Rediscovering Ignaz Philipp Semmelweis (1818—1865)

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Ignaz Philipp Semmelweis was a Hungarian obstetrician who discovered the cause of puerperal or childbed fever (CBF) in 1847 when he was a 29-year-old Chief Resident ("first assistant") in the first clinic of the lying-in division of the Vienna General Hospital. Childbed fever was then the leading cause of maternal mortality, and so ravaged lying-in hospitals that they often had to be closed. The maternal mortality rate (MMR) from CBF at the first clinic where Semmelweis worked, and where only medical students were taught, was 3 times greater than at the second clinic, where only midwives were taught, and Semmelweis was determined to find out why.

Semmelweis concluded that none of the purported causes of CBF could explain the difference in MMR between the 2 clinics, as they all affected both clinics equally. The clue to the real cause came after Semmelweis' beloved professor, Jacob Kolletschka, died after a student accidentally pricked Kolletscka's finger during an autopsy. Semmelweis reviewed Kolletschka's autopsy report, and noted that the findings were identical to those in mothers dying of CBF. He then made 2 groundbreaking inferences: that Kolletschka must have died of the same disease as mothers dying of CBF, and that the cause of CBF must be the same as the cause of Kolletschka's death, because if the 2 diseases were the same, they must have the same cause.

Semmelweis quickly realized why the MMR from CBF was higher on the first clinic: medical students, who assisted at autopsies, were transferring the causative agent from cadavers to the birth canal of mothers in labor with their hands, and he soon discovered that it could also be transferred from living persons with purulent infections. Bacteria had not yet been discovered to cause infections, and Semmelweis called the agent "decaying animal organic matter." He implemented chlorine hand disinfection to remove this organic matter from the hands of the attendants, as soap and water alone had been ineffective.

Hand disinfection reduced the MMR from CBF 3- to 10-fold, yet most leading obstetricians rejected Semmelweis' doctrine because it conflicted with all extant theories of the cause of CBF. His work was also used in the fight raging over academic freedom in the University of Vienna Medical School, which turned Semmelweis chief against him, and forced Semmelweis to return to Budapest, where he was equally successful in reducing MMR from CBF. But Semmelweis never received the recognition that his groundbreaking work deserved, and died an ignominious death in 1865 at the age of 47 in an asylum, where he was beaten by his attendants and died of his injuries.

Fifteen years later, his work was validated by the adoption of the germ theory, and honors were belatedly showered on Semmelweis from all over the world; but over the last 40 years, a myth has been created that has tarnished Semmelweis' reputation by blaming the rejection of his work on Semmelweis' character flaws. This myth is shown to be a genre of reality fiction that is inconsistent with historical facts.

Key words: autopsy, childbed fever, chorioamnionitis, germ-cell theory of disease, hand disinfection, history of medicine, Joseph Lister, maternal mortality, puerperal fever, revisionist myth, Semmelweis University, Vienna Medical School

"The discovery of Semmelweis was possible only for a man… whose intellect was kept keen and alert because of the warmth of his human sympathy."

—Sir William Sinclair

The year 2018 marked the 200th anniversary of the birth of the Hungarian obstetrician Ignaz Philipp Semmelweis, who was responsible for saving the lives of more pregnant women than any other obstetrician in history, and for which he earned the epithet "The Savior of Mothers." No other obstetrician has had so many honors showered on him after his death, or has been treated so unjustly during his lifetime as Ignaz Semmelweis.

Semmelweis was touched with genius. Before the age of 30, while he was still a first assistant (the equivalent of Chief Resident or Lecturer), he elucidated the cause of childbed (puerperal) fever with what Professor Fritsch of Breslau described as "the annihilating logic of his statistics."[1] He also proved that the disease could be prevented in most cases if the attendants disinfected their hands with a chlorine solution before examining women in labor. The importance of Semmelweis' discovery in saving lives was compared to that of Jenner's cowpox inoculations by Semmelweis' contemporary Ferdinand Ritter von Hebra,[2] and by one of Semmelweis' earliest biographers, Sir William Sinclair, Professor of Obstetrics and Gynecology at Manchester University, England, who wrote:

"In the whole history of medicine, we find a clear record of only two discoveries of the highest importance in producing direct and immediate blessings to the human race by the saving of life and the prevention of suffering. These were the discoveries of Edward Jenner and Ignaz Philipp Semmelweis."[1]

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But the significance of Semmelweis' work transcended his immediate results. Semmelweis himself saw as his main contribution the claim that every case of childbed fever, without exception, had only 1 cause, and not multiple causes, as all his contemporaries believed.

> "The most important difference between my opinion and the opinion of the English physicians," Semmelweis wrote, "consists in this: in every case, without a single exception, I assume only one cause, namely, decaying organic matter, and am convinced of this."[2]

We know that cause today as β-hemolytic streptococcus, Lancefeld group A.[3,4]

Semmelweis' insight was far ahead of its time, and immensely important to the development of modern concepts of disease. Its significance was not understood either by Semmelweis' contemporaries or by his latter-day critics, who have attributed to dogmatism his insistence that all cases of childbed fever had the same cause.[5] But, as Professor Carter has shown, Semmeweis' groundbreaking idea that specific diseases had necessary causes "provided a model for subsequent research [and] directly influenced the rise germ theory";[7,10] indeed, modern medicine began with the "the rise of causal concepts of disease" of which Semmelweis was the progenitor.[8] And even today, researchers in the philosophy of science continue to debate Semmelweis' methodology,[6,9] and Professor Gillies of University College, London, has said that "Semmelweis' investigations of puerperal fever are some of the most interesting in the history of medicine."[7–10]

A hospital, a street, and the University in Budapest are now named after Semmelweis, and 9 films, 3 plays, and even an opera have been made about his life.[11] Busts and statues of Semmelweis can be found all around the world, the latest erected in 2105 outside Tehran University in Iran, and his marble statue is 1 of the "Immortals" that stands in the International Hall of Surgical Science in Chicago honoring the 10 greatest physicians in history.[11] The United Nations Educational, Scientific and Cultural Organization (UNESCO) officially recognized the 100th anniversary of his death in 1965, and Austria honored it by issuing a commemorative stamp bearing Semmelweis' likeness.[11] But the accolades came only after his death: Semmelweis never received the credit and recognition that his work deserved during his lifetime.

For all its triumphs, medicine has a dark history of opposing new ideas and those who proposed them. The contumely with which advocates of lumpectomy for the treatment of breast cancer were derided by "master surgeons" who were mutilating women with radical and ultra-radical mastectomies[12] provides a relatively recent example. This dark history exacted a terrible toll from Semmelweis. And even today, after all the accolades have been bestowed and statues erected, his reputation has been newly tarnished by reinterpretations of the events of his life that portray him as a deeply troubled man whose character flaws were solely responsible for the rejection of his work during his lifetime.[5,13–16] These, as we shall see, are faux histories written neither by medical historians nor obstetricians that cannot withstand scrutiny.

