Arboviral Disease Surveillance — Kansas, 2015

Contents

Background

Arboviruses (arthropod-borne virus) are commonly spread to humans through the bites of infected mosquitoes, ticks, sand flies, or midges. This report focuses on those arboviruses transmitted by mosquitoes. West Nile virus is the leading cause of domestically acquired arboviral disease in the United States and Kansas[1]. West Nile virus was first identified in the United States in 1999 and spread throughout the United States. 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[1]. 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[1]. Most people with 'West Nile virus Fever' recover completely but fatigue and weakness can last for weeks or months[1]. 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 will die[1].

From 1999 – 2015 there were a total of 43,937 cases and 1,911 deaths in the United States from West Nile virus[2]. During 2012, the United States experienced an outbreak of West Nile virus that resulted in the second highest number of cases since 2002, with 5,674 cases reported to the Centers for Disease Control and Prevention[2]. The number of cases declined sharply in 2013 with a 56.5% reduction in cases reported to CDC[2]. However, Kansas had a 63% increase in human cases in 2013. Cases continued to decline nationally in 2014 with an 11% reduction from 2013. Kansas had a substantial reduction in West Nile virus cases, 41%, from 2013 to 2014[3].

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 2002. Mosquito surveillance was focused to Sedgwick County in 2013. 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 May 19 to August 15, 2015 by Dr. Christopher Rogers with the Kansas Biological Survey. From 2012-2014 mosquito surveillance was conducted over 24 weeks. Federal grant funds were reduced for this project in 2015, therefore, we decreased the number of weeks of surveillance from 24 to 13. Surveillance was conducted in Sedgwick County, where human cases have been reported most frequently in Kansas. Mosquito surveillance has been conducted solely in Sedgwick County since 2013. The traps were placed where mosquito arbovirus transmission was most likely to occur. 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. Nine traps were set each week in Sedgwick County. The traps were placed 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 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 the species level. Mosquito counts of greater than 1,000 per trap were divided into a smaller subset for identification due to budget constraints. Mosquitoes of the genus *Culex (Culex spp.)*, the most common West Nile virus vector, were submitted to the Kansas Health and Environmental Laboratories (KHEL) for testing. Results from the enumeration and identification were entered in a Microsoft® Excel® spreadsheet and submitted by KBS to KDHE weekly via e-mail.

West Nile Virus Testing of Mosquitoes

Culex spp. were tested at the Kansas Health and Environmental Laboratories. Mosquitoes were divided into homogenizer vials by date and trap location containing up to 50 mosquitoes each and tested for West Nile virus by reverse transcription polymerase chain reaction (RT-PCR). The results were entered in an Excel® spreadsheet and sent to KDHE. 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.)

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 most recent CDC case definition (Appendix A). Confirmed and probable cases are reported to CDC and are included as the case count (e.g. confirmed + probable = total number of cases). It is important to note that these definitions are to be used for case counts only and are not used for clinical diagnosis. In addition, the county in which the person resides is used as the case's location for surveillance purposes, although they may have been infected elsewhere. Prior to 2011, Kansas only reported confirmed cases, therefore, we are only able to compare case counts and rates of West Nile virus from 2011-2014.

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. Once the case investigation is complete, all confirmed and probable cases are reported to the ArboNET surveillance system and the results are posted to the ArboNET website. Information on human West Nile virus case counts and rates can be found in KDHE's annual publication, Reportable Infectious Diseases in Kansas.

The incidence rate (number of cases per 100,000 people) of West Nile virus neuroinvasive disease cases for Sedgwick County was compared to the State of Kansas, the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota), and the United States. Incidence rates were limited to neuroinvasive disease cases as reporting for these cases is believed to be more consistent and complete than for non-neuroinvasive disease cases[4].

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 and the United States Department of Agriculture's Animal and Plant Health Inspection Service. 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.

