

## Cholera and the Pump on Broad Street: The Life and Legacy of John Snow

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AFTER ALL, IT REALLY IS ALL OF HUMANITY THAT IS UNDER THREAT DURING A PANDEMIC.

- Dr. Margaret Chan, Director General of the World Health Organization

THERE IS STILL A PUMP in the Golden Square neighborhood on what was once called Broad Street. It does not work, for it is merely a replica of the original, and like the original its handle is missing. It serves as a curiously simple monument to the events that took place over one hundred years ago, when the real pump supplied water to the Broad Street residents. In 1854, hundreds of these hapless locals dropped dead within days of each other as Soho experienced one of the most brutal outbreaks of cholera that London has ever seen.<sup>1</sup> Not even the most eminent physicians could say what caused the disease, or why it came and went as it did.

John Snow's solution to the cholera crisis broke the medical conventions of his era, slowed the progress of a virulent intercontinental disease, and forever changed the way society confronts public health problems.

### **Cholera, The Blue Death**

Cholera plagued civilization for many generations before John Snow's breakthrough. Medical researchers confirm that cholera was present in India in the seventeenth and eighteenth centuries, though records of diseases with cholera-like symptoms extend back as far as the fifth century B.C. The first intercontinental surge, referred to as the First Pandemic, occurred from 1817 to 1823.<sup>2</sup> Following waterways, cholera spread from India to Syria, East Africa, and Japan, but did not enter Europe. The Second Pandemic brought cholera to mainland Europe and Britain, then across the Atlantic Ocean to New York and Montreal between 1826 and 1837. Nine years later, the Third Pandemic began, promptly ravaging John

Snow's area of southern London.

Microbiology has shown that cholera comes from a bacterium called *Vibrio cholerae* that enters the body through contaminated water or possibly food. The bacteria's interference in the small intestine causes profuse diarrhea and vomiting. The consequent dehydration produces several distinctive symptoms. As the concentration of water in the bloodstream decreases, the blood becomes thick and tarlike. Capillaries rupture, which often turns the skin blue. The heart rate becomes irregular, and dehydrated limbs begin to shrivel. The nervous system, however, remains intact until the end, leaving the victim fully conscious of the pain. Without treatment, death occurs within days—or even hours—of the first symptoms.<sup>3</sup>

Before the days of modern technology, physicians knew little of cholera's origins. Most of them believed that diseases such as cholera were caused by foul odors, or miasmas, in the atmosphere.<sup>4</sup> They also thought that cholera was, given the symptoms, fundamentally a condition of the blood rather than the digestive system.<sup>5</sup> These speculative conclusions led to a diverse spectrum of largely ineffective “remedies.” Public anxiety rose in proportion to the death toll. Britain established its first Board of Health, and scientific institutes offered monetary rewards for methods of preventing or curing cholera. For decades, nothing worked.

Enter John Snow.

### **John Snow, the Teetotaler**

Despite his modest background, John Snow distinguished himself early in life as a bright boy with a special talent for mathematics. At the age of fourteen, he secured a medical apprenticeship with William Hardcastle in Newcastle-upon-Tyne. Snow's tenure with Hardcastle exposed him to cholera patients for the first time during an outbreak in Killingworth in 1832.

Snow continued his studies in London and became a fully certified physician, receiving invitations to join the Westminster Medical Society (of which he later became president) as well as the Royal College of Physicians and the London Epidemiological Society (of which he was a founding member).<sup>6</sup> He devoted much of his time to the newly-developed field of anesthesiology, designing and constructing inhalers to dispense ether and chloroform more effectively with less risk of overdose. Although the concept of anesthesia originated in Boston, many modern practitioners regard John Snow as the world's first professional anesthetist because he spent his career administering these new anesthetics to the general public.<sup>7</sup> The Royal Medical and Chirurgical Society declared him to be “more extensively conversant with its operation, and more successful in administering it, than any living person.”<sup>8</sup> He was even summoned to the palace to give chloroform to Queen Victoria during labor.<sup>9</sup>

John Snow was modest, industrious, and taciturn. He confounded the medical community with his decision to become a vegetarian and abstain from liquor. On occasion, he publicly advocated for temperance.<sup>10</sup> His friend, Benjamin Ward Richardson, wrote that “... he lived on an anchorite's fare, clothed plainly, kept

no company, and found every amusement in his science books, his experiments, and simple exercise.”<sup>11</sup> His lifestyle along with his work made him a controversial figure in Victorian England.