His Early Life

Semmelweis was the son of a wealthy grocer, the fifth of 10 children. He was born and lived on the Buda side of the Danube, the great river that barrels through the heart of Budapest, Hungary's capital twin-city. He was of German descent, and Austria has tried to claim him as 1 of its sons, but Germans have been living in the Carpathian basin continuously since the 10th century, when Hungary's first king and patron saint, St. Stephen, married the Bavarian princess Gisela in 966.[17] Semmelweis' ancestors moved to Hungary in the 16th century, and Semmelweis was Hungarian through and through.[18]

By the turn of the 19th century, Budapest had eclipsed Vienna architecturally, culturally, and intellectually,[19] but when Semmelweis was born, Buda, which had not yet been united with the city of Pest, was a commercially bustling but academically backward provincial town, and the education Semmelweis received at the Catholic gymnasium was said to be "deficient" by Viennese standards.[1] Still, he graduated with honors (*secundus eminens*) in 1835, studied philosophy for 2 years as required of all prospective university applicants, and enrolled in the University of Vienna in 1837 to study law at his father's request.[18] He switched to medicine after a year, spent 2 years in Pest after his first year before returning the Vienna in 1841 to finish his clinical studies, and graduated in 1844.[18] His Doctor of Medicine degree was conferred in April 1844, his Master of Midwifery diploma in August 1845, and in November 1845 he graduated as an operating surgeon.[18]

A contemporary described Semmelweis as "of a happy disposition, truthful and open-minded, extremely popular with friends and colleagues";[1,18] and later in life, he was referred to as "the genial Semmelweis" in an obituary of a different physician (Mayrhoffer).[20] He was said to be playful and popular, and did not mind being teased. He and his friends frequently visited his family's country estate in Sopron. But after graduation, he threw himself wholeheartedly into all his many activities, and became an ambitious, diligent, meticulous doctor.[18]

Semmelweis is said to have had "a mental block when it came to writing up and publishing his work."[10] This is difficult to accept, as when he finally did put pen to paper to write his treatise, *The Aetiology, Concept and Prophylaxis of Childbed Fever* (*Aetiology*), he wrote well and very clearly, and made complicated arguments extremely lucidly, even when judged by a translation in which "there [was] no effort to render Semmelweis' German into anything like polished English."[21]

Professor Carter has noted that "the original edition of *Aetiology* is much better written than most scholars seem to believe,"[2] and Professor Gillies said Semmelweis "stated his views clearly, and often developed incisive arguments in their favour."[10] Semmelweis himself attributed this "mental block" to "an innate aversion to every form of writing,"[2] but there may have been more substantive reasons.[22] In any event, the rejection of his views about the origin and prevention of childbed fever cannot

be attributed to a delay in publishing his results (see below).

The Tenor of His Time

Political climate

Semmelweis was born on July 1, 1818, three years after Napoleon's defeat at Waterloo, and the ratification of the Treaty of Chaumont at the Congress of Vienna that ushered in an age of conservatism after 25 years of almost continuous war. Borders were redrawn to establish a balance of power in Europe; civil rights and self-government by ethnic minorities within multi-ethnic empires were ignored, and there was an inevitable reaction. This occurred in 1848, when revolutions swept across Europe in what is called the "Springtime of the People." They started in January in Venice and Naples, spread to Paris in February, and engulfed the Austrian empire on the 13th of March. Two days later, the uprising in Hungary began; it escalated into a War of Independence from Austria in September, and ended a year later with Hungary's defeat by the joint forces of Austria, Croatia, Transylvania, and Russia.[23] Semmelweis saw Hungary lose a war that ruined his family, but never lived to see it win the peace by the Compromise of 1867, and the formation of the dual Austro-Hungarian monarchy.

The same sequence of restoration and rebellion took place within the Vienna medical school. The University was controlled through its administration by bureaucrats in the Ministry of Education, who set the curriculum, decided all faculty appointments, and opposed all that was new. All one had to do to become the Emperor's favorite was "to display a natural aversion to every innovation."[24]

In 1836, Baron von Türkheim, the newly appointed Vice-Director of Medical Studies, was determined to change all that by promoting young, talented men who would eventually make Vienna the medical capital of the world in the 19th century.[24] These men were Karl von Rokitansky, who championed autopsies as the means to determine what internal changes in the body produced disease symptoms and who changed the way people thought about medical diseases; Ferdinand Hebra, who founded modern dermatology; and Joseph Skoda, who advocated auscultation and percussions as the means by which to correlate symptoms with the underlying pathology and who became famous as a diagnostician.[20] Unfortunately, Türkheim died in 1846, and his death tipped the balance in the ensuing power struggle between his protégés and the old guard in the wrong direction for Semmelweis, who became the first casualty of this internecine war.[25,26]

Rokitansky and Skoda saw Semmelweis' discovery as the crowning achievement of their new diagnostic methodology and became his ardent supporters, but Skoda used Semmelweis' work for his own political purposes and never accepted Semmelweis' views of disease causation.[25] Semmelweis' Chief, Johann Klein, had been Head of the Vienna Maternity Clinic since 1922 and belonged to the old guard. Klein has been described as a dull, unimaginative, but politically well-connected man who owed his position to bureaucratic patronage. He was drawn into the fight between the reformers led by Skoda, and the powerful reactionary Anton Rosas, who had replaced Türkheim's successor, Ernst Feuchtersleben, as Vice-Director of Medical Studies.[24] Skoda used Semmelweis' results as a *causus belli* to test the scope of the academic freedoms won by the medical faculty in March 1848, following the riots in Vienna. Semmelweis became his unintended victim.[25,26]

The Vienna General Hospital

The Vienna General Hospital where Semmelweis worked before and after he graduated from medical school was a huge complex of charity hospitals that opened in 1784.[20] The changes made to the lying-in hospital after it opened essentially provided Semmelweis with a quasi-randomized trial arrangement ripe for discovering the cause of childbed fever.[27]

The lying-in hospital at first had one clinic, 178 beds, and one professor; in 1834, additional buildings and 600 beds were added, and the clinic split into 2 parts; each clinic had 1 professor and 1 first assistant, who was appointed for 2 years. Semmelweis' future chief, Johann Klein, became the head of the maternity clinic in 1822 and the head of the first clinic after 1834.[20]

Patients were admitted to each clinic on alternate days, but on weekends they were admitted only to the first clinic.[2] Half of the medical students and half of the midwives were taught at each clinic until October 10, 1840, after which all medical students were assigned to the first clinic and all midwives to the second clinic.[2]

Beginning in 1823, autopsies were performed routinely at the hospital in an attempt to "trace disease symptoms to internal structural changes."[20] The hospital retained control of the corpses of all charity patients who died there; about 6 new cadavers became available daily for dissection.[20]

Much of the teaching of medical students occurred in the morgue, who assisted with all autopsies, after which they often went straight to the lying-in hospital without changing their clothes, and examined women in labor without wearing gloves or gowns.[20] Pregnant women in labor were subjected to an average of 5 pelvic examinations, with the exception of women in premature labor, who were never examined in order to delay birth if possible.[2,20]

Theories of childbed fever

In Semmelweis' day, diseases were classified based on signs and symptoms, and since signs and symptoms had many causes, the same diseases were thought to have many causes. The many causes of childbed fever were divided into 2 groups: internal and external. Internal causes included factors such as fear, and many pregnancy-related factors such as lochia suppression, decreased weight caused by the emptying of the uterus, and the volume of milk secreted.[20]

The most widely believed external causes were miasmas and epidemics. Miasmas were invisible, noxious-smelling particles of decaying matter that were suspended in the air and gave it a foul odor; they could come from purulent discharges (ichor) and other effluvia from diseased individuals,

rotting marshy swamps, or urban cesspools.[26] Epidemics were caused by the *genius epidemicus*, which arose from atmospheric−cosmic−telluric influences, and was affected by the weather and the seasons.[20] The method by which epidemics were spread was hotly disputed between those who attributed it to environmental causes, and focused on improving ventilation and reducing crowding to prevent the disease; and those who believed the disease was iatrogenically spread by the clothing and hands of the attendants.[28,29]

There were 2 types of miasmas, contagions and infections.[27] "Contagion" referred to the agent causing a disease, not merely to its transmissibility; contagions always caused the same diseases, such as smallpox. Infectious miasmas could cause different diseases in different individuals;[26] a mother could contract childbed fever after delivery from a patient who had erysipelas, but not from a patient who had smallpox or scarlet fever.

