
EFFECT OF SEMMELWEIS 1.

Ignac Semmelweis: infection control, statistical analysis and quality control

Semmelweis Igác: infékciónkontroll, statisztikaia analízis és minőség ellenőrzés

Prof. dr. Forrai Judit DSc
Semmelweis Egyetem Népegészségtani Intézet
forraijud@gmail.com

Initially submitted October 10, 2015; accepted for publication november10, 2015

Abstract:

Semmelweis "the Saviour of Mothers" had found the full truth: doctors and medical students who had previously autopsied mothers cadaver were infected the mothers during childbirth. The essence and aetiology of puerperal fever had showed the mode of its prevention, but with this new theory he was unable to convince his contemporaries of his simple and clear ideas. Semmelweis investigated and analyzed the monthly statistical data, the infection and the result after the prevention: the hand washing with chlorine solution was the cause of mortality rate decreased. In this article we intend to deal with the questions which illuminate the statistical conceptions and infection control methods of Semmelweis, their active role in the discovery of the aetiology of puerperal fever, one of the first applications of the methods of statistics in clinical medical science: epidemiology and its effects on the development of medical statistics and quality controll.

Keywords: Ignac Semmelweis, history of puerperal fever, epidemiology, infection control, quality controll.

1. Introduction

Ignac Semmelweis (1818-1865) was born in 1818 in Buda on the west bank of the Danube in the city of Pest-Buda, Hungary. Joseph Semmelweis his father was a herb- store keeper, in his own „White Elephant” shop. His house of birth is today the Semmelweis Medical Science Museum. Ignac the fourth child¹ was educated at the Catholic Gymnasium on Castle Hill - Buda from 1829. In 1837 he began to study law but switched to medicine and graduated in 1844 at the University of Vienna. He began his medical career in obstetrics and midwifery at the world famous Allgemeines Krankenhaus. The first director of this division

¹ Joseph Semmelweis and Theresa Müller's children: 1813 Charles Philip, 1814 Philip Alajos, 1815 Julianna Anna Theresa, 1818 Ignac, 1820 John, 1823 Aloysia, 1827 Maria Theresa

was *Lukas Johann Boer*² before Johann Klein (1788–1856). *Chiari* doctor³ was the direct boss of Semmelweis.⁴ Semmelweis married with Maria Wiedenhoffer, and he had five children. At this time he came under the influence of the remarkable young academic physicians, *Joseph Skoda* (1805–1881) who taught general medicine and statistics, *Josef Hyrtl* (1810–1894) anatomist, *Carl L. Sigmund* (1810-1883) syphidologist, *Ferdinand Hebra* (1816–1880) a dermatologist, and *Carl Rokitansky* (1804–1878), professor of pathologic anatomy.

2. The different theories of Childbed fever

Various theories have been held as to the cause of epidemic disease. "*Galenic*" varieties blamed eclipses, comets, influences from the Earth and other *natural phenomena*. "*Miasmatic*" hypotheses concentrated on the spread of disease by the agency of foul vapours and smells. *Contagion* meant much what it does today. Liebigian theory - that the illness was caused by the introduction of *non-living organic matter* into the patient - was named for the German chemist Justus von Liebig, and unlike the other older ones was propounded in the nineteenth century. Other etiology of puerperal fever was the *milk-fever theory*⁵ represented by Klein, the chief of Semmelweis in Vienna, the *phlogistic theory* that it was caused by the inflammation of various abdominal and pelvic organs, as proposed by Friedrich Benjamin Osiander (Göttingen) and Karl Franz Naegele (Heidelberg). New aspects of the theory by Carl Eduard Siebold (Göttingen) was that the puerperal fever as a form of *blood "deterioration"* caused by disturbing factors that prevent the evacuation of certain materials accumulated during pregnancy. On the other hand, epidemic cause was *cosmic, telluric influences*. Such strange doctrines were advocated by several German contemporaries of Semmelweis, including Dietrich Wilhelm Busch (Marburg) and the most fierce enemy of Semmelweis, Wilhelm Friedrich Scanzoni (Würzburg). It became apparent that childbed fever was a *hospital disease* which seemed to have affected more frequently hospitals from the second decade of the 19th century, i.e., from the period when pathological anatomy was the dominating feature in medicine.

Several eighteenth century British physicians realized that puerperal fever was transmissible⁶. Charles White ascribed these cases of "*putrid fever*" to retained material in the uterus, foul air and a filthy environment; he recommended cleanliness and fresh air, that bedding be washed, and he employed isolation of cases and burning sulphur fumigation of wards. Joseph Clarke noted the association of puerperal fever with the foundation of the Lying-in Hospitals.

