Historical Evolution of Epidemiology

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History of Epidemiology

Seven land marks in the history of Epidemiology:

1) **Hippocrates (460BC):** In his essay entitled "On Airs, Waters, and Places,": Environment & human behaviors affect health. Used rational approach instead of supernatural viewpoint.
2) **John Graunt (1662): Quantified births, deaths and diseases** (Statistician, founder of demography in London).
3) **James Lind (1747): Scottish naval doctor, treated scurvy among sailors with fresh fruit (lemons)**…first Clinical trial in history (Findings officially adopted by the navy in 1795).
4) **Sir Percival Pott (1775): observed chimney sweeps had high incidence of scrotal cancer (due to contact with soot). He recommended that chimney sweeps bathe once a week.**

History…

4) William Farr (1839): Established application of vital statistics to evaluate health problems…Founder of medical statistics.

5) John Snow (1854): tested a hypothesis on the origin of an epidemic of cholera in London.

6) Alexander Louis (1872): French physician, Systematized application of numerical thinking (quantitative reasoning and clinical trials).

7) Sir Bradford Hill (1965): Suggested criteria for establishing causation.

Epidemiology flourished as a scientific discipline in 1940s

John Snow (1813–1858)

- An English physician and modern-day father of epidemiology
- He used scientific methods to identify the cause of the epidemic of cholera in London in 1854
- He believed that it was the water pump on Broad Street that was responsible for the disease
  - The removal of the pump handle ended the outbreak

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Photo source of portrait: http://www.ph.ucla.edu/epi/snow/fatherofepidemiology.html. Public Domain

Cholera Outbreak in London, 1854

John Snow conducted a series of investigations in London. Snow conducted his classical study in 1854 when an epidemic of cholera developed in the golden square of London.

During the time of microscope development, snow conducted studies of cholera outbreak both to discover the cause of cholera and how to prevent its recurrences.

During that time Farr and Snow had major disagreement about the cause of cholera. Farr adhered to what was called the miasmatic theory of diseases, according to this theory, which was commonly held at that time, diseases were transmitted by a miasma or a cloud with bad smell that clung low on the earth surface.

