Classic paper presentation

John Snow, Cholera, the Broad Street Pump; Waterborne Diseases Then and Now

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BACKGROUND

The 18th–19th centuries brought industrialization and large-scale population migration into cities of Europe including London. One result of this demographic shift was overcrowding in poor housing, served by inadequate or nonexistent public water supplies and waste-disposal systems. In London, the introduction of sewers and flushing toilets directly draining into the Thames led it to becoming an open stinking sewer, due to high tides and strong winds pushing seawater upstream. These conditions resulted in repeated outbreaks of water-borne diseases such as cholera, dysentery, tuberculosis, typhoid fever, influenza, yellow fever, and malaria, and other infectious diseases, as well as the loss of the fishing industry.

Cholera is an acute diarrhea caused by infection with the bacterium, *Vibrato cholera*. It is endemic in over 50 countries and also the cause of large epidemics. Since 1817, cholera spread rapidly throughout the world

John Snow was born in 1813 in York, England, the first of nine children. His father was a laborer and later a farmer. John saw unsanitary conditions in his hometown with a river contaminated by town sewage. As a medical apprentice from age 14, he experienced a cholera epidemic in a coal-mining village. Snow vowed to resist drink, gambling and marriage, and became a vegetarian. At age 23 he began medical studies and graduated from the University of London in 1844. John Snow, a physician now considered a founding father of modern epidemiology was the personal anesthetist to Queen Victoria and founding member of the London Epidemiological Society. In 1848, Snow was developing his anesthesia practice in the cholera afflicted district when he

The Report of the Committee on Scientific Inquiries in Relation to the Cholera Epidemic of 1854 concluded that:

> *"Either in air or water it seems probable that the infection can grow. Often it is not easy to say which of these media may have been the chief scene of poisonous fermentation; for the impurity of one commonly implies the impurity of both; and in considerable parts of the metropolis (where the cholera has severely raged) there is rivalry of foulness between the two."*

When the next cholera epidemic struck London from August to September, 1854, primarily in the Soho area adjacent to Broad Street, Snow investigated it and traced some 600 cholera deaths occurring in a 10-day period. He was struck by the observation that the cases either lived close to or were using the Broad Street pump for drinking water. He also determined that brewery workers and poorhouse residents in the area, both of whom relied on local wells, escaped the epidemic. Snow concluded that access to uncontaminated water prevented them from cholera infection, while users of the Broad Street pump became infected. He persuaded the doubtful civic authorities to remove the handle from the Broad Street pump, and the already subsiding epidemic disappeared within a few days.

The Broad Street Pump, John Snow Memorial, Broadwick Street (formerly Broad Street) in, London.

As noted in Snow's report on cholera:

"The most terrible outbreak of cholera . . . took place (in London) in Broad Street, Golden Square, and the adjoining streets, a few weeks ago . . . there were upwards of five hundred fatal attacks of cholera in ten days. The mortality . . . probably equals any that was ever caused in this country, even by the plague; and it was much more sudden, . . . The mortality would undoubtedly have been much greater had it not been for the flight of the population . . . in less than six days . . . the most afflicted streets were deserted by more than three-quarters of their inhabitants."

"There were a few cases of cholera in the neighborhood of Broad Street, Golden Square, in the latter part of August; and the so-called outbreak which commenced in the night of 31 August and the 1st September, was, in all similar instances only a violent increase of the malady. I suspected some contamination of the water of the much-frequented pump in Broad Street . . . but on examining the water. I found so little impurity in it of an organic nature . . . I requested . . . to take a list, at the General Registrar's Office, of the deaths of cholera, registered during the week ending 2nd September . . . Eighty-nine deaths from cholera were registered during the week, in the three sub-districts."

"I found that nearly all the deaths had taken place within a short distance of the pump . . . With regard to the deaths . . . there were sixty-one instances in which I was informed that the deceased persons used to drink the water from Broad Street, either constantly or occasionally. . ."

"The Workhouse in Poland Street is more than three-quarters surrounded by houses in which deaths from cholera occurred, yet out of five hundred and thirty five inmates, only five died of cholera . . . The Workhouse has a pump-well on the premises, in addition to the supply from the Grand Junction Waterworks, and the inmates never sent to the Broad Street for water. If the mortality in the Workhouse has been equal to that in the streets immediately surrounding it . . . upward of one hundred persons would have died."

"There is a brewery in Broad Street, near the pump, and . . . no brewer's men were registered as having died of cholera, . . . above seventy workmen employed in the brewery, none of them had suffered from cholera . . . at the time the disease prevailed. The men . . . do not drink water at all . . .. There is a deep well in the brewery, in addition to the New River water."

"The result of the inquiry then was that there has been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking water of the above-mentioned pump-well. I had an interview with the Board of Guardians of St. James parish, . . . the handle of the pump was removed the following day."

The cholera epidemic, which was already declining, fell off and disappeared once the pump usage stopped. As a result of this episode, Benjamin Disraeli, together with other members of Parliament, adopted the plan of the Thames Authority and passed legislation forcing the overhaul of London's water and sewage systems, which after completion, contributed to the nonreturn of cholera.