Mosquito Control

The Sedgwick County Health Department, City of Wichita, Sedgwick County Extension Office, and McConnell Air Force Base worked together in an effort to educate citizens, control mosquitoes, and decrease the risk of West Nile virus transmission in Sedgwick County. The Sedgwick County Health Department developed a palm card highlighting the three 'D's of prevention; drain, dress, and DEET (Appendix B). Code Enforcement Officers with the Metropolitan Area Building and Construction Department (MABCD), distributed the West Nile virus palm cards to citizens as they conducted inspections throughout the city of Wichita and Sedgwick County. The Sedgwick County Extension Master Gardeners, Extension Agents, and the 22nd Medical Group Public Health staff at McConnell Air Force Base also distributed the palm cards. The following list contains examples of the public locations where the posters were displayed; neighborhood City Halls, libraries, swimming pools, recreation centers, golf courses, and city park restrooms.

The City of Wichita deployed mosquito larvicide "dunks" to areas of standing water that were likely breeding locations for mosquitoes based on surveillance data. The 'dunks' were deployed in areas when the mosquito counts were *Culex spp.* $\geq$20 per trap. The larvicide contained in the dunks is a type of bacteria, *Bacillus thuringiensis israelensis*, or Bti. When the Bti are eaten by mosquito larvae it prevents their development into adult mosquitoes. It is non-toxic to other insects, fish, animals, and humans. One dunk treats approximately 100 square feet of water and lasts up to 30 days.

Measures to Predict West Nile Virus Cases

There have been several peer-reviewed manuscripts that have evaluated the utility of mosquito surveillance data to attempt to quantify a measure or measures that can be used to predict human West Nile virus transmission from mosquitoes to humans[5-7]. Although the Vector Index is considered the gold-standard it relies on the outcome of test results from mosquitoes for West Nile virus (or other arboviruses) which can cause, at a minimum, a one to two week delay[6]. KDHE evaluated the utility of the Vector Index in 2013, when 10.5% of our vials were positive for WNV, revealed no correlation between the VI and human cases in Kansas[8]. It does not appear that the VI is a useful measure to predict human cases of WNV in Kansas[8]. KDHE has not calculated VI since the 2013 study. The use of the VI may be re-evaluated when subsequent years of data are available.

Evaluation of surveillance data from 2013 & 2014 revealed a strong correlation between the two-week mean *Culex* prevalence and human cases that occurred in Sedgwick County, and the entire state of Kansas, two and three weeks later[3]. The 2015 mosquito surveillance season abruptly ended in mid-August, before the majority of reported cases were infected with WNV. Therefore we were unable to evaluate the correlation between *Culex* prevalence and human cases in Kansas for 2015.

Results

Mosquito Surveillance

Mosquito Identification

Mosquito collection began on May 19, 2015 and continued weekly through August 15, 2015. All identified species (Table 1) have been previously documented in Kansas.

Table 1. Mosquito species collected, Sedgwick County, 2015.

Mosquito Species	Number	% Total
Aedes vexans	25,736	65
Culex tarsalis	6,698	17
Psorophora horrida	3,357	8
Culex pipiens/quinquefasciatus	1,307	3
Anopheles quadrimaculatus	1,045	3
Aedes albopictus	578	1
Ochlerotatus triseriatus	172	<0.5
Psorophora columbiae	155	<0.4
Psorophora ciliata	106	<0.3
Anopheles punctipennis	98	<0.3
Culex erraticus	79	<0.2
Ochlerotatus zoosophus	77	<0.2
Psorophora discolor	48	<0.2
Culux resturans	27	<0.1
Culiseta inornata	22	<0.1
Anopheles barberi	3	<0.1
Anopheles epactius	3	<0.1
Ochlerotatus nigromaculis	1	<0.1
Ochlerotatus campestris	1	<0.1
Orthopodomyia signifera	1	<0.1
Psorophora ferox	1	<0.1
Total	**39,624**	

Table 2. Mosquito species collected by year, Sedgwick County*.

