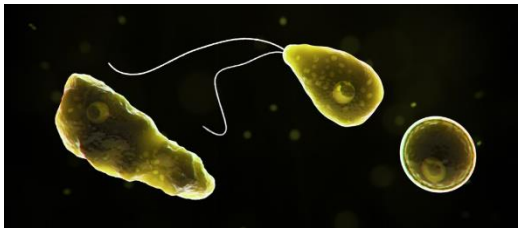
Primary Amebic Meningoencephalitis



Naegleria fowleri (commonly referred to as the “brain-eating amoeba” or “brain-eating ameba”), is a free-living microscopic ameba*, (single-celled living organism). It can cause a rare** and devastating infection of the brain called primary amebic meningoencephalitis (PAM). The ameba is commonly found in warm freshwater (e.g. lakes, rivers, and hot springs) and soil. *Naegleria fowleri* usually infects people when contaminated water enters the body through the nose. Once the ameba enters the nose, it travels to the brain where it causes PAM, which is usually fatal. Infection typically occurs when people go swimming or diving in warm freshwater places, like lakes and rivers. In very rare instances, *Naegleria* infections may also occur when contaminated water from other sources (such as inadequately chlorinated swimming pool water or heated and contaminated tap water) enters the nose [1-4]. You **cannot** get infected from **swallowing** water contaminated with *Naegleria*.

Illness and symptoms

Primary amebic meningoencephalitis (PAM), is a disease of the central nervous system [1,2]. PAM is caused by *Naegleria fowleri*, a free-living ameba. It is a rare disease* that is almost always fatal [3]; only 4 people in the U.S. out of 143 have survived infection from 1962 to 2017 [4]. Signs and symptoms of *Naegleria fowleri* infection are clinically similar to bacterial meningitis, which lowers the chances of initially diagnosing PAM [4]. Humans become infected when water containing *Naegleria fowleri* enters the nose and the ameba migrates to the brain along the olfactory nerve [2,3]. People do not become infected from **drinking** contaminated water. Symptoms start 1-9 days (median 5 days) after swimming or other nasal exposure to *Naegleria*-containing water. People die 1-18 days (median 5 days) after symptoms begin [4]. PAM is difficult to detect because the disease progresses rapidly so that diagnosis is usually made after death [1,2]. Signs and symptoms of the infection include:

Stage 1

- Severe frontal headache
- Fever
- Nausea
- Vomiting

Stage 2

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

The disease is generally fatal [3]; among well-documented cases, there are only five known survivors in North America: one from the U.S. in 1978 [5], one from Mexico in 2003 [6], two from the U.S. in 2013 [4,7,8], and one from the U.S. in 2016. The original U.S. survivor's condition gradually improved during a one-month hospitalization. The only reported side effect to treatment was a reduction in leg sensation for two months after discharge, which gradually improved. There was also no detection of *Naegleria fowleri* 3 days post-treatment [5]. It has been suggested that the original survivor's strain of *Naegleria fowleri* may have been less virulent, which contributed to the patient's recovery. In laboratory experiments, the California survivor's strain did not cause damage to cells as quickly as other strains, suggesting that it is less virulent than strains recovered from other fatal cases [9].

The Mexico survivor's condition did not begin to improve until 40 hours after hospital admission. On day 22 of admission, there was no abnormality shown in the brain scan and the patient was discharged the next day. The patient was followed up for the next 12 months without any recurrence of disease [6].

After 35 years without a *Naegleria* survivor in the United States, during the summer of 2013, two children with *Naegleria fowleri* infection survived. The first, a 12-year-old girl, was diagnosed with PAM approximately 30 hours after becoming ill and was started on the recommended treatment within 36 hours. She also received the investigational drug miltefosine, and her brain swelling was aggressively managed with treatments that included therapeutic hypothermia (cooling the body below normal body temperature). This patient made a full neurologic recovery and returned to school. Her recovery has been attributed to early diagnosis and treatment and novel therapeutics including miltefosine and hypothermia [7].

The second, 8-year-old, child is also considered a PAM survivor, although he has suffered what is likely permanent brain damage. He was also treated with miltefosine but was diagnosed and treated several days after his symptoms began. Therapeutic hypothermia was not used in this case [8].

In the summer of 2016, a 16-year-old boy was reported as the 4th U.S. PAM survivor. This patient was diagnosed within hours of presentation to the hospital and was treated with the same protocol used for the 12-year-old 2013 survivor. This patient also made a full neurologic recovery and returned to school.

Overall, the outlook for people who get this disease is poor, although early diagnosis and new treatments might increase the chances for survival.

Treatment

Although most cases of primary amebic meningoencephalitis (PAM) caused by *Naegleria fowleri* infection in the United States have been fatal (139/143 in the U.S., [1]), there have been five well-documented survivors in North America: one in the U.S. in 1978 [2,3], one in Mexico in 2003 [4], two additional survivors from the U.S. in 2013 [5,6], and one from the U.S. in 2016. It has been suggested that the original U.S. survivor's strain of *Naegleria fowleri* was less virulent, which contributed to the patient's recovery. In laboratory experiments, the original U.S. survivor's strain did not cause damage to cells as rapidly as other strains, suggesting that it is less virulent than strains recovered from other fatal infections [7].

Recently an investigational breast cancer and anti-leishmania drug, miltefosine [8], has shown some promise in combination with some of these other drugs. Miltefosine has shown ameba-killing activity against free-living amebae, including *Naegleria fowleri*, in the laboratory [9, 10]. Miltefosine has also been used to successfully treat patients infected with *Balamuthia* [11] and disseminated *Acanthamoeba* infection [12]. If you are a clinician and have a patient with suspected *Naegleria* or other free-living ameba infection, please contact the CDC Emergency Operations Center at 770-488-7100 to consult with a CDC expert regarding the use of this drug.

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The second child, an 8-year-old male, is also considered a PAM survivor, although he has suffered what is likely to be permanent brain damage. He was also treated with miltefosine but was diagnosed and treated several days after his symptoms began. Cooling of the body below normal body temperature was not used [6].

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Prevention

The CDC suggests that the following measures may reduce your risk of naegleria infection:

- Don't swim in or jump into warm freshwater lakes and rivers.
- Hold your nose shut or use nose clips when jumping or diving into warm bodies of fresh water.
- Avoid disturbing the sediment while swimming in shallow, warm fresh waters.

Sources:

- Medline Plus
- Mayo Clinic