

The Contributions of Two Public Health Pioneers: John Snow and Joseph Goldberger

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Similar to many professional disciplines, public health was shaped by pioneers who made important contributions. Two trailblazers, whose work current public health officials should be aware of are Drs. John Snow and Joseph Goldberger. Although Snow is a well known public health figure, mentions of his work in contemporary health promotion and public health text books are generally limited and typically comment only on his study of the Broad Street Pump (BSP) cholera outbreak. The accomplishments of Joseph Goldberger receive even less coverage than those of Snow. Goldberger's work in identifying the cause of pellagra was instrumental in creating the field of nutritional epidemiology (Elmore, & Feinstein, 1994). Because of the scant coverage of these men's accomplishments, and their importance, these two men's professional contributions and similarities in their lives and careers will be discussed in this paper.

Dr. John Snow (1813-1858)

John Snow was the first of eight children born to Frances and William Snow of York, England on March 15, 1813. Little is known about Snow's childhood but it is recognized that his parents were not wealthy. Snow's father was a carman, who pulled carts to transport goods (Vinten-Johansen, Brody, Paneth, Rachman, & Rip, 2003).

Education in 1820's was a privilege for British children, as universal schooling was not instituted in England until the 1880's. Considering Snow's lot in life he would have been considered fortunate to be allowed to attend school. It is believed that Snow was a student at the Dodsworth Elementary School in York, which was an inexpensive private school (Snow, 1995; Vinten-Johansen et al., 2003).

During June of 1827 at the age of 14 Snow entered into a medical apprenticeship under the supervision of a Dr. Hardcastle in the town of Newcastle. His first assignments as an apprentice were likely to deliver drugs to patient's homes. Apprentices such as Snow were allowed to see patients, but usually only those who could not pay for a doctor's services. During this training period Snow was not allowed to attend university lectures, but Dr. Hardcastle did invite him to occasionally follow along on hospital rounds (Galbraith, 2002). It was not known how Snow paid for his medical training but it

was believed that a mysterious uncle on his mother's side of the family, a Charles Empsom, helped with these expenses (Vinten-Johansen et al., 2003).

It was during his internship that Snow became a vegetarian, began exclusively drinking water that he had distilled and concluded that a healthy colon was a key to a healthy life. He was also an ardent walker and strongly disapproved of alcohol usage. The apprenticeship provided Snow's first exposure to cholera when he helped treat victims at a mine in Killingsworth during 1832 (Vinten-Johansen et al., 2003).

Upon completing the internship in 1836 Snow applied to and was accepted into the Hunterian Medical School which, was located in the Soho section of London. Snow made the trip from York to London on foot, a distance of about 400 miles. His circuitous route to medical school took him through Liverpool and Wales and lasted four to five weeks. Much of medical school at this time was self-directed and students were required to purchase tickets to attend special lectures and presentations. Many of the lectures that Snow attended were held at the Westminster Hospital, which was near the Hunterian Medical School (Galbraith, 2002).

In 1838 Snow passed a test to become a surgeon and was duly admitted to the Royal College of Surgeons. He also held a certificate of apothecary, but had yet to earn one as a physician, which was the third and most prestigious component of medical training at the time. It was not until 1844 that Snow sat for a test that was offered at the University of London to achieve his vocational goal of becoming a licensed physician, he passed (Vinten-Johansen et al., 2003).

Upon graduation Snow hung a shingle on his Frith Street apartment and opened a medical practice. Unfortunately, at the time, London was home to 21 medical schools and there were a plethora of doctors in town. Snow was not especially successful as a practicing physician as competition for patients was fierce and his bedside manner was described as "very peculiar." In spite the bedside manner issue Snow was immensely respected by his peers (Vinten-Johansen et al., 2003).

Snow, a regular attendee of scientific meetings and conferences, attended a presentation by Francis Boott, a Boston physician, on December 19,

1846 that would change his career. Boott performed a tooth extraction using ether to thwart the pain that was associated with the procedure. The use of ether was important because nothing was previously known to decrease the pain and suffering that was associated with many medical procedures. Besides reducing pain, there were two peripheral, yet important benefits of using ether. First, patients were more apt to sit still during procedures, which allowed doctors to operate with more precision. Secondly, patients were more likely to submit to needed surgeries, knowing that much of the anticipated pain would be attenuated (Vinten-Johansen et al., 2003).

Through experiments conducted on animals, and experience with patients Snow learned that all people were susceptible to the effects of ether. The effects, were however, influenced by a person's breathing rate, body size, age and whether or not the person was alcoholic. By 1847 Snow had developed an apparatus that could deliver ether in a controlled dosage while accounting for temperature and the saturation of the ether. This delivery method was an improvement over the practice of placing an ether-saturated cloth over patient's mouths. Snow was appropriately recognized as an anesthesiology expert and his services were in great demand (Vinten-Johansen et al., 2003).

