Arboviral Disease Surveillance — Kansas, 2012

Background

West Nile virus is an arbovirus (arthropod-borne virus) most commonly spread by infected mosquitoes. West Nile virus was first identified in the United States in 1999 and spread throughout the United States. From 1999 – 2012 there have been a total of 37,088 cases and 1,549 deaths in the United States[1].

Arboviruses, including West Nile virus, are transmitted by the bite of an infected mosquito. Natural transmission involves a mosquito-bird-mosquito cycle; animals such as humans and horses do not circulate enough virus to re-infect a blood-feeding mosquito, and thus are referred to as "dead-end" or "accidental" hosts. Several species of mosquitoes are responsible for transmission of arboviruses but *Culex* species are the primary vector for West Nile virus in the United States.

The incubation period for arboviral infections vary. The incubation period for West Nile virus ranges from 3 to 15 days with an average incubation period of approximately one week. Arboviral infections may be asymptomatic or may result in illness of variable severity. Approximately 80% of people who become infected with West Nile virus do not develop any symptoms[2]. About one in five people who are infected develop a fever with other symptoms such as headache, body aches, joint pains, vomiting, diarrhea, or rash[2]. Most people with 'West Nile virus Fever' recovery completely but fatigue and weakness can last for weeks or months[2]. Less than 1% of people who are infected develop a serious neurological illness, such as encephalitis or meningitis, and approximately 10% of people who develop this kind of an infection die[2].

The Kansas Department of Health and Environment (KDHE) began surveillance for West Nile virus (WNV) in 2001 and the first human case was reported in Kansas in 2003. This surveillance system has three main components: mosquito surveillance, human surveillance, and reporting the results to public health partners.

Methods

Mosquito Collection

Mosquito surveillance was conducted weekly from June 13 to October 24, 2013 by Dr. Christopher Rogers with the Kansas Biological Survey. Surveillance was conducted in those areas of Kansas where mosquito arbovirus transmission was most likely to occur or human cases had been previously reported. These areas are where large numbers of migratory birds, extensive mosquito habitats, and large human populations coincide.

An Encephalitis Vector Survey (EVS) trap, with dry ice as a carbon dioxide source, was used to collect mosquitoes. These traps typically attract mosquitoes that feed on humans or other mammals. An average of 13 traps was set each week in ten counties. The traps were put out at the designated location in the early evening and were collected the following morning. The contents of the traps were secured in a container and labeled with the address and/or GPS coordinates of the location of the trap. The mosquitoes were transported to the Kansas Biological Survey (KBS) at the University of Kansas for identification.

Mosquito Identification

The KDHE contracted with the Kansas Biological Survey (KBS) to enumerate and identify mosquitoes to species level. Mosquito counts of greater than 1,000 per trap were divided into a smaller subset for identification due to budget constraints. Those mosquitoes identified as potential West Nile virus vectors were submitted to the Kansas Health and Environmental Laboratories (KHEL) via the Douglas County Health Department courier for testing. Results from the enumeration and identification were entered on a Microsoft® Excel® spreadsheet and submitted by KBS to KDHE weekly via e-mail.

Arbovirus Testing in Mosquitoes

The mosquitoes from each trap location were tested at KHEL by polymerase chain reaction (PCR) for West Nile, St. Louis encephalitis, and La Crosse encephalitis viruses. The results were entered in an Excel® spreadsheet and sent to KDHE weekly. All results were posted to KDHE's website and reported to the ArboNET surveillance system. ArboNET is a national arboviral surveillance system managed by the Centers for the Disease Control and Prevention (CDC) and state health departments. The United States Geological Survey provides disease maps of reported human, mosquito, bird, sentinel, and veterinary arboviral disease cases. These maps can be accessed at the joint USGS and CDC website.

Human Case Surveillance

West Nile virus, and all other arboviral diseases, is a reportable disease in Kansas. It is a passive surveillance system; healthcare providers or laboratories are required to report cases to KDHE. Cases were classified according to the 2011 CDC case definition (Appendix A). It is important to note that these definitions are used for case counts only and are not used for clinical diagnosis. In addition, the county in which the person resides is used for surveillance purposes, although they may have been infected elsewhere.

