Tick IPM Series Part 2:
Tick-borne Disease: Integrated Risk Management

June 24, 2020
Webinar Details

• Welcome

• A recording of this webinar will be available within a week at
  • http://www.neipmc.org/go/ipmtoolbox
We Welcome Your Questions

• Please submit a question at any time using the Q&A feature to your right at any time

• If you’d like to ask a question anonymously, please indicate that at the beginning of your query.
Stephen M. Rich,
Professor of Microbiology
Director of the Laboratory of Medical Zoology
University of Massachusetts, Amherst
Some Questions for You
Outline

• Overview
• Public Health Exposure
• Tick Reports
• Passive Surveillance Database
• Future Webinars
Ticks don’t:
Jump,
Fly, or
Drop from trees
Personal Protection

- Proper clothing
  - Light colored
  - Tuck pant leg into socks
- CHECK for ticks
Personal Protection (chemical)

- **TREAT CLOTHING**
  - Permethrin (acaricide)

- **TREAT SKIN**
  - DEET (repellent)
Source Reduction

- Kill questing ticks
  - Perimeter Spray
- Kill ticks on hosts
  - 4-posters
  - Bait boxes
  - Vaccines (@ ticks)
- Reduce infection
  - Wildlife vaccine (@pathogens)
  - Transgenics
The Story Line of TBD

Pre-Tick Bite  
Tick Bite  
Post-Tick Bite
The Story Line of TBD

Pre-Tick Bite

Tick Bite

Post-Tick Bite
The Story Line of TBD

- Pre-Tick Bite
- Tick Bite
- Post-Tick Bite
THREATS TO PUBLIC HEALTH
THREATS TO PUBLIC HEALTH

HAZARD

A HAZARD is something that has the potential to harm you

RISK

RISK is the likelihood of a hazard causing harm

EXPOSURE
HAZARD

EXPOSURE

RISK
• Tick species
  • Different species, different hazards
Human Biting Ticks

Deer tick
*(Ixodes scapularis)*

Dog tick
*(Dermacentor variabilis)*

Lone Star tick
*(Amblyomma americanum)*

Lyme borreliosis
Babesiosis
Anaplasmosis
*Borrelia miyamotoi*
Powassan virus (Deer tick virus)

Tularemia
Rocky Mountain Spotted Fever

Ehrlichiosis
Southern Tick-associated rash illness (STARI)
Alpha-galactose (Red meat Allergy)
EXPOSURE

• Tick species
  • Different species, different hazards

• Duration of feeding
  • Pathogen transmission takes time
Risk increases with feeding
(time of attachment)
In-processing

- Match online order to mailed tick (six digit order#)
- Identify tick species and photograph dorsal/ventral
- Determine feeding status
  - FLAT
  - PARTIALLY FED
  - ENGORGED
EXPOSURE

• Tick species
  • Different species, different hazards

• Duration of feeding
  • Pathogen transmission takes time

• Infection status
  • Not all ticks are infected
Test for Pathogens

Break up tissue

Total nucleic acid extraction

Determination of bacterial presence using qPCR

96-wells
Questions
Tick Reports
Find a tick?

Order a comprehensive TickReport™ and learn what disease causing microbes the tick may be carrying, including pathogens that cause Lyme disease.

Order a TickReport

1. Place Your Order

Standard identification and testing for common to your species of tick, including pathogens that cause Lyme disease, costs $50 per tick. We also offer expanded packages that test a wider array of pathogens.

View detailed pricing

TICKREPORT

suits in 72 hours

suits are securely delivered via email within 3 business days after your tick arrives at our lab.