### Snow versus Cholera

Snow’s interest in cholera, first piqued in Killingworth, did not resurface until 1849. He published a pamphlet speculating that cholera must be, fundamentally, a digestive disease, because the initial symptoms were vomiting and diarrhea. This premise led Snow to conclude that the contagion entered and left the body through the oral-fecal route, and therefore that cholera was caused by consuming a contaminated substance.<sup>12</sup> His argument contradicted the multitude of doctors who believed that cholera was essentially a disorder of the blood. Indeed, Snow acknowledged his unorthodoxy in the pamphlet: “It is quite true that a great deal of argument has been employed on the opposite side, and that many eminent men hold an opposite opinion.”<sup>13</sup> However, this awareness would not prevent him from pursuing his own theory.

The chance to substantiate his conjectures with statistical proof arrived in 1854 with the Third Pandemic. During a serious outbreak in the region of Albion Terrace, he began a project that he termed his “Grand Experiment.”<sup>14</sup> Through an extensive survey of the neighborhood, he demonstrated that around six out of every seven cholera deaths had occurred in houses that received water from the Southwark and Vauxhall Company, instead of the Lambeth Company.<sup>15</sup> Though both companies drew their water from the Thames, the Southwark and Vauxhall Company drew further downstream, in a much more polluted area.<sup>16</sup> This strongly supported Snow’s postulated connection between cholera and contaminants in water. Although epidemiology textbooks still present Snow’s 1854 survey as a quintessential example of public health investigation,<sup>17</sup> it has been largely eclipsed in historical memory by his subsequent study during the outbreak on Broad Street.

In hindsight, it is widely believed that the events on Broad Street began with Frances Lewis, a five-month-old infant. As to how the child contracted the disease, we remain ignorant to this day. Dr. William Rogers attended her as she experienced diarrhea and exhaustion, both symptoms of cholera, without cramps or discolored skin. Frances died within a few days.<sup>18</sup> Her mother, Sarah Lewis, washed the soiled clothes and emptied the dirty water into a cesspool in front of the house.

It did not take long for their Broad Street neighbors to contract the disease. Within ten days, the number of deaths from cholera exceeded five hundred. Snow himself would later describe it as “...the most terrible outbreak of cholera which ever occurred in this kingdom.”<sup>19</sup> In the years since, Britain has never again experienced an outbreak of the same magnitude.

John Snow lived in Soho. The area of Broad Street in question was but a few blocks from his house. He knocked on doors all around the Golden Square neighborhood, stopping at the houses of those who were healthy and well as those who were ill to inquire about the family’s consumption of water. He drew a map,

which has subsequently become famous because of the precedent it set for modern epidemiological investigations, with a small black mark representing every death (see appendix I). At the center of the affected area was the Broad Street Pump.

At first the recorded data seemed to imply that the pump and the outbreak were unrelated. Some deaths had occurred much closer to other pumps, while some establishments on Broad Street within a block of the pump had escaped the scourge of cholera. With a little persistence, however, Snow found explanations that transformed these apparent inconsistencies into evidence supporting his theory.

Broad Street water had a reputation for being colder and more carbonated than the water from surrounding pumps, so it had attracted a clientele from adjacent neighborhoods. Upon interviewing the families of the deceased who had lived far away, Snow discovered that many of the children and adults had been in the habit of stopping to drink from the pump as they walked to school and work each morning. When he inquired how the employees of the Lion Brewery had all remained healthy despite working across the street from the Broad Street pump, their employer informed him that they seldom drank from the pump. They much preferred the liquor they received as part of their wages. The workhouse just down the road had inadvertently escaped the outbreak by using water from a private well. But perhaps the most convincing example was the death of Susannah Eley, a widow who had moved away from Broad Street to the distant district of Hampstead. Her surviving sons told Snow that she had retained a fondness for Broad Street water and regularly had it delivered to her new home. Thus, her death and the death of her visiting niece were readily explained. Snow concluded: "The result of the inquiry then was, that there had been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking the water from the above-mentioned pipe-well."<sup>20</sup>