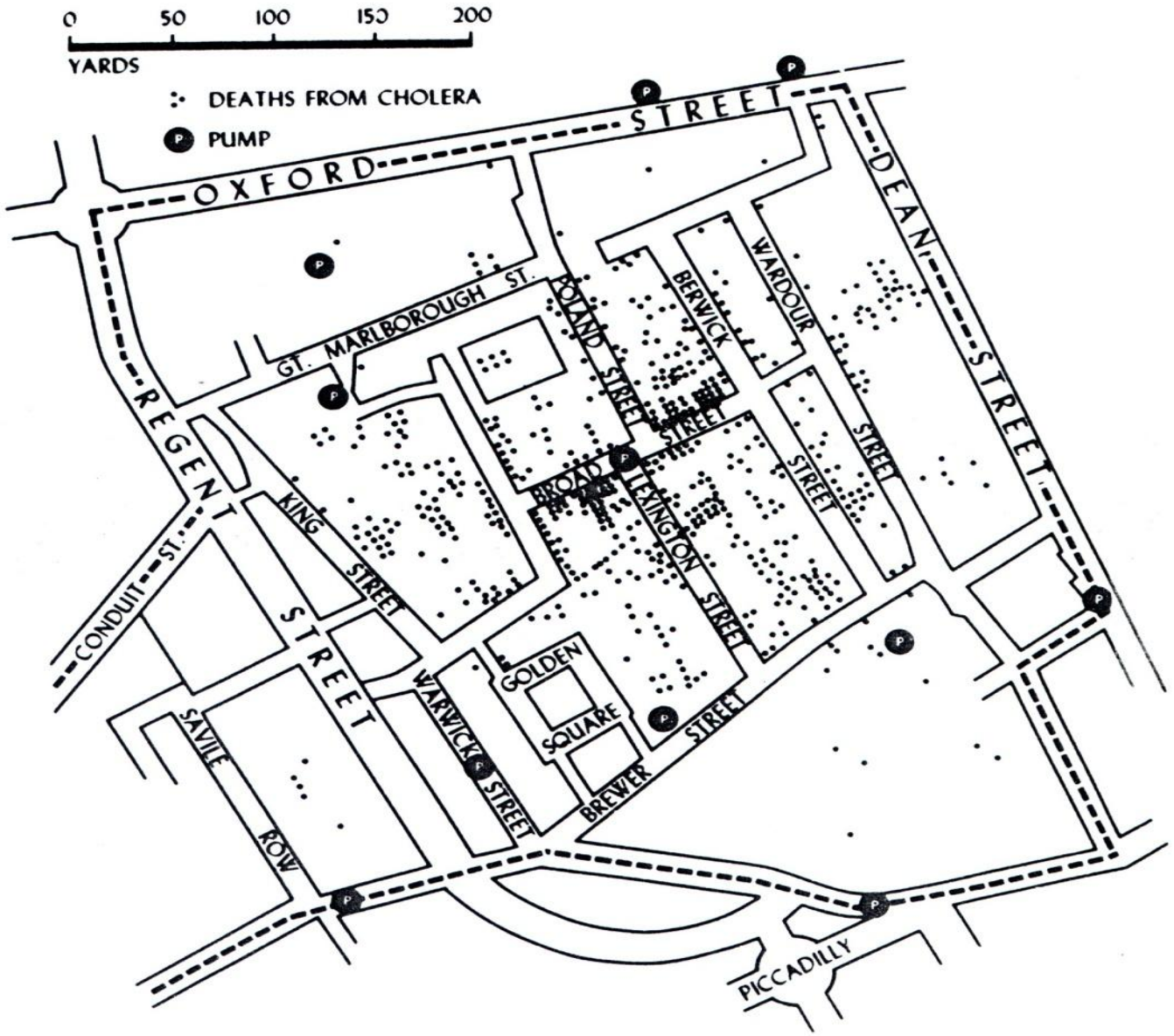
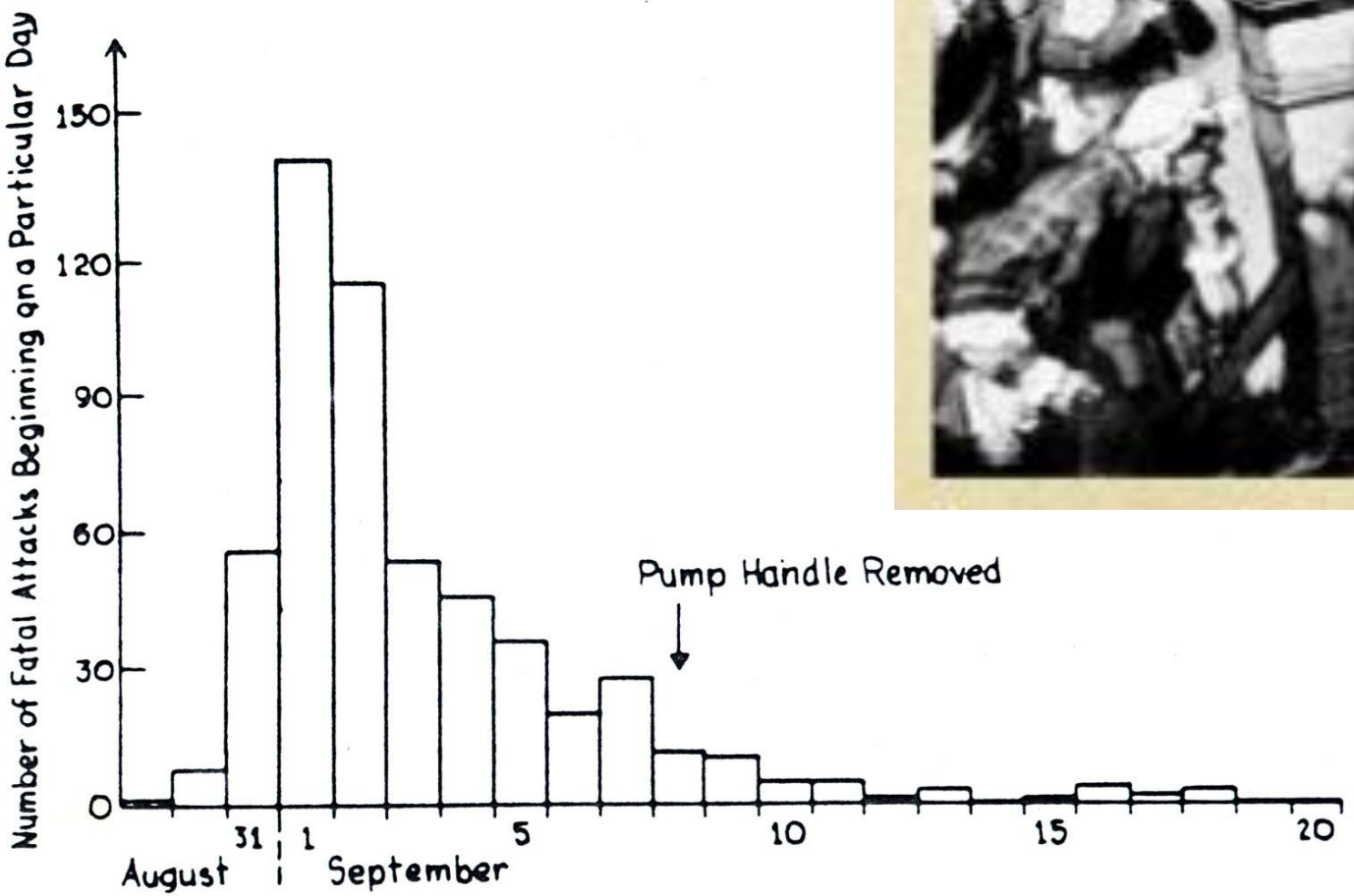


