West Nile Virus Study Guide

INTRODUCTION

West Nile Virus (WNV) is a member of the family Flaviviridae (genus Flavivirus).

WNV was first isolated in the WN province of Uganda in 1937. Human and equine outbreaks have been recorded in portions of Africa, southern Europe, North America, and Asia. It is not known when or how WNV was introduced into North America, although international travel of infected persons to New York, importation of infected birds or mosquitoes, or migration of infected birds are all possibile sources of introduction. In humans, WNV infection usually produces either no or a mild flu-like disease with fever, sometimes accompanied by rash, but it can cause severe and even fatal disease, sometimes affecting the brain or spinal cord ("neuroinvasive disease"), in a small number of people. In the U.S. approximately 7% of all seriously ill patients have died, and among patients with neuroinvasive disease caused by WNV infection, 10% of these patients have died.

Unlike WNV within its historical geographic range, or St. Louis encephalitis (SLE) virus in the western hemisphere, mortality in a wide variety of bird species has been a hallmark of WNV activity in the U.S. The reasons for this are not known; however, public health officials have been able to use bird mortality (particularly birds from the family Corvidae) to track the movement of WNV. As of September 2005, WNV has been shown to affect almost 300 species of birds. However, most birds survive WNV infection. This has been shown in studies of resident birds within the regions of most intensive virus transmission where a high proportion of these birds had antibodies against WNV .The contribution of migrating birds to natural transmission cycles and dispersal of both WNV and SLE viruses is poorly understood.

WNV has been transmitted principally by *Culex* species mosquitoes, the usual vectors of SLE virus. Thirty-six species of mosquitoes have been shown to be infected with WNV. This wide variety of WNV-infected mosquito species means that many different animals can serve as hosts to the virus in the U.S.: 27 mammalian species have been shown to be susceptible to WNV infection and disease has been reported in 20 of these (including humans and horses). It must be remembered, however, that the finding WNV in a mosquito species does not necessarily meant that species is a competent (or capable) vector of WNV.

TRANSMISSION OF THE VIRUS

Q. How do people get infected with WNV?

A. The main route of human infection with West Nile virus is through the bite of an infected mosquito. Mosquitoes become infected when they feed on infected birds, which may circulate the virus in their blood for a few days. The virus eventually gets into the mosquito's salivary glands. During later blood meals (when mosquitoes bite), the virus may be injected into humans and animals, where it can multiply and possibly cause illness.

Q. What is the risk of catching WNV?

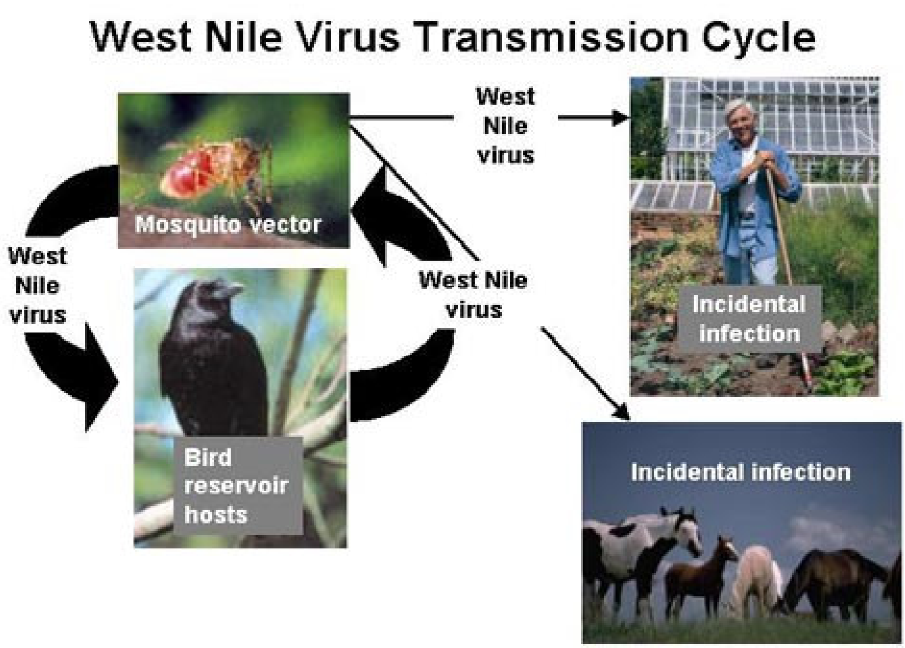
A. For most, risk is low. Less than 1 percent of people who are bitten by mosquitoes develop any symptoms of the disease and relatively few mosquitoes actually carry WNV.

