Chapter 3: **Guidelines for Hand Hygiene in Health Care Settings**

1 CE Hour

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**Learning objectives**

- Explain the normal bacterial skin flora.
- Describe the relation of hand hygiene and acquisition of health care-associated pathogens.
- List methods used to evaluate hand hygiene products.
- Review trial data for soaps and alcohol-based products.
- Discuss irritant contact dermatitis resulting from hand-hygiene measures.

**Introduction**

This course provides health-care personnel (HCPs) with a review of data regarding the relation of hand hygiene and acquisition of health care-associated pathogens and the methods used to evaluate the efficacy of hand-hygiene products. In addition, it provides specific data and study information regarding the review of preparation used for hand hygiene plain nonantimicrobial soap and alcohol-based antiseptics.

This course provides recommendations to promote improved hand-hygiene practices and reduce transmission of pathogenic microorganisms to patients and personnel in health-care settings. It provides information regarding the contact dermatitis resulting from hand-hygiene measures and factors to consider when selecting hand hygiene products.

**Historical perspective**

For generations, handwashing with soap and water has been considered a measure of personal hygiene. The concept of cleansing hands with an antiseptic agent probably emerged in the early 19th century. As early as 1822, a French pharmacist demonstrated that solutions containing chlorides of lime or soda could eradicate the foul odors associated with human corpses and that such solutions could be used as disinfectants and antiseptics.

In 1961, the U. S. Public Health Service produced a training film that demonstrated handwashing techniques recommended for use by health-care personnel. At the time, recommendations directed that personnel wash their hands with soap and water for 1–2 minutes before and after patient contact. Rinsing hands with an antiseptic agent was believed to be less effective than handwashing and was recommended only in emergencies or in areas where sinks were unavailable.

In 1975 and 1985, formal written guidelines on handwashing practices in hospitals were published by CDC. These guidelines recommended handwashing with nonantimicrobial soap between the majority of patient contacts and washing with antimicrobial soap before and after performing invasive procedures or caring for patients at high risk. Use of waterless antiseptic agents (e.g., alcohol-based solutions) was recommended only in situations where sinks were not available.

In 1988 and 1995, guidelines for handwashing and hand antisepsis were published by the Association for Professionals in Infection Control (APIC). Recommended indications for handwashing were similar to those listed in the CDC guidelines. The 1995 APIC guideline included more detailed discussion of alcohol-based hand rubs and supported their use in more clinical settings than had been recommended in earlier guidelines. In 1995 and 1996, the Health Care Infection Control Practices Advisory Committee (HICPAC) recommended that either antimicrobial soap or a waterless antiseptic agent be used for cleaning hands upon leaving the rooms of patients with multidrug-resistant pathogens (e.g., vancomycin-resistant enterococci [VRE] and methicillin-resistant staphylococcus aureus [MRSA]). These guidelines also provided recommendations for handwashing and hand antisepsis in other clinical settings, including routine patient care. Although the APIC and HICPAC guidelines have been adopted by the majority of hospitals, adherence of health-care personnel to recommended handwashing practices has remained low.

Recent developments in the field have stimulated a review of the scientific data regarding hand hygiene and the development of new guidelines designed to improve hand-hygiene practices in health care facilities. This literature review and accompanying recommendations have been prepared by a Hand Hygiene Task Force, composed of representatives from HICPAC, the Society for Healthcare Epidemiology of America (SHEA), APIC, and the Infectious Diseases Society of America (IDSA).
Normal bacterial skin flora

To understand the objectives of different approaches to hand cleansing, a knowledge of normal bacterial skin flora is essential. Normal human skin is colonized with bacteria; different areas of the body have varied total aerobic bacterial counts (e.g., 1 x 106 colony forming units (CFUs)/cm2 on the scalp, 5 x 105 CFUs/cm2 in the axilla, 4 x 104 CFUs/cm2 on the abdomen, and 1 x 104 CFUs/cm2 on the forearm). Total bacterial counts on the hands of medical personnel have ranged from 3.9 x 104 to 4.6 x 106. In 1938, bacteria recovered from the hands were divided into two categories: transient and resident. Transient flora, which colonize the superficial layers of the skin, are more amenable to removal by routine handwashing. They are often acquired by health-care personnel during direct contact with patients or contact with contaminated environmental surfaces within close proximity of the patient. Transient flora are the organisms most frequently associated with health care-associated infections. Resident flora, which are attached to deeper layers of the skin, are more resistant to removal. In addition, resident flora (e.g., coagulase-negative staphylococci and diphtheroids) are less likely to be associated with such infections. The hands of health-care personnel may become persistently colonized with pathogenic flora (e.g., S. aureus), gram-negative bacilli, or yeast. Investigators have documented that, although the number of transient and resident flora varies considerably from person to person, it is often relatively constant for any specific person.