² Lukas Johann Boer (originally Boogers) (1751-1835) was a pioneer of "natural childbirth", and as founder of the Vienna School of Obstetrics he developed natural aids to childbirth.

³ Johann Baptist Chiari studied medicine in Vienna under stern economical conditions. Already while still a student he was active in obstetrical departments. He was conferred doctor of medicine at Vienna in 1841 with the dissertation: *De legibus mechanicis motus muscularis*. After obtaining a doctorate in surgery the following year, he got a position as assistant physician at the first obstetrical clinic in Vienna under professor *Johann Klein* (1788-1856), and subsequently devoted himself entirely to his specialty, gynaecology. Chiari stayed with Klein from 1842 to 1844, and in 1845-1847 was active at the operative institute. In 1848 he became deputy to the obstetrical physician-in-chief,

⁴ Papp, Z.: Preface. In: Remember to Ignac Semmelweis (ed. Gazda I. Szállási Á, Kapronczay K.) Budapest-Piliscsaba. MATI. 2001. I. vol. 9-19.

⁵ Hallett, Ch. The Attempt to Understand Puerperal Fever in the Eighteenth and Early Nineteenth Centuries: The Influence of Inflammation Theory. *Med Hist.* 2005 January 1; 49(1): 1–28.

⁶ Margaret DeLacy, 'Puerperal fever in eighteenth-century Britain', *Bull. Hist. Med.*, 1989, 63 (4): 521–56

Alexander Gordon considered it to be infectious, and also noted that the incidence of puerperal fever in his wards mirrored that of *epidemic erysipelas*. He noted that infection followed attendance by particular doctors and midwives, and advised that those attending a case of puerperal fever should wash their hands and fumigate their clothes; bedding should be burnt or fumigated also. Fever was caused by the introduction of "*putrid matter*". He did not spare himself blame: "It is a disagreeable declaration for me to mention, that I myself was the means of carrying the infection to a great number of women." Unfortunately Gordon relied on conventional treatments for established cases, relying on vigorous purging and bleeding, and he became an unpopular figure as rumours arose that his interventions were the real cause of the problem. Alexander Gordon was perhaps the most insistent of those who claimed that the origin of puerperal fever lay in an inflammatory process, and he emphasized the need to bleed and purge the patient as copiously and as early in the disease as possible.⁷

The American physician Oliver Wendell Holmes investigated epidemics of puerperal fever in nineteenth century Boston. He reviewed the publications of the British pioneers above, and also noted cases of severe fever and death in those involved in attending cases of puerperal fever or carrying out autopsies on such cases. In 1843 he published a paper entitled "The contagiousness of puerperal fever", including a set of recommendations for good practice. Many members of the American medical profession attacked him; finally the American Medical Association backed Semmelweis' work as it became known, and opposition to Holmes died away.

However, no one before Semmelweis had clearly recognized that the immediate cause of puerperal fever was *unclean manual* intrusion and that it was similar to pathological processes observed in patients with infected wounds. Of the German contemporaries, it was Gottfried Eisenmann (Würzburg) who came closest to the point, stating in 1857 that the doctrine of puerperal fever is based on that of *infected wounds*, but later in his discussion he got mixed up as regards epidemics and miasma. As we know, the essence of Semmelweis' findings was that "*puerperal fever is caused by cadaveric particles adhering to the hands of the physician who examines the childbed patients; thus it is of utmost importance that he should clean his hands properly before a visit, for which purpose [he advised] the chlorine solution.*"

He also realized that the identical pathological symptoms found in the cadavers of the mothers and in their newborn infants must have identical causes, and therefore childbed fever cannot be considered the specific disease of childbed patients. Besides statistical evidence, his belief that there must be some connection between physicians' examining childbed patients after dissections and puerperal fever itself got strong confirmation when he was faced with the unfortunate death of a good friend of his, Jakob Kolletschka, professor of forensic medicine in Vienna, who died in 1847 after his finger had been cut by a medical student's knife: on autopsy, the cadaver showed identical symptoms of those who died of puerperal fever. Thus, Semmelweis inferred that puerperal fever is also caused by a *septic wound* and is just another kind of pyemia, brought about by contact with an infectious agent, specifically by some putrid

⁷ George W Lewis, 'Epidemiology of puerperal fever: the contribution of Alexander Gordon', *Med. Hist.*, 1993, 37: 399–410;

particle (cadaverous particles or any putrid exudates of the living organism) introduced into the genital organs by the hand of the examining physician and entering into the blood stream.