We suggest using UPS or FedEx for fastest service.
### Deer (Blacklegged) tick tests
- *Borrelia burgdorferi* (Lyme)*
- *Borrelia miyamotoi* (relapsing fever)*
- *Borrelia mayonii*
- *Anaplasma phagocytophilum*
- *Babesia microti*
- *Ehrlichia-muris-like*

### Non-Deer (non-Blacklegged) tick tests
- *Borrelia burgdorferi* (Lyme)*
- *Borrelia lonestari* (STARI)*
- *Rickettsia rickettsii* (Rocky Mountain Spotted Fever)
- *Rickettsia parkeri*
- *Rickettsia philipii*
- *Ehrlichia chafeensis* (Ehrlichiosis)
- *Francisella tularensis* (Tularemia)
- *Borrelia burgdorferi* (Lyme)
Tick Identification

Species: Ixodes scapularis (Black-legged or Deer tick)
Sex: female
Stage: adult
Feeding Stage: unknown

Internal Quality Control Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tick DNA Quality</td>
<td>PASSED</td>
<td>included</td>
</tr>
<tr>
<td>Tick RNA Quality</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Test Results

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Result Date</th>
<th>Result</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borellia generalis</td>
<td>--</td>
<td>POSITIVE</td>
<td>included</td>
</tr>
<tr>
<td>(Lyme or relapsing fever: generic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borellia burgdorferi sensu lato</td>
<td>--</td>
<td>POSITIVE</td>
<td>included</td>
</tr>
<tr>
<td>(Lyme borreliosis: specific)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borellia miyamotoi</td>
<td>--</td>
<td>NEGATIVE</td>
<td>included</td>
</tr>
<tr>
<td>(Hard tick relapsing fever)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Babesia microti</td>
<td>--</td>
<td>NEGATIVE</td>
<td>included</td>
</tr>
<tr>
<td>(Babesiosis often found in humans)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaplasma phagocytophilum</td>
<td>--</td>
<td>NEGATIVE</td>
<td>included</td>
</tr>
<tr>
<td>(Human Granulocytic Anaplasmosis: HGA)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TickReport Fee: $50.00
Total: $50.00

Customer & Patient Information

Customer Contact:
Stephan Rich
965 E. Pleasant St.
Amherst, MA 01002
Phone: 4135901913
Email: smirch@umass.edu

Patient Information:
Host Source:
City: Amherst
State: MA
Zip: 01002
Attached: Yes
Site of Attachment: Back
Rash Present: Yes
Rash Size: 1"

Date tick was removed: 03/19/2016
Customer Notes: n/a
PUBLIC Health benefits of exposure assessments
Passive Surveillance
# Surveillance (Hazard/Risk/Exposure)

<table>
<thead>
<tr>
<th>Threat</th>
<th>Hazard</th>
<th>Risk</th>
<th>Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Sampling Ticks</td>
<td>Indirect</td>
<td></td>
<td>Direct</td>
</tr>
<tr>
<td>Human Case Reports</td>
<td></td>
<td>Indirect</td>
<td>Direct</td>
</tr>
<tr>
<td>Surveillance of Human-biting ticks</td>
<td></td>
<td></td>
<td>Direct</td>
</tr>
</tbody>
</table>

## Threats and Infection Rates

- **Tick encounter rate**: Indirect to Direct
- **Infection rates among ticks**: Direct to Indirect
- **Duration of tick exposure**: Direct

**Hazard/Risk/Exposure**

- **Field Sampling Ticks**: Indirect
- **Human Case Reports**: Indirect
- **Surveillance of Human-biting ticks**: Direct
Questions
PASSIVE SURVEILLANCE DATABASE
Blacklegged Tick Hazards and Lyme Disease Risk
# TickReport Data fields

