



## *West Nile Virus & Other Mosquito-borne Infections*

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**W**est Nile virus (WNV) can cause serious and sometimes fatal illness. This virus has been documented in the USA since 1999 and is most often spread through the bite of an infected mosquito. In 2002, WNV caused the largest epidemic of a mosquito-borne viral meningoencephalitis (severe neurological disease) ever recognized in the Western Hemisphere. In the USA, more than 4100 human WNV disease cases were reported from 740 counties in 39 states and the District of Columbia. The epidemic was focused in the central USA, from the Great Lakes to the Gulf Coast. Approximately 3000 individuals were hospitalized with central nervous system infection, with 284 fatalities. Intensive West Nile virus activity continued in 2003, with most cases reported in the Great Plains and immediately west of the Rocky Mountains. Updates on WNV activity can be found at: <http://www.cdc.gov/westnile>.

Other mosquito-borne viral infections in the USA include: St. Louis encephalitis (SLE); Eastern and Western equine encephalitis (EEE and WEE); and LaCrosse (LAC) encephalitis. Human illness due to these other viruses is less common than WNV, though occasional large outbreaks can occur. Dengue fever is a mosquito-borne virus that is an important health concern in Latin America and Asia. This disease has been seen on rare occasions in Hawaii as well as in Texas, usually along the border with Mexico.

### **Prevalence and Distribution**

First seen in the greater New York City area in 1999, WNV has now become established

throughout much of the USA and North America. By 2002, only 6 states (including Alaska and Hawaii) had not reported any WNV activity. It is likely that all lower 48 states will eventually report WNV activity. High levels of WNV activity with shifting geographic focal points are expected in the future. WNV transmission has also been reported in parts of Canada, Mexico, and the Caribbean. Less than 1% of all people exposed to a WNV-infected mosquito develop severe disease; the remainder show no or only mild symptoms. Based on surveys in which blood samples were taken in areas of virus activity, it is estimated that 60-2000 human WNV infections occurred for each reported hospitalized case. This suggests a total of 180,000 to 600,000

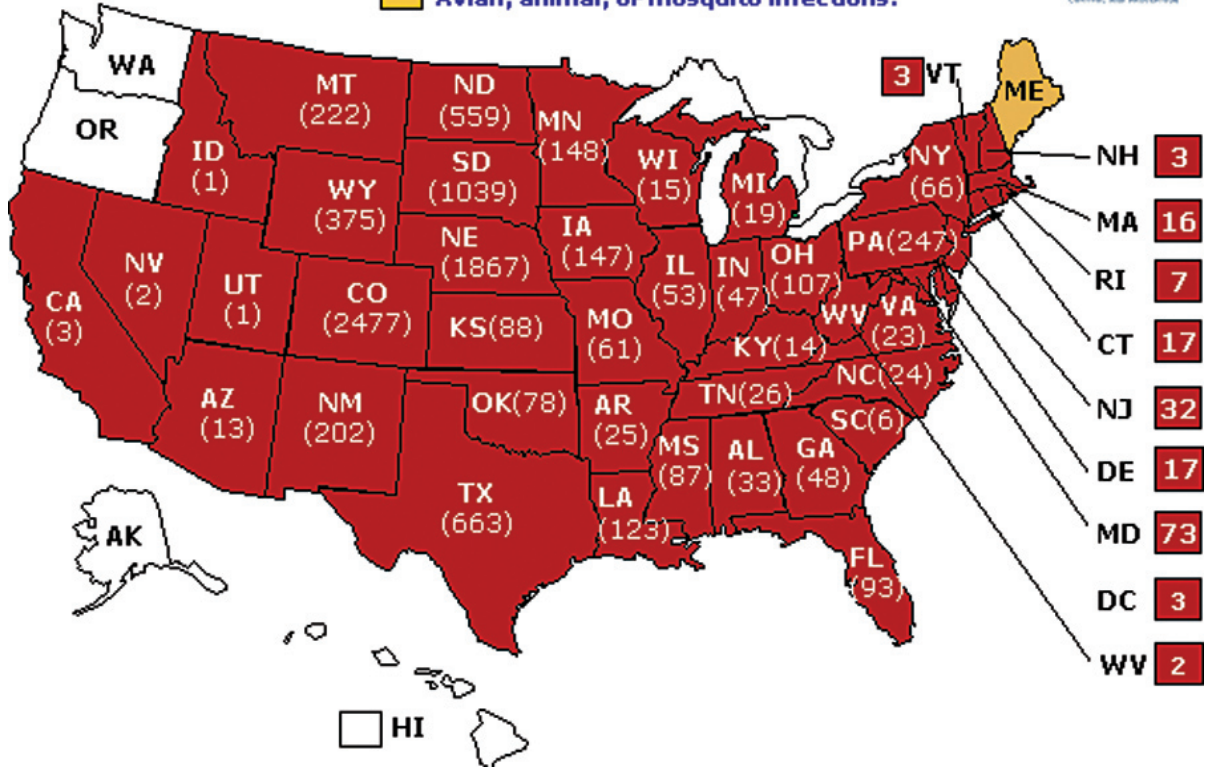
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*A female Aedes albopictus mosquito, also known as the Asian Tiger Mosquito, feeding on a human host. Photo courtesy of the CDC*

