Biography

Historical Moments in the Recognition of Hand Hygiene for Control of Infections: A Short Biography of Ignaz Philipp Semmelweis (1818-1865)

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In recent years, numerous articles have attested to the value of handwashing in the prevention and control of diseases. In fact, it has been touted as the "single most important measure for preventing nosocomial infection."[1] However, the contention for its efficacy was not accepted readily, and even today implementing the procedure is problematic.[2] Convincing healthcare providers that handwashing is paramount to preventing transmission of diseases has been painstakingly slow. Of the proponents for implementing procedures for good hand hygiene, 3 are especially prominent, Moses Maimonides, Oliver Wendell Holmes, and Ignaz Philipp Semmelweis.

Moses Maimonides was born in Cordova, Spain in 1135, the son of a prominent rabbi, Maimonides. In the midst of financial devastation and the death of his business partner and brother David, Maimonides turned to medicine. In addition to becoming the chief rabbi of the large Jewish community in Cairo, he began practicing the healing arts for his monetary support. His lectures to his students were true to the tradition of the Talmud and the Bible, in which ablution is promoted, and included an emphasis on the merits of cleanliness: "Never forget to wash your hands after having touched a sick person," he is quoted as saying.[3]

Six hundred years after Maimonides' death, the American physician and author Oliver Wendell Holmes reiterated the importance of cleanliness in his essay, "Puerperal Fever, as a Private Pestilence," which was first published in 1843.[4] Although Holmes was convinced that the fever was transmitted from patient to patient by none other than the doctors and nurses attending them, he never was certain of its specific means of transmission. Furthermore, most of the physicians of his time rejected his theory, and accompanying the discrediting of the contagious nature of puerperal fever was that of the importance of handwashing.[3]

Although these and other individuals, including Guiseppe Alessandro Giannini (1774-1818), postulated the theory of control of diseases through the use of sanitary measures, the individual to whom the medical profession primarily is indebted is Ignaz Philipp Semmelweis. He not only promoted but also proved the importance of handwashing by developing a methodology that was particularly astute and unprecedented in his time. Unlike Holmes and other medical researchers, who characterized puerperal fever simply by its symptoms, Semmelweis explained its cause and why certain symptoms of the disease occurred.[3] This article takes a brief look at his life and his contribution to the control of infectious diseases.

Childhood and Adolescence

Semmelweis was born in July 1818 in Ofen, Hungary, the fourth child of Joseph and Therese Semmelweis. His ancestors had come to Pest along with other Germans invited by the Austrian rulers, who thought that the German blood would help dilute the rebellious passions of the Hungarians. His parents were storekeepers who netted a comfortable income that also was sufficient for providing education for their 8 children. Although he received a good education, Ignaz found the combination of the German spoken by his Austrian schoolmasters and the Hungarian street talk confusing, and for his entire life he suffered from a profound lack of confidence in his ability to speak or write either language.[5] Nevertheless, he managed to complete grammar school, the Gymnasium of Buda, and a philosophy curriculum at the University of Pest.[6] Because his father had planned for him to become a part of the legal and accounting department of the Imperial Army, Ignaz was sent to Vienna to prepare for that career. He arrived at the University of Vienna on November 8, 1837. He was only 19 years old and completely unsuited by temperament for the technicalities of imperial law. Further, the environment in Vienna was less than welcoming: the Viennese tended to tolerate Hungarians as though they were uncouth children. Semmelweis soon bristled at their attitudes and longed to return to his city of gardens and promenades. Hence, he was in a particularly receptive mood when a friend he met at a coffeehouse invited him to visit an anatomy class. His medical career was about to begin.[5,6]

Medical Training

Attendance at one dissecting session and a lecture was sufficient to convince Semmelweis to terminate his legal

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studies, and he promptly paid his medical tuition and embarked on a career in which he had a personal interest. He remained at the Vienna Medical School for little more than a semester, however, because the taunting of the Viennese students proved to be more than he could endure. He would have left sooner had his mentor, a brilliant professor named Josef Skoda, not intervened and attempted to mitigate matters. Despite the common bond he had with Skoda, who also came from a scorned area and was a rebel by nature, Semmelweis returned to Budapest to continue his medical studies. He spent 2 years at the New School of Medicine in Budapest studying the required courses in chemistry, pathology, therapeutics, anatomy, and physiology. Although he did not have to contend with the attitudes that had troubled him in Vienna, he was dissatisfied in Budapest, finding the school less inspiring than the University of Vienna.[5]

