Chapter 5: Hand hygiene

Hand washing is one of the most effective infection control practices.

Indications for hand hygiene:

- Before and after direct patient contact.
- Before putting on sterile gloves.
- Contact with body fluids, mucous membranes, open skin and wound dressings.
- Before making contact with a clean site after touching a contaminated site.
- After touching a high-touch environmental surface/equipment near the patient.
- After removing gloves.
- Before eating or drinking.
- After using the bathroom.

Gloves do not fully protect against hand contamination.

Plain soap (non-antimicrobial): used for routine hand washing, when hands look dirty. It will only remove loosely adherent transient bacteria through mechanical friction. It will not decontaminate the hands.

Antimicrobial soap: used if there has been visible hand contamination with blood or body fluids. Chlorhexidine has adequate cover against Gram-positive, Gram-negative organisms and viruses but poor cover against mycobacterium and fungi. Iodine compounds have a slightly decreased action against fungi and good cover against all the other microorganism groups. Both chlorhexidine and iodine compounds have an intermediate onset of action and thus need adequate contact time. Chlorhexidine retains its efficacy in the presence of blood and has a lower incidence of adverse skin reactions.

Alcohol-based hand rubs can be used provided the hands are not obviously dirty or contaminated with proteinaceous material. If an alcohol hand rub is used, it is important to keep the hands and forearms wet during the whole procedure. Using inadequate volumes of alcohol-based rub (0.2–0.5 ml) is as efficient as washing with plain soap and water. Approximately 15 ml of alcohol-based rub is required. Roughly one minute should be spent rubbing the forearm. Thereafter, hands and fingers should

be rubbed in the same manner as for hand washing. Alcohol has good cover against Gram-positive and Gram-negative organisms and also against mycobacteria and viruses. It also has a fast onset of action and should be allowed to evaporate. It has virtually no activity against spores and protozoal oozytes. Physical hand washing with antimicrobial soap and vigorous washing and rinsing is important for spore-forming organisms, such as *Clostridium difficile* and *Bacillus anthracis*.

Nails: Artificial nails and nail polish should not be used in the operating rooms or ICU. Fingernails should be kept short and clean. Avoid using nail brushes during hand washing as they damage the skin and therefore increase the risk of contamination by microorganisms.

Non-sterile gloves should be worn whenever contact with blood, body fluid, mucous membranes, non-intact skin and potentially infectious materials is anticipated. They need to be removed as soon as possible, and therefore be changed between different procedures on the same patient. They should not be reused. Gloves must be removed before touching equipment if they were in contact with the patient. Curtains, clinical notes, pens, computer keyboards, and cellular and landline telephones must not be touched with contaminated gloves.

Alcohol-based hand rubs used on gloved hands can be considered in settings with inadequate supply of gloves to meet the above requirements. This practice may potentially degrade the quality of the gloves, making them prone to leakage.

Bare below the elbow: Different societies have conflicting recommendations with regards to coverage of the arms. This contentious issue has led to multiple guideline changes. Unfortunately, studies have had conflicting results. The proponents of "bare below the elbow" argue that garments have a high risk of being contaminated and by removing them as far away as possible from the hands will decrease the risk of contamination of the hands and increase the efficacy of hand washing. Opponents to "bare below the elbow" argue that the skin sheds millions of squamous cells every day that contain both normal skin flora and pathogenic microorganisms. By covering up the arms to the wrists, the load of squamous cells entering the environment will be decreased. False nails, nail polish, wristwatches and stoned rings should not be worn.

Simple hand washing has been shown to be one of the most effective infection control practices in everyday practice in protecting anaesthesiologists and patients from colonisation and/or infection with microorganisms.[34-36]

Rationale

Our hands carry a high count ($3.9 \times 104–4.6 \times 106$ of colony-forming units [CFUs]/cm^2) of resident and transient bacteria.[37-40] The function of the resident flora is microbial antagonism by competing for nutrients. Resident flora are usually not associated with healthcare-associated infections, but they may cause infection when introduced into sterile body cavities.[37,41]

Transient flora are the more problematic pathogens. Patients harbour pathological bacteria in septic wounds, and also on intact skin. Since on average humans shed approximately 106 skin squames per day,[42] these pathological microbes also contaminate the environment around the patient. Healthcare workers can contaminate their hands by simple "clean" procedures, such as feeling a patient's pulse, or by touching the bed or the patient's file.[37,43-51] In one study,[52] 52% of healthcare workers who entered vancomycin-resistant enterococci (VRE) infected patients' cubicles and whose hands were free from VRE, were contaminated by the time they exited the cubicles. These healthcare workers had not touched the patients at all and were contaminated purely by interacting with the surrounding environment. There was a 70% contamination rate for the healthcare workers who touched patients.

