John Snow, MD: anaesthetist to the Queen of England and pioneer epidemiologist

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John Snow's accomplishments in medicine, anesthesia, and epidemiology constituted an achievement that changed the face of medical practice. He conducted translational research in his home laboratory that enabled him to understand the mechanisms of vaporizing volatile anesthetic agents—ether and chloroform—so that safe delivery systems of anesthesia could be designed. He brought obstetric anesthesia into acceptance against religious, ethical, and medical beliefs by administering chloroform to Queen Victoria for the births of Prince Leopold and Princess Beatrice. He mapped out the spread of cholera and developed a transmission theory based on his knowledge of respiratory physiology. He published his theory in an essay in 1849, where he described cholera to be a communicable disease spread by contamination of the water supply. He acted on his theory of water transmission and may have expedited the end of the Broad Street London epidemic by removing the handle of the local water pump.

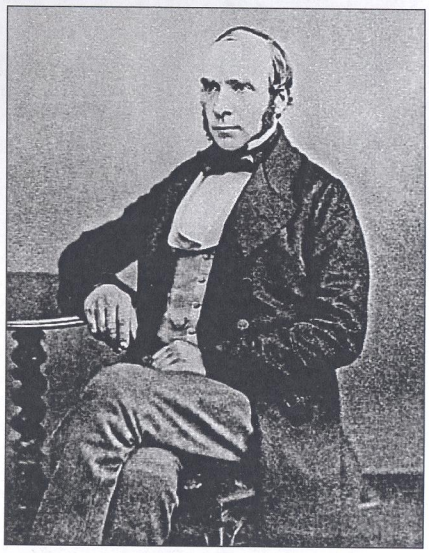

Figure 1. John Snow in the mid-1850s. Courtesy of the National Library of Medicine.

BIRTH AND EDUCATION

John Snow *(Figure 1),* the oldest of nine children of Francis and William Snow, a laborer, was born on March 15, 1813, in the city of York. He was baptized by the Rev. G. Brown, the minister of All Saints Church on North Street in Micklegate Ward. "Gate" was the medieval Danish word for street and a cultural reflection of the ninth-century influence of the Scandinavian invaders. Even today, the Snow family graveyard can be found alongside the church. York was a Roman walled city and became a northern English capital because it was positioned at the junction of two rivers, the Ouse and the Swale. During Snow's childhood, most of the streets in Micklegate were considered unsanitary. Inhabitants drew water from wells or directly from the rivers. The river water was contaminated by runoff from market squares, cesspools, cemeteries, and dunghills. Snow's early experiences with the effects of contaminated water may have laid the groundwork for his later concerns with the purity of the water supply.

In England, as early as the 16th century, university-trained physicians diagnosed and treated "internal" ailments, were recognized as true physicians, and were thus given the title "Doctor." Barbers and barber-surgeons were considered the manual workers of medicine, and they performed venesection and treated "external" conditions such as abscess. Apothecaries, who were originally merchants and retailers in spices, drugs, and medicinal compounds, sold medications and filled prescriptions from physicians. Apothecaries and surgeons kept the title of "Mister." James I chartered the Worshipful Society of Apothecaries of London in 1523—separating them from the Grocers Company. The barber-surgeons remained a city of London company. Then, in 1558, Henry VIII created the Royal College of Physicians of London. Finally, in 1800, the surgeons separated from the barbers and became the Royal College of Surgeons of London. Since that time, they have been located in Lincoln's Inn Fields. In 1843, the Royal College was given national jurisdiction and became the Royal College of Surgeons of England.

In 1827, at the age of 14 years, John Snow became an apprentice to William Hardcastle, a surgeon-apothecary in Newcastle-Upon-Tyne. During this time, he "walked the wards"

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Figure 2. Recent photograph of Snow's lodging in Frith Street marked by a historical marker on the wall above the street sign. Source: Frerichs RR. Photo tour of John Snow's London. Los Angeles: UCLA Department of Epidemiology, School of Public Health. Available at http://www.ph.ucla.edu/epi/snow/phototour1.html.

of Newcastle Infirmary. As an apprentice, he could not drink, gamble, or marry. Snow converted his views on temperance to teetotalism and eventually signed an abstinence pledge in 1835. He was also a vegetarian and, when possible, drank only distilled water that had been tested for purity.