Relation of hand hygiene and acquisition of health care-associated pathogens

Trials have studied the effects of handwashing with plain soap and water versus some form of hand antisepsis on health-care-associated infection rates. Health care-associated infection rates were lower when antiseptic handwashing was performed by personnel. In another study, antiseptic handwashing was associated with lower health-care-associated infection rates in certain intensive-care units, but not in others.

Health care associated infection rates were lower after antiseptic handwashing using a chlorhexidine-containing detergent compared with handwashing with plain soap or use of an alcohol-based hand rinse. However, because only a minimal amount of the alcohol rinse was used during periods when the combination regimen also was in use and because adherence to policies was higher when chlorhexidine was available, determining which factor (i.e., the hand-hygiene regimen or differences in adherence) accounted for the lower infection rates was difficult. Investigators have determined also that health care-associated acquisition of MRSA was reduced when the antimicrobial soap used for hygienic handwashing was changed.

Increased handwashing frequency among hospital staff has been associated with decreased transmission of Klebsiella spp. among patients; these studies, however, did not quantitate the level of handwashing among personnel. In a recent study, the acquisition of various health care-associated pathogens was reduced when hand antisepsis was performed more frequently by hospital personnel; both this study and another documented that the prevalence of health care-associated infections decreased as adherence to recommended hand-hygiene measures improved.

Outbreak investigations have indicated an association between infections and understaffing or overcrowcing; the association was consistently linked with poor adherence to hand hygiene. During an outbreak investigation of risk factors for central venous catheter-associated bloodstream infections, after adjustment for confounding factors, the patient-to-nurse ratio remained an independent risk factor for bloodstream infection, indicating that nursing staff reduction below a critical threshold may have contributed to this outbreak by jeopardizing adequate catheter care. The understaffing of health-care personnel can facilitate the spread of MRSA in health-care settings through relaxed attention to basic control measures (e.g., hand hygiene). In an outbreak of Enterobacter cloacae in a neonatal intensive-care unit, the daily number of hospitalized children was above the maximum capacity of the unit, resulting in an available space per child below current recommendations. In parallel, the number of staff members on duty was substantially less than the number necessitated by the workload, which also resulted in relaxed attention to basic infection-control measures. Adherence to hand-hygiene practices before device contact was only 25 percent during the workload peak, but increased to 70 percent after the end of the understaffing and overcrowding period. Surveillance documented that being hospitalized during this period was associated with a fourfold increased risk of acquiring a health care-associated infection. This study not only demonstrates the association between workload and infections, but it also highlights the intermediate cause of antimicrobial spread: poor adherence to hand-hygiene policies.

METHODS USED TO EVALUATE THE EFFICACY OF HAND-HYGIENE PRODUCTS

Current methods

Investigators use different methods to study the in vivo efficacy of handwashing, antiseptic handwash, and surgical hand antisepsis protocols. Differences among the various studies include 1) whether hands are purposely contaminated with bacteria before use of test agents, 2) the method used to contaminate fingers or hands, 3) the volume of hand-hygiene product applied to the hands, 4) the time the product is in contact with the skin, 5) the method used to recover bacteria from the skin after the test solution has been used, and 6) the method of expressing the efficacy of the product (i.e., either
percent reduction in bacteria recovered from the skin or log reduction of bacteria released from the skin). Despite these differences, the majority of studies can be placed into one of two major categories: studies focusing on products to remove transient flora and studies involving products that are used to remove resident flora from the hands. The majority of studies of products for removing transient flora from the hands of health-care personnel involve artificial contamination of the volunteer’s skin with a defined inoculum of a test organism before the volunteer uses a plain soap, an antimicrobial soap, or a waterless antiseptic agent. In contrast, products tested for the preoperative cleansing of surgeons’ hands (which must comply with surgical hand antisepsis protocols) are tested for their ability to remove resident flora without artificially contaminating the volunteers’ hands.

In the United States, antiseptic handwash products intended for use by health-care personnel are regulated by FDA’s Division of Over-the-Counter Drug Products (OTC). Requirements for in vitro and in vivo testing of health-care handwash products and surgical hand scrubs are outlined in the FDA Tentative Final Monograph for Healthcare Antiseptic Drug Products (TFM). Products intended for use as health-care personnel handwashes are evaluated by using a standardized method. Tests are performed in accordance with use directions for the test material. Before baseline bacterial sampling and before each wash with the test material, 5 ml of a standardized suspension of Serratia marcescens are applied to the hands and then rubbed over the surfaces of the hands. A specified volume of the test material is dispensed into the hands and is spread over the hands and lower one third of the forearms. A small amount of tap water is added to the hands, and hands are completely lathered for a specified time, covering all surfaces of the hands and the lower third of the forearms. Volunteers then rinse hands and forearms under 40 degrees C tap water for 30 seconds. Ten washes with the test formulation are required. After the first, third, seventh, and tenth washes, rubber gloves or polyethylene bags used for sampling are placed on the right and left hands, and 75 ml of sampling solution is added to each glove; gloves are secured above the wrist. All surfaces of the hand are massaged for 1 minute, and samples are obtained aseptically for quantitative culture. No neutralizer of the antimicrobial is routinely added to the sampling solution, but if dilution of the antimicrobial in the sampling fluid does not result in demonstrable neutralization, a neutralizer specific for the test formulation is added to the sampling solution. For waterless formulations, a similar procedure is used. TFM criteria for efficacy are as follows: a 2-log-10 reduction of the indicator organism on each hand within 5 minutes after the first use, and a 3-log-10 reduction of the indicator organism on each hand within 5 minutes after the tenth use.