The cases were entered into EpiTrax, Kansas' electronic disease surveillance system, and the corresponding local health department completed the investigation. The Arboviral Disease Investigation Guideline contains information to provide technical assistance with local surveillance and disease investigation. They contain not only disease specific information, but also sample letters, reporting forms, sample communication sheets and other tools to assist the local public health department.

Information on human West Nile virus case counts and rates can be found in KDHE's annual summary, Reportable Infectious Diseases in Kansas.

Animal Case Surveillance

West Nile virus infection of animals is not a reportable disease in Kansas. However, positive laboratory results are sent to KDHE as a courtesy from the Kansas Department of Agriculture's Division of Animal Health or the United States Department of Agriculture's Animal and Plant Health Inspection Service. All animal cases reported to KDHE during 2012 were in horses. West Nile virus cases in horses may serve as a sentinel of West Nile virus activity in Kansas. Kansas does not conduct surveillance of dead birds for West Nile virus.

Results

Mosquito Surveillance

The first mosquito collection began on June 13 and continued weekly through October 25. The following counties had at least one trap location during the surveillance time frame: Atchison, Butler, Chase, Doniphan, Douglas, Jefferson, Lyon, Morris, Sedgwick, Shawnee, and Wyandotte.

Mosquito Identification

The following mosquito species were identified in Kansas during 2012 (Table 1).

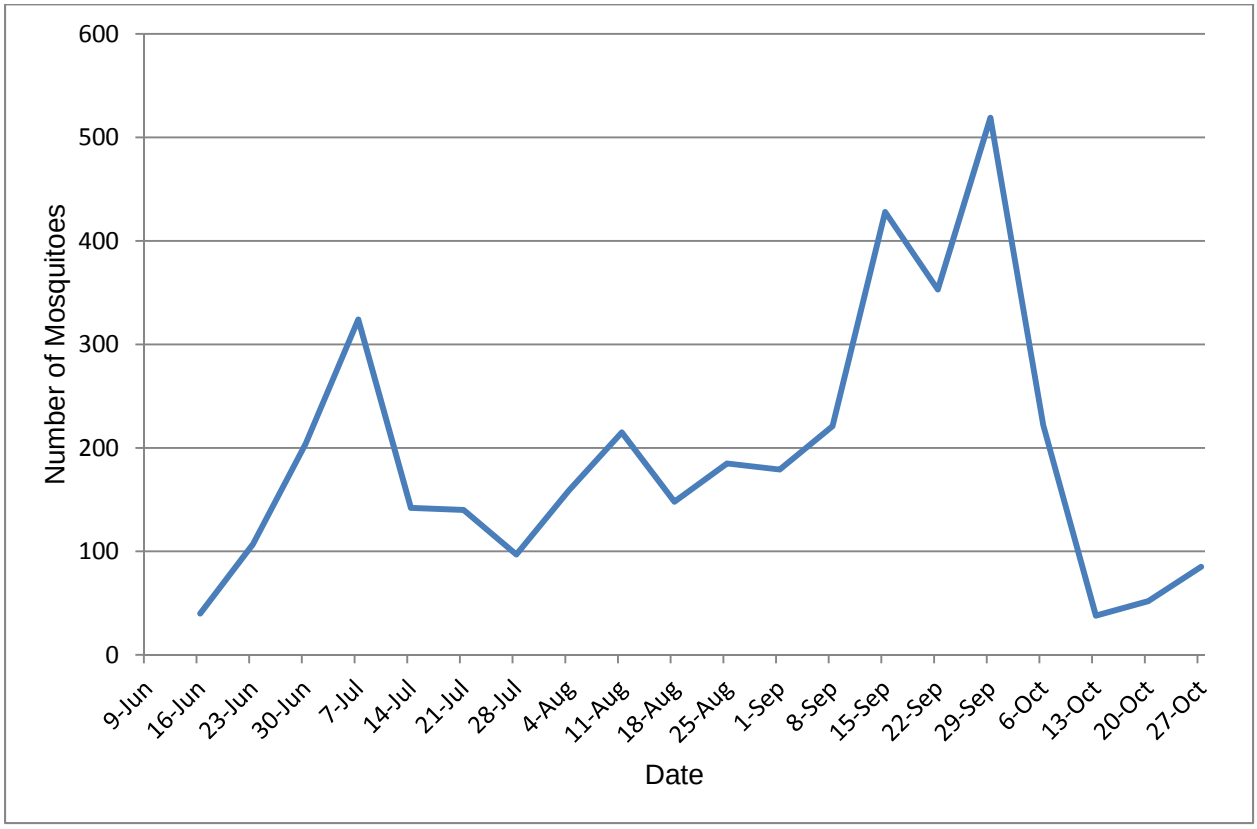
Table 1. Mosquito species identified, Kansas, 2012.

