Concise Review for Clinicians

Hand Hygiene: A Frequently Missed Lifesaving Opportunity During Patient Care

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Health care–associated infections constitute one of the greatest challenges of modern medicine. Despite compelling evidence that proper hand washing can reduce the transmission of pathogens to patients and the spread of antimicrobial resistance, the adherence of health care workers to recommended hand-hygiene practices has remained unacceptably low. One of the key elements in improving hand-hygiene practice is the use of an alcohol-based hand rub instead of washing with soap and water. An alcohol-based hand rub requires less time, is microbiologically more effective, and is less irritating to skin than traditional hand washing with soap and water. Therefore, alcohol-based hand rubs should replace hand washing as the standard for hand hygiene in health care settings in all situations in which the hands are not visibly soiled. It is also important to change gloves between each patient contact and to use hand-hygiene procedures after glove removal. Reducing health care–associated infections requires that health care workers take responsibility for ensuring that hand hygiene becomes an everyday part of patient care.

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CFU = colony-forming units; HCW = health care worker; MRSA = methicillin-resistant *Staphylococcus aureus*

Nosocomial infections affect nearly 10% of hospitalized patients and represent a major problem in health care facilities, resulting in prolonged hospital stays, substantial morbidity and mortality, and excessive costs.[1] In the United States, health care–associated infections contribute to the deaths of nearly 90,000 hospital patients each year and increase annual medical expenses by approximately $4.5 billion.[2] In addition, multidrug-resistant pathogens are commonly involved in such infections and render effective treatment challenging. The hands of health care workers (HCWs) are the primary mode of transmission of multidrug-resistant pathogens and infections to patients.[3] Proper hand hygiene is the single most important, simplest, and least expensive means of preventing health care–associated infections and the spread of antimicrobial resistance. Nevertheless, in most health care institutions, adherence to recommended hand-washing practices remains unacceptably low, rarely exceeding 40% of situations in which hand hygiene is indicated.[4] Why do HCWs consistently fail to perform this simple and inexpensive procedure, thereby compromising patient safety and the quality of medical care? The reasons for poor hand-hygiene practices include lack of scientific knowledge, unawareness of risks, misconceptions (eg, glove use obviates the need for hand hygiene), unavailability of hand-hygiene facilities (sinks or alcohol dispensers), lack of role models among colleagues or superiors, understaffing or patient overcrowding, and lack of institutional priority.

This article reviews basic principles of hand hygiene in health care settings, reasons for nonadherence to hand-hygiene practices, and possible targets for improving adherence to recommended practices, with special emphasis on the advantages of the more efficient, simple, and feasible alcohol-based hand rubs over the traditional hand-washing procedure with soap and water.

SEMMELWEIS' FORGOTTEN LESSON

The Hungarian obstetrician Ignaz Philipp Semmelweis (1818-1865) was one of mankind's great benefactors. In 1847, Semmelweis was head of the Women's Hospital in Vienna, Austria. He noted that puerperal fever was more common on a maternity ward where physicians and medical students provided care to women in labor (ward A) than it was on the ward where midwives assisted at deliveries (ward B). Peripartum mortality on ward A was as high as 18%, compared to only 3% on ward B.[5] At that time, miasma (bad air), dirty bed linen, low social status, and climatic influences were considered possible reasons for the higher mortality on ward A. In contrast, Semmelweis postulated that physicians and students were contaminating their hands while performing autopsies on

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A question-and-answer section appears at the end of this article.

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nonrefrigerated bodies and subsequently introducing a fatal etiologic agent ("cadaverous particles") into the birth canal during vaginal examination. Washing their hands with soap and water before examining women in labor did not prevent the epidemic of puerperal fever, and the hands retained a disagreeable odor from the autopsy rooms.