Because the effects of ether were rather slow and it was expensive, Snow was always on the lookout for other substances that might be more effective and cheaper. After experimenting with chloroform on animals, he extended his testing to humans and found it to be less pungent, more easily inhaled, produced effects quickly, and was less expensive than ether. Thus, although he continued searching for other compounds, and for a period thought that amylene might be more effective than ether or chloroform, he principally used chloroform for the remainder of his practice. Snow eventually performed anesthesia on more than 5000 patients including Queen Victoria when she delivered her eighth and ninth children (Smith 2002).

A cholera outbreak in England during October of 1848 would change Snow's life and professional legacy. At that time scientists had fallen into one of two camps, the contagionists such as Snow who believed that cholera was spread from person to person and the non-contagionists or sanitarians, who believed that it was contracted by inhaling smelly poisons called miasmas. These miasmas were thought to disrupt the body's balance and cause disease. Snow disagreed with this assertion because miasmas were ubiquitous in London and relatively few Londoners were stricken with cholera (Bingham, Verlander & Cheal, 2004). Because he understood gasses from his work as an

anesthenologist he knew that to have an effect airborne substances such miasmas had to be inhaled at close range, which did not happen in most cholera cases. He further noted that those who lived adjacent to ill people and seemingly breathed the same air, but had different water sources, did not become ill. He additionally reported that people working in the "offensive trades," such as tanners, where miasmas were ever present, did not suffer from higher rates of cholera than the general population. Snow also learned that some people got the disease and lived in areas where miasmas were not present (Snow, 1855).

Snow's beliefs on cholera transmission would have classified him as a contingent contagionist, as he believed that the disease arose from people drinking water or ingesting food that had been contaminated by the fecal wastes of the ill. He also believed that alcohol could make a person more susceptible to the disease and that dust from feces of the ill could be inhaled and cause cholera (Vinten-Johanson, 2003).

A law passed by Parliament aided Snow with his cholera research. By the year 1855 it was law that no company could draw drinking water from the tidal zone of the Thames River where the water was known to be contaminated with sewage. At the time two businesses provided most of the drinking water to south London residents with rather random geographic overlap. The Lambeth Company moved their intake pipes upstream to meet the new legal requirement before their rival the Southwark and Vauxall Company (S&V) did so. Snow anticipated the natural experiment that would occur if the next cholera outbreak came about before the S & V intake pipes had been moved upstream. When it did occur Snow compared disease rates of S&V with Lambeth customers and he was able to show that those using S & V water were 14 times as apt to suffer from cholera as those using Lambeth water (Vinten-Johanson, 2003).

The process of collecting and analyzing the data was not easy as Snow admitted to having difficulty in determining the water source of many residences. A solution was found when Snow learned that S&V water had a much higher salt concentration than did the Lambeth water and he could then easily distinguish the water source with a quick laboratory test. He further learned that in some cases the city of London had available data on the water source in homes. In those cases it was unnecessary to test the water for salt content (Vinten-Johansen et al., 2003).

Snow is best known for his study of the Broad Street Pump (BSP) cholera outbreak that devastated London's Soho district during August and September of 1854. While investigating this outbreak Snow constructed a map of the neighborhood that

was dotted with shallow pumps. His data showed that 380 of 574 cases of cholera occurred among people who lived closer to the BSP than any other pump. At the same time Snow became aware of a woman named Sushannah Eley who had become ill with cholera, but lived miles from the BSP in an area where no cases were occurring. An investigation revealed that she had lived in the BSP neighborhood as a child and had developed an affinity for the taste of that water. In later life, after moving, she had her hired man deliver BSP water to her on a regular basis. Snow deduced that the exposure that produced cholera in Ms Eley was BSP water. It was eventually learned that a baby in the neighborhood, who was likely the index case, had initiated the outbreak when her mother washed the baby's soiled diapers a few feet from the BSP (Vinten-Johansen et al., 2003). On September 8, 1854 Snow had the handle removed from the BSP and the epidemic, which was already on the wane, was halted. Thus despite not knowing the biological cause of the outbreak Snow was able to stop it by knowing its mode of transmission. To this date the mode of transmission is the most important factor in stopping infectious disease outbreaks (Paneth, 2004). Snow eventually created six rules to prevent contracting cholera that are presented in Table 1.

It appears that Snow led a healthy life with the exception of a kidney problem in 1845 when he was forced to take a break from his work. His death would occur thirteen years later. On June 10 Snow suffered a stroke and died soon after that on June 16, 1858 at the age of 45. An autopsy revealed that he had survived an old case of tuberculosis and his kidneys were shrunken, granular and encysted. At the time of his death Snow was searching for the cause of rickets (Vinten-Johansen et al., 2003).

