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St. Louis Encephalitis [1]

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St. Louis encephalitis (SLE) virus is a flavivirus that is transmitted to humans and other vertebrates primarily by mosquitoes of the genus *Culex* . Infection with SLE results in inapparent infection in a variety of birds and mammals with a resultant period of viremia that lasts a matter of days. Humans represent an incidental, deadend host. The clinical spectrum of human SLE infection includes inapparent infection, mild illness (febrile with headache), aseptic meningitis, and encephalitis which can progress to coma and death. Inapparent infection is most common in the young, whereas encephalitis, especially that progressing to coma and death, is more common in the elderly.

The first human disease outbreak recognized to be caused by the SLE virus occurred in St. Louis, Missouri, in 1933. Since then, many SLE epidemics have been documented in North America with the vector species varying by region. In Florida, the primary SLE vector is *Culex nigripalpus* , a ubiquitous species found throughout central and south Florida. SLE outbreaks in Florida were documented in 1959, 1961, 1962, 1977 and 1990. These outbreaks demonstrated the need for ongoing routine surveillance within the state for SLE and other arboviruses.

Research in Florida has been conducted primarily at the Epidemiology Research Center in Tampa, which was established in 1961 in response to the epidemics of 1959 and 1961, and at the Florida Medical Entomology Laboratory in Vero Beach. Vector surveillance in Florida has been conducted primarily at the county level. Since 1978, many counties have established and maintained sentinel chicken flocks for monitoring SLE virus transmission in nature.

Case Definition

SLE should be considered in the list of possible diagnoses for any person who develops encephalitis in Florida, especially if the encephalitis has onset from August through December, occurs in an older person, or is of unusual severity. Serologic testing for SLE virus can be obtained from the HRS Office of Laboratory Services. For a discussion of the clinical presentations of SLE case patients see Appendix B. For a discussion of the available laboratory tests, see Appendix C, "Laboratory Evaluation of Flaviviruses."

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Suspect Case (Clinically Compatible Case)

A person with any of the following clinical syndromes, and no other, most likely is considered a suspect case of SLE: headache with fever, aseptic meningitis and encephalitis. These three clinical presentations can be considered to be a continuum of disease from mild to severe, and any degree in between may be seen. Any suspect case should have paired acute and convalescent sera obtained at least two weeks apart to be tested for arboviral titers. The first serum is tested immediately and an aliquot saved for later testing with the second specimen.

Presumptive Case

A presumptive case of SLE is a person with a clinically compatible illness and:

- only a single serum available
    1. HI titer > 1:40
    2. CF titer > 1:16
    3. SN index >1.7
    4. IFA titer > 1:64
    5. significant levels of IgM antibody directed against a serogroup; OR
- stationary high titers (see item 1) in acute and convalescent sera by each of these tests; OR
- cases that are fatal five (5) or more days post-onset; presence of demonstrable antibody on necropsy findings consistent with SLE infection.

Confirmed Case

A person with a clinically compatible illness and

- four-fold or greater rise or fall in antibody titer (HI, CF, IFA) between acute- and convalescent-phase sera or SN 1.3 log10 or greater increase in neutralization index between acute- and convalescent-phase sera; OR
- detectable IgM antibody in a single serum or cerebrospinal fluid sample; OR
- isolation of the agent from the patient.

Serologic findings that do not present a clear pattern may require interpretation by comparing results obtained against other likely viral agents. Clinical and epidemiologic data are examined for completeness. An unusually early rise in CF antibody may reflect an anamnestic response or an inaccurate onset date due to failure to recognize patient prodromal symptoms or transcription errors. These variables are investigated if puzzling laboratory findings are to be fitted to the clinical diagnosis. Help in the interpretation of serologic results is obtained from the HRS Epidemiology Office or the HRS Office of Laboratory Services.

Surveillance and Control

The ideal surveillance program for SLE measures the amount of SLE virus amplification and transmission in nature and reliably provides information on the occurrence of human disease. The value of surveillance is to increase the ability to predict when and where transmission to humans is likely to occur, and to accurately monitor the course of transmission to humans in time and space. A complete surveillance program consists of monitoring seroconversion rates in sentinel chickens, weather analysis, vector abundance and the incidence of human infection and disease. Intensification of surveillance and initiation of control measures occur in response to evidence of increased SLE transmission in nature.