His Life and Work

"The most memorable of all assistantships in Vienna"[22]

Semmelweis decided to specialize in obstetrics after failing to obtain an appointment first as Assistant to Forensic Pathologist Jacob Kolletschka, for reasons that are not known, and then to Skoda, as the post had been promised to someone else.[24] He was accepted as a trainee ("aspirant physician's assistant") at the first maternity clinic on July 1, 1844, and appointed first assistant 2 years later on his 28th birthday.[2] During his training, Semmelweis performed many autopsies on obstetric and gynecology patients with Rokitansky's permission, and, as first assistant, he performed autopsies on all mothers who had died of childbed fever every morning before starting his ward rounds. Later in the day, he reported to Klein on every patient when he made his ward rounds, and taught students in the afternoon.[20]

Semmelweis spent a total of 28 months as first assistant, in 2 stints that corresponded to 2 distinct phases of his discovery. The first stint lasted just 4 months, as his predecessor, Franz Breit, was given a 2-year extension of his appointment, causing Semmelweis to withdraw as first assistant in October 1846.[2] The news came at the worst possible time, as his father had just died.[18] Semmelweis had planned to spend time in the maternity clinic at Dublin's Rotunda Hospital and studied English during the winter of 1846, but changed his plans after Breit was appointed Professor in Tübingen in February 1847. Before resuming his position as first assistant on March 20, 1847, Semmelweis went to Venice with 2 friends, hoping that "Venetian art would revive my spirits."[2] Upon his return, he learned of a fateful event that gave him insight into the cause of childbed fever.

Excluding causes: first stint as first assistant (July 1, 1846−Oct. 20, 1846)

It was common knowledge that the maternal mortality rate (MMR) in the first clinic was much higher than in the second clinic; it had been investigated by several commissions. But witnessing the devastation as first assistant made Semmelweis feel responsible for the deaths, and he was determined to find the cause. His closest friend, Lajos Markusovszky, described his determination:

> "I had the chance to see him, both in the hospital and at home—his watchful restlessness, his eagerness to examine people and conditions, his prying eyes trying to penetrate into the murderous disease, his zest to discover its cause."[18]

Semmelweis began his research by excluding all the proposed causes of childbed fever that could not account for the difference in MMR between the 2 clinics because they affected each clinic equally. He first excluded epidemic causes, the most widely believed cause of childbed fever in Europe. He reasoned that if epidemic influences were the cause of childbed fever, then the disease would have the same effect in both clinics, and also in the city of Vienna. Therefore, not only would the MMR in the first and second clinics be the same, but the rate would also be the same among "street births," that is, among women who delivered on the way to the hospital. Yet, it was well known that despite the adverse conditions under which they delivered, very few of them contracted childbed fever.[2]

Semmelweis next excluded atmospheric and seasonal influences by compiling statistics for the highest and lowest MMR for each month, and proving "numerically that every month of the year has presented both favorable and unfavorable states of health of patients in the first clinic,"[2] that is, that each month of the year could have the lowest and highest MMRs in different years.

After excluding epidemics and seasonal variation, Semmelweis turned his attention to endemic causes, and excluded every putative factor by showing that deaths and their putative causes did not covary.[9] His analysis of overcrowding was particularly exhaustive, as many believed that overcrowding was an important cause of childbed fever since epidemics occurred most commonly in overcrowded urban slums.

Because no record of overcrowding was kept, Semmelweis used the number of deliveries as a proxy for overcrowding. He first determined which of the 76 months in the period January 1841 to May 1847 had the highest MMR, and how many deliveries there were in that month: this was January 1846, when there were 336 deliveries and the MMR was 13.4%. Semmelweis showed that, in 24 of the 76 months, there were fewer than 336 deliveries (ie, less crowding); yet, the MMR was greater than 13.4%. Moreover, the *absolute* number of deaths, not only the MMR, was higher in 13 of these 24 months. Finally, Semmelweis demonstrated that there was no temporal correlation between the number of deliveries and MMR by showing that, as the number of monthly deliveries declined, there was no corresponding decrease in MMR.[21]

One by one, Semmelweis eliminated each putative cause that operated equally in the 2 clinics. Out of desperation, he even eliminated the differences that did exist between the 2 clinics to determine the effect on MMR, even though he did not for a moment believe that the

differences could explain the differences in the MMR between the 2 clinics.

The first was the route that the priest took to the death chamber to administer the last rites. He could go directly into the death chamber in the second clinic, but had to pass through 5 wards to reach the death chamber in the first clinic; and as he went, an attendant rang a bell that instilled terror into the mothers who heard it. Fear was thought to predispose to childbed fever, so Semmelweis asked the priest to alter his route, which, of course, had no effect on the maternal mortality rate.[2] Feeling "like a drowning man grasping at straws," Semmelweis also had women deliver in the lateral instead of the dorsal position, as this position was used at the second clinic, but, of course, to no avail.[2] At the end of it all:

> "Life seemed worthless. Everything was in question; everything seemed inexplicable; everything was doubtful. Only the large number of deaths was an unquestionable reality."[2]

This was the situation when he withdrew as first assistant in October 1846, but upon his return from Venice, Semmelweis was to have what Professor Wangensteen called a "penetrating insight without parallel in the history of medicine."[30]

Discovering the cause: second stint as first assistant: March 20, 1847−March 19, 1849

On resuming his position as first assistant, Semmelweis was shocked to learn that Kolletschka had died after a student pricked Kolletschka's finger during an autopsy. Semmelweis examined Kolletschka's autopsy report, and, except for the genital area, noted that the internal changes were indistinguishable from the autopsy findings in women dying of childbed fever. He had already made exactly the same observation in newborns who died after birth, and whose mothers invariably had childbed fever: "autopsies of the newborns disclosed results identical to those obtained in autopsies of patients dying from childbed fever,"[2] which led him to conclude that they had died of "the same disease as the maternity patients."[2]

Semmelweis now came to the same conclusion about Kolletschka: he, too, had died of childbed fever, only now he also knew what had caused Kolletschka's death:

> "It was the wound by the autopsy knife that had been contaminated by cadaveric particles. Not the wound, but contamination of the wound by the cadaveric particles caused his death."[19]

Semmelweis then made the groundbreaking inference that "if it is the same disease, it must have the same cause,"[19] and that therefore the cause of death of mothers and newborns dying from childbed fever must be the same as the cause of Kolletschka's death.

> "In Kolletschka, the specific causal factor was the cadaverous particles that were introduced into his vascular system. I was compelled to ask whether cadaveric particles had been introduced into the vascular system of those patients whom I had seen die of this identical disease."[2]

Semmelweis immediately understood how the cadaveric particles reached mothers in labor: via the hands of their attendants.

> "Because of the anatomical orientation of the Viennese medical school, professors, assistants, and medical students have frequent opportunity to contact cadavers. Ordinary washing with soap is not sufficient to remove all adhering cadaverous particles. This is proven by the cadaverous smell that the hands retain for a longer or shorter time. In the examination of maternity patients, the hands, contaminated with cadaverous particles, are brought into contact with the genitals of these individuals, creating the possibility of resorption. With resorption, cadaverous particles are introduced into the vascular system of the patients."[2]

Since medical students were taught only at the first clinic, mothers in labor at the first clinic were examined more frequently than mothers in labor at the second clinic, and had a greater chance of having cadaveric particles introduced into their birth canals.

Search for corroborating evidence

Semmelweis now sought evidentiary support for his theory in the monthly statistics kept by the lying-in hospital since it opened. He first compared the annual MMRs for the 2 clinics for the years 1833−1839 with the years 1840−1846, that is, for the years before and after medical students and midwives were separated, and the results were startling. During 1833−1839, the average ratio of the MMR for first versus the second clinic was 1.15 (range, 0.6−2.3); during 1840 to 1846, the average ratio of MMR for the first versus the second clinic was 3.5 (1.5−4.1)[21] (Table 1).