On May 15, 1847, Semmelweis ordered that all students and physicians scrub their hands with a 4% chlorinated lime solution after dissecting cadavers and before examining patients. At that time, microorganisms were unknown to be the cause of infection, and Semmelweis may have chosen chlorinated lime because of its deodorizing characteristic. After introduction of the new hand-hygiene practice, the maternal mortality rate dramatically decreased to less than 3% and remained low for years. Nevertheless, Semmelweis' recommendations were strongly opposed by his coworkers. Rightfully, although undiplomatically, he denounced his unenlightened colleagues as "killers," and his appointment in Vienna ended prematurely. He returned to Pest, Hungary, where he instituted his antiseptic hand-hygiene method in 2 other hospitals, reducing their mortality rates from more than 10% to less than 1%. Although most physicians at that time ignored his theory, Semmelweis opened a new era in medical science by introducing hand antisepsis in surgery and obstetrics.

Later studies confirmed Semmelweis' findings about the important role of HCWs' hands in the transmission of nosocomial pathogens. Interestingly, although Semmelweis is frequently called a pioneer of hand washing, he actually replaced hand washing with hand disinfection. Chlorinated lime has recently been shown to be one of the most active currently existing disinfectants, reducing bacterial counts on the skin by 6.1 $\log_{10}$ colony-forming units (CFU). Because chlorinated lime is harmful to the skin, alcohol was later used as a hand antiseptic. Semmelweis' intervention represents the first evidence that disinfection of heavily contaminated hands between patient contacts can reduce nosocomial transmission of contagious diseases more efficiently than hand washing with plain soap and water. However, many subsequently published guidelines continued to recommend washing with soap and water as the standard hand-hygiene practice for decades.[6] Ignorance of scientific evidence supporting the use of an alcohol-based hand rub is difficult to explain. Hand washing may represent an old cultural heritage of human civilization that in the past served not only for the removal of dirt but also to deliver people symbolically from physical and moral evils.[5]

More than 150 years after Semmelweis' epidemiological observations and despite advances in microbiology and infection control, implementation of proper hand hygiene remains a challenge in clinical practice today. Recently, completely revised guidelines for hand hygiene in health care settings were published in the United States by an international group from the Centers for Disease Control and Prevention.[7] According to these new hand-hygiene guidelines, the use of an alcohol-based hand rub is the preferred method of hand hygiene in the health care setting. Hands should be washed with soap and water primarily when they are visibly soiled or contaminated with blood, other body fluids, or proteinaceous material. This usually represents less than 10% of all routine patient contacts. In general, the hands should be either rubbed with alcohol (the standard procedure for clean hands) or washed with soap (if visibly soiled), but both procedures should not be used at the same time.

MICROBIAL SKIN FLORA

Normal human skin harbors bacteria, usually between 10^2 and 10^6 CFU/cm^2. During daily activity, HCWs progressively accumulate microorganisms on their hands from direct patient contact or contact with contaminated environmental surfaces and devices.[8] Traditionally, microorganisms residing on the hands are divided into resident and transient flora.

Resident flora colonizes deeper skin layers and is more resistant to mechanical removal than transient flora. This group consists mainly of coagulase-negative staphylococci and corynebacteria, with a population density between 10^2 and 10^3 CFU/cm^2. These bacteria multiply in hair follicles and remain relatively stable over time. Resident flora generally has lower pathogenic potential than transient flora and is considered important for colonization resistance, preventing colonization with other, potentially more pathogenic, microorganisms.

Transient flora colonizes the superficial skin layers for short periods and is usually acquired by contact with a patient or contaminated environment. These microorganisms are easily removed by mechanical means such as hand washing. Transient flora (eg, *Staphylococcus aureus*, gram-negative bacilli, or *Candida* species) is responsible for most health care–associated infections and the spread of antimicrobial resistance.

TWO BASIC CONCEPTS OF HAND HYGIENE

Two fundamentally different hand-hygiene concepts exist.[9] Hand washing refers to the application of a plain (nonantimicrobial) or antiseptic (antimicrobial) soap, mechanical friction generated by rubbing the hands together for 1 minute (covering all surfaces of the hands and fingers), rinsing with water, and drying thoroughly with a disposable towel (which is then used to turn off the faucet). The cleaning activity is attributed to detergent properties, which

result in mechanical removal of dirt (soil and organic substances) and loosely adherent flora (most transient flora and a small portion of the resident flora) from the hands. Plain soaps have minimal or no antimicrobial activity, reducing bacterial counts from hands by 0.6 to 1.1 $\log_{10}$ CFU in 15 seconds, 1.8 to 2.8 $\log_{10}$ CFU in 30 seconds, and 2.7 to 3.0 $\log_{10}$ CFU in 1 minute.[5] Prolonged hand washing does not considerably further reduce bacterial counts. Some investigators use other terms for hand hygiene, such as hand antisepsis, disinfection, degerming, decontamination, or sanitizing. In general, "hand antisepsis" indicates hand hygiene with an antiseptic agent, either washing the hands with an antimicrobial soap or using an alcohol-based hand rub.