In 1841, he returned to Vienna, where Skoda, who was to become a lifetime mentor and friend, and another Bohemian professor, Karl von Rokitansky, sought to direct Ignaz toward orderly laboratory research. He was unwilling to devote his life to research, however, considering the questions they raised too abstruse—and he was not interested in writing papers, a matter that would later adversely affect the acceptance of his scientific findings. When the time approached for Semmelweis to submit and defend his doctoral thesis, he was seized by what was to become a recurrent condition, a "spiritual crisis," and he took a detour away from medicine and into botany. His thesis, entitled "*Tractatus de vita plantarum,*"[7] celebrated in elaborate prose the glories of the rhododendron, daisy, and peony and suggested that the aesthetic phenomena of the plants were beyond human comprehension and were to be appreciated only by the principles of "natural philosophy." Although the thesis gave only the barest nod to prosaic science, it was accepted, possibly because a prominent member of the jury that examined the young candidate was Josef Skoda, and Semmelweis was awarded the degree of doctor of medicine.[5]

Before he could attend the ceremonial conferral of his degree, he had to rush back to Budapest to be with his dying mother. His absence from the ceremony was regarded by some individuals as impetuous behavior, a trait that was repeated later in life often to his disadvantage.[8,9] While he was in the city, Semmelweis considered briefly settling there because his MD provided the credential he needed to establish himself as a general practitioner, and his father's health and income were declining. In the end, however, Vienna won out, and Semmelweis left his beloved city to return to the welcoming reception of the faculty who "saw in him an *enfant terrible* of enormous promise."[5] Among his well-placed friends were, in addition to Skoda and von Rokitansky, Ferdinand von Hebra, an acknowledged innovator in the treatment of skin diseases, and Jakob Kolletschka, a professor of forensic medicine. They once again sought to steer their young protégé toward research, but he decided instead to pursue a graduate course in surgery and midwifery.[5]

During his training in surgery, Semmelweis became particularly distressed with the number of operations that ended fatally or produced intractable infections. He could not understand the disinterest in seeking to find out, as he wrote to a friend, "why one patient succumbs rather than another in identical circumstances." The indifference left him very discouraged.[5] At one point, he applied for a position on Skoda's staff, but he lost out to a competitor and resumed his studies in obstetrics. By 1845, he had passed all the qualifying examinations for degrees in surgery and obstetrics. In February 1846, he succeeded in obtaining the position of first assistant to Professor Johann Klein in the Lying-in Hospital, a division of the Allgemeines Krankenhaus, or General Hospital of Vienna. His association with Klein was to become a bitter war between the older man, later described as an arrogant and "evil antagonist, armored in invincible stupidity and bureaucratic power," and the young, sensitive, and somewhat impetuous challenger of acceptable procedure.[5]

Early Medical Career

Upon assuming charge of the First Obstetric Clinic, Semmelweis encountered an appalling death rate from childbed fever of 11.4 to 18 percent. The rate was 3 to 4 times worse than that of the Second Clinic, which was in the hands of a staff of midwives. The difference between the 2 clinics was so conspicuous that the patients themselves begged to be placed in the Second Clinic rather than in Dr Klein's First Section, which they associated in their minds with the stench and anguish of death.[6,10] Indeed, they preferred to give birth in the street or in their homes unattended to being placed in the First Section.[5] Because the Second Section also was publicly funded, a pregnant unmarried woman could be attended in childbirth and later have the child placed for adoption or in an orphanage. To do so, however, she had to agree to 2 conditions: to allow herself to be used for teaching purposes throughout labor and delivery and to serve as a wet nurse in the foundling hospital for as long as she was able. To avoid having to meet these criteria, women often opted for the waiver that applied if the mother gave birth while on the way to the hospital: they would give birth at home or on the street and then be rushed to the hospital, where they and their children would receive the desired medical attention.[5,6] These incidents occurred at a rate of approximately 100 per month.[5] What Semmelweis found particularly disturbing was that the Second Section's lower mortality rates and incidences of puerperal fever included these women who had given birth under the least favorable and least sanitary circumstances. He became convinced that the secret to the problem lay hidden in the different operational procedures being used in the 2 Sections. He began to systematically address those differences, having the Sections use each other's various procedures, such as delivery positions.[6]

