ArboNET: National surveillance system for arboviral diseases in the United States

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ArboNET background

- National electronic surveillance system for arboviral diseases in the U.S.
- Developed in 2000 in response to the detection of WNV in the U.S. in 1999
- Non-WNV arboviral diseases added to the system in 2003
ArboNET objectives

- Monitor the epidemiology, incidence, and geographic spread of WNV and other arboviruses
- Provide timely information regarding arboviral diseases to public health officials, government leaders, researchers, clinicians, and the public
- Support prevention and control efforts, and stimulate research on arboviral diseases
- Evaluate funding needs
Arboviruses listed in ArboNET

- Cache Valley (CV)
- California serogroup (CAL) [unspecified]
- Chikungunya (CHIK)*
- Colorado tick fever (CTF)*
- Dengue (DEN)
- Eastern equine encephalitis (EEE)
- Jamestown Canyon (JC)
- Japanese encephalitis (JE)
- LaCrosse (LAC)
- Powassan (POW)
- St Louis encephalitis (SLE)
- Venezuelan equine encephalitis (VEE)
- Western equine encephalitis (WEE)
- West Nile (WN)

*Added in 2008
Scope of ArboNET surveillance

- Human disease cases
- Presumptive viremic donors (PVDs) from routine blood donor screening
- Veterinary
- Avian
- Sentinel chickens
- Mosquitoes
Human disease case and PVD data elements

- Demographics (age, sex)
- County of residence
- Date of symptom onset (or date of donation)
- Type of arbovirus (WNV, LAC, SLE, EEE, etc.)
- Case status (Confirmed, probable, suspect, not a case)
- Clinical syndrome (Encephalitis, meningitis, fever, asymp)
- Hospitalized
- Outcome (Died/survived)
- Blood or organ recipient
New human disease case data for 2008

- Medical risk factors
  - Underlying medical conditions
  - Immunosuppressive medications

- Laboratory where arboviral testing was performed
  - Public health laboratory (CDC or state)
  - Commercial laboratory
Non-human surveillance data elements*

- Animal species
- State and county
- Date of symptom onset or collection
- Type of arbovirus (WNV, LAC, SLE, EEE, etc.)

*Includes veterinary, dead birds, sentinel chickens, and mosquitoes
Data reporting and flow

- Health care providers, veterinarians, and commercial labs report data to their state/local health department
- State/local health departments receive and enter surveillance data into an electronic database
- State health departments upload data to CDC database regularly (usually weekly)
- CDC analyzes data and disseminates information regularly (weekly during the WNV season)
Dissemination of ArboNET data

- Weekly updates posted online and EpiX
- Weekly updates of US Geologic Service (USGS) maps with number of cases by state and county
- Monthly MMWR updates from July-November
- Annual MMWR summary
- Peer-reviewed journal articles
ArboNET data provided in weekly updates

- Human neuroinvasive and non-neuroinvasive disease cases by state
- Human deaths by state
- Human case demographic data (age, sex)
- Viremic blood donors by state
- Veterinary, avian, sentinel, and mosquito cases/pools
- Comparisons to previous year at same week
### 2007 West Nile Virus Activity in the United States

<table>
<thead>
<tr>
<th>State</th>
<th>Encephalitis/Meningitis</th>
<th>Fever</th>
<th>Other Clinical/Unspecified</th>
<th>Total</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>17</td>
<td>7</td>
<td>0</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Arizona</td>
<td>50</td>
<td>45</td>
<td>2</td>
<td>97</td>
<td>6</td>
</tr>
<tr>
<td>Arkansas</td>
<td>13</td>
<td>7</td>
<td>0</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>California</td>
<td>154</td>
<td>220</td>
<td>6</td>
<td>380</td>
<td>20</td>
</tr>
<tr>
<td>Colorado</td>
<td>99</td>
<td>477</td>
<td>0</td>
<td>576</td>
<td>7</td>
</tr>
<tr>
<td>Connecticut</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Delaware</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Florida</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Georgia</td>
<td>23</td>
<td>24</td>
<td>3</td>
<td>50</td>
<td>1</td>
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<tr>
<td>Idaho</td>
<td>10</td>
<td>120</td>
<td>2</td>
<td>132</td>
<td>1</td>
</tr>
<tr>
<td>Illinois</td>
<td>57</td>
<td>26</td>
<td>18</td>
<td>101</td>
<td>4</td>
</tr>
<tr>
<td>Indiana</td>
<td>14</td>
<td>7</td>
<td>3</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>Iowa</td>
<td>12</td>
<td>15</td>
<td>3</td>
<td>30</td>
<td>3</td>
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<tr>
<td>Kansas</td>
<td>14</td>
<td>26</td>
<td>0</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Kentucky</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Louisiana</td>
<td>27</td>
<td>13</td>
<td>0</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Maryland</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Michigan</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Minnesota</td>
<td>44</td>
<td>57</td>
<td>0</td>
<td>101</td>
<td>2</td>
</tr>
<tr>
<td>Mississippi</td>
<td>50</td>
<td>86</td>
<td>0</td>
<td>136</td>
<td>4</td>
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</tbody>
</table>
WNV-Long-Term Effects- Clin Inf Dis Journal

THURSDAY, Aug. 24 (HealthDay News) -- Half of people infected with the West Nile virus experience ongoing health problems such as fatigue, headaches, depression and tremors a year after diagnosis, U.S. researchers report.