The alcohol hand-rub procedure involves the use of alcohol rather than water. In contrast to hand washing, the objective of this procedure is a more effective and rapid reduction of skin flora by killing, not mechanically removing, microorganisms (all transient flora and most resident flora). Therefore, the alcohol hand-rub procedure should not be confused with hand washing. Vigorous friction, rinsing with water, and drying with a towel are unnecessary. Instead, the technique consists of rubbing alcohol onto both hands until it completely evaporates, usually requiring 15 to 30 seconds. Because alcohol kills microorganisms only where it comes into contact with the skin, the use of sufficient amounts of alcohol (3-5 mL) and spreading it onto all surfaces (rather than mechanical friction) is crucial. Most dispensers deliver 1.5 to 2.0 mL of alcohol per application; therefore, 2 applications are usually necessary to completely cover both hands.[10]

The antimicrobial activity of alcohols is based on protein denaturation. They have excellent and rapid (within seconds) germicidal activity against vegetative bacteria, fungi, and many viruses. For hand rubs, ethanol, isopropanol, and/or n-propanol are used (listed in order of increasing antibacterial activity at equal concentrations). Alcohol concentrations of 60% to 95% (vol/vol) kill 3.4 to 5.8 $\log_{10}$ CFU in 30 seconds, with higher concentrations having better antibacterial activity.[5] However, concentrations of greater than 95% are less potent because water is essential for protein denaturation. The presence of organic material diminishes the antibacterial activity of alcohols by 0.2 to 0.7 $\log_{10}$ CFU. Alcohol solutions are also highly effective against mycobacteria (the bacteria most resistant to the disinfection process) and multidrug-resistant pathogens but have poor or no activity against bacterial spores and protozoal oocysts. Supplementation with 1% hydrogen peroxide may render alcohol sporocidal.

In general, alcohol rubs are approximately 100 times more effective against viruses than any form of hand washing.[5] Ethanol has better virucidal activity than other alcohols. Transmission of viruses is of concern in a broad range of health care institutions, including pediatric wards, bone marrow transplantation units, and long-term care facilities. The recent epidemic of severe acute respiratory syndrome (SARS) emphasized the importance of good hand hygiene once again; alcohol effectively kills all coronaviruses. The virucidal activity of alcohol against enveloped viruses (such as influenza virus or human immunodeficiency virus) is good, except for rabies virus. Certain nonenveloped viruses (such as enteroviruses, rotaviruses, or norovirus [formerly called Norwalk-like or small-structured virus]) may require higher alcohol concentrations (70%-80%).

Alcohol solutions lack persistent activity on resident skin flora. The resident flora regrows within hours after exposure to alcohol, presumably from bacteria residing in hair follicles. The addition of disinfectants (chlorhexidine, quaternary ammonium compounds, triclosan, or octenidine) may delay the regrowth of bacteria. This effect is usually desirable only in surgical hand antisepsis, in which long-term antimicrobial effectiveness under gloved hands may be beneficial. To date, no clinical studies have addressed this issue.[5]

