INFECTIOUS DISEASE PREVENTION AND CONTROL

# HAND HYGIENE PRACTICES IN HEALTHCARE SETTINGS

PROTECTING CANADIANS FROM ILLNESS

Public Health Agency of Canada
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# INTRODUCTION

## Introductory Statement

The Public Health Agency of Canada (PHAC) develops infection prevention and control guidelines to provide evidence-based recommendations to complement provincial/territorial public health efforts in monitoring, preventing, and controlling healthcare-associated infections. These guidelines support infection prevention and control professionals, healthcare organizations and healthcare providers in developing, implementing and evaluating infection prevention and control policies, procedures and programs to improve the quality and safety of health care and patient outcomes.

The purpose of this guideline, *Hand Hygiene Practices in Healthcare Settings*, is to provide a framework for developing programs, policies and procedures for hand hygiene in healthcare settings.

Guidelines, by definition, include principles and recommendations and should not be regarded as rigid standards. This guideline, whenever possible, has been based on research findings. In some areas, where there is insufficient published research, a consensus of experts in the field has been used to provide recommendations specific to practice. This guideline may need to be adapted to meet local, provincial or territorial requirements.

The information in this guideline was current at the time of publication. Scientific knowledge and medical technology are constantly evolving. Research and revisions to keep pace with advances in the field are necessary.

## Target Users

This guideline is intended to assist infection prevention and control professionals and all other healthcare providers responsible for developing policies and procedures related to hand hygiene in all healthcare settings, such as hospitals, clinics or physicians' offices. This guideline addresses hand hygiene practices in healthcare settings only and is not intended for home, community, school or residential use.

## Guideline Working Group

The *Hand Hygiene Practices in Healthcare Settings* guideline is one in a series of infection prevention and control guidelines developed by PHAC with technical expert advice from PHAC's Steering Committee on Infection Prevention and Control Guidelines Working Group. The Guideline Working Group was composed of members representing paediatric and adult infectious disease, hospital epidemiologists, acute and long-term care infection prevention and control practitioners, and home care, public health, medical microbiology, occupational health, respiratory therapy and emergency response professionals.

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# OVERVIEW

The objective of this guideline is to identify and promote hand hygiene as the most effective way of preventing the transmission of healthcare-associated infection (HAI) to patients, staff and visitors in all healthcare settings. The guideline will identify effective infection prevention and control measures related to hand hygiene by emphasizing the central role an organizational hand hygiene program has in preventing HAI.

The term “hand hygiene” represents a new term in the healthcare vocabulary, replacing the more narrow term of “handwashing”. Hand hygiene is a comprehensive term that refers to handwashing, hand antisepsis and actions taken to maintain healthy hands and fingernails. Handwashing is a process for the removal of soil and transient microorganisms from the hands using soap and water. Hand antisepsis is a process for the removal or destruction of resident and transient microorganisms on the hands using an antiseptic agent, either by rubbing hands with alcohol-based hand rub or handwashing with an antiseptic soap. Hand antisepsis has also been referred to as antiseptic handwash, antiseptic hand-rubbing, hand decontamination and hand disinfection.

For the purposes of this document, the term *patient* refers to a patient, resident or client in all settings where health care is provided. This guideline does not include hand hygiene related to surgery or gloving recommendations related to routine practices and additional precautions. The use of gloves is discussed in the PHAC infection control guideline, *Routine Practices and Additional Precautions for Preventing Transmission of Infection in Health Care* (1999), which is currently under revision; *Preventing the Transmission of Bloodborne Pathogens in Health Care and Public Service Settings* (1997) and *Prevention and Control of Occupational Infection in Health Care* (2002).

There are four main sections to this guideline. Parts A to D describe the framework for developing hand hygiene policies, programs and procedures in healthcare settings, Part E contains the Appendices and Part F lists the references.

**Part A** of this guideline describes the role played by hands in the transmission of microorganisms from one person to another in the healthcare setting. Major attention is given to how the hands of the healthcare worker (HCW) are frequently in contact with patients and their environment. Hands are identified as the surfaces most at risk for contamination with microorganisms during the delivery of care. As such, hands are primary vectors for cross-transmission. This section also explains the relationship between hand hygiene and HAI and the impact of improved hand hygiene practices.

**Part B** outlines hand hygiene programs and measures for improving adherence to hand hygiene practices.

**Part C** outlines the selection and dispensing of products for hand hygiene and effective hand hygiene techniques.

**Part D** provides the recommendations for hand hygiene practices to prevent the cross-transmission of microorganisms in healthcare settings, including the use of alcohol-based hand rub (ABHR) at the point-of-care as the preferred method of hand hygiene in **all healthcare settings** unless exceptions apply (i.e., when hands are visibly soiled with organic material, if

exposure to norovirus and potential spore-forming pathogens such as *Clostridium difficile* is strongly suspected or proven, including outbreaks involving these organisms).

