A review of cholera dynamics due to climatic variables and modeling

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Introduction

• Cholera - an infection of the small intestine caused by the bacterium *Vibrio cholerae*

• A global killer with the world especially developing countries of Asia, Africa and Latin America witnessing an extraordinary rise in cholera infection and transmission since the 1990s.
  
  • 1.4 billion people at risk of cholera
  • 2.8 million (uncertainty range 1.4 - 4.3 million) cases per year
  • 91,000 (uncertainty range 28,000 - 142,000) deaths per year (Ali et al. 2012)

• This presentation is a review of the literature dealing with the influence of climatic stresses on cholera dynamics in Asia, Africa and Latin America.
Climatic variables cause cholera outbreaks

• Climatic changes and an increase in extreme weather events (extreme temperature, drought or rainfalls) have been linked to the cholera incidences/outbreaks.

• Cholera outbreaks show biannual peaks in its native homeland, the Bengal Delta (Bangladesh and a part of India) while it shows a single annual peak infection pattern in the most affected areas of the world.

• Akanda et al. (2009) documented dual peak as a consequence of
  
  • low flows in the major rivers Ganges, Brahmaputra and Meghna enhancing coastal phytoplankton to encroach to the inland
  
  • high flows sourcing floods that might be the reason of post-monsoon peak of cholera outbreaks
Climatic variables cause cholera outbreaks

• Coastal phytoplankton in the Bengal Delta has a unique positive relation with the increase of sea-surface temperature (Jutla et al. 2011) while in the most coastal areas of the world this is inversely related.

• Combination of seasonal hydroclimatology, high population density, floodplain geography, and coastal ecology made this delta region more vulnerable to periodic cholera outbreaks.

• Climate change and highly variable seasonal extremes i.e., higher floods and droughts may cause more complex situation in future.

• In some parts of Africa, outbreaks occur during the dry season or right after the heavy rainfalls (Lawoyin et al., 1999).

• In the Americas, disasters caused by the El Nino preceded large cholera outbreaks (WHO, 1999).
Historic cholera in Bengal delta

- Historical distribution of endemic cholera in South Asia. The level of endemicity (calculated as the average incidence during the 15 healthiest years between 1901 and 1945) is shown by the variation in the density of dots (S. Swaroop, R. Pollitzer, 1955)
Monthly cholera deaths in the Dhaka district between 1893 and 1940 from historical records for former British India. The typical seasonal pattern with two peaks per year is modulated by longer cycles with considerable variation in total deaths from year to year (Pascual et al., 2002)
Average annual mortality per 1000 of population in provinces of former British India between 1920 and 1939 and average annual rainfall in the same period. Provinces with a single seasonal peak (open circles) and provinces with two annual peaks (black circles) are shown (Pascual et al., 2002)
Variability of seasonal cholera in the high endemic provinces Bengal and Madras (bimodal pattern) and in the epidemic Punjab province (single peak). Bold lines show the main rainfall season with the South West monsoon in Bengal and Punjab, and the North East monsoon dominating Madras (Pascual et al., 2002)
Cholera outbreaks with dual peaks

- Monthly cholera incidence in Dhaka, Matlab, Bakerganj, Bangladesh, and Kolkata, India, and high and low flood inundation in central and northeastern Bangladesh, 1988–2007 (Akanda et al., 2013)
Climatic variables cause cholera peaks

- Areas under risk of recurrent cholera outbreaks in spring and fall because of cholera transmission mechanisms driven by coastal salinity intrusion (ppt) (approximate area under influence of the spring transmission mechanism are shown by the orange shaded region) and regional flood inundation (%) (approximate area under influence of the fall transmission mechanism are shown by the blue shaded region) (based on 1988–2007 average) (Akanda et al., 2013)
Models done so far

- There are no software tools capable of combining hydrodynamic modeling and health risk analyses. Mark, et al. (2015) showed a methodology to link dynamic urban flood modeling with quantitative microbial risk assessment (QMRA) for understanding the interaction between urban flooding and health risk due to cholera.

- There is a research gap of evaluating the impact of future extreme climatic variables that might be accountable for further increase of peaks of cholera outbreaks in many regions of the world.
References


Thank you very much

Any comments/ Questions