URGENT NEED FOR IMPROVING HAND HYGIENE IN THE HEALTH CARE SETTING

Proper hand hygiene can prevent health care–associated infections and the spread of antimicrobial resistance. Antimicrobial resistance prevalence rates are increasing in many countries around the world. In the United States, during the 5-year period from 1997 through 2001 the proportion of methicillin-resistant *S aureus* (MRSA) among isolates of *S aureus* causing nosocomial infection continuously increased nationwide from 22.4% to 38.7%.[11] This growth has been paralleled by an increase in other multidrug-resistant organisms such as vancomycin-resistant enterococci, vancomycin–intermediately resistant *S aureus*, and vancomycin-resistant *S aureus*.[12] The reasons for these worrisome findings are complex and not entirely clear, but inconsistent isolation practices, misuse of antimicrobial agents, failure to conduct active surveillance cultures, and poor adherence to hand-hygiene practice may have key roles.[13,14] For example, in some northern European countries, such as Finland and The Netherlands, where a strict MRSA containment "search-and-destroy" strategy and the routine use of alcohol-based hand rubs are standard practice, the prevalence of MRSA remains below 1%. In contrast, most southern European countries, which have had inconsistent isolation precautions and hand-washing recommendations for several decades, are struggling with high prevalence rates of MRSA (>30%) and health care–associated infections.[15]

Table 1. **Indications for Hand Hygiene During Patient Care***

Wash hands with soap and water when hands are visibly dirty or contaminated with proteinaceous material, blood, or other body fluids (IA) and if exposure to *Bacillus anthracis* is suspected or proven (II)
In all other clinical situations described below when hands are not visibly soiled, an alcohol-based hand rub should be used routinely for decontaminating hands (IA)
Before having direct contact with patients (IB)
Before donning sterile gloves when inserting a central intravascular catheter (IB)
Before inserting indwelling urinary catheters, peripheral vascular catheters, or other invasive devices that do not require a surgical procedure (IB)
After contact with a patient's intact skin (eg, when taking a pulse or blood pressure or lifting a patient) (IB)
After contact with body fluids or excretions, mucous membranes, nonintact skin, and wound dressings if hands are not visibly soiled (IA)
If moving from a contaminated body site to a clean body site during patient care (II)
After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient (II)
After removing gloves (IB)

*Classified according to the level of scientific evidence and based on Centers for Disease Control and Prevention hand-hygiene guidelines.[7] Category IA = strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiological studies; category IB = strongly recommended for implementation and supported by certain experimental, clinical, or epidemiological studies and a strong theoretical rationale; category IC = required for implementation, as mandated by federal or state regulation or standard; category II = suggested for implementation and supported by suggestive clinical or epidemiological studies or a theoretical rationale.

The goal of hand hygiene is a sufficient reduction of microbial counts on the skin to prevent cross-transmission of pathogens among patients. It is easier to keep the hands clean than to make them clean. The critical density of microorganisms on the hands needed for the spread of pathogens remains unknown. It may depend on the type and duration of contact, the type of microorganism, and the patient's resident flora (ie, their colonization resistance). As observed by Semmelweis in 1847, washing with plain soap is not always sufficient to prevent hand-borne transmission of pathogens. Although in most instances hand washing is probably sufficient to prevent transmission of microorganisms, in some cases the use of soap and water fails to remove or, paradoxically, even increases the bacterial counts on the skin over baseline counts from clean hands, presumably because of heavy contamination or recontamination by the soap, faucet, or sink.[16,17] In fact, none of the hand-washing techniques, durations of washing, or types of soaps (antimicrobial or nonantimicrobial) have demonstrated antimicrobial activity equal to or better than that of alcohol-based hand rubs.[5] Multiple in vitro and in vivo experiments have indicated considerably better antimicrobial killing with alcohol hand disinfectants than with hand washing, and the use of alcohol-based hand rubs has been associated with a decrease in nosocomial infection rates.[3,5,18-20]

INDICATIONS FOR HAND HYGIENE AND GLOVING

Table 1 summarizes patient-care situations in which hand hygiene is indicated.[7] According to recently revised hand-hygiene guidelines, the use of an alcohol-based hand rub is the preferred method of hand hygiene. In general, hands should be either rubbed with alcohol (the standard procedure for clean hands) or washed with soap (if visibly soiled); both procedures should not be used at the same time. The use of alcohol immediately before or after hand washing with soap and water is not recommended because it may cause dermatitis. To avoid confusion, alcohol hand-rub dispensers should not be placed adjacent to sinks but rather placed close to patients (eg, at bedside). Alcohol-impregnated wipes are not as effective as alcohol hand rubs and are not recommended for routine hand hygiene. For hand hygiene outside health care facilities, such as before and after working hours, before eating, or after using a restroom, the use of soap and water is the recommended method.

