EarthDate

Mapping a Killer

John Snow's 1854 map of cholera deaths in Soho, London, helped reveal that contaminated water from a single pump was spreading the disease. The map became one of the earliest and most influential examples of using data and geography to track an epidemic.

Credit: By after John Snow - Unknown sourceTransferred from en.wikipedia to Commons., Public Domain, https://commons.wikimedia.org/w/index.php?curid=403247

In the mid-1800s, London's SoHo neighborhood was a terrible smelling place to live, as raw sewage ran through the gutters into open cesspools. When a cholera epidemic broke out, 600 people died and many remaining residents fled, fearing – as was common then – that foul air spread the disease.

Local physician John Snow didn't buy it. Ten years earlier, he had proposed that cholera spread through contaminated water. But lacking proof, he was ignored. With an outbreak on his doorstep, he saw an opportunity to test his hypothesis – and save his neighborhood.

First, he obtained the addresses of every person who had died. Then he walked the streets plotting the deaths, and everything else, on a map. Soon a pattern emerged. Most of the cases clustered around one public water well.

He began interviewing area residents. Locals with their own private wells had not gotten sick. Workers at a nearby pub, who drank a daily ration of beer instead of pump water, were also spared.

Snow convinced local authorities that water from the well was to blame, and persuaded them to remove the pump handle, forcing residents to draw their water elsewhere. Immediately the cholera outbreak ended.

With his cholera map, Snow had begun the field of evidence-based epidemiology. This was well before germ theory and microscopes could identify the true culprit, the cholera bacteria, that had spread through sewage leaking into the water supply.

I'm Scott Tinker.

Background: Mapping a Killer

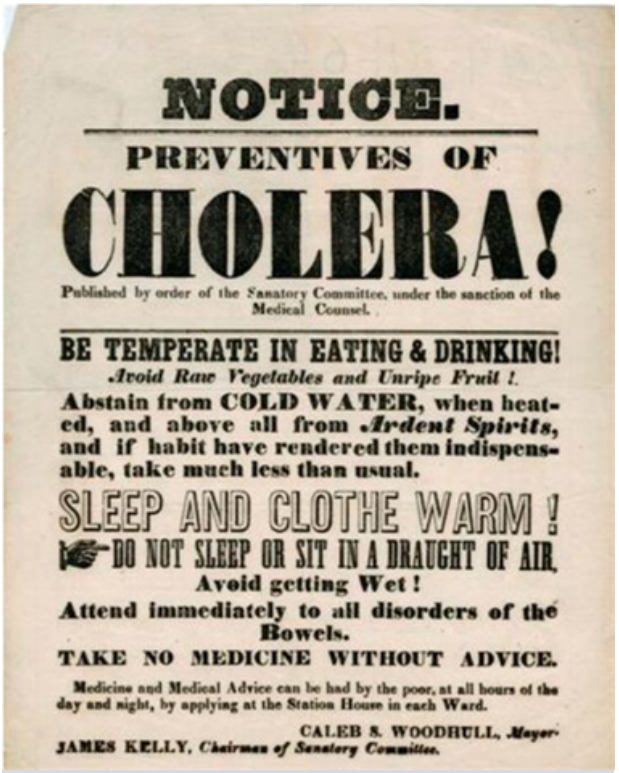
Synopsis: In 1854 London, a deadly cholera outbreak was blamed on "bad air." But when physician John Snow mapped the deaths around a single water pump on Broad Street, a new pattern emerged. His evidence-based investigation helped launch modern epidemiology and marked a pivotal shift from received wisdom to empirical science.

London, 1854

- The Soho district was densely packed with people and with smells. Smoke and emissions from factories thickened the air, mingled with raw sewage that ran through the streets and seeped from poorly built cesspools.
- In late August, people began dying. Entire households were wiped out within a matter of days. Many of the deaths clustered along Broad Street, and nearly three-quarters of the residents fled in fear.
- The diagnosis was cholera. Victims suffered sweating, vomiting, and profuse "rice-water" diarrhea. In just ten days, more than 600 people died in this working-class neighborhood.
- Most believed the cause was the foul air or "miasma," as they called it.
- But why were so many deaths centered on Broad Street?
- One physician was determined to find out.

