



SARS and PPE (Part 5)

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Editorial note:

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The virus for SARS was identified within one month of the disease being known. It is the coronavirus. And some eight weeks later, the civet is thought to be the most probable animal from which the virus jumped to infect man. However, unlike zoonoses, this infection can spread from human to human and not just from animal to man. Further, SARS has proved fatal and to date in Singapore, there have been 33 deaths among 206 infected with the virus.

Although the epidemic seems to have died down – Hong Kong was taken off the list of countries with local transmission on 23 June 2003, while China, Taiwan and Canada were removed by 6 July 2003, and no country remains on the WHO list – there are predictions that the coming winter might see a resurgence of SARS or some other novel viral infection. So we need to be prepared. At the personal level, how?

PPE stands for personal protective equipment. This is what I want to discuss in this article. The fact that personal protection is effective at all stems from our understanding of the transmission and infectivity of virus infections. This understanding is just over 200 years old.

HISTORY

The 19th century saw the beginnings of modern medicine. Two important advances so altered the course of medical history that concepts of illness, methods of treatment and hygiene practices at the end of the century bore only a slight resemblance to what they were at the beginning. These two advances were anaesthesia and the discovery of microorganisms as causes of disease.

The organisation of physicians, hospitals and public health activities arose out of the 19th century after alterations brought on by the Industrial Revolution. Before the discovery of bacteria as the cause of disease, the principal focus of preventive medicine and public health had been sanitation. The invention of the water closet by John Harrington (1561-1612) facilitated flushing away human waste and helped to keep dwellings clean.

However, at Amoy Gardens in Hong Kong, this failed. The outbreak of SARS was traced to the faulty sanitation system in one block of apartments. There was no water trap to prevent the backflow of faecal material into the homes. And so instead of just spread of SARS by droplet infection, it was discovered that SARS could also spread by the oral-faecal route.

Going back to the first century, Varro had said that swampy land was dangerous because “certain minute

animals, invisible to the eye, breed there and borne of the air reach the inside of the body by way of the mouth and cause disease”.

In the middle ages, shunning lepers, fleeing from areas of pestilence and segregating the severely ill all represented awareness that diseases could be transmitted.

In the 16th century, Fracastoro demonstrated his perception that there were “seeds” in the environment, which could multiply in the body and produce disease. His contemporary Giralamo Cardano reasoned that these “seeds of disease” were live creatures.

Leeuwenhoek in the 17th century discovered microscopic creatures. In the late 18th century, Agostino Bassi of Lodi suggested that many contagious diseases such as smallpox, typhus, plague and cholera were also due to live organisms.

A battle emerged between those who believed that diseases were definitely contagious and those who ascribed epidemic illness to causes such as environmental change and internal bodily derangement. By the 18th century, anti-contagionists noted that quarantine was not convincingly successful and that an epidemic such as yellow fever was often terminated by weather changes. Further, they observed that even people in contact with yellow fever victims did not necessarily contract the disease. (They did not know that mosquitoes were responsible for transmitting the infective agent or that their absence in winter ended the threat of being bitten and infected.) That epidemics were most frequent in crowded slums was interpreted by the anti-contagionists as additional evidence that the environment was the prime cause – unhealthy air, poor food, and polluted water – rather than living creatures.

However, by then, Edward Jenner had introduced a new concept of creating immunity to a dangerous disease by producing an entirely different mild illness through vaccination.

Semmelweis (1818-65) used statistics to assemble facts and analyse the obstetric happenings in Vienna with regard to puerperal sepsis to prove the contagious nature of postpartum infection. He noted two different mortality rates – one was high where medical students were trained (10-20%), chiefly due to puerperal fever, versus another where mid-wives were trained for the job (3%). He discovered that doctors and students normally came to the ward to examine patients, directly from the autopsy room. In contrast, the midwives did not attend autopsies.

