Tick-Borne Disease Burden and Trends in the U.S.

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Outline

• Key tick-borne diseases, their distributions and vectors
• Current disease burden
• Disease trends and drivers
• Tick-borne disease prevention (briefly)
Key tick-borne diseases, their distributions and vectors
Nationally notifiable tick-borne diseases in the U.S.

• Anaplasmosis
• Babesiosis
• Ehrlichiosis
• Lyme disease
• Powassan virus disease
• Spotted fever rickettsiosis
• Tularemia
Important tick species in the U.S.

Blacklegged Tick
Brown Dog Tick
Rocky Mountain Wood Tick
Lone Star Tick
Groundhog Tick
Soft Tick
American Dog Tick
Gulf Coast Tick
Western Blacklegged Tick
Distribution of nationally notifiable tick-borne diseases

- Lyme disease
- Anaplasmosis
- Babesiosis
- Rocky Mountain spotted fever
- Ehrlichiosis
- Tularemia
Current disease burden
## Reported cases of tick-borne diseases in the U.S. states and territories, 2016

<table>
<thead>
<tr>
<th>Diseases</th>
<th>2016 Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplasmosis/Ehrlichiosis*</td>
<td>5,750</td>
</tr>
<tr>
<td>Babesiosis</td>
<td>1,910</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>36,429</td>
</tr>
<tr>
<td>Powassan virus disease</td>
<td>22</td>
</tr>
<tr>
<td>Spotted fever rickettsioses**</td>
<td>4,269</td>
</tr>
<tr>
<td>Tularemia</td>
<td>230</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48,610</strong></td>
</tr>
</tbody>
</table>

*All anaplasmosis and ehrlichiosis species, including undetermined
**Includes *R. rickettsii, R. parkeri, Rickettsia* species 364D
## Top notifiable diseases, U.S., 2016

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlamydia</td>
<td>1,598,354</td>
</tr>
<tr>
<td>Gonorrhea</td>
<td>468,514</td>
</tr>
<tr>
<td>Syphilis</td>
<td>88,042</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>60,120</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>53,850</td>
</tr>
<tr>
<td><strong>Lyme disease</strong></td>
<td><strong>36,429</strong></td>
</tr>
<tr>
<td>HIV diagnoses</td>
<td>34,755</td>
</tr>
<tr>
<td>Pertussis</td>
<td>17,972</td>
</tr>
</tbody>
</table>

## Top notifiable diseases, Middle Atlantic U.S., 2016

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlamydia</td>
<td>200,882</td>
</tr>
<tr>
<td>Gonorrhea</td>
<td>51,765</td>
</tr>
<tr>
<td><strong>Lyme disease</strong></td>
<td><strong>19,675</strong></td>
</tr>
<tr>
<td>Syphilis</td>
<td>13,113</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>7,820</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>4,993</td>
</tr>
<tr>
<td>HIV diagnoses</td>
<td>4,488</td>
</tr>
<tr>
<td>Pertussis</td>
<td>3,124</td>
</tr>
</tbody>
</table>
Confirmed Lyme disease cases by age and sex, U.S., 2001-2016
Lyme disease under-reporting in the U.S.

• All reportable conditions are subject to under-reporting.
• Magnitude of under-reporting less for diseases that:
  – Are rare or unusual
  – Require hospitalization
  – Have a definitive diagnostic test
• Principal reasons for under-reporting of Lyme disease:
  – Busy health care providers don’t fill out the report form.
  – Health departments do not have time to follow up on missing information.
# Estimates of Lyme disease under-reporting

<table>
<thead>
<tr>
<th>State</th>
<th>Year</th>
<th>Under-reporting</th>
<th>Method</th>
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<tr>
<td>CT</td>
<td>1992</td>
<td>6-9 X</td>
<td>MD survey(^1)</td>
</tr>
<tr>
<td>MD</td>
<td>1992-3</td>
<td>10-12 X</td>
<td>MD survey(^2)</td>
</tr>
<tr>
<td>NY</td>
<td>1991-4</td>
<td>4 X</td>
<td>Tick bite model(^3)</td>
</tr>
<tr>
<td>WI</td>
<td>1992-8</td>
<td>3 X</td>
<td>Record review (^4)</td>
</tr>
</tbody>
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Lyme disease testing by large commercial laboratories in the U.S.

