

MMED

African Institute for the Mathematical Sciences

Muizenberg, South Africa

June, 2015

Thinking About Data

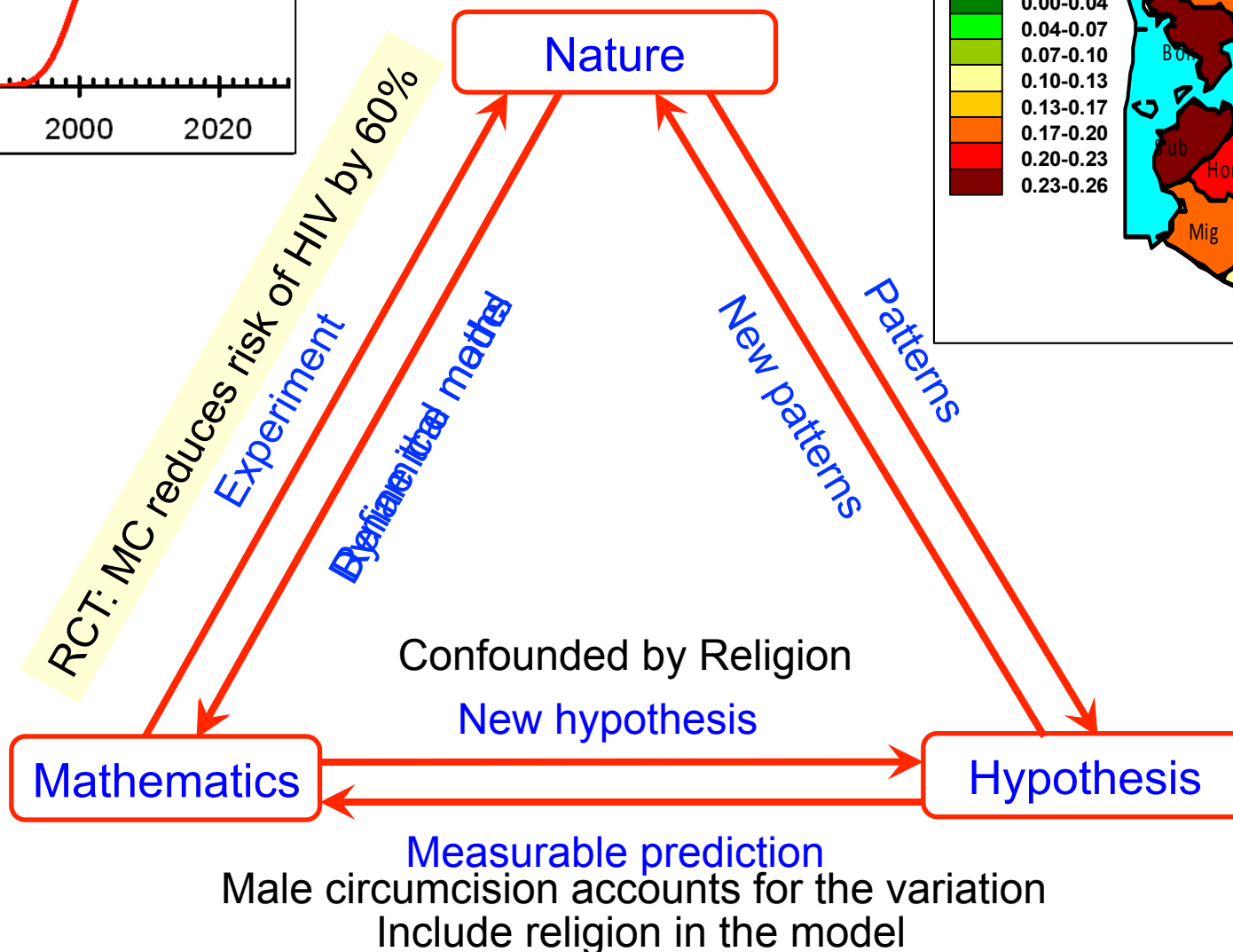
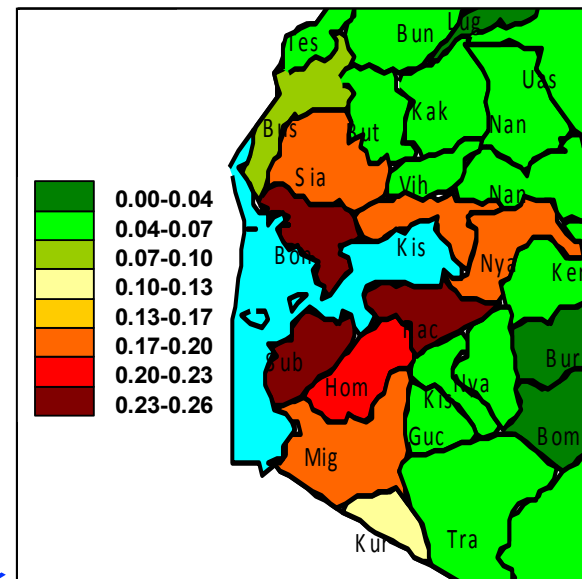
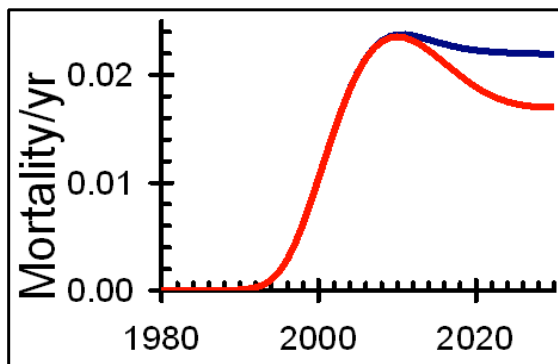
Brian Williams, Ph.D.