Almost immediately after his discovery made in 1847, Semmelweis made it compulsory for all physicians and medical students performing dissections to disinfect their hands before examination of patients, even though this was met with some protest from those concerned and a certain degree of scepticism by his chief, Professor Klein. Semmelweis did not and could not know at the time that the chlorine hand wash destroyed not only the smell otherwise retained after simple soap washings but also the bacteria clinging to the skin. Nevertheless, the chlorine hand wash inaugurated obstetric antisepsis. As a result, mortality rates were greatly reduced with the introduction of the chlorinated lime hand wash.

3. Chloride of lime the antiseptic agent

Chloride of lime is a white, alkaline powder; it consists of crumbles, is slightly soluble in water and has a specific smell. Its smell emerges most likely due to the hypochlorous acid and the chlorine, both of which are released from the chloride of lime through the carbon-dioxide of wet air. Its composition is approximately: $[3 \text{ CaCl}(\text{OCl}) \cdot \text{Ca}(\text{OH})_2] \cdot 5 \text{ H}_2\text{O}$. Chloride of lime is gradually dissolving, while releasing oxygen - when the evolved oxygen is released, the chloride of lime has a whitening, disinfecting and deodorizing effect.

Usability: whitening of cellulose, paper and textiles (nowadays substituted by less aggressive and more environmental friendly products like hydrogen-peroxide); fumigation of stables (it neutralises e.g. pathogens of anthrax and chicken cholera, if diluted in the ratio of 3 to 20), disinfection of waste and latrines, and sterilization of drinking water (formerly).⁸ The emergence of large-scale industrial production of textiles made chemical whitening necessary. The Swedish pharmacist *Karl Wilhelm Scheele* (1742-1786) discovered the chlorine and the alkaline-solution of chlorine gas in 1774, which were successfully used by the French chemist *Claude-Louis Berthollet*⁹ (1748 -1822) to whiten textiles. However, if it was too thin, it had no effect at all, and if it was too concentrated, it could burn the cloth. The transportation of the corrosive liquid was very difficult, too. The English *Smithson Tennant*¹⁰ (1761-1815) found a solution to all these problems in 1798: he conducted gas of chlorine into the solution of calcium-hydroxide, so that calcium-hypochlorite or chloride of lime emerged, which had the same whitening effect, but a massive state. Therefore, it could easily be transported and the whitening solution of the appropriate concentration could also easily be prepared, since the chloride of lime was simply and safely to proportion by weighing. Tennant founded several factories to make use of the new procedure, textile factories bought his products, so the factory-owner and inventor made his fortune.¹¹ It is interesting, that in 1795

⁸ Römpf, H.: Vegyészeti Lexikon (Chemic Lexicon). Műszaki Kiadó Budapest 1981, II.kötet 898.oldal

⁹ Grapí P. *The Marginalization of Berthollet's Chemical Affinities in the French Textbook Tradition at the Beginning of the Nineteenth Century*. Annals of Science, Volume 58, Number 2, 1 April 2001 , pp. 111-135(25)

¹⁰ Tennant is best known for his discovery of the elements iridium and osmium, which he found in the residues from the solution of platinum ores in 1803. He also contributed to the proof of the identity of diamond and charcoal. The mineral Tennantite is named after him.

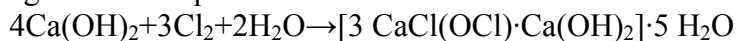
¹¹ Szabadváry Ferenc: A kémia eredete és tárgya. (The source and subject of Chemistry). 1998. Mundus, Magyar Egyetemi Kiadó <http://www.hik.hu/tankonyvtar/site/books/b46/ch10.html>

the Hungarian *Pál Kitaibel*¹² (1757 – 1817) also developed chloride of lime, but since he did not think about its practical usability, we only can rely on his notices, which prove that he even took precedence of Tennant.¹³

Both chlorous water and chloride of lime were officially used in Hungary according to the IV. Austrian Pharmacopoeia used between 1834 and 1855, and also to the later Austrian and Hungarian formularies. (I. Hungarian Pharmacopoeia, 1871-)

Chlorina liquida (Chlorum liquidum, Acidum muriaticum oxygenatum), or chlorous water was produced from common salt (NaCl) with the help of manganese-dioxide (MnO₂) and concentrated sulphuric acid.