Hinckley A, Connally N, Meek J, et al.
Clinical Infectious Diseases 2014; 59:676-81

Results:

• 3.4 million Lyme disease tests conducted annually on 2.4 million patients
• 288,000 estimated infections (Range: 244,000 – 444,000)
• Annual cost of testing alone estimated to exceed $490M per year
Incidence of clinician diagnosed Lyme disease in the U.S., 2005-2010


Results:

• >103 mil person-years of observation
• 44,445 outpatient and 985 inpatient Lyme disease diagnoses identified
• Epidemiologic patterns similar to U.S. surveillance data
• Estimated 329,000 patients treated for Lyme disease annually (range 296,000 - 376,000)
Estimates of Lyme disease under-reporting

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<td>3 X</td>
<td>Record review (^4)</td>
</tr>
<tr>
<td>All</td>
<td>2008,10</td>
<td>8-10 X</td>
<td>Lab survey,(^5) Claims data(^6)</td>
</tr>
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Disease trends and drivers
Discovery of tick-borne pathogens as causes of human disease by year, 1960–2016

- Year represents when tickborne pathogen was recognized as cause of human disease.
Reported Lyme Disease Cases by Year, U.S., 1991-2016

Cases

Year


Probable* Confirmed

0 5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000
Other nationally notifiable tick-borne diseases have also increased.

Annual Reported Cases of Three Selected Tick-borne Diseases, 2000–2015

- Anaplasmosis
- Ehrlichioses
- Spotted fever group rickettsioses

Reported Cases

Source: cdc.gov/mmwr/mmwr_nd/index.html; cdc.gov/mmwr/volumes/65/wr/pdfs/mm6546.pdf
Lyme disease U.S. case distribution: 16-year trend

N = 17,209

N = 36,429

* One dot placed randomly within county of residence for each confirmed case

Geographic expansion of ticks – locations where *Ixodes scapularis* recorded

- **Established**: ≥6 or more ticks or ≥1 life stage recorded in a single year
- **Reported**: <6 individuals of a single life stage recorded in a single year

Tick-borne disease emergence – re-emergence in the U.S.

- Reforestation
- Overabundant deer
- Expansion of suburbia into wooded areas
- Abundant habitat around homes for Lyme reservoir hosts
- Increased numbers of ticks
- Increased exposure opportunities in people
- Changing climate

Source: K. Stafford, CT Agricultural Experiment Station

Climate, weather, and tick-borne diseases

- Warmer annual temperatures will result in a generally northward expansion in tick distribution.
- Warmer temperatures increase reproductive capacity of ticks, leading to larger populations of ticks.
- Higher moisture levels allow tick survival in warmer environments.
- With milder winters and earlier springs, tick vectors will likely show earlier seasonal activity.
- Larger tick populations, longer seasonal activity and expanding range of ticks will likely increase risk of human exposure to infected tick.

Tick-borne disease prevention
Protection against tick-borne diseases

No vaccines are currently available in the U.S., but a Lyme disease vaccine trial is underway in Europe...

Valneva Reports Positive Phase I Interim Results for Its Lyme Vaccine Candidate VLA15

Phase I study (VLA15-101) primary endpoint met

- No safety concerns associated with VLA15 in any treatment group

Encouraging Immunogenicity with VLA15

- VLA15 is immunogenic in all doses and formulations tested
- Good OspA-specific IgG antibody responses against all OspA serotypes

Protection against tick-borne diseases relies on …

• Reducing exposure to ticks
  – On persons, pets, and property
• Quickly removing any ticks on people or their clothing
• Early and accurate diagnosis and treatment
Lyme disease prevention toolkit

• Brochure
  – Lyme Disease: A Public Information Guide

• Fact Sheets
  – Lyme disease prevention fact sheet for outdoor workers
  – Lyme disease prevention fact sheet for hikers
  – Lyme disease prevention fact sheet for golfers
  – Lyme disease fact sheet for pregnant women
  – Lyme disease fact sheet for parents

• Radio PSAs
  – Lyme disease prevention (3 versions)
  – Talking to Patients about Preventing Tick Bites

• Trail Sign

• Lyme Disease Prevention for Kids
  – Crossword puzzle and information sheet for kids
  – Prevention bookmarks

http://www.cdc.gov/lyme/
Summary and Conclusions

• Tick-borne diseases are an important public health concern in the U.S.
• Tick-borne diseases are increasing in the U.S. in incidence, distribution, and in the numbers of new disease agents.
• The drivers for tick-borne disease emergence are related to increasing exposure to infected ticks, largely a result of increasing deer populations and other changes in natural or built environments.
• In the absence of vaccines to any tick-borne disease in the U.S., primary prevention focuses on reducing exposure to ticks and quickly removing any ticks on people or their clothing.
Thank you for your time and interest!

Acknowledgments:
Numerous staff in CDC’s Division of Vector-Borne Diseases but particularly Paul Mead, Gil Kersh, Becky Eisen, Susanna Partridge and Ann Perea

The findings and conclusion in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.