New insight into predicting cholera epidemics in the Bengal Delta

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Cholera, an acute diarrheal disease caused by the bacterium Vibrio cholerae, has reemerged as a global killer. Outbreaks typically occur once a year in Africa and Latin America. But in Bangladesh the epidemics occur twice a year - in the spring and again in the fall.

Scientists have tried, without much success, to determine the cause of these unique dual outbreaks - and advance early detection and prevention efforts - by analyzing such variables as precipitation, water temperature, fecal contamination and coastal salinity. Now, researchers from Tufts University, led by Professor of Civil and Environmental Engineering Shafiqul Islam, have proposed a link between cholera and fluctuating water levels in the region's three principal rivers - the Ganges, Brahmaputra and Meghna.

"What we are establishing is a way to predict cholera outbreaks two to three months in advance," says Islam, who also holds an appointment as professor of water and diplomacy at The Fletcher School at Tufts. "It's not a microbiological explanation. The key is the river discharge and regional climate."

The Tufts researchers' findings were reported in the latest issue of Geophysical Research Letters, published October 10, 2009.

Understanding cholera's environmental catalysts

Vibrio cholerae lives and thrives among phytoplankton and zooplankton in brackish estuaries where rivers come into contact with the sea. The Bengal Delta, which scientists have considered the native land of cholera, is fed by three rivers.

Almost all of the rainfall in the region occurs during the four-month monsoon season between June and September. Water levels in the river system rise, causing floods that cover 20 percent of the land in an average year. Water levels then fall rapidly, though low-lying, depressed areas remain submerged for weeks.

The Tufts team tracked the month-by-month incidence of cholera using data from the International Center for Diarrhoeal Disease Research, a treatment center that recorded incidences of cholera for the biggest population center of Bangladesh from 1980 to 2000.

The Tufts team correlated these cholera incidence statistics with an analysis of water discharges from the three rivers. Their findings suggested two distinctive epidemic patterns that are associated with the seasonal cycles of low river flows and floods.

A spring outbreak occurs in March, during the period of low river flow in Bangladesh. The low river flow allows seawater from the Bay of Bengal to move inland, transporting bacteria-carrying plankton.

A second epidemic occurs in September and October, after monsoon rains have raised water levels. Here, a different dynamic takes place. Floodwaters have mixed water from sewers, reservoirs and rivers. As the floods recede, contamination is left behind..

Predicting cholera before it happens

Islam and his team linked the incidence of cholera cases to the level of

water flow in the rivers. In order to confirm their findings, the researchers looked for a consistent pattern. They analyzed the incidence of cholera in five years of severely low river flow from 1980 to 2000 and compared it with five years of average and below average river flow. The same analysis was done for extreme, average and below average floods to study the fall epidemic.

The researchers found a relationship between the magnitude of cholera outbreaks and the severity of the region's seasonal low river flow and floods. "The more severe the low river flow, the larger the spring epidemic," says Islam. "The same thing is true with flooding during the fall." Islam says that the findings will contribute to the development of systems to anticipate and predict cholera outbreaks based on the hydroclimate of the region.

More information: Akanda, A. S., A. S. Jutla, and S. Islam (2009), "Dual peak cholera transmission in Bengal Delta: A hydroclimatological explanation," *Geophys. Res. Lett.*, 36, L19401, doi: 10.1029/2009GL039312

Source: Tufts University