On December 7, 1831, the first British epidemic of Asiatic cholera was confirmed, and it occurred right in Newcastle. Early the next year, the coal-mining village of Killingsworth was devastated by the outbreak. As a surgeon-apothecary apprentice, Snow treated many victims of the disease. By the time the epidemic waned later that year, several Newcastle physicians and surgeons had founded a medical school. John Snow was one of the eight students who enrolled. He already had 5 years of experience as a surgeon-apothecary apprentice and knew the required Latin and Greek.

MEDICAL TRAINING IN LONDON

By 1836, John Snow was ready to undertake the required university education so that he could add the title "Doctor" to his name. First, he went to Liverpool to visit his uncle Charles Empson—where he probably got financial support. From there, he walked the 400 miles to London. He enrolled in the Hunterian School of Medicine at 16 Great Windmill Street for a fee of £34. This medical school was founded by William Hunter, a British anatomist, in 1769. The Lyric Theater stands on this spot today. Snow rented a room at 11 Bateman's Building on Bateman Street in an alley that connected Soho Square to Queen Street.

At the Hunterian School of Medicine, John Snow was taught the emerging medical specialty of obstetrical medicine and obtained clinical experience at the Westminster Hospital, where he also "walked the wards." An advantage of this training was that if a patient died, a postmortem could be performed in the "dead room." At the time, bodies were often embalmed with arsenic for dissection. Many of the students became sick. John Snow set up a series of carefully designed experiments and was able to demonstrate that the inhalation of arsenic vapor caused these illnesses. He published his finding, and the result was a change in the practice of preserving bodies for anatomical dissection. This discovery also led to the discontinuation of the sale of candles laced with arsenic. Such candles burned brighter than regular candles, but they gave off toxic arsenic vapor as well.

Snow became a member of the Royal College of Surgeons in May 1838 and a licentiate of the Society of Apothecaries in October 1838, at the age of 25 years. However, although he could practice medicine as a surgeon, it wasn't until he obtained a bachelor of medicine degree from the University of London on November 23, 1843, that he could attach the prefix "Doctor" to his name. The completion of his doctorate required knowledge of French and Latin and proficiency in philosophy and logic. He was awarded his MD in 1844.

In his new lodgings at 54 Frith Street, Soho *(Figure 2),* Snow set up practice as a surgeon and general practitioner and excelled in the care and delivery of babies. Soho was one of Central London's most densely populated areas; 540 people resided in the 600-foot-long Frith Street. He remained at this address until 1852. During this time, he was very frugal, was a health enthusiast, dressed plainly, and remained a bachelor.

John Snow personally investigated a wide range of medical concerns. He connected the three realms of bedside, hospital, and laboratory medicine and became one of the early proponents of clinically relevant research. He identified respiration and asphyxia as his areas of expertise. He studied the effects of respiration on circulation and the chemistry and physics of inhaled gases, with a special interest in anesthetic gases and their application to midwifery. He developed a trochar and cannula that allowed tapping of the pleural space without allowing air entrainment. John Snow's first four publications were letters to the editor in *The Lancet* and *London Medical Gazette.* One of his first original papers was "On asphyxia, and on the resuscitation of still-born children," which was published in 1841.

John Snow, MD, was respected by his colleagues as an astute diagnostician. Snow joined the Westminster Medical Society (renamed the Medical Society of London in 1849), and this gave him a forum to discuss and debate his scientific endeavors. He attended weekly society meetings and often gave case reports. There were frequent hot debates among the society members, and Snow was heavily involved in these interactions. Richard Bright and William Addison were among the attendees at these meetings.

