Disaster Medicine and Public Health Preparedness

www.cambridge.org/dmp

Letter to the Editor

Cite this article: Hameed S, Akram F, Niaz I, Munawar M and Abid A (2025). Unveiling a Growing Concern: *Naegleria fowleri*'s Emergence as a Brain-Eating Threat. *Disaster Medicine and Public Health Preparedness*, **19**, e72, 1–3
https://doi.org/10.1017/dmp.2025.73

Received: 06 April 2024
Revised: 02 August 2023
Accepted: 21 February 2025

Corresponding author:
Sadaf Hameed;
Email: sadaf.hameed@ucp.edu.pk

Unveiling a Growing Concern: *Naegleria fowleri*'s Emergence as a Brain-Eating Threat

Sadaf Hameed[1], Farah Akram[2], Iram Niaz[1], Muqaddas Munawar[1] and Amina Abid[1]

[1]Faculty of Science and Technology, University of Central Punjab, Lahore, Pakistan and [2]Rural Health Centre, Farooka, Sargodha, Pakistan

Evolution ensures that there will always be winners and losers in the primordial relationship between pathogens and hosts, and more importantly, that these outcomes will continue to evolve over time. The emergence of new infectious diseases and the reappearance of old risks are constant occurrences. However, it is feared that climate change will exacerbate this trend. Any such "ramping up" of disease emergence can have a variety of possible consequences, ranging from negligible global impact to the occurrence of a potentially catastrophic, collective disease event.[1] To illustrate the intricate interplay between climate change and infectious diseases, Casadevall et al. highlighted that climate change increases the pathogenicity of *Candida auris*, a multidrug-resistant fungal disease.[2] Changes in temperature and humidity can create more favorable conditions for the growth and spread of fungi, which may amplify the virulence of this pathogen. Another growing concern involves *Naegleria fowleri*, colloquially referred to as "brain-eating amoeba," a thermophilic single-celled organism. The infections of Naegleria *fowleri* are most prevalent during the summer season, when the temperature of the water aligns with the amoeba's thermal preferences and individuals engage in recreational water-based activities such as diving and aquatic sports.

In 2022, *Naegleria fowleri* caused a total of 6 fatalities in Karachi, Sindh, Pakistan. On July 4, 2023, in Lahore, Punjab, Pakistan, another tragic incident occurred when a 30-year-old individual perished.[3] The global incidence of *Naegleria fowleri* infection revealed a stark reality, with merely 4 of 157 individuals in the US having managed to survive the infection from 1962-2022. These statistics serve as a poignant reminder of the 98% mortality rate associated with *Naegleria fowleri.* Even though the infection is considered rare, it always ends in fatality.

Remarkably, 5 well-documented survivors of *Naegleria fowleri*'s infection have been known in North America. It has been hypothesized that the recovery of certain patients from infection might have been influenced by the fact that the initial strain of *Naegleria fowleri* found in the first surviving case in North America was less virulent. Laboratory trials further signify that this strain was less adept at quickly destroying brain cells, indicating less virulence compared to the strains recovered from previous lethal cases.

In order to cure the infection, a few patients were treated with therapeutic interventions such as amphotericin B, miconazole/fluconazole/ketoconazole, and/or rifampin-similar to the initial survivor. However, assessing the effectiveness of the treatment regimen remains challenging as these patients did not survive.[4]

Naegleria fowleri is basically responsible for causing primary amebic meningoencephalitis (PAM), a severe neurological condition. This infection is prevalent in warm fresh water sources like hot springs, rivers, and lakes, as well as in soil. The mode of entry for *Naegleria fowleri* is through the olfactory neuroepithelium (located in the nasal cavity), causing an acute and often fatal condition of the central nervous system (CNS). Infection caused by *Naegleria fowleri* results in meningoencephalitis (inflammation of the brain and its surrounding membranes) as well as cerebral edema (accumulation of fluid causing brain swelling). Tragically, these complications culminate in death within a remarkably short period of 7-10 days after the amoeba enters the human brain.[5] Despite its rarity, this condition is exceedingly fatal and tends to be underreported in terms of its prevalence.