To Semmelweis, the next step was clear: physicians and students under his charge were to wash hands with soap and water and soak them in chlorinated lime solution before entering the clinic or ward, and to repeat this after each examination. Despite complaints, he persisted in his demands. Over the next few months, the 18% obstetrical death rate declined to 1.2%. Awed by this result, the chief of service,

◀ Page 17 – SARS and PPE (Part 5)

apparently for personal reasons, condemned Semmelweis, arranged for him to be lowered in rank, and limited his practising privileges when he reported his results to the Medical Society of Vienna. His paper was greeted with virulent attacks. He was so hurt that he returned to Budapest where his methods effected a marked diminution in mortality rates. Semmelweis could be credited with having for the first time constructed a statistically tested system of asepsis (keeping germs away from the patient) before the germ theory had arrived.

Joseph Lister (1827-1912) was in Glasgow, in an intellectual climate modified by works on infections and germs. Among a variety of substances used on wounds from earliest times, some like urine and turpentine were probably antiseptic in effect while others no doubt contributed to infection.

Lister saw the frequent severe infections attending operations as additional evidence that something circulating in the air was responsible – possibly invisible particles which he called “disease-dust”. When Pasteur’s work of 1860 was brought to his attention, he appreciated the connection between his own observations on wounds and the microscopic bacteria involved in fermentation. Pasteur used heat to sterilise. Lister sprayed carbolic acid over the patient during an operation to kill any bacteria before they could grow in the wound. In 1867, he published a paper in the *Lancet* on his experience with 11 cases and he gave full credit to Pasteur’s work.

However, surgeons remained generally unconvinced. The leader of American Surgery, Samuel Gross, in late 1878 wrote, “Little if any faith is placed by any enlightened or experienced surgeon on this side of the Atlantic in the so-called carbolic acid treatment of Professor Lister.” Lister’s great contribution was to emphasise in the minds of surgeons the necessity for getting and keeping wounds free of contamination.

The employment of rubber gloves in operations was an innovation of the early 20th century. When William Halsted introduced them to protect the hands of his OT nurse (whom he later married), one of his students suggested their use by operators too, since they could be sterilised. At first, the gloves were relatively thick, and many refused to wear them. Even when the rubber was made thinner, some operators, especially in Europe, wore sterile cloth gloves over the rubber. (Masks were brought in even later, and as recently as the 1940s and 1950s, many highly placed surgeons left the nose uncovered, wearing the mask over the mouth only.)

BUGS TODAY

In microbiology today, microorganisms are classified into the Cellular and Unicellular kingdoms. Under the Cellular kingdom are three groups of organisms – Prions (protein particles less than 5nm), Viroids (comprise single strand of RNA e.g. hepatitis D virus, also less than 5nm) and viruses (20-200nm). The Unicellular kingdom is subdivided into two – Prokaryotic cells (20-200nm) consisting of chlamydia, mycoplasma, rickettsiae, bacteria and mycobacteria; and

Eukaryotic cells consisting of fungi and protozoa. At 200nm, the mycobacteria are the smallest free-living microorganisms. There are 16 families of viruses that infect humans, of which coronavirus is one of them. The size of the coronavirus is about 60-100nm.

The SARS virus represents a novel group of coronavirus that is distinguishable from the known human and animal corona viruses. Evolutionally, it is situated at an equal distance from groups II & III coronavirus and is now classified as the sole Group IV coronavirus. As a family, coronaviruses usually cause respiratory and enteric infections. The virus contains a 27-32kb RNA genome encoding multiple gene products, which are usually translated from individual mRNAs. Some gene products are processed from a large polyprotein: continuous protein synthesis and processing are necessary for viral RNA synthesis. Therefore, viral proteases are important potential antiviral targets.

The virus encodes four to five structural proteins, including spike (S), membrane (M), envelope (E), nucleocapsid (N) and an optional protein, haemagglutinin-esterase (HE) protein.

The experience from animal coronaviruses suggests that coronaviruses tend to develop persistent infections, with a long-term carrier state. Viruses may continue to evolve as a result of recombination and mutation. The viruses may cause diseases as a result of both direct cytotoxic effects and immune mediated mechanisms. The latter is particularly evident with feline and murine coronaviruses.

