



## 'Brain-Eating Amoeba' A Review

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### Abstract

Naegleria fowleri is a protist that, infects the Central Nervous System. It produces primary amoebic meningoencephalitis. The infection is very dangerous because it has 95% mortality rate. More number of cases are seen in countries like Australia, United States, Europe, and Pakistan. There are 3 cases in which Naegleria fowleri may come contact with humans i.e., by recreational activities, ritual practices and by involvement of therapies (nasal irrigation therapy). There are primary treatment and adjunctive treatment to cure this infection.

**Keywords:** Primary amoebic meningoencephalitis; Recreational activities; Ritual practices; Nasal irrigation therapy; Primary treatment; Adjunctive treatment

### Introduction

Naegleria fowleri, is a free-living, eukaryotic amoeba named after Malcolm Fowler. Malcolm Fowler was the first to describe primary amoebic encephalitis (PAM) that was caused by Naegleria fowleri [1,2]. It is a freshwater protist usually contaminated by soil [3].

As per reports 'A deadly brain eating amoeba' is crawling its way northward from the southern states of US. According to the report by Centres for Disease Control and Prevention (CDC) the cases are increasing northward. Once the amoeba enters the nose, it travels to the brain and causes Primary amoebic encephalitis (PAM). The infection occurs when people go for diving or swimming in warm freshwater places.

### Where are brain-eating amoebas found?

Naegleria fowleri lives in warm water. It can survive in water as hot as 113° F. These amoebas are found in places like

- ✓ Warm lakes, ponds, and rocks pits.
- ✓ Mud puddles.
- ✓ Warm, slow-flowing rivers, especially those with low water levels.
- ✓ Untreated swimming pools and spas.

- ✓ Hot springs and other geothermal water sources.
- ✓ Thermally polluted water, such as water runoff from power plants.

### Etiology

The infection of N. fowleri causes amoebic meningoencephalitis. The infection occurs when warm freshwater containing Naegleria fowleri enters nose and moves towards Central Nervous System (CNS). This typically occurs when people go for swimming or any recreational activities in warm freshwater. The incubation period for this infection is about 1-14 days, before the diagnosis of encephalitis symptoms.

### Epidemiology

The brain-eating amoeba i.e., Naegleria fowleri is found all over the world. It is found in freshwater, hot water springs, polluted water but not in seawater [4,5]. This infection was observed in New Zealand, Europe, Africa, Asia, America and Australia [3]. The protist can also be found in thermally polluted water. Many cases of infections occurred by recreational activities and ritual practices. According to the reports 34 cases

have been observed from 2007 till 2008 [4]. There are many people who enjoy swimming in pools during summer season. But there is lack of awareness about the PAM in people and this increases the risk of amoebic meningoencephalitis among people. There are many water bodies which are untreated, that is the major cause to increase level of pathogens in various water reservoirs.

### ***Pathophysiology***

During recreational activities or ritual practices, the freshwater containing amoeba enters the central nervous system, through nasal passage, amoeba penetrates the respiratory epithelium and moves through the cribriform Plate to central nervous system [6]. The infection leads to tissue necrosis and edema of brain. The severity of the infection depends on protein Nfal, nitric oxide production and pore-forming proteins. Nfal helps the amoeba attachment to target cells. Amoeba has Feeding cups it to ingest bacteria and fungi. Due to the Feeding cups it directly Phagocytose the Brain cells. So, the *N. fowleri* is known as brain eating amoeba. The virulence of this amoeba leads to primary amoebic encephalitis [7].

### ***Diagnosis***

The signs and symptoms appear within 2 to 8 days of onset of infection [8,9]. The symptoms include headaches, fever, photophobia, confusion, seizures, positive Kernig sign, positive Brudzinski sign and coma. The increased in cerebral spinal fluid (CSF) pressure directly leads to death [8]. There is significant increase red blood Cells and abnormal changes in color of CSF is observed [10,11]. Due to destruction of tissues by food cup, there is a release of cytolytic molecules including neuraminidases, phospholipases and phospholipolytic enzymes which

helps in nerve destruction [12]. After performing Magnetic resonance imaging (MRI) of the brain, the abnormal changes have been observed in brain.

### ***How is the infection transmitted from water?***

There are numerous cases in which *Naegleria fowleri* infects humans.

- ✓ By recreational activities.
- ✓ By performing ritual practices.
- ✓ Involvement of therapies (nasal irrigation therapy).