Semmelweis next compared the average MMR for the years 1784−1822 with the years 1823−1833. These years corresponded, respectively, to the period before and after routine autopsies were introduced at the hospital, but before the maternity clinic was separate into 2 clinics. The results were, again, startling: the average MMR for 1784−1822 was 1.3%; the average MMR for 1823−1833 was 5.8%.[2]

Semmelweis' findings also explained for the first time many observations about childbed fever that could not previously be explained, such as: (1) the much lower frequency of childbed fever among women who delivered in the street before reaching the hospital ("street births") or prematurely, because they were examined less frequently; (2) the increase in frequency of childbed fever with the number of foreign students, because they were more conscientious than local students, and examined patients more frequently; and (3) the occurrence of childbed fever in rows on the ward, because after delivery mothers were returned to the same bed in which they had labored, and had been examined by their attendants during labor.

Prophylaxis

Semmelweis also knew immediately how these deaths could be prevented.

> "Suppose cadaverous particles adhering to hands caused the same disease among maternity patients that cadaverous particles adhering to the knife caused in Kolletschka. Then if those particles are destroyed chemically, so that in examinations patients are touched by fingers but not by cadaverous particles, the disease must be reduced."[2]

With Klein's approval, Semmelweis implemented a policy of hand disinfection using a chlorine solution at the end of May 1847. Before selecting the solution, Semmelweis experimented on his own hands to determine which solution best removed the last vestiges of the odor caused by the cadaveric particles.[18] This point needs emphasis, as even today what Semmelweis implemented is referred to as "hand washing"[7]: it was not. It was hand *disinfection* with a chlorine solution.

The short-term results from hand sterilization were dramatic: having lost 93 of 606 women (15.4%) to childbed fever during the previous 2 months, there were only 14 (1.8%) of 782 deaths during the 3-month period of June–August 1847 after hand sterilization was implemented.[2] But there were soon to be relapses.

Other sources of the cause of childbed fever

The first of these occurred in October 1847, when a pregnant patient with "discharging medullary cancer of the uterus" was admitted to the first clinic in October 1847. This patient:

> "…was assigned the bed at which the rounds were always initiated…The consequence was that of twelve patients then delivering, eleven died. The ichor [pus] from the discharging medullary carcinoma was not destroyed by soap and water. In the examinations, ichor was transferred to the remaining patients, and so childbed fever multiplied. Thus, childbed fever is caused not only by cadaverous particles adhering to the hands but also by ichor from living organisms."[2]

TABLE 1
Maternal mortality rate from childbed fever: 1833–1846

	First clinic			Second clinic			
Year	Births	Deaths	MMR (%)	Births	Deaths	MMR	MMR ratio
1833	3737	197	5.3%	353	8	2.3%	2.3
1834	2657	205	7.7%	1744	150	8.6%	0.9
1835	2573	143	5.6%	1682	84	5.0%	1.1
1836	2677	200	7.5%	1670	131	7.8%	1.0
1837	2765	251	9.1%	1784	124	7.0%	1.3
1838	2987	91	3.0%	1799	88	4.9%	0.6
1839	2781	151	5.4%	2010	91	4.5%	1.2
Medical and midwifery students separated							
1840	2889	267	9.5%	2073	55	2.6%	3.7
1841	3036	237	7.7%	2442	86	3.5%	2.2
1842	3287	518	15.8%	2659	202	7.5%	2.1
1843	3060	274	8.9%	2739	164	5.9%	1.5
1844	3157	260	8.2%	2956	68	2.3%	3.6
1845	3492	241	6.8%	3241	66	2.0%	3.4
1846	4010	459	11.4%	3754	105	2.7%	4.2

Data taken from Semmelweiss[21] (Table I, p 356, and Table XXII, p 457).

MMR, maternal mortality rate (%).

Kadar. Semmelweis' life and work. Am J Obstet Gynecol 2019.

Prior to this patient's admission, Semmelweis had required students and attendants to disinfect their hands with chlorine only when they first entered the maternity ward; after that, he thought it sufficient for them to wash their hands in soap and water, as "students in the labor room had no opportunity to contaminate their hands anew" once they had disinfected their hands before entering the labor ward.[2]

Realizing that the disease-causing agent in cadaverous particles could be transferred from living individuals as well, Semmelweis immediately required all attendants to sterilize their hands with chlorine between examining patients as well as before entering the labor ward. He did not, as Loudon claimed, change his mind "after much agonizing."[13] But even this proved insufficient.

In November 1847, a pregnant patient was admitted who had a "discharging carious left knee" but normal genitalia, by which time hand sterilization after each patient examination had been implemented. Nevertheless, Semmelweis could tell by the smell that "ichorous [purulent] exhalations of the carious knee completely saturated the air of her ward," causing 11 mothers to die of childbed fever in November and another 8 in December. Semmelweis concluded that:

> "The ichorous [purulent] particles that saturated the air of the maternity ward penetrated the uteruses already lacerated in the birth process. The particles were resorbed, and childbed fever resulted. Thereafter, such individuals were isolated to prevent similar tragedies."[2]

By the end of 1847, then, before he was 30 years old, Semmelweis had worked out the cause of puerperal fever, how it was spread, and how it could be prevented.

The necessary ("sine qua non") cause was decaying animal organic matter, the

source of which could be "a diseased person of any age, sex, regardless of whether the person suffers from childbed fever," which was transferred to the mother by "examining fingers, operating hands, instruments…[or] anything that is contaminated by animal-organic matter," and then resorbed through damaged skin or mucous membranes or "any point of the body that is stripped of epidermis and epithelium."[2]

Semmelweis understood that although childbed fever was transmissible, it was not a contagious disease, and consistent with accepted usage, he distinguished between infections and contagions:

> "A contagious disease is one that produces the contagion by which the disease is spread. This contagion brings about only the same disease in other individuals. Smallpox is a contagious disease because smallpox generates the contagion that causes smallpox in others. Smallpox causes only smallpox, and no other disease. Scarlet fever cannot be contracted from someone suffering from smallpox. Conversely, another disease can never bring about smallpox. Childbed fever is different."[2]

Communication of findings

Semmelweis did not publish his results in a medical journal until 1858. Nevertheless, his findings were effectively communicated by other means to major maternity hospitals in Europe and England, which led the eminent medical historian Erna Lesky to conclude:

> "Thus, it may be said that hardly any [medical] discovery had ever received such quick publicity as that by Ignaz Philipp Semmelweis. It is only legend therefore if the delayed acceptance of Semmelweis' theory is constantly ascribed to the fact that Semmelweis himself tarried writing about it."[24]

Semmelweis and several foreign graduate students who visited his department in the second half of 1847 wrote letters to prominent obstetricians in Europe. The first and most important of these was dated December 21, 1847, and has been translated into English by Professor Carter.[31] It was written by Hermann Schwartz to Professor Michaelis of Kiel, who implemented hand disinfection with excellent results, and conveyed the information to Professor Levy in Copenhagen. Levy's department was regularly plagued with outbreaks of childbed fever, yet he rejected Semmelweis' conclusions, and published Schwartz's letter that Michaelis had forwarded to him in Danish with a critical response.[31]

This letter is of historical importance because it proves that Semmelweis' theory was rejected by institutions plagued with childbed fever even when his theory was correctly communicated, and refutes the claim that Semnmelweis' delay in publishing his findings in a medical journal, and the misunderstandings that this allegedly caused about his actual views, were the main reasons that his teachings were not accepted.[5,13–16]

The next reports of Semmelweis' work were 2 editorials by Hebra published in the *Journal of the Society of Physicians*, the first in December 1847, the second in April 1848.[2] In both editorials, he asked "directors of all maternity clinics, many of whom Dr. Semmelweis may already have notified of these most important observations, to report their confirming or disconfirming evidence."[2] Other graduate students also disseminated Semmelweis' findings: Charles Routh wrote a lecture delivered to the Royal Medical and Surgical Society, London, in November 1848, and published in *The Lancet*;[32] Friedreich Wieger delivered and published a similar essay in Strasbourg;[20] and Franz Hector von Arneth, assistant in the second clinic, expounded Semmelweis' thesis to the Academie de Medicine in Paris, later in Edinburgh, Scotland,[33] and again, much later, to the St. Petersburgh Medical Society in 1862.[1]

The most important report of Semmelweis' work was given by Carl Haller, senior physician and assistant director of the Vienna General Hospital. He presented the most persuasive evidence that Semmelweis had of the effectiveness of hand sterilization to the Medical Society of Vienna on February 23, 1849, and then published it in the society's journal.[32] The data consisted of comparative MMRs for the first and second maternity clinics for the years 1839–1848, which showed a dramatic drop in the MMR for the first maternity clinic following the introduction of hand sterilizations to 1.1% in 1848[34] (Table 2). Haller's concluding remarks indicate that, although an internist, he understood before surgeons did the importance to surgery of Semmelweis' prophylaxis:

> "The importance of this experience for lying-in hospitals, and for hospitals generally speaking, *especially for the surgical wards*, is so immeasurable, that it appears worthy of the attention of all men of science, and it certainly deserves due recognition from the high authorities of the State"[1] [italics added].