It is important to recognize that examination gloves do not provide complete protection against acquisition of microorganisms. Microorganisms from patients have been recovered from the hands of up to 30% of HCWs who wore gloves.[21,22] Therefore, hand hygiene is always needed after glove use and removal. Gloves should be used only when contact with blood, body fluids, or other potentially infectious materials, mucous membranes, and nonintact skin are anticipated. Each pair of gloves should be used for the care of only 1 patient. They should be removed immediately after caring for the patient (before touching any surface) and should be changed between care of contaminated and clean body sites on the same patient. Failure to remove gloves after patient contact may result in the spread of nosocomial pathogens among patients or in contamination of surfaces. Gloves should not be washed or reused. Powderless gloves are preferred because alcohol may interact with residual powder and produce a gritty feeling on the hands.

REPLACING HAND WASHING WITH THE ALCOHOL HAND-RUB PROCEDURE

In addition to its superior antimicrobial efficacy, the alcohol hand-rub procedure has other advantages compared with hand washing (Table 2).

Time for Hand Hygiene

At least 1 to 2 minutes are required for hand washing compared with 15 to 30 seconds for the alcohol hand-rub

technique.[4] In the intensive care unit, where as many as 40 opportunities for hand hygiene per hour of care occur, time constraint becomes the most important limiting factor. Multiple studies have shown that understaffing and increased workload are risk factors for health care–associated epidemics.[23,24] In a mathematical model with 3 opportunities for hand hygiene per HCW per hour, 100% adherence would result in 1.3 hours of hand washing per shift (or 17% of total nursing time).[25] Switching to alcohol hand disinfection would decrease the time necessary for hand hygiene to 0.3 hours (or 4% of total nursing time). In addition, HCWs can use the alcohol rub while walking to the next patient, saving additional time and human resources. Importantly, HCWs simply cannot afford to use almost one fifth of their time for hand washing.

Risk of Contamination of Hands and Environment

Washed hands can become recontaminated from faucets or by splashes from traps or sinks. *Pseudomonas aeruginosa* is commonly found in tap water. In addition, plain soaps may become contaminated during use, and waterborne bacteria from the plumbing system may be present in the tap water. In contrast, alcohol hand rubs eliminate the risk of hand contamination or microbial dispersal into the environment because alcohol kills rather than removes microorganisms. Contamination of alcohol-based solutions with vegetative bacterial forms has not been reported. Alcohol dispensers can be reused as long as they are not visibly soiled.

Accessibility of Hand-Hygiene Facilities

Limited accessibility of hand-hygiene facilities has been shown to be an important risk factor for poor adherence to recommendations.[26] In a recent study, adherence to hand-hygiene recommendations decreased with the number of beds in a patient room, from 70% for rooms with 1 bed to 59% for 2 beds, 55% for 3 beds, 48% for 4 beds, and 33% for 5 beds, suggesting that the distance to the closest hand-hygiene facility is crucial.[27] Sinks cannot be installed at locations most convenient for HCWs. In contrast, alcohol dispensers can be placed on or between beds, at the entrance to patient rooms, and at nursing desks and can even be carried in the pockets of HCWs.[28] The easier accessibility of alcohol dispensers obviates the need to repeatedly return to the sink, wash hands, dry them, and return to the patient's bedside to resume care. Easy, immediate access to alcohol dispensers is the key element in improving adherence to hand hygiene. A sufficient number of alcohol dispensers (2-3 per patient bed) should be placed at bedside, especially in areas with high workload, such as the intensive care unit.

Table 2. **Advantages of Alcohol-Based Hand Rubs Compared With Washing With Soap and Water**

Characteristic	Hand washing	Alcohol-based hand rub
Removal of transient flora	90%	99.999%
Removal of resident flora	No	99%
Required time for procedure*	>1-2 min	15-30 s
Removal of debris	Yes	No
Risk of hand recontamination by faucet	Yes	No
Risk of contamination of soap/hand rub	Yes	No
Accessibility	Limited (at sink)	Unlimited
Towel needed to dry hands	Yes	No
Adverse effects on skin	Rare	Very rare
Adherence >40%	Rare	Likely
Flammable	No	Yes, but low risk

*Time includes walking to and from the hand-hygiene facility (sink or alcohol dispenser).