<table>
<thead>
<tr>
<th>CLIENT/SUBSCRIBER</th>
<th>TICK</th>
<th>BITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>species</td>
<td>attached_to_skin</td>
</tr>
<tr>
<td>tid</td>
<td>stage</td>
<td>attached_site</td>
</tr>
<tr>
<td>email</td>
<td>sex</td>
<td>attached_minutes</td>
</tr>
<tr>
<td>name</td>
<td>feeding</td>
<td>rash(size)</td>
</tr>
<tr>
<td>address</td>
<td>host</td>
<td>tick_removed_date</td>
</tr>
<tr>
<td>city</td>
<td>host_gender</td>
<td>remark</td>
</tr>
<tr>
<td>state</td>
<td>host_age</td>
<td>dna_extraction_method</td>
</tr>
<tr>
<td>zipcode</td>
<td>location_city</td>
<td></td>
</tr>
<tr>
<td>country</td>
<td>location_state</td>
<td></td>
</tr>
<tr>
<td>phone</td>
<td>location_zipcode</td>
<td></td>
</tr>
<tr>
<td>fax</td>
<td>location_country</td>
<td></td>
</tr>
<tr>
<td>client_memo</td>
<td>referred_by</td>
<td></td>
</tr>
<tr>
<td>followup_okay</td>
<td>tick_dna_quality(species)</td>
<td></td>
</tr>
</tbody>
</table>
TickReport Archive (2006-present)

- LMZ has tested >70,000 human-biting ticks since 2006
  - Ticks sent from all 50 US states (and beyond)
  - Approx 40% annually from MA
    - Approx. 12% from Cape Cod (2014-present)

<table>
<thead>
<tr>
<th>State</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA*</td>
<td>40.89%</td>
</tr>
<tr>
<td>NY</td>
<td>11.73%</td>
</tr>
<tr>
<td>ME</td>
<td>5.81%</td>
</tr>
<tr>
<td>NH</td>
<td>5.78%</td>
</tr>
<tr>
<td>VA</td>
<td>3.72%</td>
</tr>
<tr>
<td>CA</td>
<td>3.72%</td>
</tr>
<tr>
<td>PA</td>
<td>3.61%</td>
</tr>
<tr>
<td>NJ</td>
<td>3.56%</td>
</tr>
<tr>
<td>VT</td>
<td>3.14%</td>
</tr>
<tr>
<td>MD</td>
<td>2.21%</td>
</tr>
<tr>
<td>RI</td>
<td>2.20%</td>
</tr>
<tr>
<td>CT</td>
<td>2.09%</td>
</tr>
<tr>
<td>NC</td>
<td>1.02%</td>
</tr>
<tr>
<td>IL</td>
<td>1.01%</td>
</tr>
<tr>
<td>WI</td>
<td>.99%</td>
</tr>
<tr>
<td>OH</td>
<td>.80%</td>
</tr>
<tr>
<td>Other</td>
<td>8.52%</td>
</tr>
</tbody>
</table>
### Human-biting ticks submitted to TickReport (2006-2020)

<table>
<thead>
<tr>
<th>species</th>
<th>count</th>
<th>CT</th>
<th>MA</th>
<th>ME</th>
<th>NH</th>
<th>NJ</th>
<th>NY</th>
<th>VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer or Blacklegged tick</td>
<td>41,149</td>
<td>1003</td>
<td>21105</td>
<td>2885</td>
<td>2741</td>
<td>1139</td>
<td>5464</td>
<td>2242</td>
</tr>
<tr>
<td>American dog tick</td>
<td>8,385</td>
<td>230</td>
<td>3111</td>
<td>490</td>
<td>915</td>
<td>425</td>
<td>703</td>
<td>132</td>
</tr>
<tr>
<td>Lone star tick</td>
<td>6,485</td>
<td>65</td>
<td>376</td>
<td>29</td>
<td>18</td>
<td>572</td>
<td>1163</td>
<td>23</td>
</tr>
<tr>
<td>Western blacklegged tick</td>
<td>1,630</td>
<td>0</td>
<td>16</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Pacific Coast tick</td>
<td>301</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Rocky Mountain wood tick</td>
<td>224</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Woodchuck tick</td>
<td>157</td>
<td>6</td>
<td>47</td>
<td>25</td>
<td>12</td>
<td>3</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Castor bean tick</td>
<td>97</td>
<td>0</td>
<td>21</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Brown dog tick</td>
<td>73</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td><em>Ixodes spinipalpis</em></td>
<td>62</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gulf Coast tick</td>
<td>58</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Ixodes angustus</em></td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Ixodes dentatus</em></td>
<td>49</td>
<td>3</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Squirrel tick</td>
<td>25</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Cayenne tick</td>
<td>19</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Asian long-horned tick</td>
<td>16</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Mouse tick</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Winter or Moose tick</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Passive Surveillance provides novel Public Health insights