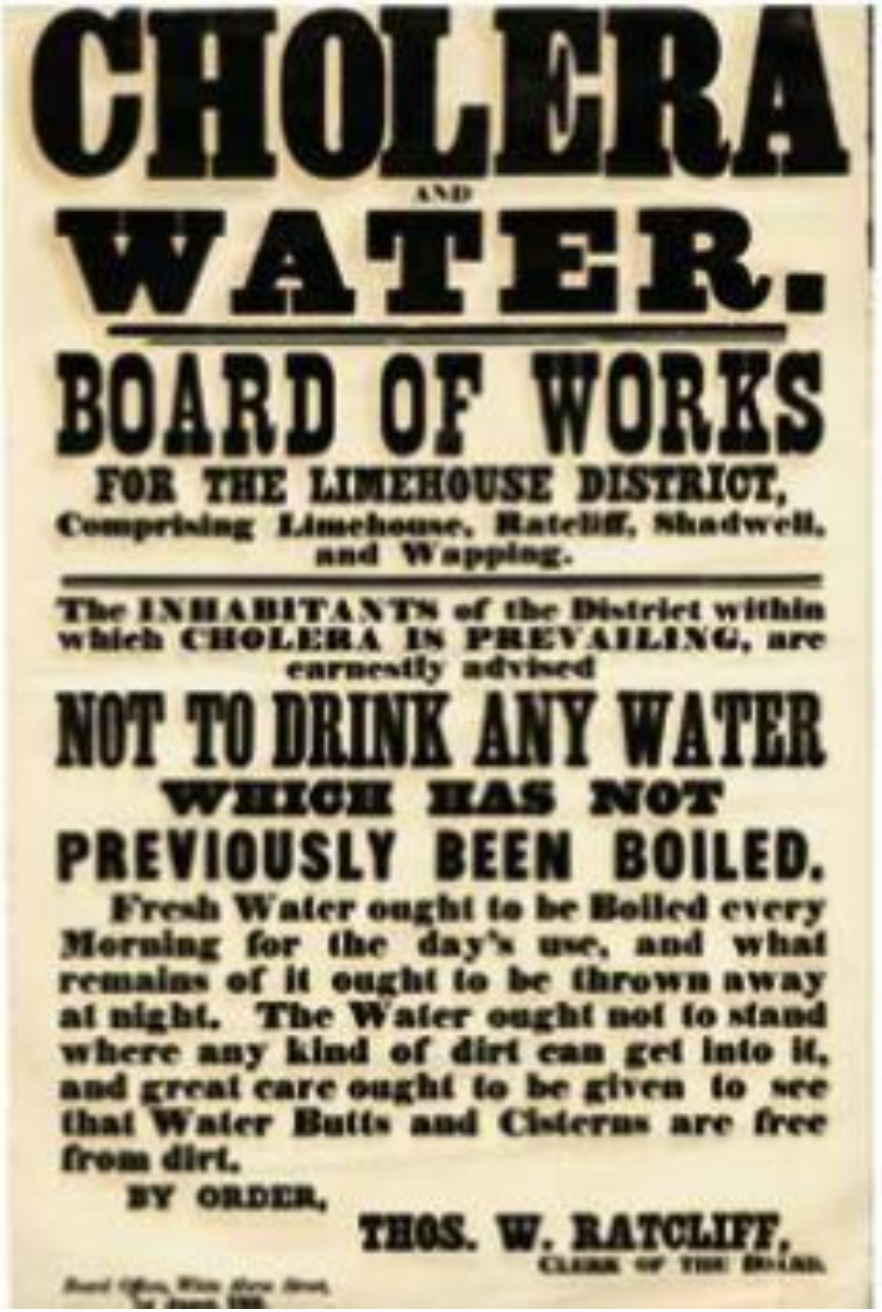
Figure 5-4 John Snow's Map of Cholera Deaths in the Soho District of London, 1848. *Source:* Adapted from *Health Care Delivery: Spatial Perspectives* by G. Shannon and G.E.A. Dever, p. 3, McGraw-Hill Book Company, 1974, and from *Some Aspects of Medical Geography* by L.D. Stamp, p. 16, Oxford University Press, 1964.

Cholera Outbreak in London, 1854

- However, Snow did not agree, he believed that cholera is transmitted through contaminated water. He began his investigation by determining where in this area in London persons with cholera lived and worked. He then used this information to map for distribution of diseases.
- Snow believed that water was the source of infection for cholera. He marked the location and searched the relationship between cases and water sources (water pumps).
- He found most cases clustered around the Broad Street pump.
- So, he decided to break the pump handle, which stopped the outbreak.
- He found that cholera was transmitted through contaminated water. This was a major achievement in epidemiology.



Snow's Epidemic Curve



CHOLERA AND WATER.

BOARD OF WORKS

FOR THE LIMEHOUSE DISTRICT,

Comprising Limehouse, Ratcliff, Shadwell, and Wapping.

The INHABITANTS of the District within which CHOLERA IS PREVAILING, are earnestly advised