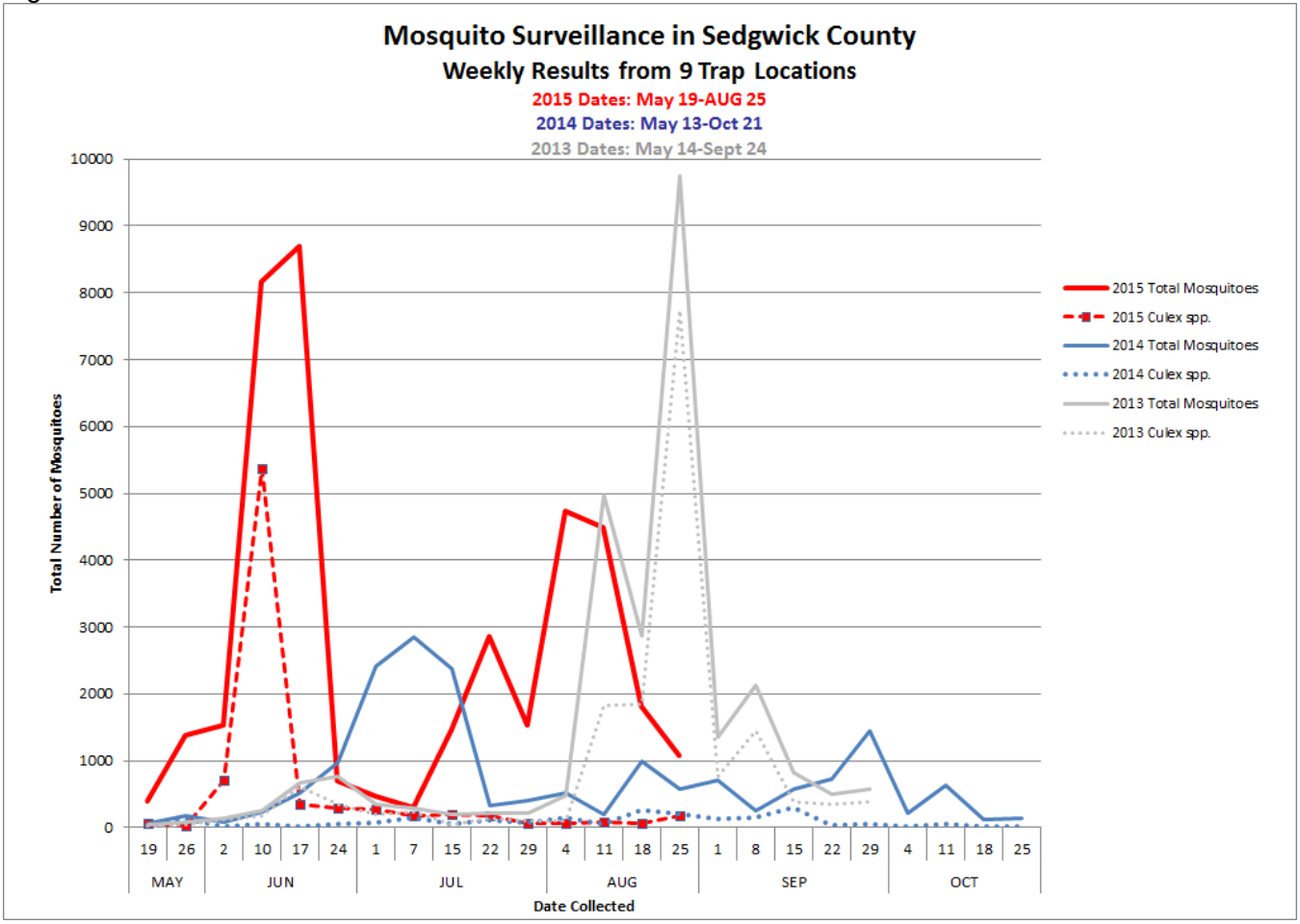
	2013		2014		2015	
Mosquito Species	#	%	#	%	#	%
Aedes vexans	6683	25	11728	68	25736	65
Culex tarsalis	9458	35	1425	8	6698	17
Culex pipiens/quinquefasciatus	6683	27	892	5	1307	3

**The percent (%) of mosquito species was calculated by dividing the number (#) of that species by the total number of mosquitoes collected for the 2015 season.*

Mosquito Abundance

A trap night is calculated by taking the number of traps per week and multiplying it by the number of weeks of surveillance. There were nine trap nights per week during the thirteen weeks of surveillance for a total of 117 trap nights. The median number of mosquitoes collected each week was 1,525 (range 402 – 8,687) and the median number of *Culex spp.* mosquitoes was 184 (range 34 – 5,368) (Figure 1). The mean number of *Culex spp.* per trap (number of mosquitoes divided by the number of traps per week) ranged from 6 – 337.

