Keep It Clean: Hand Hygiene and Skin Antisepsis

Source: Nursing Spectrum Continuing Education

Objectives

The goal of this program is to provide nurses with information about the relationship between skin and the transference of pathogenic microorganisms. After studying the information presented here, you will be able to —

- Explain the pros and cons of using gloves as personal protective equipment during patient care.
- Describe three natural features of skin that can support or hinder the transference and growth of microorganisms on the caregiver and patient.
- Explain how hand hygiene and skin antisepsis work in combination to prevent infection.

In the 1960s and 1970s, nursing students were often taught how to manage contaminated objects with their bare hands. This included cleaning incontinent patients and counting bloody sponges. In surgery, the scrub nurse would hand off a sponge forceps from the active surgical field, complete with biologic contamination, to the barehanded circulating nurse during sponge counts. Hands often came in contact with microbe-laden material, and the answer was simply hand washing. Nonsterile gloves were not readily available for dirty tasks.

Today, gloves of all varieties are available in patient care areas. But gloves are not a panacea for dealing with evolving "super bugs" of the 21st century.

Whether at the surgical site or on the hands of the caregiver, skin is inherently laden with resident and transient flora. Inadequate hand hygiene allows opportunistic pathogens in varying life stages to transfer between patients and other surfaces during everyday activities. Studies monitoring hand washing reveal that many people do not wash their hands properly after using the toilet or diapering a baby. This translates into the OR, where body substances abound, and the risk for transference is a
serious concern.\textsuperscript{2,3} Hand hygiene and skin antisepsis in surgery depend on using products according to the manufacturer's recommendations. The products must be used correctly and provide microbial kill to be effective.\textsuperscript{2,4}

Iowa State University posted results from hand cultures online (www.extension.iastate.edu/foodsafety/files/Yuckphotos.pdf) that show agar culture plates of the hands of food service personnel. The cultures show the difference in microbial load between washed hands and simply "rinsed" hands. Washing with soap reduced microbial load, but did not eliminate it. Common inanimate environmental objects, such as purse bottoms and countertops, were cultured and grew multiple strains of microorganisms and enormous numbers of bacterial colonies. Other cultures in the Iowa study, such as nonsterile glove boxes (not unlike the exam glove boxes in patient care areas) grew positive results. According to the CDC, 76 million people annually get a fatal food borne disease, such as salmonella and E. coli, which can be attributed to improper hand hygiene. As many as 5,000 die of the illness. Patient illness and death closely match these statistics. (These sources can be viewed online at www.cdc.gov/cleanhands and www.mayoclinic.com/health/handwashing/HQ00407.)

The dirty hands of many people reach into the same box for nonsterile gloves for personal protection and transmit microorganisms to the box and its contents. Caregivers feel a false sense of security when they don gloves and wear them for prolonged periods, performing multiple tasks without changing them.\textsuperscript{4} Moisture and heat builds under the gloves, creating favourable living conditions for bacterial reproduction and endospore reactivation.\textsuperscript{5,6} The surface of a glove picks up microorganisms from the environment and deposits them wherever it makes contact. Gloves do not always protect the patient and may, in fact, provide a transfer vehicle for portable pathogens.\textsuperscript{4-6}

The microbial load on any surface is capable of causing postoperative complications, such as wound dehiscence or systemic morbidity.\textsuperscript{6} Research reveals that prevention of cross-contamination and surgical site infection consists of appropriate skin antisepsis for both the patient and the caregiver.\textsuperscript{5} Hand hygiene and skin antisepsis are not singular processes and are effective only during the moment they are performed.\textsuperscript{1,3-5} Each contact with different areas of the patient's body and the patient care environment (e.g., bed rails, clothing, stethoscope, and blood pressure cuff) requires cleansing of the hands and device or changing of gloves to prevent deposition of new bacteria. In essence, a caregiver can transfer bacteria from one part of the patient's body to another because each body part has its own level of bioload. Moving resident flora to another part of the body creates a pathogenic potential for the patient.\textsuperscript{5}

**Background**
Science has progressed since 1846 in Vienna, when physician Ignaz Semmelweis posited the dangers of microbial transfer from contaminated hands to patients in the obstetric suite of Vienna General Hospital. Many postpartum patients of his day died of puerperal fever (e.g., caused by Clostridium sordellii) before he put forth his theories about hand washing and the benefits to safe patient care. Some physicians of his time regarded his theories as nonsense and openly mocked him. Semmelweis noted that more resident physicians’ patients died than did patients of midwives. The key factor was that the residents were performing autopsies on women who died from postpartum sepsis without washing their hands before attending to other patients’ deliveries. The use of chlorine during hand washing lowered the maternal mortality rate. Physician Oliver Wendell Holmes Sr. proposed the same theory about hand washing and significantly decreased maternal sepsis and mortality in the United States. Retrospective studies of Semmelweis’ data have shown that handwashing between patient contacts decreased the incidence of infection and lowered the mortality rate.

