Semmelweis: A Lesson in Epidemiology

King-Thom Chung and Christine L. Case

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During the 19th century, women and their babies were dying in childbirth at alarming rates in Europe and the United States. In some years, as many as one in every four women who delivered their babies in hospitals died from puerperal fever. In 1795, Alexander Gordon, a Scottish physician, wrote that puerperal fever was transmitted "…by a practitioner who had previously attended patients affected with the disease." He recommended that doctors and nurses wash their hands after attending infected patients. The American physician, Oliver Wendell Holmes in 1843 advocated handwashing to prevent puerperal fever. Holmes was horrified by the prevalence of the disease in American hospitals, which he believed to be an infectious disease passed to pregnant women by the hands of doctors. He recommended that a physician finding two cases of the disease in his practice within a short time should remove himself from obstetrical duty for a month. Holmes's ideas were greeted with disdain by obstetricians in the United States. The medical community was not ready to accept the recommendations of Gordon and Holmes.

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Why were physicians reluctant to accept the important of handwashing? Perhaps because they didn't understand the nature of infectious diseases. Robert Koch's work on the Germ Theory of Disease would not come for another 30 years. Or, perhaps the answer was more pragmatic: The lack of indoor plumbing made it difficult to get water. In order to make the water comfortably warm, it would have to be heated over a fire. Additionally, contact with water sources was associated with diseases such as malaria and typhoid fever. A different motive was stated in 1910 by physicians in New York who protested Josephine Baker's program to teach hygiene to child care providers. Thirty physicians sent a petition to the Mayor complaining that "was ruining medical practice by keeping babies well." (1) Concern for the health of mothers and babies has been of concern to many—but perhaps no one was as passionate, or as consumed, as Ignaz Semmelweis.

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Ignaz Philipp Semmelweis was born on July 1, 1818 in either Buda or Pest, Hungary. After completing schooling at the Gymnasium of Buda and the University of Pest in 1837, he enrolled at the University of Vienna Law School. Bored by his law studies, he was fascinated by what he saw when he visited the anatomy lab and he transferred to the Medical School the following fall. The next year, he transferred to the University of Pest Medical School to be close to his family. His parents had eight children to support and the savings incurred living at home may have been important. The facilities at Pest were out-dated and inadequate, however, and in the Fall of 1840, Semmelweis returned to the University of Vienna Medical School where he received both Doctor of Medicine and Master of Midwifery degrees in 1844.

Following his graduation, Semmelweis obtained a position at the Lying-in (obstetrics) Hospital of Vienna General Hospital. Vienna General Hospital was a teaching hospital that accepted patients who were too poor to have private physicians. In 1840, Johann Klein, the new director of the Lying-in Hospital had made procedural changes. The hospital consisted of two clinics: formerly medical students and midwives were instructed in both clinics. Subsequently, medical students were instructed in the First Clinic and Mid-

wives, in the Second. Medical students no longer used a model to learn their practice, now they used adult female and newborn cadavers. The First Clinic became a source of gossip throughout Vienna because the death rate due to puerperal fever in the First Clinic ranged between 13 and 18%, four times that of the Second Clinic. Poor women had learned they had a better chance of surviving childbirth if they gave birth before going to the hospital. (These were called street births.) On arriving at the hospital, the women begged to be assigned to the Second Clinic, although the Second Clinic had more patients and was overcrowded..

Semmelweis studied with exceptional zeal. He spent each morning doing dissections in the pathology lab and each afternoon attending patients in the Clinic. Here, he observed the disease which would become his obsession. He was keenly aware that his patients were terrified and suffering.

There were several hypotheses on the cause of puerperal fever including suppression of lochial discharge and internal fibrin deposits. Unfortunately, no one realized that these were the result, not the cause of the disease. On autopsy, the pus in the cadavers led to the notion that milk accumulated in the body to cause the disease. Some physicians cited the nebulous "influences" of the obstetric hospitals as the cause of the disease.

It is unlikely that Semmelweis had read Holmes's paper on puerperal sepsis published the previous year. Semmelweis was probably at as much of a loss as anyone else to explain the occurrence.

Klein saw that Semmelweis was an industrious student and, in 1846, appointed Semmelweis to Assistant in the First Clinic. The young Assistant's duties included teaching the 44 medical students and performing all clinical examinations.

