# POWASSAN VIRUS DISEASE

(Powassan encephalitis, POW)

## REPORTING INFORMATION

- **Class B:** Report by the end of the next business day after the case or suspected case presents and/or a positive laboratory result to the local public health department where the patient resides. If patient residence is unknown, report to the local public health department in which the reporting health care provider or laboratory is located.
- Reporting Form(s) and/or Mechanism:
  - Ohio Confidential Reportable Disease form (HEA 3334, rev. 1/09)
  - Positive Laboratory Findings for Reportable Disease form (HEA 3333, rev. 8/05)
  - Via the Ohio Disease Reporting System (ODRS) or telephone
  - The Ohio Department of Health (ODH) Mosquito-borne Illness Case Investigation worksheet is available for use to assist in local disease investigation. Information collected from the form should be entered into ODRS and not sent to ODH, unless otherwise requested. If requested, the form can be faxed to 614-564-2456.
- Key fields for ODRS reporting include: import status (whether the infection was travel-associated or Ohio-acquired), date of illness onset and all the fields in the Epidemiology module.

## AGENT

Powassan virus is an RNA virus in the genus Flavivirus of the Flaviviridae family. There is substantial serologic cross-reaction with other flaviviruses (e.g. dengue, St. Louis encephalitis, yellow fever, Japanese B encephalitis, West Nile virus).

**Infectious dose:** A single bite from an infectious tick.

## CASE DEFINITION

### Clinical Description

Most arboviral infections are asymptomatic. Clinical disease ranges from mild febrile illness to severe encephalitis. For the purposes of surveillance and reporting, based on their clinical presentation, arboviral disease cases are often categorized into two primary groups: neuroinvasive disease and non-neuroinvasive disease.

*Neuroinvasive disease*

Many arboviruses cause neuroinvasive disease such as aseptic meningitis, encephalitis or acute flaccid paralysis (AFP). These illnesses are usually characterized by the acute onset of fever with headache, myalgia, stiff neck, altered mental status, seizures, limb weakness or CSF pleocytosis. AFP may result from anterior ("polio") myelitis, peripheral neuritis or post-infectious peripheral demyelinating neuropathy (i.e. Guillain-Barre syndrome). Less common neurological manifestations, such as cranial nerve palsies, also occur.

*Non-neuroinvasive disease*

Most arboviruses are capable of causing an acute systemic febrile illness (e.g. West Nile fever) that may include headache, myalgias, rash or gastrointestinal symptoms. Other physical complaints include vertigo, stiff neck or muscle weakness without progression to more clinically apparent neurological involvement.

**Clinical Criteria for Diagnosis**

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.

Non-neuroinvasive disease:

- Fever or chills as reported by the patient or a healthcare provider and
- Absence of neuroinvasive disease and
- Absence of a more likely clinical explanation.

**Laboratory Criteria for Diagnosis**

- Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, cerebrospinal fluid (CSF) or other body fluid or
- Four-fold or greater change in virus-specific quantitative antibody titers in paired sera or
- Virus-specific immunoglobulin M (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 with 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 with 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 the following laboratory criteria for a confirmed case:
  - Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood, CSF or other body fluid or
  - Four-fold or greater change in virus-specific quantitative antibody titers in paired sera or
  - Virus-specific IgM antibodies in serum with confirmatory virus-specific neutralizing antibodies in the same or a later specimen or
  - Virus-specific IgM antibodies in CSF and a negative result for other IgM antibodies in CSF for arboviruses endemic to the region where exposure occurred.
- Non-neuroinvasive disease: A case that meets the above clinical criteria for non-neuroinvasive disease and one or more of the following laboratory criteria for a confirmed case:
  - Isolation of virus from, or demonstration of specific viral antigen or nucleic acid in, tissue, blood 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.

**Comments**
The seasonality of Powassan virus is predictable. In Ohio, cases could occur from May to September, when the specific vector ticks are active.

**Imported arboviral diseases:** Human disease cases due to dengue or yellow fever are nationally notifiable to CDC using specific case definitions. However, many other exotic arboviruses (e.g. chikungunya, Japanese encephalitis, tick-borne encephalitis, Venezuelan equine encephalitis and Rift Valley fever viruses) are important public health risks for the United States as competent vectors exist that could allow for sustained transmission upon establishment of imported arboviral pathogens. Healthcare providers and public health officials should maintain a high index of clinical suspicion for cases of potentially exotic or unusual arboviral etiology, particularly in international travelers. If a suspected case occurs, it should be reported to the appropriate local/state health agencies and CDC.