Adverse Effects on Skin

Intact skin on HCWs' hands helps to protect both them and their patients from acquiring or transmitting nosocomial pathogens. Health care workers with dermatitis are more likely to harbor *S aureus* and other pathogenic bacteria than those with healthy skin. Skin drying and irritation can be avoided by adding emollients to alcohol formulations, such as glycerol (1%-4%), silicone oils, refattening agents, or rehydrating agents. Moreover, alcohol hand rubs cause substantially less skin irritation and dryness than washing with soap. Hand washing removes lipids from the skin, whereas alcohol compounds only redistribute them. However, either strategy can result in dryness of the skin if skin-care products are not applied regularly. Therefore, HCWs should be advised to use hand lotions or creams frequently to minimize the occurrence of irritant contact dermatitis. Allergies to alcohol are extremely rare, but reactions can be caused by emollients and other compounds added to the alcohol. Importantly, to avoid skin irritation and prevent dilution of the alcohol to concentrations with insufficient antimicrobial activity, alcohol should not be applied to wet skin or to hands with soap residue. Some commercially available alcohol formulations may change the color of fingernails. Other factors that influence the acceptance of alcohol products by HCWs include the odor, color, and consistency of the product.

Flammability

The flash points of common commercially available hand-rub products are 21°C to 34°C, depending on the type and concentration of alcohol.[5] Therefore, alcohols should be stored away from high temperatures and flames, and containers should be designed to minimize evaporation. In

Europe, where alcohol-based hand rubs have been used extensively for decades, the incidence of fires associated with such products is extremely low.[9] In the United States, 1 flash fire, purportedly caused by a spark of static electricity generated by removal of an isolation gown while the person's hands were still wet with alcohol, has been reported.[29] To assess the frequency of fires associated with alcohol-based hand-rub dispensers, a Web-based survey of health care facilities in the United States was performed. Of 840 facilities that completed the questionnaire, 798 reported using alcohol-based hand rubs. None of the responding facilities reported a dispenser-related fire.[30] On the basis of these data, the risk of fire is substantially lower than the risk of MRSA acquisition and subsequent infection.

Emergence of Resistance of Microorganisms to Alcohol

The increasing use of alcohol for hand hygiene raises concern about the risk for emergence of resistant microorganisms. Despite extensive use, there is no evidence that such resistance has emerged in vitro or in vivo, suggesting that the mechanism of action (protein denaturation) or the rapid killing effect may not allow the development of resistance. In addition, the rapid evaporation of alcohol prevents extended exposure of microorganisms to subinhibitory concentrations of alcohol, possibly reducing the risk of emergence of resistance.

Types of Alcohol Formulations

Most of the experience accumulated to date is with low-viscosity rinses, but gel formulations have recently been proposed to reduce the drying effect and irritation of alcohols, potentially enhancing adherence to hand hygiene. An in vitro study indicated that gel formulations had lower antimicrobial activity (0.7-1.1 $\log_{10}$ CFU) than rinses with the same alcohol content ($P<.01$).[31] However, further clinical studies are needed to evaluate the relative efficacy of alcohol rinses and gels in reducing the transmission of nosocomial pathogens. Some gels may leave a sticky layer on the hands from the nonabsorbable gelling (thickening) system, necessitating frequent washing of the hands after repeated applications of a gel formulation. To date, no studies of the acceptance by HCWs of gels compared with rinses, a critical determinant for good adherence to hand hygiene, have been undertaken.

Effect of Wearing Rings and Artificial Fingernails

The skin underneath rings is heavily colonized with bacteria, but whether wearing rings results in greater transmission of pathogens is unknown. In a recent study by Trick et al,[32] ring wearing increased the frequency of hand contamination. However, contamination was considerably less frequent after the use of an alcohol-based hand rub than after washing with plain soap and water. Health care workers wearing artificial fingernails have been epidemiologically implicated in several outbreaks of infection caused by gram-negative bacilli (especially *P aeruginosa*) and yeasts.[33] Therefore, HCWs should not wear artificial fingernails when involved in direct patient care. Whether the length of natural fingernails is a factor in the spread of pathogens is unknown.