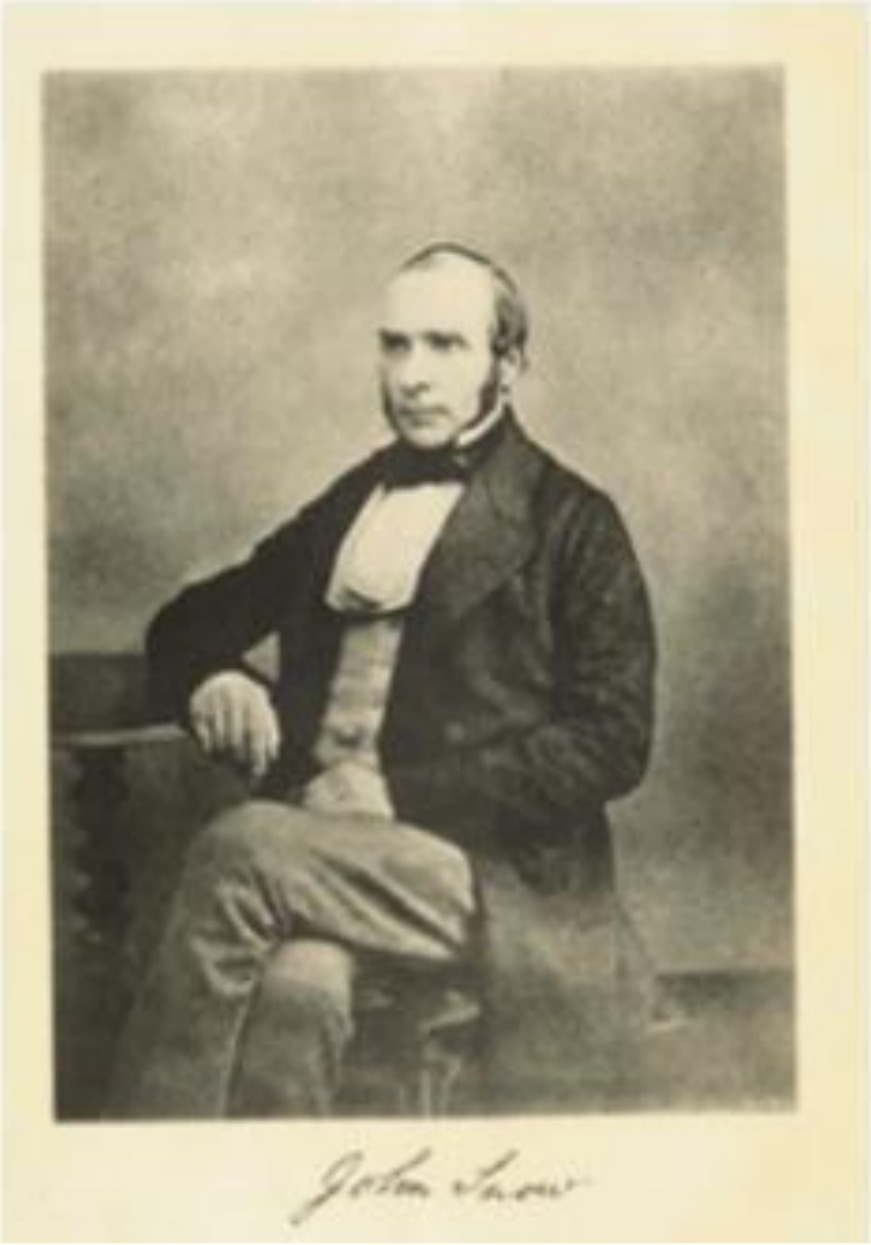
NOT TO DRINK ANY WATER

WHICH HAS NOT PREVIOUSLY BEEN BOILED.

Fresh Water ought to be Boiled every Morning for the day's use, and what remains of it ought to be thrown away at night. The Water ought not to stand where any kind of dirt can get into it, and great care ought to be given to see that Water Butts and Cisterns are free from dirt.

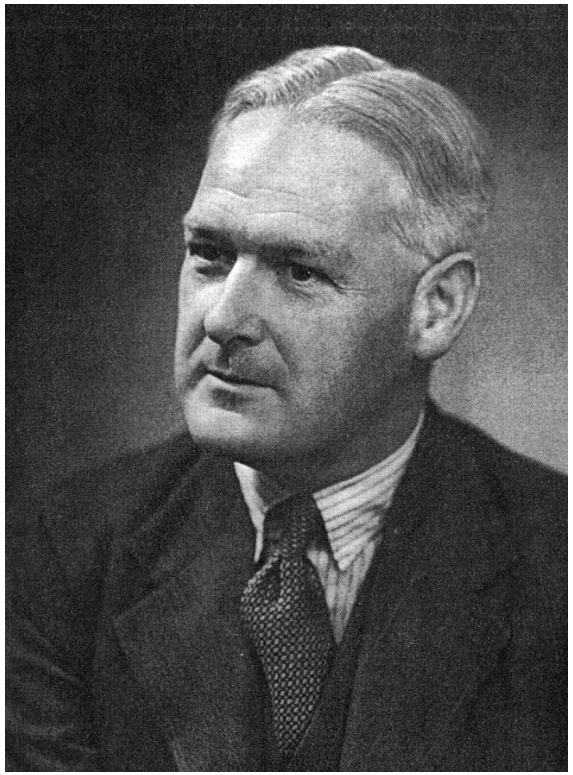
BY ORDER,

THOS. W. RATCLIFF,
CLERK OF THE BOARD.



Sir Austin Bradford Hill, 1965

- *In what circumstances can we pass from [an] observed association to a verdict of causation? Upon what basis should we proceed to do so?*



Guidelines for judging whether an association is causal

Hill's Criteria: Nine criteria useful in establishing epidemiologic evidence of a causal relationship between a presumed cause and an effect:

1. **Temporality:** cause precedes effect.
2. **Strength of association**: large relative risk.
3. **Consistency**: repeatedly observed by different persons, in different places, circumstances, and times.

Guidelines for judging whether an association is causal

4. **Biological gradient (dose response):** larger exposures to cause associated with higher rates of disease. And reduction in exposure is followed by lower rates of disease (reversibility).
5. **Biological plausibility**: makes sense, according to biologic knowledge of the time.
6. **Experimental evidence.**
7. **Other criteria: Analogy** (cause & effect relationship already established for a similar exposure or disease).
8. **Coherence** (not seriously conflict with the generally known facts of the natural history and biology of the disease).
9. **Specificity** (one cause lead to one effect) and

Framingham Study, Started 1948

What is the Framingham study?