However, no changes occurred in the mortality rates, and Semmelweis managed only to incur the sneers of the midwives and the displeasure of Johann Klein.[11] Heated

discussions with the students and staff, which were reported to Klein, exacerbated the mounting tension between the 2 men. Semmelweis' suspicions began to sound like the "new-fangled" contagion theories that were being propagated by the British and were anathema to Klein. After 5 months, they were no longer on speaking terms. When Semmelweis insisted on continuing his investigations, Klein was infuriated and demoted him to the rank of "aspirant" and shortly thereafter terminated him. Health Ministry officials investigated the situation, but rather than making a martyr of the fierce Hungarian resident, they drafted a report suggesting that the number of incidences of puerperal fever in the First Section probably was a result of too many examinations of the women's genitalia in the course of teaching exercises. Although their proposal that the male students were rougher than the female midwives was considered absurd by most physicians, they inadvertently provided an important clue that Semmelweis later would recognize.[5,6]

Being dismissed in the first year after medical school humiliated Semmelweis, but he soon was restored after Skoda and von Hebra succeeded in securing an official promise that the young man would be reappointed after an interval to allow tempers to sooth. Semmelweis took advantage of the time by going on holiday to Italy with his friend Lajos Markusovszky (Marko). When they returned 2 months later, Semmelweis was shocked and distressed to learn of the death of his friend Kolletschka. Grief-stricken, Semmelweis obtained copies of the death record and autopsy reports and began studying them in detail. He learned that his friend had been performing an autopsy when a student accidentally jabbed Kolletschka's finger with a scalpel that had been used on the cadaver. The next day, Kolletschka suffered throbbing pain and then observed the red streaks of lymphangitis advancing up his arm. The autopsy report noted bilateral pleuritis, pericarditis, peritonitis, meningitis, multiple abscesses, and metastasis of the infection to one eye. The findings were similar to not only those of other accidents and surgery casualties, but also, to a surprising degree, those Semmelweis had observed in the many hundreds of women who had died of puerperal fever. As he contemplated the findings, which he noted pursued him "day and night," Semmelweis began to recognize other similarities between his friend's death and those of the women: the students who examined the pregnant women and their infants in the First Section also had participated in autopsies, whereas the midwives in the Second Section had had no such contact.[5,6] Writing to his friend Marko, Semmelweis noted that, "It must be the fingers of the medical students, soiled by recent dissections, that carry those death-dealing cadaver's particles into the genital organs of women in childbirth—especially to the level of the cervix of the uterus."[5]

Semmelweis' discovery brought a mixture of excitement and agony. Finally, he was beginning to see the connection between the deaths and the procedures on First Section, but to his horror he realized that he himself had gone directly from performing autopsies in the morgue to examining the women in First Section. He immediately posted notices in First Section requiring that all students and doctors entering the wards for the purpose of making an examination wash their hands, both before and between examinations, with a chlorine solution he provided. The previous minimum death rate of 7 percent dropped to 2.38 percent almost immediately, and in successive months it was down to less than 2 percent.[5,7] By the end of 2 years, the clinical mortality rate in Klein's wards had been reduced to 1%.[12]

Taking his theories into the laboratory, Semmelweis and Georg Lautner, an assistant to von Rokitansky, were successful in showing transmission of fatal puerperal fever to parturient rabbits directly after delivery by introducing pus recovered from the vaginal tract of women dying of the fever. Sepsis did not occur when chlorinated lime also was introduced into the rabbit's vagina. He considered these findings in light of the absence of the fever among the women who delivered outside the hospital or who delivered themselves in the hallways or staircases. Despite his striking findings, Semmelweis was not able to convince his colleagues to support his theories.[12] Nevertheless, Semmelweis continued to insist that handwashing procedures be used by everyone attending the women.