Gloves do not fully protect against contamination.[53] When high-risk procedures such as nappy changes were examined, there was only a 50% reduction in contamination when gloves were used. In a study by Hayden et al.[52] on VRE contamination, 3% of VRE-negative healthcare workers who were wearing gloves were contaminated. This was 86% lower than their ungloved counterparts. Ehrenkranz and Alfonso[54] cultured the moisture found on the inside of used gloves after nursing staff had touched the groins of patients infected with *Proteus mirabilis,* and found up to 600 CFU/ml of the organism. Although gloves are a useful adjunct to hand hygiene, they are not a substitute for proper hand decontamination.

Various studies have shown that microorganisms can survive for prolonged periods. Noskin et al.[55] showed that VRE can survive for more than 60 minutes on gloved and ungloved hands, and in the environment. This was also true for *Enterococcus feacalis*, *E. faecium*, *Pseudomonas aeruginosa* and *Burkholderia cepacia* when used in a study to show contamination by handshaking. When the bacteria were suspended in saline, contamination occurred up to 30 minutes later. However, if these bacteria were suspended in sputum, contamination occurred up to 180 minutes later.[56]

Despite this compelling evidence that hands are an important vector for cross-contamination, in general, compliance rates in healthcare workers are low. It is difficult to determine an exact figure because when overt observers are used in studies, the compliance tends to be higher because of the so-called "Hawthorne effect".[57] If you know that you are being watched, you will tend to be more compliant. Covert observers may not witness every opportunity for hand washing, and they may also be noticed by healthcare workers, which again will lead to the Hawthorne effect. In one study, the Hawthorne effect led to a 55% increase in compliance.[58] Overall, between various studies, the compliance rate remained below 50%.[59-61]

A study by Biddle and Shah[62] showed that indications for hand hygiene according to the WHO 5 Moments of Hand Hygiene reached 54 episodes per hour in high task density periods such as challenging airway situations, complicated emergence or the haemodynamically unstable patient. In 82% of incidents where

hand hygiene should have occurred, there was failure to do so by all providers.

Munoz-Price et al.[63] showed that placing an alcohol-based hand rub on the anaesthetic work station improved compliance to hand hygiene.

The quality of hand decontamination also remains a problem. The amount of time spent on hand washing, the amount of decontaminant used and the type of decontaminant all play an important role. Noskin et al.[55] found that after an inoculum of VRE, hand washing for five seconds with water alone made no difference to the degree of contamination. When two soaps were used for five seconds, there was still 1% recovery of the initial inoculum. A time of 30 seconds was needed for complete decontamination. In laboratory studies by Larson et al., it was found that one ml of alcohol-based hand rub or liquid soap had lower bacterial reduction rates than three ml of the product.

Indications for hand hygiene are as follows:[34,36]

- Before and after direct patient contact.
- Before putting on sterile gloves.
- Contact with body fluids, mucous membranes, open skin and wound dressings.
- Before making contact with a clean site after touching a contaminated site.
- After touching a high-touch environmental surface near the patient.
- After removing gloves.
- Before and after eating or drinking.
- After using the bathroom.

Recommendations

Plain soap (non-antimicrobial)

Plain soap (non-antimicrobial) should be used for routine hand washing when hands look dirty. It will only remove loosely adherent transient bacteria and will not decontaminate the hands.[54,64,65]

Soap (antimicrobial)

Antimicrobial soap should be used if there has been visible hand contamination with blood or body fluids.

Alcohol-based hand rubs

Alcohol-based hand rubs[37] can be used provided the hands are not obviously dirty or contaminated with proteinaceous material. If an alcohol hand rub is used, it is important to keep the hands and forearms wet during the whole procedure.[66] Using inadequate volumes of alcohol-based rub (0.2–0.5 ml) is as efficient as washing with plain soap and water.[67,68] Approximately 15 ml of alcohol-based rub is required. Roughly one minute should be spent rubbing the forearm. Thereafter, hands and fingers should be rubbed in the same manner as for hand washing. The hands should be kept above the level of the elbows. When choosing an alcohol-based hand gel, it is very important to ensure that it complies with the test standard EN 12791[58] for hand rub formulations. Many commercially available hygienic hand rubs do not meet the standard EN 1500[69] which is similar to the EN 12791. Alcohol-based hand rubs should be easily accessible to improve compliance. They should be placed close to the anaesthesia workstation or close to the doors to the operating theatre. Wall-mounted dispensers will also increase compliance.[70,71] Dispensers should be at least 2.5 cm away from ignition sources as there is a small risk of fire.