Contemporary Issues

Methicillin-resistant Staphylococcus aureus costs between $3,000 and $35,000 per incidence per year to treat, according to one study. But the cost is immeasurable when a life is lost because of infection. More than 20,000 deaths per year are attributed to surgical site infections, with deep chest and thoracic procedures topping the list. “Super bugs,” such as vancomycin-resistant Enterococci and Clostridium difficile, have entered the realm of easily transferred but difficult to treat infections. The risk of death from multisystem organ failure after surgery is doubled if the patient becomes septic after surgery. Skin antisepsis is one way to minimize the risk of infection at the surgical site, but it must be paired with adequate hand hygiene of the surgical team to be effective. Hand hygiene and skin antisepsis are the primary steps in preventing surgical site infections in all surgical procedures.

In 2008, Medicare started to deny reimbursement to surgical facilities for preventable mediastinitis resulting from contamination during cardiac surgery. Surgical technique and the entire team’s maintenance of a sterile environment during procedures are major factors in preventing infection. Facilities have addressed some of the issues associated with microbial transfer by the nonsterile team by installing motion sensor hand gel dispensers and no-touch paper towel dispensers.

Obstacles

The skin is a protective barrier that when intact minimizes the host’s exposure to UV rays of the sun and prevents absorption of certain toxins and penetration by microorganisms. It serves as a thermoregulatory guardian and sensory organ. Anatomically, all the functions of the skin have a synergistic role in the wellness of the body. But some of the functional structures designed to protect the host from infection can create
opportunistic avenues for microorganisms to enter the body surreptitiously.\textsuperscript{5,6,7}

Let's explore three physiologic protective factors associated with human skin that can be problematic. First is the “intactness” factor of the skin as a whole. The surface of healthy intact skin does not provide favourable living conditions for the resident bacteria on the skin surface.

Balance in the numbers of resident bacteria helps prevent transient bacteria from accumulating.\textsuperscript{7} The normal epidermal surface is somewhat dry, salty, and avascular with a low pH. This is not a friendly surface for bacterial colonization.\textsuperscript{7} But the skin as a physical barrier is easily breached. Small tears or perforations in the skin leave the host vulnerable to microbial entry, thereby changing the survivability factor in favour of transient bacterial growth. Examples of simple breaks include body piercings, pimples, hangnails, and tiny injuries such as paper cuts.\textsuperscript{7,8} The intentional incising of the patient's skin can provide a portal of entry for any living microorganism (e.g., methicillin-resistant Staphylococcus aureus or vancomycin-resistant Enterococci) or dormant bacterial endospore (e.g., Bacillus or Clostridia classes).\textsuperscript{4,6,7,8}

Second, consider the structure of the skin and its physiologic appendages. Most skin surfaces have hair-bearing follicles, which include the ducts of sebaceous holocrine glands (i.e., oil glands). The face, scalp, and chest have the highest number of holocrine glands. The sebum, or oil contained in these glands, is not sterile and contains amino acids and lipids, which are nutritious for microorganisms. The follicle provides a locus for microbial growth and transfer across the surface of the hair as it exits the skin surface. Obstruction of oil glands and sequestering of colonizing microorganisms can cause inflammation and an abscess.

Two types of suderiferous (i.e., sweat) glands, apocrine or eccrine, accompany sebaceous glands in different body locations and offer additional nutritional media and moisture for the growth of Staphylococcus aureus and Corynebacterium. Release of sweat from apocrine glands in the armpits and groin and from eccrine glands over the remainder of the body surface is part of the thermoregulatory process of the skin. Odours produced in the hair-bearing areas of the body are the result of bacterial growth and degradation. Microbial growth can be augmented by the use of skin lubricating lotions that can inactivate many antiseptic skin products.\textsuperscript{7}

The third consideration is the flexibility and mobility of the skin’s surface. Skin is generally pliable. Manipulation of the oil and sweat glands increases discharges onto the surface of the skin. A susceptible recipient can be contaminated by pathogens transferred by these body substances if the skin is not intact. Surface cells desquamate daily, and 10% of shed cells carry viable bacteria.\textsuperscript{7} Dry, cracked skin sheds more epithelial cells, decreasing microbial growth inhibitors.\textsuperscript{5,6} Increased numbers of living microorganisms or bacterial endospores are transferred to patients or objects in the environment.\textsuperscript{7}