Products intended for use as surgical hand scrubs have been evaluated also by using a standardized method. Volunteers clean under fingernails with a nail stick and clip their fingernails. All jewelry is removed from hands and arms. Hands and two thirds of forearms are rinsed with tap water (38 degrees C to 42 degrees C) for 30 seconds, and then they are washed with a non-antimicrobial soap for 30 seconds and are rinsed for 30 seconds under tap water. Baseline microbial hand counts can then be determined. Next, a surgical scrub is performed with the test formulation using directions provided by the manufacturer. If no instructions are provided with the formulation, two 5-minute scrubs of hands and forearms followed by rinsing are performed. Reduction from baseline microbial hand counts is determined in a series of 11 scrubs conducted during 5 days. Hands are sampled at 1 minute, 3 hours, and 6 hours after the first scrubs on day 1, day 2, and day 5. After washing, volunteers wear rubber gloves; 75 ml of sampling solution are then added to one glove, and all surfaces of the hands are massaged for 1 minute. Samples are then taken aseptically and cultured quantitatively. The other glove remains on the other hand for 6 hours and is sampled in the same manner. TFM requires that formulations reduce the number of bacteria 1-log-10 on each hand within 1 minute of product application and that the bacterial cell count on each hand does not subsequently exceed baseline within 6 hours on day 1; the formulation must produce a 2-log-10 reduction in microbial flora on each hand within 1 minute of product application by the end of the second day of enumeration and a 3-log-10 reduction of microbial flora on each hand within 1 minute of product use by the end of the fifth day when compared with the established baseline.

Because of different standards for efficacy, criteria cited in FDA TFM and the European EN 1500 document for establishing alcohol-based hand rubs vary. Alcohol-based hand rubs that meet TFM criteria for efficacy may not necessarily meet the EN 1500 criteria for efficacy. In addition, scientific studies have not established the extent to which counts of bacteria or other microorganisms on the hands need to be reduced to minimize transmission of pathogens in health care facilities; whether bacterial counts on the hands must be reduced by 1 log-10 (90 percent reduction), 2 log-10 (99 percent), 3 log-10 (99.9 percent), or 4 log-10 (99.99 percent) is unknown. Several other methods also have been used to measure the efficacy of antiseptic agents against various viral pathogens.

**Shortcomings of traditional methodologies**

Accepted methods of evaluating hand-hygiene products intended for use by health-care personnel require that test volunteers wash their hands with a plain or antimicrobial soap for 30 seconds or 1 minute, despite the observation in the majority of studies that the average duration of handwashing by hospital personnel is less than 15 seconds. A limited number of investigators have used 15-second handwashing or hygienic hand-wash protocols. Therefore, almost no data exist regarding the efficacy of plain or antimicrobial soaps under conditions in which they are actually used by health-care personnel. Similarly, certain accepted methods for evaluating waterless antiseptic agents for use as antiseptic hand rubs require that 3 ml of alcohol be rubbed into the hands for 30 seconds, followed by a repeat application for the same duration. This type of protocol also does not reflect actual usage patterns among health-care personnel. Furthermore, volunteers used in evaluations of products are usually surrogates for health-care personnel, and their hand flora may not reflect flora found on
the hands of personnel working in health-care settings. Further studies should be conducted among practicing health-care personnel using standardized protocols to obtain more realistic views of microbial colonization and risk of bacterial transfer and cross-transmission.

**REVIEW OF PREPARATIONS USED FOR HAND HYGIENE**

**Plain (non-anti-microbial) soap**

Soaps are detergent-based products that contain esterified fatty acids and sodium or potassium hydroxide. They are available in various forms including bar soap, tissue, leaflet, and liquid preparations. Their cleaning activity can be attributed to their detergent properties, which result in removal of dirt, soil, and various organic substances from the hands. Plain soaps have minimal, if any, antimicrobial activity. However, handwashing with plain soap can remove loosely adherent transient flora. For example, handwashing with plain soap and water for 15 seconds reduces bacterial counts on the skin by 0.6–1.1-log-10, whereas washing for 30 seconds reduces counts by 1.8–2.8-log-10. However, in several studies, handwashing with plain soap failed to remove pathogens from the hands of hospital personnel. Handwashing with plain soap can result in paradoxical increases in bacterial counts on the skin. Nonantimicrobial soaps may be associated with considerable skin irritation and dryness, although adding emollients to soap preparations may reduce their propensity to cause irritation. Occasionally, plain soaps have become contaminated, which may lead to colonization of hands of personnel with gram-negative bacilli.