**Part E** contains the following appendices.

- Appendix I provides a summary of the PHAC guideline development process.
- Appendix II outlines how the strength and quality of supporting evidence is assessed.
- Appendix III outlines how recommendations are rated (strength of evidence).
- Appendix IV describes the indications, advantages, disadvantages and special considerations of various hand hygiene products.
- Appendix V outlines the proper techniques for effective use of ABHRs and handwashing. Diagrams outlining proper technique are included.
- Appendix VI defines the abbreviations and acronyms used in this guideline.
- Appendix VII provides the list of definitions of terms used in this guideline.

**Part F** lists the references used in this guideline.

# PART A
# THE ROLE OF HANDS IN THE TRANSMISSION OF MICROORGANISMS

## THE ROLE OF HANDS IN THE TRANSMISSION OF MICROORGANISMS

**Background**

The efficacy of hand disinfection in reducing nosocomial infections was initially demonstrated by Semmelweiss in 1847[1;2]. Adherence to hand hygiene recommendations is the single most important practice for preventing the transmission of microorganisms in health care, and directly contributes to patient safety[3;4]. Despite published guidelines from national and international infection prevention and control organizations emphasizing the importance of hand hygiene[4;5]and specific promotional campaigns[6], healthcare providers' adherence to hand hygiene remains suboptimal[7;8]. A 2000 report suggested that the incidence of hospital-acquired infection in the United Kingdom could potentially be reduced by 15% if hand hygiene recommendations were followed as part of the National Health Standards national plan[9;10].

Hand hygiene represents a new term in the healthcare vocabulary emphasizing the central role an organizational hand hygiene program has in preventing healthcare-associated infections (HAIs). It replaces the narrow term "handwashing." Hand hygiene is a more comprehensive term that includes handwashing, hand antisepsis and actions taken to maintain healthy hands and fingernails. One method of hand hygiene is handwashing, which entails removing soil and transient microorganisms from the hands using soap and water. Another method of hand hygiene is hand antisepsis, which includes removing or killing resident and transient microorganisms on the hands using an antiseptic agent, by either rubbing hands with alcohol or handwashing with an antiseptic soap. This latter process has also been referred to as antiseptic handwash, antiseptic hand-rubbing, hand decontamination and hand disinfection. The use of an alcohol-based hand rub (ABHR) is the preferred method of hand hygiene in healthcare settings[3;4], unless exceptions apply (i.e., when hands are visibly soiled with organic material, if exposure to norovirus and potential spore-forming pathogens such as *Clostridium difficile* is strongly suspected or proven, including outbreaks involving these organisms).

Several studies have demonstrated that ethanol, isopropyl, or *n*-propanol ABHRs reduce bacterial counts on the hands of healthcare workers (HCWs) markedly better than washing hands with plain soap and water, and are as or more effective than handwashing with an antiseptic soap[11-19].

Hand hygiene performed with an ABHR may reduce the impact of some of the identified barriers to handwashing, including lack of time, inaccessibility of designated handwashing sinks, inadequate supplies for handwashing (e.g., hand towels, soap), hand hygiene products poorly accepted by users and concern over the deleterious effect of frequent handwashing. HCWs commonly report the amount of time necessary for effective handwashing as a reason to not wash their hands. Voss and Widmer[20] compared ABHR to handwashing and reported that it took intensive care unit (ICU) nurses approximately 40 to 80 seconds to go to a sink, wash and dry their hands and return to patient care activities, whereas use of an ABHR available at each patient's bed took only 20 seconds. When multiplied by the number of times HCWs should be washing their hands each day, the time saving is considerable.

Decreased HAI rates have been observed when adherence to hand hygiene improves[6;21-27]. However, achieving and sustaining improved adherence to hand hygiene is difficult, and promotional and educational programs have had only short-term effects[28]. Multimodal promotion programs have demonstrated short-term improved adherence to hand hygiene and reductions in HAI rates[6], but have not demonstrated that these effects are maintained. Ongoing direct observation and feedback on hand hygiene performance using validated methods appear to be effective methods of increasing hand hygiene compliance, but may be difficult to sustain on a continual basis[23;29-31].

Barriers resulting in poor adherence to hand hygiene may be organizational, related to the individual HCW or to a patient safety issue. Organizational barriers, such as a lack of accessibility, inadequate maintenance of hand hygiene facilities and poor access to hand hygiene products, overcrowding and understaffing, and a lack of role models, negatively affect adherence to hand hygiene[32]. Individual HCW barriers may include the misconception that hand hygiene is not necessary when gloves are worn, skepticism about the value of hand hygiene when the hands are not visibly soiled, lack of peer pressure to perform hand hygiene[29;33], lack of time to perform handwashing[20], lack of understanding of the clear association between healthcare-associated microorganisms on the hands of HCWs and HAI, and lack of understanding of how effective hand hygiene, when indicated, reduces the cross-transmission of microorganisms[3;7;8;34]. Lastly, as a component of patient safety, poor adherence to hand hygiene may be addressed if patients are empowered to request HCWs to follow effective hand hygiene practices[35-37].