Armed with this data, Snow requested permission to address the Board of Guardians assembled by St. James's Parish to deal with the continued problem of cholera. Although Snow's ideas were controversial, the Board consented to his proposed plan of action—removing the handle of the Broad Street Pump. It was done the very next day. Upon digging at the sight of the pump, it was discovered that the well beneath it ran close to sewage pipes and cesspools in front of neighboring houses. We may never determine how the well was contaminated, but evidence suggests that it could have been the dirty water that Sarah Lewis discarded upon the death of her infected infant.

Snow's work on cholera received mixed reviews during his lifetime. Though some of his colleagues were supportive, the president of the Board of Health, Benjamin Hall, and the former president, Edwin Chadwick, openly denounced his ideas. He was summarily rebuffed by the Committee for Scientific Inquiries, whose report read, "... we see no reason to adopt this belief. We do not find it established that the water was contaminated in the manner alleged ..., nor is there before us any sufficient evidence."<sup>21</sup> Furthermore, a competition in Paris offering £1,200 for a means of controlling the spread of cholera rejected his second, definitive version of *On the Mode of the Communication of Cholera* which he submitted in 1856.<sup>22</sup> In fact, the obituary printed in *The Lancet* following Snow's death in 1858 briefly praises his research of anesthetics without even mention-

ing his work on cholera.<sup>23</sup> In Victorian England, his ideas were too novel and controversial to gain immediate acclaim.

However, the overwhelming statistical evidence gradually led the medical community to embrace his conclusions. Even the Committee for Scientific Inquiries acknowledged in the appendix to its skeptical report, that “there are some cases of disease and death which we find ourselves unable to explain upon any other hypothesis than that of the deleterious influence of the water.”<sup>24</sup> Shortly after the publication of Snow’s findings, Reverend Henry Whitehead embarked on a similar investigative survey of the Broad Street area with the intention of disproving Snow’s theory. He was moved by his findings to agree with Snow and later called him “as great a benefactor in my opinion to the human race as has appeared in the present century.”<sup>25</sup> Snow’s beliefs became even more plausible in light of Louis Pasteur’s work on the germ theory of disease in 1859, and Robert Koch’s work with *Vibrio cholerae* under the microscope in 1884. In 1886, the Local Government Board credited Snow with, “demonstrating incontrovertibly the connection of cholera with the consumption of specially polluted water, startling the profession by the novelty of his doctrine, and inaugurating a new epoch of etiological investigation.”<sup>26</sup>

### The Legacy

John Snow’s immediate contribution to history was the water-borne theory of cholera. This discovery gave society the ability to prevent the disease from spreading. When cholera returned to England in 1866, eight years after Snow’s death, the London physicians kept the disease under control “by the following of the light of his [Snow’s] researches.”<sup>27</sup> By common consent, cholera was the single worst epidemic disease of the nineteenth century.<sup>28</sup> It still poses a threat in underdeveloped areas of the world. The fact that we speak of it without fear in Europe and North America is remarkable in the context of the past few centuries. Finding a solution to cholera was as stunning as a solution to AIDS would be today.<sup>29</sup> It is an achievement for which we must credit the work of many people, but principally John Snow.

The broader importance of Snow’s work is the emergence of epidemiology as a field of modern science. Without the techniques of microbiology, he analyzed the spread of disease by using simple statistics to demonstrate a correlation between two factors—water impurity and the occurrence of cholera. His logical methods shaped the way we confront public health dilemmas today. Maps such as his are employed so regularly that the practice now has an official name—medical cartography. Field studies in the style of the ones that he conducted in the cholera-stricken neighborhoods of London have a name as well—shoe leather epidemiology. His studies are frequently cited as models in lectures and textbooks.<sup>30</sup> Indeed, he is commonly referred to as “the father of epidemiology.”<sup>31</sup> Dr. David Satcher, the former director of the Center for Disease Control and Prevention, reportedly approached the most challenging public health issues with the catch-phrase “Where is the handle on this Broad Street Pump?”<sup>32</sup> Among

health-care professionals, Snow's significance is now so apparent that in 2003, the readers of *Hospital Doctor*, a magazine circulated in the medical community, voted Snow as the Greatest Doctor in History—with Hippocrates himself finishing second.<sup>33</sup> Without question, Snow's work forever changed our approach to health and medicine.

