Michigan Vector-Borne Disease Update

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Why do we care?

- Mosquito-borne diseases are present in Michigan every year and present a serious risk to human and animal health.
- Mosquito Control is one of the foundations of preventive public health practice.
- MDHHS performs and supports human and ecologic surveillance for mosquito-borne disease in order to inform the public, healthcare providers, and stakeholder agencies about preventive measures and control options.
Mosquito-borne virus illness

- Generally 3-15 days incubation period
- Symptoms range from acute febrile illness, to painful arthritis, to neuro-invasive disease and hemorrhage
- Depend upon age, medical history, etc.
- Various viruses with different abilities to cause clinical illness
  - West Nile: 1 in 5 morbidity/<1% severe/3-15% severe illness results in death
  - EEE: rare, but high mortality ~33%
  - Chikungunya: >70% morbidity, rarely fatal
  - Zika: mild clinical illness, but may cause severe birth defects
- Treatment is supportive
Neuro-invasive disease

Is an inflammation of the brain, or meninges with symptoms ranging from mild to acute, both physical and mental.

- Headaches
- Neck pain
- Fever
- Confusion
- Irritability
- Tremors
- Coma
- Death
Michigan mosquito-borne diseases

**Endemic Diseases**
- West Nile Virus
- St. Louis Encephalitis
- Eastern Equine Encephalitis
- California Group Viruses

**Imported Diseases**
- Chikungunya
- Dengue
- Zika

**Zoonotic**

**Anthroponotic**
Arbovirus Human Cases: Michigan 2018

- Michigan’s local health departments (LHDs) and the MDHHS promptly investigate all reports of mosquito-borne disease using the Michigan Disease Surveillance System (MDSS)

- As cases are confirmed, the information is reported to the Centers for Disease Control and Prevention (CDC) through the ArboNET system

- Throughout the arbovirus transmission season, surveillance information is posted to the Michigan Emerging Diseases website at www.michigan.gov/emergingdiseases

<table>
<thead>
<tr>
<th>Arbovirus</th>
<th>Locally Acquired/Imported</th>
<th>2018 Cases</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Equine Encephalitis</td>
<td>Locally Acquired</td>
<td>1 case (Allegan Co.)</td>
<td>0</td>
</tr>
<tr>
<td>Jamestown Canyon Virus</td>
<td>Locally Acquired</td>
<td>2 cases (Oakland, Menominee)</td>
<td>0</td>
</tr>
<tr>
<td>West Nile Virus</td>
<td>Locally Acquired</td>
<td>104 cases (3rd highest year)</td>
<td>9</td>
</tr>
<tr>
<td>Dengue</td>
<td>Imported</td>
<td>8 cases</td>
<td>0</td>
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</tbody>
</table>
West Nile Virus – 2018 National Data*

~2,500 WNV cases  
>120 fatalities

*provisional data as of 12/11/18
WNV- MI Epidemiology

Geographic Distribution - Statewide

Seasonal epidemic late summer into fall

Habitat Distribution – primarily urban/suburban

Humans – 1 in 150 severe symptoms; up to 20% mild; and 80% no symptoms
  ◦ Age Distribution – all ages, primarily older (50+)

Key Factors – Culex species & birds, hot/ dry summers
Michigan: West Nile virus human cases 2002-2018

- 2002: 104 West Nile Human Cases, 9 West Nile Deaths
- 2018: 104 West Nile Human Cases, 9 West Nile Deaths
2018 WNV Epidemiology in Michigan

Cases: 104
Fatalities: 8
Asymptomatic Donors: 12

Neuroinvasive: 79%
Fever: 21%

Onset Range: June 19– Oct 20
Age Range: 19 – 92
Median Age: 65
Male: 64%

69% of WNV cases in four counties
2018 Arbovirus EPI Curve
Michigan Mosquito Surveillance Capacity