Miasma: The Belief in Bad Air

- For generations, disease was believed to spread through "bad air," regardless of the illness. The theory, known as miasma, held that poisonous vapors rising from decay and filth caused sickness.
- The belief was widespread and influential.
  - In 1844, a professor writing in The Builder asserted that, "From inhaling the odour of beef, the butcher's wife obtains her obesity."
  - Two years later, English social reformer Edwin Chadwick reported to a Parliament that "…all smell is disease."
  - Even Florence Nightingale argued that houses built over drains allowed odors to escape and infect the residents with illnesses such as scarlet fever, measles, and smallpox.


NOTICE.

PREVENTIVES OF

CHOLERA!

Published by order of the Sanatory Committee, under the sanction of the Medical Counsel.

BE TEMPERATE IN EATING & DRINKING!

Avoid Raw Vegetables and Unripe Fruit !.

Abstain from COLD WATER, when heated, and above all from *Ardent Spirits*, and if habit have rendered them indispensable, take much less than usual.

SLEEP AND CLOTHE WARM !

DO NOT SLEEP OR SIT IN A DRAUGHT OF AIR.

Avoid getting Wet !

Attend immediately to all disorders of the Bowels.

TAKE NO MEDICINE WITHOUT ADVICE.

Medicine and Medical Advice can be had by the poor, at all hours of the day and night, by applying at the Station House in each Ward.

CALEB S. WOODHULL, *Mayor.*

JAMES KELLY, *Chairman of Sanatory Committee.*

An 1849 Cholera prevention poster by the Sanatory Committee, under the sanction of the Medical Counsel, in New York City. The poster reflects the widespread belief in miasma; such guidance assumed that cold or foul air caused disease rather than contaminated water.

Credit: By CNX OpenStax - http://cnx.org/contents/GFy_h8cu@10.53:rZudN6XP@2/Introduction, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=49924891

- Public health efforts reflected this thinking. Ventilation became a priority.
  - Newly invented ventilators were required on British ships and factories were mandated to provide enough "window and openings…to insure a proper supply of fresh air."
  - Aromatic bonfires were lit to purify the air.
  - Individuals carried perfume, incense, and nosegays, small bundles of flowers, to mask offensive smells.

Background: Mapping a Killer

- Miasma theory was not irrational. Disease did more often occur in filthy, overcrowded areas where the air truly was foul.
  - When cities removed waste and improved drainage, illness sometimes declined. From observation alone, bad smells and disease appeared linked.
- What was not yet understood was that these sanitation efforts often reduced the contamination of water supplies, interrupting the actual pathway of infection.
- The explanation fit what people could see and smell. But it did not explain every pattern.

John Snow: From Assumption to Evidence

- John Snow was born into a working-class family in 1813, but through apprenticeship and formal training he built a respected medical practice in London. By 1854, his office stood just minutes from Broad Street.
- A decade earlier, Snow had proposed that cholera spread through contaminated water rather than bad air. But lacking proof, his theory was largely dismissed.
- Now, faced with a deadly outbreak close to home, Snow saw an opportunity to test his hypothesis.
- He began at the Register General's office, identifying who was dying. Then he walked the neighborhood, recording addresses and marking them on a street map. Houses, businesses, and public water pumps were carefully plotted. Each death was a data point.
- As the marks accumulated, a pattern emerged. The densest cluster centered on the public water pump on Broad Street.
- Snow did more than map locations. He interviewed residents, doctors, and survivors. Those who lived far from Broad Street but drank from the pump fell ill. One former resident even had the water delivered to her home; both she and her visiting niece died.
- Meanwhile, nearby households with private wells were spared.

This illustration is from the time of another cholera epidemic in 1866 LondonIt shows there was growing acceptance that death came from unclean water provided via public pumps as discovered by Dr John Snow during the 1854 epidemic

Credit: By George John Pinwell - Fun (Magazine), 18 August 1866, Public Domain, https://commons.wikimedia.org/w/index.php?curid=159105486

- Workers from a local alehouse, given a daily allotment of beer instead of pump water, suffered no deaths.
- The evidence suggested a common source.
- Armed with his map, later known as the "ghost map," Snow urged the parish officials to remove the pump handle, disabling access to the well.
- The outbreak soon subsided, and Snow's evidence was compelling. But it did not instantly overturn decades of belief. Many officials remained committed to the idea that bad air caused disease.
- It would take years, and the rise of germ theory, before waterborne transmission was widely accepted.