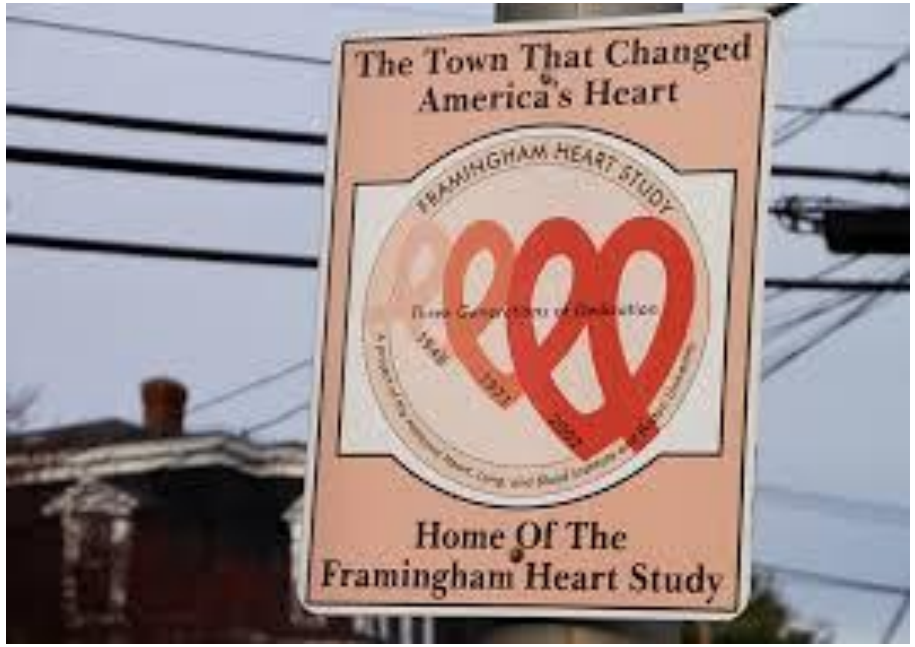
Where did it start?

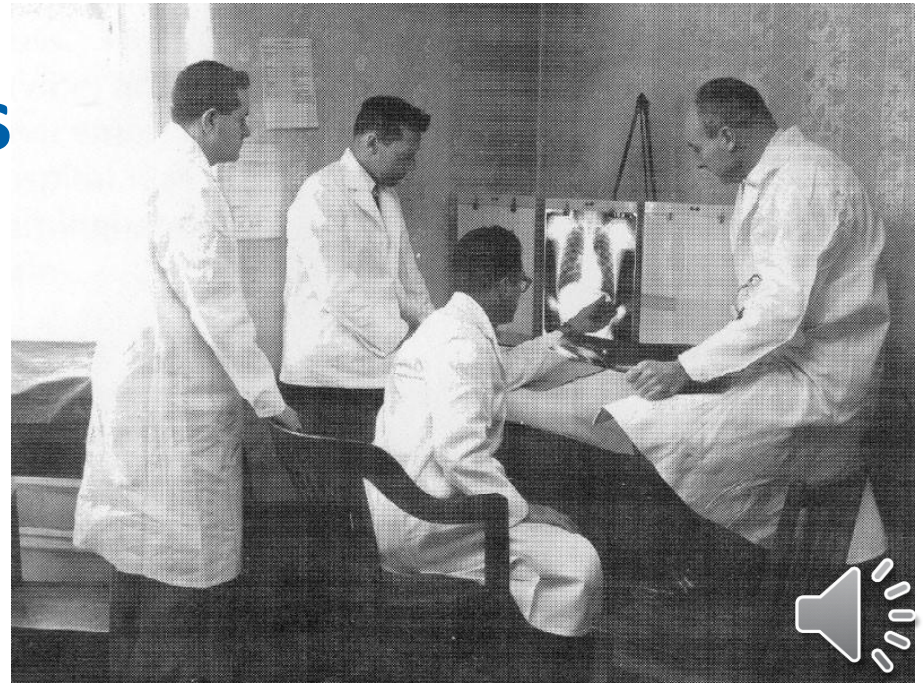
What was the disease studied?

What are the most important findings

How many people participated?

When did it end?