Mosquito Species	**County**
Aedes aegypti	Douglas
Aedes albopictus	Atchison, Butler, Chase, Doniphan, Douglas, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Aedes cinerreus	Shawnee
Aedes vexans	Atchison, Chase, Doniphan, Douglas, Jefferson, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Anopheles crucians	Wyandotte
Anopheles punctipennis	Butler, Doniphan, Douglas, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Anopheles quadrimaculatus	Atchison, Butler, Chase, Doniphan, Douglas, Lyon, Sedgwick, Shawnee, Wyandotte
Anopheles walkeri	Atchison
Culex erraticus	Doniphan, Shawnee
Culex pipiens/quinquefasciatus	Atchison, Butler, Chase, Doniphan, Douglas, Jefferson, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Culex tarsalis	Atchison, Butler, Chase, Doniphan, Douglas, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Culex resturans	Atchison, Butler, Chase, Doniphan, Douglas, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Culiseta inornata	Butler, Chase, Doniphan, Douglas, Lyon, Morris, Sedgwick, Shawnee, Wyandotte
Ochlerotatus triseriatus	Atchison, Butler, Chase, Doniphan, Douglas, Lyon, Shawnee
Orthopodmyia signifera	Shawnee
Psorophora ciliata	Doniphan
Psorophora colombiae	Doniphan, Shawnee
Psorophora discolor	Douglas

Mosquito Abundance

There was an average of 10 traps set one evening per week for a total of 20 weeks of surveillance. The median number of mosquitoes collected each week was 169 (range 38 – 519) (Figure 1).

Figure 1. Total number of mosquitoes collected, Kansas, 2012.



Arbovirus Testing in Mosquitoes

Mosquitoes were pooled for testing by location with up to 50 mosquitoes included per pool. A total of 196 mosquito pools were tested for LaCrosse and St. Louis encephalitis virus, and West Nile virus. There were three WNV-positive mosquito pools, one in each of the following counties: Douglas, Doniphan, and Sedgwick.

Human Case Surveillance

In 2012, a total of 57 cases of West Nile virus in humans were reported (Figure 2). This was the highest number of cases reported in Kansas since 2003. There were 7 confirmed and 14 probable cases of neuroinvasive WNV and 3 confirmed and 33 probable cases of non-neuroinvasive WNV. The median age was 54 years (range 2 – 89 years). Thirty-four cases

(60%) were hospitalized. Three (5%) deaths were reported. The earliest case was reported in April, with 88% (50/57) of cases occurring in July (n= 18), August (n = 15), and September (n = 17). The highest number of cases was in Sedgwick County residents with 37% (21/57) (Table 2). The incidence of all West Nile virus cases (both non-neuroinvasive and neuroinvasive) was 2.00 per 100,000 population (Figure 3).

Animal Case Surveillance

One West Nile virus positive horse from Sedgwick County was reported on August 8, 2012.

Figure 2. Human cases of WNV by week of disease onset, Kansas, 2012.