Background: Mapping a Killer

The Root Cause: Subsurface Pathways

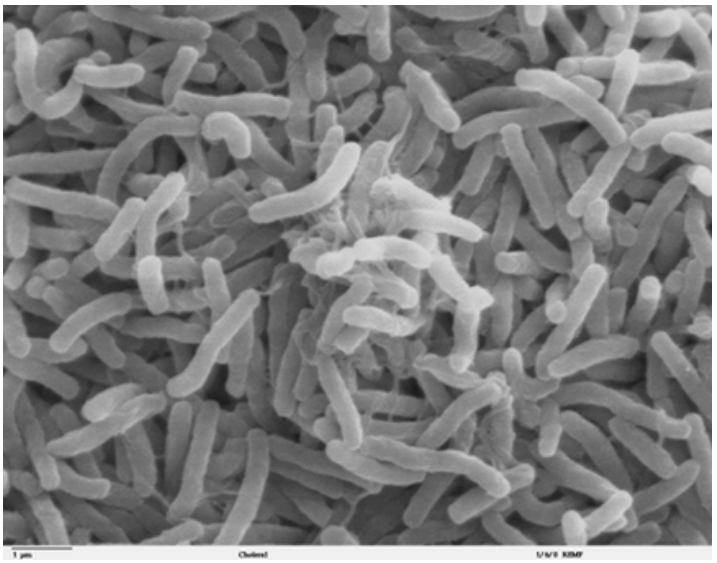
- The Broad Street pump did not draw water from a pristine underground spring. Like many London wells at the time, it tapped shallow groundwater beneath crowded city streets.
- Nearby, only a few feet away, stood a brick-lined cesspit that collected household waste. The lining was cracked, and liquid waste seeped into the surrounding soil.
- Soil is not solid rock but a mixture of mineral particles and porosity (open pores). Water moves through the pores. In some soils, the movement is slow, which can allow the soil to filter out some contaminants. In others, especially in disturbed urban ground, contaminated water can travel more freely.
- Beneath Broad Street, wastewater carrying cholera bacteria percolated downward, then flowed laterally into the well's water supply.
- The pump concentrated that contamination and delivered it directly to households. What seemed like a clean, refreshing source of water was in fact connected, invisibly, to human waste only yards away.
- John Snow did not know the name of the bacterium responsible. He did not have a microscope that could see the Vibrio cholerae organism.
- But he did not need to identify the organism to identify the pathway. His map revealed that the disease followed the water.

Variation of John Snow's 1854 map of the Soho cholera outbreak. Broad Street sits at the center, where death marks cluster densely around the public water pump. Other pumps are marked with X's, yet far fewer deaths occurred near wells such as the one by Golden Square, revealing a striking pattern that pointed to a single contaminated source.

Background: Mapping a Killer

Building Evidence

- Many officials remained skeptical and miasma theory did not disappear overnight. Snow published his finding, but acceptance was slow.
- It would take decades, and the laboratory work of scientists such as Louis Pasteur and Robert Koch, to firmly establish that microscopic organisms cause disease. Germ theory provided the biological mechanism Snow lacked. His ghost map had pointed to the environmental route long before the microbe was isolated.
- What Snow demonstrated was more than the source of a single outbreak. He showed that patterns could be measured, mapped, and tested. He transformed scattered tragedy into data.
- From that moment, the study of disease shifted from inherited explanation to empirical evidence.
- The killer in Soho was not the air. It was the water moving silently beneath the streets. Once that pathway was traced, a new scientific discipline began to take shape, built not on received wisdom but on evidence.



Scanning electron microscope image of Vibrio cholerae, the bacterium that causes cholera. Invisible in 1854, this microbe traveled through contaminated water to the Broad Street pump, confirming decades later the pathway John Snow first mapped.

Credit: Copyrighted free use, https://commons.wikimedia.org/w/index.php?curid=197609

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Fact Sheet:
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