## Notes

1. John Snow, "On the Mode of Communication of Cholera," 2nd ed., *Snow on Cholera* (New York: Hafner Publishing, 1965): 38.
2. G. C. Cook, "The Asiatic Cholera: An Historical Determinant of Human Genomic and Social Structure," *Cholera and the Ecology of Vibrio cholerae* (London: Chapman and Hall, 1996): 20-21.
3. Irwin Sherman, *Twelve Diseases that Changed Our World* (Washington DC: ASM Press, 2007): 33.
4. Ralph Frerichs, interview by author, digital recording of telephone conversation, 18 March 2009.
5. Peter Vinten-Johansen, email to author in response to questions, 25 March 2009.
6. "Epidemiological Society," *The Lancet* 1 (1850): 156.
7. Rosalind Stanwell-Smith, interview by author, digital recording of telephone conversation, 5 April 2009.
8. Royal Medical and Chirurgical Society of London, *Proceedings of the Royal Medical and Chirurgical Society of London*, Volume III (1861):47.
9. John Snow, *The Case Books of Doctor John Snow* (London: Wellcome Institute for the History of Medicine, 1994): 271, 471.
10. Thomas Snow, "A Doctor's Teetotal Address Delivered in 1893," *British Temperance Advocate*, 1888: 182.
11. Benjamin Ward Richardson, "John Snow, M.D., A Representative of the Medical Science and Art of the Victorian Era," *The Asclepiad*, 1887: 277.
12. Peter Vinten-Johansen et al, *Cholera, Chloroform, and the Science of Medicine: a Life of John Snow*. (New York: Oxford University Press, 2003): 200-201.
13. John Snow, *On the Mode of Communication of Cholera* (London: Wilson and Ogilvy, 1849): 5-6.
14. Sandra Hempel, *The Strange Case of the Broad Street Pump* (Berkeley and Los Angeles: University of California Press): 165.
15. John Snow, "Cholera and the Water Supply," *The Times*, 26 June 1856: 12.
16. Snow, *Snow on Cholera*, 90.
17. Leon Gordis, *Epidemiology*, 2nd ed. (Philadelphia: W.B. Saunders Company, 2000): 11; Many Magnus, *Essentials of Infectious Disease Epidemiology* (Sudbury: Jones and Bartlett Publishers, 2008): 23-24.
18. Henry Whitehead, *Report for the St. James Parish Cholera Inquiry Committee* (London: J. Churchill, 1855): 163-165.
19. Snow, *Snow on Cholera*, 38.
20. *Ibid.* 70.

21. General Board of Health, *Report of the Committee of Scientific Inquiries in Relation to the Cholera Epidemic of 1854* (London: Eyre and Spottiswoode, 1855): 52.
22. Richardson, "John Snow, M.D.," 287.
23. "Births, Marriages, and Deaths," *The Lancet*, 1858: 635.
24. General Board of Health, *Appendix to Report of the Committee of Scientific Inquiries in Relation to the Cholera Epidemic of 1854* (London: Eyre and Spottiswoode, 1855): 153.
25. Ralph Frerichs, "Snow on Cholera: A Sight and Sound Voyage into the History of Epidemiology," *John Snow – A Historical Giant in Epidemiology*, <<http://www.ph.ucla.edu/epi/snow.html>> 16 February 2009.
26. Local Government Board, *Fifteenth Annual Report of the Local Government Board, Supplement Containing Reports and Papers on Cholera* (London: Eyre and Spottiswoode, 1886): 110.
27. Thomas Snow, "Dr. Snow on the Communication of Cholera," *The Times*, 20 November 1885: 4.
28. Irwin Sherman, *The Power of Plagues* (Washington DC: ASM Press, 2006): 167.
29. Frerichs, interview.
30. Hempel, *Strange Case*, 165.
31. Frerichs, interview.
32. American Academy of Family Physicians, "FP Report," <<http://www.aafp.org/fpr/970100fr/index.html>> 17 May 2009.
33. Frerichs, "Snow on Cholera."