# Indicates human disease case(s).  
 Yellow indicates Avian, animal, or mosquito infections.



WNV Map.  
 Distribution of WNV infection during 2003. If WNV infection in any area of a state is reported to CDC Arbonet, that entire state is shaded accordingly, with the total number of human cases in parentheses. Courtesy of the CDC



human WNV infections in the USA during 2002 alone. Once infected with WNV, individuals probably develop long-lasting, if not lifelong, immunity to the virus.

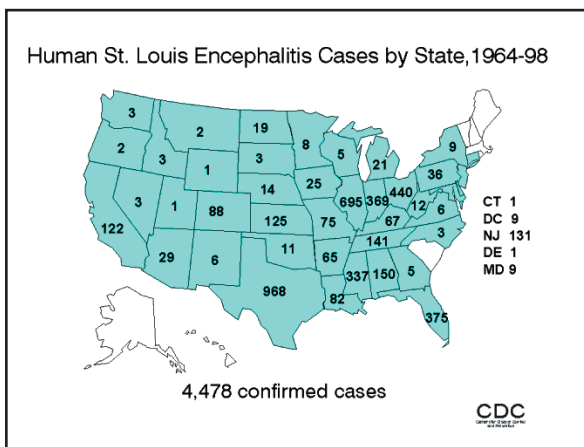
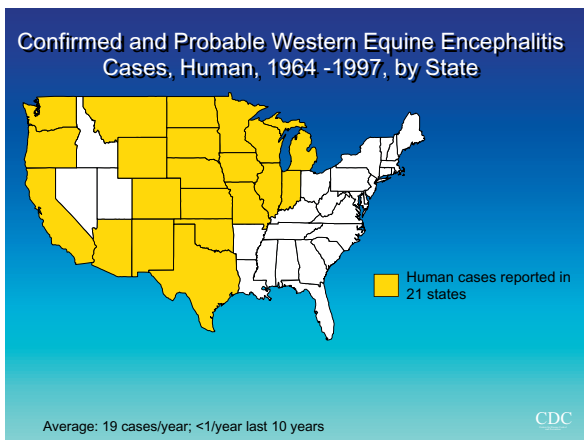
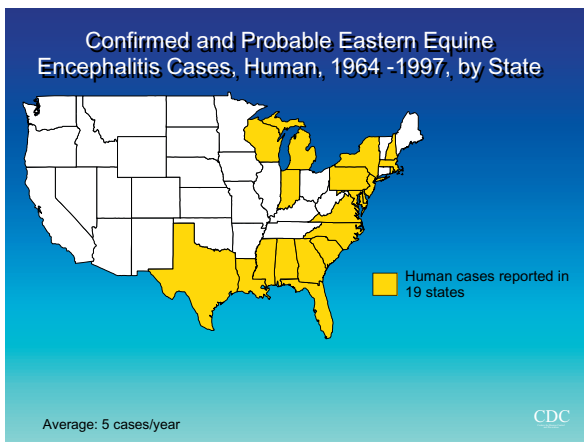
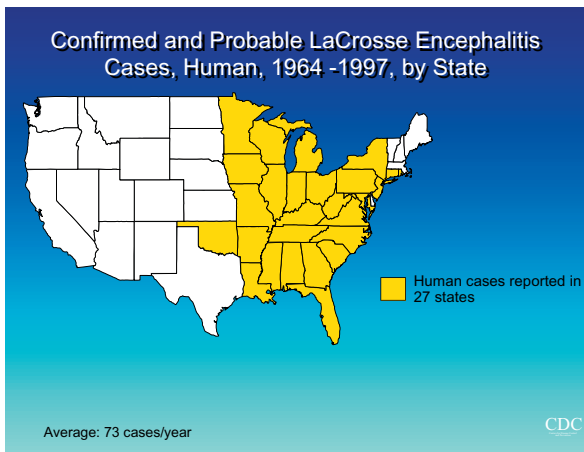
Other mosquito-borne viral diseases in the USA have tended to be more regional. Between 1964 and 2000, there were 2776 cases of California serogroup virus infections (mainly LAC encephalitis) reported in 27 states, all in the eastern half of the USA. LAC encephalitis is traditionally active in the upper Midwest and Great Lakes states, with an increasing number of cases in Mid-Atlantic states. Only 182 human cases of Eastern equine encephalitis (EEE) were reported from 1964 to 2000, with an average of 5 cases each year, mostly occurring in the eastern half of the country. During that same period, 640 cases of Western equine encephalitis (WEE) have been reported; however, in the past 10 years less than 1 case per year has been reported. Like WNV, St. Louis encephalitis (SLE) is an "epidemic" arbovirus that has been responsible for more disease than the other domestic arboviral diseases: 4482 cases were reported from 1964 to 2000, with almost 2000 of those reported in 1975 alone. Cases have been reported in most states, with concentrations in the Midwest, Texas, and California. A significant outbreak of SLE occurred in northeastern Louisiana

