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From Ignaz Semmelweis to the Present: Crucial Problems of Hospital Hygiene

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This Second International Conference on the Quality of the Indoor Environment in Hospitals, held again in Prague due to the success of the first conference [1], was particularly concerned with problems of infection in hospitals. All the important questions were asked: who, what, why and how to prevent infection. Answers ranged from advances in ventilation and related environment control to the most basic – the simple command "now wash your hands". The wheel has turned full circle since Ignaz Philipp Semmelweis in May 1847 told his staff to wash their hands between examining patients, most particularly when moving from examination of the dead to examination of the living. Over the 150 or so years since then understanding has developed and good practice been instituted (Pamela Clare Ntaki (2005), seminar paper). There are several milestones we should note [2]. Semmelweis started the practice of hand washing by physicians before and after examining each patient [3]. Later came the use of protective gloves and other clothing where contact with body fluids or tissues was expected. Developments have been made in the use of antiseptics and sterilisation of instruments in surgical procedures and finally we now undertake the proper disposal of medical waste products [4].

Before the industrial revolution most women had their children at home. Movement of populations into the cities brought them to hospitals. Here the development of obstetrics, which included all aspects of pregnancy, birth and the perinatal period, evolved into the study of gynaecology. Care of the mother and the child moved from the home and the midwife to the hospital and the doctor. A consequence was puerperal fever or septicaemia which was the main cause of death in child birth during the nineteenth century and at that time infant mortality rates were high. Babies raised in a clean environment, regularly breast fed, and well cared for ran the risk of death rates of 80 to 100 per 1000 at that time. The inner city rates were dramatically higher, 300 deaths per 1000 on average mainly due to poverty, dreadful housing, general unhealthy conditions and an appalling urban sanitary situation. Mass education along with improved sanitation for the general public and the advances in obstetrics finally led to a decline in infant mortality rates by the end of the century.

The hospitals were no example for good hygiene. Surgery was performed without regard for cleanliness. Doctors wore filthy coats, often moving directly from the autopsy room to the operating room. These coats were a badge of their office that they wore with pride. Unfortunately it was a practice that spread deadly infections like septicaemia and gangrene.

The situation would not improve until Ignaz Philipp Semmelweis started the systematic application of

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hygienic behaviour as a necessary condition of health care. Fortunately he was not alone and there were many whose names are perhaps even better known who came after him including Florence Nightingale, Louis Pasteur, Joseph Lister, Robert Koch but also many others.

Semmelweis took up appointment as assistant physician at the First Maternal Clinic in Vienna, Austria, in 1846. At this time the rate of maternal mortality had reached its peak in Europe – diagnosis of which was called "child–bed" or puerperal fever. Semmelweis quickly recognised the cause and proposed that doctors as well as midwives and nurses were infecting the women during delivery with "infectious particles" mostly transmitted on their the hands. Only by washing their hands with chlorinated lime, which Semmelweis introduced in the Vienna clinic in 1847, did maternal mortality drastically fall. Over one month the mortality from puerperal fever declined in his clinic from over 12% to a little over 2%. Despite this dramatic result, Semmelweis refused to communicate his method officially to the learned circles of Vienna, nor was he eager to explain it in a paper. Ferdinand von Hebra finally wrote two articles on his behalf but although foreign physicians and the leading members of the Viennese school were impressed by Semmelweis' results the papers failed to generate widespread support. His observations went against the current scientific opinion of the time, which blamed diseases on quite odd causes. It was also argued that even if his findings were correct, washing one's hands each time before treating a pregnant woman, as Semmelweis advised, would be too much work. Nor were doctors eager to admit that they had caused so many deaths. They tended to claim that their profession was one divinely blessed and thus their hands could not be dirty.

During 1848 Semmelweis widened the scope of his washing protocol to include all instruments coming in contact with patients in labour and he statistically documented his success in virtually eliminating puerperal fever from the hospital ward, leading his colleague and friend Skoda to attempt to call for an official commission to investigate the results. The proposal for a commission was ultimately rejected by the Ministry of Education due to a political conflict in the university and government bureaucracies. Semmelweis was an active liberal, but a conservative movement gained power in 1848 and in 1849 he was dismissed from his position. Skoda delivered an address on the subject in the Imperial and Royal Academy of Sciences in October of 1849, but Semmelweis had neglected to correct his friends' papers to make known their mistakes when describing his work. Semmelweis was finally persuaded to present his findings personally in 1850 with some success. However, he abruptly left Vienna later that year to return to Pest, without notifying even his closest friends. This hasty decision ruined his chances to overcome the Viennese sceptics.

