"One Health"

“Greater progress in prevention and control of infectious diseases requires a more directed effort focusing on the complex interplay between human health, the health of animals, and the environment.”

-CDC One Health Office

West Nile Virus in Michigan

EPIDEMIOLOGY AND HUMAN CASE INVESTIGATION

Kim Signs, DVM
Zoonotic Disease Epidemiologist
One Health Webinar Series
MDCH Communicable Disease Division
July 9, 2013
The West Nile Virus Cycle

- The virus is maintained by a mosquito-bird cycle
- Primary amplifying and bridge vectors are *Culex* species mosquitoes
- Typical virus amplification reaches peak levels in late summer

Figure © Gabe Hamer

Surveillance for Arboviruses Including WNV

<table>
<thead>
<tr>
<th>Ecologic</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecologic surveillance provides the best opportunity for early detection and intervention to reduce human risk</td>
<td>• Meningitis/encephalitis patients</td>
</tr>
<tr>
<td>• Reservoir species (birds)</td>
<td>• Blood donors</td>
</tr>
<tr>
<td>• Sentinel species (non-avian wildlife and domestic animals)</td>
<td></td>
</tr>
<tr>
<td>• Mosquitoes</td>
<td></td>
</tr>
</tbody>
</table>
Geographic Distribution of Arboviruses

- **West Nile virus** (WNV) – flavivirus, first detected in the state in 2001, now endemic
- **St. Louis Encephalitis virus** (SLE) – flavivirus, historic outbreak in the 1970’s, sporadic cases
- **LaCrosse virus** (LAC) – bunyavirus, sporadic cases
- **Eastern Equine Encephalitis virus** (EEE) – alphavirus, sporadic cases, occasional outbreaks particularly in equine
- **Powassan virus** – flavivirus, tick-borne

Michigan’s WNV Interagency Group

- Michigan Department of Community Health
  - Bureau of Epidemiology
  - Bureau of Laboratories
- Michigan State University
  - Diagnostic Center for Population and Animal Health
  - Department of Entomology
- Michigan Department of Agriculture and Rural Development
  - Pesticide and Plant Pest Mgt. Division
  - Animal Industry Division
- Michigan Department of Natural Resources
  - Wildlife Diseases Laboratory
- Michigan Department of Environmental Quality
  - Water Division
  - Waste and Hazardous Materials Division
A One Health Approach to WNV in Michigan

**LOCAL & STATE PARTNERS IN DISEASE SURVEILLANCE**

**HUMAN CASES**
- Private Health Care Provider
- Blood Collect. Agency
- Laboratories
- Local Public Health Dept.

**DOMESTIC/ZOO ANIMAL CASES**
- MSU DCPAH
- MDA Animal Ind. Div

**ECOLOGIC CASES**
- DNR Wildlife Div.
- Local Public Health Dept.
- MSU DCPAH MED ENT
- Mosquito Control District

**STATEWIDE SURVEILLANCE & DATA INTEGRATION**

**FEDERAL SURVEILLANCE PROGRAM**
- MDSS
- MDCH CD DIVISION
- ARBONET

**NETSS/ NEDSS**
- CDC
- ARBONET

---

**ArboNET**

- ArboNET is a web-based surveillance data network comprising 54 state and local public health departments and CDC
- Surveillance for Arbovirus disease including West Nile virus, St. Louis encephalitis, Eastern Equine encephalitis, Dengue and others
- A unique strength of ArboNET is that it combines reporting of human, ecologic, and geographic data into one surveillance system.
National Surveillance Data

www.cdc.gov/westnile

- Epi-X: CDC Arboviral Activity Update
  - All arboviruses
  - Updated weekly
- USGS West Nile virus page
  - All arboviruses by geographic region
  - Epi-curves of human and animal cases

Michigan Outputs

- Data is shared with the public for local consumption
- County and zip-code level data
- Prevention information is provided
Purpose of Website

www.michigan.gov/westnilevirus

- Inter-agency site with MDCH, MDARD, MDNR, MDEQ, MDTMB, e-Michigan, and MSU.
- Disseminate up-to-date information on WNV surveillance data in birds, horses, humans, and mosquitoes.
- Solicit dead corvid reports and specimens for testing.