The chloride of lime is also called Cloretum Calcis, Calcaria Chlorata, Calcaria chlorinica, Calcaria oxymuriatica, Chloris calcicus, Chloretum calcariae. Gas of chlorine is to be conducted into fresh calcium-hydroxide. The process takes place according to the following chemical equation:



At first, Semmelweis used Chlorina liquida, but later he switched over to the cheaper chloride of lime, from which he gave 1 ounce (35 gram) to 2 libra (840 gram) water, that is, he let hands disinfect with a 4%-suspension, without acidification. One had to wash one's hands, which were previously to clean with soap and nail-brush, until they became slippery from the great alkaline power. The evolved chlorine destroyed the micro-organisms on the skin. Hospitals, however, insisted on disinfecting hand-washes several times a day, so the skin of the hands became wounded and inflamed. Therefore, other disinfecting procedures were preferred, e.g. the use of phenol-solution or sublimate. An order of 1938, however, restored the disinfection by chlorine, together with acidification by acetic acid.¹⁴

4. Investigate of Semmelweis

In Vienna at the Allgemeines Krankenhaus there were two obstetric divisions: patients in the First Division were examined by doctors and medical students, while midwives attended to the patients in the second division. Semmelweis noticed that the mortality in the First Division was three times that of the Second Division. Most doctors considered childbed fever unpreventable, but Semmelweis's tender heart was touched by the screams and moans of the dying women, and he decided to put all his energies into finding the cause and cure of childbed fever. He spent hundreds of hours autopsying the bodies of dead patients. After several months, he noticed that the death rate in Second Division, where doctors and medical

¹² Hungarian botanist, zoologist and mineralogist. Qualified in medicine but never practised. Assistant to Jacob Joseph Winterl at the Institute for Chemistry and Botany, University of Pest. Became professor of botany after Winterl's death in 1809.

¹³ Szathmáry László: Kitaibel Pál (1757-1817), a magyar kémikus. (Pal Kitaibel the Hungarian chemist) http://www.neumann-haz.hu/muvek/tudomanytortenet/2_Szakmatortenetek/Szathmary/kron_szathmary_kitaibel.pdf

¹⁴ Mozsonyi Sándor: Semmelweis Ignác (1818-1865) munkásságának néhány gyógyszerészeti és kémiai vonatkozása http://www.neumann-haz.hu/muvek/tudomanytortenet/4_Neves_tudosok_munkassagarol/Semmelweis/Semmelweis_gyogyszeresz.pdf

students were in charge, was very high while the death rate in Ward Two, where midwives were in charge, was low¹⁵.

"Miasmatic" theories did not fit: the women of Vienna unsurprisingly tried to get into the safer ward when they could, and the Second Clinic was the more crowded of the two. Puerperal mortality was, oddly, higher than average in the apparently healthiest young women having their first child: Semmelweis noted that they were also the ones with the longest period of labour in hospital. Conversely, the women admitted as "street-births", poor girls who had often literally been delivered in the filth of a street, and thereby avoided the luxuries of the hospital, had lower mortalities. He tried exchanging the staff on the two wards: relative mortality rates switched in tandem.

The final link in the chain came in March 1847, Jakob Kolletschka — professor of forensic pathology, colleague and friend of Semmelweis — died of septicaemia after sustaining an accidental wound to the hand during an autopsy. The discovery of the true cause of childbed fever makes for fascinating reading, thus we quote Semmelweis: *“On March 20 of the same year, a few hours after my return to Vienna, with rejuvenated spirits I took over again the post of Assistant Physician in the First Obstetrical Division, but was soon overwhelmed by the sad news that Professor Kolletschka, whom I revered highly, had died during my absence. The history of his illness is as follows: Kolletschka, Professor of Forensic Medicine, frequently participated with his pupils, in the performance of medico-legal autopsies; during such an exercise, he was stuck in a finger by a student with a knife which was used during the post-mortem, in which finger I do not recall. Professor Kolletschka then soon became ill with lymphangitis and phlebitis in the same upper extremity and died, during my absence in Vienna, of a bilateral pleuritis, pericarditis, peritonitis, and meningitis, and some days before his death, a metastasis formed in one eye. Still animated by my visit to the Venetian treasure houses of Art, still more agitated by the report of Kolletschka’s death, there was forced on my mind with irresistible clarity in the excited state the identity of this disease, of which Kolletschka died, with that from which I had seen so many hundreds puerperae die. The puerperae died likewise of phlebitis, lymphangitis, peritonitis, pleuritis, pericarditis, meningitis, and metastases were also formed in them¹⁶.”*

Semmelweis began experimenting with various cleansing agents and, from May 1847, ordered that all doctors and students working in the First Division wash their hands in chlorinated lime solution before starting ward work, and later before each vaginal examination. The results were extraordinary — the mortality rate from puerperal fever in the division fell from 18% in May 1847 to less than 3% in June–November of the same year.

Doctors were carrying something from sick patients and dead bodies to healthy patients; men who were dedicated to healing were transmitting the disease themselves and that the students and doctors who attended the expectant mothers saw them after having just performed autopsies. He realized that the infection was being transmitted from the doctor to the patient, and that this was the cause of the high mortality rate of the First Division.

