

A Comprehensive Study on Irremediable Fatal Parasite: *Naegleria fowleri*

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ABSTRACT: Primary Amoebic Meningoencephalitis (PAM) is a severe disease that caused by an amoeba 'Naegleria fowleri' which is also called as Brain-eating amoeba. This amoeba belongs to the kingdom of Protista and genus naegleria. The target site of this amoeba is Central Nervous System (CNS) which leads to death of an individual with mortality rate of around 95-97%. Recently in September 2020, the case of PAM was reported in US of a six-year-old boy when he lost his life battling with this disease. Few months after the US case, the Florida Department of Health also issued warning regarding spreading of rare brain eating amoeba disease in Florida. This systematic article tries to comprehend the basic information regarding the Naegleria fowleri with its morphology, history, life cycle and epidemiology. This review also provides all the necessary information regarding detection and diagnosis, symptoms and treatment of PAM. Despite the fact that this is rare & harmful disease, more research needs to be done to understand the clinical manifestations of the same with its good medication.

Keywords: Naegleria fowleri, PAM, Epidemiology

I. INTRODUCTION

Naegleria fowleri is also known as Brain eating amoeba. Naegleria fowleri (figure 1) is a free living single celled living organism which causes primary amoebic meningoencephalitis (PAM). Naegleria genus contains more than 30 species in which only Naegleria fowleri is pathogenic in human beings (De Jonchere, 2004). Naegleria is an amoeba which is commonly found in warm freshwater like (lakes, hot springs, rivers etc.). Naegleria fowleri is a thermophilic organism and the optimum temperature for the growth is up to 46°C (115°F) and they can survive for short period at the higher temperature. It is found to be rare. They occur mainly during the summer months. And infections are more likely to be found in southern tier states. Naegleria fowleri was first described by the dr. Fowler and Cutler in 1965 (Australia) and they found that it causes PAM (primary amoebic meningoencephalitis) (Fowler & Cutler, 1965).



Figure 1: Computer-generated representation of Naegleria fowleri (Jan Wesner Childs, 2020)

Morphology

Naegleria fowleri is also known as brain eating amoeba. It is a free-living microscopic amoeba and it is single-celled living organism which is present in the fresh water (lake, river). It

can cause a rare and devastating infection of the brain called primary amoebic meningoencephalitis (PAM) (Visvesvara GS., 2010).

Naegleria fowleri is part of the kingdom Protista (subkingdom: Protozoa) that can be further

classified into Phylum: sarcomastigophora (Subphylum: sarcodina). A full taxonomic

classification is mentioned in Table 1 (Sawyer et al., 1975).

Table 1: Taxonomic Classification

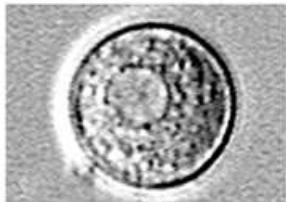
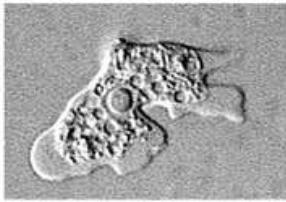
Kingdom	Protista
Subkingdom	Protozoa
Phylum	Sarcomastigophora
Subphylum	Sarcodina
Superclass	Rhizopodia
Class	Acarpomyxea
Order	Schizopyrenida
Family	Vahlkampfiidae
Genus	Naegleria
Species	Fowleri

Life Cycle

Life cycle of *Naegleria fowleri* is described in three stages namely cyst, trophozoite & flagellate. The most infective stage is Trophozoite stage. The diagnostic stage is called

when the trophozoite is present in the CSF (cerebrospinal fluid) in the flagellate form. All the three stages are explained in table 2 with their respective microscopic representation (Visvesvara et al., 2012 & Visvesvara et al., 2007).

Table 2: Various stages and their description

Stages	Microscopic image	Description
Cyst Stage		Cyst exist in spherical shape with diameter around 7-15 µm. As per morphological characteristics, cyst is smooth and consist of single nucleus with single layered wall which is not seen in the brain tissue. Cyst is the most resistive stage and it is formed when the environmental conditions are unfavorable.
Trophozoite Stage		Trophozoite consist of single nucleus. The diameter of trophozoite is about 10-35 µm with granular appearance. In trophozoite, binary division is mode of replication. It is infective stage and it is found in cerebrospinal fluid and brain tissues.
Flagellated Stage		The diameter of flagellated stage is about 10-16 µm with pear shape & bi-flagellated stage. This stage is formed from trophozoite due to adverse environmental changes. It is temporary & the non-feeding stage (as it is occasionally seen in CSF). Flagellated stage will form a cyst in future when the environmental conditions become unfavorable.

Epidemiology

Epidemiology is the study of frequency, distribution and determinants of diseases and other health related conditions in a human population. It is important to understand the epidemiology of Naegleria fowleri for prevention of disease like PAM (primary amebic meningoencephalitis). PAM caused by brain eating amoeba (*naegleria fowleri*) which has a worldwide distribution that occurs most frequently in tropical areas during hot summer months. Most of the reported cases from 1937-2007 was occurred in the united states of primary amoebic meningoencephalitis (caused by *naegleria fowleri*).