- Bay area county mosquito control districts (N=4)
- Commercial city and township mosquito control programs
- Federally funded local health department surveillance in WNV high-incidence jurisdictions (N=5)
Local Health Department Mosquito Surveillance

- CDC funded
- MDHHS provides training to LHDs in cooperation with MSU and MMCA
- Provide for timely, low-cost, non-labor intensive surveillance program to detect WNV activity at the community level
- Program to provide “actionable” information
- May provide training, expertise, and experience for future surveillance needs (emerging vector-borne diseases) and public health workforce
2018 Positive Mosquitoes

- 159 West Nile positive pools
- No other arboviruses identified in mosquito pools
- Most mosquito surveillance from Bay Area Mosquito Control Districts
- Michigan State University tests via PCR for EEE, LAC, SLE, and WNV
- Five local health jurisdictions test mosquito pools using VecTOR Test kits
Statewide Human & Mosquito EPI Curves

Mosquito MIR = #infected mosquitoes/1,000 mosquitoes
Arbovirus testing available at the MDHHS Bureau of Labs

- When to consider?
- Arbovirus serology
  - West Nile virus
  - Eastern Equine Encephalitis
  - St. Louis Encephalitis
  - LaCrosse Encephalitis
- Arbovirus travel panel
  - Chikungunya
  - Dengue
  - Zika
Human Diagnostic Testing for Arboviruses

Patients presenting with meningitis/encephalitis from May-Nov should be tested for all arboviruses potentially circulating in Michigan; WNV, SLE, EEE, California Group viruses (LaCrosse)

CSF is the preferred specimen
  ◦ MDHHS turn-around is approximately 1 week

Paired sera is an alternative to CSF
  ◦ At MDCH, reserved for hospitalized patients for whom CSF is not available, more prolonged turn-around time

Flavivirus (SLE, WNV) cross-reaction poses a diagnostic dilemma, particularly for commercial labs that lack an equivalent EIA for SLE.
Other arboviruses identified in Michigan: 2018*

**Jamestown Canyon Virus**

- Member of the California Group viruses
- Emerging arbovirus with focus in the Upper Midwest
- First human cases identified in Michigan in 2018
  - Two cases
  - Oakland and Menominee Counties

*provisional data as of 12/11/18
Other arboviruses identified in Michigan: 2018*

**Eastern Equine Encephalitis**

- Periodic outbreaks in horses in MI
  - Generally SW Lower MI, however recently identified further north
  - Last large outbreak 2010

- Sporadic cases identified in white-tailed deer
  - Two identified in MI 2018
  - Cass County (1), Barry County (1)

- Sporadic human cases and during outbreak years
  - One case identified in MI 2018
  - Allegan County

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*provisional data as of 12/11/18
**Aedes albopictus in Michigan**

- On August 20, 2018 the Asian tiger mosquito was identified in Wayne County for the second year in a row
- Focal introduction/infestation near a tire business
- Wayne County health department, MDHHS, MSU, and the City of Romulus coordinated surveillance and response to the identification
- Mosquito control was initiated early September
- Increase in population until late October

![Graph showing Aedes albopictus collected: Romulus Site](chart.png)
Using Tick Surveillance to Estimate Lyme Disease Risk and Drive Public Healthy Action in Michigan
Lyme disease: background information

- Lyme disease is the most common vector-borne disease in the United States (Mead 2015)

- Vector: Ticks
  - Main vector in northeastern and north central U.S.: *Ixodes scapularis* (AKA blacklegged and deer tick)

- Pathogen: *Borrelia burgdorferi*
  - Bacterium
  - Spirochete
What is a tick?