### Antiseptic Considerations

Ineffective hand washing may be part of the problem.\textsuperscript{7} Further investigation is warranted concerning the use of antiseptic soaps in all
settings. Overuse of antiseptic soaps, especially at home, may be causing increased resistance in certain bacteria. Products such as shampoo, dishwashing detergent, toothpaste, and deodorant used in the home contain 0.15 to 0.3% triclosan as a bactericide. Triclosan blocks lipid synthesis in E. coli by inhibiting certain enzymes. Studies have shown that continued use of antiseptic products has prompted the proliferation of drug- and antiseptic-resistant strains of microorganisms in the natural environment. The targeted bacteria are not killed because of inadequate contact time with the bactericide; they continue to reproduce, genetically transmitting resistant plasmids — bacterial DNA molecules capable of self-replication — to the next generation. Pseudomonas aeruginosa has been shown to develop resistance to antibiotics such as ciprofloxacin after exposure to triclosan. Not all bacteria respond in kind, but some experts suggest that triclosan and other antimicrobials are overused in household products and may result in antibiotic and antiseptic resistance in the natural environment.

Skin damaged by repeated washing loses the anatomic flexibility and surface protection of the natural epidermis. Washing damaged skin is not as effective as washing healthy skin. As skin health declines, resistant microorganisms colonize the surface. Hand washing increases skin damage and can augment transference of bacteria during patient care. One researcher reports that post-scrubbing irritation persisted for several days and the skin did not return to a healthy state for 17 days. Decreased numbers of natural flora on the hands of long-term antiseptic users is followed by decreased resistance to topical infections. Loss of resident flora indicates a shift in skin pH and decline in natural barrier protection. Damaged skin maintains and sheds higher numbers of bacteria.

**In Surgery**

Many healthcare workers continue to have poor hand hygiene despite best-practice evidence about microbial transfer between individuals. The role of antiseptic soaps is under investigation, and the results of studies often yield conflicting results. (See table below.)

### Products for Skin Antisepsis and Hand Hygiene

<table>
<thead>
<tr>
<th>Product</th>
<th>Chemical Properties</th>
<th>Use in Skin Antisepsis</th>
<th>Considerations</th>
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<tbody>
<tr>
<td>Povidone iodine solution</td>
<td>10% (1.0% available iodine) or 17.5% (1.7% available iodine) Povidone iodine</td>
<td>Broad-spectrum microbicide. Used in patient skin antisepsis.</td>
<td>Sometimes referred to as “paint.” Used full strength. Tuck towels in at patient’s sides to prevent pooling. Commonly used on patient’s skin after scrub with detergent form (e.g., two-step prep).</td>
</tr>
<tr>
<td>Povidone iodine scrub</td>
<td>7.5% (1.7% available iodine) Povidone iodine in detergent soap</td>
<td>Broad-spectrum microbicide. Can be used as surgical hand scrub.</td>
<td>Diluted with sterile water or saline before use. Tuck towels in at patient’s sides to prevent pooling.</td>
</tr>
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<tr>
<td>Povidone iodine spray</td>
<td>5.0% (0.5% available iodine) or 10% (1.0% available iodine) Povidone iodine (1.0% available iodine)</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic.</td>
<td>Fast, even application; minimal risk of pooling. Prevent aerosolization in the sterile environment.</td>
</tr>
<tr>
<td>Povidone iodine gel</td>
<td>10% Povidone iodine (1.0% available iodine)</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic.</td>
<td>Fast application; minimal or no risk of pooling. Used alone.</td>
</tr>
<tr>
<td>Iodine povacrylex</td>
<td>Iodine povacrylex in 74% isopropyl alcohol. (0.7% available iodine)</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic.</td>
<td>Used as a rapid one-step skin prep. Resists removal as a lasting barrier during surgery and for several days postoperatively. Alcohol base is flammable and must be completely dry before drapes are applied.</td>
</tr>
<tr>
<td>Chlorhexidine gluconate tincture</td>
<td>4% Chlorhexidine gluconate in 70% isopropyl alcohol</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic</td>
<td>Used as a rapid one-step skin prep. Alcohol base is flammable and must be completely dry before drapes are applied. Can cause corneal, neural, and ear damage.</td>
</tr>
<tr>
<td>Chlorhexidine gluconate scrub</td>
<td>2.5% Chlorhexidine gluconate in detergent soap</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic. Can be used as surgical hand scrub</td>
<td>Diluted with sterile water or saline before use. Tuck towels in at patient's sides to prevent pooling. Used alone. Residual antibacterial effects for four to six hours. Can cause corneal, neural, and ear damage.</td>
</tr>
<tr>
<td>Chlorhexidine gluconate spray</td>
<td>0.1% Chlorhexidine gluconate</td>
<td>Broad-spectrum microbicide. Used in patient skin antiseptic</td>
<td>Fast, even application; minimal risk of pooling. Used alone. Can cause corneal, neural, and ear damage. Prevent aerosolization in the sterile environment.</td>
</tr>
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### Product Chemical Properties Use in Skin Antisepsis Considerations

