Tick Surveillance as a Public Health Tool

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Overview of Trends, New Concerns

- Majority of vector-borne diseases in the U.S. are tickborne diseases
- Increasing number of tickborne disease cases over time
- Expanding geographic range of tickborne cases
- Growing number of tickborne agents recognized to cause human disease
- *Introduction of new tick species that may serve as vector of human pathogens*
Majority of Reported Vector-Borne Diseases are Spread by Ticks

Cases of Nationally Notifiable Vector-borne Diseases Reported in the U.S., 2017

- Lyme disease (68%)
- Other tickborne Diseases (27%)
- Mosquito- or flea-borne diseases (5%)

N = 62,399 cases
Increasing Number of Tickborne Disease Cases

Annual Reported Cases of Lyme disease

- Confirmed cases
- Probable cases*

*National Surveillance case definition revised in 2008 to include probable cases; details at http://www.cdc.gov/ncphi/disss/nndss/casedef/lyme_disease_2008.htm
Expanding Geographic Range of Tickborne Disease Cases

Distribution of reported Lyme disease cases, 2001 and 2015

cdc.gov/lyme/stats/index.html
Growing Number of Tickborne Agents Recognized to Cause Human Disease, 1909-1960

- **Amblyomma spp.**
- **Dermacentor spp.**
- **Ixodes spp.**
- **Ornithodoros spp.**

**Rickettsia rickettsii** (Rocky Mountain spotted fever)

1900

**Francisella tularensis** (tularemia)

1920

**Borrelia turicatae** (tick-borne relapsing fever)

1940

**Borrelia hermsii** (tick-borne relapsing fever)

**Borrelia parkeri** (tick-borne relapsing fever)

1960

**Colorado tick fever virus** (Colorado tick fever disease)

**Powassan virus** (Powassan encephalitis)
Growing Number of Tickborne Agents Recognized to Cause Human Disease, 1960-2018

- Amblyomma spp.
- Dermacentor spp.
- Ixodes spp.
- Ornithodoros spp.

1960:
- Babesia microti (babesiosis)

1980:
- Borrelia burgdorferi (Lyme disease)
- Ehrlichia chaffeensis (ehrlichiosis)

2000:
- Rickettsia parkeri (rickettsiosis)
- Anaplasma phagocytophilum (anaplasmosis)

2020:
- Rickettsia philipii (Pacific Coast tick fever)
- Heartland virus (Heartland virus disease)
- Borrelia mayonii (Lyme disease)
- Borrelia miyamotoi (B. miyamotoi disease)
- Ehrlichia muris (ehrlichiosis)
Reported Distribution of Lyme Disease Vectors has Expanded

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

Multistate Infestation with the Exotic Disease–Vector Tick
Haemaphysalis longicornis — United States, August 2017–September 2018

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Distributions of ticks and tickborne pathogens change over time.

Likelihood of human encounters with ticks and tickborne pathogens change over time and space.

Tick surveillance is intended to monitor trends in presence, abundance, and infection prevalence in medically important ticks to direct public health action.
Uses of Tick Surveillance Data in Public Health

- Provide actionable, evidence-based information to clinicians, the public, and policy-makers
  - Tracking changes in tick distribution, abundance
  - Identifying which pathogens are present in ticks and quantifying prevalence
  - Defining when ticks are active

- Explain and predict epidemiological trends
  - Expanding range and incidence of Lyme disease cases
  - Rarity of Lyme disease in the south, despite presence of the vector
  - Risk of exposure to agents of TBDs that are not notifiable
  - Predicting future expansion of ticks and TBD cases
Ticks of Public Health Significance

- Frequent human biters
- Capable of:
  - acquiring human pathogens during blood feeding on zoonotic hosts
  - maintaining infection between life stages
  - transmitting pathogens during blood feeding
- Of more than 80 species of ticks described in the U.S., roughly a dozen are frequent human biters and proven vectors of human pathogens (bridging vectors)
Range Maps of Ticks that Bite Humans in the U.S.

https://www.cdc.gov/ticks/geographic_distribution.html
Three Species as Vectors of Majority of Human Diseases

- *Ixodes scapularis*
  - Lyme disease
  - Anaplasmosis
  - Babesiosis
  - *Borrelia miyamotoi* disease
  - Powassan disease
  - Ehrlichiosis (*E. muris eauclairensis*)

- *Amblyomma americanum*
  - Ehrlichiosis; Heartland virus disease; Tularemia

- *Dermacentor variabilis*
  - Rocky Mountain spotted fever; Tularemia
CDC Goals for *Ixodes scapularis* Surveillance

- Update species distribution maps (reported and established counties)
- Define which pathogens are present in ticks and at what prevalence
- Assess regional differences in the density of host-seeking infected ticks
Reported Distribution of Lyme Disease Vectors has Expanded

1996

2015

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

Reported Ranges of Vectors and Cases are Expanding

1996

2015

Reported Lyme disease cases: one dot placed randomly within county of residence for each reported case

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
Density of Infected Host-Seeking Nymphs as an Acarological Risk Measure

Reported vector distribution 2015

Modeled acarological risk (DIN) 2004-2006

Reported Lyme disease cases 2015

Potential Range Expansion, *Ixodes scapularis*

Reported Distribution

Distribution of Suitable Habitat

How Does CDC Support State Tick Surveillance Efforts?

- Provide funding to states through ELC to support tick surveillance
- Technical guidance on approach and jurisdiction-specific considerations
- Tick identification and limited pathogen testing for *I. scapularis* and *I. pacificus*
  - *B. burgdorferi* s.s., *B. mayonii*, *B. miyamotoi*, *A. phagocytophilum* and *Ba. microti*
Tick Surveillance Program Progress, 2018

- Developed guidance for standardization of tick surveillance efforts
- Enhanced support to state health departments for tick surveillance
  - Funded ~25 jurisdictions through ELC to support tick surveillance
  - Identified 1,500 ticks to species (submitted from 3 jurisdictions)
  - Tested ~5,000 ticks for 5 known human pathogens submitted by 8 jurisdictions and 1 CoE
- Developed the Tick Module in ArboNET
Questions?

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- Additional Information:
  
  www.cdc.gov/ticks/surveillance/