- Ticks are more closely related to spiders and mites than insects.
- They must feed on blood to complete their life cycle.
- Ticks feed on a variety of animals from small and medium sized mammals, to birds and lizards.
- It is generally within the enzootic, or tick/animal cycle that tick-borne diseases are maintained.
- There are two major families of ticks:
  - Argasidae – Soft ticks
  - Ixodidae – Hard ticks
Ticks are common in Michigan

*Dermacentor variabilis* (American dog tick)
- Found in wooded and brushy habitats
- Most common tick in Michigan
- Oval scutum with white markings, brown abdomen
- Adults commonly bite and are active from early spring through the end of summer
- Vector: Rocky Mountain spotted fever

*Ixodes scapularis* (blacklegged tick)
- Common in wooded and brushy habitats
- Smaller size than *D. variabilis*
- Rounded, black scutum, red or gray abdomen
- Adults and nymphs will readily bite people. Adults: April – July, October – November
- Nymphs: May – August
- Vector: Lyme disease, anaplasmosis, babesiosis, deer tick Rocky Mountain spotted fever

Images: Kent Loeffeler, Cornell University
How do ticks sense their environment?

- Unlike insects ticks have no antennae.
- Unlike insects or spiders, hard ticks have 2 simple eyes or no apparent eyes.
- Ticks sense their environment with sensory organs on their legs and palps.
- They can detect heat, CO2, movement, and other ticks.
How do ticks find their prey?

The ticks that concern us in human health in the U.S. find their prey by “questing”

Ticks climb onto vegetation to await a passing animal often along animal and man-made trails

They may also crawl short distances in response to CO2

Ticks DO NOT jump, fly, or drop onto people from trees
Blacklegged tick & *B. burgdorferi* biology
Responsible for the majority of Lyme disease illness in the U.S. This is due to:

- Small size
- First infectious stage
- Active during peak outdoor recreation periods in the NE and Upper Midwest U.S.
Ticks will embed their mouthparts in the skin, and may be difficult to detect due to their small size. Prompt removal of ticks is preventative for Lyme disease as studies have shown it takes >36 hours for efficient \textit{B. burgdorferi} transmission to occur.

People come into contact with ticks while working or recreating in wooded areas or areas with shade and vegetation, which is the preferred habitat for Blacklegged ticks and small mammals.

**Ecology of Lyme disease**

Lyme disease is maintained in nature through a cycle of infection between Blacklegged ticks and small mammals.
What are symptoms of Lyme disease?

- Fever
- Fatigue
- Muscle aches (myalgia)
- Joint aches (arthralgia)
- Headache
- Erythema migrans (“bull’s-eye”) rash (3-30 days post-tick bite)
- Lameness/arthritis

If untreated: may manifest as disease of the nervous system, the musculoskeletal system, or the heart
Prevention

Avoid tick habitats

Protect your body from ticks
- Repellents: DEET for exposed skin, and permethrin for clothing

Find and remove ticks promptly
- Daily tick checks/shower
- Remove attached ticks with tweezers

Protect pets from ticks

Perform daily tick checks

CDC.gov

Lyme disease vaccination

Avoid tick-infested areas

Beauvoir Department of Health and Human Services
Not all ticks are infected

- Only blacklegged ticks transmit Lyme disease
- Only two stages of blacklegged ticks transmit Lyme disease

**B. burgdorferi** infection rate*

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Females</th>
<th>Infected Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>36-40%</td>
<td></td>
</tr>
<tr>
<td>Nymph</td>
<td>9-15%</td>
<td></td>
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*Endemic Locations
Public health significance

In 2013, Lyme disease was the 5th most commonly reported notifiable disease in the U.S.


Approximately 3.4 million LD tests nationwide in 2008 from 7 large commercial laboratories

- Cost estimates for laboratory services of $492 million
- Estimate 288,000 LD cases/year

2005-2010 Truven Health MarketScan Commercial Claims and Encounters Database analyzed

- Estimate 329,000 LD cases/year

Leading vector-borne disease, with increasing incidence over time...
... and over space

http://www.cdc.gov/lyme/stats/index.html
First detection of ticks, pathogen, and cases: Michigan’s UP late ‘80s, early ‘90s

Prevalence of *Borrelia burgdorferi* in Host-Seeking Ticks (Acari: Ixodidae) from a Lyme Disease Endemic Area in Northern Michigan

Isolation of *Borrelia burgdorferi* from Two Patients in Michigan
Low-incidence, emerging Lyme disease state

Michigan’s Upper & Lower Peninsulas differ in case incidence
  - UP >10/100,000
  - LP approx. 1/100,000

Currently tracking the invasion of infected blacklegged ticks into new areas in the state
Who does tick-borne disease affect?