Doll and Hill study, 1950

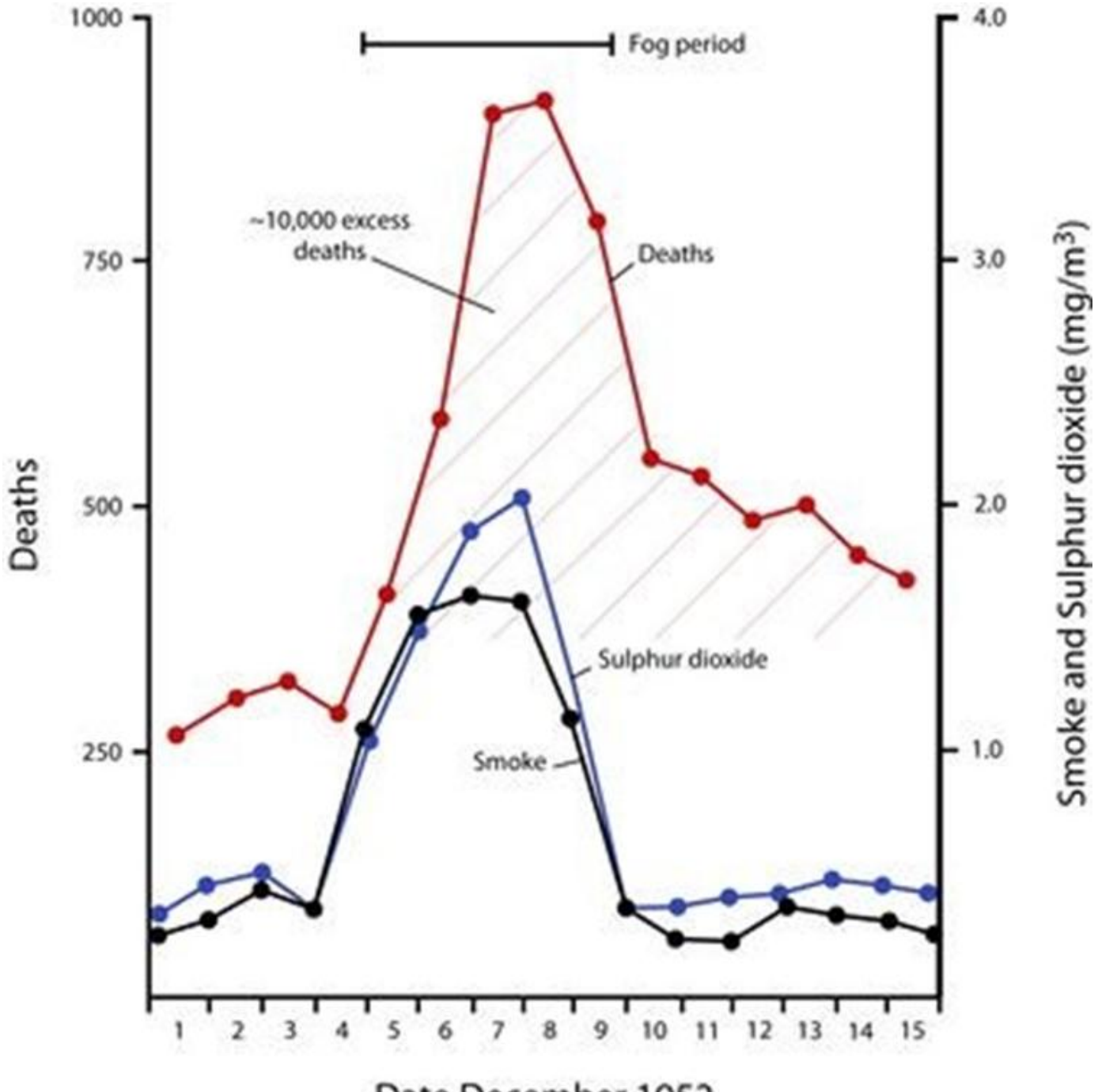
Richard Doll and Bradford Hill:

One of the first large scale epidemiological studies to establish a link between smoking and lung cancer.

(British Doctors' study in 1951): provided conclusive evidence that led to changing public perception and government policy regarding smoking.

London Smog Disaster, 1952

- Air pollution causes respiratory illnesses and death.
- When fog and soot from coal burning created a dense smog in Winter, 1952, in London, the smog was around for five days from December 5–10.
- There was a substantial increase in mortality
- The death rate in London in the previous week was around 2,062
- In the week of the smog, 4,703 died


Fog period
~10,000 excess deaths
Deaths
Sulphur dioxide
Smoke
Deaths
Smoke and Sulphur dioxide (mg/m3)
1000
750
500
250
4.0
3.0
2.0
1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Epidemiology and Polio Vaccine

In April, 1955, Dr. Thomas Francis, director of Poliomyelitis Vaccine Evaluation Center at the University of Michigan, announced that the two-year field trial of the Salk vaccine against polio was up to 90% effective

“The results announced by Francis effectively marked the beginning of the end of polio as the most life-threatening and debilitating public health threat to the children of the United States“.

Breast cancer screening (Swedish two country trial)

- Screening with mammography was started in 1977 in the counties of Kopparberg and Ostergotland.
- The results at 29-year follow-up: A substantial and significant reduction in breast cancer mortality was associated with an invitation to screening (31% lower mortality rate in women diagnosed via mammography).
- At 29 years of follow-up, the number of women needed to undergo screening for 7 years to prevent one breast cancer death was 414

Mysterious virus in the Four Corners Region of US

An outbreak of sudden respiratory illness occurred in the Four Corners region of the southwestern U.S. in 1993

- In similar outbreaks in 1918 and 1936, there was an increase in the number of mice in the region due to the abundance of pi-on nuts (from pine trees), (food for rodents) brought on by increased rainfall
- Epidemiologic study confirmed the connection between rodents and households with sick occupants