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<tr>
<td>Chloroxylenol scrub</td>
<td>3% chloroxylenol, 3% cocarnidopropyl PG-dimonium chloride phosphate in detergent soap</td>
<td>Broad-spectrum microbicide. Used in patient skin antisepsis. Can be used as surgical hand scrub.</td>
<td>Diluted with sterile water or saline before use. Tuck towels in at patient’s sides to prevent pooling. Iodine and Chlorhexidine free.</td>
</tr>
<tr>
<td>Parachlorometaxylenol (PCMX)</td>
<td>0.3% chlorometaxylenol</td>
<td>Bactericidal. Used in patient skin antisepsis. Can be used as surgical hand scrub.</td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>Concentrations of 60% to 90%</td>
<td>Bactericidal in 30 seconds and inhibits viruses in two minutes as surgical hand hygiene gel.</td>
<td>Used on hands with no visible soil or biologic contamination. Most brands contain emollients, such as aloe vera. Alcohol does not penetrate biologic material and does not provide lasting antimicrobial effects. Can cause corneal and nerve damage. Flammable.</td>
</tr>
</tbody>
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Patient compliance with presurgical showers with antiseptics is inconsistent. One facility had patients bathe upon arrival in the preoperative holding area using prewarmed no-rinse wipes impregnated with 2% Chlorhexidine gluconate antiseptic. The usual concentration for CHG surgical soap is 4%. The lower concentration of CHG was effective at reducing bacterial counts, particularly in the hair-bearing regions of the groin and axillae, because it remained in contact with the skin until the initial skin incision. The facility reported a 66% reduction in surgical site infections attributed to use of CHG during the pilot study although no other products were used for comparison. A review of preoperative bathing or showering with 4% CHG did not show any benefit over cleaning the skin with any antiseptic, even common household soap. The 2% CHG no-rinse wipe may have been beneficial because of the mild mechanical exfoliation associated with applying the wipe to the skin and the chemical residue absorbed by epidermal cells. Prewarming the CHG cloth contributed to patient comfort and compliance in use.

Other considerations in patients’ skin antisepsis include the duration of chemical contact, the use of adherent antimicrobial drapes (incise sheets), and one-step preps. Plastic adherent drapes with iodophor or other antimicrobial properties minimize microbial transfer during the surgical procedure, but may cause breakdown of the
protective epidermal surface when they are removed at the end of the case. Iodophor and alcohol-based one-step preps are applied to the skin and are intended to remain on the patient’s skin for several days postoperatively. Natural epidermal shedding of the skin is supported by the antiseptic coating. CHG is known to bind with the stratum corneum of the epithelium, providing six hours of antimicrobial effect. Attempts to rub one-step prep material off the skin prematurely will cause the loss of natural epidermal protective activity. If removal is necessary, an alcohol-based removal solution is commercially available from the manufacturer.

The Surgical Team

Cognitive variables ranging from one’s personality to attitudes and beliefs influence a person’s practice of hand hygiene. Healthcare professionals should perform hand hygiene in different ways using different products according to the situation. Antiseptic soap and warm tap water should be used when arriving on duty, before meals, for removing visible soil, and before leaving the surgical suite for home. Gel rubs with an alcohol base are used when hands are not visibly soiled or when patient skin or equipment has been handled. Gel rubs can irritate the skin and are flammable; however, many gel rubs contain emollients to minimize skin breakdown. The gel rub remains in contact with the skin, offering prolonged chemical action against microorganisms similar to the no-rinse CHG wipes.

Surgical hand scrubs before gowning and gloving include antiseptic detergent and a sponge-brush apparatus. The sponge-brush mechanically removes skin detritus. The detergent component decreases the surface tension of the skin as the antiseptic properties chemically destroy bacteria. The sponge surface causes less skin irritation than the brush portion of the sponge-brush apparatus and is recommended for use over the thinner parts of the hands and arms. Surgical hand and arm scrubbing should include one of the following methods: counted stroke scrub, anatomic scrub by area, or timed scrub. Health professionals should clean their fingernails using a nail pick and antiseptic soap under running water. Artificial nails harbor microorganisms and are not permitted in surgical hygiene. Nail polish that is unchipped and less than 4 days old is acceptable.