Anyone working or recreating in forested or forest-edge habitats, including:

- Man-made trail systems
- Trails used by animals
- Campgrounds
- Brushy or grassy areas near buildings or yards
- Wooded river banks

Riverside Park, Ottawa County, MI
MDHHS Surveillance Efforts

**PASSIVE**
- Targeted surveillance
- More specific geographic location of ticks & potential tick-borne disease risk
- Emerging tick and pathogen surveillance

**ACTIVE**
- Routine
- Required by public health code
- Follow-up investigations; One Health collaborations

Emerging tick and pathogen surveillance may lack specificity due to difficulty determining exposure location.

- Human case surveillance
- Public tick submissions
Michigan Lyme Disease Cases by Year: 2002-2017

**2016 EPI SNAPSHOT**
1,295 investigations
Cases (n=221)
- Confirmed: 158
- Probable: 63

**Age**
- Range: 3-89 years
- Median: 45 years

**Race/Ethnicity**
- >85% Caucasian, Non-Hispanic

**EPI PROJECTIONS**
Based upon 2008-2017 averages

- 21% increase in case referrals/investigations per year
- 19% of case referrals meet case definition as confirmed, probable, or suspect case

**2020: Prediction**
3,150 referrals and 600 Lyme disease cases

†Case definition change
Reported Lyme disease cases in Michigan: 2017 EPI Curve

251/291 cases reporting onset date
2017 Human Lyme Disease Cases by County of Residence

Human Case Count
- 0
- 1-5
- 6-20
- Above 20
Lyme disease testing available at the MDHHS Bureau of Labs

- When to consider?
- Nationally recognized two-step testing algorithm
  - Step 1. Enzyme Immunoassay screen (EIA)
    - Highly sensitive test
    - *If Step 1 is equivocal or positive proceed to Step 2*
  - Step 2. IgM and IgG Immunoblot (IB/Western Blot)
    - Highly specific test
    - 2+ of 3 bands positive for IgM positive
    - 5+ of 10 bands positive for IgG positive

Image: CDC
Passive Tick Surveillance: Public Tick Submission

- From public, local health departments, human and animal healthcare providers
- Provides expert identification of tick species to guide:
  - Healthcare decisions
  - Future prevention and control efforts
- Test live blacklegged ticks for *B. burgdorferi*
- Information posted to Michigan Disease Mapper online application

**Public Tick Submissions: Michigan 1999-2018**

- Graph showing the number of ticks submitted from 1999 to 2018 with a significant increase in recent years.
- Red dashed line indicating a baseline or threshold for tick submissions.
Active Tick Surveillance: Focused Tick Drags

**Benefits:**
- Results can be verified
- Indicates high risk for human illness

**Drawbacks:**
- Personnel & time constraints
- Influenced by weather & location
Active Tick Surveillance: Focused Tick Drags

➢ Field surveillance coordinated with academic partners
➢ Locations directed by:
  • Public tick submissions
  • Veterinary submissions
  • Reported disease cases
➢ 2018 activities:
  • Over 220 total km sampled at 143 sites
  • 1,537 ticks collected April-November
  • Collaboration with CDC for emerging pathogen screening
Invasive Asian Longhorned Tick

• Not normally found in the Western Hemisphere, these ticks were first reported in the United States in 2017

• Have been found on pets, livestock, wildlife, and people

• The female tick can lay eggs and reproduce without mating

• In other countries, bites from these ticks can make people and animals seriously ill
  • As of October 2018, no harmful germs have been found in the ticks collected in the United States; research is ongoing
  • As of October 2018 longhorned ticks have been found in: Arkansas, Connecticut, Maryland, North Carolina, New Jersey, New York, Pennsylvania, Virginia, West Virginia
Hands on Training: Local Health Department staff will gain hands-on experience in standard methods for field collection and identification of medically important ticks and mosquitoes.