Jim Scott, Ph.D, M.A., M.P.H.

The object of all science, whether natural science or psychology, is to co-ordinate our experiences into a logical system.

Einstein A. *The Meaning of Relativity* (1922)

What is Science



RCT: MC reduces risk of HIV by 60%

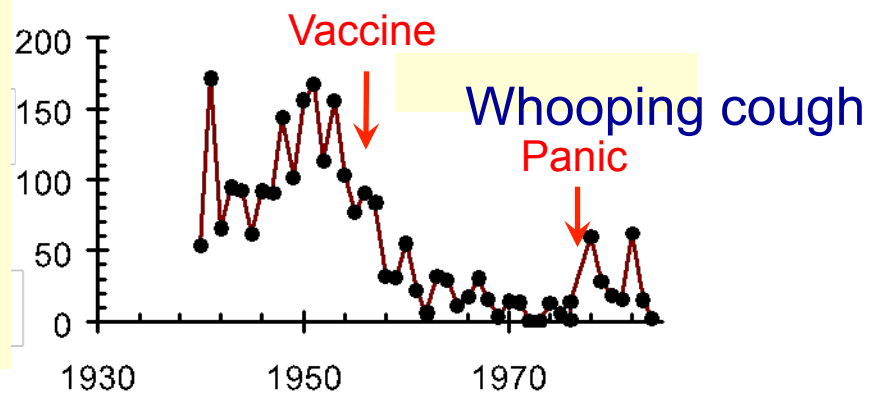
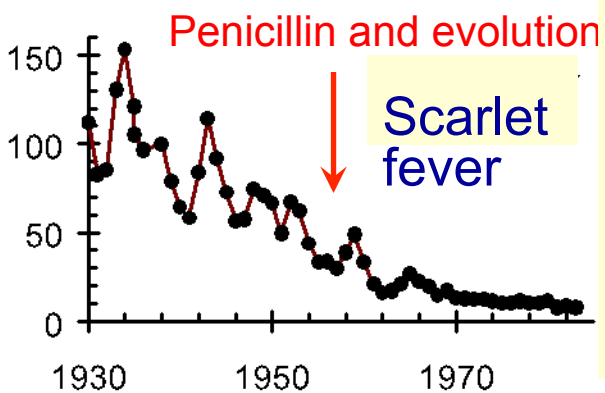
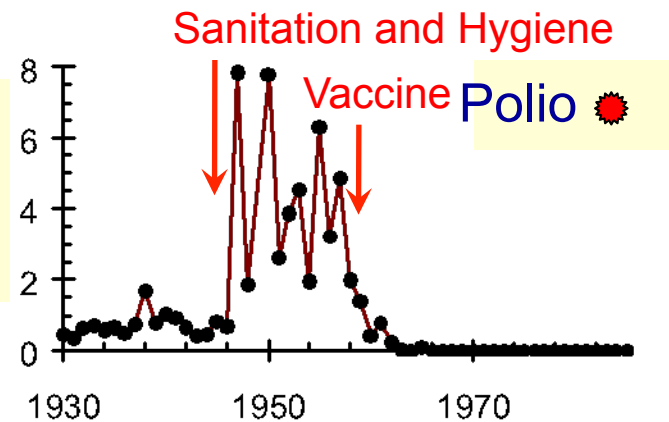
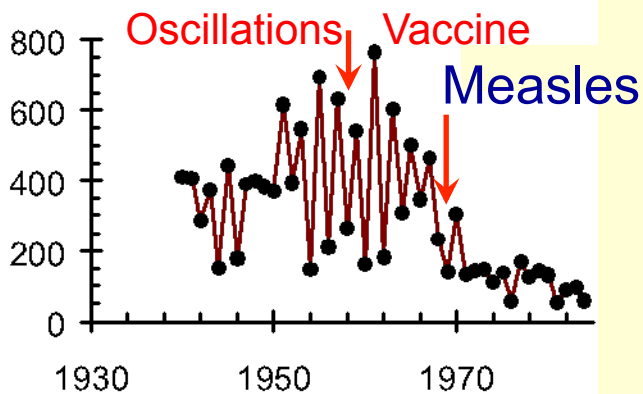
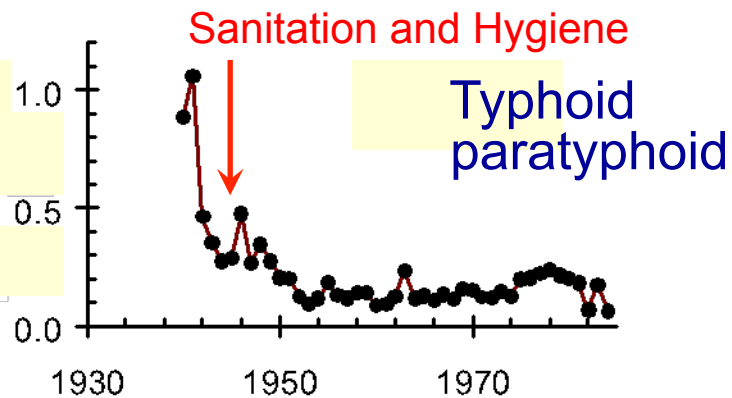
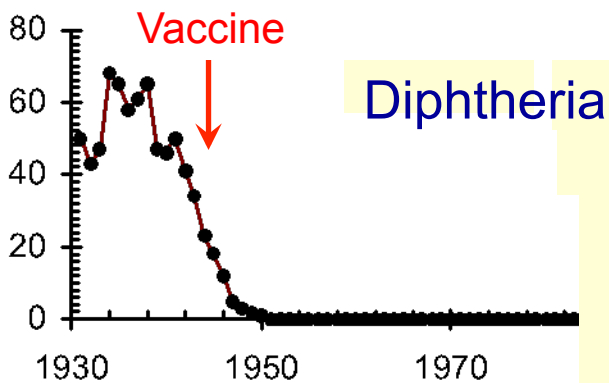
Modern science is the mathematization of hypothesis about nature combined with rigorous experimentation—Joseph Needham