ANESTHESIA

On Saturday, December 19, 1846, a London dentist, James Robinson, demonstrated the administration of the anesthetic gas ether for the first time in England. A couple of months earlier, William T. G. Morton had demonstrated ether anesthesia on the other side of the Atlantic Ocean in Boston. As early as 1843, Snow had experimented with ether for promoting respiration in his self-made research laboratory on Frith Street. Ether gave John Snow the opportunity to bring his laboratory experience and clinical work to bear on a potent chemical whose properties were still mysterious. There were mixed reviews of

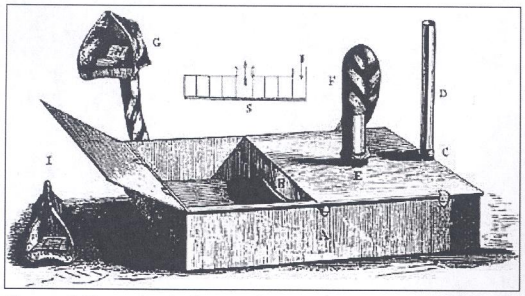


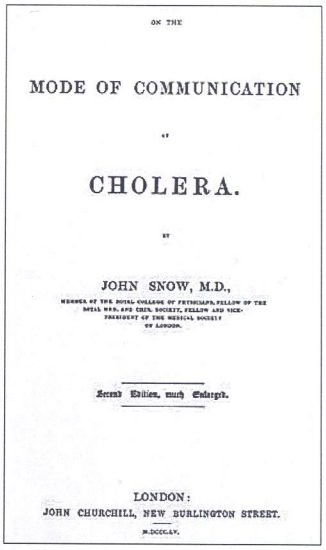
Figure 3. Engraving in Snow's 1847 book showing an apparatus for the application of ether.

the drug's efficacy because of its poor delivery system and physicians' lack of pharmacological understanding. Snow was able to introduce scientific principles into the arena of anesthesia administration. He designed an inhaler that would allow for the accurate, controlled delivery of ether while taking into account temperature changes *(Figure 3)*. In the USA, Morton struggled to patent ether but was unsuccessful. Snow never attempted to patent ether or any of the innovative apparatuses he designed but instead published clear descriptions so that others could copy his works.

Within 2 years of Robinson's demonstration, Snow was the most accomplished anaesthetist in the British Isles. Snow's expert administration of ether changed him from a struggling Soho general practitioner into an anaesthetist whose services were in constant demand by London's principal surgeons. In 1847, he published *On the Inhalation of Ether,* a practical guide for administration of the drug. He took a special interest in patients with respiratory disease and devised animal studies to test his hypotheses and then presented his findings at peer-reviewed meetings. He logged more than 5000 anesthetic procedures in 12 years of practice. The types of cases in order of frequency were dental extractions, lithotomy, lithotripsy, excision of breast tumors, treatment of hemorrhoids, repair of anal fistulae, repair of cleft lips, and anesthesia for childbirth.

Chloroform was introduced in 1847 by an Edinburgh obstetrician, James Young Simpson. John Snow studied chloroform much as he had studied ether. He soon realized that accuracy of delivery and patient monitoring were even more important when administering chloroform than when administering ether because chloroform was much more potent. On January 28, 1848, a 15-year-old girl named Hannah Greener presented for the surgical resection of a toenail and was administered chloroform, which had been poured onto a tablecloth and held to her face. The procedure was done at her home. She rapidly became pulseless and died. Snow investigated this death and the deaths that followed. In what was one of the first peer reviews in anesthesia, Snow concluded that Hannah's death was the result of the uncontrolled administration of chloroform via a saturated cloth—the first recorded death due to anesthesia—and that scientifically engineered vaporizers should be used instead. He published his conclusions in a letter to *The Lancet* and even published the first treatise on chloroform.

The use of anesthetics for relief of pain in obstetric patients was considered unethical by many medical leaders and general society. The Church of England preached against its use. However, on April 7, 1853, Queen Victoria asked John Snow to administer chloroform analgesia for the delivery of her eighth child, Prince Leopold. This was such a success that it was repeated for the delivery of Princess Beatrice 3 years later. Obstetrical anesthesia now had the royal blessing, and medical and religious acceptance soon followed.


ON THE

MODE OF COMMUNICATION

OF

CHOLERA.

BY

JOHN SNOW, M.D.,

Second Edition, much Enlarged.

LONDON:
JOHN CHURCHILL, NEW BURLINGTON STREET.

Figure 4. Treatise published by John Snow.