## 1. MICROBIOLOGY

HCWs' hands are in frequent contact with patients and their environments, making hand surfaces the most at risk for contamination with microorganisms during the delivery of care and potentially the vehicles for transfer of microorganisms.

The inability to rid the hands of certain microorganisms following handwashing led Price[38] to propose the concept of resident and transient microorganisms. Microorganisms, also called normal flora, are resident or colonizing microorganisms in or on a host, with growth and multiplication without any overt clinical expression or detected inflammatory reaction in the host. Bacterial flora is normally acquired during and after birth, until the normal flora is established[39]. Normal flora evolves and changes over the life of the host. Many factors influence a change in the normal flora, including previous exposure to antibiotics, admission to hospital or the ICU[40] or medical instrumentation.

Resident microorganisms survive and multiply on the skin but do not generally cause illness. *Staphylococcus epidermidis* is the predominant species (spp.) of resident flora in humans[41]. Other resident bacteria on skin include *Staphylococcus hominis* and other coagulase-negative staphylococci, followed by coryneform bacteria (*Propionibacteria*, *Corynebacteria*, *Dermabacter*) and *Micrococci* spp.[42]. Resident fungi may include *Malassezia* (*Pityrosporum*) spp.[43]. Resident skin microorganisms are not usually implicated in HAI, but can cause infections in the host after surgery or invasive procedures, or when the patient is immunocompromised.

Transient microorganisms vary in number and kind, and are relatively scarce on clean skin and/or skin unexposed to contaminants[11]. They represent recent contaminants on the hands acquired from colonized or infected patients, contaminated environments or contaminated equipment. Transient microorganisms are not consistently isolated from the hands of most

people and do not multiply on the skin[38]. In contrast to the resident microorganisms, the transient microorganisms found on the hands of HCWs are more frequently implicated in HAI. The most common transient microorganisms include *Staphylococcus aureus*, including methicillin - resistant strains, Gram-negative bacilli, yeast and viruses (e.g., influenza virus, respiratory syncytial virus, norovirus, rotavirus)[44-46]. When performed effectively, hand hygiene removes transient microbial contamination[11].

Adherence to hand hygiene may be improved if HCWs understand the relationship between transient microorganisms on their hands and contact with the patients and the patient environment.

Other elements that influence the transfer of microorganisms from surface to surface and affect cross-contamination rates include type of microorganism, source and destination surfaces, size of inoculum[5] and ambient temperature and humidity. The following section discusses the steps that result in the transmission of healthcare-associated microorganisms and the imperative for hand hygiene[3].

## 2. THE TRANSMISSION OF MICROORGANISMS ON HANDS

As outlined by Boyce et al.[4] and reiterated by the World Health Organization (WHO) *Guidelines on Hand Hygiene in Health Care* (2009)[5], the transmission of microorganisms from one patient to another via HCWs' hands involves the five sequential steps listed below.

**Five sequential steps for the transmission of microorganisms from HCWs' hands**

1. Microorganisms are present on the patient's skin or have been shed onto inanimate objects immediately surrounding the patient.
2. Microorganisms are transferred to the hands of the HCW.
3. Microorganisms are capable of surviving for at least several minutes on a HCW's hands.
4. Handwashing or hand antisepsis by the HCW is inadequate or omitted entirely, or the agent used for hand hygiene is inappropriate.
5. The contaminated hands of the HCW must come into direct contact with another patient or with an inanimate object that will come into direct contact with the patient.

**Note:** The term "organisms" used in the original publications has been replaced with microorganisms[3-5].

The evidence that supports each of these five steps is outlined in Part A, Sections 2.1 to 2.5.

## 2.1. MICROORGANISMS PRESENT ON A PATIENT'S SKIN OR IN THE INANIMATE ENVIRONMENT

Microorganisms that cause HAIs can be found on normal patient skin in addition to infected body sites[44;45;47-56]. The skin of hospitalized patients is frequently colonized by staphylococci[54], enterococci[56], *Enterobacteriaceae,* other Gram-negative bacilli[48] and *Candida* spp. The duration of hospitalization and previous antibiotic use are factors leading to colonization. Compared with a group of non-hospitalized healthy adults, inpatients were found to have significantly higher carriage rates of *Proteus*, *Pseudomonas* and *Candida* spp., and significantly higher levels of antimicrobial resistance in all types of microorganisms from a number of skin sites[50]. The most heavily colonized areas of a patient's skin include the perineal and inguinal areas, although the axillae, toe web space, trunk and upper extremities[48-52;54;56-58] are also frequently colonized.