... the supreme goal of all theory is to make the ... basic elements as simple and as few as possible without ... surrendering ... a single datum of experience.

—Albert Einstein, 1933

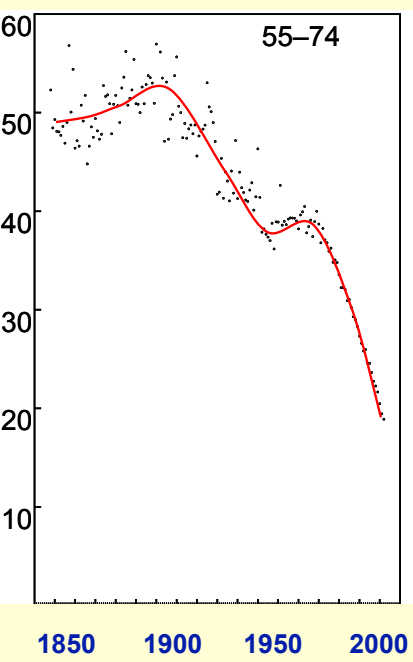
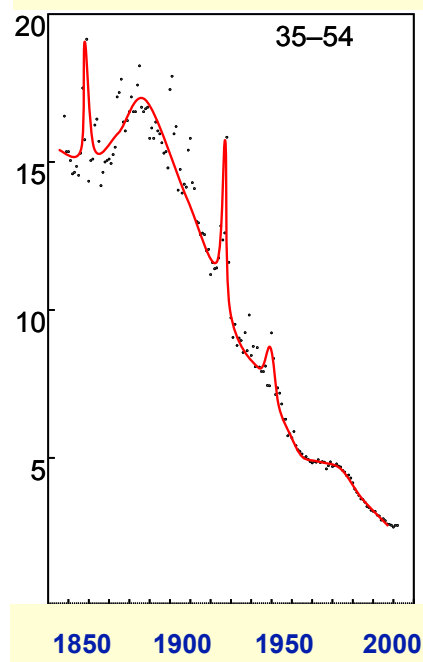
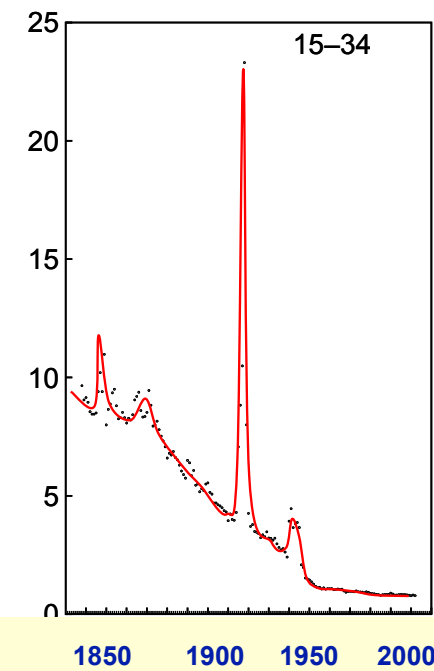
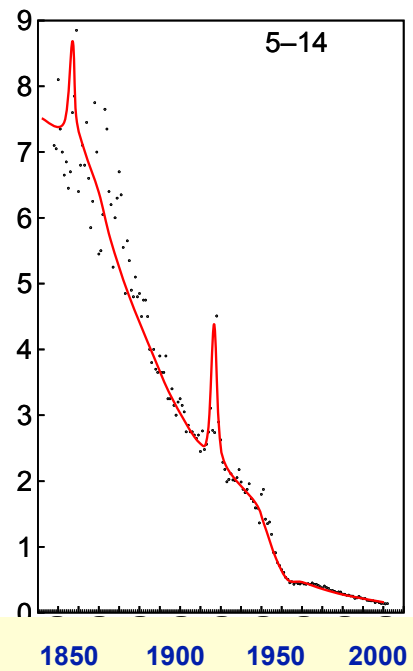
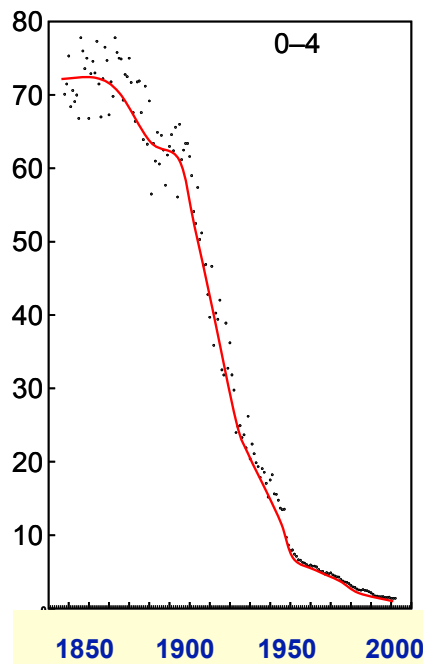
Only introduce complexity as the data or the question demand it.