It is now necessary to re-look the WHO definitions for suspected and probable SARS. As reported last month (*BMJ*, 21 June 2003, pg 1354-8) from the Prince of Wales Hospital, Shatin, New Territories, Hong Kong, in the early stages of SARS, the main discriminating symptoms are not cough and breathing difficulty, but fever, chills, malaise, myalgia, rigors, and possibly abdominal pain and headache. Documented fever of more than 38°C is uncommon in the early stages and radiological evidence of pneumonia changes often precedes fever. Further in their study of 515 people presenting to their screening clinic (of whom 418 were without SARS and 97 with SARS), the authors concluded that the WHO case definitions for suspected SARS have a negative predictive value of 86%, a sensitivity of 26% and a specificity of 96% for detecting SARS in patients who have not been admitted to hospital. The accuracy of the WHO guidelines for identifying suspected SARS was 83%.

In another paper also from the Prince of Wales Hospital, Hong Kong, it was reported that lymphopenia was common among patients with SARS. (*BMJ*, 21 June 2003, pg 1358-62) Both CD 4 and CD 8 counts decreased during the early course of SARS. Low CD 4 and CD 8 lymphocyte counts at presentation were associated with adverse outcomes. The authors further stated that leucocytosis with neutrophilia, thrombocytopenia and isolated prolonged activated partial thromboplastin time were common in patients with SARS.

There is still no effective antiviral agent against the SARS coronavirus.

PROTECTION

While the search for a vaccine goes on, we as healthcare workers need to take care of ourselves. If we fail, the end result could be death. Hence, the need to understand the basis for the use of various equipment, and not only to understand, but also to use the equipment properly one hundred percent of the time. Otherwise, there is little benefit if any, and worse, a false sense of security.

Guidelines have been issued by the Ministry of Health (MOH), and guidelines from other countries and agencies are available on the Internet. These need constant updating as SARS the disease continues to be unravelled and new lessons learnt. Guidelines should be followed from the point of patient presentation until their discharge. To the many frontline doctors, that patient before you could be suffering from SARS. From 1 July 2003, Tan Tock Seng Hospital (TTSH) has opened its Emergency Department to the public at large and is not catering solely to the work of SARS screening. So in a way, the risk is dispersed back to doctors in the community. Healthcare workers caring for patients with SARS are at risk of contracting SARS. Personal protective equipment is mandatory to prevent transmission of SARS in healthcare settings. Further, in view of the atypical presentations of SARS in patients with multiple medical problems or on immunosuppression drugs, a very high index of suspicion is necessary. And this is especially so, as the reliability of a travel history to SARS-affected areas has lessened. So if there is any uncertainty, ensure for your safety and health that full protection is worn.

It is easy to remember “m3g”, which stands for mask, gown, gloves and goggles. So before you get close up to any patient (i.e. within coughing or sneezing distance) think about *m3g* and the necessity for one or more of these to be in place before you start the medical consultation. Further, you need training on how to use these equipment and for the N95 mask, proper fitting is essential. Above all, hand hygiene and proper thorough handwashing are crucial. Hands should be washed before and after contact with any patient, after activities likely to cause contamination and after removing gloves. Likewise, the stethoscope needs to be disinfected with alcohol wipes after use.

MASKS

On 6 April 2003, the Sunday Times Life Section ran an educational piece on masks and showed pictures of different types of masks available for sale in the pharmacies. But are they necessary or even effective?

Three types of masks were showcased; the paper mask, the surgical mask and the N95 mask. The paper mask allows anything with a diameter less than 5 microns (or 5000 nanometers) to pass through the paper and into the respiratory system. It offers little protection against viruses, as it has no filter (unlike the 3-ply surgical mask). It tears easily because of moisture from saliva. People who serve food can use it for hygiene purposes but not those with a cough or cold.

The surgical mask is what surgeons are supposedly used to wearing. It prevents droplets and viruses more than 4 microns in diameter, from passing through. It is made of paper with a gelatinous layer. It must be changed every four hours or once it becomes wet with fluid. For those who wear spectacles, water vapour will keep forming on their lenses. When wearing, the mask must be opened with the pleats facing downwards to cover the face completely. The nose clip must be adjusted to conform to your nose and there should be no gaps on either side of the mask. When worn correctly, it is comfortable and provides good ventilation. Before the SARS crisis, surgical masks were sold at about 60 cents each, and come only in adult sizes. But because of SARS, the price rose to between S\$1.50 and S\$3 each. These masks are effective in preventing the spread of infectious diseases by droplets such as the flu. The patient/sufferer wears the mask to prevent him/her from spreading the disease to those around. Masks also prevent the wearer from touching their noses and mouths. An effective barrier mask has nose clips allowing no room for gaps. Masks made of woven materials such as cotton or gauze do allow viral particles through them, and so while they may look cute and decorative with cartoon characters, cloth masks will not give adequate protection.