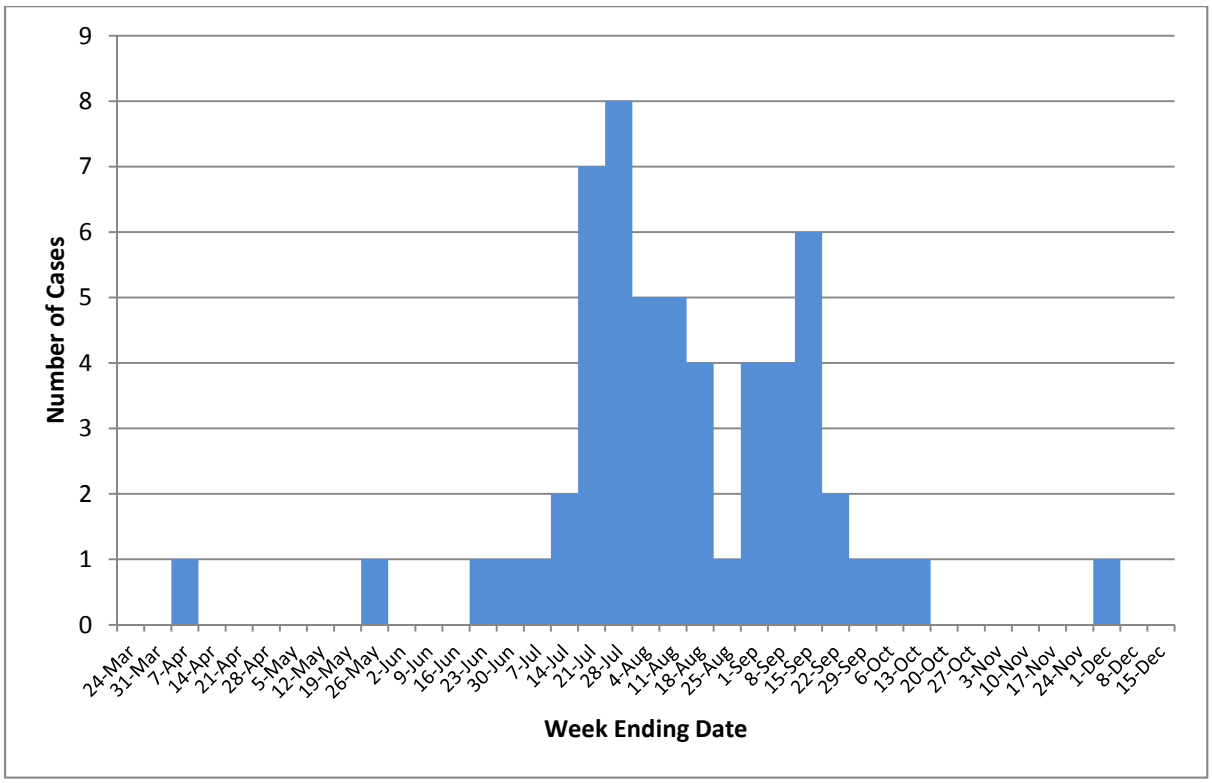
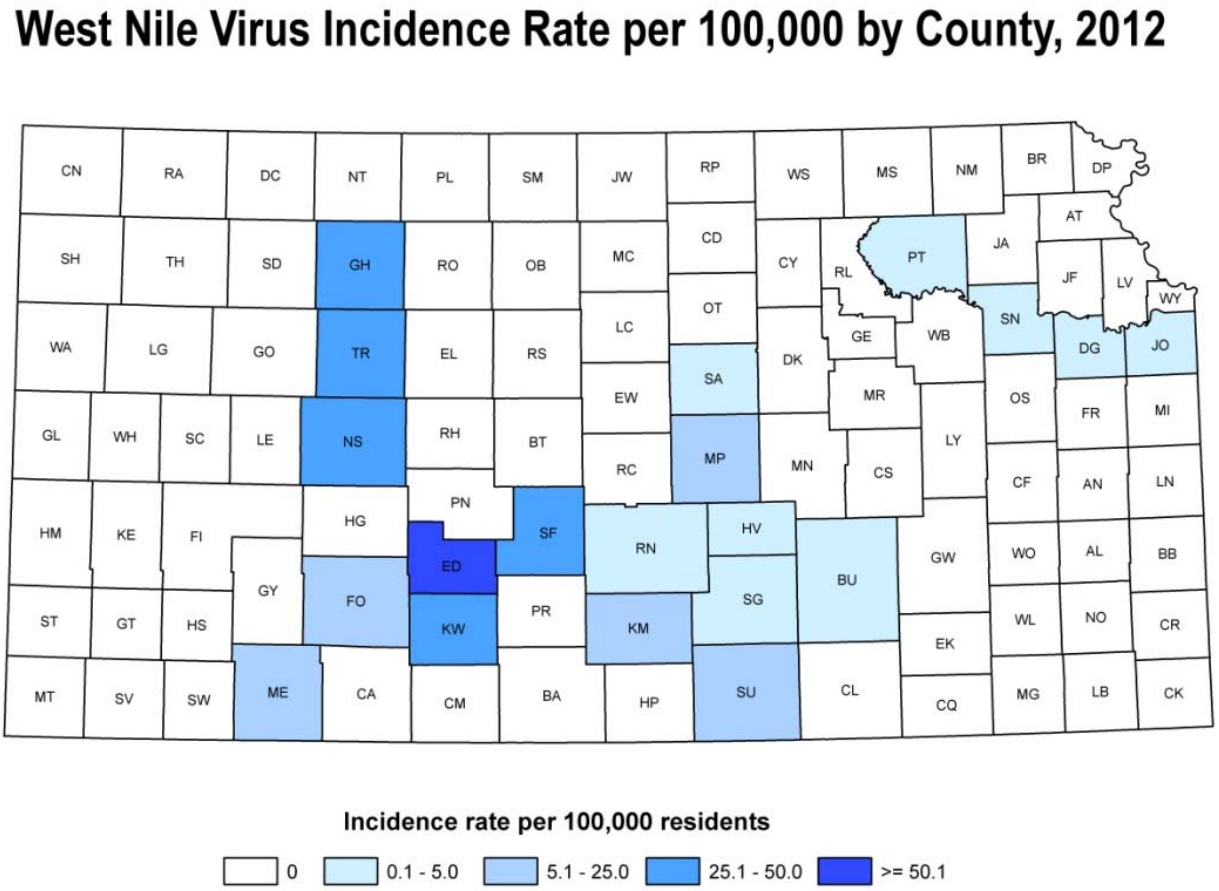