People who spend a lot of time outdoors are more likely to be bitten by an infected mosquito. They should take special care to avoid mosquito bites.

Q. **How soon do infected people get sick?**
A. People typically develop symptoms from 3 to14 days after they are bitten by an infected mosquito.

Q. **What are some of the symptoms of the WNV?**
A. WNV affects the central nervous system. However, symptoms vary:
Serious Symptoms in a Few People. Less than one percent (about one in 150 people) of individuals infected with WNV will develop severe illness. The severe symptoms can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may be permanent.
Milder Symptoms in Some People. Up to 20 percent (about one in five) of the people who become infected will display symptoms which can include fever, headache, body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms generally last for just a few days, although some people have been sick for several weeks.
No Symptoms in Most People. Approximately 80 percent of people (about 4 out of 5) who are infected with WNV will not have any symptoms at all.

Q. **What is the basic transmission cycle of WNV?**
A. Mosquitoes become infected when they feed on infected birds, which may circulate the virus in their blood for a few days. Infected mosquitoes can then transmit West Nile virus to humans and animals while biting to take blood. The virus is located in the mosquito's salivary glands. During blood feeding, the virus may be injected into the animal or human, where it may multiply, possibly causing illness.
Transfusions, Transplants, and Mother-to-Child. All donated blood is checked for WNV before being used. The risk of getting WNV through blood transfusions and organ transplants is very small, and should not prevent people who need surgery from having it. Transmission during pregnancy from mother to baby or transmission to an infant via breastfeeding is extremely rare.
Not through touching. WNV is not spread through casual contact such as touching or kissing a person with the virus, or by breathing in the virus.



PREVENTION

Use Insect Repellent on exposed skin when you go outdoors
Use an EPA-registered insect repellent such as those with DEET (N, N-diethyl-meta-toluamide), picaridin or oil of lemon eucalyptus.

Clothing Can Help Reduce Mosquito Bites
Wear long-sleeves, long pants and socks when outdoors. Mosquitoes may bite through thin clothing, so spraying clothes with repellent containing permethrin or another EPA-registered repellent will give extra protection. Don't apply repellents containing permethrin directly to skin. Do not spray repellent on the skin under your clothing. Light-colored clothing can help you see mosquitoes land on you.

Be Aware of Peak Mosquito Activity Hours
The hours from dusk to dawn are peak biting times for many species of mosquitoes. Take extra care to use repellent and wear protective clothing during evening and early morning – or consider avoiding outdoor activities during these times.

Drain Standing Water
Mosquitoes require standing water to lay their eggs and complete their larval development cycle. Eliminating standing water sources around your home will reduce mosquito breeding habitats.

Install or Repair Screens
Having well-fiiting screens on both windows and doors will prevent mosquitoes from entering indoors.

TREATMENT

Q. How do health care providers test for West Nile virus?

A. Your physician will first take a medical history to assess your risk for West Nile virus. People who live in or traveled to areas where West Nile virus activity has been identified are at risk of getting West Nile encephalitis; persons older than 50 years of age have the highest risk of severe disease. If you are determined to be at high risk and have symptoms of West Nile encephalitis, your provider will draw a blood sample and send it to a commercial or public health laboratory for confirmation.

The most commonly used WNV laboratory test measures antibodies that are produced very early in the infected person. These antibodies, called IgM antibodies, can be measured in blood or cerebrospinal fluid (CSF), which is the fluid surrounding the brain and spinal cord. This blood test may not be positive when symptoms first occur; however, the test is positive in most infected people within 8 days of onset of symptoms.

In some instances, health departments may conduct or request additional testing from CDC before officially reporting a case to CDC's ArboNET Surveillance System. The state or CDC reference laboratory may repeat the initial IgM-antibody testing.

Q. How is West Nile encephalitis treated?

A. There is no specific treatment for West Nile virus infection. In more severe cases, intensive supportive therapy is indicated, often involving hospitalization, intravenous fluids, airway management, respiratory support (ventilator), prevention of secondary infections (pneumonia, urinary tract, etc.), and good nursing care.