The Components of Surveillance

Surveillance for SLE virus is an ongoing program designed to monitor viral activity over time, especially between epidemics. Surveillance activities are necessarily geared to the likelihood of the public health threat posed and to the means available within each county. Different agencies become involved at various times during routine surveillance. In addition to monitoring the occurrence of SLE in humans and the activity of SLE virus in nature, a crucial part of a good surveillance program is to disseminate this information to the proper agencies and persons.

Sentinel Chicken Seroconversion Surveillance

The SLE virus is present in mosquitoes throughout much of central and south Florida during most of the year. Sentinel chickens can be infected during any month, but transmission is most likely from August through November. Sentinel chicken programs are maintained by the Department of Agriculture and Consumer Services (DACS) Bureau of Entomology and Pest Control through the local Mosquito Control Districts, depending on local resources and priorities. Maintaining such a program includes flock placement, flock care, periodic collection, processing and shipping of blood specimens, and notification of appropriate agencies and persons regarding seroconversion data. Under certain conditions backyard chickens are bled. For further information on sentinel chicken selection, maintenance, bleeding, site selection and use of backyard sentinels, please see Appendices D, E, and F.

Under ideal circumstances, sentinel chicken flocks would be located in every county, because the transmission of SLE virus can be quite local. However, if no flocks are maintained in a county, then the CPHU relies on the results of sentinel chicken surveillance in contiguous counties to aid in decision making. Sentinel chicken surveillance is conducted June through November of each year. In years of unusually high virus activity such as during 1991, monitoring is done year-round.

For a meaningful determination of rates of sentinel chicken seroconversion, it would be necessary to maintain six flocks, of six birds each, in each participating county. Weekly collection of blood specimens would be taken from alternating halves of sentinel flocks from June through November, unless transmission indicates the need for weekly testing. Biweekly samples would be obtained during the rest of the year if year-round monitoring is indicated. It is important to correctly maintain sentinel chickens for the accurate determination of seroconversion rates. The seroconversion rate is the number of chickens that seroconverted during a given weekly sampling period divided by the number of birds that were seronegative at the beginning of that period.

Testing of serum from sentinel chickens is done by HRS Laboratory Services. Results are communicated weekly to the county coordinator submitting specimens, who then notifies the County Health Officer and the local Mosquito Control Director. Also, a weekly statewide listing of results is sent by fax to HRS Epidemiology and the DACS Bureau of Entomology and Pest Control.

Interpretation of Sentinel Chicken Seroconversion Data

The sentinel chicken seroconversion rate is the number of chickens seroconverting divided by the total number of seronegative chickens at the beginning of the period. Annual sentinel chicken SLE seroconversion rates can vary from zero to nearly 40 percent during nonepidemic years. In forecasting human SLE epidemics, the two most important factors to consider are:

- When during the year the seroconversions occur: A rate of seroconversion that is not particularly important in September may be very important in June and indicative of potential SLE transmission to humans. Clumped seroconversions (for example, 50 percent seroconversion in three different flocks over a three-week period) in April, May or June; or high (70 percent) total seroconversion rates from April through November indicate an epidemic threat; AND

- The seroconversion rate during any three week period: As the total number of sentinel chickens seroconverting to SLE increases, so does the epidemic threat for a given area. Many seroconversions over a short period are of greater concern than the same number of seroconversions over a longer period.

Weather Analysis: Rainfall Monitoring

Daily rainfall is the single most important meteorological factor to track when attempting to predict changes in vector abundance as well as viral amplification and transmission. Monitoring daily rainfall is important for three reasons. First, the length of the south Florida dry season is an important factor in determining the potential survival of overwintering

and potentially infected *C. nigripalpus* mosquitoes. During years with a long dry season (i.e., January through June), there is a lower potential for virus transmission during the following autumn. If the dry season is short, as in 1990, viral amplification and transmission can begin as early as May or June. Second, once the dry season ends, heavy spring rains allow a quick, early season buildup of vector mosquitoes. Finally, daily rainfall patterns are responsible for driving the overall behavior of this mosquito species by determining when and where eggs are laid, when host seeking and biting occurs, and when virus is transmitted.

Rainfall data may be available from the National Weather Service. For more localized information, however, it is often necessary to do independent measurements. To monitor daily rainfall, fence post style rain gauges are read, emptied, and the amount of rainfall recorded at roughly the same time each day. Three types of annual rainfall records are kept. First, the timing, amount, and intensity of rain at the beginning of the wet season are recorded. This alerts personnel to a potential buildup of the vector population. Second, daily rainfall records throughout the wet season are recorded. Patterns of heavy rain (2 inches) followed by 10- to 14-day droughts are ideal for allowing extrinsic incubation of the virus in infected vectors and for synchronizing vector egg laying, blood feeding and potential virus transmission. Finally, it is important to know when the dry season begins, as this may mark the end of virus transmission for that year.