Skoda's use of Semmelweis' work for political ends

On January 16, 1849, Skoda proposed to the College of Professors that a commission be appointed to investigate the reason for the precipitous fall in MMR at the first clinic following the introduction of chlorine hand disinfection.[35] The proposal was a pretext for Skoda to test the scope of the independence that the faculty had won from the administration in March 1848. The proposal was unanimously accepted; but after Rokintansky, Skoda, and Franz Shuh were elected by secret ballot as members of the Commission, Klein lodged an objection, which made it clear that he took Skoda's proposal as a personal attack on him.[20] Despite support from a majority of Professors, Klein took the matter to the administrative authorities, who disbanded the Commission. Klein, who had promised Semmelweis that he would extend his appointment for which he had applied on December 1, 1848,[34] now changed his mind, and denied Semmelweis' application for an extension of his assistantship.[33] Semmelweis appealed, but his appeal was rejected.

The political situation then changed. Thun-Holstein was appointed minister

of education on July 28, 1849, the position of vice-director of education was eliminated, Rosas lost his power over the faculty, and Rokitansky became the first freely elected dean of the medical school on October 1, 1849.[26,36] Skoda seized the opportunity to renew his offensive against the old guard by giving a lecture on Semmelweis' work to the Academy of Sciences on October 18, 1849.[36]

Skoda titled his lecture "*Regarding Dr. Semmelweis' Discovery of the True Cause of the Unusually High Incidence of Sickness among the Patients of the Viennese Maternity Hospital and the Means of Reducing This Incidence to Normal Levels,*"[2,34] making it clear that he was addressing only the cause of the difference in MMR between the 2 clinics, not the causes of puerperal fever itself. So he only discussed cadavers as the source, and "cadaveric atoms" as the cause, of childbed fever, and never mentioned that childbed fever could originate from other sources, such as the mother with cancer of the uterus or the mother with a discharging knee infection.

Skoda framed Semmelweis' work as research of the Vienna Lying-in hospital.[36] He recounted his proposal for a commission to investigate the cause of the reduction in MMR from childbed fever on the first clinic, and described how his proposal had been rejected despite being supported by a majority of the College of Professors. He then attacked obstetricians in Prague for unnecessarily allowing women to die of childbed fever by examining patients without first disinfecting their hands, as Semmelweis had recommended.[2,36]

Thus, although Skoda is portrayed as one of Semmelweis' most influential supporters,[14] Skoda used Semmelweis' discovery only to promote his own interests, and caused Semmelweis more harm than any other individual.[36] He was responsible for Semmelweis being denied an extension of his assistantship, and, with his lecture to the Academy of Sciences, Skoda misrepresented Semmelweis' views about the cause of childbed fever and embroiled Semmelweis in a bitter personal dispute with Scanzoni and other Prague obstetricians by attacking them personally.

TABLE 2
Maternal mortality rate from childbed fever

	First clinic (Prof. Klein)			Second clinic (Prof. Bartsch)		
Year	Births (n)	Deaths (n)	MMR (%)	Births (n)	Deaths (n)	MMR (%)
1839	2781	151	5.4%	2010	91	4.5%
1840	2889	267	9.5%	2073	55	2.6%
1841	3036	237	7.7%	2442	86	3.5%
1842	3287	518	15.8%	2659	202	7.5%
1843	3060	274	8.9%	2739	164	5.9%
1844	3157	260	8.2%	2956	68	2.3%
1845	3492	241	6.8%	3241	66	2.03%
1846	4010	459	11.4%	3754	105	2.7%
1847	3490	176	5.04%	3306	32	0.9%
1848	3780	45	1.1%	3219	43	1.3%

MMR, maternal mortality rate.

Adapted from Györy.[32]

Kadar. Semmelweis' life and work. Am J Obstet Gynecol 2019.

Semmelweis' lecture to the Medical Society of Vienna

Semmelweis finally spoke publically about his discovery in a lecture on the origin and prevention of childbed fever to the Medical Society of Vienna on May 15, 1850, the discussion of which was continued at the general meetings held on June 18 and July 15.[2] Although Semmelweis did not publish his lecture, Dr. Heinrich Herzfelder, the First Secretary of the society, wrote in his minutes of the meetings that Semmelweis had discovered that the "previously devastating puerperal epidemics" originated

> "only through resorption of foul organic matter into the blood of the mother, and this matter, unless it is generated internally, comes from external sources. Most often it comes from the dissection of corpses, and is transmitted to the female organs by the obstetricians themselves. For this reason, Semmelweis has ordered thorough washings with chlorine solution before every delivery. In this way, he has been fortunate enough to halt the spread of the previously serious epidemic."[2]

Herzfelder also noted that Semmelweis' views were opposed by Lumpe and Zipl, who argued that the data supported a miasmatic cause of childbed fever, but was supported by Chiari, Arneth, Helm, and Hayne.[1,2] He concluded by saying that the position taken by Lumpe and Zipl, as well as by Scanzoni and Seyfert, were adequately refuted by Semmelweis' solution to the problem, which, he said, "can be considered a triumph of medical research."[1,2]

His summary indicates that Herzfelder correctly understood Semmelweis' theory, and considered it "a true triumph of medical discovery,"[2] and also documents that Skoda, who was present at the meeting, did not defend Semmelweis after he was attacked.

Return to Budapest

Three months after he delivered his lecture, Semmelweis abruptly left Vienna and returned to Pest-Buda without so much as saying goodbye to his friends. Semmelweis had applied for a position as private Docent in obstetrics on February 9, 1850; but, despite support from Rokitansky, who was now Dean of the medical school, Klein opposed it, and it was denied on April 2, 1850. A Docent was a private lecturer, and the post would have allowed Semmelweis access to university facilities and to continue his research. Semmelweis reapplied on May

17, 1850,[35] and was named Private Docent of theoretical obstetrics on October 10, 1850, but he was denied access to cadavers, so he could not have continued his research. "Such a limited Docentship was of no use to [him],"[2] so he returned to his native Pest-Buda.

Life in Budapest

The Pest-Buda to which Semmelweis returned were not the cities in which he grew up. They were now the capital of a defeated country under martial law, run by German-speaking officials, whose police had been replaced by Austrian gendarmerie that sent spies to all scientific meetings to ferret out political conspiracies, and required the minutes of every meeting to be submitted to the authorities.[1] The Hungarian Academy of Sciences had suspended its meetings, the only Hungarian medical journal had ceased publication, and the only medical publication in Hungary was the officially censored Minutes of the Pest Medical Society.[1] In short, an enervating climate of suspicion permeated the University that killed creativity and the exchange of ideas. Added to that, both of Semmelweis' parents had died, his family had been financially ruined by the War of Independence, his 3 brothers who had participated in it were in exile, and the 1 brother, a priest, who remained had assumed a Hungarian name, Szemerényi, in a fit of patriotic zeal.[18] Semmelweis had no job, and his patrimony had likely been exhausted.[1]

Moreover, his doctrine was immediately challenged at the very first gathering of physicians that he attended.[2] Semmelweis was told that an epidemic of childbed fever was raging at St. Rókus Hospital, yet there were no medical students or routine autopsies performed here: how could that be squared with his theory? Semmelweis visited the hospital the next day, and immediately understood the cause of the epidemic.