RISKS OF WEST NILE VIRUS

Q. Who is at risk for getting West Nile encephalitis?

A. All residents of areas where virus activity has been identified are at risk of getting West Nile encephalitis; persons over 50 years of age have the highest risk of severe disease. It is unknown if persons with weakened immune systems are at increased risk for WNV disease. Being outside, especially at dawn or at dusk, means you're at risk of being bitten by an infected mosquito. Pay attention to avoid mosquito bites if you spend a lot of time outside, either working or playing.

Q. What proportion of people with severe illness due to West Nile virus die?

A. Among those with severe illness due to West Nile virus, case-fatality rates range from 3% to 15% and are highest among the elderly.

Q. If I live in an area where birds or mosquitoes with West Nile virus have been reported and a mosquito bites me, am I likely to get sick?

A. Even in areas where the virus is circulating, very few mosquitoes are infected with the virus. Even if the mosquito is infected, less than 1% of people who get bitten and become infected will get severely ill. The chances you will become severely ill from any one mosquito bite are extremely small.

Q. Can you get West Nile encephalitis from another person?

A. No. West Nile encephalitis is NOT transmitted from person-to-person. For example, you cannot get West Nile virus from touching or kissing a person who has the disease, or from a health care worker who has treated someone with the disease.

Q. If a person contracts West Nile virus, does that person develop a natural immunity to future infection by the virus?

A. It is assumed that immunity will be life long; however, it may wane in later years.

Q. Besides mosquitoes, can you get West Nile virus directly from other insects or ticks?

A. Infected mosquitoes are the primary source for West Nile virus. Although ticks infected with West Nile virus have been found in Asia and Africa, their role in the transmission and maintenance of the virus is uncertain. However, there is no information to suggest that ticks played any role in the cases identified in the United States.

WEST NILE AND ANIMALS

West Nile Virus and Dead Birds

Q. Do birds infected with West Nile virus die or become ill?

A. In the 1999 New York area epidemic, there was a large die-off of American crows. As of September 2005, West Nile virus has been identified in almost 300 species of birds found dead in the United States.

Q. How many types of animals have been found to be infected with West Nile virus?

A. Although the vast majority of infections have been identified in birds, West Nile virus has been shown to infect horses, cats, bats, chipmunks, skunks, tree squirrels, and lagomorphs.

Q. Can you get West Nile virus directly from birds?

A. There is no evidence that a person can get the virus from handling live or dead infected birds. However, persons should avoid bare-handed contact when handling *any* dead animals and use gloves or double plastic bags to place the carcass in a garbage can.

Q. How do you report/handle a dead bird?

A. DHS has a WNV dead bird hotline where dead birds may be reported for pick up and tested for WNV. After a dead bird has been reported, you will be contacted if that bird will be picked up for West Nile virus testing. If you have not been contacted within 24 hours of your report, you may safely dispose of the dead bird in your trash. There is no evidence that West Nile virus can be acquired by handling dead birds, but it is best not to handle the dead bird with your bare hands. Use gloves, a shovel, or a plastic bag to place the bird in a trash bag for disposal. Please DO NOT freeze dead birds.

West Nile Virus and Horses

Q. Has West Nile virus caused severe illness or death in horses?

A. Yes, while data suggest that most horses infected with West Nile virus may recover, results of investigations indicate that West Nile virus has caused deaths in horses in the United States.

Q. How do the horses become infected with West Nile virus?

A. The same way humans become infected—by the bite of infectious mosquitoes. The virus is located in the mosquito's salivary glands. When mosquitoes bite or "feed" on the horse, the virus is injected into its blood system. The virus then multiplies and may cause illness. The mosquitoes become infected when they feed on infected birds or other animals.

Q. Can I get infected with West Nile virus by caring for an infected horse?

A. West Nile virus is transmitted by infectious mosquitoes. There is no documented evidence of person-to-person or animal-to-person transmission of West Nile virus.

Q. Can a horse infected with West Nile virus infect horses in neighboring stalls?

A. No. There is no documented evidence that West Nile virus is transmitted between horses.

Q. My horse is vaccinated against eastern equine encephalitis (EEE), western equine encephalitis (WEE), and Venezuelan equine encephalitis (VEE). Will these vaccines protect my horse against West Nile virus infection?

A. No. EEE, WEE, and VEE belong to another family of viruses for which there is no cross-protection.

West Nile Virus and Dogs and Cats

Q. Can West Nile virus (WNV) cause illness in dogs or cats?

A. A relatively small number of WNV infected dogs (<40) and only 1 WNV infected cat have been reported to CDC during 2003. Experimentally infected dogs* showed no symptoms after infection with WNV. Some infected cats exhibited mild, nonspecific symptoms during the first week after infection--for the most part only showing a slight fever and slight lethargy.
It is unlikely that most pet owners would notice any unusual symptoms or behavior in cats or dogs that become infected with WNV.