Puerperal fever is a nosocomial infection that frequently leads to peritonitis and septicemia. The disease begins as an infection of the uterus resulting from childbirth or abortion. *Streptococcus pyogenes*, a group A ß-hemolytic *Streptococcus*, is the most frequent cause. Penicillin and aseptic techniques have made puerperal sepsis an uncommon disease.

Semmelweis collected information from both clinics. One particular fact caught his attention, wealthy women and street births were not examined by the medical students who had spent their mornings dissecting cadavers. The death of his good friend, Jakob Kolletschka, a professor of forensic pathology, in 1847 was a horrible shock to Semmelweis but also provided him a needed insight. Kolletschka had sustained an accidental laceration during an autopsy. He developed lymphangitis in his arm, pleuritis, pericarditis, and peritonitis. Five days later he died. Kolletschka died with identical symptoms and pathology as seen in the puerperal fever patients. An earlier event had stayed on Semmelweis's mind. In 1844, Semmelweis watched the obstetrician Johann Chiari remove a tumor from a patient's cervix. The operation was considered simple and Semmelweis had seen it done many times. A few days later the women died of puerperal fever. Neither patient had given birth and Kolletschka had not been in the First Clinic. Semmelweis had found his explanation, "the transmission of cadaveric particles clinging to the hand, [and] also by ichorous discharges originating in living organisms." (2)

In May 1847, he ordered all medical students to wash their hands with chlorinated lime before entering the delivery room. The mortality rate dropped to under 2%. In October, 12 women in a row of beds became ill and 11 died. Semmelweis logically looked at the first patient examined that day, a woman admitted not for childbirth but because she had a uterine infection. Semmelweis modified the washing procedure to require everyone to wash their hands with chlorinated lime after examining each patient. The staff and students objected because the chlorine irritated their skin and washing took too much time, but generally they complied with the new rule. Semmelweis's success annoyed Klein who had seen the death rate rise under his

administration and his ire caused him to demote Semmelweis.

Semmelweis had used techniques that would later be called the science of epidemiology. This was likely construed as unsound because biological science was discovering the value of controlled experiments during the 19th century. During 1849, Semmelweis let himself be convinced by friends that animal tests would convince the skeptics. He conducted nine experiments that clearly showed puerperal fever in rabbits that were contaminated with cadaver material. Then he abruptly stopped; it was obvious to him that using clinical statistics was a better way to prove the method of transmission and prevention of the disease.

Semmelweis was averse to writing and stubbornly refused to publish his findings. His medical students and associates were promoting his doctrine, however. At one point in 1850, the Board of Studies of the Vienna Medical School voted to study the correlation between puerperal-fever mortality in institutions that did not perform cadaver dissection and those that did. Somehow, the powerful Klein scuttled this move and Semmelweis was not reappointed as Assistant in the First Clinic. His new job as a clinical professor for Theoretic Midwifery should have been a good position but it came with a degrading and embarrassing *restriction to the use of the model for teaching.* Later, it was learned that malicious tampering had changed the wording from *practice on the model and the cadaver*. It was too late; Semmelweis had left Vienna.

In 1850, Semmelweis accepted a position at the University of Pest, where he reduced the incidence of puerperal fever to less than 1%. That same year, Semmelweis's successor in the First Clinic, Karl Braun reported to the Vienna Society of physicians that the handwashing did not prevent puerperal fever. Semmelweis responded in his typical brusque manner that Braun was incompetent or, at best, negligent.

The disease reappeared under Semmelweis's watch in 1856, but this time it was different. When new mothers were infected at parturition, the child was almost always infected as well; this time the children were fine. Semmelweis concluded that the infection was occurring after birth. The women languished for nine days prior to discharge, lying on sheets still soiled from patients who had lain on them before. The cause was not nurses failing to change sheets. The laundry had been taking away bags of sheets and returning bags of unwashed sheets. Semmelweis gathered the smelly bags and barged into the office of the hospital administrator. Dumping the sheets on Statthaltereirat von Tandler's desk, Semmelweis announced that this was the cause of the new outbreak of puerperal fever.