Benefits to Public Health

- Epidemiologists can draw relationships between ecologic data and human case data
- May allow for prediction of disease outbreak
- Control and education efforts can be mobilized to minimize human disease
Ecologic Testing Capacity in Michigan

Diagnostic Center for Population and Animal Health (DCPAH)

- **Arbovirus Dx**—animals (equine, domestic pets, wildlife):
  - PCR (tissue, swabs, blood feathers, CSF)
  - IHC (tissue)
  - IgM Capture ELISA (serum)

- **Entomology/MMG**
  - Mosquito PCR (SLE, WNV, EEE, LaCrosse)

Mosquito testing/surveillance

In Michigan, limited mosquito surveillance and testing is conducted through the Bay Area Mosquito Control Districts. While this provides a good indicator of mosquito activity and infection, it does not provide specific information as to the risk in Michigan’s most highly affected regions.
2012 West Nile Virus Activity* in Michigan

![Graph showing the weekly count of human WNV cases and the Culex mosquito population from April to October 2012. The graph indicates the peak infection rate occurred in late July and early August. The first WNV+ mosquito pool/neurologic wildlife detected is marked with a star.]

Arbovirus Case Definition

A clinically compatible case of arboviral disease is defined as follows:

Neuroinvasive disease
- Fever (≥100.4°F or ≥38°C) as reported by the patient or a health-care provider, AND
- Meningitis, encephalitis, acute flaccid paralysis, or other acute signs of central or peripheral neurologic dysfunction, as documented by a physician, AND
- Absence of a more likely clinical explanation.

Non-neuroinvasive disease
- Fever (≥100.4°F or ≥38°C) as reported by the patient or a health-care provider, AND
- Absence of neuroinvasive disease, AND
- Absence of a more likely clinical explanation.
Patients presenting with meningitis/encephalitis from May-Nov should be tested for all arboviruses potentially circulating in Michigan; WNV, SLE, EEE, LAC

- CSF is the preferred specimen
  - MDCH 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.
Diagnosing Arboviruses Other Than WNV

- CDC and MDCH offer MIA and EIA tests for EEE, SLE and CGV not available through commercial labs
- IFA is methodology utilized by commercial laboratories offering EEE, SLE and CGV serology (lower cost, no BSL concerns)
- IFA is less sensitive than EIA at detecting IgM
- MDCH asks hospitals to submit CSF on patients with suspect viral meningitis/encephalitis for the arbovirus panel testing
- In 2010, several meningitis/encephalitis patients that tested “negative” for IgM and/or IgG utilizing an IFA against arboviruses at commercial labs were found to be positive using IgM EIA, MIA and PRNT methodology at BOL

Take Home Message

- MDCH utilizes “state of the art” methodologies for detecting arbovirus infections
- MDCH provides these tests free of charge to Michigan physicians and their patients
- Proper specimen and test selection is crucial in making the diagnosis of arboviral disease
  - CSF: IgM* MIA for WNV, SLE, EEE, IgM EIA for LAC
  - Serum: IgM* EIA, PRNT on acute and convalescent specimens

* IgG alone cannot be utilized to diagnose an acute arboviral illness
Human WNV Case Identification

Case #1
44yo male
Oakland Co.

Case #2
57yo male
Oakland Co.

Case #3
52yo female
Allegan Co.