Snow's pioneering epidemiologic investigation proved the mode of transmission of a waterborne disease that ravaged many parts of the world in the 19th century and still occurs in the 21st century. The *V. cholera* organism was originally grown in 1854 but was reported in local Italian medical literature and not recognized internationally. International recognition for the definitive identification and growth of the organism during his investigation of an epidemic of cholera in Egypt was given to the eminent German bacteriologist, Robert Koch in 1883. Filipo Pucini was ultimately recognized for the discovery in 1984 when the organism was formally named *Vibrio choleraeae pucini 1854*. Robert Koch was the discoverer of anthrax in 1880, and tuberculosis in 1882, and leader in defining criteria for causation of infectious diseases; he was awarded a Nobel Prize in Medicine in 1905 (see Chapter 7).

The Broad Street pump episode demonstrated that cholera was water-borne and thus the means to prevent it had already been identified almost 30 years before. Snow also established the basic methodology of modern public health for infectious disease investigation and contributed to establishing the validity of the Germ Theory, which was still highly controversial at this time.

The disinfection of drinking water through both filtration and chlorination processes has been one of the major achievements of public health. Clean water was responsible for nearly half the total mortality reduction in major cities, three-quarters of the infant mortality reduction, and nearly two-thirds of child mortality reduction.

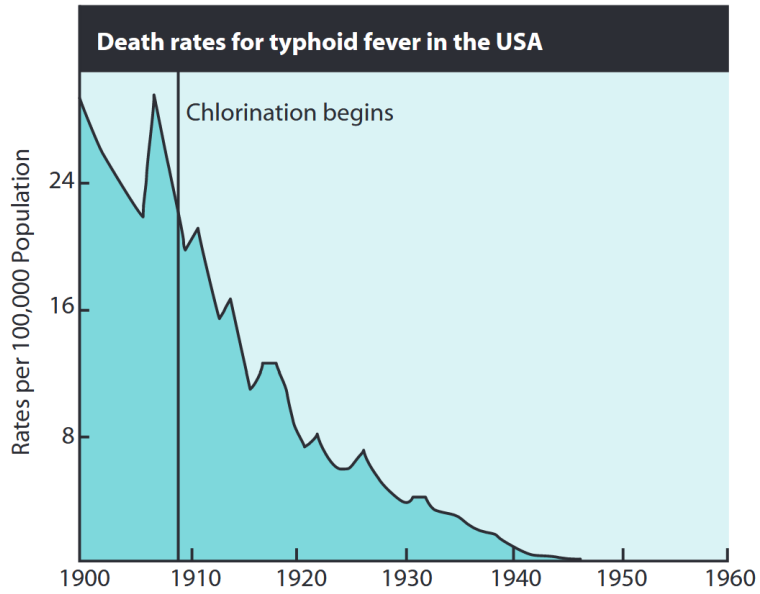


FIGURE 5.1 US mortality rates for typhoid fever and water chlorination. *Source: Chlorine Chemistry Council (C3) and Canadian Chlorine Coordinating Committee (C4). Drinking water chlorination: a review of disinfection practices and issues. Adapted from US Centers for Disease Control and Prevention, Summary of Notifiable Diseases, 1997. Available at: http://www.waterandhealth.org/drinkingwater/wp.html (accessed 16 August 2016).*

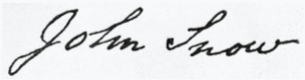
Today, waterborne disease is given less recognition, as standards of water and sewage treatment are assumed to be part of modern living. However, waterborne enteric disease continues to be among the major killers in many parts of the world, especially among children. Waterborne disease may be so common that it escapes detection in many countries, especially those where hepatitis (especially A and E) is endemic and where incidence of gastroenteritis from *shigella*, *Escherichia coli*, rotavirus, and many other enteric infectious agents remains high. Another example is *Helicobacter pylori*, the cause of chronic peptic ulcer disease and the recognized cause for gastric cancer. Helicobacter, which affects nearly half of the world's population and is related to poverty and poor hygiene is also waterborne.

Snow's brilliant, game-changing studies of cholera in 1854 earned him the title "the father of modern epidemiology." His work led directly to steps taken to improve water safety in London, setting new standards for other urban centers across the industrialized world, resulting in cholera, typhoid, and other enteric infectious diseases largely disappearing in many countries and saving of millions of lives over the years. Yet cholera, along with many other waterborne diseases, remains a serious challenge to public health with severe health, economic, and social effects globally particularly on the poorest populations, especially those in developing countries or in disaster situations in the 21st century.

BIOGRAPHY

Dr. John Snow (1813–58). London practicing obstetrician/anesthesiologist who conducted a detailed epidemiologic investigation of London cholera epidemic adjacent to the now famous Broad St. pump. *Courtesy: University of California at Los Angeles (UCLA) School of Public Health. Available at: http://www.ph.ucla.edu/epi/snow/snowcricketarticle.html*

Born	15 March 1813 York, England
Died	16 June 1858 (aged 45) London, England
Alma mater	University of London (MD)
Known for	Anaesthesia Locating source of a cholera outbreak (thus establishing the disease as water-borne)
	Scientific career
Fields	Anaesthesia Epidemiology
	Signature



Thank you