Figure 1.



There were 39,624 mosquitoes collected during 13 weeks of surveillance. The mosquito *Aedes vexans*, a pest mosquito that does not transmit disease, comprised the majority (65%) of mosquitoes collected in 2015 (Table 1). *Culex tarsalis* (17%), one of the primary vectors for WNV in Kansas, was collected at increased numbers compared to 2014 (8%) (Table 2).

Arboviral Testing

A total of 125 vials were tested for West Nile virus; only 1 vial tested positive (0.8%) for West Nile virus. The mosquitoes in the only WNV positive vial were collected on August 15. This was the same proportion of positive vials as in 2014 (1/143, 0.7%).

Human Case Surveillance

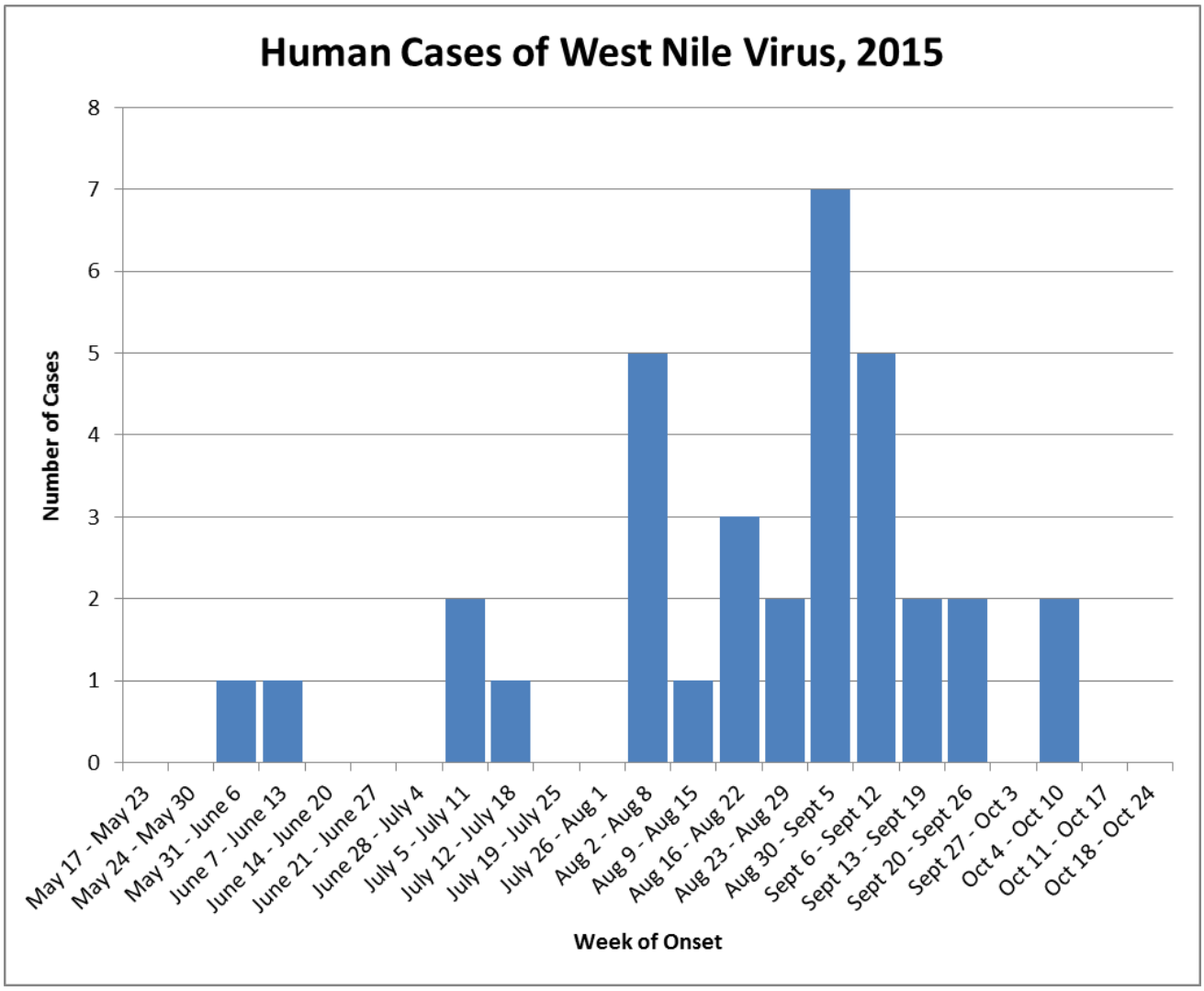
State of Kansas

A total of 34 human cases of West Nile virus were reported in the state of Kansas in 2015 (Table 3). This was a 37% decrease in cases from 2014 (N = 54). There were 22 cases of non-neuroinvasive WNV and 12 cases of neuroinvasive WNV. The earliest case became ill in June; the majority (50%) of cases had disease onset during September (Figure 2). The median age of case-patients was 60 years (range 26 – 82 years). Twenty cases (59%) were hospitalized. Two deaths (6% of total cases) were reported. In the United States, 7% of West Nile virus cases resulted in death in 2015[2].

Table 3. Human West Nile virus case characteristics, Kansas, 2013-2015.

	2013	**2014**	**2015**
Number of Cases	**92**	**54**	**34**
Age (years)			
Median	59.5	54	60
Range	12-85	10-78	26-82
		Number of Cases (%)	
Gender			
Male	63 (68)	32 (61)	21 (62)
Female	29 (32)	20 (39)	13 (38)
Month of Disease Onset			
July	3 (3)	1 (2)	3 (9)
August	13 (14)	23 (43)	12 (35)
September	67 (73)	27 (50)	15 (44)
October	9 (10)	3 (6)	2 (6)
Clinical Status			
Neuroinvasive disease	33 (36)	18 (33)	12 (35)
Non-neuroinvasive disease	59 (64)	38 (70)	22 (65)
Hospitalized	56 (61)	27 (52)	20 (59)
Died	8 (9)	0	2 (6)