July
August

Patient requested WNV + Lyme testing at ER x2
PCP collected initial and convalescent serum, processed at Mayo and per PCP request, was forwarded to MDCH BOL

Initial Specimen CSF
Sent direct to MDCH BOL
Initial sample to confirm 7 days

Initial Specimen CSF
processed at ARUP & forwarded to MDCH BOL
Initial sample to confirm 12 days

Initial Specimen CSF
processed at Mayo & forwarded to MDCH BOL
Initial sample to confirm 32 days

Prevention and intervention activities need to be implemented as soon as possible in the transmission cycle to be effective - to reduce the number of human cases
Prevention

- Early detection
- Personal Protection
- Mosquito Control

Education

- Surveillance Data Updated weekly
  - Emerging Diseases website
  - ArboNET USGS maps
- Risk Groups (age, health status, outdoor exposure, etc)
- Personal Protection
  - Source reduction
  - Behavior modification
  - Repellent Use
  - Vaccination
### Community Mosquito Control

<table>
<thead>
<tr>
<th>Cultural Controls</th>
<th>Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational campaigns</td>
<td>Larviciding</td>
</tr>
<tr>
<td>Filling areas prone to flooding</td>
<td>Killing mosquito larvae before they emerge</td>
</tr>
<tr>
<td>Drain management</td>
<td>The best, most cost-effective preventive measure</td>
</tr>
<tr>
<td>Scrap-tire campaigns</td>
<td>Adulticiding</td>
</tr>
<tr>
<td>Draining/filling abandoned pools</td>
<td>Killing mosquitoes “on the wing”</td>
</tr>
<tr>
<td></td>
<td>Ultra-low volume applications</td>
</tr>
</tbody>
</table>

Communities in Michigan with active mosquito control historically report fewer human cases of West Nile virus disease, despite detecting the disease in mosquitoes and wildlife yearly.

---

### Lyme Disease in Michigan

**Epidemiology and Human Case Investigation**

Erik Foster, MS  
Medical Entomologist  
One Health Webinar Series  
MDCH Communicable Disease Division  
July 9, 2013
The Lyme Disease Cycle

Ticks and wildlife hosts flourish in habitats with overlapping resources and environmental suitability.

Small mammals such as mice and chipmunks are reservoirs. Our companion animals, especially dogs, may become infected and show signs of illness.

People may become infected by an *Ixodes scapularis* tick when working or recreating in tick habitats.

Tick-borne diseases of Michigan

- Historically rare in the Lower Peninsula
- Tick-borne illnesses occurring in Michigan include:
  - **Lyme disease**
  - Rocky Mountain Spotted Fever
  - Anaplasmosis
  - Powassan Encephalitis (Deer tick virus)
- Other potential tick-borne illnesses:
  - Babesiosis
  - Ehrlichiosis
  - Tularemia

**Diseases underlined in blue are potentially transmitted by the Blacklegged tick.**
A One Health Approach to Lyme in Michigan

**LOCAL & STATE PARTNERS IN DISEASE SURVEILLANCE**
- **HUMAN CASES**
  - Private Health Care Provider
  - Laboratories
  - Local Public Health Dept.
- **PUBLIC TICK SUBMISSION**
  - MDARD PPPM
  - MSU DCPAH
- **ECOLOGIC INDICATORS**
  - DNR Wildlife Div.
  - MSU DCPAH/Fisheries & Wildlife
  - Local Public Health Dept.
  - Local Veterinarians

**STATEWIDE SURVEILLANCE & DATA INTEGRATION**
- MDSS
- MDCH CD DIVISION

**FEDERAL SURVEILLANCE PROGRAM**
- NETSS/NEDSS
- CDC

---

**Surveillance for *Ixodes scapularis* and Lyme Disease**

<table>
<thead>
<tr>
<th>Ecologic/Animal</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen submitted ticks</td>
<td></td>
</tr>
<tr>
<td>- Identified and forwarded to MDCH-BOL for Lyme testing if <em>I. scapularis</em> &amp; alive</td>
<td></td>
</tr>
<tr>
<td>- Lyme disease is not an animal reportable condition, however, building relationships with local veterinarians may allow for information to passed on if there is a rise in local animal cases</td>
<td></td>
</tr>
<tr>
<td>Field studies</td>
<td></td>
</tr>
<tr>
<td>- Small mammal trapping</td>
<td></td>
</tr>
<tr>
<td>- Tick drags</td>
<td></td>
</tr>
<tr>
<td>- PCR detection of <em>B. burgdorferi</em></td>
<td></td>
</tr>
</tbody>
</table>