Vector Monitoring

The accurate measurement of vector abundance and population structure is a critical component of arboviral surveillance. Factors such as vector movement, blood feeding, egg laying and the age of the population determine whether there is a high or low risk of viral transmission. The number of mosquitoes collected is not as important as the day-to-day changes in the number collected. Therefore, it is the quality of collections, not the quantity, that is important.

There are many different ways to monitor mosquito populations, and no particular method is vastly superior to the others. Ideally, the method of surveillance should remain constant from year to year, allowing comparison between years. Sampling sites should remain constant from year to year, as well for the same reason.

Surveillance of SLE activity in nature based on viral assay of pooled mosquito samples is presently considered experimental in nature, but could be a viable source of important data in the future.

Surveillance of Human Disease

County Public Health Unit (CPHU) Activities

All confirmed and probable cases of SLE require epidemiologic investigation. Epidemiologic investigation involves: A) a search for new undetected cases; and B) classifying cases as to time, place and person. To do this you will need:

- the chronological distribution of cases (epicurve);
- geographic distribution of where cases reside (spot maps);
- demographics of cases; and
- likely place of exposure of cases (location of outside activity in the two weeks previous to illness).

Epidemiologic investigation is done by the individual CPHU epidemiology staff, with consultation and coordination with the Epidemiology Program. Such cases are reported to the Epidemiology Program within 72 hours. Additionally, probable and confirmed cases are reported on HRS-H Form 2001.

Further, the designated person(s) in the CPHU communicates with the appropriate mosquito control personnel. Specifically, the CPHU reports the location of cases and the known exposure factors to the appropriate mosquito control agency. All communications with the Epidemiology Program and with Mosquito Control are accomplished before information is released to the media or to the public.

Physician/Hospital Activities

Physicians and hospitals are required by Florida statute to report suspected cases to the CPHU. All suspect cases require an acute serum and cerebrospinal fluid (CSF) to be shipped immediately to the laboratory. A convalescent serum should be obtained two to three weeks after the acute. The CPHU works with physicians and hospitals to properly obtain sera and other diagnostic specimens.

HRS Laboratory Activities

The HRS laboratory performing serologic studies for SLE immediately reports by telephone the results of all probable and confirmed serologic or virologic tests to the CPHU, the Epidemiology Program, and to the attending physician. Follow-up written reports are submitted as soon as possible. During an outbreak, a weekly summary report indicating the number of sera submitted, number tested, and number positive by county is required by the Epidemiology Program.

Epidemiology Program Activities

The Epidemiology Program, under the direction of the state epidemiologist, directs all statewide surveillance for human SLE cases and conducts epidemiologic analysis of data on human cases, when indicated. The Epidemiology Program communicates routine statewide surveillance data on human cases to the following:

- CPHU directors/administrators in affected counties;
- CPHU epidemiology offices in the affected counties;
- all district offices, who in turn communicate with CPHU administrators/directors (including unaffected counties);
- state health officer;
- DACS Bureau of Entomology and Pest Control; and
- Centers for Disease Control, USPHS.

HRS District Office Activities

The district office provides advice and leadership to the counties during both epidemic and interepidemic periods. District offices provide technical and other assistance to counties as needed to help assure that surveillance activities and case investigations are carried out and that response to actual or potential human disease is appropriate and timely.

DACS Bureau of Entomology and Pest Control Activities

DACS Bureau of Entomology and Pest Control provides weekly reports of statewide human and sentinel chicken flock data to local mosquito control agencies. It also provides mosquito control, technical support and other services as needed to local mosquito control programs and CPHUs, and may help facilitate the sharing of mosquito control personnel and equipment between districts, as allowed for in Florida Statutes 388.231 and 388.351.

Medical Alert and Control

A medical alert is issued when the potential for SLE transmission to humans has been determined to be significant. The determination of medical alert status by the CPHU, in consultation with the State Health Office, constitutes a declaration by the state health officer that "a threat to the public health exists," as per Florida Statute 388.45. This supersedes rules promulgated under statute 388.4111 that restrict arthropod control measures on certain public lands. Sections 388.231 and 388.351 of the Florida statutes authorize the movement of mosquito control personnel and equipment into affected counties from other counties.