Joseph Goldberger

Joseph Goldberger was born to Samuel and Sarah Goldberger in the Carpathian Mountain region of Hungary in 1874. Life was difficult for the Goldbergers, and Samuel, a shepherd, moved the family to the United States in 1881 when Joseph was 7 years old. Once in America Samuel opened a grocery store on the Lower East Side of Manhattan

(Akst, 2000).

Reports of Goldberger's childhood and adolescence are scant, but it is documented that upon high school graduation he studied at the City College of New York. After earning a Bachelor's Degree he continued his studies at the Bellevue Hospital Medical School, also located in New York City. While at Bellevue Joseph was taught by Dr. Herman Biggs, then the director of New York City's public health department (Rosner, 2004). Upon completing his medical degree in 1895 Goldberger set off for Williamsburg, Pennsylvania where he opened a medical practice. His career as a practicing physician was apparently unremarkable (Kraut, 2003).

Finding himself bored with the life of a small town physician Goldberger attempted to join the United States Navy as a physician, but was rejected. He was soon successful in his job search as he was hired at the United States Public Health Service (USPHS). Among his first assignments was to investigate a yellow fever outbreak in Tampico, Mexico. While in Tampico he was infected with yellow fever, but did gain lifetime immunity from re-infection. Goldberger subsequently traveled to Puerto Rico where he studied malaria and later went to Brownsville, Texas where he fought dengue fever. Closer to his childhood home, Goldberger studied and battled Schamburg's Disease in Philadelphia and typhoid in Washington, DC (Akst, 2000).

While working at the USPHS Goldberger was introduced to the sister of a colleague. Her name was Mary Humphries Farrar, the daughter of a wealthy New Orleans lawyer. Mary and Joseph were eventually married on April 19, 1906 against the wishes of both sets of parents. Although Goldberger loved his family, which eventually included four children, his work kept him busy and he was often away. It was while he was away that he consistently wrote letters to Mary that are the basis of much of what is presented in the book, Goldberger's War (Kraut, 2003).

Similar to how Snow became interested in studying cholera, a medical circumstance would guide Goldberger to study pellagra. During the spring of 1914 Goldberger was sent to the American South to study the disease. Pellagra is a disease, now known

Table 1.
Six Rules Proposed by John Snow to Prevent Cholera

- 1) Avoid water that might be contaminated with sewage
- 2) Extend the availability of wash basins to the poor
- 3) Everyone coming into contact with cholera victims should be especially attentive to cleanliness
- 4) Linens soiled by cholera evacuations are to be boiled,
- 5) Cholera victims are to be separated from the healthy
- 6) All provisions brought into the home should be boiled in water

(Vinten-Johansen et al., 2003).

to be caused by a lack of niacin (Vitamin B₃) in the diet. Its symptoms include a red rash, acute diarrhea, and dementia. It caused death in about 40% of cases. But, in 1914 some believed the disease to be mosquito borne while still others thought it was infectious (Tulchinsky p 39).

Similar to the scientific techniques used by Snow to study cholera, Goldberger used personal observations and a solid knowledge base in his efforts to discover the cause of pellagra. Both Snow and Goldberger were voracious readers of and contributors to the scientific literature. For example, Goldberger learned that studies done in Illinois had shown that herdsmen were exempt from the pellagra, likely because they ate meat regularly. Goldberger was convinced that pellagra was caused by a nutritional factor when he noted that those with diets low in fish, meat, eggs and milk were particularly susceptible. He also opined that the disease might be caused by over-milling corn, similar to how over-milled rice had been shown to cause beriberi. Additionally Goldberger observed that no people in the military, where food was abundant, acquired pellagra (Kraut, 2003).

Goldberger was able to make the connection between health and socio economic status when he observed that the poor were more apt to get the disease than were the wealthy. This led him to a theme that permeated his work in public health. He understood that individual choices were not the only factor that affected the public's health, as he correctly believed that the causal webs of some diseases included broad social and economic factors that made some groups more vulnerable to disease than others. Without using the exact words Goldberger had described what is now called a "health disparity." He fought hard using pen and podium to change the systems that kept the Southern wage-earners, who typically worked in textile mills, downtrodden (Kraut, 2003).