Education and Motivation of HCWs

Switching from hand washing to an alcohol hand-rub procedure requires a system and behavioral change in health care institutions. Once HCWs become familiar with the alcohol hand rub, most abandon the hand-washing procedure.[19,28] Strategies to improve hand-hygiene adherence must be multifaceted and include the education and motivation of HCWs, the use of performance indicators, and hospital management support. Writing new hand-hygiene guidelines alone is not enough. Simple training sessions for HCWs should be held on each ward to introduce the advantages of alcohol hand rubs over hand washing. In addition, patients can be educated about the importance of hand hygiene and be encouraged to ask HCWs to comply with hand-hygiene guidelines. The efficiency of the hand-rub technique can be evaluated with an alcohol product supplemented with fluorescent dye and an ultraviolet light.[9] Another way to estimate the quality of hand hygiene is to evaluate the consumption of soap and alcohol. If HCWs strictly follow the Centers for Disease Control and Prevention hand-hygiene recommendations, the ratio between soap and alcohol consumption should be close to 1:10. In order to improve patient safety and reduce costs, good hand hygiene should become one of the highest priorities in health care institutions.

CONCLUSION

The hands of HCWs are the most common mode of transmission of pathogens to patients. Proper hand hygiene can prevent health care–associated infections and the spread of antimicrobial resistance. Factors that contribute to poor adherence to hand hygiene include poor access to handwashing facilities (sinks), the time required to perform standard hand washing, irritant contact dermatitis associated with frequent exposure to soap and water, high workloads, knowledge deficits among HCWs, and the failure of administrative leaders to make hand hygiene an institutional priority.

Scientific evidence and ease of use support the use of alcohol-based hand rubs for hand hygiene during patient

care. The alcohol hand-rub technique is microbiologically more effective, more accessible, and less likely to cause skin problems and saves time and human resources. As a consequence, alcohol hand rubs are associated with substantially better adherence to hand hygiene than hand washing. The use of alcohol-based hand rubs should replace hand washing as the standard for hand hygiene in health care settings in all situations in which the hands are not visibly soiled.

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Questions About Hand Hygiene

1. Which *one* of the following statements about microbial skin flora is *false*?
   a. Transient flora is responsible for most health care–associated infections
   b. Resident flora is acquired from contacts with patients and contaminated environments
   c. Resident flora is considered important for preventing colonization with potentially more pathogenic microorganisms
   d. Plain soaps have minimal or no antimicrobial activity and reduce bacterial counts from hands only by mechanical removal
   e. The antimicrobial activity of alcohols on skin flora is diminished by the presence of organic material

2. Which *one* of the following statements about alcohol hand rubs is *false*?
   a. Alcohol should be rubbed onto all surfaces of the hands until it completely evaporates, and vigorous friction or drying with a towel are unnecessary
   b. There is no evidence that the use of alcohol for hand hygiene can increase the risk for emergence of resistance against antiseptics
   c. Alcohol hand rubs cause substantially more skin irritation and dryness than hand washing with soap and water
   d. All hand-washing techniques demonstrate a lower antimicrobial activity than alcohol hand-rub procedures
   e. Alcohol should not be applied on wet skin after hand washing with soap and water

3. Which *one* of the following durations of hand washing is needed to reduce bacterial counts on hands by 3 $\log_{10}$ CFU?
   a. 15 seconds
   b. 30 seconds
   c. 45 seconds
   d. 1 minute
   e. 2 minutes

4. Which *one* hand-hygiene practice has the *lowest* risk for adverse effects on the skin?
   a. Hand washing with nonantimicrobial soap and water
   b. Hand washing with antimicrobial soap and water
   c. Use of an alcohol-based hand rub
   d. Hand washing followed by the use of an alcohol-based hand rub
   e. Use of examination gloves

5. Which *one* of the following ethanol concentrations (vol/vol) has the *highest* antimicrobial activity against bacteria and viruses?
   a. 60%
   b. 70%
   c. 80%
   d. 90%
   e. 99%

Correct answers:
1. *b*, 2. *c*, 3. *d*, 4. *c*, 5. *d*