Table 2. Human cases of WNV by week of disease onset and county of residence, Kansas, 2012 (n=57).

MMWR Week of Disease Onset	Week Ending Date	County *(One case per county unless otherwise noted)*
14	April 7	Trego
15	April 14	
16	April 21	
17	April 28	
18	May 5	
19	May 12	
20	May 19	
21	May 26	Douglas
22	June 2	
23	June 9	
24	June 16	
25	June 23	Pottawatomie
26	June 30	Sedgwick
27	July 7	Sedgwick
28	July 14	Harvey, Sedgwick
29	July 21	McPherson (2), Reno, Sedgwick (3), Sumner
30	July 28	Butler, Reno, Sedgwick (6)
31	August 4	Sedgwick (4), Sumner
32	August 11	Edwards (2), Sedgwick (2), Stafford (2)
33	August 18	Graham, Johnson (2), Sedgwick
34	August 25	Butler
35	September 1	Edwards, Kingman, Sedgwick (2),
36	September 8	Ford (2), Saline, Shawnee
37	September 15	Ford, Johnson, Kiowa, Meade, Stafford, Sumner
38	September 22	Butler, Ness
39	September 29	Shawnee
40	October 6	Johnson
41	October 13	Reno
42	October 20	
43	October 27	
44	November 3	
45	November 10	
46	November 17	
47	November 24	
48	December 1	Johnson
49	December 8	

Figure 3.



Discussion

During 2012, the United States, and Kansas, experienced an outbreak of West Nile virus with more cases reported nationally than in any year since 2003[3]. West Nile virus has a complicated ecological cycle between birds and mosquitoes[4]. Many of these factors are influenced by weather[4]. Analysis of the West Nile encephalitis epidemic in Dallas, Texas during 2012 found that a mild winter with higher than normal daily temperatures and the absence of hard winter freezes likely contributed to the outbreak[5]. During the winter of 2011-2012 Topeka, Kansas recorded its second warmest winter (December, January, and February) with an average temperature of 37.6°F (3.1°C)[6].