Q. Does my dog/cat becoming infected pose a risk to the health of my family or other animals?

A. There is no documented evidence of dog or cat-to-person transmission of West Nile virus. The evidence suggests that dogs do not develop enough virus in their bloodstream to infect more mosquitoes. Cats develop slightly higher levels of virus in their bloodstream, but it is unclear if this would be enough to infect mosquitoes.

Q. How do cats and dogs become infected with West Nile virus?

A. Dogs and cats become infected when bitten by an infected mosquito. There is also evidence that cats can become infected with the virus after eating experimentally infected mice.

Q. Can I become infected with WNV if a dog with the virus bites me?

A. Preliminary studies have not been able to detect virus in the saliva of infected dogs. This suggests that dog bites pose a low risk, if any, of transmission of WNV from dogs to other animals or people.

Q. Should a dog or cat infected with West Nile virus be destroyed?

A. No. There is no reason to destroy an animal just because it has been infected with West Nile virus. Full recovery from the infection is likely.

West Nile Virus and Squirrels

Q. Can tree squirrels infected with West Nile virus transmit the virus to humans?

A. A small number of tree squirrels have tested positive for the West Nile virus. There is no evidence that people could become infected with the West Nile virus by being near an infected squirrel or in the yard with a dead one. However, the presence of an infected squirrel does mean that there could be infected mosquitoes nearby, and people should wear protective clothing and repellent, and avoid maintaining mosquito-breeding sites on their property.

West Nile Virus and Wild Game/Meat

Q. Is there a risk of getting infected with West Nile virus (WNV) if I eat turkey or another animal that has been infected with the virus?

A. There is no evidence that people can become infected with WNV from eating infected meat. Proper handling and thorough cooking of meat before it is consumed can eliminate the small, theoretical risk of infection.

Q. Are duck and other wild game hunters at risk for West Nile virus infection?

A. Because of their outdoor exposure, game hunters may be at risk if mosquitoes in areas bite them with West Nile virus activity. The extent to which West Nile virus may be present in wild game is unknown.

Q. What should wild game hunters do to protect against West Nile virus infection?

A. Hunters should follow the usual precautions when handling wild animals. If they anticipate being exposed to mosquitoes, they should apply insect repellent to clothing and skin, according to label instructions, to prevent mosquito bites. Hunters should wear gloves when handling and cleaning animals to prevent blood exposure to bare hands and meat should be cooked thoroughly.

SURVEILLANCE

Q. What is the California West Nile surveillance program?

A. The California Department of Health Services (DHS) has overseen a statewide mosquito-borne encephalitis surveillance program since 1969 for Western equine encephalitis (WEE), St. Louis encephalitis (SLE), and other viruses. In 2000, DHS and other agencies expanded the program to enhance the ability to detect WNV. A protocol to report and test dead birds was added to the existing surveillance system for encephalitis cases, mosquito testing, and monitoring of sentinel chickens.

Encephalitis Case Surveillance

DHS tracks cases of human, horse, and ratite (e.g., emu, ostrich) encephalitis. The routine testing of encephalitis cases for WNV assists in the early detection of the virus in California. Human and animal encephalitis cases are also routinely tested for WEE and SLE viruses.

Mosquito Testing

Mosquitoes are sampled for the presence of WNV, WEE, and SLE viruses. Local mosquito and vector control agencies also monitor the abundance and type of mosquitoes.

Sentinel Chicken Testing

Over 200 chicken flocks are strategically placed throughout the state and are tested every two weeks during the mosquito season to detect evidence of infection from WNV, WEE or SLE viruses.

Dead Bird Surveillance

California began to test dead crows and related birds for WNV in 2000. Monitoring dead crows and other birds will help identify where the virus is occurring in the State. State agencies, private organizations, and individuals participate in the surveillance program by reporting dead bird sightings. DHS arrange to collect the dead bird from the location it was found if WNV testing is appropriate.