¹⁵ Zoltán, I.: Semmelweis. *Comm. Hist. Artis Med.* .55-56

¹⁶ Gortvay G, Zoltan I. Semmelweis: his life and work. Budapest: Akademiai Kiado, 1968

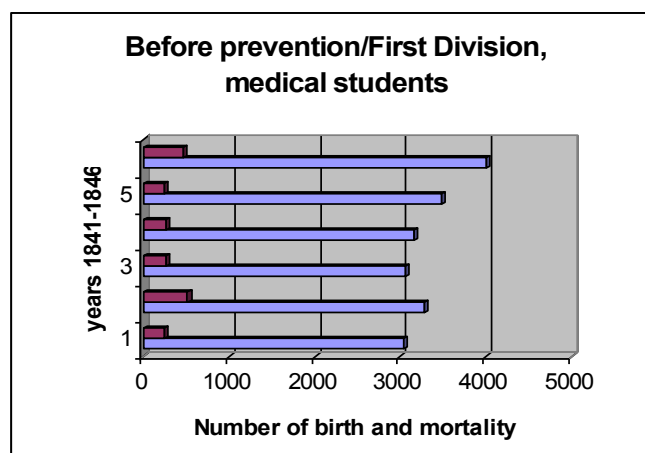
Semmelweis's concentrated aetiological researches then reached a point where his rich pathologic-anatomical knowledge, the keen sighted clinical observations, and his familiarity in the literature demanded the application of another science. That was statistics, and its application a remarkable discovery. The epoch-making discovery grew out from the use of the pragmatic methods.

Semmelweis began to study the regular statistical reports of the clinic with great interest. He started from the raw figures of births and deaths in the years 1841-1846, then computed the maternal mortality rates. He did the same in the relation of the 2nd (midwifery) clinic, too, by which the state of health of the patients in the two neighbouring clinics became comparable.

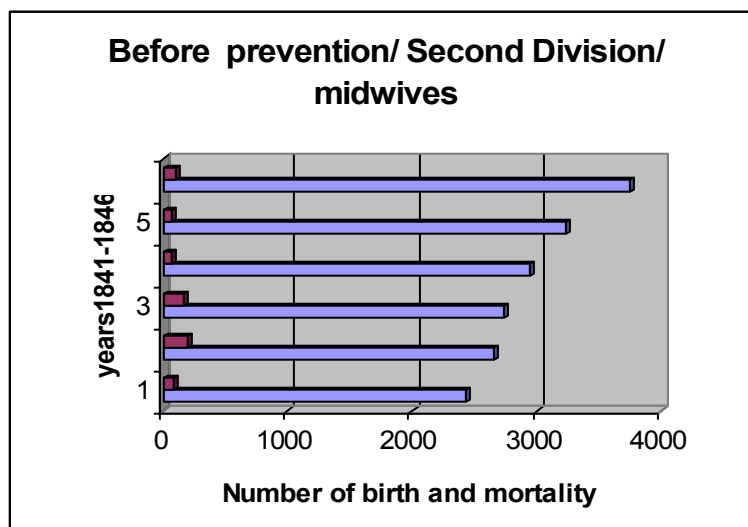
Semmelweis used more than 60 tables of mortality rates to confirm other competing theories and to confirm his hypothesis that cadaveric particles had been transmitted to the patients, and that his solution of hand cleaning had prevented this mode of transmission. Statistical methods in Europe at this time were mostly based on observations of empirical evidence, such as charts and tables.

Year	First Division medical students			Second Division Midwives		
	Births	Deaths	%	Births	Deaths	%
1841	3036	237	7.7	2442	86	3.5
1842	3287	518	15.8	2659	202	7.5
1843	3060	274	8.9	2739	169	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
Total	20042	1989	9.92	17.791	691	3.38

1. Table Annual mortality before prevention



1. ábra Anyai halálozás a klinikán az orvostanhallgatók miatt, prevenció előtt



2. ábra Anyai halálozás a bábák között prevenció előtt

At the time of his discovery, the *germ theory* of infection was unknown, nevertheless, Semmelweis's momentous discovery helped prepare the way for its understanding, which was later to be fully explicated by Louis Pasteur.

4. Semmelweis and science

In 1850 *Semmelweis* returned to Hungary to work in Pest; where he greatly contributed to the development of Hungarian public health. It was here that he continued his fight for the acceptance of his theory and practice until his tragic death.

Although he published only a few statistical data on his activity in Pest in his *Aetiology*; these figures clearly show that statistics remained a controlling force in *Semmelweis's* medical conscience; he indeed looked upon statistics as being "*in the service of collective conscience.*" During his activity in the Rokus Hospital as head physician (1850-1854); the mortality rate of births was only 0.89 per cent; while in the First Division maternity clinic in Vienna, the former scene of his activities, 400 mothers per cent) died in 1854 owing to the neglect of prevention.