The maternity wing of the hospital was an annex of the surgical division, and the senior surgeon was in charge. He started his daily ward rounds on surgical patients, most of whom had wound and other infections, and then proceeded to examine obstetric patients. It was obvious to Semmelweis that he had ample opportunities to contaminate his hands with decaying animal organic matter, and to introduce it into the birth canals of laboring women.

On May 20, 1851, Semmelweis took an unpaid job as Director of the Obstetric Division of St. Rókus Hospital, and immediately separated the maternity unit from the surgical division. The hospital admitted obstetrical patients only during the months of August and September when the University Obstetric Clinic was closed for vacation; for the rest of the year, Semmeweis filled these beds with gynecological instead of surgical patients. He instituted chlorine disinfection, not only for obstetrical cases, but for gynecological and surgical cases as well. The results were dramatic: the MMR from childbed fever fell to 0.85%. It established Semmelweis' reputation, and allowed him to develop a private practice on which he now depended for his livelihood. Semmelweis also developed gynecologic surgery, in which he had always had an interest, and was the first to perform ovariotomy in Hungary in 1863.

Martial law in Hungary was lifted in 1854, and amnesty declared in 1856, which led to a revival of intellectual life. Janos Balassa, Professor of Surgery at the University, led the revival in medicine, and started the *Medical Weekly*, edited by Markusovszky. On July 18, 1855, Semmelweis was appointed Professor of Theoretical and Practical Midwifery at the University of Pest, following Professor Birly's death.[2]

Semmelweis assumed his position in October 1855, and immediately faced "opposition everywhere and in everything" as he tried to implement measures to reduce the appalling MMR from childbed fever, so much so that he bought linen for the wards out of his own funds, and had great difficulty obtaining reimbursement.[1] Nevertheless, during his first year, 1855−1856, Semmelweis reduced the MMR from childbed fever to an unprecedented 0.39%, and his assistant published the results in the *Wiener Medizinische Woshenschrift*.[18] The report engendered the following editorial comment:

> "We thought that this theory of chlorine disinfection had died out long ago: the experience and the statistical evidence of most of the lying-in institutions protest against the opinions expressed in this article: it would be well that our readers should not allow themselves to be misled by this theory at the present time."[1]

Semmelweis' clinic was eventually relocated, and through his tireless efforts, Semmelweis managed to keep the MMR from childbed fever during the last year at the old facility, 1859−1860, to 0.9%.[2] Despite all the obstacles he faced, Semmelweis declined an invitation to apply for the Professorship in Zurich in 1856, and in 1857 married the beautiful daughter of a wealthy Buda merchant. The following year he gave a series of 7 lectures on his doctrine to the Medical Society, which were published as a series of articles in the *Medical Weekly*. These formed the basis for his *Aetiology*, which he started to write in 1859, and published in October, 1860.[18]

Semmelweis sent copies his book to medical societies and leading obstetricians throughout Europe. He received some very positive responses, but only a few, short reviews in the medical press.[18] Then came unfavorable responses from Prague, Vienna, Munich, Berlin, and elsewhere. Exasperated, and already visibly aged, Semmelweis wrote a 92-page "Open Letter" addressed to leading doctors around Europe who had rejected his theories, and in which he blamed them for the deaths of countless numbers of women.[18] Much has been made of these letters, but as Sir William Sinclair pointed out, in those letters, Semmelweis "always had something to say for which the ordinary conventional methods of address were inadequate," and since he also summarized his doctrine, they were probably more effective at that point in conveying Semmelweis' message "than a method more conventionally correct," for matter containing personalities is always read, and the letters likely conveyed his doctrine to those who had never read about it before.[1]

Yet, the episode had a salutary ending. On May 7, 1862, the Presidential Council and the University faculty in Pest, after reviewing Semmelweis' book, recommended that Semmelweis' prophylaxis be introduced in all hospitals and obstetrical practices in Hungary.[15] Then, on July 4, 1863, he received a letter from Professor Hugenberger of St. Petersburg, who enclosed a copy of the report on the Proceedings of the Medical Society of St. Petersburg, which had discussed the etiology and prophylaxis of puerperal fever at 5 consecutive meetings, and which Hugenberger ended:

> "You will see from this how many followers you have in the Far North, and how strongly the younger men support you. By that alone much is gained, for it is in their hands that the future lies."[1]

The letter "had the happiest effect upon Semmelweis."[1] He gave up all thought of further defending his doctrine. He continued to write on gynecological topics prolifically until the end, his last article on ovariotomy remaining unfinished in 1865.[18]

Critique of Semmelweis' Doctrine

A proposition can be true, but unjustified, justified but untrue, or both justified and true. Semmelweis' theory of the etiology and prevention of childbed fever was true, but was it justified by his evidence? The most his critics would allow was that he may have proved *one* cause of childbed fever, but not that *every* case of childbed fever had the same cause. But this is not so much a criticism of Semmelweis' theory per se as of inductions in general, because inductions are always general claims from particular observations that can never be proved conclusively.

Scientific theories are judged by their explanatory power.[37] Semmelweis' causal theory was not only justified on that ground because it explained so many previously unexplained observations, but also because it was supported by a great variety of evidence. The variety of evidence supporting a hypothesis is an important a factor in its acceptance, because the more ways in which a hypothesis is tested, the more likely it is that it will be rejected if it is untrue.[35] The evidence from St. Rókus Hospital increased the variety of situations in which Semmelweis' theory by proving that purulent discharges from surgical, and not only obstetrical, patients were sources of "decaying animal organic matter."

Simplicity, the Occam's razor principle, also favored Semmelweis' doctrine. To argue that Semmelweis proved the cause of only the difference in MMRs between the 2 clinics is to argue for 2 different causes of childbed fever instead of 1: one causing the increase in mortality between the 2 clinics, the other causing the residual 3% or so deaths that remained even after eliminating the first cause.[34]

Semmelweis' theory was not rejected because he failed to prove that every case of childbed fever was caused by decaying animal organic matter, but because it conflicted with the accepted paradigms of his day;[9] or, as Lesky put it, because it required "a complete reversal in the approach to the entire theory of 'fevers,' which at the time formed the great part of contemporary nosology."[24] The requisite paradigm shift occurred about 15 years after Semmelweis' death, when the germ theory of disease was accepted. Joseph Lister was its principal beneficiary, and that is why Lister's asepsis was accepted and Semmelweis' was not.[9]

How then are inductions arrived at if they cannot be proved by evidence? Hempel suggested that:

> "The transition from data to theory requires creative imagination. Scientific hypotheses and theories are not *derived* from observed facts, but *invented* in order to account for them"[38] [italics in original].

Therein lay Semmelweis' genius. He saw both the similarities and differences between smallpox and childbed fever. They were similar in that every case had an identical necessary cause, but they were also different, because smallpox could be contracted only from someone suffering from smallpox, whereas childbed fever could be contracted from a variety of different sources.