In 1901, the Hungarian Academy of Sciences offered a prize for the best monographs "On the History of Asepsis and Antisepsis, With Special Reference to the Teaching of Semmelweis." The United Nations declared 1965 as Semmelweis year. And, two hundred years after its founding, on November 7, 1969, the Medical School in Budapest was renamed the Semmelweis University of Medicine.

Another puerperal fever outbreak occurred in the 1857–1858 academic year. This time the cause was a nurse who had not changed sheets after infected patients. Semmelweis reported this event in the new Hungarian medical journal, *Orvosi Hetilap*. The publication achieved the desired results—the nurse no longer worked in the hospital—and Semmelweis became a regular contributor to the journal. Semmelweis's doctrine was being promoted in England by James Simpson, and, in the United States Holmes had republished his paper on the cause of puerperal fever.

In 1861, Semmelweis published his only report on his findings concerning puerperal fever. The rambling, 543-page monograph entitled *Die Ætiologie* included all of his data and tables but didn't reflect the brilliant logic he had shown in discovering the method of transmission of the disease. His book was largely ignored. In frustration, he began to

publish Open Letters to opponents of his doctrine. One such opponent was Rudolf Virchow, a German physiologist, who told Berlin obstetricians that puerperal fever was the result of weather conditions. Semmelweis had charts showing that the mortality from puerperal fever varied widely during any single month and could not be due to weather. Instead of using his data, Semmelweis responded in an Open Letter to Virchow that "823 of my pupil midwives…know better than Virchow [and are] more enlightened than the members of the Berlin Obstetrical Society…"(3)

Semmelweis had a wife and three children to provide happy diversions from the tribulations of his professional life. He married 18-year old Marie Weidehofer in July 1857. Eighteen months later, Semmelweis oversaw the delivery of their first child. A physician came to their home and a bowl of chlorinated water was provided for him. The infant son, named Ignaz, died the next day. The diagnosis was hydrocephalus. His second child, a daughter, died at four-months of age from peritonitis. Their next three children born in 1861, 1862, and 1864 were all healthy.

Semmelweis could not separate his belief in handwashing from himself. When physicians disagreed with the practice of handwashing, Semmelweis took it as personal abuse**.** In the course of his family tragedies and controversies with unbelieving colleagues, Semmelweis's behavior became increasingly erratic. He was tormented by the continuing outbreaks of puerperal fever. The rate of infection at the Paris Maternité was 12% in 1861. Perhaps he thought about his own role in spreading the disease through his many mornings spent in dissections. His wife, embarrassed by his bitter and emotional displays, contacted his medical associates for assistance. He was persuaded to have himself committed to a sanitarium in Vienna. In the sanitarium, a physician noticed that Semmelweis had a cut on one finger, probably the result of surgery. The wound became gangrenous and septicemia spread the bacteria to other organs. Ignaz Semmelweis died of puerperal fever on August 13, 1865.

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Twenty-four years later, a speaker at the Academy of Medicine in Paris expressed his skepticism that disease could be spread by hands. An outraged member of the audience shouted at the speaker "The thing that kills women with [puerperal fever]…is you doctors that carry deadly microbes from sick women to healthy ones." (4) The man who shouted was Louis Pasteur who had, that year, observed *Streptococcus pyogenes* in the blood of puerperal fever patients.

In 1995, Stole and Lanky (5) stated that "iatrogenic disease usually reveals not error, but ignorance." This was undoubtedly true of Semmelweis's colleagues. Antibiotics and autoclaves have solved many of the early problems of infection but, according to the Centers for Disease Control and Prevention (CDC), "Handwashing is the single most important means of preventing the spread of infection."(6) Handwashing is taught at every level of school, advocated in the work place, and emphasized during medical training. Yet, recent studies indicate that lack of or improper handwashing still contributes significantly to disease transmission. In 1997, a report published by researchers at the CDC revealed that hands were washed before an interaction 27% of the time in a long-term care facility. (7) A 1996 study by researchers at Ohio State University College of Medicine identified handwashing rates as low as 31% in an emergency department. (8) Approximately two million nosocomial infections occur each year in the United States. $500 million would be saved if just 17% of the nosocomial infections were prevented. (9) This money could be saved for such things as cancer or AIDS research.

Semmelweis might feel vindicated by the acceptance of his idea. Would he still feel the same frustration with the medical community's failure to adopt this behaviorial change?

References

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