Number of cases (k)



Diseases in England and Wales, 1930 to 1980

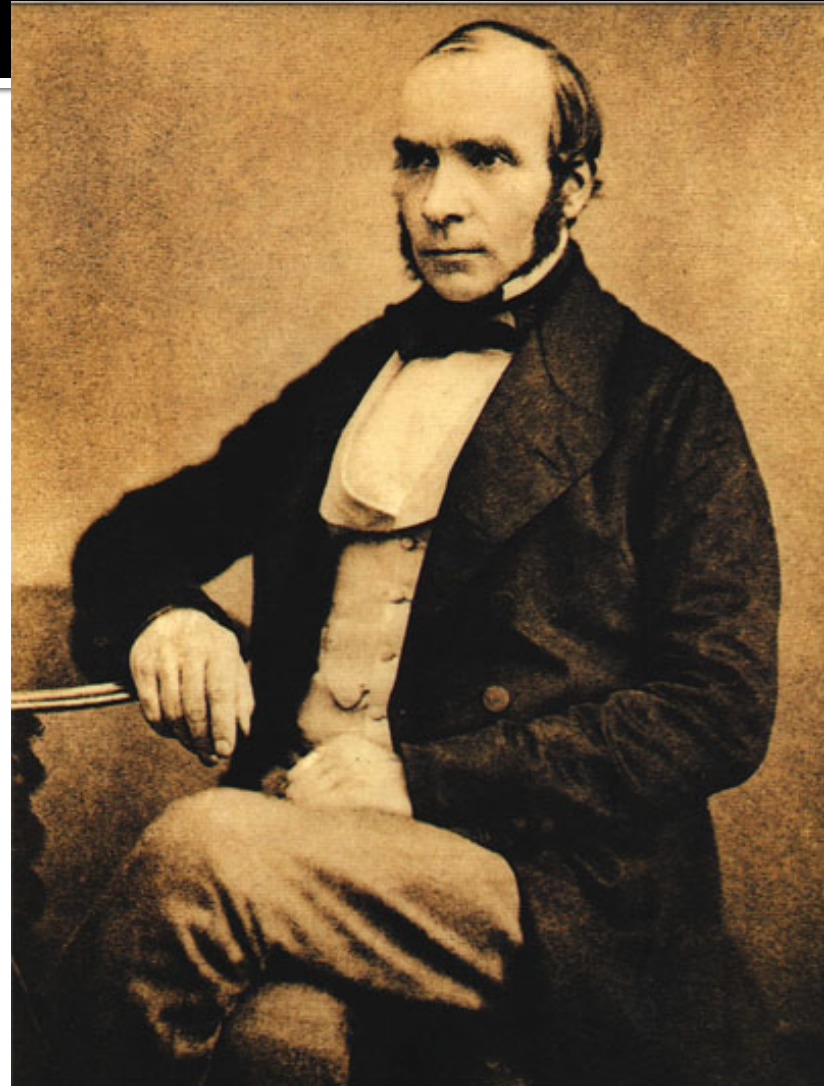
Deaths/thousand



All cause mortality among men in England and Wales, 1838-2002: Cholera, flu, war and antibiotics.
Richard Peto.