in 2001. Maps, charts, and other information detailing the arboviral encephalitides can be found at: <http://www.cdc.gov/ncidod/dvbid/arbor/arbovase.htm>

### Mode of Transmission

The most important route of WNV transmission, as well as other mosquito-borne viral diseases discussed here, is through the bite of an infected mosquito. The main cycle of WNV is between mosquitoes and birds. Mosquitoes become infected with the virus when they feed on a bird infected with WNV. Approximately 10 to 14 days after the mosquito bites the infected bird, the mosquito can transmit the virus to another bird or mammals, including humans. The mosquito injects the virus into the bird, animal, or person while taking a blood meal. As of 2002, WNV had been found to infect 36 species of mosquitoes and more than 160 species of birds. Many of these mosquito species are most likely to bite between dusk and dawn.

Other modes of WNV transmission are also possible but represent a very small percentage of cases. While the bite of an infected mosquito remains the most important means of transmission, investigations have confirmed that WNV can be spread through blood transfusion and transplanted



organs. Beginning in July 2003, all donated blood is screened for the presence of WNV. Transplacental (mother-to-child) WNV transmission has been reported, and possible transmission through breastfeeding (mother-to-child) has also been reported. Transmission of WNV and similar viruses to laboratory workers has also occurred on very rare occasions.

While no person-to-person transmission of WNV has been documented, transmission through shared, contaminated needles is a possibility. Touching or sharing utensils with a person infected with WNV does not pose a risk of infection. Evidence also suggests that mosquitoes are unlikely to become infected with WNV by biting a person infected with the virus, most likely because humans do not develop sufficient viremia (circulating virus in the bloodstream) to continue the transmission cycle.

### Symptoms and Diagnosis

The incubation period for WNV, the time between infection from a mosquito bite until symptoms appear in humans, appears to range from 3 days to 2 weeks. About 80% of human WNV infections do not result in any symptoms or illness. 20% of infected individuals develop West Nile fever (WNF), but only 1 in 150 infected persons develops severe disease such as encephalitis or meningitis.