### ***Recreational activities***

The free-living amoeba lives in freshwater lakes, rivers, canals, hot springs, geothermal water and in swimming pools [7,13-15]. This *N. fowleri* amoeba exists in 3 forms i.e cyst form, trophozoite form and flagellate form. The amoeba feeds on bacteria and fungi that are present in freshwater debris. The deadly brain eating amoeba enters central nervous system through nasal passage. This usually happens when contaminated water is inhaled by nostrils, while performing recreational activities. For example, swimming or diving in untreated water without nose clip may increase the chances of entering amoeba through nostrils, it moves to brain tissues. It leads to serious haemorrhaging, inflammation, and edema of brain tissue [13,16].

During summer season temperature reaches upto 50°C. So, many people turn towards freshwater canals, ponds and swimming pools. The crowd for recreational activities is endless [17]. There are many cases of sudden death of people due to lack of medical facilities, untreated freshwater bodies and lack of available specialist to identify the causative agent (Figure 1).



**Figure 1: Recreational activities in summer.**

### ***Ritual practices***

In many Asian countries there are Ritual practices performed in freshwater bodies. According to the reports from Aga Khan University Hospital in Karachi, there are deaths each year due to PAM. But after investigating, the result came out was that the people didn't had history of swimming [18].

Muslims pray five times in a day. And before the prayer, the carryout abluion. In this process the wash their mouth, face, arm, nose, and feet. While performing this, some people, forces the water inside the nostrils. If the water is contaminated by pathogens like

*N. fowleri*, it enters the brain through nasal passage and increases the risk of PAM. As per the data the first

death of the Muslim male patient doing abluion in America has been reported [19]. These suggest that practicing abluion by untreated water may develop a risk of PAM.

The measures should be taken to overcome the risk. Before using the water for ritual practices, it should be disinfected or boiled so that, the pathogens are inactivated. Sterilize water can also been used to kill many micro-organisms [19].

As we know Ganga River is famous for its ritual baths so, millions of people participate in the Holy Bath. In this type of rituals there is great risk of transmitting infectious diseases. But still there is not a single case of PAM, that is associated with this practice [20].



**Figure 2: Ritual practices in river.**

The care must be taken while performing any ritual practices by water.

Disinfectant like Chlorine should be added to water bodies before performing religious practice.

### ***Involvements of therapies***

Neti pots are used as a therapy to get rid of Symptoms like facial pain, headaches, allergic rhinitis and nasal congestion. Performing this therapy for many days will reduce fever, common cold and chronic sinus [21,22]. Due to this therapy the excess mucus and debris from the nose are flush out. In this therapy saline solution is used. According to the Ayurvedic and Yogic traditions, hypertonic saline nasal irrigation (HSNI) is therapy to cure sinus

symptoms [23,24]. The device used in Nasal irrigation therapy is like Aladdin's lamp. The inhaled water from one nostril, drains out by the other nostril. In this process if the water is unboiled and without sterilized,

there is a great risk of PAM. To avoid this, water should be well treated before use.

### ***Treatment***

This infection is rarest and has high mortality rate in humans. The information about the medication efficacy is based on vitro studies. In many in vitro studies of *N. fowleri* infection, amphotericin B is mostly used. Beside this, various other medicines like fluconazole, miconazole, miltefosine, azithromycin and rifampin are used. To study in vitro/ in vivo, medications like zeocin, roxithromycin, rokitamycin, hygromycin and clarithromycin [25,26].

### Prevention

To prevent this infection people should avoid exposure of freshwater bodies during summer season. Disinfectants should be added to water bodies to decrease the risk of PAM. The people who love recreational activities should avoid jumping into water bodies, they should take care that, water is not entering their nose. Before performing ritual practices in water, disinfectant should be added to the water. Sterilize water should be used for nasal irrigation therapy.

### Conclusion

*Naegleria fowleri* is found worldwide in various countries. The infection caused by *N. fowleri* is very dangerous and directly attacks brain. The survival rate is very less in this infection. There is lack of awareness amongst people about primary amoeba meningoencephalitis (PAM). Due to this never-ending crowd is seen in freshwater bodies in summer season. People should know how to prevent this serious infection. There are various places of freshwater bodies, where water is untreated. The best thing to control the deadly infection, is to take care that, water doesn't enter the nose.

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