EPIDEMIOLOGY

When the second pandemic of Asian cholera reached London in the autumn of 1848, John Snow's understanding of respiratory physiology led him to question the predominant theories about the transmission of this lethal disease. The prevailing theory of the mid-1800s was that cholera was an airborne infection that was concentrated at low levels of altitude where the air—and thus the disease—settled. Miasmatists blamed cholera on bone merchants and workers in slaughterhouses, knacker's yards, and other offensive trades, whose foul-smelling odors were thought to be closely involved in transmission. Snow used his knowledge of inhalational anesthetics to argue that if inhalation of miasmus was the mechanism of transmission, then the workers most closely involved in offensive trades would be prime targets—and that was not the case. Based on scientific data that he collected, he determined that cholera could be transmitted only by swallowing "morbid matter" specific to the disease.

Snow conducted the world's first epidemiological study on the differential mortality of cholera in 32 London subdistricts. In August 1848, Snow published his findings supporting the

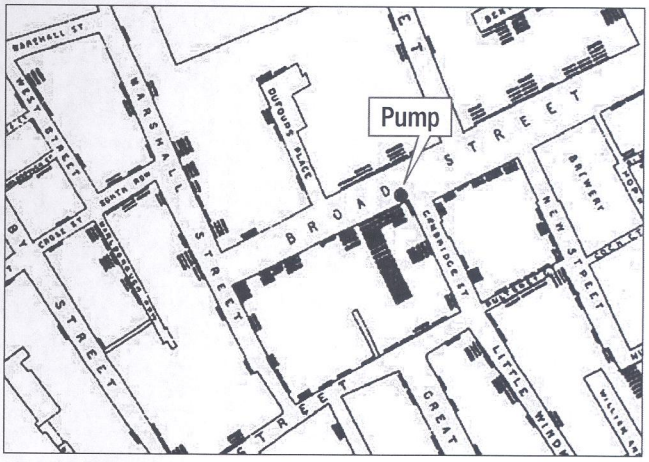


Figure 5. Each bar denotes a death at each address close to the Broad Street pump. Source: Snow J. *On the Mode of Communication of Cholera.* London: John Churchill, 1855.

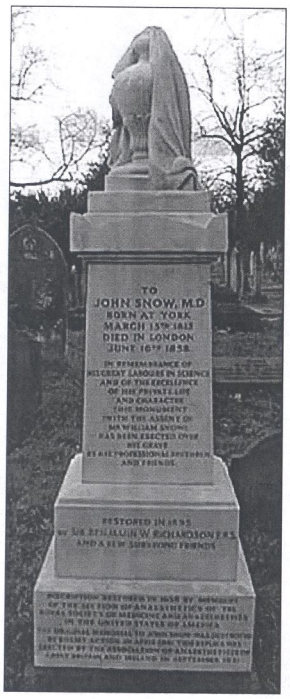


Figure 6. Tombstone of Dr. John Snow. Source: Frerichs RR. John Snow's final rest. Los Angeles: UCLA Department of Epidemiology, School of Public Health. Available at http://www.ph.ucla.edu/epi/snow/death.html.

Figure 7. A replica of the Broad Street Pump with the handle missing can be found on Broadwick Street, the renamed Broad Street. The actual site of the pump is marked by a red curbstone and a historical marker on a nearby wall. Source: Frerichs RR. The Broad Street pump. Los Angeles: UCLA Department of Epidemiology, School of Public Health. Available at http://www.ph.ucla.edu/epi/snow/phototour3.html.