Q. What do I do if I see a dead bird?

A. DHS has a WNV dead bird hotline where dead birds may be reported for pick up and tested for WNV. After a dead bird has been reported, the resident will be contacted if that bird will be picked up for West Nile virus testing. If you have not been contacted within 24 hours of your report, you may safely dispose of the dead bird in your trash. There is no evidence that West Nile virus can be acquired by handling dead birds, but it is best not to handle the dead bird with your bare hands. Use gloves, a shovel, or a plastic bag to place the bird in a trash bag for disposal. Do not freeze dead birds.

Ecologic Surveillance

Detection of WNV in bird and mosquito populations helps health officials predict and prevent human and domestic animal infections. Surveillance to detect WNV should focus on the avian and mosquito components of the enzootic transmission cycle. Non-human mammals, particularly equines, may also serve as effective sentinels because a high intensity of mosquito exposure makes them more likely to be infected than people. Descriptions of the avian-, mosquito-, and non human mammal-based surveillance strategies follow.

1. Mosquito

Mosquito-based surveillance remains the primary tool for quantifying the intensity of virus transmission in an area, and should be a mainstay in most surveillance programs for WNV and other arboviruses.

GOALS OF MOSQUITO-BASED SURVEILLANCE: To 1) use data on mosquito populations and virus infection rates to assess the threat of human disease; 2) identify geographic areas of high risk; 3) assess the need for and timing of interventions; 4) identify larval habitats for targeted control; 5) monitor the effectiveness of this type of surveillance and improve prevention and control measures; and 6) develop a better understanding of transmission cycles and potential vector species.

a) Protocols and specimens
   1) Adult mosquitoes are collected using a variety of trapping techniques and are used to identify the mosquito species and primary vector species present in an area and the relative density of those species. When coupled with virus detection protocols, mosquito collections can be screened for the presence of virus and provide a quantifiable index of WNV activity. Adequate sampling requires trapping regularly at representative sites throughout a community, and rapid testing of collections of sufficient size to detect low infection rates in the vector population. Minimally, adult mosquito density (number collected per trap night) and infection rate (number of individual mosquitoes estimated containing WNV per 1,000 specimens tested) should be recorded for each area to provide a basis for tracking mosquito density and virus incidence.
   2) Larval mosquitoes are collected by taking dip samples from a variety of habitats to identify species present in the area and to identify mosquito sources. Thorough mapping of larval habitats will facilitate larval control or source reduction activities. In addition, where larval management is not feasible, quantitative estimates of larval densities will permit anticipation of new adult emergences. Minimally, the number of larvae collected per dip and location where collected should be recorded to provide a basis for tracking larval production and association of larval density with resulting adult mosquito population density.
b) Recent experience
   1) If mosquito trapping effort is intensive, detection of WNV in mosquitoes might precede detection of virus activity by other surveillance tools. If mosquito trapping effort is inadequate, WNV positive mosquitoes may not be detected prior to the identification of a virus in dead bird, sentinel animal, or human WNV disease cases.
   2) Moderate to high infection rates sustained for several weeks in *Cx. pipiens* or *Cx. quinquefasciatus* have been associated with subsequent human outbreaks. Sustained high infection rates early in the year are associated with a higher risk for subsequent outbreaks.
   3) Large numbers of WNV positive *Cx. tarsalis* pools have been found in association with WNV activity in areas where this species is common. Meaningful infection rates have not yet been determined.
   4) Avian epizootics may occur without demonstrable human WNV infection. The epizootics are demonstrated, in part, by detection of WNV positive mosquito pools containing only species that feed predominantly on birds (e.g., *Cx. restuans*).
   5) During 1999-2002, WNV was detected in 36 mosquito species in the U.S. (see www.cdc.gov/ncidod/dvbid/westnile/mosquitoSpecies.htm). The vast majority of isolates came from *Cx. pipiens*, *Cx. quinquefasciatus* and *Cx. restuans*. Numerous isolates have also come from several potential accessory vectors (i.e., *Cx. tarsalis, Cx. salinarius, Oc. Ae. albopictus, Oc. triseriatus, Ae. vexans, Cx. nigripalpus*). While detection of WNV in these species demonstrates intensified virus transmission (i.e., virus in primarily mammal-feeding or opportunistic mosquitoes), the contribution of these species to human risk is poorly understood.
c) Advantages of mosquito-based surveillance include the following:
   1) It may provide the earliest evidence of transmission in an area.
   2) It helps establish information on potential mosquito vector species.
   3) It provides an estimate of vector species abundance.
   4) It gives quantifiable information on virus infection rates in different mosquito species.
   5) It provides quantifiable information on potential risk to humans and animals.
   6) It provides baseline data that can be used to guide emergency control operations.
   7) It allows evaluation of control methods.
d) Disadvantages of mosquito-based surveillance include the following:
   1) It is labor-intensive and expensive.