- Source of infection

Mainly the amoeba *Naegleria fowleri* infects the human being through contaminated water which is normally found in fresh water lake, rivers and hot springs. It infects the humans via nasal route instead of oral route (people do not get infected by drinking contaminated water). The maximum cases of this infectious disease got reported after

swimming in warm bodies of water(Maclean et al., 2004).

- Site of infection

The site of infection is Nasal Mucosa (route through nose).

- Mode of transmission

It transmits into the human body through nasal route by making contact with contaminated water and contaminated soil. This amoeba live as physical reservoir or as a free living amoeba in the warm waterwhose natural pray is bacteria. The transmission does not occur from person to person contact (Yoder et al., 2010).

- Route of transmission

The trophozoite of *Naegleria fowleri* enters the nose and this trophozoite migrates to the brain along with the olfactory nerve through cribriform plate of ethmoid bone and then it reaches to the brain and destroys the brain tissues (figure 2). It also causes the inflammation of meninges which is responsible for causing PAM (Marciano et al., 2007).

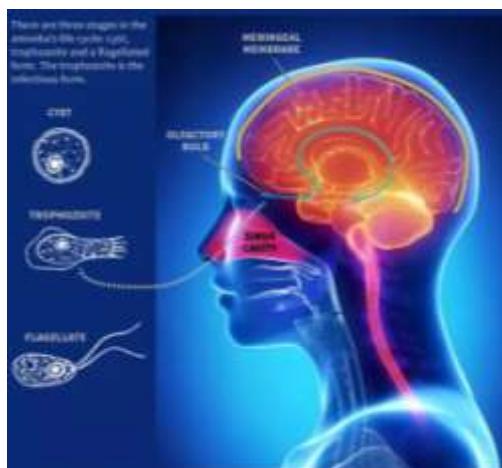


Figure 2: Brain-eating amoeba life cycle (Karl Tate, 2013)

Disease and Symptoms

Naegleria fowleri cause PAM (primary amebic meningoencephalitis). Symptoms of PAM are not specific to this disease (Carol Dersarkissian, 2020). Symptoms include:

- Headache
- Fever
- Stiff neck
- Loss of appetite
- Vomiting
- Altered mental state
- Seizures
- Coma
- Hallucination

- Drooping eyelid

- Blurred vision

- Loss of the sense of taste

Diagnosis and Detection

There are several tests for diagnosis of *naegleria fowleri* by taking cerebrospinal fluid from brain. The *naegleria fowleri* infection can be diagnosed in laboratory by detecting the antigen and the nucleic acid of the organism in the CSF, biopsy or tissues specimen. This diagnosis tests include Antigen detection test, amoeba culture test, environmental detection test, direct visualization

test, polymerase chain reaction (Marciano-cabral et al., 2007).

a. Antigen detection test

In this test an antigen has to be taken from the CSF and make a reaction of this antigen to a specific antibody and pass this antigen antibody complex reaction through a chemical labelled antibody which glows under a specific type of light.

b. Amoeba culture test

This test would be done on the culture media and in the culture media amoeba increases their colonies. The sample of the amoeba would be added to growth plate which is covered by the bacteria that can serve as a food source for naegleria fowleri. So, the initial screening is accomplished by incubating the plate at a higher temperature (108°F/42°C) that kills most of the free living thermolabile amoeba except the thermophilic (heat loving) amoeba such as naegleria fowleri. This test is used for the screening of the thermophilic naegleria fowleri.

c. Environmental detection test

In this test the sample of amoeba collected, concentrated and put into culture media to grow and after that screening of naegleria fowleri is done with the help of molecular methods.

d. Direct visualization test

In this test fresh sample of CSF is collected for checking the motility of the amoeba under the microscope. The amoeba is stained by specific stains such as giemsa-wright or a modified trichome stain for the identification of amoeba in the microscope.

e. Polymerase chain reaction

In the PCR a specific molecular tool used which can amplify the DNA of the amoeba (trophozoite stage of naegleria fowleri) from the CSF and a brain tissue.

Treatment

The drug like amphotericin B is mainly used for the treatment. And other anti-infective or anti-amoebic drug like miltefosine, miconazole, fluconazole and combinations of drugs are also be useful in the treatment. The drug amphotericin B is performed intravenously. And the drug miltefosine saved two patients which were infected by naegleria fowleri in 2013 (Seidel et al., 1982).

Prevention and control

The naegleria fowleri infects the people when the contaminated water enters human body through the nose. So, to prevent the infection-

control the growth of naegleria fowleri by taking measure steps- do proper chlorination of the swimming pools, avoid swimming in the warm water bodies etc. (Vargas-Zepeda et al., 2005 & Kaminsky et al., 2002).

II. CONCLUSION

Naegleria fowleri is a deadly parasite which is accountable for PAM (primary amoebic meningoencephalitis). It is most dangerous amoeba of naegleria genus with death rate of approximately 95% in human beings. It is pervasive in the countries where the summer months are very hot. This parasite infects the humans when they come in contact with infected water. This parasite begins the infection in the human body from the nose (nasal passage) and then reaches the brain with the infective stage (trophozoite) to the central nervous system and causes death within 4-9 days. Despite the fact that brain eating amoeba is rare deadly disease but no antidote is available to treat this disease has been found yet. At present, amphotericin B and miltefosine is used to treat serious infection. Apart from this, many researchers are trying to find the antidote to get rid from this deadly amoeba, meanwhile it is important to take precaution from our side to be safe such as avoiding use of swimming pools and hot water lakes.

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