The clinical symptoms of PAM typically manifest within the timeframe of 1-15 days after exposure to *Naegleria fowleri.* In the initial stages, individuals affected by PAM may frequently experience symptoms like fever, severe headaches, and nausea. As the infection advances, the individual may develop increased sensitivity to light (photophobia), disorientation, convulsions, and even slip into coma. Interestingly, these advanced symptoms bear resemblance to those experienced by individuals afflicted with bacterial meningitis.[6]

The PAM is generally diagnosed with laboratory testing, although these tests are not universally accessible. Due to the rarity and initial difficulties in detection, postmortem diagnostic assessments are occasionally conducted. The PAM can be confirmed through laboratory analysis of cerebrospinal fluid (CSF) or brain tissue for the presence of *Naegleria fowleri* organisms, nucleic acids, or antigens. Understanding the life cycle of *Naegleria fowleri* is crucial

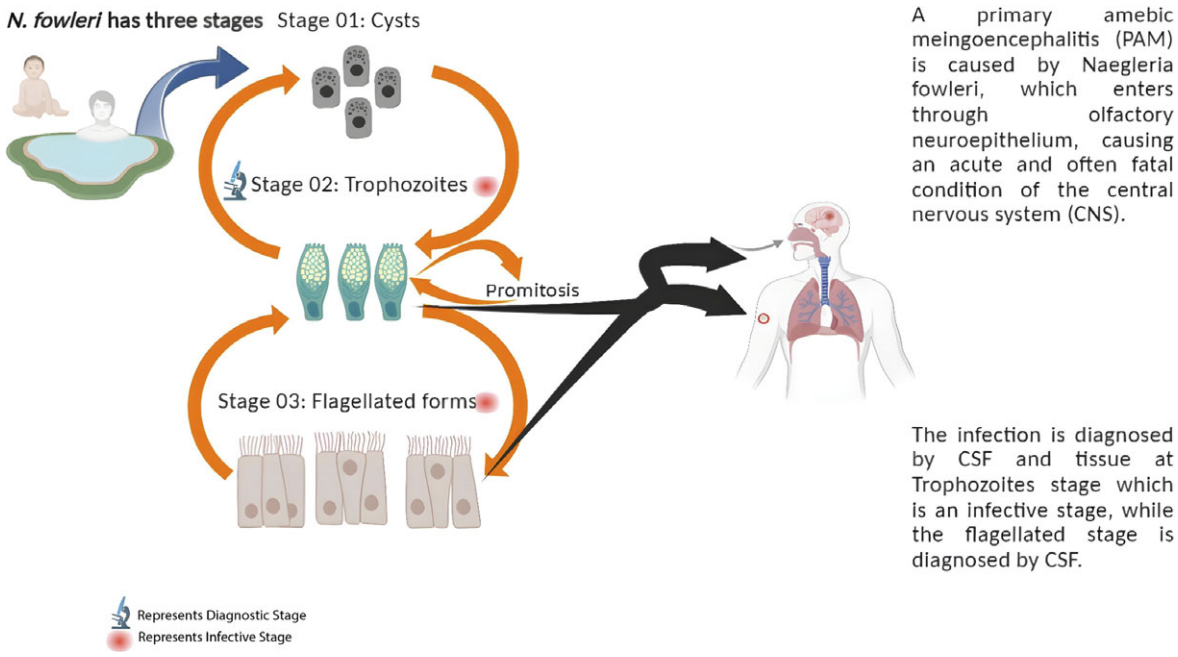

Figure 1. The Stages of Naegleria fowleri.

to comprehending its threat and devising efficient strategies to prevent its transmission and mitigate its impact.