Figure 2. Number of Human West Nile virus Cases by Week of Disease Onset, Kansas, 2015.



West Nile virus Neuroinvasive Disease

From 2014 to 2015 the neuroinvasive case rate decreased in the State of Kansas (33%) and the West North Central region (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) (21%).

There were two cases of neuroinvasive West Nile virus disease in Sedgwick County in 2015 compared to 0 cases in 2014 (Table 4). The three year median (2013-2015) for neuroinvasive disease in Sedgwick County was 2 cases.

Table 4. West Nile virus neuroinvasive disease count and incidence rate* by year, 2012-2015.

Region	2013		2014		2015	
	Count	*Rate*	*Count*	*Rate*	*Count*	*Rate*
Sedgwick County	4	0.79	0	-	2	0.39
Kansas	34	1.17	18	0.62	12	0.41
West North Central	288	1.38	104	0.50	82‡	0.39
U.S.	1,267	0.40	1,347	0.42	1,455‡	0.47

**Number of cases per 100,000 population, based on U.S. Census population estimates for July 1, 2015.*
†U.S. Census region, West North Central includes; Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.
‡ *Data from http://www.cdc.gov/westnile/resources/pdfs/data/wnv-disease-cases-and-pvds-by-state-2015_07072016.pdf*

Other Arboviral Diseases

In 2015, there were 16 cases of other arboviral diseases reported to the Kansas Department of Health and Environment. All cases of Chikungunya virus (n = 11) and dengue virus (n = 4) acquired the disease outside of the United States in countries where these diseases are endemic. One case of La Crosse encephalitis virus was reported in northeast Kansas. The patient did not travel outside of the area during the incubation period. This means the virus was likely acquired from a mosquito in Kansas. This was the first case of La Crosse encephalitis reported in Kansas since CDC began keeping records in 1964.

Animal Surveillance

Animal Case Surveillance

There were no WNV-positive animals reported to KDHE in 2015.

