Mosquito-Borne Viral Diseases

Summary

The mosquito-borne viruses (also called arboviruses), are a group of illnesses that are transmitted through the bite of an infected mosquito. The diseases of this group that have been transmitted in New Mexico are Western equine encephalitis virus (WEEV), St. Louis encephalitis virus (SLEV), and West Nile virus (WNV). Travelers to endemic areas can be exposed to other arboviral illnesses such as dengue virus (DENV), chikungunya virus (CHIKV), Japanese encephalitis virus (JEV), yellow fever virus (YFV), or Zika virus (ZIKV). The majority of arboviral infections are asymptomatic or mild. Most arboviruses can cause a generalized viral illness with symptoms including, fever, headache, myalgia, arthralgia, and rash. In some cases, fever, malaise, and weakness can linger for weeks after infection.

For some arboviruses (WEEV, WNV, SLEV, JEV), illness can progress to neuroinvasive disease, meaning the central nervous system can be infected. Neuroinvasive disease can result in aseptic meningitis or encephalitis and can cause altered mental status, coma, or death. In rare cases, other neurologic manifestations like Guillian-Barré syndrome and/or acute flaccid paralysis can occur. The elderly are at greatest risk of severe neuroinvasive illness when infected with SLEV and WNV and children are most at risk when infected with WEEV. The severity of symptoms and long-term outcome of illness varies considerably when neuroinvasive disease occurs.

In some cases, travel associated DENV and YFV infections can result in hemorrhagic fever and shock syndrome. These are severe cases where initial, nonspecific symptoms progress to hemorrhage (petechiae (capillary break and leakage), ecchymosis (blood leaking under skin), bleeding nose and gums, melena (black, tarry stools) and shock (azotemia, tachycardia, hypotension). Mortality is high in YFV cases that progress to hemorrhagic fever and DENV cases that progress to shock.

CHIKV is becoming more common globally and is therefore increasing in risk for travel associated infections. Symptoms are like those stated, fever, headache, fatigue, rash, but also include severe joint pain that can become chronic. ZIKV is the only mosquito-borne arbovirus known to cause fetal death and birth defects in fetuses whose mother was infected during pregnancy. Babies born after ZIKV infection while in the womb can have microcephaly and sever brain abnormalities. ZIKV is also the only arbovirus with documented sexual transmission.

Control of these diseases is primarily through effective mosquito control and personal protective measures to prevent mosquito bites.

Agent

Each disease is caused by a specific virus: WEEV and CHIKV viruses are in the family Togaviridae (*Alphavirus*); SLEV, DENV, JEV, ZIKV, YFV, and WNV are in the family Flaviviridae (*Flavivirus)*.

Transmission

Vector: A mosquito that can become infected with an arbovirus through the bite of a reservoir host and subsequently transmit it to another host or human through an second bite later on (**Fig. 1**).

In the United States mosquito species in the genus *Culex* are the principal vectors of WEEV, WNV and SLEV. These mosquitoes are present throughout New Mexico. They also transmit JEV abroad.

DENV, CHIKV, YFV, and ZIKV could potentially be vectored by invasive *Aedes aegypti* and *A. albopictus* mosquitoes, which are present in New Mexico and have been confirmed as far north as Bernalillo County.

Reservoir host: A reservoir host is an animal that maintains the survival and transmission of a virus and is fed upon by mosquitoes which can result in transmission to humans (**Fig. 1**).

Birds are the reservoir hosts of WNV, WEEV, SLEV and JEV infections. Pigs are an additional reservoir host for JEV. Mosquitoes typically feed on these animals in late spring, summer and early fall; therefore, these months are the main transmission window for local arboviruses. Little is known about the overwintering mechanisms for these viruses. The virus may remain viable in infected hibernating adult female mosquitoes, birds or other animals.

Primates, including humans, are the reservoir for CHIKV, DENV, YFV and ZIKV.