Mysterious virus in the Four Corners Region of US

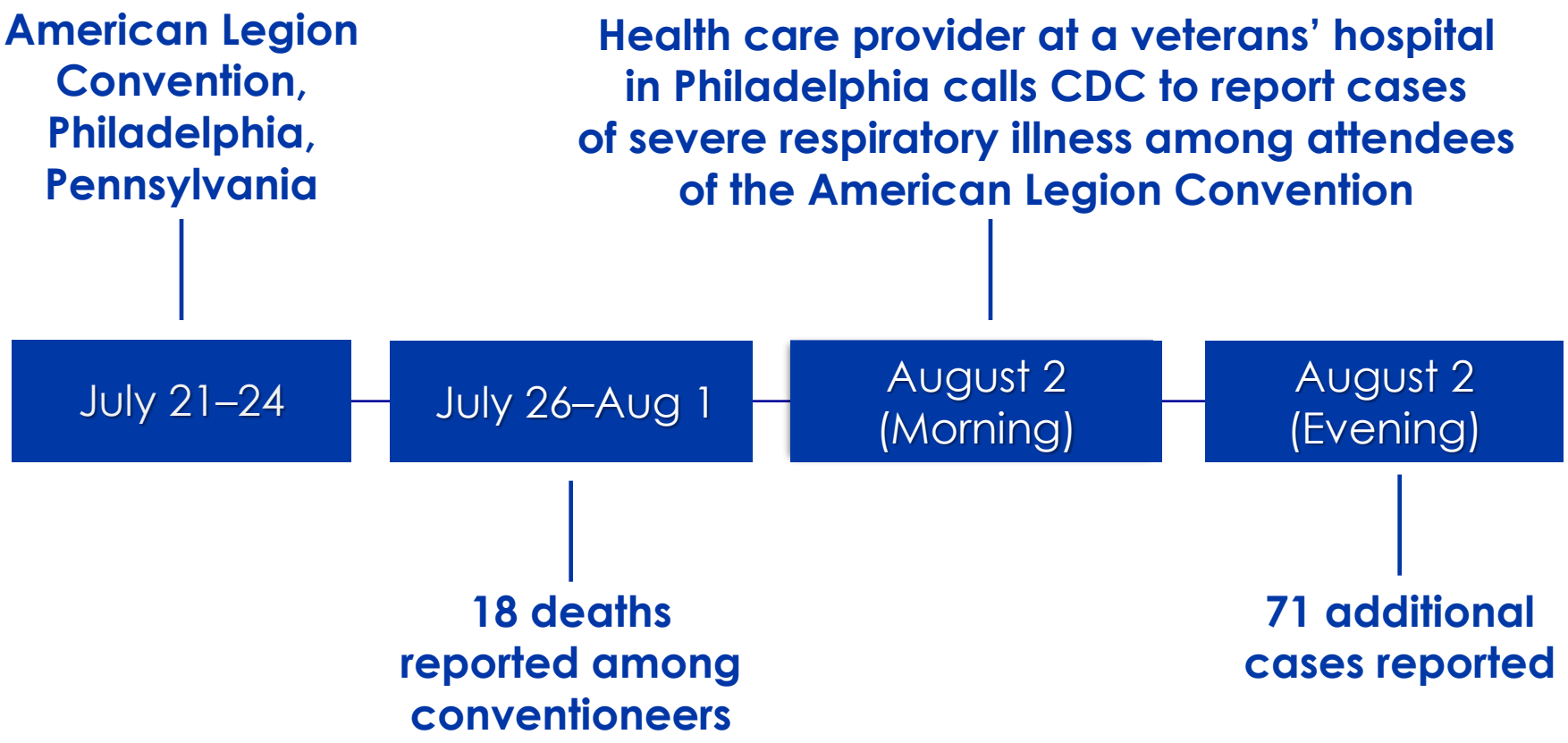
Hanta virus was discovered in rodents that excreted the virus in their feces and urine

- People inhaled the dust particles that contained the virus and became ill (hantavirus pulmonary syndrome)
- To prevent the spread of the virus:
  - Mice-proof the home
  - Wear a mask while sweeping in the home
  - Wash the floor with an antiseptic solution