Gel antiseptic rubs are appropriate for use after removing surgical gloves. However, powdered gloves can leave residue on the hands that cause irritation, and the residue should be washed off with soap and water. Gel antiseptic rubs do not remove debris or soil; therefore, hand washing with an antiseptic product is necessary for adequate hand hygiene. Skin is never rendered sterile, but controlling microbial load at an irreducible minimum is important for both the patient and the caregiver.
Nonsterile surgical team members wear gloves during routine patient care as a component of personal protective equipment. Sterile gloves are commonly used in place of nonsterile exam gloves because they conform to the contours of the hand and feel like a second skin for intubating and suctioning patients. Unfortunately, many nonsterile anaesthesia team members wear the same pair of gloves throughout the entire surgical case after being exposed to patient body substances during intubation. Gloves can become comfortable and feel natural to the wearer. Some anaesthesia personnel, for example, adjust monitors and press keys on a computer keyboard wearing the same gloves used for oropharyngeal procedures and then inject medications, such as propofol, into the patient’s IV. The same computer keyboard is used or monitor button pressed several times during the day by many anaesthesia personnel, who in turn render patient care with or without gloves. Transference of living microorganisms or bacterial endospores between surfaces in the OR and the patient is a demonstrated reality.

Any residual microbial contamination can be transferred from the inanimate surface to the patient and possibly to injectable medication. For example, propofol is lipid-based and supports microbial growth. The FDA found that contaminated propofol was the source of postoperative fever and chills in some patients in the mid-1990s and again in 2007. Studies have shown that certain microbes can persist on surfaces more than 24 hours and can be transferred from gloved or nongloved hands to multiple surfaces. Dried bacteria can form resistant endospores as self-protection and later reanimate and replicate themselves by binary fission when conditions again become favourable, such as entry into a host. Examples of endospore-forming bacteria of particular concern include several genera of Bacillus and Clostridium (e.g., Bacillus cereus, Clostridium difficile, and Clostridium perfringens). (See examples of endospore-forming bacteria below.)

**Examples of Endospore-Forming Bacteria**

Endospore-forming bacteria are Gram’s stain positive. Endospores are formed in response to environmental changes on skin and inanimate surfaces that do not support active bacterial growth and reproduction. The process takes about eight hours and is known as sporulation. Endospores are protective capsules that form inside bacteria to resist ultraviolet and gamma radiation, temperature changes, desiccation, and many chemicals in the environment; they cause the outer covering of the bacterial cell to shed. When living conditions are favourable, the endospore reanimates and reproduces by binary fission because the genetic material of the bacterium has been preserved.

- Phylum Firmicute (means tough skin)
- Class: Bacilli (aerobic)
- Genus: Bacillus (gram-positive rods)
- B. anthracis (anthrax)
- B. cereus (food poisoning)
- Non-pathogenic Bacillus (heat resistant: used in steam sterilization testing)
- B. subtilis
- B. stearothermophilus (also known as genus Geobacillus stearothermophilus)
  - Class: Clostridia (anaerobic) gram-positive rods
  - Genus: Clostridium
    - C. perfringens (gangrene, food poisoning)
    - C. difficile (several forms of colitis)
    - C. tetani (tetanus)
    - C. botulinum (botulism)
    - C. sordellii (toxic shock, gynaecologic infections)
  - Genus: Helicobacter gram-positive coccus (passed orally into GI tract)
    - H. pylori (gastric and intestinal ulcers)

Gloved hands carry a larger microbial load because of the nature of the glove material's texture. The most common bacteria isolated from keyboards were coagulase-negative staphylococci, bacillus, and MRSA. Best practices indicate that gloves should be removed after any procedure and hands should be washed or treated with an alcohol-based gel rub. Caregivers should perform hand hygiene several times during patient care if they are handling multiple areas of the patient's body or touching multiple items throughout the patient care environment. Gloves are never 100% impervious, and the wearer could be contaminated during patient contact. A study in Australia testing the porosity of surgical gloves proved that all gloves tested were porous enough to transfer bacteria from the wearer’s hands to the patient and vice versa.

Proper skin antisepsis and hand hygiene can minimize surgical site infections. Skin antisepsis includes surgical techniques such as the use of antimicrobial adherent incise drapes and antiseptic solutions that bind with skin cells. Hand hygiene benefits the surgical team member as well as the patient. Knowing which product and method to use is essential to preventing surgical site infections. Given the micro porosity of surgical gloves, caregivers must use skin antiseptic products appropriately so they will provide an effective microbial kill and minimize microbial transfer between wearer and patient.
References:


