# Assessing the Contributions of John Snow to Epidemiology

## *150 Years After Removal of the Broad Street Pump Handle*

*Nigel Paneth*

On September 8, 1854, John Snow did not remove the handle of a pump, nor did he end an epidemic of cholera in London. However, the evening before, he did convince the municipal authorities to remove the handle of the popular water pump near the corner of Broad and Cambridge Streets in Soho. Probably to Snow's surprise—because his public health advice generally fell on deaf ears—the authorities followed his advice on the following day. As for the Soho outbreak, it was already on the wane, cholera deaths having declined from 127 on September 2 to 30 on September 8. The epidemic ended, as Snow himself wrote, because the local citizenry packed up and left.[1(p.51)]

Snow is not unique in being a hero remembered for feats never accomplished. However, unlike some mythic heroes, once the myth is removed, good reasons for remembering Snow remain, especially for epidemiologists. Snow's work on cholera illustrates, perhaps better than any other body of writings, a key epidemiologic principle: that the most important information to have about any communicable disease is its mode of communication. Once mode of communication is established, preventive measures nearly always follow, a principle as true for SARS in the 21st century, as for AIDS in the 20th and cholera in the 19th. Snow suspected that the agent of cholera was a tiny agent—too small to be seen with the naked eye, capable of reproduction, and probably constructed like a cell.[1(p.15)] However, unlike several of his medical contemporaries, Snow was not distracted by a fruitless microscopic search for the agent. Rather, he focused his science squarely on establishing the ways in which the disease was transmitted from person to person. We sometimes assume that the science of disease control operates in stepwise fashion, starting with agent identification. However, knowing the specific agent is often only faintly relevant to infectious disease control and is regularly preceded (as it was for cholera, typhoid fever, yellow fever, AIDS, and SARS, among many other diseases) by discovery of the mode of communication and by interruption of transmission. The 1983 pre-HIV recommendations of the Centers for Disease Control and Prevention[2] for AIDS prevention do not greatly differ from current policy.

It is sometimes taught that Snow's work demonstrates that the phenomenologic or "black-box" quality of epidemiology is more valuable to public health than is the pursuit of subcellular mechanisms of disease. However, this is a misunderstanding of Snow, whose insights into cholera transmission flowed from a deep understanding of the disease's pathophysiology and pathochemistry. Snow simply chose to pursue a disease mechanism that does not operate within cells, but within populations of people. The laws

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of disease communication, as Snow showed for cholera, are as ironclad in their generalizability as is any molecular theory of disease pathogenesis.

We are taught in epidemiology to favor multicausal models of disease and to keep our minds open to a wide variety of influences on disease risk. In this we more closely resemble Snow's sanitarian opponents—who repeatedly accused Snow of being too narrow in his thinking—than we do Snow. Instead of believing that cholera could be communicated in more than one way—by inhalation from the atmosphere or by drinking contaminated water—Snow argued that it could be communicated solely by what we now call the fecal–oral route. Instead of seeing all rotting garbage and sewage pouring into the river as causes of disease, Snow argued that the only dirty water that caused cholera was water contaminated by the evacuations of cholera patients, no matter how clean it appeared.

This is not to say that Snow, who was born to working class parents, was unaware of the social forces that determined the distribution of cholera. To the contrary, he specified the mechanisms by which poverty enhanced the spread of cholera. Lack of soap and water to wash hands and clothes, lack of light to see inadvertent soiling, lack of training in hygienic behavior, and work practices in mines that forced men to defecate and eat in the same place were all phenomena that increased opportunities for exposure to the fecal-borne agent of disease. Snow's sanitarian opponents saw poverty in a more general way, giving little attention to the specific mechanisms by which poverty increased the risk of cholera. Instead, they tended to invoke characteristics of the poor such as heavy drinking, which fit into the standard prejudices of the day. In today's world, we can repeatedly show that poverty predisposes to ischemic heart disease, certain cancers, and stroke. However, such demonstrations are no substitute for addressing the question of which components of poverty are responsible for each of these social gradients in disease risk.