2) Substantial expertise is required for collecting, handling, sorting, species identification, processing, and testing.
3) Collectors may be at risk from mosquito bites, especially if day biting species are important bridge vectors, and should wear topical repellents and/or repellent-treated clothing when working in areas where a risk of WNV transmission exists.

e) Minimal components of an entomological surveillance program

A comprehensive mosquito surveillance program must include larval and adult sampling components, a mapping/record keeping component, a virus-testing component, and a data analysis component. To provide useful data, the surveillance program must be sustained and maintain a consistent effort over several seasons. The exact design of mosquito-based surveillance programs will vary by geography and availability of financial and personnel resources. Not every community will be able to support a comprehensive mosquito-based surveillance program. Minimally, a mosquito-based WNV surveillance program must include the following:

1) Collection of adult mosquitoes using gravid traps and/or light traps, providing representative geographic coverage and with sufficient trap sites and trapping frequency to obtain sample sizes required to detect WNV at relatively low infection rates. Use both fixed and flexible trap positions if possible.
   (a) Fixed positions allow for the development of a database that would let public health officials compare population data to previous years and spatially map changes in mosquito abundance.
   (b) Flexible sites allow for response to epidemiological and natural events (e.g., a suspected human case, dead crow, or a flood).
   (c) A variety of trapping methods should be used, including the following:
      (i) CDC light traps baited with CO_2 for sampling potential accessory vectors.
      (ii) Gravid traps for *Cx. pipiens* and *Cx. quinquefasciatus* to sample primary WNV vectors.
   (d) Trap distribution will be influenced by the following species factors:
      (i) Habitat diversity, size, and abundance;
      (ii) Resource availability;
      (iii) Proximity to human population centers and/or recreational areas; and
      (iv) Flight range of vector species in the area.
2) Laboratory support to identify the mosquitoes' species, and to test the specimens for the presence of WNV. Determine infection rates by species.
   (a) Make arrangements with a lab for testing. Rapid turnaround is essential.
   (b) Focus initially on *Culex* mosquitoes to provide first indication of WNV presence.
   (c) Once virus is detected in *Culex* mosquitoes, pool and test all potential vector species with emphasis on incriminated or suspected species.
3) Data management and analysis capabilities to allow tracking of adult mosquito densities and infection rates over time and space. Patterns of virus activity are more likely to be useful than predetermined threshold levels.
4) Development of a plan with descriptions of actions that will be taken in response to indicators of WNV activity.

2. Avian

Avian morbidity/mortality surveillance

Avian morbidity/mortality surveillance appears to be the most sensitive early detection system for WNV activity, and should be a component of every state's arbovirus surveillance program. It should include at least two basic elements: the timely reporting and analysis of dead bird sightings and the submission of selected individual birds for WNV testing.

GOAL OF AVIAN MORBIDITY/MORTALITY SURVEILLANCE: Use bird mortality associated with WNV infection as a means of detecting WNV activity in a location.

1) Protocols and specimens

Generally, avian surveillance should be initiated when local adult mosquito activity begins in the spring. Samples from birds in good condition (unscavenged and without obvious decomposition or maggot infestation) may be submitted for laboratory testing. As with all dead animals, carcasses should be handled carefully, avoiding direct contact with skin. For greatest sensitivity, a variety of bird species should be tested, but corvids (crows, jays, magpies) should be emphasized. The number of bird specimens tested will depend on resources and whether WNV infected birds have been found in the area.. Many jurisdictions may limit (or even stop) dead bird surveillance once WNV is confirmed in their region. It is suggested that dead bird surveillance continue in each region as long as it remains necessary to know whether local transmission persists, because dead-bird-based surveillance is the most sensitive method for detection of WNV activity in most regions.

A single organ specimen from each bird is sufficient to detect WNV. Kidney, brain, or heart is preferable. Swabs of the mouth cavity from corvids may also be used and these oral swabs are the preferred specimen from corvid carcasses. Testing results are usually provided within 1-2 weeks after specimen submission.