## Annotated Bibliography

### Primary Sources

"Births, Marriages, and Deaths." *The Lancet* (1858): 635.

*The Lancet* printed a brief obituary that praised Snow's research on anesthetics without mentioning his cholera work. This underscores the idea that much of Snow's acclaim came after his death.

"Epidemiological Society." *The Lancet* (1850): 156-157.

This brief article names John Snow as one of the founding members of the London Epidemiological Society.

General Board of Health. *Report of the Committee of Scientific Inquiries in Relation to the Cholera Epidemic of 1854*. London: Eyre and Spottiswoode, 1855.

Presented to the House of Commons in the year following the outbreak on Broad Street, this report is highly skeptical about John Snow's theory, representing the skepticism of the broader medical community. I quote it in my paper.

General Board of Health. *Appendix to Report of the Committee of Scientific Inquiries in Relation to the Cholera Epidemic of 1854*. London: Eyre and Spottiswoode, 1855.

This was published as a supplement to the above report. Unlike the original report,

it does not dismiss Snow's theory completely. I quote it in my paper to demonstrate the gradual change in sentiment.

Local Government Board. *Reports and Papers on Cholera in England in 1893*. London: Eyre and Spottiswoode, 1894.

This document, regarding later outbreaks of cholera in England, was presented to the House of Commons many years after Snow's death. By 1894, Snow's ideas were entirely accepted, and the report is highly complimentary. This further demonstrated the medical community's eventual embrace of Snow and his ideas.

Local Government Board. *Fifteenth Annual Report of the Local Government Board, Supplement Containing Reports and Papers on Cholera*. London: Eyre and Spottiswoode, 1886.

Two decades after the Broad Street outbreak, Snow's ideas had gained much greater favor. This report, presented to the House of Commons, praises Snow and his theory at great length. I quote it in my paper.

Registrar General. *Report on the Cholera Epidemic of 1866 in England*. London: Eyre and Spottiswoode, 1868.

Like the preceding four documents, this report analyzing previous cholera outbreaks was presented to the House of Commons. It contains the reproductions of Snow's data that I use in appendix III.

Richardson, Benjamin Ward. "John Snow, M.D., A Representative of the Medical Science and Art of the Victorian Era." *The Asclepiad*, 1887, Vol. 4, pp 274-300.

Benjamin Richardson was a colleague and intimate friend of John Snow. His relatively short biographical article published following Snow's death provided unique insights into Snow's thoughts, habits, and idiosyncrasies.

Royal Medical and Chirurgical Society of London. *Proceedings of the Royal Medical and Chirurgical Society of London*, Volume III (1861).

Shortly after Snow's death, the society praised Snow, particularly stressing the importance of his work with anesthetics. This is important because most people see his work on cholera as being his principal concern and his most successful endeavor. I quote this document in my paper.

Snow, John. "Cholera and the Water Supply" (Letter to the Editor). *The Times* 26 June 1856: 12, column B.

Snow's letter to the editor provides the statistic that roughly six cholera deaths occurred among individuals consuming Southwark and Vauxhall water for every one cholera death among consumers of Lambeth water. I use this statistic when describing the outbreak.

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\_\_\_\_\_. *The Case Books of Doctor John Snow*. London: Wellcome Institute for the History of Medicine, 1994.

Although cholera research was the field that would earn Snow a place in history, the vast majority of his work with patients involved administering anesthetics. His case books demonstrate the importance he placed on this second pursuit and the diligence with which he worked.



\_\_\_\_\_. "On the Mode of Communication of Cholera." London: Wilson and Ogilvy, 1849. *The John Snow Archive and Research Companion*. Vinten-Johansen, Peter. Michigan State University, East Lansing, MI. <<http://matrix.msu.edu/~johnsnow/index.php>>. 18 April 2009.

