Mosquito & Tick Surveillance in West Virginia

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West Virginia Department of Health & Human Resources
Charleston, WV
Objectives

• Determine distribution of Lyme disease using human disease incidence and tick surveillance data
Tick-borne diseases by causative organism(s) and presence of tick vectors in West Virginia

<table>
<thead>
<tr>
<th>Tick-borne Disease</th>
<th>Pathogen(s)</th>
<th>Tick Vector(s) Present in WV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tularemia</td>
<td><em>Franciscella tularensis</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td>Anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Ehrlichiosis</td>
<td><em>Ehrlichia chaffeensis</em></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Ehrlichia ewingii</em></td>
<td></td>
</tr>
<tr>
<td>Lyme disease</td>
<td><em>Borrelia burgdorferi</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Powassan encephalitis (?)</td>
<td>Powassan virus</td>
<td>Groundhog tick (<em>Ixodes cookei</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Babesiosis (?)</td>
<td><em>Babesia microti</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Rocky Mountain spotted fever and</td>
<td><em>Rickettsia rickettsii</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td>other spotted fever rickettsioses</td>
<td>(and other spotted fever group</td>
<td>Brown dog tick (<em>Rhipicephalus sanguineus</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Rickettsia</em>)</td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gulf Coast tick (<em>Amblyomma maculatum</em>)</td>
</tr>
</tbody>
</table>
Summary of four tick-borne diseases reported in West Virginia 2000-2010

<table>
<thead>
<tr>
<th>Disease Name</th>
<th>Total Cases Reported</th>
<th>Annual Range</th>
<th>Annual Mean</th>
<th>Annual Median</th>
<th>Standard Deviation</th>
<th>Cumulative Incidence per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tularemia</td>
<td>2</td>
<td>0-1</td>
<td>0.2</td>
<td>0</td>
<td>0.4</td>
<td>0.01</td>
</tr>
<tr>
<td>Ehrlichiosis</td>
<td>8</td>
<td>0-3</td>
<td>0.7</td>
<td>0</td>
<td>1.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Rocky Mountain spotted fever</td>
<td>49</td>
<td>0-10</td>
<td>4.5</td>
<td>4</td>
<td>3.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>772</td>
<td>17-201</td>
<td>70.2</td>
<td>39</td>
<td>58.1</td>
<td>3.88</td>
</tr>
</tbody>
</table>
Reported Cases of Lyme Disease -- United States, 2011

1 dot placed randomly within county of residence for each confirmed case
Lyme Disease in West Virginia

Incidence of Lyme disease cases per 100,000 by county — West Virginia, 2011 (n=119)

- Berkeley: 58.63
- Fayette: 4.38
- Greenbrier: 5.59
- Hampshire: 33.60
- Jefferson: 66.39
- Mineral: 3.55
- Morgan: 39.92
- Wood: 1.15

Endemicity is based on the occurrence of 2 or more cases where the county is named as the count of exposure within 30 days of symptom onset.

Endemicity status is considered only on the basis of reported cases where all of the following criteria are true: 1) case was classified as confirmed; and 2) physician documented EM ≥3 cm; and 3) county of exposure was known and was within WV; and 4) case was reported from 2007-2011; and 5) appropriate confirmatory laboratory results per CDC case definition.
Lyme Disease Diagnostic Testing in West Virginia

The importance of appropriate testing

• Of 128 “not a case” investigations in 2011, only 27 had appropriate laboratory testing documented.
  – About 79% of investigation did not have CDC-recommended two-tier testing.

• 85 (66.4%) of these investigations had IgM Western blots as the only laboratory testing documented.

We are likely missing many cases of Lyme disease!
Lyme Disease Diagnostic Testing in West Virginia

Two-Tiered Testing for Lyme Disease

First Test
- Enzyme Immunoassay (EIA)
- OR
- Immunofluorescence Assay (IFA)

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

Positive or Equivocal Result
- Consider alternative diagnosis
- OR
If patient with signs/symptoms consistent with Lyme disease for ≤ 30 days, consider obtaining a convalescent serum
West Virginia DHHR Local Health Department Lyme Disease Surveillance Questionnaire

Are you familiar with CDC's recommended two-tier testing for Lyme disease?

- Yes: 62%
- No: 29%
- Unsure: 9%

What is the most challenging part of Lyme disease?

- Case ascertainment: 34%
- Getting in contact with healthcare providers: 33%
- Obtaining exposure information from Lyme cases: 19%
- Never conducted Lyme disease investigations: 14%
West Virginia DHHR Local Health Department Lyme Disease Surveillance Questionnaire

Do you feel you would benefit from training on Lyme disease case investigation?