As a result of this insistence, an outright war broke out between him and Klein. The Chief refused to have any part in an investigation Semmelweis requested of the Imperial Commission; students who sought the Chief's favor would try to sabotage the disinfection efforts. Klein made sure that Semmelweis had to struggle for supplies, and every lecture Klein gave was tinged with sarcasm concerning the chlorine washings. Then, suddenly, in October 1847, disaster struck the First Section. Twelve women in 2 rows of beds developed puerperal fever, and 11 of them died, despite the students having washed their hands before beginning their examinations. At a loss to explain what had happened, Semmelweis began an investigation and learned that the first woman examined had had a copiously discharging carcinoma of the uterus. Semmelweis had scrubbed with the chlorine solution before examining her, but he had used only soap and water for examinations conducted thereafter. His conclusion was that infections could be spread from one patient to another by the examining physician, and he commanded that his students begin washing with the chlorine solution before examining any patient. Again, the mortality rate subsided. Subsequently, when 8 women died and their deaths were traced to a woman with a draining infection of the knee, Semmelweis concluded that unventilated air in the ward might be responsible for the spread of infection, and he insisted that patients with discharging infections be kept in isolation. Once again, the mortality rate dropped.[5,6]

Unfortunately, although Semmelweis kept copious notes, he refused to report his findings in medical journals, partly because he was still self-conscious about his poor language skills and he feared that he could not articulate his thoughts sufficiently.[9] For the most part, the early publications were those of his colleagues. In 1847, von Hebra wrote of his friend's discovery in a brief editorial published in a local Viennese medical journal, and the next year, he published in the same journal a second paper in which he compared Semmelweis' findings with Edward Jenner's.

These articles are considered the first publications of Semmelweis' findings, but in fact they have a precursor finally recognized in 1991. In a letter written by Semmelweis to Professor Carl Edvard Marius Levy in Copenhagen, the former explained his theory in far more detail than did von Hebra's letter, which was published at approximately the same time. Levy published Danish translations of the letter and of von Hebra's announcement, along with a critical response, in "The Etiology" (for an English translation of the letter, see Carter et al[13]). In addition, in 1848, his student Charles H.F. Routh wrote a lecture on the causes of the endemic puerperal fever; it was delivered in London and subsequently published in a British medical periodical. A few months later, another student, Friedrich Weiger, published a similar essay. In October 1849, Skoda gave public recognition to Semmelweis' theory in an address to the Academy of Sciences in Austria. Skoda also published his remarks, with the result that Semmelweis was elected to membership in the Academy. Finally, in May 1850, Semmelweis himself delivered a lecture to the Viennese medical association; although the lecture was never published, an official account of the meeting was published, as were responses by several persons who participated in the discussion of the lecture. Likewise, von Rokitansky made a strong statement supporting Semmelweis.[13]

These instances call into question some of the "mythology" surrounding Semmelweis, particularly the picture of the lonely, misunderstood figure who fought almost universal opposition but was overwhelmed by sheer weight of numbers and influence. Indeed, they show that Semmelweis actually had much support from influential friends. One hypothesis regarding his failure to achieve his potential is that he lived out a self-fulfilling prophecy. According to this theory, he was unable to shake the self-perception of being a maladroit, graceless outlander speaking the wrong dialect and rejected for the right university jobs, being similarly unable to accept the reality of his genius and sense of worthiness. At the same time, juxtaposed with the poor self-image was the "typical" opposite: a megalomania, rage, and grandiosity that swept him to ruin.[9]

Regardless of the psychological or political factors affecting Semmelweis' career, his investigations suddenly were interrupted: revolution struck Europe in 1848, bringing to a halt the progress he was making. Semmelweis enlisted in the Academic Legion and volunteered to fight for a constitutional monarchy, but the war efforts were overcome quite quickly, and he returned to the hospital.[5,9]

