go to: http://www.tickencounter.org/tick_identification
Brown Dog Tick

Diseases/pathogens: Rocky Mountain spotted fever, canine ehrlichiosis and canine babesiosis

Go to: http://www.tickencounter.org/tick_identification
A brief introduction to blacklegged tick ecology...
(Lyme disease focus)
In nature, the LD pathogen is maintained in a tag team dynamic between blacklegged ticks and hosts.
Blacklegged ticks are active 10-12 months of the year but different life stages have different activity periods.

- Larvae
- Nymphs
- Adults

Relative activity

Month

0
0.1
0.2
0.3
Nymphs of one generation infect larvae of the next generation via a reservoir host population.
Why are most cases of Lyme disease in mid-summer?

http://www.cdc.gov/lyme/stats/graphs.html
The same summer peak is seen for babesiosis and anaplasmosis

Babesiosis
(2013, CDC)

Anaplasmosis (2000-2010, CDC)
A brief introduction to Lyme disease:

- Spirochete (bacterium) – *Borrelia burgdorferi*
  - obligate parasite
  - tick-borne zoonosis
    - Northern hemisphere distribution
    - 2 vector tick species in North America
    - ≥2 pathogenic bacteria species in North America
Lyme disease in humans

Acute phase - febrile illness with:

- "bull's-eye" rash (70% of cases)
- malaise
- fatigue
- muscle aches
- joint aches

- Full recovery usually with early recognition & treatment with antibiotics
Lyme disease is an increasing problem in the United States.

Establishment in UP in early 1980s

10-yr study: mostly passive surveillance


Walker et al. 1998, Foster 2004
Progression of *Borrelia burgdorferi* emergence in Michigan

**Michigan LD Risk Map:**

- **2009**
- **2015**

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**Figure 12**

- **County with known Blacklegged Tick populations:**
  - Known populations and elevated risk of Lyme disease.

- **County with increased risk of establishing Blacklegged Tick populations:**
  - Potential spread areas.

- *** The Blacklegged Tick is the tick that transmits Lyme disease in Michigan**

- **Ecologic studies conducted from 2001 - 2008**

- **County with known risk for Lyme disease [Endemic County*]**

- **County with potential risk for Lyme disease [Unconfirmed County*]**
Distribution of canines samples and ticks

Lyme disease infected tick

Blacklegged ticks from canines 2015-2017
Other Tick-borne Diseases
Borrelia mayonii

- Also causes Lyme disease in US
- Clinical Signs
  - Like *B. burgdorferi*: fever, headache, rash, neck pain, arthritis
  - Unlike *B. burgdorferi*: nausea, vomiting, diffuse rash, higher bacterial concentration in blood
- Currently only found in Upper Midwest
Anaplasmosis

- Agent: *Anaplasma phagocytophilum*
- Infects white blood cells
- Clinical Signs:
  - 1-2 weeks after bite
  - Fever, chills, body aches, headache, nausea, rash is rare
  - Severe disease: difficulty breathing, kidney failure, neurologic signs, death
- Not a reportable disease in Canada, but is in US
Anaplasmosis

https://www.cdc.gov/anaplasmosis
Babesiosis

- Agent: *Babesia microti* (most commonly cause of disease in humans)
- Infects red blood cells
- Clinical Signs
  - May be asymptomatic
  - Signs develop within a week of bite, progress over weeks to months
  - Fever, chills, sweats, headache, myalgia, loss of appetite, nausea, fatigue
  - Hemolytic anemia, jaundice, dark-colored urine
  - Life-threatening if weakened immune system
- 2013 first locally acquired case in Canada
Babesiosis
Powassan Virus

- **Agent:** Flavivirus, closely related to West Nile Virus, St. Louis Encephalitis virus, and Tick-borne Encephalitis virus
- **Three cycles in North America**
  - Woodchuck tick/woodchuck, Squirrel tick/squirrel, Blacklegged tick/white-footed mouse
- **Transovarial transmission - larvae are infected**
- **Clinical Signs**
  - 1 week to 1 month after tick bite
  - Many asymptomatic
  - Fever, headache, vomiting, weakness, confusion, loss of coordination, speech difficulties, seizures, encephalitis, meningitis
- **10% of cases are fatal**
  - 50% of survivors have permanent neurological damage
Borrelia miyamotoi

- Closely related to bacteria that causes Tick-borne Relapsing Fever
- Transovarial transmission - larvae are infected
- Clinical Signs
  - Fever, chills, headache, body and joint pain, fatigue
- Fewer than 60 well-documented human cases in US
- Unknown how common infection is in the US
Ehrlichiosis

- Agent: *Ehrlichia chaffeensis*, *E. ewingii*, *E. muris*-like (Blacklegged tick)
- Infects white blood cells
- Clinical Signs
  - Develop 1-2 weeks after bite
  - Fever, headache, chills, muscle aches, nausea, red eyes, rash (60% of children, <30% adults)
  - Difficulty breathing, bleeding disorders, death
Ehrlichiosis
Rocky Mountain Spotted Fever

- **Agent:** *Rickettsia rickettsii*
- **Infects** endothelial cells

**Clinical Signs**

- Acute signs seen 2-14 days after bite
- Acute fever, headache, myalgia, vomiting, general discomfort
- Rash appears 2-5 days after onset of fever; 90% of infected people get some form of rash
- Vasculitis, neurologic deficits, damage to internal organs
Rocky Mountain Spotted Fever
So, what now?

- Blacklegged ticks are expanding range and seem to be invading unexpected areas
- We eventually expect to see the entire state turn red indicating Lyme disease emergence
- We expect to see new tick species invade and become established
  - Lonestar tick
  - And bring their own pathogens too!
What can we do now?

- Personal protection: stay on trails, use repellent products (DEET, permethrin, picaridin), frequent tick checks, appropriate clothing

- Encourage tick submission to MDHHS - visit http://www.michigan.gov/emergingdiseases for more information on Lyme disease and other tick-borne diseases in Michigan
What can we do now and in the future?

- Host animal management – culling
- Vaccination
  - Human LD vaccine in development
  - Vaccinate host animals
- Tick preventative
  - Already used on companion animals, but could it be used on wild populations?
- Peri-domestic treatments
  - Yard management
  - Tick tubes
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Questions?

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How do we detect ticks and tick-borne disease?
Borrelia burgdorferi canine serosurveillance has limitations

- Bias in sampled population
- Use of tick preventative
- Cannot account for history of travel to endemic regions
- Unable to identify individual animals or multiple test results
- Insufficient information, changing sample sizes
- Cross reaction with Borrelia miyamotoi
- Sensitivity in emerging areas

Therefore, we need to collect ticks from dogs!
Canine Tick Collection

- 114 veterinary clinics and animal shelters participated 2015-2016*
- 60 dogs examined March to June and June to November
- Report both positive and negative dogs
- All blacklegged ticks assayed for *Borrelia burgdorferi* by qPCR

* Spring 2015 collection limited to Southern Lower Peninsula
How are blacklegged ticks establishing in rural areas?
Can urban parks act as islands for tick
How do ticks find hosts?

(c) G. Hickling, University of Tennessee