So in the tradition of the Japanese, when a person has a cold or cough and needs to go out and mingle in public places, he or she will wear a surgical mask. The purpose is to not spread germs into the air when he or she coughs or sneezes. This is civic consciousness of a very high degree and this practice is worth emulating.

N95 MASK

The WHO approved the N95 mask for use by medical staff as well as patients with confirmed or suspected SARS. N95 masks generate static electricity, which is effective in stopping very small particles from getting on the surface of the mask. They are made of polypropylene fabric, using a non-woven technology that increases the density and filtering function. Small particles above 0.3 microns cannot pass through (0.3 microns equals 300 nm). N95 masks are used to protect against highly transmissible respiratory infections such as tuberculosis (which as mentioned before is 200nm in size). “N” actually stands for NIOSH – The National Institute for Occupational Safety and Health of the USA, and “95” reflects the filter efficiency of the mask. So “N95” means the mask is 95% efficient at filtering out particles of a size of approximately 0.3 microns and above. And a N100 mask has a 99.7% efficiency of filtering out these small particles. They are tested using an aerosol of sodium chloride. The coronavirus is about 100nm in size and when expelled from patients, it is usually bigger than this in size because it is enveloped in saliva as droplets. But if the droplet dries up in the environment to leave the virus intact, the mask is still more than sufficient (if correctly worn) to prevent the virus reaching the respiratory tract through the mouth and nose (but the mask does not protect the eyes) because of the static electricity of the mask.

N95 masks were sold at pharmacies for S\$2.95 each but the price rose to between S\$4 and S\$5 when SARS hit Singapore. Mask fitting is a critical process for N95 masks to prove effective. Hence it comes in different sizes, each with its code number. To wear the mask, you need to press the mask firmly against your face with the nose-piece on the bridge of your nose. The two bands are then positioned, the top band high on the back of your head and the lower band below your ears. Both hands are used to mould the metal nose-piece to fit the nose shape. To test fit the mask, both hands are cupped over the mask and with vigorous exhalation, no air should leak around the margin of the mask. If air leaks, the nose-piece and bands are adjusted to see if a better fit is possible. If this is not possible, change to a different size of mask and repeat the procedure. When there are no air leaks, a confirmatory test is necessary. In this test, after you have worn the correct size mask properly, a transparent hood with a one-way valve is put over your head and neck. An aerosol of Bitrex solution in a hand-held nebuliser is squirted many times into the hood as you breathe normally. Bitrex contains sodium chloride, denatonium benzoate (bitter taste) and water. You aim to taste this solution, not smell it. If you fail to taste the solution, then you have passed the test and your mask is properly fit tested to your face. Remember the size and number of this mask e.g. for 3M brand, it may be 8210 or 8110S, or 1860. So if you change the brand of mask, to ensure your own protection, you must undergo the same stringent fit testing again.

Therefore, in the MOH guidelines issued on 26 April 2003 in a booklet form, there are clear guidelines on the use of this Respirator (High Filtration) mask. On page 12, it states: "The N95 respirator or equivalent mask must be used according to the manufacturer's instruction and fitted so that there is a proper seal between the mask's sealing surface and the wearer's face. It must be secured over both the nose and mouth." Under "Fit Testing", it states seven points worth restating here:

1. Every health care worker must be fit tested for the appropriate size.
2. A qualified person must carry out fit testing for every health care worker.
3. Once fit tested appropriately, the health care worker must use the same model and size.
4. The self-seal check/fit check is mandatory for every staff on every occasion: on first fitting on the respirator, on reapplying the respirator and when the respirator is dislodged.
5. The fit test should be repeated before a different model of mask is used.
6. The wearer must be clean shaven. Beard, stubble or long moustaches may cause leakage into the respirator.
7. Individuals with a compromised respiratory system, such as asthma, should consult a physician before wearing the respirator.