**Alcohols**

The majority of alcohol-based hand antiseptics contain either isopropanol, ethanol, n-propanol, or a combination of two of these products. The majority of studies of alcohols have evaluated individual alcohols in varying concentrations. Other studies have focused on combinations of two alcohols or alcohol solutions containing limited amounts of hexachlorophene, quaternary ammonium compounds, povidone-iodine, triclosan, or chlorhexidine gluconate.

The anti-microbial activity of alcohols can be attributed to their ability to denature proteins. Alcohol solutions containing 60 percent–95 percent alcohol are most effective, and higher concentrations are less potent because proteins are not denatured easily in the absence of water. The alcohol content of solutions may be expressed as percent by weight (w/w), which is not affected by temperature or other variables, or as percent by volume (vol/vol), which can be affected by temperature, specific gravity, and reaction concentration (123). For example, 70 percent alcohol by weight is equivalent to 76.8 percent by volume if prepared at 15 degrees C, or 80.5 percent if prepared at 25 degrees C. Alcohol concentrations in antiseptic hand rubs are often expressed as percent by volume. Alcohols have excellent in vitro germicidal activity against gram-positive and gram-negative vegetative bacteria, including multidrug-resistant pathogens (e.g., MRSA and VRE), Mycobacterium tuberculosis, and various fungi. Certain enveloped (lipophilic) viruses (e.g., herpes simplex virus, human immunodeficiency virus [HIV], influenza virus, respiratory syncytial virus, and vaccinia virus) are susceptible to alcohols when tested in vitro. Hepatitis B virus is an enveloped virus that is somewhat less susceptible but is killed by 60 percent–70 percent alcohol; hepatitis C virus also is likely killed by this percentage of alcohol. In a porcine tissue carrier model used to study antiseptic activity, 70 percent ethanol and 70 percent isopropanol were found to reduce titers of an enveloped bacteriophage more effectively than an anti-microbial soap containing 4 percent chlorhexidine gluconate. Despite its effectiveness against these organisms, alcohols have very poor activity against bacterial spores, protozoan oocysts, and certain nonenveloped (nonlipophilic) viruses.

Numerous studies have documented the in vivo anti-microbial activity of alcohols. Alcohols effectively reduce bacterial counts on the hands. Typically, log reductions of the release of test bacteria from artificially contaminated hands average 3.5-log-10 after a 30-second application and 4.0–5.0-log-10 after a 1-minute application. In 1994, the FDA TFM classified ethanol 60 percent–95 percent as a Category I agent (i.e., generally safe and effective for use in antiseptic handwash or health care hand-wash products) (19). Although TFM placed isopropanol 70 percent–91.3 percent in category IIE (i.e., insufficient data to classify as effective), 60 percent isopropanol has subsequently been adopted in Europe as the reference standard against which alcohol-based hand-rub products are compared. Alcohols are rapidly germicidal when applied to the skin, but they have no appreciable persistent (i.e., residual) activity.

However, regrowth of bacteria on the skin occurs slowly after use of alcohol-based hand antiseptics, presumably because of the sublethal effect alcohol have on some of the skin bacteria. Addition of chlorhexidine, quaternary ammonium compounds, octenidine, or triclosan to alcohol-based solutions can result in persistent activity. Alcohols, when used in concentrations present in alcohol-based hand rubs, also have in vivo activity against several nonenveloped viruses. For example, 70 percent isopropanol and 70 percent ethanol are more effective than medicated soap or nonmedicated soap in reducing rotavirus titers on fingerpads. A more recent study using the same test methods evaluated a commercially available product containing 60 percent ethanol and found that the product reduced the infectivity titers of three nonenveloped viruses (i.e., rotavirus, adenovirus, and rhinovirus) by greater than 3 logs. Other nonenveloped viruses such as hepatitis A and enteroviruses...
(e.g., poliovirus) may require 70 percent–80 percent alcohol to be reliably inactivated. However, both 70 percent ethanol and a 62 percent ethanol foam product with emollients reduced hepatitis A virus titers on whole hands or fingertips more than nonmedicated soap; both were equally as effective as antimicrobial soap containing 4 percent chlorhexidine gluconate in reducing reduced viral counts on hands. In the same study, both 70 percent ethanol and the 62 percent ethanol foam product demonstrated greater virucidal activity against poliovirus than either nonanti-microbial soap or a 4 percent chlorhexidine gluconate-containing soap. However, depending on the alcohol concentration, the amount of time that hands are exposed to the alcohol, and viral variant, alcohol may not be effective against hepatitis A and other nonlipophilic viruses. The inactivation of nonenveloped viruses is influenced by temperature, disinfectant-virus volume ratio, and protein load. Ethanol has greater activity against viruses than isopropanol. Further in vitro and in vivo studies of both alcohol-based formulations and anti-microbial soaps are warranted to establish the minimal level of virucidal activity that is required to interrupt direct contact transmission of viruses in health care settings.