In Hungary, Semmelweis took charge of the maternity ward of Pest's St. Rochus Hospital from 1851 to 1857. His hand and equipment washing protocols reduced the mortality rate from puerperal fever there to less than 1% and his ideas were soon accepted throughout Hungary. During this period he married and in time fathered five children and built a large private practice. He became Chair of Theoretical and Practical Midwifery at the University of Pest in July 1855. Later, in 1857, Semmelweis turned down an offer of a Chair in Obstetrics in Zurich. Vienna still remained quite hostile to him. Finally, in 1861, Semmelweis published his discovery in a book, *Die Ätiologie, der Begriff und die Prophylaxis des Kindbettfiebers*. A number of unfavourable foreign reviews of the book prompted Semmelweis to lash out against his critics in series of open letters written in 1861–62, which did little to advance his ideas. At a conference of German physicians and natural scientists, most of the speakers rejected his doctrine. One of them was Rudolf Virchow. This case is sometimes put forward as an example of a situation where scientific progress was slowed down by the inertia of established professionals.

The establishment's failure to recognise his findings earlier led inevitably to the tragic and unnecessary death of thousands of young mothers, but he was ultimately vindicated. In July 1865 Semmelweis suffered what appeared to be a nervous breakdown, though some modern historians believe his symptoms may have indicated the onset of Alzheimer's disease or senile dementia. After a journey to Vienna imposed by friends and relatives he was committed to an insane asylum, the Niederösterreichische Landesirrenanstalt in Wien Döbling, where he died only two weeks later. Traditionally, he is said to have died the victim of a generalised blood poisoning similar to that of puerperal fever, which had been contracted from a surgically infected finger but this is disputed. H. O. Lancaster, in the *Journal of Medical Biography*, wrote: "Much biographical material has been written on Semmelweis, yet the true story of his death on 13 August 1865 was not confirmed until 1979, by S. B. Nuland. After some years of mental deterioration, Semmelweis was committed to a private asylum in Vienna. There he became violent and was beaten by asylum personnel; from the injuries received he died within a fortnight. Thus some dramatic theories have

been destroyed, including that he was injured and infected at an autopsy, which if true would have been a wonderful case of Greek irony."

Another figure who must take credit for recognising the need for good hygiene was Florence Nightingale (1820–1910). She was the engine behind the drive for hospital reform in the mid-nineteenth century. She rose to prominence through her work during the Crimean War. At that time it was common that for every soldier killed on the battlefield, two died of disease (dysentery, diarrhoea, typhoid, malaria). The situation was worsened by soldiers from small isolated rural areas who had never suffered from childhood illnesses, such as measles and mumps. They lacked immunity for these infections which were common and serious on the battlefield. Outbreaks of these "camp and campaign" diseases were made worse by the crowded and unsanitary conditions. Florence Nightingale had tremendous success in her humanitarian venture at the Scutari Barracks Hospital during the war and was able to convince the world of the need for improving hygiene and sanitation as well as having trained professional nurses attending to the patients in hospital wards. When she arrived at the hospital in Scutari, there were plenty of rats, lice, fleas, but there was little cutlery. Miss Nightingale and her nurses were allowed just one pint of water per patient per day for the purpose of washing and drinking and for making tea so the ladies own personal circumstances were hardly hygienic. However, with hard work and determination, she turned the situation around and by the time she returned to England, she had become a national heroine.

Although Semmelweis is recognised as the pioneer of an antiseptic policy to prevent nosocomial disease only after his death did the germ theory of disease develop. Shortly after the Crimean war had finished Louis Pasteur (1822–95) showed that the old idea of "spontaneous generation" was untenable and then that most infectious diseases are caused by germs. So the ideas of Semmelweis with "infectious particles", and the "little animals" of Leeuwenhoek were vindicated. Pasteur also laid a cornerstone of modern medicine when he showed that rotting and fermentation could occur without any oxygen if micro-organisms were present. Importantly he suggested three methods to get rid of these micro-organisms: to filter them out, to heat them up, or to expose them to chemical solutions. Methods of infection control that have stood the test of time. The first two options were not appropriate for use in people but in the case of wounds the third held out promise.

The next step was taken by Joseph Lister who had become aware of the paper published by Pasteur and conducted experiments. Lister (1827–1912) was a famous British surgeon who promoted the idea of sterile surgery while working at the Glasgow Royal Infirmary. At that time, the usual explanation for wound infection was that exposed tissues were damaged by "miasma" in the air. This was the most widely accepted notion of infection at the time. It was believed that under certain circumstances, air became charged with an "epidemic influence" and combined with the emissions of organic decomposition from the earth to create "miasma" which produced disease. The surgery wards of that time actually smelled bad due to rotting wounds.

Carbolic acid (phenol) had been in use as a deodorant, so Lister tested the results of spraying instruments, surgical incisions and dressings with a phenol solution. He found that the solution swabbed on wounds markedly reduced the incidence of gangrene and subsequently published, in 1867, a series of articles on the "Antiseptic principle of the practice of surgery" describing this procedure. He also made surgeons wear clean gloves and wash their hands before and after operations with 5% carbolic acid solutions. Instruments were also washed in the same solution and assistants sprayed the solution in the operating theatre. Many of his contemporaries laughed at him, but Lister was said to have never bothered to reply and only heaved an occasional sigh at the world's stupidity.

