From Broad Street to Boston:
Tracking Infectious Disease Outbreaks
Using Molecular Epidemiology

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Overview of today’s talk:

• Broad Street Cholera Epidemic – London, 1854

• Current understanding of Cholera

• Impacts of modern Cholera – Haiti, 2010
Cholera
Cholera

- 3-5 million cases and 100,000+ deaths annually

The Broad Street Cholera epidemic

Miasma – noxious air
Contagion – infectious particle
The Broad Street Cholera epidemic

Hypothesis: Cholera victims drank contaminated water

Snow, J. “On the Mode of Communication of Cholera,” 1855
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Snow’s methods

- Find cases of disease
- Identify connections between sick people
- Epidemiology – the study of the incidence, distribution, and potential control of disease
- Stopped the epidemic without treating, or even identifying, the cause
Vibrio cholerae: a bacterial pathogen

Pathogenic strains are infected with a virus!
CTX Phage (Virus)

TCP
*Vibrio cholerae* is infected with a virus
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*Vibrio cholerae* is infected with a virus
Vibrio cholerae: a bacterial pathogen

- **Cause of Cholera:**
  - Ingestion of contaminated food or water
*Vibrio cholerae* produces Cholera Toxin
Vibrio cholerae intestinal colonization

Intestinal cell = blue/red


**Vibrio cholerae**: a bacterial pathogen

- **Cause of Cholera:**
  - Ingestion of contaminated food or water

- **Spread of Cholera:**
  - Infected humans produce ~20L of stool containing ~10,000,000,000,000 bacteria each day
Cholera treatment

- Rehydration with intravenous fluids
- Cholera salts to restore lost electrolytes
- Antibiotics for extremely severe cases
- Moderately effective short-term Cholera vaccines
Recap

- John Snow’s study of the Broad Street epidemic serves as the foundation of epidemiology.

- Pathogenic strains of *Vibrio cholerae* are infected with a virus.

- Humans contract Cholera by ingesting food or water contaminated with a pathogenic strain.

- Cholera is extremely rare in the developed world.
The earthquake in Haiti

• January, 2010

• ~100,000 killed, millions homeless

• Significant damage to infrastructure
“An outbreak of Cholera is very unlikely at this time… While the current water, sanitation, and hygiene infrastructure in Haiti would certainly facilitate transmission of Cholera, Cholera is not circulating in Haiti, and the risk of Cholera introduction to Haiti is low. Most current travelers to Haiti are relief workers from countries without endemic Cholera, and they are likely to have access to adequate sanitation and hygiene facilities within Haiti.” – March, 2010
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How did Cholera get to Haiti?

1) Evolution
2) Migration
3) Introduction
Sequencing the Haitian outbreak strain

Haiti

New Strain?

Africa?

Asia?
Sequencing the Haitian outbreak strain

- DNA isolated, 4 am – 11/9
- Sequencing, 10 pm – 11/9
- Preliminary conclusions, 11/11
Haitian outbreak genome

How did Cholera get to Haiti?

1) Evolution
2) Migration
3) Introduction
Cholera epidemic in Haiti

- UN aid workers identified as the source of Cholera in Haiti
- Rioting directed against UN peacekeepers
Response to the Haiti outbreak

• Provide vaccination or preventative care for aid workers from Cholera-endemic areas

• Stockpile Cholera vaccines for rapid deployment

• Calls for the UN to pay reparations to Haiti
Conclusions:

• Social context to outbreaks of infectious disease

• Curing a disease is only the first step

• Responding to Cholera outbreaks requires a comprehensive approach...
“A comprehensive, integrated strategy for Cholera prevention and care”

Access to quality care

Access to quality infrastructure

Snow, J. “On the Mode of Communication of Cholera,” 1855
Thank you!

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