After observing who was affected with pellagra, Goldberger decided that experiments would be necessary to find its cause. His riskiest studies involved some of the incarcerated at Rankin Prison Farm located near Jackson, Mississippi. After securing approval from the Mississippi governor, Goldberger recruited 12 prisoners for his study. He set out to intentionally trigger pellagra in prisoners by manipulating their diets. The experimental diets were high in salt pork, cornmeal, rice and molasses which were then the staples of the Southern diet. The experimental prisoners were segregated from the remainder of the prison population and mesh netting was put in place to limit prisoner's exposure to mosquitoes in order to eliminate the possibility that pellagra was a vector borne disease. Six of the 11

prisoners who finished the study developed, pellagra while none of the control group did. In another study he intentionally injected 16 volunteers with the blood of pellagra victims and demonstrated that the disease was not infectious (Akst, 2000).

In a subsequent study, which began in April of 1916, Goldberger assessed the influence of living in a southern mill village on the incidence of pellagra. This study employed a cohort design where he followed approximately 400 people who were employed at one of seven South Carolina mills. Among the independent variables in the study were the vitamins and minerals in people's diets, with the dependent variable being the development or non-development of pellagra. The study showed that those who had more known vitamins and minerals in their diets were less apt to develop pellagra. He also showed that no babies got the disease and women were more apt to become diseased than were men. Finally, poverty, as measured by income, was found to predict pellagra. This is an important finding because it was known that food availability in mill homes decreased as income decreased. Accordingly Goldberger fought for cow ownership, crop diversification and attempted to change economic and social conditions in order to bring about changes in disease rates. Changes that were eventually made included the efforts of county agents who taught farmers the importance of crop diversification and dietary variety (Kraut, 2003).

By 1918 Goldberger was in the Army working as a public health officer. One of his first assignments was to battle the Spanish Flu that was killing millions. Again Goldberger led risky experiments such as one where he intentionally infected 62 people (Kraut, 2003). Even though such experiments were commonplace at that time it is hoped that such an investigation would not be allowed in modern day research settings (Elmore & Feinstein, 1994).

During 1921, after the Spanish Flu had run its devastating course Goldberger returned to the lab and searched for the cause of pellagra. He thought that the source of the disease was a lack of an amino acid in the diet, namely tryptophan. It was later learned that tryptophan was not the cause or cure for pellagra. However, Goldberger was virtually correct as tryptophan can be converted to niacin in the body. Goldberger demonstrated in other studies that brewer's yeast, which was inexpensive, could reverse the effects of pellagra in six to ten weeks. Similar to how Snow did not know what it was in the BSP water that caused cholera, Goldberger did not know what it was in brewer's yeast that vanquished pellagra. It was not until 1937 that Conrad Elvehjem at the University of Wisconsin determined that niacin

(Vitamin B₃) prevented and cured pellagra (Science Odyssey, n.d.).

Goldberger became ill and died during January of 1929 of hypernephroma, a rare form of kidney cancer. He was eulogized at Haines Point in Washington, DC and his cremated remains were scattered there. The rabbi who performed the ceremony referred to him as a "Soldier of Science." After Goldberger's death his widow Mary continued his work. She fought for the federal government to provide more money to fund research and wanted a new agency to be created to serve that purpose. Her objective was achieved in 1930 when Herbert Hoover signed the Ransdell Act. The agency that was formed by monies that resulted from the Ransdell Act was the National Institutes of Health (Kraut, 2003).

Conclusions

Although Snow and Goldberger were born 61 years apart and did their scientific work on different continents, they shared numerous characteristics. Both were trained physicians who did not flourish as practicing doctors, and both gravitated to public health where they were much more successful. Other similarities include battling the conventional wisdom of their days. Snow showed that cholera was infectious and Goldberger demonstrated that pellagra was not.

Although Goldberger was nominated for a Nobel Prize, the seminal work of both he and Snow was not widely recognized until after their deaths. The cholera vibrio was identified by Dr Robert Koch in 1884. Similarly University of Wisconsin researchers did not identify pellagra's cause and cure, niacin, until 1937 (<http://www.pbs.org/wgbh/aso/databank/entries/bmgold.html>).

Snow and Goldberger used similar strategies in conducting their investigative work. Both were voracious readers of, and contributors to, the scientific literature and both used observations and statistics to test their hypotheses (Elmore & Feinstein, 1994).

Although it is arguable whether Snow had a personal or family life, both he and Goldberger sacrificed time that could have been spent with family and friends devote themselves to science. Goldberger missed the births of two of his four children while he was away from home. Snow, who never married and apparently had no serious, intimate social relationships was completely dedicated to his work. His apartment on Frith Street and a later one on Sackville Street were full of animals and equipment that he used in his experiments. He also regularly attended and presented his scientific findings at meetings of the Westminster Medical Society, which

met every Saturday night. Lastly both died of kidney-related ailments (Kraut, 2003).

It is clear that these medical crusaders made enormous contributions to public health and science. Contemporary public health officials should be aware of and appreciate the contributions of these pioneers who preceded us in the field.

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