- Yes: 81%
- No: 14%
- Unsure: 5%

Mock case scenarios average score: 54%
Range: 20% - 100%

<table>
<thead>
<tr>
<th>Case</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
<th>Case 5</th>
</tr>
</thead>
<tbody>
<tr>
<td># Incorrect</td>
<td>9</td>
<td>12</td>
<td>11</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Correct Answer</td>
<td>Probable</td>
<td>Not a case</td>
<td>Suspect</td>
<td>Confirmed</td>
<td>Not a case</td>
</tr>
</tbody>
</table>
West Virginia Lyme Disease Healthcare Provider Questionnaire

- Delivered questionnaire to local healthcare providers about their Lyme disease diagnostic procedures
- The survey is ongoing

Location of practice (town and county in WV)

Years in practice

Directions: Unless otherwise stated, please check one option for each question.

1. How many patients have you seen who you suspected had Lyme disease in the past three years (e.g., you ordered tests, saw clinical signs of Lyme disease, or prescribed antibiotics)?
   - One case
   - 2-10 cases
   - 11-20 cases
   - Greater than 20 cases

2. If you suspect a patient has Lyme disease, which laboratory test would you routinely order to confirm your diagnosis? Choose only one.
   - ELISA/IFA only
   - ELISA/IFA with reflex to IgM and IgG WB
   - IgM WB only
   - Other:

3. Indicate laboratories from which you order Lyme disease tests. Check all that apply.
   - LabCorp
   - Quest Diagnostics
   - ARUP
   - Solias
   - VisiMed
   - iGenex
   - Other:

4. Do you report suspect and confirmed cases of Lyme disease to the patient’s LHD within one week of diagnosis?
   - Yes
   - Sometimes
   - No
   - Not sure or do not understand

5. Have you or been contacted by a local health department to provide additional clinical information about any of your suspect or confirmed Lyme disease patients?
   - Yes
   - No
   - I am not sure or do not understand the question.

*Please provide comments on the method of contact and how it can be improved.

6. “Form A” (page 3) is used by LHDs in West Virginia to obtain clinical information once a Lyme disease positive laboratory result has been received. Have you ever filled out “Form A” for one of your patients?
   - Yes
   - No
   - I am not sure or do not understand the question.

*Please provide comments on the usefulness of this form and how it can be improved.

*Provider Quick Sheet for Lyme disease* (page 4) has information about laboratory testing and resources for patients and providers. Have you ever received this document from a patient’s LHD?
   - Yes
   - No
   - I am not sure or do not understand the question.

*Please provide comments on the usefulness of the quick sheet and how it can be improved.

Information about West Virginia’s Lyme disease surveillance system is available on the West Virginia Department of Health and Human Resources website. Have you ever visited this website?
   - Yes
   - No
   - I am not sure or do not understand the question.

*Please visit the page and provide comments on its usefulness and how it can be improved.

Thank you for your participation in this survey.
Lyme Disease Surveillance-Case Investigations

Miguella Mark-Carew, PhD
Zoonotic Disease Epidemiologist
April 30th, 2013
Presentation Outline

By the end of this webinar, participants should be able to:

- Understand Lyme disease and its epidemiology
- Understand the West Virginia Lyme disease surveillance system (WVLDSS)
- Conduct thorough Lyme disease case investigations
- Perform surveillance case ascertainment for Lyme disease
2011 National Case Definition of Lyme disease
(Borrelia burgdorferi) for National Surveillance

Confirmed case

1) A case of EM with a known exposure OR
2) A case of EM with laboratory evidence of infection and without known exposure OR
3) A case with at least one late manifestation that has laboratory evidence of infection
2011 National Case Definition of Lyme disease (Borrelia burgdorferi) for National Surveillance

Exposure: Having been (less than or equal to 30 days before onset of EM) in woody, bushy or grassy areas (i.e. potential tick habitats) in a county in which Lyme disease is endemic.