*Lyme disease human surveillance focuses on identification of clinically acute cases:*

- Physician reported Lyme disease
- Laboratory reports
Lyme disease risk and human case incidence in Michigan: 2012

E. Foster, MDCH. 2013

Case Onsets: 2012

*based on analysis of 70 cases w-reported onset date, 2012.   E. Foster, MDCH. 2013
Case Investigation

INFORMATION YOU NEED TO GET STARTED:

DATE OF ILLNESS ONSET

COMPLETE CLINICAL PRESENTATION

DETAILED LAB RESULTS

TRAVEL HISTORY IN-STATE AND OUT-OF-STATE

EXPOSURE TO POTENTIAL TICK HABITATS (WOODED, BRUSH, OR GRASSY AREAS IN A LYME DISEASE ENDEMIC COUNTY OR STATE)

Definitions

Exposure
- Having been (< 30 days before onset of EM) in wooded, brush, or grassy areas (i.e., potential tick habitats) in a county in which Lyme disease is endemic.
- A history of tick bite is not required.

Endemicity
- A county in which Lyme disease is endemic is one in which at least two confirmed cases have been acquired in the county or in which established populations of a known tick vector are infected with B. burgdorferi.

Laboratory Evidence of Infection
- Positive culture for B. burgdorferi, OR
- Two-tier testing interpreted using established criteria, where:
  - Positive IgM immunoblot is sufficient only when ≤30 days from symptom onset
  - Positive IgG immunoblot is sufficient at any point during illness
- Single-tier IgG immunoblot seropositivity using established criteria.
- CSF antibody positive for B. burgdorferi by Enzyme Immunoassay (EIA) or Immunofluorescence Assay (IFA), when the titer is higher than it was in serum
Surveillance Case Definition

Confirmed:

a) a case of physician Dx EM with a known exposure OR,

b) a case of physician Dx EM with laboratory evidence of infection and without a known exposure OR,

c) a case with at least one late manifestation that has laboratory evidence of infection.

Probable:

a) any other case of physician-diagnosed Lyme disease that has laboratory evidence of infection

NOTE: Cases of Lyme disease can not be closed-out as suspect

Erythema Migrans (EM) Rash

EM is defined as a skin lesion that typically begins as a red macule or papule and expands over a period of days to weeks to form a large round lesion, often with partial central clearing. The rash is not painful or pruritic, but it may be warm to the touch:

- A single primary lesion must reach greater than or equal to 5 cm in size across its largest diameter.
- Secondary lesions also may occur.
- Annular erythematous lesions occurring within several hours of a tick bite represent hypersensitivity reactions and do not qualify as EM.

Tick bite with mild allergic reaction. Not an erythema migrans. Allergic reactions typically appear within the first 48 hours of tick attachment and are usually <5 cm in diameter.

Classic EM—Circular red rash with central clearing that slowly expands

Early disseminated Lyme disease—multiple red lesions with dusky centers
Late Manifestations (Disseminated Lyme disease)

- **Confirmatory**:
  - Arthritis (objective episodes of joint swelling)
  - Bells palsy or other cranial neuritis
  - Encephalomyelitis (CSF titer must be higher than serum titer), lymphocytic meningitis, or radiculoneuropathy
  - 2nd or 3rd degree atrioventricular block

- **Non-confirmatory**
  - Arthralgia
  - Bundle branch block
  - Cognitive impairment or encephalopathy
  - Fatigue, fever/sweats/chills, headache, myalgias, myocarditis, neck pain
  - Other rash
  - Palpitations, paresthesias, or visual/auditory impairments