- **Assessing Threats**
  - Who is getting bit by ticks?
  - When are they getting bit?
  - Where are these bites occurring?
  - What disease causing pathogens are involved?
Who is getting bit?
Age distribution of tick attacks
When are people/pets getting bit?
Seasonal Tick Activity (MA, 2019)

- Deer ticks
- Dog ticks
- Lone Star ticks

www.TickReport.com/stats
Deer (Blacklegged) tick tests
*Borrelia burgdorferi (Lyme)*
*Borrelia miyamotoi (relapsing fever)*
*Borrelia mayonii*
*Anaplasma phagocytophilum*
*Babesia microti*
*Ehrlichia-muris-like*

Non-Deer (non-Blacklegged) tick tests
*Borrelia burgdorferi (Lyme)*
*Borrelia lonestari (STARI)*
*Rickettsia rickettsii (Rocky Mountain Spotted Fever)*
*Rickettsia parkeri*
*Rickettsia philipii*
*Ehrlichia chafeensis (Ehrlichiosis)*
*Francisella tularensis (Tularemia)*
*Borrelia burgdorferi (Lyme)*
Where are these bites being reported?
Tick Bite Distribution
Distance between geo-location of tick bite and home address

N=51,439
## TickReport submissions from West Coast

<table>
<thead>
<tr>
<th></th>
<th>B. burg</th>
<th>B. miya</th>
<th>Ba. microti</th>
<th>A. phag</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. pacificus (n=381)</td>
<td>1.3%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>0.5%</td>
</tr>
<tr>
<td>I. spinipalpis (n=28)</td>
<td>14.3%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>10.7%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2.2%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>1.2%</td>
</tr>
<tr>
<td><strong>Non-endemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. cookei (n=1)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>I. holocyclus (n=1)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>I. ricinus (n=6)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>16.7%</td>
</tr>
<tr>
<td>I. scapularis (n=111)</td>
<td>27.0%</td>
<td>2.7%</td>
<td>3.6%</td>
<td>7.2%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>25.2%</td>
<td>2.5%</td>
<td>3.4%</td>
<td>7.6%</td>
</tr>
</tbody>
</table>

Alpha-Gal Red Meat Allergy
TickReports – Lone star ticks
*Amblyomma* (2017-2019)

N=4,931 Amblyomma tick bites (36.4K)
Alpha gal surveillance

- Human tick-bite data should be part of epidemiological investigations
  - Qualitative and Quantitative aspects of each tick encounter
- Human-biting tick data provides proactive evaluation of tick encounters
What pathogens are involved in these tick encounters?
Centerville, MA (2019)

Massachusetts (2019)
TBD pathogens and vectors

Ehrlichia muris in Ixodes cookei Ticks, Northeastern United States, 2016–2017

Guang Xu, Patrick Pearson, Stephen M. Rich

Author affiliation: University of Massachusetts–Amherst, Amherst, Massachusetts, USA

DOI: https://doi.org/10.3201/eid2406.171755

Ehrlichia muris is an agent of human ehrlichiosis. To determine its geographic spread in the United States, during 2016–2017, we tested 8,760 ticks from 45 states. A distinct clade of E. muris found in 3 Ixodes cookei ticks from the northeastern United States suggests transmission by these ticks in this region.
INDIVIDUAL benefits of exposure assessments
Course of action after early summer events

