

Fact sheet

Primary amebic meningoencephalitis (PAM)–*Naegleria fowleri*

What are Primary amebic meningoencephalitis (PAM) and *Naegleria fowleri*?

Primary amebic meningoencephalitis (PAM) is a rare brain infection caused by the free-living amoeba *Naegleria fowleri*. PAM is a serious disease which destroys brain tissue and causes brain swelling and death. Almost all cases are fatal. Commonly referred to as “brain-eating amoeba,” *Naegleria fowleri* can be found throughout the world, typically in natural, warm freshwater environments (lakes, rivers, hot springs, etc.). They are heat-loving and prefer higher temperatures up to 115°F (46°C). When temperatures decline, the amoeba become dormant and survive buried in the sediment of water bodies, where they are not a threat, but they can become active when temperatures warm. In the United States (U.S.), the majority of infections occur in the warmer southern states.

How are *Naegleria fowleri* infections spread?

Infection occurs when *Naegleria fowleri* enters the nose. From there it travels along the olfactory nerve to the brain, where it begins to destroy brain tissue. You **cannot** get infected from drinking contaminated water or person-to-person spread. Infected people typically report participation in activities that can cause water to go up the nose, such as

swimming underwater, diving, and head dunking. Infections most often occur during the summer months in warm, freshwater lakes and reservoirs. Although rare, infections have also occurred from using contaminated water to cleanse nasal passages for religious practices, or from using a neti pot or similar sinus rinsing device.

What are the signs and symptoms of PAM?

Symptoms of PAM can be mild at first, but progress rapidly from stage 1 to stage 2.

Stage 1 includes:

- Severe frontal headache
- Nausea
- Vomiting
- Fever

Stage 2 includes:

- Stiff neck
- Seizures
- Altered mental status
- Hallucinations
- Coma

Once symptoms start, death generally occurs in 1 to 18 days (median 5).

How long after infection do symptoms appear?

Symptoms generally start between 1 and 9 (median 5) days after getting contaminated water up your nose.

Who is most at risk?

Children and adolescents, especially males, are more at risk of infection. This may be because young boys are more likely to participate in water activities, such as diving and playing, that increase the chances of stirring up amoeba from the bottom of lakes and reservoirs, as well as getting water up the nose.

How is PAM diagnosed?

Symptoms may look similar to bacterial meningitis, so it may be difficult to initially diagnose. Because of this and the rarity of the disease, about 75% of diagnoses are made after the death of the patient. Only a few laboratories in the U.S. can perform the necessary diagnostics tests, which include the detection of *Naegleria fowleri* organisms, nucleic acid, or antigen in either cerebrospinal fluid (CSF), biopsy, or tissue specimens.

How is PAM treated?

Recently, an investigational drug called miltefosine has shown promise in treating PAM in combination with other drugs. Miltefosine is commercially available and physicians should call the CDC Emergency Operations Center at 770-488-7100 to consult with an expert regarding the use of this drug to treat PAM.

How can *Naegleria fowleri* infection be prevented?

When swimming:

The only certain way to prevent infection is to avoid water-related activities in natural, warm

bodies of freshwater. If you decide to recreate, you should always assume there is a certain level of risk and take the following precautions:

- Limit the amount of water that goes up your nose. Hold your nose shut, use nose clips, or keep your head above water.
- Avoid recreating in warm bodies of freshwater when water temperatures are high and water levels are low.
- Avoid digging in, or stirring up sediment in shallow, warm bodies of freshwater.

When rinsing sinuses:

Naegleria fowleri can grow in public and private water systems, especially when the water is inadequately disinfected. You should take at least 1 of the following precautions when you prepare a solution to rinse, irrigate, or flush your sinuses:

- Use distilled or sterile water; or
- Boil the water for 1 minute (3 minutes at elevations above 6,500 ft) then let cool; or
- Filter the water with an NSF 53, NSF 58, or another filter that reads absolute pore size of 1 micron or smaller.

Where can I get more information?

- Your personal healthcare provider
- [Centers for Disease Control and Prevention](#)
- [Mayo Clinic](#)