Mosquito Control

The City of Wichita deployed 600 larvicide dunks within areas of standing water that were identified as likely mosquito breeding locations based on adult mosquito surveillance. No adulticiding (spraying for adult mosquitoes) was performed.

'Fight the Bite' educational campaign materials were developed and distributed in a variety of formats, including posters and palm cards. There were a total of 1,700 palm cards, 387 posters, and 425 door hangers distributed within Sedgwick County during 2015. This is a 26% increase from the number of 'Fight the Bite' educational materials distributed during 2014[3].

Discussion

Mosquito surveillance was focused to Sedgwick County in 2013 to concentrate efforts to the county where the highest number of human cases had been reported each year. This allowed for an increase the number of surveillance sites in a highly populated area, an increase the amount of data collected, and for quantification of an action level at which mosquito control efforts should occur for public health officials.

Sedgwick County serves as the proxy for mosquito activity, and West Nile virus disease transmission, in the state. Unfortunately, a budget reduction in this program for the 2015-2016 grant year made it necessary to stop mosquito surveillance in mid-August instead of mid-October. Therefore the 2015 mosquito surveillance data was not compared previous years.

In 2015, Kansas reported the first case of La Crosse virus (LACV) encephalitis in the state. The patient did not travel outside of their county of residence during the incubation period, suggesting that the patient was infected locally. The primary vector of La Crosse virus is *Aedes triseriatus,* a mosquito found in Kansas. In 2009, an eight year old boy was diagnosed with La Crosse Virus neuroinvasive disease in Missouri[9]. Both the Kansas and Missouri patients resided in the Kansas City metropolitan area. Although the majority of LACV cases are reported from the upper Midwestern and Mid-Atlantic States, healthcare providers in this area should maintain a high clinical suspicion for LACV among patients with unexplained meningoencephalitis occurring during the summer and fall[9].

Outbreaks of arboviruses, such as West Nile virus, are difficult to predict due to the variety of factors that can influence transmission of this disease including weather (e.g. precipitation and temperature, animal and human host abundance, and human behaviors (e.g. use of repellent, outdoor activity, etc.)[4].

People should take the following precautions to protect against West Nile virus:

- 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.

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Appendix A: West Nile virus surveillance case definition, 2015

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.

Appendix B: Sedgwick County Health Department, 'Fight the Bite' Palm Card

Fight the BITE!

Mosquitoes are annoying.

They can also cause serious health problems. These tiny insects spread diseases like West Nile Virus to humans and heartworms to our pets.

The best way to avoid bites from these little suckers is to follow the three Ds:

DRAIN

Eliminate standing water; mosquitoes need water to breed. Check pots, gutters, tires, tarps, wagons, wheelbarrows – anything that holds water. Change any standing water in wading pools, pet dishes and bird baths several times a week. And, use mosquito dunks or mosquito-eating fish in ponds and stagnant water.

DEET

Use insect repellents that contain DEET. DEET offers the best protection against mosquito bites. Follow product label directions. Avoid over-application.

DRESS

Wear long, loose-fitting clothing when outdoors, especially at dawn and dusk hours, which is when mosquitoes are most active.

West Nile Virus Facts

Spread

- West Nile virus infection is spread to humans and mammals such as horses by the bite of an infected mosquito.
- Mosquitoes are infected when they feed on the blood of infected birds.
- WNV cannot be spread person-to-person or mammal-to-person.

Symptoms

- About 1 in 150 people infected with WNV develop severe illness that may require hospitalization, and about 30 will have a more mild illness.
- Mild symptoms can include fever, headache, body aches, nausea, vomiting, swollen lymph glands and skin rash.
- More severe symptoms include neck stiffness, disorientation, tremors, convulsions, muscle weakness, vision loss, numbness, paralysis and even coma or death.
- If you develop severe symptoms, seek medical attention immediately.
- Pregnant women and nursing mothers are encouraged to talk to their doctors if they develop symptoms.

For more information about West Nile Virus and mosquito bite prevention, contact the

Sedgwick County Health Department at 316-660-7300

or visit www.sedgwickcounty.org.

Sedgwick County... working for you

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Our Mission

To protect and improve the health and environment of all Kansans