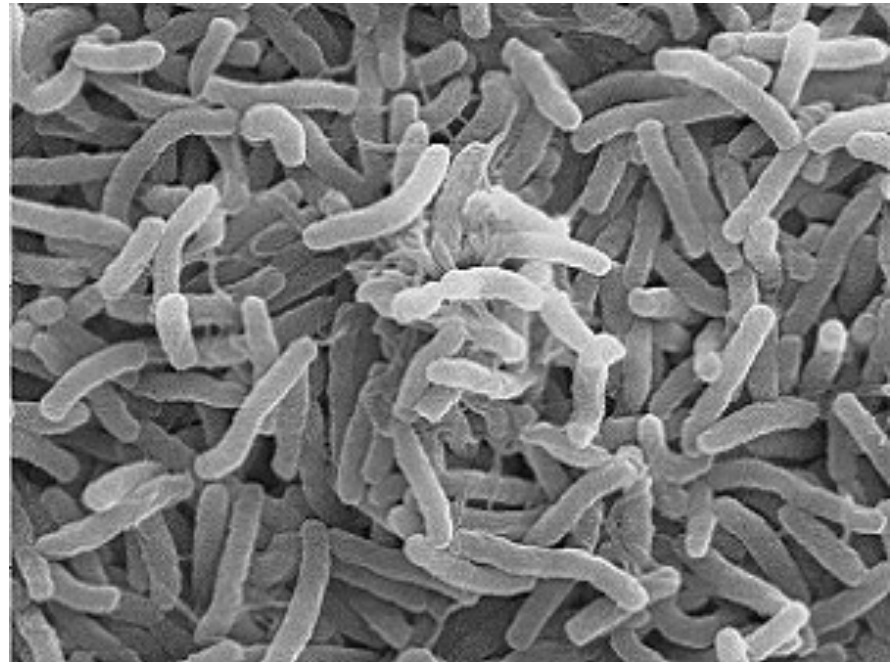
John Snow

- Considered father of field epidemiology
- Conducted a series of investigations of cholera outbreaks in London
- Acclaimed Anesthesiologist



London Cholera Epidemics

- 4 outbreaks between 1831 and 1854
- Most believed cholera was transmitted through vapors – “Miasma”
- Snow proposed that cholera was actually spread by contaminated water
- Considered “folly”



William Farr

- Supported conventional 'miasmatic' theory of disease
- Eventually became proponent of the 'germ' theory of disease
- Contemporary of John Snow



Farr's Data

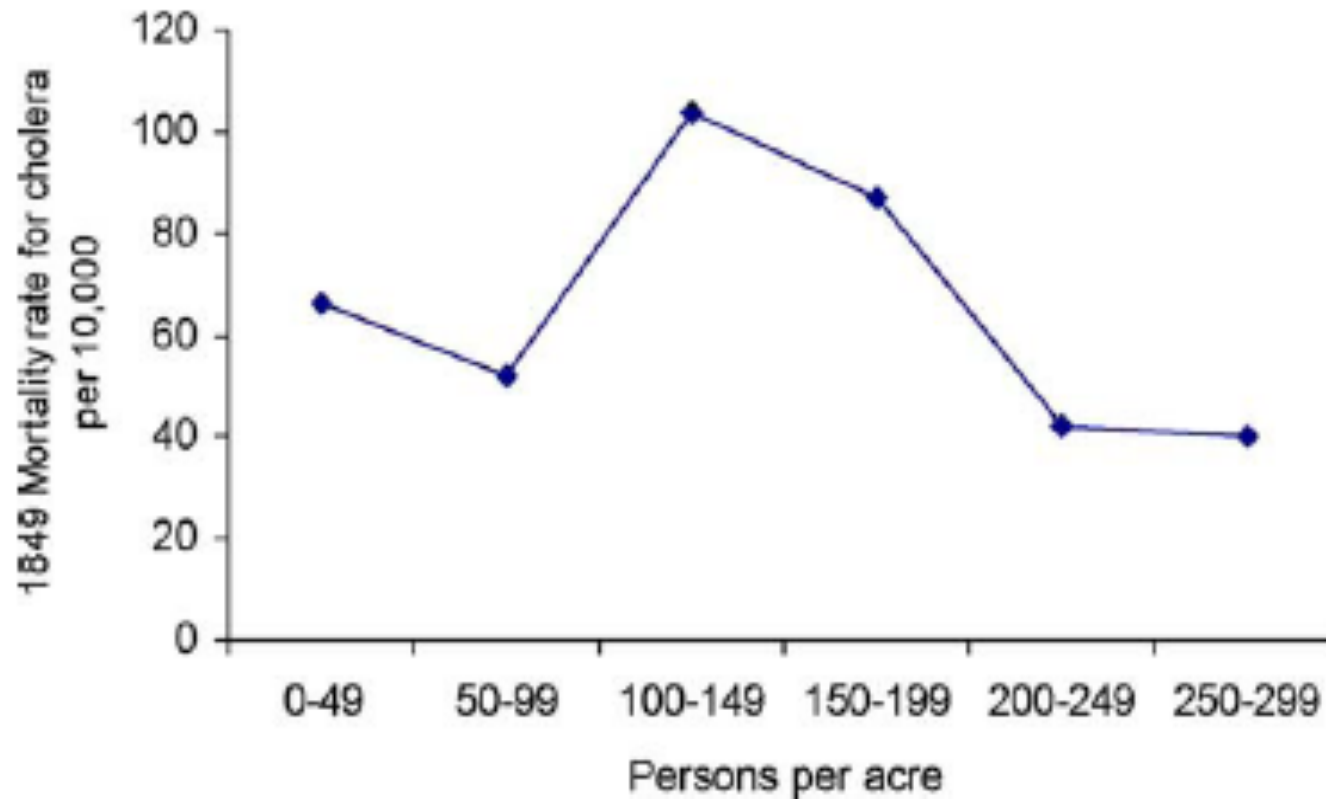


Figure 3 Death from cholera vs. persons per acre.