WNF can be difficult to distinguish from other viral infections. Symptoms of mild WNV disease include fever, headache, body aches, occasionally a skin rash on the trunk of the body, and swollen lymph glands. Symptoms of mild disease will generally last a few days and then resolve without treatment.

Severe disease associated with WNV outbreaks includes meningitis (inflammation of the membranes surrounding the brain), encephalitis (inflammation of the brain), or meningoencephalitis (inflammation of the brain and the surrounding membranes). More recent investigations have also described a polio-like syndrome associated with WNV, involving cases of acute flaccid paralysis. The symptoms of severe WNV disease include headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis.

Advanced age is by far the most significant risk factor for developing severe disease after infection. The risk of severe disease is greatest among people age 50 years and older.

*CDC Arbonet Maps. These maps show the distribution of infection of LAC, EEE, WEE, and SLE during 2003. Updated maps are available from the CDC at <http://www.cdc.gov/ncidod/dvbid/arborl/arbocase.htm>.*

## Treatment and Complications

No specific treatment is yet available for WNV infection. Patients with severe disease often require hospitalization, which may involve intensive care and even mechanical ventilation. Although several potential treatments have been suggested for WNV encephalitis, no evidence is available yet to document the efficacy of these treatments.

Fatality rates among persons with severe WNV disease in the USA have remained constant at approximately 10% in 2000, 2001, and 2002. Advanced age is the most important risk factor for death, with patients older than 70 years of age at highest risk. In New York, persons 75 years and older were nearly nine times more likely to have a fatal outcome than younger persons. Encephalitis with severe muscle weakness and a change in the level of consciousness were also prominent clinical risk factors predicting fatal outcome. Some limited data suggest that certain pre-existing conditions, such as diabetes mellitus or immunosuppression, may be independent risk factors for death.

Many individuals hospitalized for severe WNV disease have substantial long-term complications. Among patients hospitalized in New York and New Jersey in 2000, more than half did not return to their previous level of function by the time of release from the hospital and only one-third were fully ambulatory. The New York City Department of Health performed a one-year follow-up of persons hospitalized with WNV disease in 1999 and found frequent and persistent symptoms, such as fatigue, memory loss, difficulty walking, muscle weakness, and depression.

## Prevention and Control

Prevention and control of WNV and other arboviral diseases requires the education and use of protective measures by individuals, the control of breeding sites on the household or facility level, and the implementation of an Integrated Mosquito Management (IMM) Program on a community-wide level. IMM involves the monitoring of WNV activity in birds, animals, mosquitoes, and humans, and the use of mosquito control measures when appropriate.

The most effective way for individuals to avoid infection is to prevent mosquito bites. This can be accomplished in several ways:

- regular use of insect repellent on exposed skin and clothing when outdoors. Repellents containing DEET (N,N-diethyl-m-toluamide) are the most effective for use

on exposed skin. Repellents containing permethrin or DEET can be used on clothing, as mosquitoes may bite through thin clothing;

- repellents containing DEET are very safe when used according to product instructions. Do not spray repellent with DEET under clothing;
- do not use permethrin directly on skin;
- products with a higher percentage of DEET (up to 50%) give longer protection. Products with more than 50% DEET do not offer additional protection;
- wearing protective clothing - long sleeves, long pants, and socks (especially when sprayed with repellent) - can further limit mosquito bites;
- avoiding exposure to mosquitoes during prime biting hours is another prevention step. Many species of mosquitoes actively bite between dusk and dawn. People should use precautions (repellent, protective clothing) especially during these hours or avoid the outdoors if possible.

