

NAEGLERIA: PREVENTABLE BY WATER CHLORINATION

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Naegleria fowleri is a free-living, thermophilic protist belonging to phylum Percolozoa, typically found in warm bodies of fresh water, such as ponds, lakes, rivers, and hot springs. It is also found in soil, near warm-water discharges of industrial plants, and in poorly chlorinated, or unchlorinated swimming pools. The trophozoite or ameboid form encysts under unfavorable circumstances and converts to a temporary biflagellate form if exposed to high temperatures. The flagellate form can exist in the cerebrospinal fluid where it can be detected microscopically and cultured on non-nutrient agar over a lawn of *Escherichia coli*. In their free living state, trophozoites feed on bacteria, while in the tissues, they phagocytize red and white blood cells and damage the tissues.¹

N. fowleri also known as the brain eating amoeba can invade and attack the human brain, causing primary amoebic meningoencephalitis (PAM). Although this occurs rarely, such an infection nearly always results in the death of the victim.² The case fatality rate is greater than 95%.³

Nägler, an early 20th century Austrian bacteriologist first identified amoebae that pass through a biflagellate stage. In 1912, Alexeieff proposed a new genus for questionable amoeboid forms, which he named *Nägleria* in honor of Nægler's work. In 1965, fifty-three years later, a report from Australia by physicians Fowler and Carter described human meningoencephalitis caused by an ameboid-flagellate, later recognized as a member of *Naegleria*. In 1970, the pathogen was designated *Naegleria fowleri* after Malcolm Fowler, who obtained one of the first isolates from human brain tissue.⁴

In humans, it invades the central nervous system via the nose, specifically through the olfactory mucosa and cribriform plate. This usually occurs as a result of the introduction of water into the nasal cavity with water that has been contaminated with *N. fowleri*, during activities like swimming, bathing, or nasal irrigation. The amoeba attaches itself to the olfactory nerve and migrates to the olfactory bulbs, where

it feeds on the nerve tissue resulting in significant necrosis and hemorrhage.⁵ From there, it migrates further along nerve fibres and enters the floor of the cranium via the cribriform plate into the brain. The organism then begins to consume cells of the brain, piecemeal, by means of an amoebostome, a unique actin rich, sucking apparatus extended from its cell surface.⁶ It then becomes pathogenic, causing PAM, which is a disease affecting the central nervous system. PAM usually occurs in healthy children or young adults with no prior history of immune compromise who have recently been exposed to bodies of fresh water. Infection has also happened when people use contaminated drinking water to cleanse their nasal passages during religious practices, use a neti pot or other device to rinse their sinuses through the nose, or get the contaminated water up their nose during recreational play.²

Symptoms of infection can start from one to seven days after exposure. Initial symptoms include changes in taste and smell, headache, fever, nausea, vomiting, and a stiff neck. Secondary symptoms include confusion, hallucinations, lack of attention, ataxia, and seizures. After the start of symptoms, the disease progresses rapidly over three to seven days, with death occurring usually from seven to fourteen days later, although it can take longer.⁷

Amphotericin B is effective against *N. fowleri* in vitro, but the prognosis remains bleak for those who contract PAM, and survival remains less than 1%. Chlorpromazine has shown therapeutic activity against *N. fowleri* in vitro and in vivo and is expected to be a more useful therapeutic agent for the treatment of PAM than amphotericin B. Miltefosine, which is still under trial has shown some promising results against this amoeba.⁸ Untimely diagnosis impedes successful treatment of infection, as most cases have been discovered on autopsy. There is no vaccine to protect against *N. fowleri* infection and efforts are being made in vaccine research.

Cases have been reported from United States, United Kingdom, Venezuela, New Zealand, Taiwan, Costa Rica, Czechoslovakia, Iran, India and Pakistan. In Pakistan the first case surfaced in Karachi in 2008 and since then death toll due to PAM is on the rise. From July to October 2012, 44 people died within a week in the Sindh province from *Naegleria* infection.⁹ At least 13 cases have been reported in

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Karachi, Pakistan, in patients who had no history of aquatic activities.¹⁰ In 2014, 12 victims succumbed to this infection in Pakistan. Infection likely occurred through ablution performed with poorly chlorinated water containing *Naegleria*.¹¹

Sindh provincial health authorities along with many civic agencies collected and tested 549 samples of water from various parts of the city and found no chlorine in 228 samples which make 41.5% of the total. A significant number of the remaining samples had less than the desired levels of chlorine.¹² This is an alarming situation. In a megacity like Karachi with a population of more than 20 million where most people live in congested places, the non-availability of chlorinated water increases the risk of *Naegleria* infection. The irony is that the disease is preventable if the optimal level of chlorination, i.e. 2 ppm is achieved. This is not Mission Impossible if immediate actions are taken in the right direction.

The incidence of infection itself is likely to increase as temperature range is rising through climate change. Also, the number of reported cases are expected to show an increase, simply because of better informed diagnoses being made both in living patients and also in autopsy findings.

The first case of the current year occurred in April in an 18 year girl who died of PAM within a day after being admitted to a private hospital in critical condition. So far, up to 31 May 2015, seven deaths have occurred due to *Naegleria* infection which is likely to increase if appropriate measures are not taken. We strongly recommend that provincial governments should adopt a strategy for proper chlorination of water not only in Karachi but the whole country. The government should also invite NGOs and other civic agencies to accomplish this pushed-behind-the-back mountainous task. At personal level at least boiled water should be used for nasal irrigation during ablution.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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None declared.