Legionnaire's disease outbreak

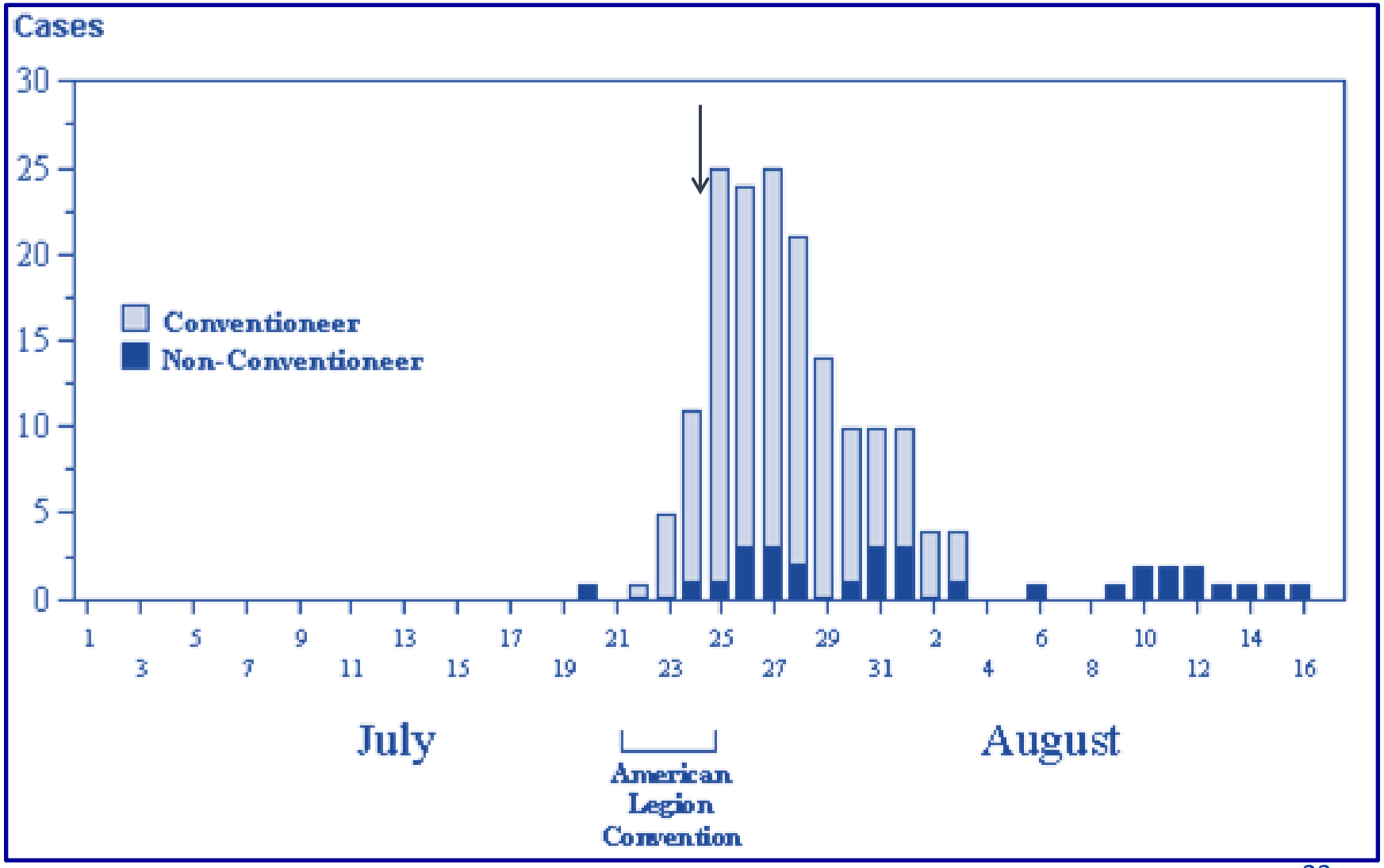
- Members of the American Legion gathered for the annual American Legion Convention held July 21 through 24, 1976, in Philadelphia.
- Soon after the convention began, a substantial number of attendees were admitted to hospital emergency departments or were examined in doctors' offices with acute onset of fever, chills, headache, malaise, dry cough, and muscle pain.
- More troublesome is that during July 26 to August 1, a total of 18 conventioneers died, reportedly from pneumonia.
- On the morning of August 2, a nurse at a veterans' hospital in Philadelphia called CDC to report cases of severe respiratory illness among convention attendees.
- Subsequent conversations that day with public health officials uncovered an additional 71 cases among persons who had attended the convention.
- The goal was to find out why these conventioneers were becoming ill and, in some cases, dying!!!

Legionnaire's disease outbreak



Fraser DW, Tsai, T, Orenstein W, et al. Legionnaires' disease: description of an epidemic of pneumonia. New Engl J Med 1977;297:1189–97.

Legionnaires' Disease Cases, by Day



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Legionnaires' Disease Attack Rates by Place

	Hotel A			Hotel B			Hotel C		
Age (yrs)	Ill	Total	Percent ill	Ill	Total	Percent ill	Ill	Total	Percent ill
≤39	3	44	6.8	3	116	2.6	6	160	3.7
40–49	9	160	5.6	11	232	4.7	20	392	5.1
50–59	27	320	8.4	25	523	4.8	52	843	6.2
60–69	12	108	11.1	19	207	9.1	31	315	9.8
≥70	11	54	20.4	5	76	6.5	16	130	12.3
Unknown	0	2	0	0	7	0	0	9	0
Total	62	688	9.0	63	1,161	5.4	125	1,849	6.8

Those who stayed in Hotel A have the highest percentage of illness — 9.0% versus 5.4% and 6.8 at other hotels (% Ill in Hotel A= 62 / 688 = 9.0%).

The age group that has the highest percentage of ill persons is those aged 70 years or older (% Ill in >70y in Hotel A = 11 / 54 = 20.4%)

Legionnaires' Disease Rate by Age Group

Hotel A Residents

Time: July 21–24, 1976

	Frequency	Unit	Rate
Age (yrs)	Sick	Total	Percentage
≥39	3	44	6.8
40–49	9	160	5.6
50–59	27	320	8.4
60–69	12	108	11.1
≥70	11	54	20.4
Unknown	0	2	0

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Legionnaires' Disease

The age group that has the highest percentage of ill persons is those aged 70 years or older, regardless of where they were staying.

Combining all age groups, those who stayed in Hotel A have the highest percentage of illness — 9.0% versus 5.4% at other hotels.

We can infer, therefore, that a connection exists between staying in Hotel A and becoming ill; we can also infer that older persons are somehow more susceptible to the disease.

Legionnaires' Disease

- Five months after the first cases of Legionnaires' disease occurred, results of the case-control study indicated that spending time in the lobby of Hotel A was a risk factor for illness
- In January 1977, the *Legionella* bacterium was finally identified and isolated and was found to be breeding in the cooling tower of the hotel's air-conditioning system; the bacteria then spread through the building whenever the system was used.
- Similar bacteria grew in warm waters in nature, such as hot springs, and also had been identified in air-conditioning cooling towers.
- The finding from this outbreak investigation lead to development of new regulations worldwide for air conditioning systems.