The life cycle of *Naegleria fowleri* can be segmented into 3 discrete stages, as illustrated in Figure 1. The amoeboid trophozoites, which, measure between 10-35 μm in length, thrive particularly well around 35˚C-46˚C and are the sole stage of *Naegleria fowleri* lifecycle that can cause infections and health complications in humans. As the organism progresses from 27˚-37˚C, it becomes pear-shaped, having (10-16 μm long) flagellate. The third type of cyst is a spherical one that can survive at lower temperatures. This cyst can transform into a trophozoite under suitable circumstances. When aquatic events occur, trophozoites have the ability to infiltrate the nasal mucosa and invade the nasal cavity. Subsequently, there trophozoites proceed to enter the cribriform plate via the olfactory bulbs and eventually propagate to the central nervous system, mainly the cerebellum, brain stem, and base of the brain, provoking massive inflammation, necrosis, and hemorrhagic damage.[7]

As the age-old adage goes, it's wiser to take precautions than to seek a remedy. Some of the recommendations enlisted below are aimed at effectively addressing the occurrence of *Naegleria fowleri* infections. The mortality rate of infectious strains can be effectively reduced by quick and accurate diagnosis followed by appropriate treatment. Medical practitioners should make sure to prescribe specific antibiotics despite broad-spectrum antibiotics as broad-spectrum antibiotics could cause resistance and hence, make treatment hard. In order to provide high-quality water, water resources must undergo carefully controlled chlorination and biological treatment. The WHO recommendations for adequate chlorination of municipal water supplies have been followed, and preventative measures have also been created to stop the development of this disease. Furthermore, tablets of chlorine can be used to treat underground water tanks twice annually for an in-depth cleaning (1 tablet for 5 L of water). All the city's swimming pools must be kept clean and properly chlorinated, and the Metropolitan Corporation Lahore is responsible for ensuring this. Many domestic preventive measures can lower the frequency of Naegleria infection. Avoiding swimming or taking a bath in unchlorinated water and encouraging people to use boiled or sterilized water for ablution, gargling, and brushing; other important instructions must be displayed in public places for everyone who uses water. The best course of action is to prevent the condition in the first place because it is lethal and has no effective treatment. We must encourage our loved ones to wear nose clips while participating in water-related activities to avoid being poisoned by the brain-eating parasite *Naegleria fowleri.* Wear earplugs if one is suffering from a ruptured eardrum. For sinus cleaning or rinsing with a neti pot, use previously boiled or distilled water.

In conclusion, it is imperative to develop guidelines for accurate diagnosis and prompt treatment. Wet mount CSF cytology should be taken into account. As a preventive measure, the use of Amphotericin-B could improve survival rates. The most important point is that prevention is better than the cure, which has not yet been developed.

Author contribution. Sadaf Hameed and Farah Akram wrote the manuscript. Iram Niaz, Muqaddas Munawar, and Amina Abid were involved in conceptualization and data collection. All authors read and approved the final manuscript.

Funding statement. None.

Competing interests. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

References

1. **Meinen A**, **Tomczyk S**, **Wiegand FN**, et al. Antimicrobial resistance in Germany and Europe - a systematic review on the increasing threat accelerated by climate change. *J Health Monit.* 2023;**8**(Suppl 3):93–108. https://doi.org/10.25646/11404
2. **Casadevall A**, **Kontoyiannis DP**, **Robert V.** Environmental *Candida auris* and the Global Warming Emergence Hypothesis. *mBio.* 2021;**12**(2): doi:10.1128/mbio.00360-21

3. **Lodhi A.** Naegleria claims first life in Punjab. *The Express TRIBUNE.* https://tribune.com.pk/story/2424735/naegleria-claims-first-life-in-punjab
4. **CDC.** https://www.cdc.gov/parasites/naegleria/illness.html
5. **Rojo JU**, **Rajendran R**, **Salazar JH**. Laboratory diagnosis of Primary Amoebic Meningoencephalitis. *Lab Med.* 2023;**54**(5):e124–e132. doi:10.1093/labmed/lmac158
6. **Che X**, **He Z**, **Tung TH**, et al. Diagnosis of primary amoebic meningoencephalitis by metagenomic next-generation sequencing: a case report. *Open Life Sci.* 2023;**18**(1):20220579. doi:10.1515/biol-2022-0579
7. **Anser H**, **Khatoon H**, **Khan S**, et al. A Review on Global Distribution of Primary Amoebic Meningoencephalitis (PAM) Caused By *Naegleria fowleri*-The Brain Eating Amoeba; 2018:

https://doi.org/10.1017/dmp.2025.73 Published online by Cambridge University Press