Source: P. Bingham, N.Q. Verlander, M.J. Cheal. Public Health (2004) 118, 387-394

Farr's Data

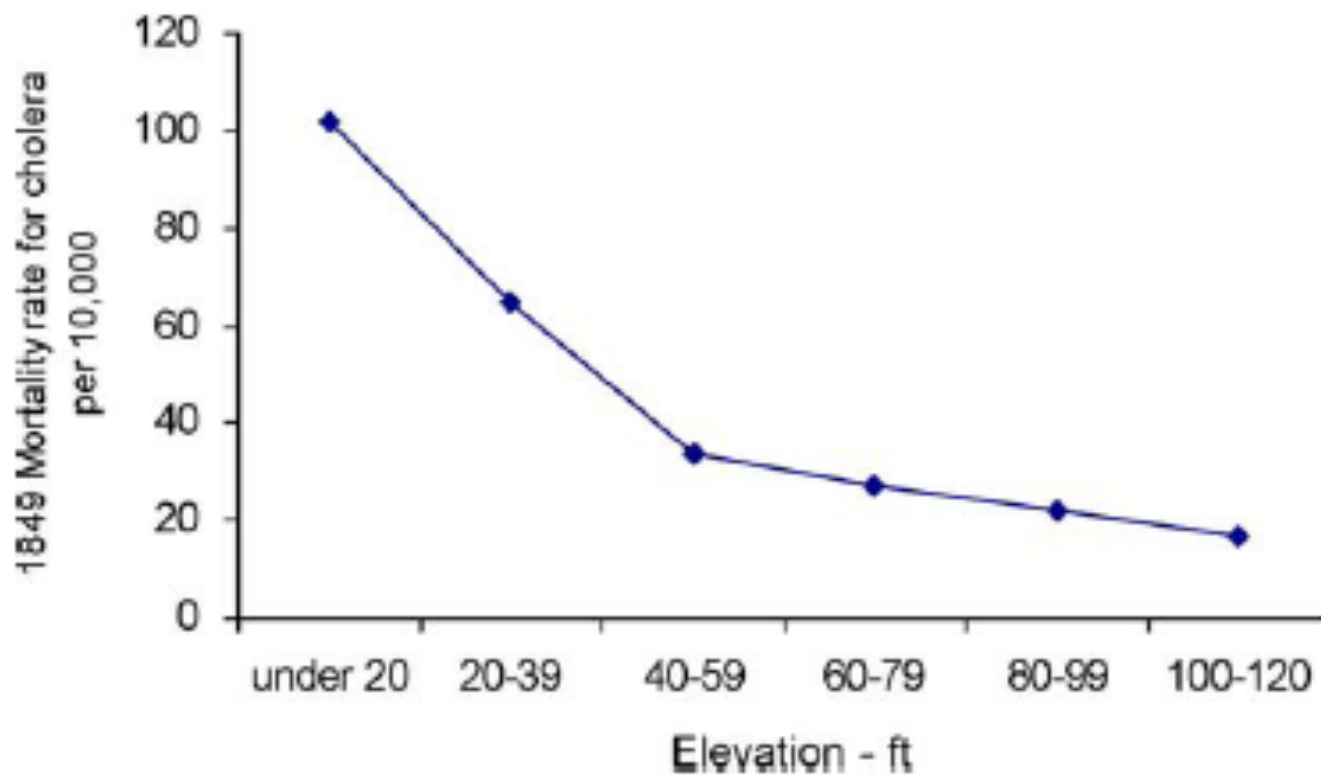


Figure 1 Death from cholera vs. elevation.

Source: P. Bingham, N.Q. Verlander, M.J. Cheal. Public Health (2004) 118, 387-394

Snow: Observations of Source Water

- Snow had noted that the two water supply companies, Lambeth Co. and Southwark and Vauxhall Co., were drawing water from Thames at a point downstream of London
- This water was heavily polluted – a likely source of infection



Snow: “The Grand Experiment”

- Before the 1854 epidemic, the Lambeth Company moved their water intake point upstream of London
- Snow decided to compare deaths from cholera in households served by the two different companies
 - Walked door-to-door to determine the water source for each house

Snow: Comparison of Mortality Rates

- July 9th to August 26th, 1854
- Mortality much higher in households that were supplied with drinking water from the Southwark and Vauxhall Company

Districts with Water Supplied by	Population (1851 Census)	Deaths from Cholera	Cholera Death Rate per 1,000 Population
Southwark and Vauxhall Co. only	167,654	844	5.0
Lambeth Co. only	19,133	18	0.9
Both companies	300,149	652	2.2