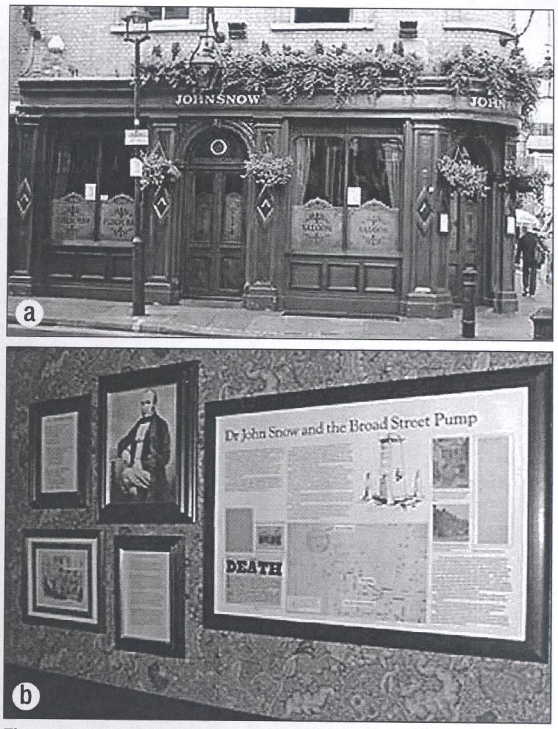


Figure 8. (a) The John Snow public house, near the original water pump. Source: The John Snow Society (http://www.johnsnowsociety.org/). **(b)** Memorabilia of John Snow on view inside the public house. Source: Frerichs RR. John Snow pub. Los Angeles: UCLA Department of Epidemiology, School of Public Health. Available at http://www.ph.ucla.edu/epi/snow/snowpub.html.

waterborne transmission of cholera in *On the Mode of Communication of Cholera (Figure 4)* and published further evidence supporting the waterborne transmission of cholera in the October *London Medical Gazette*. He reported that houses that drew water from the reaches of the River Thames above London supplied by the Lambeth Water Company (water free from the heavy fecal contamination of the lower reaches of the Thames) had few incidents of cholera. In contrast, homes supplied by the Southwark and Vauxhall Water Company (which drew water from the lower reaches of the Thames) had a high incidence of cholera. The most unpleasant aspect of Snow's theory was that cholera victims were infected by swallowing other people's fecal matter. These theories were not well accepted, and *The Lancet* published an article that was very critical of Snow. Most continued to support the idea that cholera was caused by inhaling the odor of decomposing animals.

When cholera returned to London in the summer of 1853, Snow undertook another extensive epidemiological study correlating cholera mortality with the source of water. He accurately linked the outbreak in Golden Square to the water pump on Broad Street. Snow had interviewed all the residents of Broad Street and received numerous complaints that the water from the pump had developed an offensive smell. He went to the General Registry Office and reviewed all the cholera deaths in the Soho area. There he discovered that the preponderance of deaths occurred around the vicinity of the Broad Street water pump *(Figure 5)*. He took his findings to the board of governors of the local St. James Parish, and they ordered the removal of the Broad Street pump handle. The epidemic of cholera subsided, but it was already waning. The medical board was not convinced by Snow's evidence, and the pump handle was replaced. For the rest of his life, John Snow continued to argue his theory that ingestion of contaminated water was the cause of cholera. He never succeeded in convincing his peers. It was not until the fourth cholera outbreak in 1866 that his theory was finally accepted.

John Snow died from a stroke at the age of 45 in June 1858 *(Figure 6)*, after spending his last years conducting laboratory and clinical experiments—mostly on himself. He continued his passion for investigating new anesthetic agents and remained vigilant in tracking down information on outbreaks of cholera throughout the world up until the time of his death.

LONDON TODAY

A replica of the pump—or maybe the original—can still be found in London on Broadwick Street (the new name for Broad Street) *(Figure 7)*, and in the background can be seen the John Snow Pub *(Figure 8)*. One of the greatest honors that can be bestowed on an Englishman is knighthood. Failing that, a public house could be named after you. Ironically, the abstemious John Snow had a public house named after him.

Today, the John Snow Society has over 1000 members worldwide and is based at the Royal Institute of Public Health in London. The society's Annual Pumphandle Lecture takes

place each September. This lecture is traditionally accompanied by a ceremony that includes removing and then replacing the pump handle. This is meant to signify the continuing challenges that face public health, not only in water quality but in other areas as well. Membership is open to anyone who wishes to celebrate the memory of John Snow, MD.

Further reading

Frerichs RR. John Snow. Los Angeles: UCLA Department of Epidemiology, School of Public Health. Available at www.ph.ucla./epi/snow.html; accessed August 29, 2005.

John Snow Society. Home page. Available at www.johnsnowsociety.org; accessed August 29, 2005.

Vinten-Johansen P, Brody H, Paneth N, Rachman S, Rip M. *Cholera, Chloroform, and the Science of Medicine: A Life of John Snow.* New York: Oxford University Press, 2003.