This is the first edition of Snow's most famous work. It is speculative and fairly short, published before both of his research experiments were conducted. His words demonstrate his awareness that the ideas he proposes are shockingly controversial. I quote this in my paper.

\_\_\_\_\_. *Snow on Cholera*. New York: Hafner Publishing, 1965.

This book is a reprint of two of Snow's most famous papers on cholera, including the second edition of *On the Mode of Communication of Cholera*. I quote in several places from his explanation of his studies.

Snow, Thomas. "A Doctor's Teetotal Address Delivered in 1836." *British Temperance Advocate*, November 1888: 182.

Thomas Snow presents his brother's arguments on behalf of temperance. This illustrates that Snow's personal lifestyle, not just his views on cholera, differed markedly from the Victorian era medical community – most doctors did not endorse the temperance movement.

\_\_\_\_\_. "Dr. Snow on the Communication of Cholera" (Letter to the Editor). *The Times*, 20 November 1885: 4, column F.

Snow's brother describes how physicians in London used Snow's research to successfully manage a cholera outbreak in 1866. This is a concrete example of Snow's impact on public health policy.

Whitehead, Henry. *Report for the St. James Parish Cholera Inquiry Committee*. London: J. Churchill, 1855. *The John Snow Archive and Research Companion*. Vinten-Johansen, Peter. Michigan State University, East Lansing, MI. <<http://matrix.msu.edu/~johnsnow/index.php>>. 18 April 2009.

Henry Whitehead presents a letter from the doctor who treated Sarah Lewis's infant, substantiating the claim that the infant could have been the cause of the outbreak.

#### **Personal Communications**

Frerichs, Ralph. Telephone Interview. 18 March 2009.

Dr. Frerichs is a professor of epidemiology at UCLA. Like many in his profession, he has a high regard for John Snow as the father of epidemiology. He also has a detailed understanding of the history surrounding John Snow, as a result of constructing the website listed in the Secondary Sources section.

Stanwell-Smith, Rosalind. Telephone interview. 5 April 2009.

Dr. Stanwell-Smith is a public health consultant and the Honorary Secretary of the John Snow Society in London. She spoke with me about Snow's significance in the modern world, the efforts of the society to memorialize him, and the replica pump's important role as a monument in Soho.

Vinten-Johansen, Peter. Email to the author. 25 March 2009.

Mr. Vinten-Johansen is a retired history professor from Michigan State University.

He is the author of *Cholera, Chloroform, and the Science of Medicine: a Life of John Snow*, which is widely regarded as the definitive Snow biography. He was able to answer some of my questions about minute details of Snow's life and work that were not featured in the printed sources.

### Secondary Sources

"Dr John Snow." Durham University. <<http://www.dur.ac.uk/johnsnow.college/about/bio/>> 16 February 2009.

This web article explains why one of the colleges within Durham University bears the name of John Snow. It also mentions the Hospital Doctor poll in which Snow was voted the greatest doctor in history.

Drasar, Bohumil and Bruce Forrest. *Cholera and the Ecology of Vibrio cholerae*. London: Chapman and Hall, 1996.

This book is a compilation of articles by various authors who discuss cholera from the scientific standpoint. It reveals an understanding of cholera that is completely different from the beliefs and speculations prevalent in the era of John Snow. Also, it describes the pathology and early history of cholera in greater detail than other sources.

"FP Report." American Academy of Family Physicians. January 1997. AAFP News Department. <<http://www.aafp.org/fpr/970100fr/index.html>> 17 May 2009.

This source reports that Dr. David Satcher and his colleagues try to approach modern public health dilemmas in the style of John Snow, just one example of Snow's influence on modern epidemiology.

Gordis, Leon. *Epidemiology*. 2<sup>nd</sup> ed. Philadelphia: W.B. Saunders Company, 2000.

Gordis's textbook, designed for beginning epidemiology students, presents John Snow's studies in London as a model of epidemiological investigation. This is concrete proof of Snow's influence and significance in this field.

Hempel, Sandra. *The Strange Case of the Broad Street Pump*. Berkeley and Los Angeles: University of California Press, 2007.