With the failed revolution of 1848, Semmelweis found himself in precarious positions, both politically and professionally. Although Skoda and other colleagues pushed for a resolution by the medical faculty to initiate an official commission to study Semmelweis' findings, Klein persuaded the Ministry of Education to skuttle it. In the spring of 1849, Klein refused to renew Semmelweis' appointment. The younger man applied for a post as a privatdocent (clinical professor) of midwifery at the University of Vienna Medical School. In the interim, Semmelweis began experiments on animals, but his investigations were interrupted when his research assistant was arrested on trumped-up charges of revolutionary activities. Although the assistant later was released, other researchers were afraid to collaborate with Semmelweis. In 1850, he finally got his appointment as privatdocent, but the initial statement indicated that it came with a humiliating condition: Semmelweis was limited to using only a mechanical model of a woman, called a "phantom," rather than cadavers. Although the actual appointment drafted by the Ministry of Health included the use of a cadaver for lectures, by the time it was presented Semmelweis had fled to Budapest.[5] His departure was so abrupt that he failed to even bid farewell to his loyal friends, an instance of thoughtlessness that may have been the greatest mistake of his career.[6]

The Budapest Years

When Semmelweis arrived in Budapest, the political climate was tenuous, and the scientific community had been silenced for all practical purposes: the primary medical journal was not being published, scientific meetings were banned unless military personnel were in attendance, and the most distinguished teachers had been killed or imprisoned. Semmelweis' work was unknown, and he sought a position in a department headed by an individual who had his own theories about puerperal fever: women needed merely to be given sufficient laxatives to purge their systems. The death toll was high, and Semmelweis noted that the chief obstetrician also was the coroner. After finally receiving an appointment as privatdocent in the University of Pest, Semmelweis gradually began to introduce his theory of using chlorine washings, with the result that the number of incidents of puerperal fever decreased and his reputation as an obstetrician was established.[5] During this time, his introspection and disregard for common courtesies in his dealings with other individuals became more pronounced, perhaps an indication of the tragedy to befall him at the end of his life.[6]

In 1855, his superior died, and Semmelweis was appointed to the post of professor of theoretical and practical midwifery, providing him the freedom and authority to pursue his crusade against puerperal fever. Also, the political situation had abetted: the journal was being published again, and medical meetings could be held without police in attendance. Semmelweis responded by publishing his findings in journals. Progress was checked, however, when 2 outbreaks of puerperal fever occurred in the hospital, one of which was attributed to negligence in the laundry room and the other to that of a nurse who had not changed the bed linen as ordered. Semmelweis terminated the nurse, who had influential friends and in turn began a battle involving charges and countercharges. In response, Semmelweis launched an attack against the Health Ministry, using inflammatory language and calling the hospitals "murder holes." In 1858, 11 years after formulating his theory, Semmelweis finally published his reasonings about puerperal fever.

During these past several years, Semmelweis had married, and his wife had borne 2 children, both of whom had

died, the first of hydrocephalus when less than 36 hours old and the younger at 4 months of peritonitis.[5] Despite the tragedies at home, Semmelweis turned his attention to a crusade abroad, one that was to prove as painful as the earlier attempts to convince physicians to institute good hand hygiene. Although the British were introducing chlorine handwashes into maternity wards, elsewhere his ideas were being rejected, and even Rudolf Virchow attacked Semmelweis, arguing instead that puerperal fever correlated with changes in the weather. Semmelweis countered with a scathing open letter. The issue enraged him and served as the catalyst to put his findings in writing, finally. The result was a massive work entitled *Die Aetiologie, der Begriff und die Prophylaxis des Kindbettfiebers*[14] (*The Etiology, Concept, and Prophylaxis of Childbed Fever*[15]), published in 1861.[6] Unfortunately, in addition to providing extensive research and clinical observations, he added a second section in which he used lofty messianic terms to attack the individuals who had doubted his findings. That same year, he wrote a highly inflammatory open letter to *The Medical Weekly* in which he attacked a professor who attributed puerperal fever to inflammation of the fallopian tubes, calling him a participant in the "massacre" of thousands of women. Other open letters followed, but had little effect, and when reports reached him of epidemics in other countries, Semmelweis fell into rages, attacking not only enemies but former friends.[5]