In 1861 more than 13 years later the discover of the cause of puerperal fever, Semmelweis wrote *The Etiology, The Concept, and the Prophylaxis of Childbed Fever*¹⁷. Johann Baptist Chiari¹⁸ was co-publisher of an important handbook on obstetrics titled *Klinik der Geburtshilfe und Gynäkologie*¹⁹. This textbook was the first to present the theories of Semmelweis regarding hygiene and prevention of the spread of puerperal fever.

¹⁷ Semmelweis, I., Carter, K. Codell: The etiology, concept, and prophylaxis of childbed fever. [University of Wisconsin Press](#), 1983.

¹⁸ Chiari with German gynecologist Richard Frommel (1854-1912) worked on and named the eponymous *Chiari-Frommel syndrome*, a postnatal disorder that is also known as the postpartum galactorrhea-amenorrhea syndrome.

¹⁹ Johann Baptist Chiari: *Klinik der Geburtshilfe und Gynäkologie* Erlangen, Enke, [1855](#)

There does not appear to be any discernible decrease in the percentage of mortality. The hand washing intervention was introduced sometime in May of 1847, thus the number of months before intervention is 16 and after is 19. monthly mortality in percent over this three-year period and clearly shows the effect of the intervention on monthly mortality.

Month	Births	Deaths	% Mortality
<u>January 1846</u>	336	45	13.39
2	293	53	18.08
3	311	48	15.43
4	253	48	18.97
5	305	41	13.44
6	266	27	10.15
7	252	33	13.10
8	216	39	18.05
9	271	39	14.39
10	254	38	14.98
11	297	32	10.77
12	298	16	5.37
13	311	10	3.21
14	312	6	1.00
15	305	11	3.6
16	312	57	18.27
<u>May 1847</u>	294	36	12.24
18	268	6	2.38
19	250	3	1.20
20	264	5	1.89
21	262	12	5.23
22	278	11	3.95
23	246	11	4.97
24	273	8	2.93
25	283	10	3.53
26	291	2	0.68
27	276	0	0
28	305	2	.65
29	313	3	.99
30	264	3	1.13
31	269	1	.37
32	261	0	0
33	312	3	.96
34	299	7	2.34
35	310	9	2.90
<u>December 1848</u>	373	5	1.34

Table 3. Monthly mortality before and after intervention

During this period, statistical methods were just beginning to be developed for the analysis of medical data, however the use of tables and charts to analyze information was well developed and is illustrated by Semmelweis as follows.

“In order to destroy the cadaveric particles adhering to the hand, although I cannot recall the date, but about the middle of May 1847, I began to use “Chlorina liquida,” with which I and every student were obliged to wash our hands before making an examination. After some time, I abandoned the Chlorina liquida because of its high price and changed to a considerably cheaper chlorinated lime. In May 1847, in the latter half of which the chlorine-washings were introduced, there still died 36 or 12.24% out of 294 puerperae; in the remaining months of 1847, the mortality among the puerperae in the First Clinic was given as follows: [see the above table]. Consequently of the 1841 puerperae cared for during 7 months, 56 died, or 3.04%, when the chlorine-washings were not yet in use, there died 459 puerperae out of 4010 in the First Clinic, or 11.4%. In the Second Division, 32 died out of 3306 or .9%. In 1848, when the chlorine-washings were used assiduously throughout the year, 45

puerperae died out of 3556, or 1.27%. In the Second Division during this year, 43 died out of the 3219 delivered or 1.33%.”

He continues to say, “ *In 1848, there were two months, March and August, in which not a single puerperal died. In January 1849, there were 403 births and 9 puerperae died, i.e., 2.23%. In February, there were 389 births and 12 puerperae died, 3.08%. March had 406 births and 20 puerperal deaths, or 4.9%.”*

His main conclusion was stated as follows “*I have assumed that the cadaveric material adhering to the examining hand of the accoucheur is the cause of the greater mortality in the First Obstetrical Clinic; I have eliminated this factor by the introduction of the chlorine-washings. The result was that the mortality of the First Clinic was confined within the limits of that of the second, as the above cited figures show. The conclusion, therefore, that the cadaveric particles adhering to the hand had in reality caused the preponderant mortality in the First Clinic, was also a correct one*²⁰.”

Semmelweis made salient observations and identified a significant need for improvement in the process of patient care.

5. Quality Control and Semmelweis

If we investigate the researches and results the life work of Semmelweis, it shows a clean outlines of basic frame of quality control and assurance more than hundred years before the definition and systems have been created.