---

Two-Tiered Testing for Lyme Disease

First Test
- Enzyme Immunoassay (EIA)
  - OR
  - Immunofluorescence Assay (IFA)
- Positive or Equivocal Result
- Negative Result

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

Consider alternative diagnosis
OR
If patient with signs/symptoms consistent with Lyme disease for ≤ 30 days, consider obtaining a convalescent serum
Caution When Reviewing Labs

CDC Guidelines for positive IgG Western Blot Interpretation include any 5 of the following 10 bands:

- P18
- P39
- P66
- P21-23
- P41
- P93
- P28
- P45
- P30
- P58

This example shows a laboratory that tests for alternate bands. Note the addition of P31, P34, P60, to make a total of 13 bands tested.
Did the patient have Erythema migrans (EM) rash that was >5 cm and diagnosed by a physician/medical professional that was noted in medical record, regardless of laboratory testing?

Yes

No

Was EM accompanied by other acute symptoms or did patient have exposure?

Yes

No

Exposure is defined as being in an area of MI or the US endemic for Lyme disease – no tick bite history is needed.

Are laboratory results present?

Yes

No

Laboratory results that meet CDC criteria:
- Positive *Borrelia burgdorferi* culture OR
- Two-tier* positive IgM Western Immunoblot (WB or IB) test collected within 30 days of onset OR
- Two-tier* positive IgG WB/IB test OR
- Single-tier positive IgG WB/IB test OR
- CSF antibody positive for *B. burgdorferi* by EIA or IFA (CSF titer must be higher than serum titer)

Laboratory results that DO NOT meet CDC criteria:
- Positive ELISA/EIA/IFA only OR
- IgM WB/IB only OR
- IgM WB/IB collected > 30 days after onset

Patient had/has at least one confirmatory sign or symptom diagnosed by physician or medical professional?

Yes

No

Patient had/has at least one non-confirmatory sign or symptom diagnosed by physician or medical professional?

Yes

No

Yes

Confirmed

Not a Case

Reports of EM rash from patients are not considered confirmatory – evidence for EM must be confirmed by healthcare provider.
**Tick Reporting in MDSS**

- Lab results from MDCH BOL are automatically entered in MDSS
  - If tick is non-*Ixodes*, results can be found under ‘Unusual Outbreak or Occurrence’
  - No IFA results will be listed in the report
- If tick is an *Ixodes scapularis*, it may be tested by IFA and Results can be found under ‘Lyme Disease’
  - Does not mean that a human case of Lyme disease actually occurred - Report can be completed as ‘not a case’.
- Tick identification and testing may be performed in support of clinical evaluation by physician – In an instance of a positive tick result, patient follow-up should be conducted

**Tick Identification and Testing**

*Kit includes:*
- plastic vial
- self-addressed, padded return envelope
- submission form
- instructions for submission
- “Ticks and Your Health” brochure

Available at: www.michigan.gov/lymedisease
Lyme Disease Prevention

What can we do to prevent tick-borne disease?

Everyone can personally prevent tick-borne disease by:

- Becoming educated about ticks
- Preventing tick bites:
  - Using personal and clothing repellents
  - Stay on the trail when hiking in the woods
  - Wear light colored clothing so ticks may be more easily seen
- Removing ticks promptly:
  - Conduct tick-checks daily/shower checks
  - Remove any attached ticks with fine tipped forceps
- Consulting healthcare provider promptly if signs of illness develop after tick bite, or being in an area endemic for Lyme disease
Guidance and Resources

- Information about ticks, tick-borne illnesses, treatment, preventions, ticks and pets, and maps.
- Order printed copies, or view online at: www.michigan.gov/cdinfo
- Flowchart to help classify cases of Lyme Disease
- Highlights symptoms and high risk areas
- Available at www.michigan.gov/cdinfo

Websites

- Emerging diseases in Michigan:
  - www.michigan.gov/emergingdiseases
- Information from CDC:
  - www.cdc.gov/lyme
- Posters, pamphlets, and guides available at:
  - www.michigan.gov/lymedisease