Alcohols are not appropriate for use when hands are visibly dirty or contaminated with proteinaceous materials. However, when relatively small amounts of proteinaceous material (e.g., blood) are present, ethanol and isopropanol may reduce viable bacterial counts on hands more than plain soap or antimicrobial soap. Alcohol can prevent the transfer of health care-associated pathogens. In one study, gram-negative bacilli were transferred from a colonized patient’s skin to a piece of catheter material via the hands of nurses in only 17 percent of experiments after antiseptic hand rub with an alcohol-based hand rinse. In contrast, transfer of the organisms occurred in 92 percent of experiments after handwashing with plain soap and water. This experimental model indicates that when the hands of health-care personnel are heavily contaminated, an antiseptic hand rub using an alcohol-based rinse can prevent pathogen transmission more effectively than can handwashing with plain soap and water.

Alcohol-based products are more effective for standard handwashing or hand antisepsis than soap or antimicrobial soaps. In all but two of the trials that compared alcohol-based solutions with antimicrobial soaps or detergents, alcohol reduced bacterial counts on hands more than washing hands with soaps or detergents containing hexachlorophene, povidone-iodine, 4 percent chlorhexidine, or triclosan. In studies examining antimicrobial-resistant organisms, alcohol-based products reduced the number of multidrug-resistant pathogens recovered from the hands of health-care personnel more effectively than did handwashing with soap and water.

Alcohols are effective for preoperative cleaning of the hands of surgical personnel. In multiple studies, bacterial counts on the hands were determined immediately after using the product and again 1–3 hours later; the delayed testing was performed to determine if regrowth of bacteria on the hands is inhibited during operative procedures. Alcohol-based solutions were more effective than washing hands with plain soap in all studies, and they reduced bacterial counts on the hands more than antimicrobial soaps or detergents in the majority of experiments. In addition, the majority of alcohol-based preparations were more effective than povidone-iodine or chlorhexidine. The efficacy of alcohol-based hand-hygiene products is affected by several factors, including the type of alcohol used, concentration of alcohol, contact time, volume of alcohol used, and whether the hands are wet when the alcohol is applied.

Applying small volumes (i.e., 0.2–0.5 ml) of alcohol to the hands is not more effective than washing hands with plain soap and water. One study documented that 1 ml of alcohol was substantially less effective than 3 ml (91). The ideal volume of product to apply to the hands is not known and may vary for different formulations. However, if hands feel dry after rubbing hands together for 10–15 seconds, an insufficient volume of product likely was applied. Because alcohol-impregnated towelettes contain a limited amount of alcohol, their effectiveness is comparable to that of soap and water. Alcohol-based hand rubs intended for use in hospitals are available as low viscosity rinses, gels, and foams. Limited data are available regarding the relative efficacy of various formulations.

One field trial demonstrated that an ethanol gel was slightly more effective than a comparable ethanol solution at reducing bacterial counts on the hands. However, a more recent study indicated that rinses reduced bacterial counts on the hands more than the gels tested. Further studies are warranted to determine the relative efficacy of alcohol-based rinses and gels in reducing transmission of health care-associated pathogens. Frequent use of alcohol-based formulations for hand antisepsis can cause drying of the skin unless emollients, humectants, or other skin-conditioning agents are added to the formulations. The drying effect of alcohol can be reduced or eliminated by adding 1 percent–3 percent glycerol or other skin conditioning agents.

Moreover, in several recent prospective trials, alcohol-based rinses or gels containing emollients caused substantially less skin irritation and dryness than the soaps or anti-microbial detergents tested. These studies, which were conducted in clinical settings, used various subjective and objective methods for assessing skin irritation and dryness. Further studies are warranted to establish whether products with different formulations yield similar results. Even well-tolerated alcohol hand rubs containing emollients may cause a transient stinging sensation at the site of any broken skin (e.g., cuts and abrasions). Alcohol-based hand-rub preparations with strong fragrances may be poorly tolerated by health-care personnel with respiratory allergies. Allergic contact dermatitis or contact urticaria syndrome caused by hypersensitivity to alcohol or to various additives present in certain alcohol hand rubs occurs only rarely.

