

Primary Amebic Meningoencephalitis (PAM)

Naegleria fowleri is the causative agent for Primary Amebic Meningoencephalitis (PAM). It is a freshwater amoeba commonly found in the environment worldwide. Most commonly, this amoeba is found in warm bodies of fresh water, such as lakes, rivers, and hot springs, warm water discharge from industrial plants, under-chlorinated swimming pools, and soil. *Naegleria fowleri* is the only species of *Naegleria* that has been found to infect humans. Although *Naegleria fowleri* is commonly found in the environment, infection occurs rarely. However, this disease has public health importance because of its high fatality rate. Only four persons out of 133 known infected individuals in the United States from 1962 to 2014 have survived. *Naegleria fowleri* infection cannot be spread from person to person contact and will not occur as a result of drinking water.

Infection with *Naegleria fowleri* is most common during the summer months of July, August, and September. They usually occur when it is hot for prolonged periods. Infections have been observed to increase during heat wave years primarily in southern tier states however recent cases in Indiana, Kansas, Minnesota and Virginia indicate an expanding geographical area where the organism appears to be thriving. In the United States, it has caused infections in 18 states (AR, AZ, CA, FL, GA, IN, KS, LA, MO, MN, MS, NC, NM, NV, OK, SC, TX, and VA).

Prior to 2008, primary amebic meningoencephalitis was not a reportable disease in Florida. However, 34 cases have been documented with Florida exposures from 1962 through 2013. Of the 34 cases, 21 were exposed in Central Florida. Reported cases described exposures in the following counties: Baker, Brevard, Broward, Citrus, Glades, Lee, Madison, Orange, Pasco, Pinellas, Polk, Putnam, Palm Beach, Seminole, Volusia and 3 unknown counties. All cases died from the disease. All but three cases were residents of Florida. One Florida resident with documented exposure internationally was reported in 2014.

Infection with *Naegleria fowleri* typically occurs when the amoeba enters the body through the nose. The amoeba travels up the nose to the brain and spinal cord where it destroys the brain tissue causing the disease primary amebic meningoencephalitis (PAM). Generally, exposure to the amoeba occurs when people use warm freshwater for activities like swimming, diving, or other rigorous activities in freshwater. Recent cases of PAM in the U.S. have been linked to the use of household tap water for irrigation of sinuses. It is unknown why certain persons become infected with the amoeba while millions of others exposed to warm recreational fresh waters do not, including those who were swimming with people who became infected.

The initial symptoms of PAM start 1 to 7 days (median 5 days) after swimming or other nasal exposure to *Naegleria*-containing water. Initial signs and symptoms of PAM include headache, fever, nausea, vomiting, and stiff neck. As the amoeba causes more extensive destruction of brain tissue this leads to confusion, lack of attention to people and surroundings, loss of balance and bodily control, seizures, and hallucinations. The disease progresses rapidly and infection usually results in death within 1 to 12 days (median 5.3 days) after onset of symptoms. There have been four documented instances of PAM cases surviving in North America. The Centers for Disease Control and Prevention have access to an investigational drug called miltefosine to treat free-living amoeba infections. While prompt diagnosis and medical treatment may influence successful treatment it is unclear what specific treatment regimen is effective. Additional treatment information for healthcare professionals can be found at www.cdc.gov/parasites/naegleria/treatment.html.

The only known way to prevent *Naegleria fowleri* infections is to refrain from water-related activities. However, some common sense measures that might reduce risk by limiting the chance of water going up the nose include:

- Avoid water-related activities in bodies of warm freshwater, hot springs, and thermally-polluted water such as water around power plants.
- Avoid water-related activities in warm freshwater during periods of high water temperature and low water levels.
- Hold the nose shut or use nose clips when taking part in water-related activities in bodies of warm freshwater such as lakes, rivers, or hot springs.
- Avoid digging in or stirring up the sediment while taking part in water-related activities in shallow, warm freshwater areas.

Recreational water users should assume that there is always a low level of risk associated with entering all warm fresh water. Because the location and number of ameba in the water can vary a lot over time, posting signs is unlikely to be an effective way to prevent infections. In addition, posting signs on only some fresh water bodies might create a misconception that bodies of water that are not posted are *Naegleria*-free.

Information about the risks associated with *Naegleria fowleri* infection should be included in public health messages discussing general issues of recreational water safety and risk.

When preparing solutions of tap water for sinus irrigation the user should use tap water previously boiled for 1 minute (at elevations above 6,500 feet, boil for 3 minutes) and left to cool, or use filtered water using a filter with an absolute pore size of 1 micron or smaller, or use clearly marked distilled or sterile water in the irrigation device. Rinse the irrigation device after each use with water that has been previously boiled, filtered, distilled, or sterilized and leave the device open to air dry completely

For additional information on PAM:

CDC, Division of Parasitic Diseases – *Naegleria fowleri* Information
<http://www.cdc.gov/parasites/naegleria/index.html>

CDC Recreational Waterborne Illness Data and Information
<http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5512a1.htm>
<http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5108a1.htm>
<http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5308a1.htm>
<http://www.cdc.gov/mmwr/preview/mmwrhtml/ss4904a1.htm>
<http://www.cdc.gov/mmwr/preview/mmwrhtml/00055820.htm>

Other Resource Articles:

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CDC - Laboratory Diagnosis of Parasites of Public Health Concern, <http://www.dpd.cdc.gov/dpdx/HTML/FreeLivingAmebic.htm>

CDC - *Naegleria fowleri* Fact Sheet, <http://www.cdc.gov/parasites/naegleria/index.html>

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