Patient factors such as insulin-dependent diabetes[59], injection drug use[60], hemodialysis[61-63] peritoneal dialysis[64], chronic skin disorders[65-67] and personal hygiene deficiencies[68] may increase *S. aureus* carriage rates. Patients with acute leukemia tend to carry Gram-negative bacteria on the skin[44]. Individuals hospitalized for two weeks or longer have been found to have a high prevalence of specific clones of coagulase-negative staphylococcus[69-73] and antibiotic-resistant *Corynebacterium jeikeium*[74].

Almost $10^7$ skin squames containing viable microorganisms are shed daily, even from average skin[67]. Microorganisms such as *S. aureus*, Gram-negative rods and *Enterococcus* spp., present on intact areas of some patients' skin, have been reported to be in the range of 100 to $10^6$ colony-forming units (CFU)/$cm^2$ [49;55;58]. These microorganisms are shed onto objects in direct contact with or in the immediate vicinity of patients, resulting in the contamination of patient gowns, bed linen, bedside furniture, etc.[56;75-77].

## 2.2. MICROORGANISMS TRANSFERRED TO HEALTHCARE WORKERS' HANDS

Pittet et al.[78] investigated bacterial contamination of HCWs' (ungloved, unwashed) hands during routine patient care in a large teaching hospital using agar fingertip impression plates. The number of bacteria recovered ranged from 0 to 300 colony-forming units (CFU). The maximum colony count was fixed at 300 CFU. Activities most likely to contaminate the fingers of caregivers were direct patient contact, respiratory tract care, handling of body fluid secretions and disruption in the sequence of patient care. Contamination of ungloved hands increased during routine patient care activity at a rate of 16 CFU/min. In this study, Gram-negative bacilli accounted for 15% of isolates and *S. aureus* for 11%. In a study of hand contamination during routine care in a neonatal intensive care unit (NICU), one contact with equipment resulted in, on average, an increase of 9 CFU of bacteria per minute of contact[79]. When comparing hand hygiene methods to remove transient skin bacteria, Ojajärvi[80] cultured the hands of burn unit nurses who changed beds, dressings and compresses with bare hands (no gloves and prior to hand hygiene). *S. aureus* was isolated in over 90% of the samples, and contamination occurred even after touching bedclothes for only a short time.

Hand contamination does not require sustained contact with patients. For example, brief contact, such as lifting a patient or taking a patient's pulse, blood pressure or oral temperature, resulted in the transfer of 10 to $10^3$ CFU of viable *Klebsiella* spp. to nurses' hands in one study[81]. In another study, nurses' hands became contaminated after having only 15 seconds of direct contact with the groins of patients heavily colonized with *Proteus mirabilis*. The nurses' hands then transferred microorganisms to the urinary catheters[51].

Other studies have documented the contamination of HCWs' hands with Gram-negative bacilli, *S. aureus,* enterococci and *Clostridium difficile* following a variety of patient care activities, such as touching a patient or a bed, bedmaking, changing a patient's gown, handling dirty linen or curtains, taking a temperature, examining or feeding a patient, lifting a patient for radiography or changing dressings[52;77;80]. A trial comparing the bacterial efficiency of various hand hygiene techniques also identified factors predisposing to hand contamination; HCWs' hands were cultured immediately after various patient-care activities. Hand contamination was found to be similar after contact with the patient, after contact with the patient environment and after contact with body fluids or waste[82]. The relative importance of hand carriage and environmental contamination contributing to *C. difficile* transmission in a hospital setting was investigated by Samore et al.[77]. Contamination was detected at more than one environmental site in 58% of patients' rooms, and often involved widely dispersed areas. *C. difficile* was cultured from the hands of 14% of HCWs, supporting the conclusion that direct and indirect routes play a role in its transmission.

Random sampling of the hands of nurses in dermatology, isolation and general wards to determine the level of contamination with transient microorganisms demonstrated that contamination with *S. aureus* and Gram-negative bacilli was greater in dermatological and general wards than in the isolation unit, where handwashing or disinfection was performed after every patient contact[18]. An investigation to identify transient flora on the hands of HCWs working in a neurosurgery unit found that 44% of personnel randomly sampled carried Gram-negative bacilli, and 11% carried *S. aureus*. Serial cultures revealed that all HCWs, at various times, carried Gram-negative bacilli, and two thirds carried *S. aureus* at least once[83].

Respiratory syncytial virus has been transmitted to caregivers who had no direct contact with infants infected with the virus. Transmission occurred when HCWs touched environmental surfaces contaminated with the infants' secretions and then touched their own eyes or nose[84].