Hempel takes the unique approach of beginning her narrative long before the events surrounding the pump, giving a detailed account of the British government's futile attempts to restrain cholera during the second pandemic. Because this was one of the first books I found, the footnotes led me to several of my other secondary sources.

"John Snow: A Historical Giant in Epidemiology." Frerichs, Ralph. 1999. UCLA Department of Epidemiology, School of Public Health. <<http://www.ph.ucla.edu/epi/snow.html>> 16 February 2009.

This is a very comprehensive website including both visual and audio accounts of Snow's life and work. It lists numerous significant writings on John Snow, which helped my research considerably.

Johnson, Steven. *The Ghost Map*. New York: Riverhead Books, 2006.

This book provided the image of Snow's portrait presented in appendix II.

Magnus, Manya. *Essentials of Infectious Disease Epidemiology*. Sudbury: Jones and Bartlett Publishers, 2008.

This textbook contains a thorough description of John Snow's mapping techniques and statistical data, presenting them to epidemiology students as quintessential examples of important skills.

Morris, Robert. *The Blue Death: Disease, Disaster, and the Water We Drink*. New York: HarperCollins Publishers, 2007.

Morris devotes the first few chapters to John Snow and the other major players in the 19<sup>th</sup> century cholera frenzy, but then he moves on to discuss the work of later scientists in perfecting our understanding cholera. Ultimately, this organizational format shows the modern-day applications of what we have learned about water-borne illnesses.

Sherman, Irwin. *The Power of Plagues*. Washington DC: ASM Press, 2006.

This book generalizes the impact of infectious diseases on society, devoting one chapter exclusively to cholera.

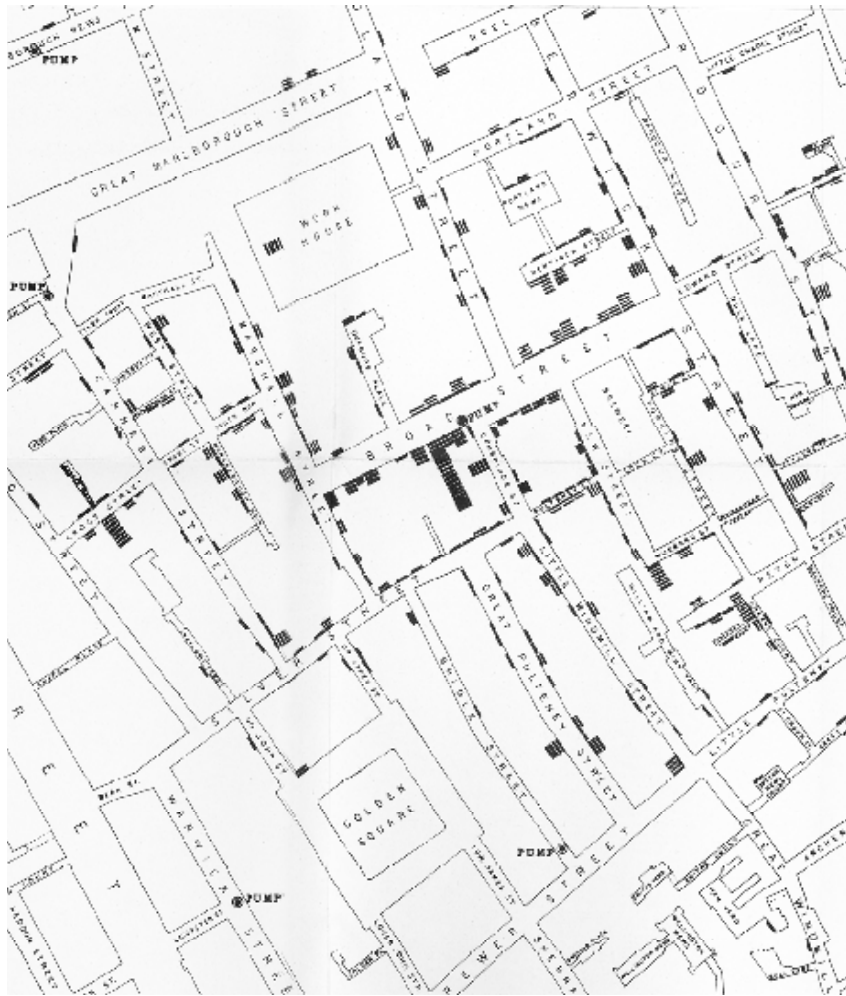
\_\_\_\_\_. *Twelve Diseases that Changed Our World*. Washington DC: ASM Press, 2007.