The aim was to save the mothers for life. By the Donabedian (conceptual) model we could follow the steps of evaluation of quality by Semmelweis health care work and conceptions retrograd. This model continues the dominant paradigm for assessing the quality of health care.²¹

The structure and resources (inputs) is to give the knowledge and informations for the medical students and the doctors, about the solution of chlorine. Dimension of quality of care structure is how resources are allocated in terms of time, place and responsiveness to the needs of patients (access). The hospital buildings, the staff belonged to the University and the Allgemeines Krankenhaus hospital (to the city of Vienna), but financing of the new solution chlorine for wash the hand - we don't know exactly who sponsored, but most likely it seems Semmelweis was who payed for it at the beginnings.

Process denotes the use of resources in terms of what is done in giving and receiving care. This can be classified into patient-related processes (intervention rates, referral rates, etc.) and organizational aspects (supply with drugs, management, payment of health care staff, collection of funds, etc.), use of time and resources (efficiency), reduction of risk (safety) Evidence-based practice (appropriateness) Patient-focused care (continuity) *The process was*, the activity, what is done and how it is done the question: to wash the hand every time by a standard method and control.

²⁰ Semmelweis, I.P.: (1941). *The Etiology, the Concept, and the Prophylaxis of Childbed Fever*. English translation by F.P. Murphy, Medical Classics 5: 350-773.

Original publication (1861) as *Die Aetiologie, der Begriff und die Prophylaxis des Kindbettfiebers*. Pest, Vienna, and Leipzig, C.A. Hartleben's Verlag- Expedition.

²¹ McQuestion, M.J. (2006) [Presentation: Quality of Care](#). Johns Hopkins Bloomberg School of Public Health.

Outcome is the population health (health improvement), clinical outcome (effectiveness), meeting expectations of public and workforce (cost–benefit).

The results, output or outcomes is that the effects of healthcare is changed in the mortality which decreased from 18-20% to 1%. The result consisted a lot of components of qualities of Semmelweis: demand, recognizing the needs, efficacy, efficiency, timeliness, safety, effectiveness, accessibility, scientific technical quality, risk management, adequacy, continuous assessment and feedback by new statistic data etc.

But this process and Semmelweis personality lack of some basic elements of the success: cooperation with the leaders of Universty, and with the health care system and staff, risk management, continuous communication and teamwork, optimization of processes.

In other hand Semmelweis fully complied with modern TQM: identified the problem, he made a detailed analysis and created a work plan, selected the solutions, constructed the solutions and finally he had evaluated it.

6. After-life of the great discovery

Several students and physicians from Germany attended the obstetric courses of Semmelweis in Vienna among whom he was extremely popular. One of these visiting physicians was **Adolf Kussmaul**, who later became a great professor of medicine in Erlangen, Freiburg, Strasbourg, and Heidelberg. Some fifty years later, he suggested in a memorial speech that the name of Semmelweis should be mentioned next to that of Lister, adding that, as opposed to Lister, who was able to build upon the great discoveries of Pasteur, Semmelweis had nothing else but his own observations and pathological findings to refer to. Another visiting physician was the assistant obstetrician Hans-Hermann Schwartz from Kiel. He was sent to Vienna by his chief **Gustav Adolf Michaelis** (1798-1848), director of the obstetrical department in Kiel. Schwartz informed his chief about the discovery of Semmelweis in great detail as soon as at the end of 1847. Michaelis adopted the practice of compulsory chlorine handwash immediately and soon reported that his results had proven the discovery of Semmelweis in every respect.

Michaelis was the most faithful follower of his doctrine among his contemporaries. Michaelis was also concerned with the increasing rate of puerperal fever observed at his clinic from the middle of 1830s. He adopted strict sanitary measures and, as a last resort, he even had to order the closing of the puerperal wards repeatedly. Although he achieved unparalleled results at the outset, his initial hope turned into bitter disappointment by 1847. It was end of this year that he read about the favorable effects of the chlorine handwash observed at the obstetric department where Semmelweis worked, as reported in the letter written by his colleague Schwartz. Michaelis had earlier pursued some "bacteriological studies" so he was quite open to the ideas of Semmelweis. He realized that the first onset of cases of puerperal fever at his department coincided with the start of introducing palpation by medical students into everyday practice. However, instead of getting more into detail on the etiology of the disease, this revelation led to his tragedy. He blamed himself bitterly for the death of many women including his own niece whose delivery had taken place a few weeks before he was informed

about the doctrine of Semmelweis. He was tortured by undue remorse and fell into deep depression. Finally, he threw himself in front of a train on August 9, 1848.

Twelve years later, Semmelweis quoted the tragic case of Michaelis in his book. Karl Edouard Marius Levy, professor of obstetrics in Copenhagen, who published an extremely critical review in the Danish Hospital News in 1848 which not even Semmelweis had read before 1858), one might think that such a shocking event as the suicide of Michaelis should have shaken awake German obstetricians. In fact, they kept rejecting the views and recommendations of Semmelweis.