In the hospital setting, it is the responsibility of the Chairman of Medical Board to ensure that every healthcare worker dealing with SARS patients, is fit tested before he or

she can interact with such patients. In the private sector, the Singapore Medical Association took on this role of ensuring that doctors had access to proper fit testing. In an email announcement from SMA on 25 June 2003, it stated that SMA had organised 10 sessions of mask fit testing and the final two were being arranged on Saturday 28 June and 5 July from 2 to 4 pm at the Alumni Medical Centre. So after SARS has been controlled, each of us should now be equipped with a mask of a certain brand and size fitted to our facial anatomy such that it is indeed effective protection when properly worn at the appropriate times. Further, each of us should know where to get supplies and who to contact. In another SMA announcement dated 30 May, 3M N95 1862 masks cost \$54 per box of 20 respirators, white 3M N95 8810 costs \$39 per box of 20 respirators. Another brand Draeger N99 Piccola FFP3V cost \$84 per box of 20 respirators.

Wearing the mask makes normal breathing difficult. All air getting into your respiratory tract has to go through this filter to be effective. Hence wearers need periods of respite from the mask, maybe after wearing it for 20 to 40 minutes. Once worn in the presence of a SARS patient, the mask should be considered potentially contaminated with infectious material and touching of the mask should be avoided. After removing the mask with gloved hands, it should not be reused. If there is no contamination, soiling or damage, reuse may be considered and again the MOH guidelines on page 13 state that to do so, "implement a procedure for safer reuse to prevent contamination through contact with infectious droplets on the outside of the respirator". Another way is to use a surgical mask over the respirator and then discard the surgical mask.

When these N95 masks were first marketed, their primary use met the CDC guidelines for mycobacteria tuberculosis control. As a respirator, it is intended to reduce wearer exposure to certain air-borne particles in a size range of 0.1 to more than 10 microns including those generated by electrocautery, laser surgery, and other powered medical instruments. It is also designed to be fluid resistant to spray, splash, spatter and aerosol of blood, body fluids and other infectious materials. For now, we have used it to combat the SARS coronavirus and we appear to have been successful.

SURGICAL MASKS

In the Lancet issue of 3 May 2003, an article was published titled "Surgical masks likely to protect against SARS". The author is Dr WH Seto from the Queen Mary Hospital in Hong Kong who did a case control study using 13 staff members infected with SARS and 241 uninfected staff members who had been exposed to 11 index patients with SARS. "Gloves, gowns and hand washing together are not as effective as masks and surgical masks provide the best protection for exposed health care workers. Masks seem to be essential for protection. The other three measures (without the mask) add no significant protection." He reasoned that this finding fits well with droplets transmission because droplets are generated at the face level, thus making the mask crucial for protection.

NEW FINDINGS

But the virus is now thought not only to spread by droplet but also by fomites so that people can catch the virus without face-to-face contact with a sick person. The WHO released findings from experiments in Hong Kong, Japan, Beijing and Germany that showed that the SARS virus can survive on common surfaces at warm temperature for 24 hours or even days. It can also remain viable in human waste for as long as four days. (*Straits Times*, 5 May 2003, pg 3, col 1-7) So it might be possible to become infected from touching a tabletop, doorknob or other objects. Also it could spread through apartment buildings, hospitals and other facilities. The virus appears to survive longer as the acidity in the stool decreases. The Japanese scientists showed the virus could survive for extended periods in the cold. The virus died at 37°C and above (that is why the body mounts a fever), started to deteriorate at 4.4°C, but seemed to remain viable indefinitely when temperatures dropped below 0°C. Scientists in Beijing reported similar results.

So Dr Klaus Stohr, the WHO's top SARS scientist said that a key unknown was how much virus was necessary for someone to become infected. The virus has the capacity to stay in the environment but we do not know whether it can survive in sufficient quantities to be dangerous. He emphasised that by far, the primary mode of transmission was through droplets that spray out when an infected person sneezes or coughs.