There were a total of 203 mosquito pools tested; 1.5% (3/203) was infected with West Nile virus. The number of human cases appears high when compared to the proportion of West Nile virus positive mosquito pools from past years[7] (Table 3). Prior to 2012 only confirmed cases of West Nile virus were reported by KDHE to CDC however in 2012 KDHE reported both confirmed and probable cases therefore the case counts from 2012 cannot be compared to prior years.

Table 3. Proportion of West Nile virus Positive Mosquito Pools Compared to Number of Reported Human Cases[7].

Year	Proportion Mosquito Pools Positive for West Nile virus (%)	Number of Human Cases
2002	6	22
2003	12	91
2004	17	43
2005	8	19
2012	1.5	57*

**Confirmed and probable cases of West Nile virus reported to CDC in 2012. Prior to 2012 only confirmed cases reported to CDC by KDHE.*

Mosquito surveillance for West Nile virus has been conducted in Kansas annually since 2001 (with the exception of 2010). In the past, surveillance sites have been distributed around the state in an attempt to represent mosquito activity for the entire state. During 2012 surveillance was conducted in 11 counties typically with one trap per location. The first WNV positive mosquito pool was collected on July 23rd (MMWR Week 21) in Douglas County, the second was collected on September 11th (MMWR Week 37) in Doniphan County, and the third was collected on September 20th (MMWR Week 38) in Sedgwick County. The WNV positive mosquito pools in Douglas and Sedgwick County were collected 9 and 12 weeks respectively after the first human case of WNV in those counties developed symptoms. There were no cases of WNV reported in residents of Doniphan County. We were unable to use WNV positive mosquito pools to predict local transmission. KDHE will conduct an After Action Review of the 2012 mosquito surveillance plan with stakeholders and modify the surveillance plan based on the feedback provided and available funding.

Outbreaks of arboviruses, such as West Nile virus, are difficult to predict. People should take the following precautions to protect against arboviruses:

- When you are outdoors, use insect repellent containing an EPA-registered active ingredient on skin and clothing, including DEET, picaridin, oil of lemon eucalyptus, or IR3535. Follow the directions on the package.
- Many mosquitoes are most active at dusk and dawn. Be sure to use insect repellent and wear long sleeves and pants at these times or consider staying indoors during these hours.
- Make sure you have good screens on your windows and doors to keep mosquitoes out.
- Get rid of mosquito breeding sites by emptying standing water from flower pots, buckets and barrels. Change the water in pet dishes and replace the water in bird baths weekly. Drill holes in tire swings so water drains out. Keep children's wading pools empty and on their sides when they aren't being used.

References

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Appendix A – 2011 West Nile Virus Surveillance Case Definition

Clinical Criteria for Surveillance Purposes

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.

Laboratory Criteria for Surveillance Purposes

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***
- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred, ***OR***
- Virus-specific IgM antibodies in CSF or serum.

Surveillance Case Definitions

- *Confirmed:*

  Neuroinvasive disease

  A case that meets the above clinical criteria for neuroinvasive disease and one or more the following laboratory criteria for a confirmed case:

  - Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
  - Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***

- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred.

Non-neuroinvasive disease

A case that meets the above clinical criteria for non-neuroinvasive disease and one or more of the following laboratory criteria for a confirmed case:

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF, or other body fluid, ***OR***
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera, ***OR***
- Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen, ***OR***
- Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred.

- *Probable:*

Neuroinvasive disease

A case that meets the above clinical criteria for neuroinvasive disease and the following laboratory criteria:

- Virus-specific IgM antibodies in CSF or serum but with no other testing.

Non-neuroinvasive disease

A case that meets the above clinical criteria for non-neuroinvasive disease and the laboratory criteria for a probable case:

- Virus-specific IgM antibodies in CSF or serum but with no other testing.

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Our Mission

To protect and improve the health and environment of all Kansans