Determining Medical Alert Status:

- The determination of medical alert status is done by the State Health Office, or by the CPHU director/administrator after consultation with the HRS district office and the State Health Office.
- In most instances, increased sentinel chicken seroconversion rates or the presence of human cases in the same or contiguous counties initiates the consideration of a medical alert. There are no precise criteria for determining the need for a

medical alert, but the decision is based on consideration of any available information in the following categories:

- sentinel chicken seroconversion rates;
- weather information;
- vector surveillance (mosquito trapping); and
- the presence of human cases.

It is believed that the combination of increased sentinel chicken seroconversions with other factors, such as weather conditions favorable for an outbreak, represents an increased risk of human disease.

Response to a Medical Alert

A medical alert results in:

1. Notification by the Epidemiology Program of the Department of Agriculture and Consumer Services, the Department of Natural Resources, and the Department of Environmental Regulation within 24 hours of the declaration of a medical alert (Florida Statute 388.45).

2. Notification by the CPHU in the affected counties of health care providers in the county concerning the potential for transmission of SLE virus to humans in the county.

3. Notification of the CPHU Directors and Mosquito Control Directors in contiguous counties by the CPHU in the affected counties.

4. Intensified surveillance efforts as needed: increased vector monitoring, weather monitoring, more active surveillance of human disease, etc.

5. Intensified mosquito control efforts when appropriate, as agreed to by the county public health unit and the county mosquito control district. Sections 388.231 and 388.351 of the Florida statutes authorize the movement of mosquito control personnel and equipment into affected counties from other counties. This is coordinated through the DACS Bureau of Entomology and Pest Control Office.

6. If, in order to protect the public health, arthropod control measures are needed on environmentally sensitive public lands that have had restricted arthropod control measures under Florida Statute 388.4111, DACS Bureau of Entomology and Pest Control and county mosquito control programs work with the appropriate state agencies to arrange for such measures.

The county public health unit director or his/her representative facilitates the above activities. This includes working closely with the Epidemiology Program, mosquito control personnel, neighboring counties, and health providers in the community, to assure that it is understood who will be responsible for each of the above activities. DACS Bureau of Entomology and Pest Control provides technical support and leadership to CPHUs and county mosquito control programs as needed during a medical alert.

Public Education

Public education activities are coordinated by the CPHU in the affected counties. Contents of public education and warnings are determined jointly by the CPHU and the county mosquito control district, with input as needed from the HRS district office, the Epidemiology Program, Bureau of Entomology and Pest Control, and the HRS Public Information Office. The goals of public education are to prevent panic, provide information, and inform the public about personal protection measures. Specifically, the county mosquito control districts and CPHUs:

- Issue strong warnings about outside evening, nighttime and early morning activities for citizens of affected counties (e.g., activities such as camping or evening and nighttime fishing are ill-advised).
- Advise persons who do continue to spend time outdoors in the evening, nighttime or early morning hours to wear protective clothing (long sleeved shirts, long pants) and to use insect repellent.
- Educate the public about the nature of the public health threat, the level of risk involved, and what is being done in response to the threat.

SLE epidemic activity may remain localized to a city or county, but Florida's last two outbreaks were more widespread, with several counties affected. Further, SLE viral activity can be very spotty with "hot spots" of activity interspersed with areas of little or no activity. Therefore, epidemic and medical alerts and control measures cannot at this time be uniformly applied in all areas of the state.

Mosquito Control Efforts and Vector Surveillance

Mosquito control efforts are the responsibility of the mosquito control program in the counties that have a program, with assistance from DACS Bureau of Entomology and Pest Control. Counties without a formal mosquito control program consult with DACS Bureau of Entomology and Pest Control, county government and the HRS district office to decide on the approach to vector control. The responsible agencies:

- Direct adequate surveillance and control resources to affected areas by coordinating with local organized mosquito control programs in affected areas, and with CPHU officials, and providing technical and operational recommendations and direction when indicated to local mosquito control director.
- Make arrangements as needed with surrounding counties to move mosquito control equipment and personnel into affected areas as provided by Sections 388.231 and 388.351, Florida Statutes.
- If, in order to protect the public health, arthropod control measures are needed on environmentally sensitive public lands that have had restricted arthropod control measures under Florida Statute 388.4111, DACS Bureau of Entomology and Pest Control and county mosquito control districts work with the appropriate state agencies to arrange for arthropod control measures.
- Attempt to gain immediate control of infected adult mosquito populations by use of insecticides applied by ground or aerial applications, as appropriate. Intensification of larviciding programs to reduce future adult populations and elimination of mosquito breeding areas, where applicable, may also be necessary.