Another major advance in the understanding of infection came in 1882 after Robert Koch presented his discovery of *Mycobacterium tuberculosis*, the TB bacillus. At last people started to understand that tuberculosis and some other diseases were not caused by "miasma" but by bacteria. Fortunately, and as a consequence of the miasma theory, people with tuberculosis were sometimes sent out of the city to sanatoria in the country, where the clean air seemed to help their recovery. It was certainly easier to breathe the air of the country. City air was heavily polluted a problem that was not really dealt with in an effective way until the mid-twentieth century. Two years later, in 1884, Robert Koch identified the *Vibrio cholera* responsible for cholera in water using a microscope. Knowing the cause meant that the disease could now be contained by public health officials.

Another of the controls on infection was the management of hospital wastes [5]. Back in the time of Semmelweis this was simply through incineration or just dumping the waste. The dumps were mostly either in specially dug pits, or the waste was just thrown into convenient bodies of water. The idea of destroying waste through incineration in

appliances designed exclusively for that purpose appeared in Europe in the second half of the nineteenth century. Production of steam was among the main reasons for building these incinerators. Limited use for medical applications of sterilisation by heat and steam started by early 1880s. The first commercial steam sterilisation system intended for medical practice, was developed in 1889. Dry heat and steam were the only methods available to sterilise routinely surgical instruments. Among other motives were the need for waste to undergo bacteriological sterilisation to prevent the spread of diseases as well as quick disposal of the increasing amount of waste resulting from rapid industrialisation and development of urban areas.

Today we understand a lot about micro-organisms and their role in disease causation. We know the importance of hygiene and cleanliness in our hospitals (Manav Bawa (2005) seminar paper). So surely the problems of the past are behind us – unfortunately this is not the case [6]. Despite the continuing concern of hospital managers and all attempts at improvement, many health-care establishments are still unable to achieve satisfactory levels of hygiene. This is particularly true in developing countries. An international survey of the prevalence of hospital-acquired infections was conducted in 14 countries in different regions of the world between 1983 and 1985 [7–9]. The results of this survey, which covered 47 hospitals of size ranging from 227 to 1502 beds (mean 614) showed a wide range of nosocomial infections, with prevalence varying from 3% to 21% (mean 8.4%) in individual hospitals. This work emphasised the importance of hygiene and sanitation in health care establishments.

Problems still exist even where standard procedures are currently in place, largely because they are not a 100% fool-proof. All instruments used in health-care facilities should be sterilised to the highest standards. However, sterilisation is by definition never absolute. It effects a reduction in the number of micro-organisms by a factor of more than 10^6 (i.e. more than 99.9999% of micro-organisms are killed). Standard reference works, such as pharmacopoeias, often state that no more than one in a million sterilised items may still carry micro-organisms. It is therefore important to minimise the level of contamination of the material to be sterilised. This is done by sterilising only objects that are clean (free of visible dirt) and applying the principles of good manufacturing practice.

A more recent concern that drastically compromises hospital hygiene is methicillin resistant *Staphylococcus aureus* (MRSA) the so-called "superbug". Official statistics show that the number of MRSA deaths doubled in the 4 years between 1999 and 2003. A report by the UK National Audit Office, published recently, suggested that as many as 5000 patients a year could be dying from infections caught in hospital. MRSA infections can cause a broad range of symptoms depending on the part of the body that is infected. These may include surgical wounds, burns, catheter sites, eye, skin and blood. Infection often results in erythema, swelling and tenderness at the site of infection. Sometimes, people may carry MRSA without having any symptoms. MRSA is particularly dangerous in hospitals due to the fact that many patients are at higher than normal risk of picking up infection.

We, as are all the hospital hygienists, very worried about what the future holds for MRSA. Already, the possibility of other micro-organisms resistant to all available antibiotics is of concern to medical staff world-wide. However, improving the state of hospital hygiene is a step forward in protecting the most vulnerable patients from the most dangerous strains of "superbugs". The challenge of medicine in the twenty-first century is to ensure the highest standards of hygiene are maintained. We should be able to provide the patient with a clean and healthy environment in which to recover. It is true we understand a lot about infectious disease causation and hospital acquired infections but the latter are still a huge problem although good practice and careful hygiene should keep them under control. Health officials around the world, at the forefront of the struggle against illness and disease, are working to improve so far as is possible the hygiene and sanitary conditions in their hospitals. The message really could not be clearer; we all have a responsibility not to spread potentially dangerous organisms in a hospital environment. Sadly, even today progress may be slow or there may be no progress as hospitals are faced with having to compromise standards of hygiene due to lack of money. Many diseases and infections can be controlled and treated but to do so takes money. Encouraging steps being taken are the education of staff on hygiene and good practice. Courses are provided for health-care institutions and their employees but even these are costly.

However, we do not forget Semmelweis, his solution was not costly. Proper hand hygiene should never be allowed to be compromised under any circumstances. Washing hands between patients should be an absolute requirement for doctors and nurses. If they fail to do this they may be doing more harm than good in their trips around the wards. It is the most important, simplest, and least expensive means of preventing nosocomial infections and the spread of microbial resistance.

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