Snow: Epidemic in Golden Square

- In addition to noting role of the water companies, Snow also described the epidemic that hit the Golden Square area of London
- He determined where cholera cases lived and worked and created a map



 pumps

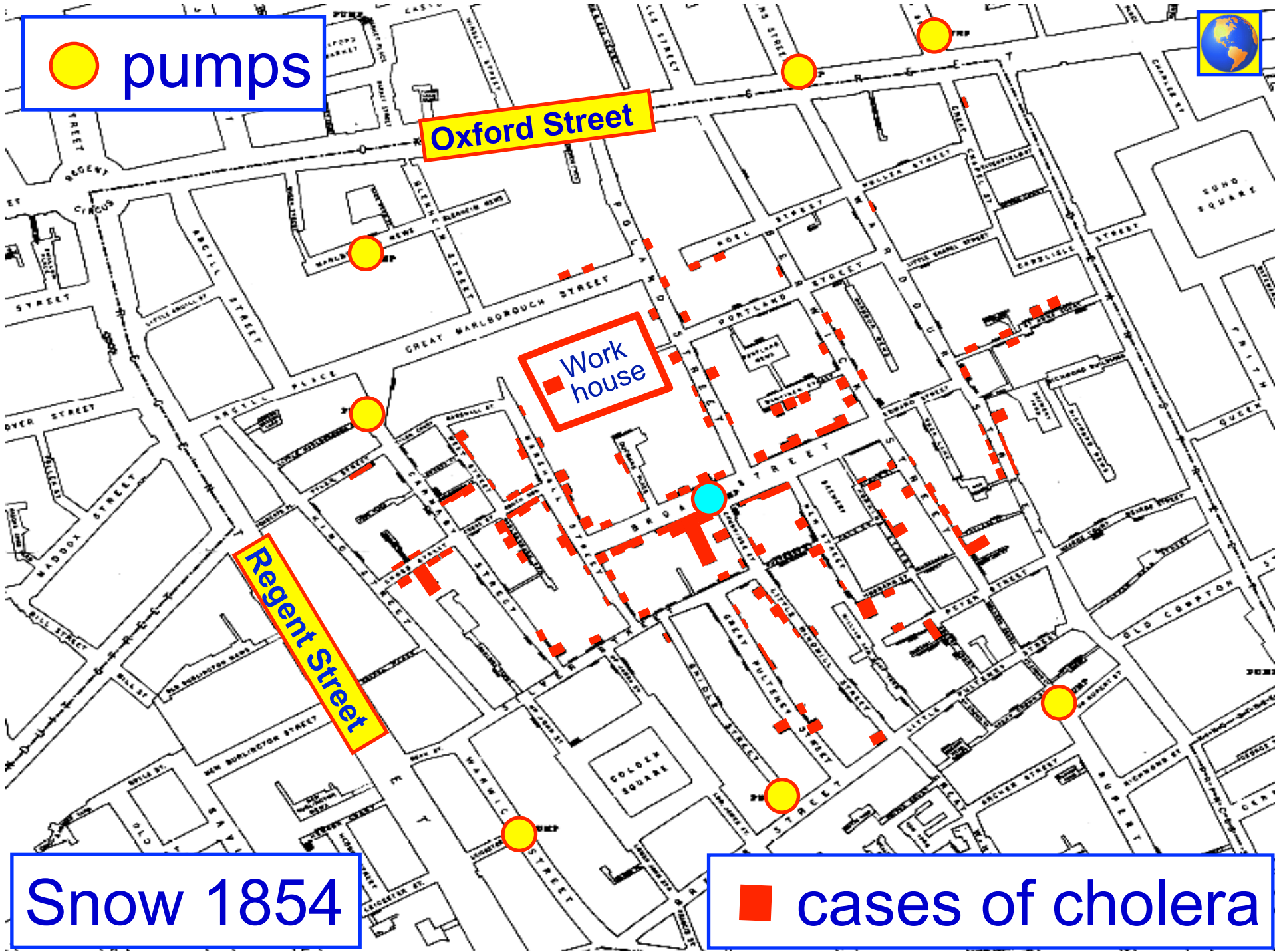
Oxford Street

Work house

Regent Street

Snow 1854

 cases of cholera



Snow: Hypothesis generation

- Since Snow believed water was the source of infection, he also plotted water pumps on map
- More of the cases were clustered around the Broad Street pump, than around other pumps