His Death

Semmelweis died an ignominious death in the insane asylum in Vienna on August 13, 1865, at the age of 47. He was beaten within an inch of his life by his attendants, trampled underfoot, placed in a straightjacket, and essentially left to die of his injuries.[39] He was buried in Vienna on August 15, 1865; his funeral was attended only by Rokitansky, Spaeth, and Carl and Gustav Braun, 2 of Semmelweis' most bitter critics. Only Markusovsky, Semmelweis' longtime friend, attended from Budapest.[39]

Semmelweis was induced into entering the "ward for maniacs at the Lower Austrian Mental Home in Vienna" by subterfuge. Concerned about his mental state, his wife Maria contacted Markusovsky, who asked a pediatrician to examine Semmelweis, and who concluded that Semmelweis was insane. Two other physicians, neither of whom had examined Semmelweis, signed commitment papers; Semmelweis was never even examined by a psychiatrist. He was taken by overnight train to Vienna, thinking he was on the way to Gräfenberg in southern Germany to "take the waters," and met at the station in Vienna by his lifelong friend, Hebra, who told Semmelweis he wanted to show him his clinic. Once inside the asylum, Hebra and Maria, who had brought him, left. Maria tried to visit him the next day, but was turned away by staff.[39]

An autopsy was performed on Semmelweis' body in the same morgue in which he himself had conducted so many postmortem examinations of women dying of childbed fever, and the cause of death was listed as "pyemia." However, 5 documents that Viennese officials had for years declined to release were finally discovered in the Vienna archives on March 2, 1977,[32] and indicated that Semmelweis had sustained serious injuries to the long bones; that he had purulent, decomposing tissue on his hands, arms, legs, and "stinking gas" between his pectoral muscles; that there was a large anterior wall abscess that had perforated into the pericardium ("a large

tearing hole in the pleura surrounded by a fist-sized ichorous center between the pleura and the pericardium"); and that there was "evidence of inflammation in the cerebrum and in the myelon."[42]

The medical records of the asylum give no indication that Semmelweis was examined on admission or any attempt made to confirm the diagnosis that he was, in fact, "insane." None of the entries in the medical records are signed, and there is no indication of who examined Semmelweis. There are no entries at all for 6 of the days Semmelweis was in the asylum. The record contained mistakes and inconsistencies, some of which were modified, giving the impression that the entries were made after Semmelweis' death.[42]

Historians disagree over the nature of Semmelweis' mental illness, whether he was suffering from an organic brain syndrome or an acute brain disorder secondary to an infection.[15] Photographs taken in 1857 and 1860 show that he had aged with shocking rapidity from the age of 39, and Sherwin Nuland has presented hearsay evidence from a neuropathologist, who has never published his findings or rendered a differential diagnosis, that Semmelweis most likely had presenile dementia;[3] but Nuland himself undercut this diagnosis by contending that Semmelweis' "growing madness" was partly the result of psychopathology (see below).

The Revisionists' Myth

Nuland created the myth that Semmelweis and no one else was responsible for his own fate. The ostensible reasons were psychological; Nuland contended that Semmelweis had a "self-destroying psyche," and an overpowering sense of "unworthiness" that made him feel:

> "…a maladroit, graceless outlander, who came from the wrong place, the wrong family, the wrong social class, spoke the wrong dialect, had been rejected from the right university jobs; in short, the outsider clanging and banging on the gates of an academic Pantheon in which he felt unworthy to dwell."[5]

Nuland created his myth in an article published in 1979.[5] He then repeated what he wrote word for word first in a book chapter,[14] then in an entire book.[15] Eventually, the myth was accepted at face value by Loudon,[13] Waller,[16] and other academics relying on them,[40] and the myth became entrenched through repetition.

Nuland was a surgeon, not a medical historian, and he admitted that he was also not a psychoanalyst.[11] Nevertheless, he expounded on the psychological consequences for Semmelweis of his feeling "unworthy."

> "As so often happens in psychopathology, that self-concept existed side by side with its opposite: a growing megalomania, a rage, and finally a towering hurricane of grandiosity that swept him to his destruction."[15]

To fit his overarching theme and its denouement, Nuland modified his diagnosis of Semmelweis' presenile dementia, making it now only partial, and wrote:

> "And finally, in a fit of growing madness that was partly organic and partly the result of his almost conscious self-prophesy, he became Samson Agonistes, blind and raging, and tried to pull down the pillars of resistance to his *Lehre*, hoping to destroy those whom he saw as his sworn enemies, not realizing that it meant his own immolation. When it was all over, only Semmelweis was dead. The temple of resistance stood."[15]

That this melodrama was accepted as accurate history is testimony to the power of story-telling. Nuland wrote well, and knew how to tell a good story, but what he wrote was not history, and it was completely devoid of analysis. For example, Nuland said Semmelweis:

> "…was a hellfire-spewing evangelist and an afflicter of conscience all at once, the kind of self-righteous goad no one wants to be near."[14]

Yet, foreign students who spent time in Semmelweis' department lectured enthusiastically about his doctrine throughout Europe, from which Sinclair concluded that this was "strong testimony to the attractive personality of Semmelweis, and the impressiveness of his teaching."[1] Nuland was aware of Sinclair's conclusion because he cited Sinclair's book in his article,[5] but he did not mention Sinclair's contrary conclusion and allow readers to decide for themselves which interpretation was more plausible, Nuland's or Sinclair's. This is the difference between storytelling and history: the storyteller recognizes only one version of a story; the historian knows that different conclusions can be drawn from the same set of facts.

Nuland speculated freely on where this fatal feeling of unworthiness that doomed Semmelweis might have come from, but the bedrock of his myth were 3 facts about Semmelweis' life: (1) he did not publish anything about his theory until 11 years after his discovery; (2) he abruptly left Vienna and returned to Budapest when notified of the restrictions placed on his docentship without saying goodbye to his friends; and (3) he wrote an intemperate "open letter" to prominent physicians around Europe who rejected his doctrine, accusing them of being murderers and assassins.

To create his myth out of these facts, Nuland disregarded the contrary conclusions of Erna Lesky, Professor of Medical History at the University of Vienna, who Nuland himself regarded as "the most authoritative and detailed source of information about that glorious place and time."[15] He also disregarded the entire scholarship of Semmelweis' most insightful contemporary English-speaking scholar, the philosopher Codell Carter, who has painstakingly reviewed a vast number of original documents, and just about everything ever written about Semmelweis in German in which much of the work of Hungarian scholars was also written.[2,7,8,10,20,39,41]

Delay in publishing

Nuland contended that Semmelweis' "failure to support his own doctrine in a public forum" prior to May 15, 1850 "was his worst omission," and a significant factor in the rejection of this teachings.[5,14] As already noted, Lesky rejected this as "only a legend,"[24] but Nuland failed to cite Lesky's conclusion and explain why he disagreed with her: storytelling can brook only 1 version of a story.

According to Nuland, Semmelweis' delay in publishing also caused his doctrine to be rejected because it gave rise to Skoda's misrepresentation that childbed fever was caused only by cadaveric particles. However, Semmelweis dispelled any confusion that Skoda may have created when he delivered his own lecture on May 15, 1850, to the Medical Society of Vienna.

Correct accounts of Semmelweis' views had also been published and disseminated throughout Europe both before and after Semmelweis' lecture.[1,2,39] Therefore, although the delay in publishing may have created pockets of misunderstanding within Europe, it could have been only an inconsequential factor in the rejection of Semmelweis' teachings.

Abrupt departure from Vienna

According to Nuland's story, "five days after being notified of the restrictions placed on his *Privatdocent* appointment…Semmelweis fled Vienna, and returned to Pest"[15] just when "his theory stood on the verge of acceptance."[12] Nuland based his conclusion on the fact that Klein did not appear in a faculty photograph dated 1853,[15] which, to Nuland, indicated that the progressive wing of the faculty was on the verge of seizing power from the old guard; but this is simply untrue. The faculty only gained full academic freedom from the Ministry on April 15, 1872,[24] which explains why Semmelweis could not secure an unencumbered Docentship even with the support of Rokintansky, who was, by then, Dean, or why Semmelweis was not invited to apply for Klein's post after Klein's death as urged by Rokitansky, Skoda, and other faculty members.[34]

Also flying in the face of Nuland's psychological theory was the overwhelming evidence that Carter had amassed since Nuland's 1979 article demonstrating that far from being on the "verge of acceptance [by] emerging leaders of Vienna medicine," there was nothing to indicate that anyone in Vienna ever understood, much less was ready to accept, Semmelweis' theory—not even Skoda, who never expressed any agreement with Semmelweis' view of the cause of childbed fever, constantly referred to its causes in the plural, and almost certainly disagreed with it (unless he didn't understand it, which seems unlikely).[40] Nuland disregarded all this evidence *tout court*.