And people diagnosed with "relatively benign" West Nile fever were just as likely to experience long-term health complaints as people who had been hospitalized with more severe West Nile virus-related illnesses, such as meningitis or encephalitis, the study found.

For the complete article, go to http://www.journals.uchicago.edu/CID/journal/issues/v43n6/39303/39303.html

[thanks to Tom Baughman, IL DPH]

from L D Haramis, IL DPH

Reply to: "WNV- Long-Term Effects- Clin Inf Dis Journal" | Submit New Posting
http://diseasemaps.usgs.gov/

West Nile Virus
St. Louis Encephalitis
Eastern Equine Encephalitis
Western Equine Encephalitis
La Crosse Encephalitis
Powassan Virus

Disease Maps 2007
USGS national map of ArboNET data
USGS state map of ArboNET data

Cumulative 2007 Data as of 3 am, May 20, 2008
These data are provisional and may be reviewed or adjusted in the future

Human Disease Cases by Week - Colorado, 2007
Arboviral diseases are nationally notifiable conditions in the U.S.

Data reported to ArboNET from all states and three other districts (i.e., DC, NYC, Puerto Rico)

Human disease cases are classified and reported according to standardized, published case definitions

- Neuroinvasive (i.e., encephalitis, meningitis, AFP)
- Non-neuroinvasive disease (e.g., fever, other)
Neuroinvasive and non-neuroinvasive disease

- **Neuroinvasive disease**
  - Testing and reporting is thought to be fairly complete and representative
  - Data used to calculate rates, project total number of cases and infections based on serosurvey data, and compare trends over time and place

- **Non-neuroinvasive disease**
  - Testing and reporting varies by year and jurisdiction
  - Data used to identify human disease in areas where no neuroinvasive cases reported
Presumptive viremic donors (PVDs)

- Routine screening of U.S. blood supply using nucleic acid amplification tests (NAAT) since 2003
- Blood services agencies report donors who screen positive to the local/state health department
- PVDs followed up by the blood services agency with additional tests (PCR, IgM) to verify infection
- Some PVDs go on to develop symptoms after donation and are then reported as a case
Human WNV disease cases reported to ArboNET, 2007 (N=3,630)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNV neuroinvasive disease*</td>
<td>1,227</td>
<td>(34)</td>
</tr>
<tr>
<td>WNV fever</td>
<td>2,350</td>
<td>(65)</td>
</tr>
<tr>
<td>Not specified</td>
<td>53</td>
<td>(1)</td>
</tr>
</tbody>
</table>

*Encephalitis (n=765), meningitis (n=452), AFP (n=63); 53 patients had both AFP and concurrent encephalitis/meningitis
WNV human neuroinvasive disease incidence in the U.S., 2007
WNV presumptive viremic blood donors reported to ArboNET, 2007 (N=352)

<table>
<thead>
<tr>
<th>Condition</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic</td>
<td>281</td>
<td>(80)</td>
</tr>
<tr>
<td>WNV neuroinvasive disease*</td>
<td>5</td>
<td>(1 )</td>
</tr>
<tr>
<td>WNV fever*</td>
<td>66</td>
<td>(19)</td>
</tr>
</tbody>
</table>

*These PVDs were counted as human disease cases
WNV viremic blood donors in the U.S., 2007
Veterinary cases/ deaths

- Not nationally notifiable
  - Collection and reporting varies by jurisdiction
  - In 2007, veterinary data reported from 36 states/districts

- Veterinarians, animal control, wildlife management officers, and public health labs report cases to states

- Primarily horses but can include other non-human mammals (e.g., dogs, squirrels, cats, raccoons)
**WNV-positive non-human mammals reported to ArboNET, 2007 (N=507)**

<table>
<thead>
<tr>
<th>Animal</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equine</td>
<td>471</td>
<td>(93)</td>
</tr>
<tr>
<td>Squirrel</td>
<td>27</td>
<td>(5 )</td>
</tr>
<tr>
<td>Canine</td>
<td>5</td>
<td>(1 )</td>
</tr>
<tr>
<td>Other species</td>
<td>4</td>
<td>(1 )</td>
</tr>
</tbody>
</table>
USGS map of ArboNET veterinary data
Avian (dead birds)

- Not nationally notifiable
  - Collection and reporting varies by jurisdiction
  - In 2007, avian data reported from 37 states/districts

- Citizens, animal control, wildlife management officers collect and submit dead birds to lab

- Testing performed varies by jurisdiction
  - None, corvids only, all birds
  - Limited number, until human case detected, all birds
  - WNV only, other arboviruses
WNV-positive bird species reported to ArboNET, 2007 (N=1,883)