Endemic: At least two confirmed cases have been acquired in the county or in which established populations of a known tick vector are infected with Borrelia burgdorferi
West Virginia DHHR OEPS Tick Survey

• Active tick sampling conducted late spring – early summer and fall – early winter 2011, 2012, and 2013
  • Coincide with *I. scapularis* emergence

• Samples from cooperating national parks, state forests, and state parks
  • Counties with established populations of blacklegged tick
  • Counties with recent Lyme disease or human anaplasmosis activity
  • Counties with blacklegged ticks recovered from human or animal residents
  • Counties with apparent suitable blacklegged tick habitat
West Virginia DHHR OEPS Tick Survey

• Standardized tick drag collecting

• Tick specimens screened for human pathogens by Army Institute of Public Health, United States Army Public Health Command
West Virginia DHHR OEPS Tick Survey 2013

- Eight counties actively surveyed
- *Ixodes scapularis* activity in Brooke County
- *Ixodes scapularis* populations recovered from Preston, Hancock, and Kanawha County (as defined in Dennis et al. (1998))
- *Ixodes scapularis* from Kanawha and Preston counties were not infected with *Borrelia burgdorferi*, *Anaplasma phagocytophilum* or *Babesia microti*
- *Ixodes scapularis* from Hancock County infected with *Borrelia burgdorferi* and *Anaplasma phagocytophilum*
- *Dermacentor variabilis* from National Boy Scout Jamboree were not infected with *Rickettsia* spp.
West Virginia DHHR OEPS Tick Survey 2013

- Single *Ixodes scapularis* from human host in Randolph County (November 2012)
- Two *Ixodes scapularis* from human host in Tucker County (January 2013)
- One *Ixodes scapularis* from human host in Hampshire County (January 2013)
- Single *Ixodes scapularis* from human host in Greenbrier County (May 2013)
- One *Ixodes scapularis* from human host in Summers County (June 2013)
West Virginia DHHR OEPS Tick Survey

- Mailed tick submission forms to West Virginia veterinarians during spring 2013
- Veterinarians could mail tick specimens for species identification
- Ticks retained for future human pathogen testing
- Human pathogen testing for surveillance purposes, not diagnostic purposes
West Virginia DHHR OEPS Tick Survey

<table>
<thead>
<tr>
<th>Species of Tick</th>
<th># of ticks submitted and identified</th>
<th>Animal species from which tick was removed</th>
<th># of counties tick species based on home county of animal</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dermacentor variabilis</em>¹</td>
<td>465</td>
<td>Dog, Cat, Human, Raccoon</td>
<td>29</td>
</tr>
<tr>
<td><em>Amblyomma americanum</em>²</td>
<td>5</td>
<td>Dog, Cat</td>
<td>3</td>
</tr>
<tr>
<td><em>Ixodes scapularis</em>³</td>
<td>104</td>
<td>Dog, Cat</td>
<td>8</td>
</tr>
<tr>
<td><em>Ixodes cookei</em>⁴</td>
<td>6</td>
<td>Dog, Raccoon</td>
<td>3</td>
</tr>
<tr>
<td><em>Haemaphysalis leporispalustris</em>⁵</td>
<td>1</td>
<td>Rabbit</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>587</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Summary of veterinary tick submissions for the current reporting period in West Virginia.

¹Vector of tularemia and Rocky Mountain spotted fever
²Vector of ehrlichiosis, tularemia, and STARI
³Vector of Lyme disease, anaplasmosis, babesiosis, and Powassan encephalitis
⁴Vector of Powassan encephalitis
⁵Vector of tularemia in rabbits
West Virginia DHHR OEPS Tick Survey

Veterinary Tick Submissions\(^1\) Across WV based on home county of animal\(^2\) (N=30) — May 20\(^{th}\) to November 25\(^{th}\), 2013

Legend
- No submissions to date
- *D. variabilis*
- *A. americanum* and *I. scapularis*
- *D. variabilis* and *I. scapularis*
- *A. americanum* and *D. variabilis*
- *D. variabilis* and *I. cookei*
- *I. scapularis*, *D. variabilis*, and *I. cookei*
- *A. americanum*, *D. variabilis*, and *H. leporispalustris*

\(^{1}\)Twenty-seven veterinary practices submitted 387 tick specimens from 194 animals (dogs, cats, raccoons, a rabbit, and humans).
\(^{2}\)30 counties are represented on the map; there were two animals with home counties in Maryland.
West Virginia DHHR OEPS Tick Survey

*Ixodes scapularis* incidence, 2013

Lyme disease infection in humans, 2013

Office of Epidemiology and Prevention Services
DIVISION OF INFECTIOUS DISEASE EPIDEMIOLOGY
www.dide.wv.gov
Summary

• Human cases of Lyme disease may be underrepresented due to inappropriate lab diagnostics

• *Ixodes scapularis*, the tick species associated with Lyme disease and human anaplasmosis, is found beyond the eastern panhandle
Summary

• Blacklegged ticks from Lyme disease endemic regions of West Virginia are infected with *B. burgdorferi* (and *A. phagocytophilum*)

• Blacklegged ticks from northern panhandle of West Virginia, a region not endemic for Lyme disease, are infected with *B. burgdorferi* (and *A. phagocytophilum*)