Mode of transmission:

- Through the bite of infected mosquitoes that have acquired the virus by feeding on an infected reservoir host. Rarely, organ and tissue transplant or blood transfusion can also cause infection. The blood supply of the United States is screened for arboviruses.
- ZIKV can also be spread through unprotected sexual contact and from a pregnant person to a fetus.

Period of communicability:

- With the exception of ZIKV, these viruses are not transmissible from human to human or from other animals to humans. ZIKV may be spread through unprotected sexual contact with an infected female partner for up to two months after exposure or onset, and with an infected male partner for up to three months after exposure or onset.

Clinical Disease

Incubation period:

Usually 2-14 days, up to 21 days for SLE or for WNV in immunocompromised people.

Illness:

Locally acquired disease in humans is most common in summer and early fall. Symptoms are variable depending on the virus and the age and general health of the individual. Mild cases often present as a febrile headache or aseptic meningitis. Severe infections are usually marked by acute onset of headache, high fever, meningeal signs, altered mental status, disorientation, coma, tremors, occasional convulsions (especially in infants), and spastic or flaccid paralysis. Case fatality rates range from 2% – 20%, and the ratio of asymptomatic infections to clinical cases can be quite high (about 80% of infections are asymptomatic). Signs and symptoms of SLEV and WNV are most severe in persons >50 years of age. Adults usually recover completely from WEEV, but about half of children affected with WEEV suffer permanent neurological effects, including progressive cognitive disability and varying degrees of physical and mental dysfunction. ZIKV is usually a mild illness with very few hospitalizations or deaths; however, infection during pregnancy can cause microcephaly, eye/ear problems, and other

congenital defects in the fetus. Severe DENV infection may cause plasma leakage, shock, severe bleeding, and multiorgan failure.

Horses suffer clinical disease with WEEV or WNV infection. Symptoms include fever, anorexia, reluctance to move, ataxia, muscle tremors, recumbency, and seizures. A vet should be notified immediately if a horse has these symptoms. Some bird species infected with WNV can become sick and die, unlike infections with SLEV or WEEV.

Laboratory Diagnosis

Patients with consistent signs and symptoms and compatible travel or exposure history in which diagnosis of an arboviral infection is highly suspected should have blood and possibly cerebrospinal fluid (CSF, if signs or symptoms of neuroinvasive disease are present) collected for testing.

Commercial laboratories in New Mexico and other states are able to test serum and/or CSF specimens. Typical patients to test include:

- Any patient with encephalitis, or atypical Guillain-Barre type syndrome and evidence of pleocytosis in the CSF.
- Any patient with suspect viral meningitis if other etiologic agents have been ruled out.
- Pregnant women who resided in or traveled to a ZIKV endemic area and had symptoms of fever, rash, headache, or arthralgia within 2 weeks of exposure.

In cases with atypical laboratory results, New Mexico Department of Health Scientific Laboratory Division (SLD) may forward samples to CDC in Ft. Collins, Colorado for further testing. Call the Epidemiology and Response Division at 505-827-0006 prior to shipment of any specimens. A submission form with brief clinical information will need to be completed.

Vaccination

Currently, there are preventative vaccines available for several travel associated arboviruses including YFV and JEV. These vaccines can be acquired locally and are recommended for anyone planning travel to endemic areas. There is one FDA approved DENV vaccine, Dengvaxia; however, this is only approved for specific residents of dengue endemic areas. It is **not approved for US residents traveling** to DENV endemic areas. Several other DENV vaccines are in the late phases of clinical trials.

There are no preventative vaccines available for locally transmitted arboviruses for humans. However, there is a WNV/WEEV vaccine for horses that should be administered by a veterinarian after 3 months of age, followed by a booster three to four weeks after.

Treatment

No antiviral medication is available for any of these arboviruses. Supportive therapy is indicated, and patients should be monitored for cerebral edema. DENV patients should avoid medications containing ibuprofen, Naproxen, or aspirin.