**Interpreting arboviral laboratory results:**

- **Serologic cross-reactivity:** In some instances, arboviruses from the same genus produce cross-reactive antibodies. In geographic areas where two or more closely-related arboviruses occur, serologic testing for more than one virus may be needed and results compared to determine the specific causative virus. For example, such testing might be needed to distinguish antibodies resulting from infections within genera (e.g. flaviviruses such as West Nile, St. Louis encephalitis, Powassan, dengue or Japanese encephalitis viruses).
- **Rise and fall of IgM antibodies:** For most arboviral infections, IgM antibodies are generally first detectable at 3 to 8 days after onset of illness and persist for 30 to 90 days, but longer persistence has been documented (e.g. up to 500 days for West Nile virus). Serum collected within 8 days of illness onset may not have detectable IgM and testing should be repeated on a convalescent-phase sample to rule out arboviral infection in those with a compatible clinical syndrome.
- **Persistence of IgM antibodies:** Arboviral IgM antibodies may be detected in some patients months or years after their acute infection. Therefore, the presence of these virus-specific IgM antibodies may signify a past infection and be unrelated to the current acute illness. Finding virus-specific IgM antibodies in CSF or a fourfold or greater change in virus-specific antibody titers between acute- and convalescent-phase serum specimens provides additional laboratory evidence that the arbovirus was the likely cause of the patient's recent illness. Clinical and epidemiologic history also should be carefully considered.
- **Persistence of IgG and neutralizing antibodies:** Arboviral IgG and neutralizing antibodies can persist for many years following a symptomatic or asymptomatic infection. Therefore, the presence of these antibodies alone is only evidence of previous infection and clinically compatible cases with the presence of IgG, but not IgM, should be evaluated for other etiologic agents.
- **Arboviral serologic assays:** Assays for the detection of IgM and IgG antibodies commonly include enzyme-linked immunosorbent assay (ELISA), microsphere immunoassay (MIA) or immunofluorescence assay (IFA). These assays provide a presumptive diagnosis and should have confirmatory testing performed. Confirmatory testing involves the detection of arboviral-specific neutralizing antibodies utilizing assays such as plaque reduction neutralization test (PRNT).

- **Other information to consider:** Vaccination history, detailed travel history, date of onset of symptoms and knowledge of potentially cross-reactive arboviruses known to circulate in the geographic area should be considered when interpreting results.

## SIGNS AND SYMPTOMS

Powassan virus disease initially presents as a nonspecific summertime illness with fever, headache, nausea, vomiting and lethargy. The disease usually progresses to meningoencephalitis, which may include meningeal signs, altered mental status, seizures, aphasia, paresis, movement disorders or cranial nerve palsies. Approximately half of survivors have permanent neurological symptoms, such as recurrent headaches, muscle wasting and memory problems. Approximately 10% of Powassan virus encephalitis cases are fatal.

## DIAGNOSIS

Preliminary diagnosis is often based on a patient's clinical features, places and dates of travel (if patient is from a non-endemic country or area), activities and epidemiologic history of the location where infection likely occurred. In addition to the other more common causes of encephalitis and aseptic meningitis (e.g. herpes simplex virus and enteroviruses), arboviruses such as LaCrosse, St. Louis encephalitis, Eastern equine encephalitis, Western equine encephalitis, Powassan and West Nile viruses should also be considered in the differential etiology.

Laboratory diagnosis of arboviral infections is generally accomplished by testing of serum or CSF to detect virus-specific IgM and neutralizing antibodies. During an acute infection, certain viruses can be isolated through culture or detected by nucleic acid amplification.

In fatal cases, nucleic acid amplification, histopathology with immunohistochemistry and virus culture of autopsy tissues can also be useful. Laboratory tests for Powassan virus infection are not commercially available, but can be requested through ODH Laboratory for testing at CDC.

## EPIDEMIOLOGY

### Source

Humans, woodchucks, snowshoe hares, coyotes, foxes, raccoons, skunks and domesticated cats and dogs are all hosts for this virus.

### Occurrence

Cases of Powassan virus have been reported since 1958 from Canada and the Northeast region of the U.S. From 2001-2012, there have been 47 documented case of Powassan virus in the U.S. in Maine, Michigan, Minnesota, New York, Pennsylvania, Virginia and Wisconsin. There have been no cases reported in Ohio. Cases occur primarily in the late spring, early summer and mid-fall when ticks are most active.

### Mode of Transmission

Humans contract Powassan virus from the bite of an infected tick, primarily *Ixodes cookei* (Groundhog tick), *Dermacentor andersoni* (Wood tick), *Ixodes scapularis* (deer tick), *Ixodes spinipalpus* and *Ixodes marxi.*

### Period of Communicability
There is no person-to-person transmission, but viremia in humans may last for 7 to 10 days.

### Incubation Period
About 1 week to 1 month.

## PUBLIC HEALTH MANAGEMENT
### Case
Investigation

If the case is suspect based upon test results of an acute serum sample, obtain a second (convalescent) serum sample to confirm the case diagnosis and sent it to the same laboratory which tested the acute sample. The ODH Laboratory will send samples to CDC for confirmation. With serologic evidence of Powassan virus infection, a history of travel and locations of potential tick exposure is obtained for the week prior to onset.