So to summarise the mask matter, for sick people, give them a surgical mask so that those around them can be protected from their bugs coughed or sneezed into the air. For healthcare workers, protect yourself with a well-fitted respirator mask. Ensure adequate supplies of the size that fits you. In Taiwan, villagers strapped bras to their faces to guard against the SARS virus due to the shortage of surgical masks. (*Streets*, 9 May 2003, pg 8) It is incorrect for use as surgical masks (unless Dr Seto's results are confirmed) and bras are not the correct substitute either. "Have mask, will travel (on business)" so said a headline on the *Straits Times* of 7 May 2003 (pg H1). It reported that a banker travelling to Shenzhen arrived with a facemask providing industrial level protection. Depending on how long he is there, one mask may prove insufficient for his needs.

THE 3 'G'S

Gloves and gowns and goggles are meant to protect hands, body and arms, and the eyes from splashes of body fluids and direct contact with patients and secretions, beds and other furniture. Guidelines for their use are adequately covered in the MOH publication referred to earlier. Goggles or eye protection should cover over spectacles if these are routinely worn. Gloved hands should not touch the eyes or eyelashes at any time. Gowns should cover body, upper arms and forearms down to the wrists and be tucked under the gloves. Except for the addition of goggles, gloves and gowns

are part of universal precautions, which became important and critical when HIV came to Singapore over 20 years ago.

UNIVERSAL PRECAUTIONS

These apply to protect against exposure to blood and body fluids:

1. Appropriate basic precautions are required to prevent skin and mucous membrane exposure when contact with blood and other body fluids of any patient is anticipated. Gloves should be worn for touching blood and body fluids, mucous membranes or non-intact skin of all patients, for handling items or surfaces soiled with blood or body fluids and for performing venipuncture and other vascular access procedures. Gloves should be changed after contact with each patient. Masks and protective eye wear or face shields should be worn during procedures that are likely to generate droplets of blood or other body fluids, to prevent exposure of mucous membrane of the mouth, nose or eyes. Gowns or aprons should be worn during procedures that are likely to generate splashes of blood or other body fluids.
2. Hands and other skin surfaces should be washed immediately and thoroughly if contaminated with blood or other body fluids. Hands should be washed immediately after gloves are removed.
3. All healthcare workers should take precautions to prevent injuries caused by needles, scalpels and other sharp instruments or devices during procedures; when cleaning used instruments; during disposal of used needles; and when handling sharp instruments after procedures.

For laboratory workers there are yet other precautions:

- a. Biological safety cabinets should be used whenever procedures are conducted that have a high potential for generating droplets.
- b. Mechanical instead of mouth pipetting devices should be used for manipulating all liquids in the laboratory.
- c. Laboratory work surfaces should be decontaminated with appropriate chemical germicide after spills and when work activities are completed.
- d. Equipment must be properly cleaned and decontaminated after use as per manufacturer's instructions.
- e. All persons should wash their hands after completing laboratory activities and should remove protective clothing before leaving the laboratory.

SELECTION OF GLOVES

Medical gloves include those marketed as sterile surgical or non-sterile examination gloves made of vinyl or latex. General purpose utility ("rubber") gloves are also used in the healthcare setting but they are not promoted for medical use. There are no reported differences in barrier effectiveness between intact latex and intact vinyl used to manufacture gloves. Thus the type of glove selected should be appropriate for the task being performed.

These are the general guidelines recommended:

1. Use sterile gloves for procedures involving contact with normally sterile areas of the body.
2. Use examination gloves for procedures involving contact with mucous membranes.
3. Change gloves between patient contacts.
4. Do not wash or disinfect surgical or examination gloves for reuse. Washing with surfactants may cause enhanced penetration of liquids through undetected holes in the glove. Disinfecting agents may cause deterioration.
5. Use general purpose utility gloves ("rubber") for housekeeping chores involving potential blood contact and for instrument cleaning and decontamination procedures. Utility gloves may be decontaminated and reused but should be discarded if deteriorated.

For SARS prevention, examination gloves are recommended as they are tight fitting over the wrist and can overlap the long sleeves of the gown, leaving no part of our forelimbs exposed. At TTSH, staff are issued with ABT and Shamrock gloves, non-sterile and made of latex. For sterile surgical gloves, Ansell and Maxitex gloves are used, both of latex material also.