Alcohols are flammable. Flash points of alcohol-based hand rubs range from 21 degrees C to 24 degrees C, depending on the type and concentration of alcohol present. As a result, alcohol-based hand rubs should be stored away from high temperatures or flames in accordance with National Fire Protection Agency recommendations.
**IRRITANT CONTACT DERMATITIS RESULTING FROM HAND-HYGIENE MEASURES**

**Frequency and pathophysiology of irritant contact dermatitis**

In certain surveys, approximately 25 percent of nurses report symptoms or signs of dermatitis involving their hands, and as many as 85 percent give a history of having skin problems. Frequent and repeated use of hand-hygiene products, particularly soaps and other detergents, is a primary cause of chronic irritant contact dermatitis among health-care personnel. The potential of detergents to cause skin irritation can vary considerably and can be ameliorated by the addition of emollients and humectants. Irritation associated with antimicrobial soaps may be caused by the antimicrobial agent or by other ingredients of the formulation. Affected persons often complain of a feeling of dryness or burning; skin that feels “rough,” and erythema, scaling, or fissures. Detergents damage the skin by causing denaturation of stratum corneum proteins, changes in intercellular lipids (either depletion or reorganization of lipid moieties), decreased corneocyte cohesion, and decreased stratum corneum water-binding capacity.

Damage to the skin also changes skin flora, resulting in more frequent colonization by staphylococci and gram-negative bacilli. Although alcohols are among the safest antiseptics available, they can cause dryness and irritation of the skin. Ethanol is usually less irritating than n-propanol or isopropanol. Irritant contact dermatitis is more commonly reported with iodophors. Other antiseptic agents that can cause irritant contact dermatitis (in order of decreasing frequency) include chlorhexidine, PCMX, triclosan, and alcohol-based products. Skin that is damaged by repeated exposure to detergents may be more susceptible to irritation by alcohol-based preparations. The irritancy potential of commercially prepared hand hygiene products, which is often determined by measuring transepidermal water loss, may be available from the manufacturer. Other factors that can contribute to dermatitis associated with frequent hand washing include using hot water for handwashing, low relative humidity (most common in winter months), failure to use supplementary hand lotion or cream, and the quality of paper towel. Shear forces associated with wearing or removing gloves and allergy to latex proteins may also contribute to dermatitis of the hands of health-care personnel.

**Allergic contact dermatitis associated with hand-hygiene products**

Allergic reactions to products applied to the skin (i.e., contact allergies) may present as delayed type reactions (i.e., allergic contact dermatitis) or less commonly as immediate reactions (i.e., contact urticaria). The most common causes of contact allergies are fragrances and preservatives; emulsifiers are less common causes. Liquid soaps, hand lotions or creams, and “udder ointments” may contain ingredients that cause contact allergies among health-care personnel.

Allergic reactions to antiseptic agents, including quaternary ammonium compounds, iodine or iodophors, chlorhexidine, triclosan, PCMX, and alcohols have been reported. Allergic contact dermatitis associated with alcohol-based hand rubs is uncommon. Surveillance at a large hospital in Switzerland, where a commercial alcohol hand rub has been used for more than 10 years, failed to identify a single case of documented allergy to the product. In late 2001, a Freedom of Information request for data in the FDA’s Adverse Event Reporting System regarding adverse reactions to popular alcohol hand rubs in the United States yielded only one reported case of an erythematos rash reaction attributed to such a product (John M. Boyce, M.D., Hospital of St. Raphael, New Haven, Connecticut, personal communication, 2001). However, with increasing use of such products by health-care personnel, true allergic reactions to such products likely will be encountered.

Allergic reactions to alcohol-based products may represent true allergy to alcohol, allergy to an impurity or aldehyde metabolite, or allergy to another constituent of the product. Allergic contact dermatitis or immediate contact urticarial reactions may be caused by ethanol or isopropanol. Allergic reactions can be caused by compounds that may be present as inactive ingredients in alcohol-based hand rubs, including fragrances, benzyl alcohol, stearyl or isostearyl alcohol, phenoxyethanol, myristyl alcohol, propylene glycol, parabens, and benzalkonium chloride.

**Proposed methods for reducing adverse effects of agents**

Potential strategies for minimizing hand-hygiene–related irritant contact dermatitis among health-care personnel include reducing the frequency of exposure to irritating agents (particularly anionic detergents), replacing products with high irritation potential with preparations that cause less damage to the skin, educating personnel regarding the risks of irritant contact dermatitis, and providing caregivers with moisturizing skin-care products or barrier creams. Reducing the frequency of exposure to hand-hygiene products would prove difficult and is not desirable because of the low levels of adherence to hand-hygiene policies in the majority of institutions. Although hospitals have provided personnel with nonantimicrobial soaps in hopes of minimizing dermatitis, frequent use of such products may cause greater skin damage, dryness, and irritation than antiseptic preparations. One strategy for reducing the exposure of personnel to irritating soaps and detergents is to promote the use of alcohol-based hand rubs containing various emollients. Several recent prospective, randomized trials have demonstrated that alcohol-based hand rubs containing emollients were better tolerated than washing hands with nonantimicrobial soaps or antimicrobial soaps. Routinely washing hands with soap and water immediately after using an alcohol hand rub may lead to dermatitis. Therefore, personnel should be reminded that it is neither necessary nor
recommended to routinely wash hands after each application of an alcohol hand rub.