- **Tick Bite**
  - **Tick ReporT**
  - **Oral Therapy** (2X 100 mg Doxycycline)

- **Skin Rash**
  - **Tick ReporT**
  - **IgM/IgG ELISA**
  - **IgM/IgG Western Blot**
  - **Optional**
  - **Oral Therapy, usually Doxycycline** (10-20 days)

- **Summer Flu**
  - **Tick ReporT**
  - **IgM/IgG ELISA**
  - **IgM/IgG Western Blot**

- **More Severe symptoms**
  - **Tick ReporT**
  - **Standard Blood tests** (cytopeniae) – co-infections
  - **Oral Therapy, (Doxy)**
  - **Oral Therapy, (Quin or Ata)**

“Feeding ticks can be evaluated for tick-borne pathogens using PCR; however, pathogen identification does not mean that transmission of infection has occurred. Nonetheless, tick testing does provide information about exposure risk, can alert health care personnel to the possibility of a specific tick-borne infection and might support the diagnosis, as was the case in our patient.”
Find a tick?

Order a comprehensive TickReport™ and learn what disease causing microbes the tick may be carrying, including pathogens that cause Lyme disease.

Order a TickReport

How it Works

1. Place Your Order
Standard identification and testing for pathogens common to your species of tick, including pathogens that cause Lyme disease, costs $50 per tick. We also offer expanded packages that test a wider array of pathogens.

View detailed pricing

2. Mail Your Tick
Place your tick in a plastic bag and mail it to our lab. We'll identify it and determine the correct tests to apply. You may also hand deliver your tick to the laboratory.

We suggest using UPS or FedEx for fastest service.

3. Results in 72 hours
Your results are securely delivered via email within 3 business days after your tick arrives at our lab.
Intercom™ communications

Since April 2019, LMZ had **5566** conversations with tick-bite victims. Median response time of 4 minutes, 23 seconds.
Questions
Some Questions for You
Find a Colleague

• To post a profile about yourself and your work:
  • http://neipmc.org/go/APra
  • “Find a Colleague” site
  • http://neipmc.org/go/colleagues
Upcoming Webinars

• **Tick IPM #3: Asian Long-Horned Tick IPM**  
  Dr. Dina Fonseca and Dr. Matt Bickerton, Rutgers University,  
  July 13, 2020. 11:00 a.m.

• **Tick IPM #4: Habitat Management for Vector-borne Diseases**  
  Dr. Allison Gardner, University of Maine,  
  August 10, 2020. 11:00 a.m.

• **Tick IPM #5: Pathogens Found in Ticks Collected on School Grounds and Public Parks**  
  Drs. Jody Gangloff-Kaufmann, Joellen Lampman, Matt Frye, NYS IPM Program. Dr. Laura Goodman, College of Veterinary Medicine, Cornell University.  
  September 14, 2020, 1:00 p.m.

• **Tick IPM #6: Host-Targeted Tick Control – What Works, What Doesn’t, and What’s New**  
  Dr. Andrew Li, Research Entomologist, USDA-ARS Invasive Insects Biocontrol and Behavior Laboratory, Beltsville, MD.  
  September 30, 2020, 11:00 a.m.

• **Tick IPM #7: Leaf Litter/Snow Removal for Tick Reduction**  
  Dr. Kirby C. Stafford III, Connecticut Agricultural Experiment Station,  
  October 7, 2020 – 11 a.m.

For Updates: https://www.northeastipm.org/ipm-in-action/the-ipm-toolbox/
Recording of Tick IPM Webinar Series

- Past recordings and today’s Webinar will be available to view **on demand** in a few business days.

- [http://www.neipmc.org/go/ipmtoolbox](http://www.neipmc.org/go/ipmtoolbox)

- You can watch as often as you like.
Acknowledgements

This presentation was funded in part by the Northeastern IPM Center through Grant #2018-70006-28882 from the National Institute of Food and Agriculture, Crop Protection and Pest Management, Regional Coordination Program.