Nuland's explanation of why Semmelweis "fled" Vienna was also incoherent. Nuland postulated that Semmelweis fled because "victory and the attainment of a professorship at the hallowed University of Vienna were inconsistent with his unconscious prophesy for himself."[15] And so Semmelweis simply made up that he was rejected in Vienna—"fantasized his rejection"[15]— and did so, according to Nuland, "because it gave him the rationalization he needed to rush back to that safe protective cocoon [Hungary], because it was safe and it was home."[15]

But Nuland also claimed that Semmelweis felt just as much an outsider in Budpest "no doubt being certain that the Magyars looked on him as a German and the Germans as a second-class Hungarian."[15] If so, then why would Semmelweis consider Budapest "safe"? Nuland did not provide an answer because he could not square the circle of his abstruse psychodrama.

The more plausible explanation for the abruptness of Semmelweis' departure was his realization that Skoda had never really agreed with his theory of puerperal fever, and had merely used it for his own political ends, which likely cost Semmelweis the extension of his assistantship. This is consistent with Lesky's conclusion that "Klein's opposition to Semmelweis was a result of this political struggle rather than of Klein's personal hostility to Semmelweis or even of Klein's skepticism about Semmelweis' work."[2] Semmelweis likely came to this realization after hearing Skoda misrepresent his views in October 18, 1849, and after witnessing Skoda's refusal to defend him after he was attacked following his own lecture on May 15, 1850. The restriction placed on his docentship was probably the last straw, and Semmelweis likely said to himself, "to hell with them all," and left Vienna. That his only true friend, Hebra, never took umbrage supports this conclusion.

Intemperate letters

Nuland's most ahistoric claim was that the intemperate letters Semmelweis wrote to European leaders of the medical profession were a major factor in the rejection of his theory, for these letters were written in 1862, long after his opponents had made up their minds about Semmelweis' theory. Nuland cited nothing to suggest that at or around the time Semmelweis first presented his theories and data, they were rejected because what he said, or how he said it, had offended anyone. On the contrary, Skoda alone had given offense to those who did not accept Semmelweis' view of the cause of childbed fever as of 1850, when Semmelweis left Vienna. Moreover, Joseph Spaeth's change of heart proved conclusively that Semmelweis' open letters were not an impediment to the acceptance of his theory.

Spaeth was a prominent Viennese obstetrician who became Professor of the second clinic in 1864. He had opposed Semmelweis' theory, and had received one of Semmelweis' vitriolic letters, in which he told Spaeth, "you Herr Professor have been a partner in this massacre. The murder must cease…".[15]

Nevertheless, after compiling his own statistics on the effectiveness of hand sterilization, Spaeth changed his opinion, and openly admitted it.

> "I also venture to state unreservedly that there is no longer any obstetrician, who is not most deeply convinced of the correctness of Semmelweis' views, even though he still talks very much against them."[42]

His Legacy

Nuland claimed that "the memory of Ignaz Semmelweis soon died out in Vienna, except as an object of disparagement"[14]; Loudon uncritically echoed Nuland claiming that "in the twenty years after his death, Semmelweis' name was mentioned only on rare occasions, and usually in uncomplimentary terms."[13] This is simply not true, and Lesky disagreed. "The immediate effect which Semmelweis had on the Vienna clinicians as from 1847 appears to have been much greater than is admitted by the historiography," she wrote.[24] Again, Nuland failed to cite her contrary opinion and to explain why he disagreed with her. Worse still, Nuland and Loudon portrayed Semmelweis as an insignificant figure who had no effect on the history of medicine.[13,15] Nothing could be farther from the truth.

Professor Carter's interest in Semmelweis stemmed from his interest in the cause of the emergence of modern medicine in the 19th century following the abrupt abandonment of bloodletting in midcentury, and traced it to the rise of causal theories of disease.[8,43] He has shown convincingly that Semmelweis significantly influenced this transition by his influence of the conceptual development of germ theory through the work of Mayrhoffer.[7]

Mayrhoffer was hired by Carl Braun in 1960 as second assistant to study the role of bacteria in childbed fever. Within 2 years of obtaining a suitable microscope, Mayrhoffer had reached the same conclusion as Semmelweis had—namely, that every case of childbed fever had the same, 1 necessary cause—the only difference being that Mayrhoffer called it "vibrions" instead of "decaying animal organic matter." Although Mayrhoffer never mentioned Semmelweis, likely because his Chief, Carl Braun, was one of Semmelweis' bitterest opponents, Erna Lesky referred to Mayrhoffer as "the second Semmelweis."[22]

Between the publication of his *Aetiology* in 1860 and his death in 1865, "Semmelweis' work was discussed in more than forty major medical publications and in more than a dozen reviews."[20] In 1964, Virchow conceded, in a lecture, "I recognize the merit of the Vienna school and most specifically that of Semmelweis."[18] Even Scanzoni, who had relentlessly attacked Semmelweis personally, acknowledged in the fourth addition of his textbook, written in 1867, that:

> "puerperal fever is now almost unanimously considered to be an infectious disease… [and] by his restless and self-sacrificing efforts in this field, Semmelweis has rendered a great service to lying-in women in our hospitals."[18]

In May 1868, three years after Semmelweis' death, Professor Boehr wrote that Semmelweis' work had dealt a severe blow to the "superstitions of our predecessors, who believed in unknown cosmic-telluric-atmospheric influences and…in miasms," and that Semmelweis'

> "…theory of infection has the characteristic of all good pathological and physiological theories; it provides a unified, clear, and entirely intelligible meaning for a whole series of anatomical and clinical facts and for the relevant experiences and discoveries of reliable observers during epidemic. None of the earlier or alternative hypotheses or theories regarding the occurrence of childbed fever has this characteristic to the same degree."[20]

Many surgeons, not only gynecologists, also consider Semmelweis to be the true father of asepsis, and Haller had recognized the importance of Semmelweis' finding to surgery as early as 1848.[34] There is contemporary evidence that at least from 1858 onward, chlorine hand disinfection was rigidly practiced in midwifery, gynecology, and surgery in Hungary long before Lister introduced his method of preventing "wound-fever" in 1865.[1,18] Moreover, because he at first based his ideas on those of Louis Pasteur, Lister focused on wound irrigation, not on the surgeon's hands, which caused Menge to call Lister's teaching a setback because:

> "He encouraged us to concentrate our whole attention on the harmless and unimportant sources of infection and forget about the physician's hands, the most important and most dangerous source of infection both for the surgeon and the obstetrician."[18]

Lister eventually abandoned his wound irrigation procedures in 1896, and adopted prophylactic antiseptic practices instead, which were essentially the same ones that Semmelweis had advocated in 1847. Although Lister denied it in a letter dated April 2, 1906,[18] Owen and Sarah Wangensteen concluded that Lister certainly knew and was influenced by Semmelweis' work in making that change.[44]

Conclusion

Semmelweis was "one of the great minds in the history of medicine,"[40] and "his shrewd assessment of the nature of contagion and puerperal fever has rarely been matched in medicine."[30] He was brilliant, original, and far ahead of his time. His doctrine was resisted not because of his character flaws, but because it flew in the face of all extant theories held by prominent obstetricians of his day. Nuland's contention that Semmelweis himself was the cause of the opposition that he faced finds no support in historical facts. Indeed, if Semmelweis had not been struck down in the prime of life and had lived to be 85 as Lister had, he would have seen his life's work vindicated, and he, not Lister, would likely have been recognized as the father of asepsis as well as of preventive medicine. Still, when all is said and done, it remains beyond cavil that he saved the lives of countless thousands of women during his lifetime—and for that, he richly deserves history's epithet, "The Savior of Mothers." ■

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