Snow should be remembered by epidemiologists for studying problems that really matter. His abiding scientific passions were the development of safe, effective surgical anesthesia and the prevention of cholera. He was not a "basic" scientist, exploring nature for its own sake, but a superb applied scientist, successful in both his major scientific undertakings. He brilliantly integrated insights from different types of scientific thought, from molecular to population, and he marshaled all scientific tools available to him, often with great ingenuity. His anesthesia research made him expert on the properties of inhaled gases, which made him intensely skeptical of the miasmatic cholera theories of his contemporaries. This is well illustrated in his controversial Parliamentary testimony of 1854, recently republished by David Lilienfeld.[3] In his anesthesia work, Snow was an early clinical epidemiologist. He kept careful notes on his anesthesia cases, noting such features as the type of operation, the patient's sex, age, body type, and social class, and later summarizing these data to examine their effects on responses to anesthetic agents and on death and complication rates.[4]

Snow faced difficulties in his cholera research that would have deterred all but the most determined of scientists. In his South London study, which was interrupted briefly by the Broad Street pump episode, Snow established most securely the mode of communication of cholera by comparing cholera death rates in an area of London with 2 different water supplies intermingled in the same neighborhoods. One of the suppliers took its water from the Thames River upstream of London; the other from the heart of the city just below where the sewers poured in.

Snow's data were far from perfect. In studying the distribution of cholera, he could only count deaths, because no systematic information was available on all cases. To establish that the water supply to houses with cholera deaths differed from the supply to houses without cholera was no simple matter. Renters did not pay the water bill, some tenants had fled, others could not be found or had died of cholera. Had Snow not ingeniously recognized that upstream Thames water could be distinguished chemically from the dirtier water collected below the sewer input, he might not have been able to establish the correlation between contaminated water and cholera deaths.

It is sometimes not recognized that when Snow first published this great study, he did not know the number of houses supplied by each water company in each subdistrict, and therefore had to expand his study to a much larger area of London, whose water supply was known in the aggregate, rather than just the neighborhoods where the water pipes of the different companies went down the same streets. Two years later, when the more detailed breakdown of water supply to houses became available to him, he was able to confirm the correctness of his earlier conclusions.[5]

The work must have been burdensome. To study cholera, he abandoned his anesthesia practice for weeks at a time, cajoled (and perhaps paid) medical colleagues to work for him, and convinced the registrar general to authorize collection of new data. Snow personally visited the homes of 658 people who died of cholera, ascertaining the water supply to each house. Snow's great clinical expertise in anesthesia made him prosperous and respected, but few of his medical friends supported his cholera theories. *The Lancet* pilloried him, Parliament saw him as obstructionist, and John Simon (the leading public health official in London) virtually plagiarized his water supply data, only to have it serve a miasmatic interpretation.[6]

Benjamin Ward Richardson, Snow's friend and first biographer, saw him as having a "rare talent for penetration into obscure problems, for casting aside objects which are coincident or accidental,"[7] while Wade Hampton Frost,

writing in 1936, saw Snow as a "man singularly endowed with the ability to think in straight lines."[8] As epidemiology completes the transition, begun not so very long ago, from a collection of insightful and creative amateurs like Snow into a regular academic discipline, the sharp focus on public health problem-solving that Snow exemplified could be put at risk. The ivory tower beckons but, like Snow, we must walk fearlessly into the heart of the epidemic to study it.

## ABOUT THE AUTHOR

NIGEL PANETH is a perinatal epidemiologist in the Department of Epidemiology at Michigan State University. He suffers from the malady of being unable to understand science fully until he knows its history; hence his interest in the evolution of epidemiology. He is 1 of the 5 authors of *Cholera, Chloroform and the Science of Medicine: A Life of John Snow* (Oxford University Press, 2003).

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## ON IMPERFECT STUDIES

*"The subject is capable of being decided by exact numerical investigation, but I have thought it better to publish my inquiry in its present imperfect state than to wait till I should be able to make such a complete research as I could wish, more especially as, by directing the attention of the profession to the question, it may be earlier decided."*

**JOHN SNOW**