Mental Decline and Death

The turbulent professional life he had led finally took its toll in the form of mental illness. After a short respite, during which he turned his attention to new procedures being devised for gynecologic surgery and performed the first ovariotomy in Hungary, his rages returned, and his conduct became increasingly unpredictable and eccentric. His lectures to his students became almost incoherent. One incident that has become famous was told by his former assistant Josef Fleischer, who recounted that when Semmelweis was suppose to give a report about filling a vacancy of a lecturer's post in his department, instead he stood, reached in his trousers pocket, and to "the astonishment of those present, began to read the text of the midwives' oath. There being no doubt any longer about his condition, his astounded colleagues took him home" (quoted on p 258).[16] Although the incident has gained considerable notice, the account has been questioned by certain authors, who note distinct discrepancies between it and other facts.[16]

Finally, in July 1865, his wife, an uncle, and an assistant escorted Semmelweis to Vienna, where they were met by von Hebra. Semmelweis was taken from the station to an institution for the mentally ill. The next day, his wife was refused access to him, and when she became ill herself, Semmelweis was left with only the guards and his memories. On August 13, 1865, he died, ironically of infection supposedly from a wound to the finger that he incurred while dissecting a cadaver.[5,6,8,12,16]

More recently, incidents regarding physical abuse in the hospital have come to light with the release of the medical records and the autopsy report on his body. In 1963, the body was exhumed and moved to a new location inside the courtyard wall of the house in which he was born (now a medical history museum named in his honor). The papers were released 14 years later, in 1977, when Georg Sillo-Seidl, a Hungarian physician and writer, obtained from the Vienna archives photocopies of a collection of documents concerning Semmelweis' illness and death. Sillo-Seidl presented the photocopies to the Hungarian Society for the History of Medicine on March 2, 1977, almost 112 years after Semmelweis' death. The next year, Sillo-Seidl published a book about his efforts to obtain the documents, along with transcriptions of the photocopies. The book, written more like a spy novel and intended for a popular audience, was denounced by Hungarian historians for its sensationalism and lurid conclusions, among them the idea that Semmelweis was murdered by his in-laws and prominent Hungarian physicians. That same year, by agreement with Sillo-Seidl, photographs of the documents, transcriptions, and translations, as well as scholarly discussions of the historical significance of these texts, were published in the Hungarian journal for the history of medicine.

In 1995, English translations of the 5 documents, along with accompanying comments, were published. The authors of that article note several discrepancies in the letters, several of Sillo-Seidl's conclusions regarding them, and significant oversights. One such oversight was the failure to call a priest to perform final sacraments, despite the knowledge that Semmelweis was a Roman Catholic and that he obviously was dying. The autopsy report is quite different from the reports that circulated immediately after Semmelweis' death and that have served as the basis for the supposition that he died of an injury to the finger. Instead, it reveals major injuries that could have been sustained only in beatings to which Semmelweis was subjected while in the asylum: serious injuries of the bones; purulently decomposed and deficient tissues on the hands, arm, and legs; stinking gas between the pectoral muscles; a large tearing hole in the pleura surrounded by a fist-sized ichorous center between the pleura and the pericardium; and evidence of inflammation in the cerebrum and in the myelon.[16]

On August 15, 1865, Semmelweis' body was buried in the Schmelzer cemetery in Vienna. Only a few persons were in attendance, most of them from the Vienna Medical School. Only one individual from Budapest, Semmelweis' longtime friend Lajos Markusovsky, attended. No family member, in-law, or colleague from the University of Pest was in attendance. Semmelweis' wife explained that her absence was because she had become so ill after his committal to the institution that she was in bed for 6 weeks. The Budapest medical weekly gave a brief notice of his death, but the Budapest newspapers contained only single-sentence announcements. Two weeks after his death, members of the Hungarian Association of Physicians and Natural Scientists were on an excursion. The statutes of the association required that a commemorative address be delivered in honor of members who had died the preceding year. However, no address was given for Semmelweis; neither then nor in coming years was his name mentioned. The

statutes of the Pest Association of Physicians required that a eulogy be given for each deceased member in the year of his death, but 7 years elapsed before one was done for Semmelweis. Only in more recent years has his work been given appropriate credit.[16]

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