Changing Geographic Range of Primary Amebic Meningoencephalitis — Minnesota, 2010

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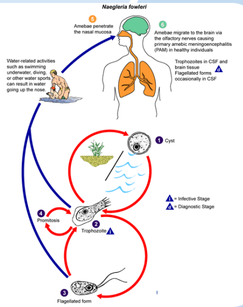
BACKGROUND

Naegleria fowleri

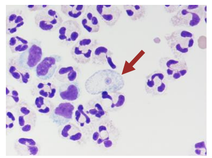
- Found in fresh water
- Thermophilic, free-living ameba; proliferates above 30° C
- Introduced into nose during activities in water, travels up olfactory nerve to the brain
- Infection known as primary amebic meningoencephalitis (PAM)
- Nearly uniformly fatal
  - Of 111 cases reviewed in the United States between 1962–2008, only 1 survived



CASE PRESENTATION

- On August 20, 2010, the Minnesota Department of Health (MDH) was notified of a case of unexplained meningoencephalitis in a 7-year-old with recent fresh water swimming exposures. The patient presented to a local hospital with fever, headache, and acute onset seizure, and was admitted to the intensive care unit with presumed bacterial meningitis. However, bacterial cultures of cerebrospinal fluid (CSF) remained negative at 48 hours; samples were sent to MDH for additional testing. The patient deteriorated rapidly over the next day and died.

- The pathologist performing the autopsy reviewed a Wright's stain of CSF drawn from the patient at the time of admission, and noted ameboid forms, raising suspicion for PAM due to *N. fowleri*.



- However, well-documented cases of PAM have previously only been reported in Southern-tier states. This case would have represented marked northward expansion of the disease.

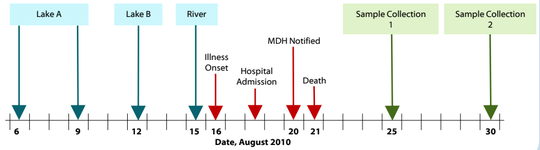
Number of case reports of primary amebic meningoencephalitis caused by *Naegleria fowleri* (n=107) by state of exposure, USA, 1962-2008

INVESTIGATION

Objectives

- Was this PAM?
- Did exposure occur in Minnesota?
- If so, why is *N. fowleri* causing illness in Minnesota?

Timeline of Exposures, Illness, and Environmental Sample Collection



METHODS

Epidemiology

- Reviewed medical records, interviewed patient's parents for exposure history

Diagnosis

- Collected patient samples, including CSF, CSF-inoculated agar plates, and brain tissue slides

Environmental Data Collection

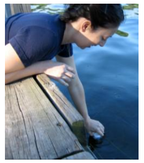
- On 2 separate days, collected data and samples from each body of water where the patient swam in the 2 weeks prior to illness onset
  - Water temperature
  - Assessment of water clarity, algal blooms, and surrounding land features
  - Samples of water (150mL x 3) and sediment (100mL x 4)

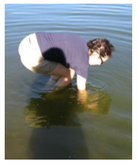
Laboratory

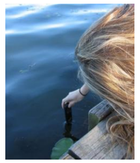
- Patient and environmental samples received by Water, Sanitation and Hygiene Laboratory Team at the Centers for Disease Control and Prevention
- Cultured samples for *N. fowleri* by incubating at 44° C
- Confirmed speciation by real-time polymerase chain reaction (PCR) and immunofluorescent antibody staining
- Genotyped isolates from CSF and water by sequencing of the 5.8S rRNA gene and internal transcribed spacers 1 and 2

Climatologic Data Collection

- Obtained historic ambient temperature and precipitation data from a National Weather Service station located within 15 miles of exposure site
- Reviewed normal temperature data for the Minneapolis–St. Paul area provided by National Climatic Data Center