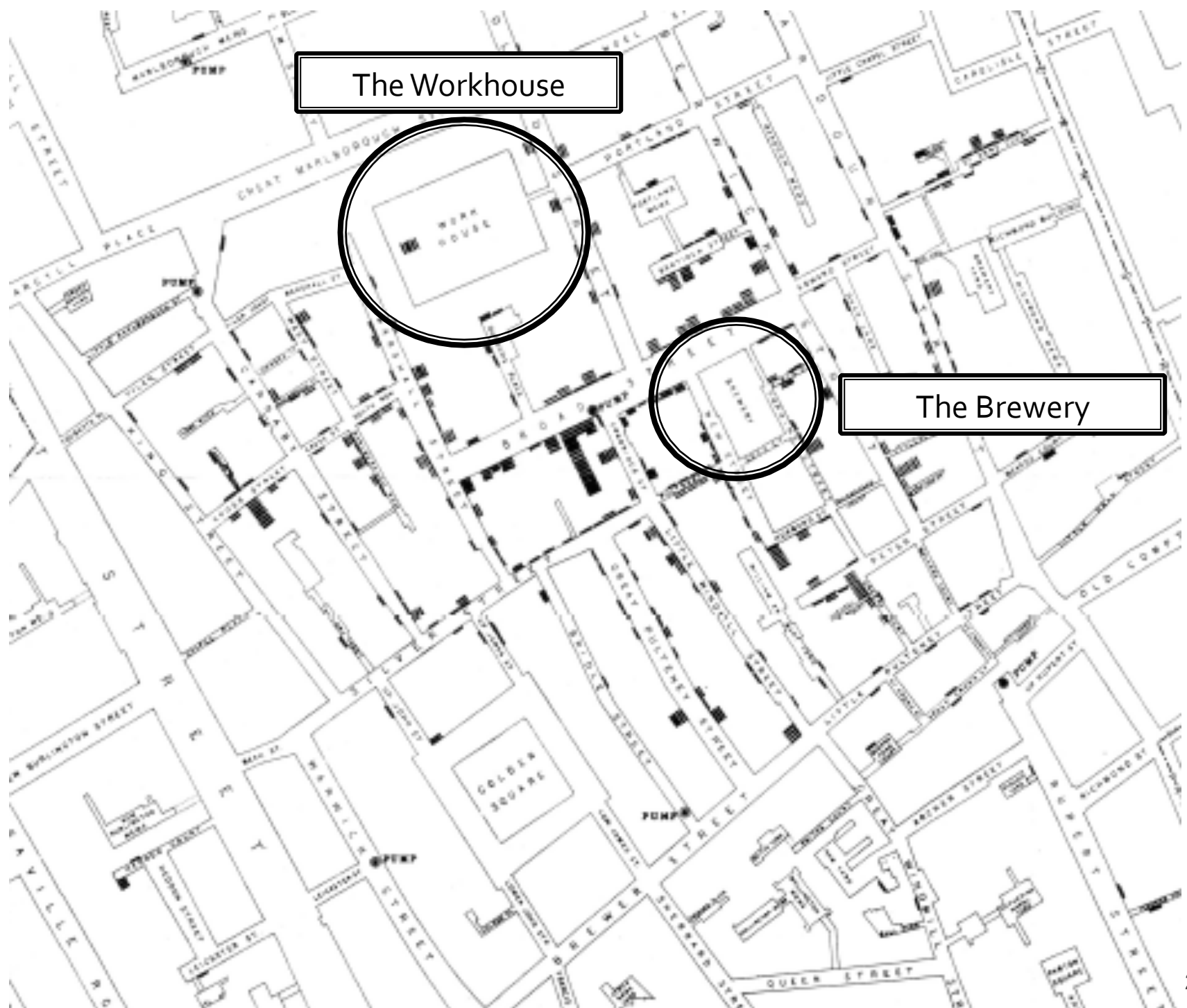


Snow: Investigating Anomalies in the Data

- Although these findings provided more support for his theory, he noted that there were relatively few cases in 2 of the blocks near the pump
- He conducted more field epidemiology to characterize that neighborhood

Snow: Factors protective against disease

- The work house
 - A large work house in the area had a deep well that served as the only source of drinking water
- The brewery
 - A nearby brewery also supplied its workers with a daily allotment of beer



The Workhouse

The Brewery

Snow: Public Health Action

- Snow took these findings to the appropriate health authorities and, as the story goes, removed the handle from the Broad Street pump
- Shortly afterwards, the cholera epidemic subsided



“Why is it, then, that Dr. Snow is so singular in his opinion? Has he any facts to show in proof? No.....The fact is, that the well whence Dr. Snow draws all sanitary truth is the main sewer. In riding his hobby very hard, he has fallen down through a gully-hole and has never since been able to get out again”

- The Lancet (editorial)

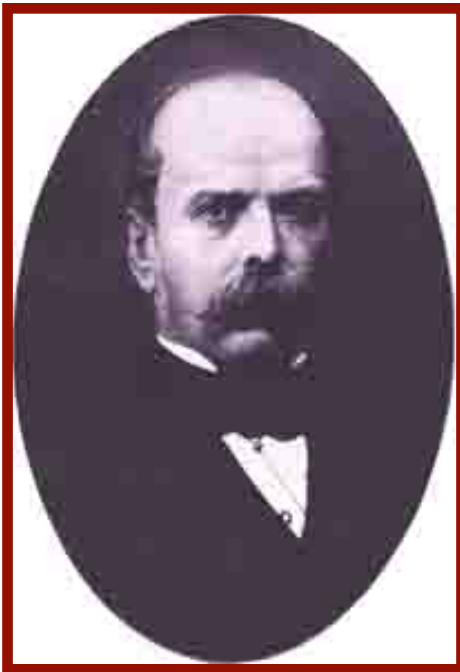
source: The Ghost Map, by Stephen Johnson 2006



Lancet 1858 Obituary column



DR JOHN SNOW—This well-known physician died at noon on the 16th instant, at his house in Sackville-street, from an attack of apoplexy. His researches on chloroform and other anaesthetics were appreciated by the profession.



In 1854 Filippo Paccini published 'Microscopical observations and pathological deductions on cholera' in which he discovered a comma-shaped bacillus which he called Vibrio, and described the organism and its relation to the disease.



Advice to young epidemiologists

Never make a calculation until you know the answer. Make an estimate before every calculation, try a simple biological argument (R_0 , generation time, selection, survival, control). Guess the answer to every puzzle. Courage: no one else needs to know what the guess is. Therefore, make it quickly, by instinct. A right guess reinforces this instinct. A wrong guess brings the refreshment of surprise. In either case, life as an epidemiologist, however long, is more fun.

Plagiarised from E.F. Taylor and J.A. Wheeler *Space-time Physics* 1963