Dengue hemorrhagic fever generally requires hospitalization and may be treated using fluid replacement therapy.

Surveillance

Case Definition:

Clinical case definition-

Patients must have a compatible exposure or travel history in addition to clinical signs.

A clinically compatible case of arboviral disease is defined as follows:

Neuroinvasive disease

- 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. Other clinically compatible symptoms of arbovirus disease include: headache, myalgia, rash, arthralgia, vertigo, vomiting, paresis and/ or nuchal rigidity.

Non-neuroinvasive disease

- Fever (chills) as reported by the patient or a health-care provider (with the exception of ZIKV, which does not always present with fever and can be suspected in the presence of at least one clinical symptom), and
- Absence of neuroinvasive disease, and
- Absence of a more likely clinical explanation. Other clinically compatible symptoms of arbovirus disease include: headache, myalgia, rash, arthralgia, vertigo, vomiting, paresis and/ or nuchal rigidity.

Laboratory criteria:

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 or serum.

Case Classification

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 serum but with no other testing.

Confirmed

Neuroinvasive disease

A case that meets the above clinical criteria for 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, with or without a reported pleocytosis, 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, or other body fluid, excluding CSF, 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.

Reporting:

Report all suspected or confirmed cases of encephalitis to the New Mexico Department of Health's Infectious Disease Epidemiology Bureau (IDEB) at 505-827-0006. Information needed includes: patient's name, age, sex, race, ethnicity, home address, home phone number, occupation, and health care provider.

Case Investigation:

Use the Arbovirus Case Report Form to complete the investigation. Information should also be entered into NM-EDSS by established procedures.

Control Measures

1. Case management

1.1. Isolation: Isolation of patients with mosquito-borne encephalitis is not required.

Contact precautions are appropriate until bacterial meningitis is ruled out. Patients suspected of having DENV, CHIK, or ZIKV should take measures to avoid mosquito bites during their viremic period (approximately 7 days after illness onset). Humans and horses are dead-end hosts for WNV, WEE, and SLE and therefore cannot pass the infection to mosquitoes that feed on them. ZIKV patients should also use barrier protection with sex partners (8 weeks for females, 6 months for males) and avoid pregnancy during that time.

2. Contact management

2.1. Isolation: None required. DENV, CHIK, and ZIKV patients should avoid exposure to mosquitoes.

2.2. Prophylaxis: Not applicable.

3. Prevention

3.1. Immunization: No vaccine is available for humans. Horses should be vaccinated annually against Western equine encephalitis, Eastern equine encephalitis, West Nile virus, and Venezuelan equine encephalitis.

3.2. Control mosquito vectors through elimination of breeding sites (i.e., standing water). Educate the public on potential backyard sources of mosquito breeding such as discarded tires, abandoned swimming pools, and other water-holding containers.

3.3. Conduct larval and adult mosquito control through community vector control programs.

3.4. Screen windows and doors of houses and buildings.

3.5. Avoid exposure to mosquitoes during hours of biting. If mosquitoes cannot be avoided, wear long sleeves and long pants and apply an effective repellent (such as DEET [chemical name, N, N-diethyl-meta-toluamide] or picaridin) to exposed skin or clothing. Do not apply repellents under clothing. Use the lowest concentration of DEET that is effective (usually 10 – 35%). Use products containing no more than

10% DEET on children and do not apply DEET-containing products to children less than two months of age. Permethrin is an effective repellent used on clothing. Do not apply Permethrin to skin. Products containing botanical essential oils (such as lemon eucalyptus oil) are also available as mosquito repellents but need to be applied more frequently than DEET- containing repellents.

3.6. Surveillance and testing of mosquito vector populations has value by identifying rates of infection and geographic areas involved.

References

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Surveillance Case Definitions for Current and Historical Conditions, Surveillance Case Definitions for Current and Historical Conditions accessed 10/04/2017.

See West Nile Virus Fact Sheets (English) (Spanish).

See Zika Fact Sheets (English) (Spanish).