There is a different type of gloves available locally where chemicals that are antibacterial and antiviral are released in the glove. It is called ProTek disposable gloves, distributed by SembCorp Express (Tel: 6462 8463). The ProTek glove is an innovative product proven effective to control bacteria and virus cross contamination. It is powered by the patented Microlite system with unique properties. It actively controls and reduces disease-causing bacteria both on hands and gloves. It is activated by normal light and it generates a patented microatmosphere that kills bacteria both inside the glove and on the entire surface of the glove. Microsphere is a sustained release system that releases chlorine dioxide, the active ingredient that kills six types of microbial organisms: viruses such as HIV, polio, rotavirus, herpes and echo; bacteria like E coli, salmonella and staphylococcus; spore formers like bacillus and clostridium; moulds like aspergillus and chaetomium; protozoa like giardia, cryptosporidium and algae. In the Microlite system technology, the molecular photocells are activated by light which then generates a chlorine dioxide microatmosphere. The use of chlorine dioxide is known to be safe, is stable in normal atmospheric conditions and is commonly used to treat drinking water. It does not produce by-products or mutagens. There are two material forms of ProTek gloves – polyethylene (which is cheaper) and polyvinyl chloride.

So besides gloves being just a barrier precautionary measure, ProTek gloves go one step further in generating chlorine dioxide, which kills certain microorganisms, on both the inside and outside of the gloves. Of course it has not been tested against the SARS virus so I mention these gloves for information only and *not* as a recommendation.

REMOVING PPE

There are definite steps of putting on and removing the PPE. When putting on PPE, the purpose is to protect oneself rather than keeping the gloves sterile for the patient's benefit (i.e. asepsis). Nonetheless, gloves are still worn last. The mask is worn first and properly adjusted to ensure proper fit. Then goggles are next, if they are required. Ensure that the goggles and the mask both provide protection without compromising the safety of each, i.e. the mask should not be moved or displaced by the goggles. Next comes the gown, and finally the gloves, with overlap of gloves over the sleeves of the gown.

In removing PPE, the gown comes off first and is disposed of without its external surface touching any part of the body. (It goes into a container/bag meant for biohazardous waste.) Next off are the gloves, followed by handwashing to ensure clean hands next touch the face. The goggles are removed next (to be cleaned, disinfected and reused), and finally the N95 mask. In between removal of the goggles and the mask, the hands should not touch the face nor rub the eyes. After the mask is off, you need to decide if it is to be reused or thrown away. If the latter, it enters the bag with the gown and gloves. If it is for reuse, it must be kept clean, preferably in a Ziploc bag, and sealed. Hands are washed again after touching the mask (as the outer surface is deemed to be contaminated).

Remember that it is important after having touched any of these "soiled" equipment, which are potentially infectious on the external surface, not to use your hands (whether gloved or not) to touch any part of your face including the eyes, nose and mouth i.e. mucosal surfaces. You can only do so after the hands are thoroughly washed and deemed clean rather than contaminated (through having touched some part of your PPE in situ on your body).

CONCLUSION

This article has been written based on the experience of the SARS epidemic as it affected Singapore. We were declared SARS-affected on 20 March 2003 and then SARS-free on 31 May 2003. As mentioned in Parliament at the end of June 2003, we spent over S\$190 million on direct purchase of equipment of which the PPE were the majority. There is also the Powered Air Purifying Respirator (PAPR) which is worn in really high risk environments with aerosolisation occurring, like in the MICU, the operating theatres or when doing bronchoscopies.

I hope the information given can be thoughtfully used should another outbreak of infectious disease occur. SMA has a list of suppliers and distributors of PPEs, and hopefully also, a system of bulk purchasing co-ordinated by the Ministry of Health such that in the global market place, we can buy the equipment when the need arises, at appropriate prices. If nobody wants to sell them to us in Singapore, then we may have to plan for local manufacture of these PPE. If nature afflicts us with outbreaks and we need so much resources to manage them, can we imagine the havoc of bioterrorism ordained by men upon us? How much more prepared must we be and what does it take to reach such levels of preparedness? Who is thinking about these scenarios? We should. ■