## 2.3. MICROORGANISMS CAPABLE OF SURVIVING ON HANDS

Bacteria and viruses can persist on hands for hours[81;85-93]. The survival of vancomycin-resistant enterococci on hands and the environment was investigated by Noskin et al.[87]. *Enterococcus* spp. survived for at least 60 minutes on fingertips. Doring and colleagues[88] demonstrated that *Pseudomonas aeruginosa* and *Burkholderia cepacia* were transmissible during handshaking (a contaminated hand shaking a disinfected hand) for up to 30 minutes using microorganisms suspended in saline, and up to 180 minutes using microorganisms suspended in sputum. In a study by Islam[89], *Shigella dysenteriae* survived on hands for up to one hour. *C. difficile* has also been found on the hands of HCWs who care for infected patients[94].

The survival of an infectious virus on hands has been demonstrated for influenza[95], rhinovirus[91;96;97], respiratory syncytial virus[98;99] and rotavirus[90]. The authors of these investigations concluded that rotaviruses and respiratory viruses retain their infectivity for several hours on hands, and strongly suggested that hands play a role in rotavirus transmission.

## 2.4. INEFFECTIVE OR INADEQUATE HAND HYGIENE

Various reasons have been identified or suggested as to why HCWs perform ineffective or inadequate hand hygiene[32]. These include misconceptions about the indications for hand hygiene, the notion that hand hygiene is not required if gloves are worn, not following proper hand hygiene techniques, lack of organizational priority, lack of infrastructure to support hand hygiene (e.g., ABHR not organization's preferred method of hand hygiene – unless exceptions

apply as noted in Part D, Section 1.2, ABHR not at point-of-care, insufficient number of or inconvenient access to designated handwashing sinks[100], insufficient hand hygiene products etc.), and lack of time to handwash[20] influenced by overcrowded work situations and/or understaffing[101-103].

Adherence to hand hygiene recommendations varies in different surveys, and has been reported to be in the range of 10% to 48% in international publications[8;104-108]. Adherence has been higher after specific interventions, but is seldom sustained[28]. Pittet et al.[8] observed 2,834 opportunities for handwashing and reported an average hand hygiene compliance of 48%. Multivariate analysis found that nurses had better compliance than any other category of HCW, and that compliance was higher on weekends. Non-adherence was higher in ICUs than in internal medicine wards during procedures that carried a high risk of bacterial contamination and when intensity of patient care was high. In a large prospective study in two participating NICUs, hand cultures of nurses working on the unit, taken immediately following hand hygiene, identified Gram-negative bacilli from 38% of nurses[109]. Trick et al.[110] found that ring wearing increased the frequency of hand contamination with potential pathogens. Artificial acrylic fingernails contribute to hands remaining contaminated with pathogens after use of either antimicrobial soap or ABHR[111].

Hand hygiene may be ineffective if an inadequate amount of product is used[17] or an inappropriate product is used[112]. In a study assessing the effect of two quantities of four different handwashing products on reductions in log CFU from the hands, Larson[17] demonstrated that 3 mL of antimicrobial soap had significantly greater reductions in log CFU than 1 mL. Kac et al.[112] compared the microbiological efficacy of an ABHR to handwashing with an unmedicated soap. The hands of 15% of HCWs were contaminated with transient pathogens before hand hygiene. No pathogens were recovered after the use of ABHR, but pathogens were present in two instances after handwashing. Similarly, Trick et al.[110] reported that hand contamination with transient microorganisms was significantly less likely after the use of an ABHR (odds ratio, 0.3; 95% confidence interval, 0.1-0.8) than after the use of medicated wipes or soap and water.

The technique and duration of handwashing is important to ensure the removal of microorganisms. Noskin et al.[87] studied the removal of vancomycin-resistant enterococci by handwashing with water alone or with two different soap preparations (regular soap and antibacterial soap). The authors determined that a five-second wash with water alone had no effect on contamination and that a five-second wash with either soap failed to remove the microorganisms completely from the fingertips. They reported that a 30-second hand wash with either soap preparation was necessary to completely remove the bacteria from hands.

Several studies have linked overcrowding, understaffing or nursing workload to the cross-transmission of staphylococcal infections, including methicillin-resistant *S. aureus* (MRSA)[101;113], extended-spectrum B-lactamase producing *Enterobacteriaceae*[114;115], *Klebsiella pneumoniae*[116], *Enterobacter cloacae*[102] and gastrointestinal viruses[103]. Stegenga et al.[103] suggested that nurse understaffing is a significant risk factor for the nosocomial spread of viral gastrointestinal infections in general paediatric patients. They hypothesized that infection control practices might be neglected as a result of increased patient acuity and/or workload, with a resultant increase in the HAI rate[103].