• Continue to determine distribution of ticks and prevalence of human disease in the tick population
Objectives

- Determine seasonal peak in arboviral activity in mosquitoes
- Compare seasonal peak of arboviral activity in mosquitoes and human hosts
- Determine geographic distribution of viruses responsible for mosquito-borne disease
- Compare geographic distribution of arbovirus in mosquitoes to human disease incidence
- Determine the impact of invasive mosquito species (*Aedes albopictus, Aedes japonicus*) on arboviral epidemiology
- Continually search for new mosquito vectors and exotic arboviruses
- Work with local health departments to reduce human incidence of mosquito-borne disease
West Virginia DHHR Mosquito Survey 2013

- Mosquito surveillance conducted May 23 through September 25, 2013
- Regular weekly sampling at counties with high La Crosse encephalitis (LAC) incidence (Raleigh, Fayette, Nicholas) and low LAC incidence (Kanawha, Wood, Jackson)
- Outlying areas were surveyed on semi regular basis by state or local WV DHHR agents
West Virginia DHHR Mosquito Survey 2013

- Standardized gravid trap, CO₂ emitting light trap, and BG Sentinel trap
- Mosquitoes tested for human pathogens (WNV, LAC, SLE, EEE) by West Virginia DHHR Office of Laboratory Services
West Virginia DHHR Mosquito Survey 2013

- Floodwater and wetland mosquito species, such as *Aedes vexans* and *Psorophora columbiae*, became more active due to heavy precipitation in late spring and summer.

- *Psorophora howardii* represents a new state record for the species. Larvae are predatory on other mosquito larvae capable of transmitting disease.
West Virginia DHHR OEPS Mosquito Survey 2013

- West Nile virus (WNV) activity in mosquitoes (*Culex pipiens*, *Culex restuans*, *Culex erraticus*) peaked during the first few weeks in June (Weeks 23-24)
- WNV activity remained low for the remainder of the summer; much lower than the mosquito WNV infection rates during 2012
• 27 of the 770 mosquito pools were infected with West Nile (WN) virus
• Listed below are the number of WN positive mosquito pools per county: Cabell (10), Nicholas (6), Wood (4), Berkeley (2), Harrison (1), Mercer (1), Fayette (1), Braxton (1), Wayne (1)
• 1 WN human case in Monongalia County
• 22 of the 770 mosquito pools were infected with La Crosse (LAC) virus

• Listed below are the number of LAC positive mosquito pools per county: Kanawha (8), Fayette (4), Jackson (3), Cabell (3), Berkeley (2), Boone (1), Wayne (1)

• First record of LAC infected mosquitoes in Wayne, Cabell, Jackson, and Berkeley counties
• 11 human cases of La Crosse encephalitis
• Listed below is the number of LAC human cases per county in West Virginia: Raleigh (3), Kanawha (2), Greenbrier (3), Nicholas (1), Mercer (1), Boone (1)
First mosquito pool with LAC virus was collected June 12
First human LAC case occurred on June 19
LAC activity in mosquitoes coincided temporally with LAC human case onset
Five mosquito pools of *Ae. japonicus* were infected with LAC virus

- *Aedes japonicus* is a competent LAC vector in laboratory studies
- First records of field-collected *Ae. japonicus* with LAC virus infection in West Virginia
West Virginia DHHR OEPS Mosquito Survey 2013

- LAC virus isolated from seven pools of mixed *Aedes* species
  - Mixed pools contained *Ae. triseriatus* and/or *Ae. albopictus*
• Four mosquito pools of *Anopheles punctipennis* and six mosquito pools of *Culex* spp. were LAC positive
  – Unknown if *Anopheles punctipennis* is a competent LAC vector
  – *Culex pipiens/restuans* may be competent LAC vector
LAC infection in *Aedes* species (*Ae. triseriatus*, *Ae. albopictus*, *Ae. japonicus*) throughout summer and early autumn.

LAC virus in other mosquito species (*Anopheles punctipennis*, *Culex* spp.) during late season feeding on (infected) mammals.
Summary

• Despite an initial peak early in the season, WNV infection remained low in the mosquito population

• LAC has been found in mosquitoes in new areas not usually associated with LAC human incidence
  • Human activity (tire and artificial container management, mosquito screens, less outdoor activity) and landscape modification may explain low human LAC incidence in these new areas

• LAC infection in mosquito populations followed the same seasonal pattern as LAC human case onset

• LAC virus has been isolated from natural populations of the *Ae. japonicus* for the first time in West Virginia