2) Use of dead birds in WNV surveillance in the United States 1999 to date
Analysis of recent avian morbidity and mortality data indicated that

- (a) The American crow was the most best species for detection of WNV in dead birds in northern regions. In southern regions, blue jays have been more sensitive than crows.
- (b) Almost all of the positive birds were found singly and not as part of a mass die-off at a single time and place.
- (c) WNV positive dead birds usually provided the earliest indication of viral activity in an area. In 2002, the detection of WNV infected dead birds was the first positive surveillance event in 1,534 (61%) of 2,531 counties in the United States reporting WNV activity.

3) Advantages of avian morbidity/mortality surveillance include the following:

- (b) The size and coloration of the birds most commonly affected by WNV makes them conspicuous (e.g., crows).
- (c) Laboratory tests have been developed to test for WNV in dead birds and some of these tests are adapted for field applications.
- (d) Due to public involvement in reporting dead bird sightings, dead wild birds are readily available over a much wider region than can be sampled by other surveillance methods.
- (e) Detection of WNV in dead birds likely signifies local transmission.
- (h) It may be used to estimate risk of human infection with WNV.

4) Disadvantages of avian morbidity/mortality surveillance include the following:

- (a) Dead bird surveillance data from different jurisdictions are difficult to compare.
- (b) Birds are highly mobile and often have extensive home ranges, so that the site of death may be distant from the site of infection (especially after the breeding season, when birds are generally less territorial).
- (c) Collection, handling, shipping, and processing of birds or their clinical specimens is cumbersome.
- (d) Systems for handling, processing, and testing have at times been overwhelmed by high public response and public expectations.
- (e) The long-term usefulness of this system is uncertain because WNV ecology will change over time, resulting in low or no avian mortality. In areas where WNV annually recurs, intense environmental sampling might not be useful.
- (f) Success is influenced by public participation, which is highly variable, and depends on the number of public outreach programs, level of public concern, etc.
- (g) Dead birds are less likely to be detected in rural areas, where there are fewer persons to observe dead birds over a wider geographic area. Another reason why fewer dead birds are found in rural areas is that it has been shown that in the western U.S., the mosquito vector

Culex tarsalis does not bite birds very often and is more common in rural than urban areas resulting in fewer reports of dead birds relative to other non-avian surveillance indicators.

Live bird surveillance

Live-bird surveillance has been used to detect and monitor arbovirus transmission (e.g., for SLE, EEE and WEE viruses). Two approaches are captive sentinel surveillance (typically using chickens, but other species have been used as well), and free-ranging bird surveillance. Both depend on blood testing, which generally requires at least 3 weeks to confirm an infection. It is recommended that research on local mosquito populations, species, and wild bird mortality be done before relying on sentinel birds as a primary means of WNV surveillance. Use of sentinel birds may require institutional animal use and care protocols, and other authorization permits.

GOAL OF LIVE-BIRD SURVEILLANCE: Regularly test a captive or free-ranging bird species until the blood test shows that the bird is positive to WNV thus indicating the presence of local WNV activity.

1) Captive sentinel surveillance

   The ideal captive avian sentinel for WNV – or any other arbovirus –would meet the following criteria: 1) it can get infected with an arbo virus, 2) it does not die from arboviral infection and it develops proteins in the blood that show it was exposed to the virus 3) it cannot make the handlers sick, and 4) it never develops enough virus in its blood to infect vector mosquitoes. Captive sentinels have been effectively used to monitor transmission of arboviruses in a standardized fashion, including SLE virus in California and Florida, especially in areas where transmission has occurred for a long time. Captive sentinel flocks should be placed near vector breeding sites or adult mosquito congregation sites, be available to allow feeding by enzootic WNV vectors. Alternatively, pre-existing captive birds (e.g., domestic poultry or pigeons, or zoo birds) may be used as sentinels.

   (a) Advantages of sentinel captive bird surveillance include the following:
      (i) Chickens have been successfully used in flavivirus surveillance for over 6 decades.
      (ii) Birds are readily fed upon by *Culex* mosquitoes.
      (iii) Captive birds are kept in one place so that when they become positive, the geographic location of arbovirus activity is definite.
      (iv) The number of birds or number of flocks can be increased or decreased as appropriate.
      (v) Mosquito-abatement districts can maintain and bleed flocks and submit specimens for testing.
      (vi) Collection of specimens is inexpensive compared with the costs of free-ranging bird surveillance.
   (b) Disadvantages of captive sentinel surveillance include the following:
      (i) Sentinel flocks detect only focal transmission, requiring multiple flocks be positioned in representative geographic areas. This is particularly true when vector mosquitoes have short flight ranges (e.g., *Culex pipiens*).
      (ii) Flocks are subject to vandalism and theft.
      (iii) Flocks must be protected from predators.
      (iv) Flock set-up and maintenance (i.e., birds, cages, feed, transportation) are expensive. Training is required for proper maintenance and sampling.
      (ii) Pre-existing flocks may already have been exposed due to previous local WNV transmission.