Although there is no direct evidence of a link between decreased hand hygiene and increased workload, an increased risk of infection in ICU settings has been demonstrated when workload increases[102;117;118]. In a cross-sectional study of MRSA in an ICU over 19 months, a weak but

statistically significant correlation between the number of MRSA cases and staff-to-patient ratios was demonstrated. No link to hand hygiene behaviours was made[117]. Investigation of an outbreak of *Enterobacter cloacae* in a NICU determined that the risk for infection was facilitated by substantial overcrowding and understaffing. By coincidence, a hospital-wide survey of handwashing performed the week before the outbreak revealed that in the NICU, non-compliance with handwashing was 37%. Whether or not understaffing was related to compliance with handwashing was not assessed[102].

The authors of a study investigating the time required for proper handwashing, compared with the use of ABHR for hand hygiene, identified that the time required by HCWs to comply with handwashing might interfere with patient care and could partly explain low compliance with handwashing. They noted that the use of ABHR for hand hygiene, with its rapid activity, superior efficacy, and minimal time commitment, allows for improved HCW hand hygiene compliance[20].

## 2.5. CROSS-TRANSMISSION OF MICROORGANISMS BY CONTAMINATED HANDS

Contaminated hands can transmit microorganisms to inanimate surfaces[119-122], and from unclean sites to clean sites on one patient or to another patient. Barker et al.[120] demonstrated that fingers contaminated with norovirus could sequentially transfer the virus to up to seven clean surfaces and from contaminated cleaning cloths to clean hands and surfaces. In one report, *Serratia marcescens* was transmitted from contaminated non-medicated soap to patients via the hands of HCWs[123]. Duckro et al.[122] concluded that hands were responsible for transferring vancomycin-resistant enterococci from the contaminated environment or patients' intact skin to other clean sites. The potential for cross-contamination between paper towel dispensers and hands can take place if either one is contaminated, whether during use or as a result of towel dispenser placement in splash zones[119;124;125]. Harrison et al.[119] found that even "manual pull" disposable folded towels and towel dispensers that are considered "hands free" can become contaminated if the surfaces at the dispenser exit are touched. This usually occurs when the paper towel is dispensed with difficulty (e.g., plugged), and the frequency of occurrence varies considerably, depending on the compatibility of the paper towel and the dispenser. The potential for contamination should be considered in the design, construction and use of paper towel dispensers.

The contaminated hands of HCWs have been implicated in HAI outbreaks[121;126;127]. A strain of *Staphylococcus epidermidis* carried on the hands of a cardiac surgeon was determined to be the source of infections among cardiac surgery patients. The epidemic strain was recovered only from the hands of that surgeon[126]. In an outbreak of multidrug-resistant *Acinetobacter baumannii* in a trauma ICU, El Shafie et al.[121] reported identical strains from patients, hands of staff and the environment. The authors noted that the lack of proper hand hygiene among patients and contact with equipment facilitated transmission in this outbreak.

Healthcare workers can transfer pathogens from their homes to patients[128;129]. An outbreak of postoperative *S. marcescens* wound infection was traced to a contaminated jar of exfoliant cream in a nurse's home. This investigation suggested the microorganism was transmitted to patients via the hands of the nurse who wore artificial fingernails[128]. Finally, an outbreak of *Malassezia pachydermatis* in a NICU was likely transmitted from a nurse's pet dog via the hands of the nurse[129].

## 3. THE RELATION BETWEEN HAND HYGIENE AND ACQUISITION OF HEALTHCARE-ASSOCIATED MICROORGANISMS

The efficacy of hand disinfection in reducing nosocomial infections was initially recognized by Semmelweiss in 1847[1], and was reaffirmed in a review of the literature by Larson[130;131].

Direct evidence that handwashing with an antiseptic agent between patient contacts reduces transmission of microorganisms, compared with no handwashing between patient contacts, was demonstrated in a hospital nursery in a landmark study in the 1950s. Infants cared for by nurses who did not wash their hands after handling an index infant colonized with *S. aureus* acquired the microorganisms significantly more often, and more rapidly, than did infants cared for by nurses who used hexachlorophene to clean their hands between infant contacts[132]. Contaminated hands of HCWs have been implicated in outbreaks in hospital settings[121;126-128]. During an outbreak of a fatal *Pseudomonas aeruginosa* infection in a NICU, contamination of the hands of a HCW with otitis externa was found to be responsible for ear-to-hand-to patient transmission. No further cases were identified after treatment of the HCW to eradicate carriage of *P. aeruginosa*[127]. In another study, hands of HCWs were found to be contaminated with strains of multidrug-resistant *Acinetobacter baumannii* identical to the strains found on patients and in their environment where open suctioning was practiced. HCWs' hands were thought to be contaminated via contact with the patient's immediate environment[121]. It has been repeatedly demonstrated that antimicrobial-resistant microorganisms may be carried from patient to patient via the contaminated hands of HCWs[133;134].