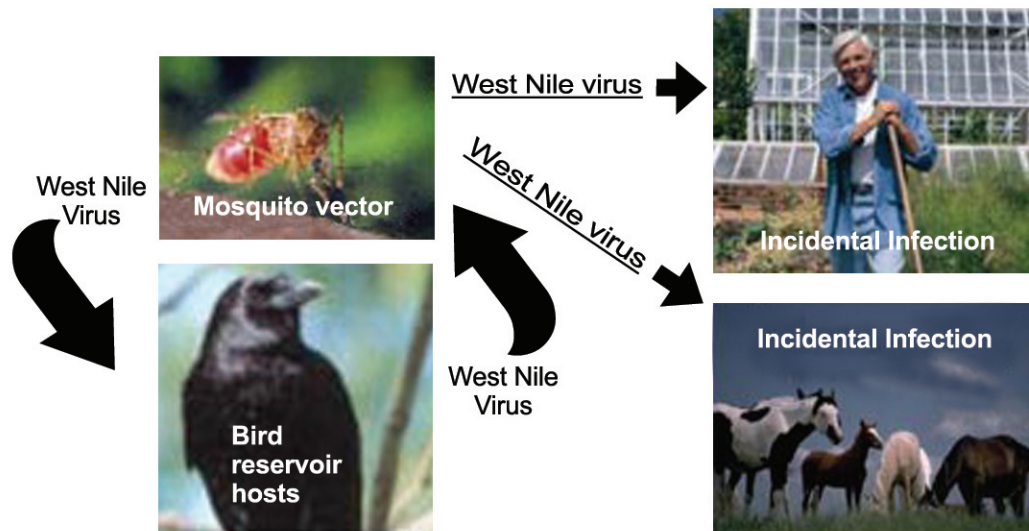
Additional steps can be taken to limit mosquito populations by eliminating or controlling mosquito-breeding sites, such as containers with standing water. In specific areas where homeless persons spend significant periods of time, campaigns can be conducted to reduce disposable containers that breed mosquitoes. In addition, local mosquito control authorities can conduct larviciding or adulticiding (control of immature or mature mosquitoes) in those areas. Possible breeding sites located near shelters should be controlled. Even a small amount of standing water can be sufficient to allow mosquitoes to breed.

Keeping mosquitoes from indoor areas is another step in prevention. The installation or repair of window and door screens in shelters and soup kitchens, as well as other places frequented by homeless persons, can help limit the risk of mosquito-borne disease.

## Special Considerations for Homeless Populations

Homeless populations may be at higher risk for WNV and other mosquito-borne diseases due to their increased exposure to the outdoors and their limited access to preventive measures. Health care providers should vigorously promote the use of insect repellents, especially for homeless persons over the age of 50. Repellent use for homeless

# West Nile Virus Transmission Cycle



WNV Cycle. Mosquitoes are the vector for WNV and birds are the usual reservoir. People, horses, and most other mammals are infected incidentally and are not reservoirs. Courtesy of the CDC

populations requires several special considerations:

- cost: access to insect repellents among persons with limited financial resources may be problematic. Some local or state health departments or mosquito control programs may be able to assist with repellent supplies or may have recommendations for lower cost products. Businesses that sell repellents may also be able assist shelters in obtaining repellents;
- personal hygiene: an additional concern for homeless populations may be limited opportunities to bathe between repellent applications. DEET is a very safe product when used as directed. While DEET can be reapplied when a person is still outdoors, most products recommend bathing when returning indoors. The availability of showering facilities is often limited for homeless persons, and this should be taken into consideration. The ability to follow directions and use the product safely is also a concern, if the product is made available for personal use;
- use of repellent on clothing: repellents with DEET or permethrin can be used on the clothing, which may be particularly useful for homeless populations. Protec-

tion from one permethrin application can last as long as 6 weeks, even through several launderings. As noted previously, permethrin should not be used directly on skin;

- For more information on safe use of repellents please consult:
  - Centers for Disease Control and Prevention: [http://www.cdc.gov/ncidod/dvbid/westnile/qa/insect\\_repellent.htm](http://www.cdc.gov/ncidod/dvbid/westnile/qa/insect_repellent.htm)
  - National Pesticide Information Center: <http://npic.orst.edu/>

## Summary

West Nile virus and other mosquito-borne viral diseases, while relatively low in incidence, pose a significant risk to homeless populations due to their potential for mosquito bites and extensive exposure to the outdoors. Increased mosquito control and frequent application of repellent are considered critical for all vulnerable populations. All persons over the age of 50 are at higher risk for severe disease, which typically results in hospitalization. ■

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