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American crow</td>
<td>991</td>
<td>(53)</td>
</tr>
<tr>
<td>Blue jay</td>
<td>273</td>
<td>(14)</td>
</tr>
<tr>
<td>Western scrub – jay</td>
<td>239</td>
<td>(13)</td>
</tr>
<tr>
<td>Yellow-billed magpie</td>
<td>110</td>
<td>(6 )</td>
</tr>
<tr>
<td>House finch</td>
<td>81</td>
<td>(4 )</td>
</tr>
<tr>
<td>House sparrow</td>
<td>58</td>
<td>(3 )</td>
</tr>
<tr>
<td>Red tailed hawk</td>
<td>30</td>
<td>(2 )</td>
</tr>
<tr>
<td>American robin</td>
<td>29</td>
<td>(2 )</td>
</tr>
<tr>
<td>Common raven</td>
<td>25</td>
<td>(1 )</td>
</tr>
<tr>
<td>Other species</td>
<td>47</td>
<td>(2 )</td>
</tr>
</tbody>
</table>
USGS map of ArboNET avian data
Sentinel chickens

- Not nationally notifiable
  - Collection and reporting varies by jurisdiction
  - In 2007, sentinel chickens reported from 14 states/districts

- Health depts place non-immune chickens in high risk areas to screen for arboviral seroconversion

- Testing performed varies by jurisdiction
  - WNV only, other arboviruses
  - Screen at variable intervals (weekly to monthly)
Mosquitoes

- Not nationally notifiable
  - Collection and reporting varies by jurisdiction
  - In 2007, mosquito data reported from 40 states/districts

- Health depts or vectors control agencies place traps to collect mosquito pools and evaluate the pools for species and arboviral infection

- Testing performed varies by jurisdiction
  - Number of traps and locations
  - PCR, culture
  - WNV only, other arboviruses
### WNV-positive mosquito pools by species reported to ArboNET, 2007 (N=8,082)

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culex spp., not specified</td>
<td>1,642</td>
<td>(20)</td>
</tr>
<tr>
<td>Cx. tarsalis</td>
<td>1,566</td>
<td>(19)</td>
</tr>
<tr>
<td>Cx. pipiens</td>
<td>1,555</td>
<td>(19)</td>
</tr>
<tr>
<td>Cx. pipiens/restuans</td>
<td>1,505</td>
<td>(19)</td>
</tr>
<tr>
<td>Cx. quinquefasciatus</td>
<td>1,081</td>
<td>(13)</td>
</tr>
<tr>
<td>Cx. pipiens complex</td>
<td>299</td>
<td>(4)</td>
</tr>
<tr>
<td>Cx. restuans</td>
<td>240</td>
<td>(3)</td>
</tr>
<tr>
<td>Cx. nigripalpus</td>
<td>68</td>
<td>(1)</td>
</tr>
<tr>
<td>Aedes albopictus</td>
<td>49</td>
<td>(1)</td>
</tr>
<tr>
<td>Other species</td>
<td>77</td>
<td>(1)</td>
</tr>
</tbody>
</table>
USGS map of ArboNET mosquito data

Background
Historical Data
FAQs
Links

Did You Know?
You can also navigate to Adjacent States by clicking on them.

Legend
- Positive Test Results
- Samples Submitted
- No Positive Test Results*

* States and counties in yellow either did not perform surveillance or did not report any positive test results from their surveillance.
ArboNET strengths (1)

- Comprehensive arboviral disease surveillance system that collects human, animal, and ecologic data
- Provides national human arboviral disease and PVD data using standardized case definitions
- Provides incidence, and geographic and temporal trends for neuroinvasive arboviral diseases
- Human, animal, and ecologic data gives broader picture of arbovirus transmission activity and migration
ArboNET strengths (2)

- Animal and ecologic data help define arbovirus animal reservoirs and vectors in the U.S. by region
- Electronic system with potential for real time reporting
- Timely, comprehensive, and readily available data feedback
- Strong collaborations between CDC, state/local health departments, blood services agencies, and USGS
ArboNET limitations

- Passive surveillance system
- Minimal clinical and laboratory data for human disease cases
- Cannot confirm that patients meet the case definition
- Can be long delays between case occurrence and reporting
- Human fever cases, animal data, and ecologic data are reported variably and likely not representative (i.e., clinically, geographically, or temporally)
- Different reporting system than is used for most other nationally notifiable diseases
- Requires significant personnel, time, and money
Do human fever case data provide a more complete picture of where human disease is occurring?

Do animal and ecologic data help predict human disease and provide timely warning for local outbreaks?

Can the data be used to develop predictive models for arboviral disease risk factors or trends?

Can the data be used to help perform clinical trials or post-marketing surveillance for a WNV vaccine?

Can the system help detect the introduction or emergence of a new domestic arbovirus (e.g., dengue, chikungunya, Japanese encephalitis, Zika)?
Acknowledgments

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- Peggy Collins and the ArboNET technical staff
- State/local health dept ArboNET surveillance coordinators