Although the full role of patient hands contributing to transmission is unclear[135], hand hygiene programs should be available to provide information to promote hand hygiene to patients and visitors. Patients and visitors should be instructed regarding the indications for and the proper technique of hand hygiene.

## 4. IMPACT OF IMPROVED HAND HYGIENE

Several observational studies from a variety of countries and settings[6;21-27;136-142] have demonstrated a reduction in HAI rates related to improved hand hygiene. Randomized controlled studies in healthcare settings that define the impact of improved hand hygiene on HAI are, however, lacking. Sustaining improved hand hygiene rates remains an issue; a return to pre-study rates often occurs once the study is completed and interventions to promote hand hygiene are discontinued[29]. Publications that have demonstrated a reduction in HAI when hand hygiene improved[6;21-27] are outlined in Table 1.

**Table 1: Improved hand hygiene and reduction of healthcare-associated infection**

| Study author/ date/setting/intervention | Methods | Hand hygiene (HH) compliance | Healthcare-associated infection (HAI) results | Comments |
|---|---|---|---|---|
| Larson, 2000[21]<br>United States<br>Two similar hospitals: 1 as intervention, 1 as control<br>Organizational climate intervention | Controlled trial (non-randomized)<br>Outcomes measured at baseline, implementation and 6 months post<br>Measured frequency of handwashing via action of dispenser in medical ICU and NICU only<br>Did not monitor if handwashing was appropriate<br>Standard hospital surveillance for MRSA and VRE | Higher HH for intervention vs. control site at baseline (RR,1.4) and during implementation phase (RR, 1.1).and even higher for intervention site (RR, 2.1) at follow-up | From baseline to follow-up, VRE decreased:<br>– by 85% in intervention group ($p$=0.002)<br>– by 44% in control group ($p$=0.03)<br>From baseline to follow-up, MRSA:<br>– decreased by 33% in intervention group ($p$=0.25)<br>– increased by 31% in control group ($p$=0.65)<br>No outbreaks in intervention hospital but 2 outbreaks (of VRE and RSV) in control ICU | Strong design with good attempts to control confounding and minimize bias |
| Pittet, 2000[6]<br>Geneva, Switzerland<br>Hospital-wide HH program: multiple interventions | Uncontrolled, before–after study<br>Baseline HH survey (1994), then twice a year surveys (1994–1997)<br>Trained ICPs did direct (unobtrusive) monitoring of HH opportunities: structured protocol<br>Monitoring of HAI, MRSA rates, ABHR consumption and antibiotic use | 1995: 47.6%<br>1996: 61.8%<br>1997: 66.2%<br>Increase in HH over time was significant ($p$<0.001)<br>Physician HH compliance (31.1%) and other HCWs (39.5%) lower than nurse compliance | 1994–1998:<br>– decreased HAI prevalence from 16.9% to 9.9% ($p$=0.04)<br>Decreased MRSA transmission: 2.16 to 0.93 episodes per 10,000 patient days ($p$<0.001) | Weak design, moderate potential for confounding<br>Unclear if other measures taken could explain results; however, did report similar profile and opportunities for HH in both time periods |

| Study author/ date/setting/intervention | Methods | Hand hygiene (HH) compliance | Healthcare-associated infection (HAI) results | Comments |
|---|---|---|---|---|
| Lam, 2004[24]<br>Hong Kong<br>12-bed NICU<br>Provided ABHR, education, posters, hands-free sinks | Uncontrolled, before–after study<br>Audits pre- and post-intervention (6 months)<br>Unobtrusive observation by trained observer<br>Surveillance of HAI | HH improved from 40% pre to 53% post ($p$=0.0002)<br>HH improvement was more prominent for high-risk procedures (35% [pre] vs. 60% [post]; $p$<0.0001) | HAI rate decreased from 17.2 per 100 patient admissions to 9.1<br>Reduced bloodstream infection and ventilator-associated pneumonia; differences were not statistically significant | Weak design, moderate potential for confounding and/or bias<br>Unclear if other measures taken could explain results (e.g., there were 1.8 pt contacts/hour in post-period vs. 2.8 at baseline, but otherwise similar high-risk contacts, personnel) |
| Zerr, 2005[25]<br>United States<br>Paediatric hospital; 9 rooms on 2 wards (chronic respiratory diseases and surgical)<br>Hospital-wide campaign with intense education, ABHR, organizational expectation | Uncontrolled, before–after study<br>5 observation periods for medical unit, 3 for surgical, from early 1999 to spring 2004<br>2 trained observers recorded staff opportunities for HH using standardized data collection forms<br>Monitored frequency of rotavirus infection | Overall HH compliance improved from 62% in period 1 to >80% in periods 4 and 5 ($p$<0.001) | Rate of rotavirus decreased from 5.9 episodes per 1000 discharged patients in 2001 to 2.2 episodes in 2004 ($p$=0.01) | Weak design, moderate potential for confounding and/or bias<br>Unclear if other measures taken could explain results, although researchers did account for annual variation in rotavirus<br>Unequal observation periods |