7. Conclusion

The real significance of the puerperal fever treatises of the late eighteenth and early nineteenth centuries lies in the glimpse they can offer into medical perception and scientific theory-building. Not only was the nature of puerperal fever highly contested by inflammationists and putrefactionists, but this was a “high-stakes” contest. The bleeding and purging of the inflammationists was seen by putrefactionists to worsen the debility of the patient, whilst the failure to bleed the patient on the part of the putrefactionists was seen as neglect by the inflammationists. Uncertainty and conflict thus prevailed; they were not to be resolved until the reception of “germ theory” towards the end of the nineteenth century.

The discovery that childbed fever was being transmitted from the cadavers in the autopsy room to the patients in the First Obstetric Division greatly reduced death at childbirth. Semmelweis creatively employed tables to prove his hypothesis. For example, using tables, he refuted the theory that overcrowding was the primary factor in mortality. Also with the table of 36 monthly mortality rates, 17 before and 19 after intervention, it was obvious to him that chlorine washing had proven his conjecture of the etiology of the disease.

Semmelweis's basic insights about the transmission of contagious diseases, underappreciated during his life, later influenced the work of Joseph Lister (1827-1912) and contributed to the germ theory of Louis Pasteur (1822-1895).

Bibliograph

1. DeLacy, M: Puerperal fever in eighteenth-century Britain. *Bull. Hist. Med.*, 1989, **63** (4): 521–56
2. Gortvay G, Zoltan I. Semmelweis (1968): his life and work. Budapest: Akadémiai Kiadó
3. Grapi P.: *The Marginalization of Berthollet's Chemical Affinities in the French Textbook Tradition at the Beginning of the Nineteenth Century*. *Annals of Science*, Volume 58, Number 2, 1 April 2001, pp. 111-135(25) <http://dx.doi.org/10.1080/000337901300103695>
4. Hallett, Ch. The Attempt to Understand Puerperal Fever in the Eighteenth and Early Nineteenth Centuries: The Influence of Inflammation Theory. *Med Hist.* 2005 January 1; 49(1): 1–28. <http://dx.doi.org/10.1017/s0025727300000119>
5. Chiari, J. B. (1855): *Klinik der Geburtshilfe und Gynäkologie* Erlangen, Enke,

6. Lowis, G. W: Epidemiology of puerperal fever: the contribution of Alexander Gordon. *Med. Hist.*, 1993, **37**: 399–410; <http://dx.doi.org/10.1017/s0025727300058749>
7. McQuestion, M.J. (2006) *Presentation: Quality of Care*. Johns Hopkins Bloomberg School of Public Health.
8. Mozsónyi S.: Semmelweis Ignác(1818-1865) munkásságának néhány gyógyszerészeti és kémiai vonatkozása in: Semmelweis Ignác emlékezete (Remember to Ignac Semmelweis) ed.Gazda I. Szállási Á, Kapronczay K. Budapest-Piliscsaba. MATI. 2001. I. vol. pp 211-218.
9. Papp, Z.: Preface. In: Remember to Ignac Semmelweis (ed. Gazda I. Szállási Á, Kapronczay K.) Budapest-Piliscsaba. MATI. 2001. I. vol. 9-19.
10. Römmp, H.: Vegyészeti Lexikon (Chemic lexicon). Műszaki Kiadó Budapest 1981, II. kötet 898. oldal
11. Semmelweis, I., Carter, K. Codell: The etiology, concept, and prophylaxis of childbed fever. [University of Wisconsin Press](http://www.wisc.edu/~wisconsinpress/), 1983.
12. Semmelweis, I.P: (1941). *The Etiology, the Concept, and the Prophylaxis of Childbed Fever*. English translation by F.P. Murphy, Medical Classics
13. Szabadvány F.: A kémia eredete és tárgya. (The source and subject of Chemistry). 1998. Mundus, Magyar Egyetemi Kiadó, <http://www.hik.hu/tankonyvtar/site/books/b46/ch10.html>
14. Szathmáry L: Kitaibel Pál (1757-1817), a magyar kémikus. (Pal Kitaibel the Hungarian chemist)
15. Zoltán, I.: Semmelweis. *Comm. Hist. Artis Med.* .55-56
16. Nuland, S.B. (2003). *The Doctor's Plague: Germs, Childbed Fever, and the Strange Story of Semmelweis*. New York, W.W. Norton & Company Inc.
17. Stigler, S.M. (1986). *The History of Statistics, the Measurement of Uncertainty before 1900*. Cambridge, The Belknap Press of Harvard University.