Alcohol has virtually no activity against bacterial spores and protozoal oozytes.[37] If there is a high risk of these pathogens, then alcohol should not be used as the sole agent for decontamination. Physical hand washing with water-based washing and rinsing is important for spore-forming organisms, such as *Clostridium difficile* and *Bacillus anthracis*.

Nails[37,39,72-75]

Despite low-quality evidence and some studies showing that nail polish or gel nails do not increase the bacterial burden, it is recommended that artificial nails and nail polish should not be used in the operating rooms or ICU. Fingernails should be kept short and clean. Avoid using nail brushes during hand washing as they damage the skin.

Sterile gloves

Sterile gloves must be worn if an invasive procedure is performed or if there is contact with sterile sites. Gloves should be of high quality to ensure patient and healthcare worker safety.

Non-sterile gloves

Gloves should be of high quality to ensure patient and healthcare worker safety. Non-sterile gloves should be worn whenever contact with blood, body fluid, mucous membranes, non-intact skin and potentially infectious materials is anticipated. They must be put on immediately before patient contact. They need to be removed as soon as possible, and thus be changed between different procedures on the same patient. They should not be reused. Gloves must be removed before touching equipment if they were in contact with the patient. Curtains, clinical notes, pens, computer keyboards, cellular and landline telephones must not be touched with contaminated gloves. Hand washing should be performed as soon as possible. Double gloves can also be worn, especially during airway manipulation where the anaesthetist's hands may become contaminated with respiratory secretions. The outer glove may be removed before touching environmental surfaces such as setting the ventilator. Gloves should not be a substitute for hand washing as there can be a degree of glove leakage during use and self-contamination when removing the gloves. Powdered and polythene gloves should not be used.

Some institutions, however, may have limited supplies of gloves that will make it challenging to change gloves as per the above indications. Current data on whether gloved hands can be disinfected with alcohol-based hand rubs are inconclusive. The exact effect of such a practice on the integrity of gloves is unknown. A study by Gao et al.[76] investigated the influence of

alcohol-based hand rubs on the tensile strength of gloves. If tensile strength can indeed be extrapolated to glove integrity, then alcohol does not seem to affect the gloves. A limitation of the study is that only thirteen brands of latex and nitrile gloves were studied. Resource-constrained facilities may opt for cheaper gloves that may not withstand the effects of alcohol-based hand rubs. Using alcohol-based hand rubs on gloves is deemed to be better than no hand hygiene at all and should be considered when gloves are in short supply.

Bare below the elbow/Arms fully covered[77,78]

Different societies have conflicting recommendations with regards to coverage of the arms. This contentious issue has led to multiple guideline changes. Unfortunately, studies have had conflicting results. The proponents of "bare below the elbow" argue that garments have a high risk of being contaminated and removing them as far away as possible from the hands will decrease the risk of contamination of the hands and increase the efficacy of hand washing. Opponents to "bare below the elbow" argue that the skin sheds millions of squamous cells every day that contain both normal skin flora and pathogenic microorganisms. By covering up the arms to the wrists, the load of squamous cells entering the environment will be decreased. Studies looking at "bare below the elbows" failed to prove that it actually made a difference in colony-forming units when fingertips were cultured.[77,78] A study by Markel et al.[79] showed a decrease in microbial contamination and particle counts when a long-sleeved garment and sterile gloves were used in mock skin preparations. The biggest decrease was for particles more than 5 µm in size.

False nails, nail polish, wristwatches and stoned rings should not be worn.

Cuts and abrasions on healthcare workers

Cuts and abrasions on healthcare workers must be covered with waterproof dressings.

High-touch environmental surfaces

The most common high-touch environment surfaces are the adjustable pressure-limiting valve and the agent concentration dial.

Hand washing technique (three-stage technique)[37,39]

The three-stage hand washing technique is as follows:

- *Stage 1 – Preparation:* Wet hands thoroughly under tepid running water before applying liquid soap or antimicrobial solution. Ensure that the hand wash solution comes into contact with all surfaces of the hand, including the wrists. Avoid very hot water as it causes skin damage.
- *Stage 2 – Washing and rinsing:* Rub hands together vigorously for a minimum of 15 seconds. Pay particular attention to fingertips, thumbs and areas between the fingers. Hands should then be thoroughly rinsed.
- *Stage 3 – Drying:* Dry thoroughly with good-quality disposable paper towel. When drying the hands, they should be patted, rather than rubbed, as rubbing leads to small cracks in the skin.