Sherman's second book is very similar to his first, with slightly more emphasis on human, rather than natural, history.

Vinten-Johansen, Peter, Howard Brody, Nigel Paneth, Stephen Rachman, and Michael Rip. *Cholera, Chloroform, and the Science of Medicine: a Life of John Snow*. New York: Oxford University Press, 2003.

The John Snow Society recommends this as the single best account of John Snow's life and works. It provided more detail than other books and articles did, and its footnotes are more extensive.

## Appendix I



Snow's famous map of the Broad Street area. Each black mark represents one death from cholera. From *Snow on Cholera* by John Snow.

Appendix II



Portrait of John Snow. From *The Ghost Map* by Steven Johnson.

## Appendix III

NINE SUMMER DISTRICTS OF LONDON.					
Houses supplied by	Estimated Population, 1851.*	Deaths from Cholera.			
		31st July to 31st Aug.	1st Aug. to 31st Aug.	1st Aug. to end of Year.	Total.
(a) Lambeth Company	126,257	34	84	210	328
(b) Southwark Company	240,229	230	577	2,213	3,020
(c) Wells and other sources	196,182	54	119	1,223	1,436
(d) TOTAL	562,668	318	780	3,646	4,744

	Deaths from Cholera to 10,000 living.			
	First Stage.	Second Stage.	Third Stage.	All Stages of Epidemic.
Southwark water, drawn from Dindorpa and containing London sewage	110	592	555	1,257
Wells and other sources	32	312	1,207	1,551
Pure Lambeth water, drawn from Thames beyond sewage range	0	51	334	385

1851.	APPARSA.	DEATHS.
August 28, Monday	Cholera outbreak.	
" 29, Tuesday	4	1
" 30, Wednesday	8	2
" 31, Thursday	56	3
September 1, Friday	143	70
" 2, Saturday	116	127
" 3, Sunday	41	75
" 4, Monday	46	71
" 5, Tuesday	35	45
" 6, Wednesday	26	37
" 7, Thursday	22	31
" 8, Friday	13	30

Tables presenting the statistics from Snow's cholera investigations regarding the Lambeth Company versus the Southwark and Vauxhall Company (top) and the outbreak in the Golden Square neighborhood near the Broad Street pump (bottom). From *Report on the Cholera Epidemic of 1866 in England* by the Registrar General.



The former site of the Broad Street Pump has become a historic site. A replica of the original pump has been erected a few yards away from the spot where the original once stood, and the adjacent pub is now called “the John Snow.” This is somewhat ironic given that Snow famously abstained from liquor. Photo courtesy of Mrs. Hannah Reimer.



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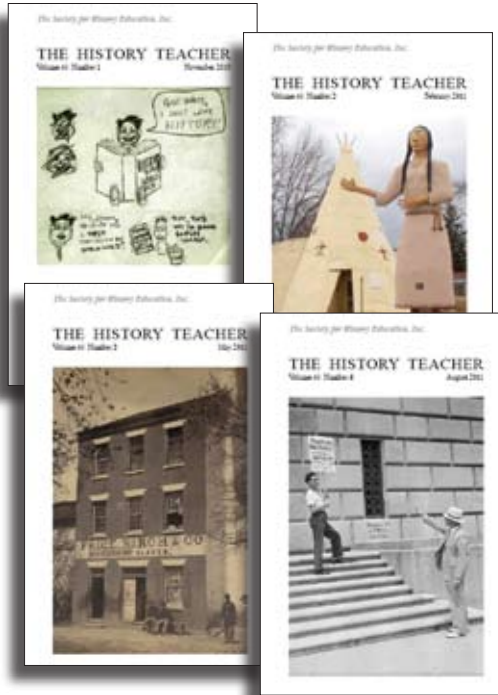
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