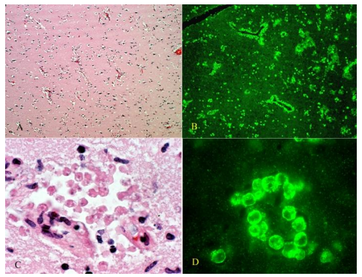




RESULTS

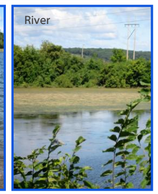
Diagnosis of PAM

- Brain histology showed diffuse amebic infiltrates around blood vessels, consistent with PAM
- *N. fowleri* was confirmed in CSF and brain tissue by real-time PCR



Exposure History

- Previously healthy 7-year-old
- No history of travel outside Minnesota in the month prior to illness onset
- Gymnast, practiced handstands underwater
- Had swum at 3 local sites in 2 weeks prior to illness onset



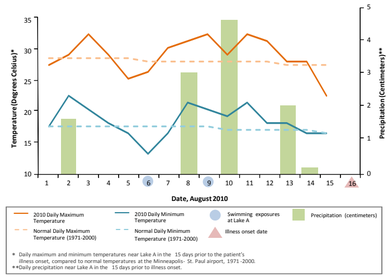
Environmental Testing Results

- *N. fowleri* was cultured from Lake A water and sediment on the first collection date, and from sediment only on the second collection date
- *N. fowleri was* not found at other two swimming sites
- Isolates of *N. fowleri* from the patient's brain and Lake A water were all genotype 3

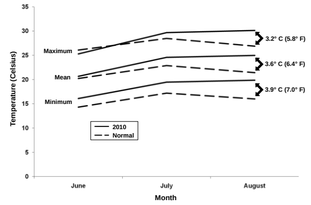
	Surface Area (acres)	Maximum Depth (meters)	Water Temperature (°C)	Algal Bloom	Clarity (meters)
Lake A	52	17.4	22.1 - 24.5	Y	<1
Lake B	162	21.3	23.0 - 25.5	N	>3
River	N/A	9	22.3 - 24.9	Y	≥1

Review of Climatologic Data

Daily Temperatures and Precipitation Near Lake A, August 1-15, 2010



Summer 2010 Monthly Temperatures at the Minneapolis-Saint Paul Airport vs. Normal Monthly Temperatures



- Average minimum temperatures in August 2010 were 3.9° C (7.0° F) above normal
- The average monthly minimum temperature for the months of June-August 2010 in the Minneapolis-Saint Paul area set a record high at 18.6 ° C

DISCUSSION

Could warmer temperatures result in northward expansion of PAM cases?

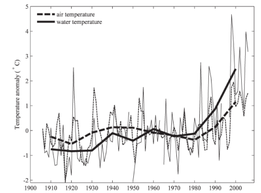


Fig. 8. Summer mean water-temperature anomaly from SSM open-lake proxy (solid curve) and air temperature anomaly from regional GISS stations (dashed curve). Light lines are annual data, heavy lines are decadal averages.

- Austin and Colman (2008) estimated annual summer mean water and air temperature anomalies over time since 1906 using data points from a buoy at the southern outlet of Lake Superior and regional weather stations
- Lake Superior water temperatures have risen about twice as fast as regional air temperatures over the past century
- In a smaller lake, such as Lake A, warming effects could be more pronounced, providing an environment in which *N. fowleri* has the opportunity to proliferate

CONCLUSIONS

- *N. fowleri* is in Minnesota and has caused disease
- This case represents the northernmost documented case of PAM in the United States by 550 miles
- It is plausible that warmer temperatures could have resulted in northward expansion of PAM cases
- Better understanding is needed of environmental risk factors besides temperature that contribute to proliferation of *N. fowleri* populations

RECOMMENDATIONS

- Clinicians
  - Consider PAM anywhere in the United States when presented with a case of meningitis or encephalitis, during hot summer months, with a history of recent fresh water swimming exposure
  - Examine CSF for presence of amebae if PAM is suspected
- CDC
  - Continue to build database of epidemiologic data and patient isolates
  - Develop laboratory toolkit that can be applied in case environmental assessments to achieve better understanding of host-pathogen-environment interactions

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