

# Fatal consequences of freshwater pearl diving

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In July 2012, a 25-year-old man was admitted to our hospital with headache, fever and reduced level of consciousness. He had an unremarkable medical history and took no regular medications. He worked as a peanut vendor and prior to becoming unwell had visited relatives in the countryside. During this time he attended a wedding and, of note, went diving for pearls in a freshwater lake. One week after returning to the city he developed a headache and a fever, for which he took paracetamol. The next day his headache had worsened in severity and he attended his local hospital, where it was noted that he was confused. At this hospital he was given a dose of ceftriaxone to cover bacterial meningitis and was transferred to our hospital.

On initial assessment, he had a temperature of 39°C. His Glasgow coma scale was 10 (M=5, V=2, E=3). His neck was stiff. He had no rash and was haemodynamically stable. Initial blood tests revealed an elevated white cell count at  $13.34 \times 10^9/L$  with 89% neutrophils. A lumbar puncture was performed which showed an opening pressure of 38 cm H<sub>2</sub>O. The cerebrospinal fluid (CSF) contained  $3260 \times 10^3/mL$  white cells with 88% neutrophils. The CSF protein was 7.9g/L. The CSF glucose was 0.15 mmol/L with a plasma glucose of 8.62 mmol/L. Gram and Zeil-Neilsen stains were negative. However on wet mount microscopy numerous amoebae were observed (**Figure 1** and **Video 1**). He had already been commenced on ceftriaxone and dexamethasone to treat presumed bacterial meningitis. In view of the CSF findings and the history of exposure to freshwater a diagnosis of primary amoebic meningoencephalitis (PAM) was considered. Amphotericin B and rifampicin were commenced. Later on the day of admission his condition deteriorated and he required intubation and ventilation. He subsequently went into cardiac arrest and could not be resuscitated. Retrospectively, a polymerase chain reaction (PCR) amplification targeting the 18s RNA gene was performed.<sup>1</sup> The PCR amplicon was sequenced and

confirmed to have 100% homology with the 18s RNA gene of *Naegleria fowleri*, the cause of PAM.

*Naegleria fowleri* is a free-living amoeba that typically lives in warm freshwater environments.<sup>2</sup> Amoebae enter the brain via the olfactory nerve after infected water is inhaled or splashed into the nose. Within the central nervous system *Naegleria fowleri* amoebae cause an intense inflammatory reaction accompanied by necrosis and haemorrhage.<sup>3</sup> PAM appears to be increasing in frequency with an expanding geographic footprint.<sup>4,5</sup> The clinical and CSF findings are difficult to distinguish from bacterial meningitis.<sup>5</sup> A history of freshwater exposure and symptoms such as the loss of the sense of smell should prompt consideration of the disease.<sup>4</sup> PAM has an extremely high case fatality rate and there are very few documented survivors. Early diagnosis and prompt initiation of an amphotericin B-based regimen are essential for a good outcome.<sup>5</sup> Additional drugs have been used such as rifampicin, fluconazole, and azithromycin.<sup>4,5</sup> To our knowledge this is the first documented case of *Naegleria fowleri* infection in Vietnam. The case highlights an important, albeit rare, risk of freshwater pearl diving.

### **Contributors**

NHP, NTHM, HDTN, TTHC, PPL, LHT, TMP, CQT, NVVC and JW were involved with the clinical care of the patient. DNHM, TVTN, SB and JC were involved with the laboratory diagnosis and prepared the images and the video file. All authors contributed to the manuscript.

### **Conflicts of interests**

The authors confirm that we have no conflicts of interest.

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**Figure legend:**

A: *Naegleria fowleri* with lymphocytes in CSF (Giemsa stain, x1000); B: *Naegleria fowleri* in CSF showing cell elongation to aid movement (wet preparation, x1000)

**Movie legend:**

*Naegleria fowleri* moving in CSF (wet preparation, x1000)