Hand lotions and creams often contain humectants and various fats and oils that can increase skin hydration and replace altered or depleted skin lipids that contribute to the barrier function of normal skin. Several controlled trials have demonstrated that regular use (e.g., twice a day) of such products can help prevent and treat irritant contact dermatitis caused by hand-hygiene products. In one study, frequent and scheduled use of an oil-containing lotion improved skin condition, and thus led to a 50 percent increase in handwashing frequency by health-care personnel. Reports from these studies emphasize the need to educate personnel regarding the value of regular, frequent use of hand-care products.

Factors to consider when selecting hand-hygiene products

When evaluating hand-hygiene products for potential use in health-care facilities, administrators or product-selection committees must consider factors that can affect the overall efficacy of such products, including the relative efficacy of antiseptic agents against various pathogens and acceptance of hand-hygiene products by personnel. Soap products that are not well-accepted by health-care personnel can be a deterrent to frequent handwashing. Characteristics of a product (either soap or alcohol-based hand rub) that can affect acceptance by personnel include its smell, consistency (i.e., “feel”), and color. For soaps, ease of lathering also may affect user preference.

Because health-care personnel may wash their hands from a limited number of times per shift to as many as 30 times per shift, the tendency of products to cause skin irritation and dryness is a substantial factor that influences acceptance, and ultimate usage. For example, concern regarding the drying effects of alcohol was a primary cause of poor acceptance of alcohol-based hand-hygiene products in hospitals in the United States. However, several studies have demonstrated that alcohol-based hand rubs containing emollients are acceptable to users. With alcohol-based products, the time required for drying may also affect user acceptance.

Studies indicate that the frequency of handwashing or antiseptic handwashing by personnel is affected by the accessibility of hand-hygiene facilities. In contrast to sinks used for handwashing or antiseptic handwash, dispensers for alcohol-based hand rubs do not require plumbing and can be made available in patient care areas. Pocket carriage of alcohol-based hand-rub solutions, combined with availability of bedside dispensers, has been associated with substantial improvement in adherence to hand-hygiene protocols. To avoid any confusion between soap and alcohol hand rubs, alcohol hand-rub dispensers should not be placed adjacent to sinks. Health-care personnel should be informed that washing hands with soap and water after each use of an alcohol hand rub is not necessary and is not recommended, because it may lead to dermatitis. However, because personnel feel a “build-up” of emollients on their hands after repeated use of alcohol hand gels, washing hands with soap and water after 5–10 applications of a gel has been recommended by certain manufacturers.

Automated handwashing machines have not been demonstrated to improve the quality or frequency of handwashing. Although technologically advanced automated handwashing devices and monitoring systems have been developed recently, only a minimal number of studies have been published that demonstrate that use of such devices results in enduring improvements in hand-hygiene adherence among health-care personnel. Further evaluation of automated handwashing facilities and monitoring systems is warranted. Dispenser systems provided by manufacturers or vendors also must be considered when evaluating hand-hygiene products. Dispensers may discourage use by health-care personnel when they 1) become blocked or partially blocked and do not deliver the product when accessed by personnel, and 2) do not deliver the product appropriately onto the hands. In one hospital where a viscous alcohol-based hand rinse was available, only 65 percent of functioning dispensers delivered product onto the caregivers’ hands with one press of the dispenser lever, and 9 percent of dispensers were totally occluded. In addition, the volume delivered was often suboptimal, and the product was sometimes squirted onto the wall instead of the caregiver’s hand.

Hand-hygiene practices among health-care personnel

In observational studies conducted in hospitals, health-care personnel washed their hands an average of five times per shift to as many as 30 times per shift; certain nurses washed their hands less than 100 times per shift. Hospitalwide surveillance of hand hygiene reveals that the average number of handwashing opportunities varies markedly between hospital wards. For example, nurses in pediatric wards had an average of eight opportunities for hand hygiene per hour of patient care compared with an average of 20 for nurses in intensive-care units. The duration of handwashing or hygienic handwash episodes by health-care personnel has averaged 6.6–24.0 seconds in observational studies. In addition to washing their hands for limited time periods, personnel often fail to cover all surfaces of their hands and fingers.
OTHER POLICIES RELATED TO HAND HYGIENE

Fingernails and artificial nails

Studies have documented that subungual areas of the hand harbor high concentrations of bacteria, most frequently coagulase-negative staphylococci, gram-negative rods (including pseudomonas spp.), corynebacteria, and yeasts. Freshly applied nail polish does not increase the number of bacteria recovered from periungual skin, but chipped nail polish may support the growth of larger numbers of organisms on fingernails. Even after careful handwashing or the use of surgical scrubs, personnel often harbor substantial numbers of potential pathogens in the subungual spaces.