Treatment

Some patients require hospitalization, where supportive care is indicated. There is no specific therapy to treat Powassan virus disease.

Isolation and Follow-up Specimens

Since the diagnosis of Powassan virus disease may not be suspected initially, enteroviral precautions (i.e. fecal, respiratory) are usually indicated for encephalitis. A convalescent sample may be required 2-4 weeks after the acute sample to confirm a case.

Public Health Significance

Not known.

### Contacts
No treatment or prophylaxis of contacts is indicated.

### Prevention and Control
Because *Ix. cookei* are often found on groundhogs and skunks and may be the primary vector of Powassan virus, environmental controls reducing human contact with small and medium-sized mammals should reduce risk for exposure to Powassan virus-infected ticks. Persons should keep areas adjacent to their home clear of brush, weeds, trash and other elements that could support small and medium-sized mammals. When removing rodent nests, avoid direct contact with nesting materials and use sealed plastic bags for disposal and to prevent direct contact with ticks.

Vaccination

There is no vaccine.

Vector Investigation

For advice on vector assessment, contact the ODH Zoonotic Disease Program (ZDP) at 614-752-1029, option 1.

**Special Information**

Powassan virus is currently the only well documented tick-borne arbovirus occurring in the United States and Canada. Because of the lack of awareness and the need for specialized laboratory tests to confirm diagnosis, the frequency of Powassan encephalitis may be greater than previously suspected. Powassan encephalitis should be included in the differential diagnosis of all encephalitis cases occurring in the northeastern United States and Great Lakes region.

**What is Powassan virus disease?**
First discovered in 1958 in Canada, Powassan virus disease is a rare, but often serious disease that is caused by a virus spread by infected ticks. Powassan virus is one of a group of arthropod-borne viruses (arboviruses) that can cause inflammation of the brain (encephalitis). Approximately 50 cases of Powassan virus disease were reported in the United States over the past 10 years. Ohio has never had a case.

**How do people get infected with Powassan virus?**
Powassan virus is transmitted by the bite of an infected tick. Powassan virus has been found in *Ixodes cookei* (Groundhog tick), *Dermacentor andersoni* (Wood tick), *Ixodes spinipalpus* and *Ixodes marxi* ticks. In Ohio, the greatest concern would be *Ixodes cookei*. Powassan virus is not directly transmitted from person to person.

**Where and when have most cases of Powassan virus disease occurred?**
Most cases have occurred in the northeastern and Great Lakes regions of the United States during late spring, early summer and mid-fall when ticks are most active.

**Who is at risk for infection with Powassan virus?**
Anyone bitten by a tick in an area where the virus is commonly found can get infected with Powassan virus. The risk is highest for people who live, work or recreate in brushy or wooded areas because of the greater exposure to potentially infected ticks.

**How soon do people get sick after getting bitten by an infected tick?**
The incubation period (time from tick bite to onset of illness) ranges from one week to one month.

**What are the symptoms of Powassan virus disease?**
Many people who become infected with Powassan virus do not develop any symptoms. Powassan virus can cause encephalitis (inflammation of the brain) and meningitis (inflammation of the membranes that surround the brain and spinal cord). Symptoms can include fever, headache, vomiting, weakness, confusion, loss of coordination, speech difficulties and seizures.

**How is Powassan virus disease diagnosed?**
Diagnosis is based on a combination of signs and symptoms and laboratory tests of blood or spinal fluid. These tests typically detect antibodies that the immune system makes against the viral infection.

**What is the treatment for Powassan virus disease?**
There is no specific medicine to cure or treat Powassan virus disease. Antibiotics are not effective against viruses, and no effective anti-viral drugs have been discovered. Treatment for severe illnesses may include hospitalization, respiratory support and intravenous fluids.

**Is there a vaccine for Powassan virus disease?**
There is no human vaccine for Powassan virus disease, and none are currently being developed.

**How can I reduce the chance of getting infected with Powassan virus?**
The best way to prevent Powassan virus disease is by protecting yourself from tick bites.

- Avoid contact with ticks by avoiding wooded and bushy areas with high grass.
- Apply insect repellents to bare skin according to label instructions.
    - Repellents containing DEET can be applied to exposed skin but only last a few hours.
    - Clothing and gear can be treated with permethrin, which remains protective through several washings.
- Find and remove ticks immediately before they have a chance to bite and attach.
    - Bathe or shower (preferably within 2 hours of being outdoors) to wash off and find ticks on your body.
    - Conduct a full-body tick check. Parents should thoroughly check children, especially in their hair.
    - Also examine clothing, gear and pets.

**For more information, please visit these websites:**
CDC Powassan Virus Disease Information http://www.cdc.gov/powassan/index.html

CDC Tick Information http://www.cdc.gov/ticks/