

Naegleria Fowleri

You cannot get infected from drinking water contaminated with *Naegleria*. You can only be infected when contaminated water goes up into your nose.

Sources of Infection & Risk Factors

Naegleria fowleri is a free-living amoeba that causes primary amoebic meningoencephalitis (PAM), a disease of the central nervous system. PAM is a rare disease that is almost always fatal. In the United States, there have been 133 PAM infections from 1962 through 2014 with only three survivors. PAM also disproportionately affects males and children. The reason for this distribution pattern is unclear but may reflect the types of water activities (such as diving or watersports) that might be more common among young boys.

Where Naegleria fowleri is Found

Naegleria fowleri is a heat-loving (thermophilic) amoeba found around the world. *Naegleria fowleri* grows best at higher temperatures up to 115°F (46°C) and can survive for short periods at higher temperatures. *Naegleria fowleri* is naturally found in warm freshwater environments such as lakes and rivers, naturally hot (geothermal) water such as hot springs, warm water discharge from industrial or power plants, geothermal well water, poorly maintained or minimally chlorinated swimming pools, water heaters, and soil, where it lives by feeding on bacteria and other microbes in the environment. Sampling of lakes in the southern tier of the U.S. indicates that *Naegleria fowleri* is commonly present in many southern tier lakes in the U.S. during the summer but infections have also recently occurred in northern states. *Naegleria* is not found in salt water, like the ocean.

Where PAM Infections Have Occurred

PAM infections have been reported from around the world. Infections have primarily occurred in southern-tier states in the U.S., but infections were documented in Minnesota in 2010 and 2012 and other northern states since that time. Over half of all reported infections have occurred in Florida and Texas. In the United States and the rest of the world, PAM is primarily spread via swimming in warm freshwater lakes and rivers (about 3 out of 4 U.S. infections from 1962-2014). Other recreational water types like hot springs and canals have also been linked to PAM infections.

Six infections in the U.S. have been associated with using water from drinking water systems to swim or use a slip-n-slide, immerse the head in a bathtub, mix solutions for nasal irrigation using a neti pot, or perform ritual nasal rinsing

or ablutation. PAM infections also occurred in the 1970s and 1980s in Australia that were linked to showering, swimming, or having other nasal exposure to contaminated drinking water. The infections were linked to piping drinking water overland, sometimes for hundreds of kilometers, that resulted in the water being heated and having low to zero disinfectant levels that resulted in the water and pipes becoming colonized by *Naegleria fowleri*. Several water systems in the states of Western Australia and South Australia continue to monitor regularly for *Naegleria fowleri* colonization in drinking water distribution systems. Infections due to contaminated water being used for religious practices have also been reported.

How PAM is Spread or Transmitted

Humans become infected when water containing *Naegleria fowleri* enters the nose, usually while swimming. People do not get infected by drinking contaminated water. The amoeba migrates to the brain along the olfactory nerve, through a bony plate in the skull called the cribriform plate, where it reaches the brain and begins to destroy the brain tissue. *Naegleria fowleri* has not been shown to spread via water vapor or aerosol droplets (such as shower mist or vapor generated from a humidifier). The amoeba has never been shown to have spread from one person to another.

Who Gets Infected

PAM infections have been reported from around the world. From 1962 through 2014, 133 infections have been documented in the U.S. Infections have occurred in all age groups, but 112 cases (84%) have occurred in children (median age of 11 years; range 8 months to 66 years). Over three-quarters (>75%) of infections have been in males. Infected people were often reported to have participated in water-related activities such as swimming underwater, diving, and head dunking that could have caused water to go up the nose.

Naegleria fowleri has also been documented to infect animals such as cattle and a South American tapir. Experimental infection can be induced in other species including mice, which are used as the model system for studying *Naegleria fowleri* infections resulting from swimming.

When Infections Occur

Infections linked to freshwater swimming mostly occur during the heat of summer in July and August in the northern hemisphere when water temperatures peak and water levels

are low. Infections can increase during heat wave years as water temperatures increase.

Risk of Infection

No data exist to accurately estimate the true risk of PAM. Hundreds of millions of visits to swimming venues occur each year in the U.S. that result in 0-8 infections per year. The extremely low occurrence of PAM makes epidemiologic study difficult. It is unknown why certain persons become infected with the amebae while millions of others exposed

to warm recreational fresh waters, including those who were swimming with people who became infected, do not. Attempts have been made to determine what concentration of *Naegleria fowleri* in the environment poses an unacceptable risk. However, no method currently exists that accurately and reproducibly measures the numbers of amebae in the water. This makes it unclear how a standard might be set to protect human health and how public health officials would measure and enforce such a standard.

Source: Centers for Disease Control and Prevention