Whether artificial nails contribute to transmission of health care-associated infections is unknown. However, people who wear artificial nails are more likely to harbor gram-negative pathogens on their fingertips than are those who have natural nails, both before and after handwashing. Whether the length of natural or artificial nails is a substantial risk factor is unknown, because the majority of bacterial growth occurs along the proximal 1 mm of the nail adjacent to subungual skin. Recently, an outbreak of P. aeruginosa in a neonatal intensive care unit was attributed to two nurses (one with long natural nails and one with long artificial nails) who carried the implicated strains of pseudomonas spp. on their hands. Patients were substantially more likely than controls to have been cared for by the two nurses during the exposure period, indicating that colonization of long or artificial nails with pseudomonas spp. may have contributed to causing the outbreak. Personnel wearing artificial nails also have been epidemiologically implicated in several other outbreaks of infection caused by gram-negative bacilli and yeast. Although these studies provide evidence that wearing artificial nails poses an infection hazard, additional studies are warranted.

Gloving policies

CDC has recommended that health-care personnel wear gloves to 1) reduce the risk of acquiring infections from patients, 2) prevent health care personnel from being transmitted to patients, and 3) reduce transient contamination of the hands of personnel by flora that can be transmitted from one patient to another. Before the emergence of the acquired immunodeficiency syndrome (AIDS) epidemic, gloves were worn primarily by those caring for patients colonized or infected with certain pathogens or by those exposed to patients with a high risk of hepatitis B. Since 1987, a dramatic increase in glove use has occurred in an effort to prevent transmission of HIV and other blood-borne pathogens from patients to health-care personnel. The Occupational Safety and Health Administration (OSHA) mandates that gloves be worn during all patient-care activities that may involve exposure to blood or body fluids that may be contaminated with blood.

Having more than one type of glove available is desirable, because it allows personnel to select the type that best suits their patient-care activities. Although recent studies indicate that improvements have been made in the quality of gloves, hands should be decontaminated or washed after removing gloves. Gloves should not be washed or reused. Use of petroleum-based hand lotions or creams may adversely affect the integrity of latex gloves. After use of powdered gloves, certain alcohol hand rubs may interact with residual powder on the hands of personnel, resulting in a gritty feeling on the hands. In facilities where powdered gloves are commonly used, various alcohol-based hand rubs should be tested after removal of powdered gloves to avoid selecting a product that causes this undesirable reaction. Personnel should be reminded that failure to remove gloves between patients may contribute to transmission of organisms.

Jewelry

Several studies have demonstrated that skin underneath rings is more heavily colonized than comparable areas of skin on fingers without rings. One study found that 40 percent of nurses harbored gram-negative bacilli (e.g., E. cloacaee, klebsiella, and acinetobacter) on skin under rings and that certain nurses carried the same organism under their rings for several months. In a more recent study involving more than 60 intensive care unit nurses, multivariable analysis revealed that rings were the only substantial risk factor for carriage of gram-negative bacilli and S. aureus and that the concentration of organisms recovered correlated with the number of rings worn. Whether the wearing of rings results in greater transmission of pathogens is unknown. Two studies determined that mean bacterial colony counts on hands after handwashing were similar among persons wearing rings and those not wearing rings. Further studies are needed to establish if wearing rings results in greater transmission of pathogens in health care settings.

Conclusion

The results of these studies demonstrated that the use of alcohol-based products containing emollients were better tolerated by health-care personnel than washing hands with nonantimicrobial soaps or antimicrobial soap and that these products are more effective in reducing the bacterial counts on the hands. One of the most important factors it also highlights is the intermediate cause of antimicrobial spread: poor adherence to hand-hygiene policies. This must be an immediate focus in all health care facilities to prevent the transmission of pathogens from patient to health care provider to patient.
## Final Examination Questions

Select the best answer for each question and mark your answers on the Final Examination Answer Sheet found on page 96, or for faster service complete your test online at Dental.EliteCME.com.

1. Transient flora, which colonize the superficial layers of the skin, are more amenable to removal by routine handwashing.
   - True
   - False

2. Hepatitis B virus is an enveloped virus that is somewhat less susceptible but is killed by 20 percent–30 percent alcohol; hepatitis C virus also is likely killed by this percentage of alcohol.
   - True
   - False

3. In all but two of the trials that compared alcohol-based solutions with antimicrobial soaps or detergents, alcohol reduced bacterial counts on hands more than washing hands with soaps or detergents containing hexachlorophene, povidone-iodine, 4 percent chlorhexidine, or triclosan.
   - True
   - False

4. Health-care personnel who wear artificial nails are more likely to harbor gram-negative pathogens on their fingertips than are those who have natural nails, both before and after handwashing.
   - True
   - False

5. Hands need not be decontaminated or washed after removing gloves.
   - True
   - False