2) Free-ranging bird surveillance

   Free-ranging birds provide the opportunity for sampling important reservoir host species and may be used both for early detection and for monitoring virus activity. This type of surveillance has been used effectively for SLE, EEE and WEE virus surveillance in several states. In each geographic area, the appropriate free-ranging bird species to be monitored should be determined by testing a variety of species and chosing the species that is most commonly positive for WNV in an area. The best species for free-ranging surveillance are those in which infection is rarely, if ever, fatal, and population replacement rates are high, ensuring a high proportion of uninfected individuals.

(a) Advantages of free-ranging bird surveillance include the following:
   (i) It has a long history of successful use in flavivirus surveillance.
   (ii) Local movement of resident wild birds may increase contact with enzootic transmission foci, thus increasing sensitivity (relative to captive sentinels).
   (iii) Set-up or maintenance costs may be minimal.
   (iv) Its sampling capability is highly flexible.
   (v) It permits evaluation of herd immunity among important amplifying hosts.
   (vi) Owner confidentiality may be less of an issue.

(b) Disadvantages of free-ranging bird surveillance include the following:
   (i) Interpretation of test results is complex and difficult.
   (ii) Handling and bleeding of birds increases the possibilty that a handler could be exposed to virus in the blood and feces of the wild birds.
   (iii) Movement of free-ranging wild birds makes it impossible to know where an infection was acquired.
   (iv) Most birds are protected by federal law, and their collection and sampling requires state and federal permits. Banding permits require complex data reporting.
   (iv) Training is required for live-trapping, blood-sampling, handling, and accurate determination of the species and age of wild birds.
   (vi) It is generally not feasible to serially bleed individual free-ranging birds because of low recapture rates (although banding can be useful).

3. Equine (Horses)

Horses appear to be important sentinels of WNV epizootic activity and human risk, at least in some geographic regions. In addition, equine health is an important economic issue. Therefore, surveillance for equine WNV disease should be conducted in jurisdictions where equines are present. Veterinarians, veterinary service societies/agencies, and state agriculture departments are essential partners in any surveillance activities involving equine WNV disease.

GOALS OF EQUINE DISEASE SURVEILLANCE: Use on the number of WNV disease horse cases to assess the threat of human disease, identify geographic areas of high risk, and assess the need for and timing of interventions.

b) <u>Recent experience</u>
   1) In 2002, horse WNV disease cases were the first indication of WNV activity in 95 (16%) of the 589 counties in the United States where human disease was reported.
   2) In general, horse WNV disease cases have been scattered. Few case clusters have been documented.
   4) A licensed equine WNV vaccine has been available in the U.S. since 2001. No studies of efficacy have been published.

c) <u>Advantages of equine disease surveillance include the following:</u>
   1) Horses are highly conspicuous, numerous, and widely distributed in some areas. They may be particularly useful sentinels in rural areas, where dead birds may be less likely to be detected.
   2) Some Horses are routinely bled and tested for other pathogens.
   3) Ill horses have been one of the earliest, if not the earliest, sentinels of WNV activity in some geographic areas.

d) <u>Disadvantages of equine disease surveillance include the following:</u>
   1) In some geographic areas, equines may not be an early sentinel (i.e., human WNV disease cases may occur simultaneously with or soon after equine cases).
   2) Necropsies are expensive.

3) Horse are not present nor common in many areas of the U.S. (e.g., densely populated metropolitan areas.
4) Widespread use of the horse WNV vaccines may decrease the occurrence of equine WNV disease and therefore horses would not be useful as sentinel animals.
5) Because horse owners typically pay for testing and veterinary care, horse surveillance may be costly.

e) Minimal components of an equine surveillance program
1) All equine neurologic disease cases should be promptly reported; the equines should be tested for infection with WNV and other arboviruses as geographically appropriate, and for rabies if appropriate.
1) Clusters of equine neurologic disease cases should be promptly investigated.

Prepared by the California Department of Health Services, Vector-Borne Disease Section with Information from www.westnile.ca.gov, www.cdc.gov, and the Center for Disease Control and Prevention's Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control

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