Vector Surveillance Program Essentials: The workshop curriculum covers the essentials of maintaining a vector surveillance program, including methods for data collection, equipment and personnel considerations.

Expert Instruction: Workshop instructors include experts from public health, vector-control agencies, and academia that have extensive experience in the fields of tick and mosquito surveillance, identification, and control.

Networking: Participants will have multiple opportunities to engage with colleagues and counterparts from across Michigan, as well as interact with our team of vector-borne disease expert instructors.
Workshop Specifics

Designed for environmental health professionals working at Michigan Local Health Departments (two staff per health jurisdiction)

At the end of the training, attendees will:

◦ Understand vector-borne disease epidemiology in Michigan
◦ Be able to conduct sampling for medically important mosquitoes and ticks
◦ Be able to arrange for diagnostic testing of specimens from their jurisdiction
◦ Be able to consult with stakeholders regarding vector control

Cost: FREE – meals and lodging provided
Workshop FAQs

Who are the vector-borne surveillance workshops meant for?

Generally LHD Environmental Health staff, however if other LHD programs areas or partner agencies are interested in participating in vector surveillance, they may also attend.

What costs are supported for the vector-borne surveillance workshops?

The workshops are free. Participant lodging (up to two nights) and meals will be provided for the duration of the workshop. The MDHHS will not reimburse mileage.

What should I bring to the training?

Materials for taking notes. Attendees will also participate in a field exercise, appropriate outdoor clothing and footwear are recommended.
Workshop FAQs

What will we take with us from the workshop?

Participants will gain an understanding of vector-borne disease epidemiology in Michigan, methods for surveillance of medically important ticks and mosquitoes, the ability to identify mosquitoes and ticks, and a basic understanding of vector control.

Participants will also take home some surveillance equipment necessities, including:

- **BG2 mosquito trap lures**
- **Tick drags (two per jurisdiction)**
- **Collection equipment for tick surveillance**
- **Flash drive with resources such as mosquito and tick keys, data sheets and reporting information, sample collection protocols, and a media tool kit.**
Michigan Disease Mapper
www.michigan.gov/midiseasemapper
UPDATED!

*Mobile-friendly
*Great info. for the public

www.michigan.gov/emergingdiseases
More resources available online

www.michigan.gov/lyme

www.cdc.gov/lyme
If you find a tick...
Don’t get Ticked!
We can Help!

CITIZEN SUBMITTED TICK PROGRAM

- Identify the tick
- Test blacklegged ticks (if alive & off a human)

Got a Tick? Submit a Pic!
Identify the tick electronically

FREE service available to MI residents!

www.Michigan.gov/lyme

MDHHS-Bugs@Michigan.gov
Why Report Communicable Diseases?

- Identification of outbreaks & epidemics.
- Enabling preventative treatment and/or education to be provided.
- Successful targeting of:
  - Prevention Programs
  - Identify Care Needs
  - Efficient Use of Resources
- Evaluation of the success of long-term control efforts
- Facilitation of epidemiologic research to uncover a preventable cause.
- Assistance with national & international disease surveillance.
- Compliance with Michigan’s public health laws.

Guide to Disease Reporting in Michigan (Brick Book)

PDF of MDHHS Brick Book

Reportable Diseases by Condition

PDF of RD List by Condition

Reportable Diseases by Pathogen

PDF of RD List by Pathogen
Questions?

Feel free to contact us at:
517-335-8165
MDHHS-Bugs@michigan.gov