| Study author/ date/setting/intervention | Methods | Hand hygiene (HH) compliance | Healthcare-associated infection (HAI) results | Comments |
|---|---|---|---|---|
| MacDonald 2004[23]<br>United Kingdom<br>Plastic surgery unit of 660-bed general hospital<br>Provided ABHR, posters, performance feedback | Uncontrolled, before–after study<br>Audits at baseline (March 2000) and November 2000<br>Standardized observation of HH<br>MRSA and use of teicoplanin monitored one year before and one year after first audit | HH compliance before clinical contact:<br>– March: 20% to 47%<br>– November: 47%<br>HH compliance after clinical contact:<br>– March: 42%<br>– November: up to 78% | Rate of new MRSA cases fell from 1.9% to 0.9% ($p<0.05$), and was sustained in months after<br>Reduced amount of teicoplanin used (76 to 64 ampoules); similar reduction seen in rest of hospital | Weak design, high potential for confounding and/or bias<br>Results on teicoplanin use elsewhere suggest that MRSA may have been decreasing and was not clearly associated with HH |
| Won, 2004[22]<br>Taiwan<br>Level III NICU<br>Multimodal HH promotion included financial incentives and regular feedback | Uncontrolled, before–after study<br>Covert observation of HH compliance weekly during 1-hour periods: 312 observation periods between 1998 and 2001<br>Observers were NICU nurses randomly chosen (no training, no inter-rater reliability)<br>Routine surveillance for HAI | Baseline: 43%<br>End of first year: 74%<br>End of second year: 80%<br>End of third: year: 82% | HAI rate per 1000 pt-days:<br>– at baseline: 15.1<br>– end of second year: 11.9<br>– end of third year: 10.2<br>Significant association between HH compliance and reduction of respiratory infections ($r=-0.385$; $p=0.014$), but not other HAI | Weak design, high potential for bias and/or confounding<br>Although authors reported no changes in facilities or staffing patterns, other measures taken could explain results (e.g., financial incentives)<br>Use of untrained observers from the unit may have introduced bias |

| Study author/ date/setting/intervention | Methods | Hand hygiene (HH) compliance | Healthcare-associated infection (HAI) results | Comments |
|---|---|---|---|---|
| Johnson, 2005[26]<br>Australia<br>5 sentinel areas in 840-bed acute care hospital<br>ABHR, detailed educational and promotional package, talking walls, computer-based education; feedback of results, senior management support | Uncontrolled, before–after study<br>HH of staff observed at baseline, 4 mo, 12 mo<br>Trained nurse observers with inter-observer standards<br>MRSA screening and treatment for colonization<br>Surveillance for MRSA<br>Lab-based identity of ESBL | HH compliance:<br>– baseline: 21%<br>– 4 mo: 41%<br>– 12 mo: 42% | MRSA colonization assessed in >90% of patients<br>MRSA colonization rates varied by ward but not over time<br>Clinical MRSA isolates decreased by 40% and ESBL by 90% between period 1 (28 months pre-intervention) and period 2 (36 months post-implementation) ($p$ <0.001) | Weak design, high potential for bias and/or confounding.<br>MRSA infection screening and decolonization program may have influenced results |
| Rosenthal, 2005[27]<br>Argentina<br>Tertiary care teaching hospital: medical and coronary ICUs<br>Focused education, feedback, visual displays | Uncontrolled, before–after study<br>Results at baseline, 4 mo, 17 mo<br>Frequent direct observation of HH opportunities by trained ICPs<br>Routine HAI surveillance: CVC-BSI, cUTI, VAP | Significant difference ($p$=0.001) in HH compliance:<br>– Pre: 23.1%<br>– Post: 64.5% | Significant difference ($p$=0.001) in HAI per 1000 pt-days:<br>– Pre: 47.6<br>– Post: 23.9 | Weak design, high potential for confounding and/or bias<br>Other interventions were in place to decrease CVC-BSI and cUTI |

cUTI (catheter-associated urinary tract infection); CVC-BSI, (central venous catheter bloodstream infection); ESBL (Extended-spectrum beta lactamase); ICP (infection control professional); ICU ( intensive care unit); MRSA (methicillin-resistant *Staphylococcus aureus*); NICU (neonatal intensive care unit); RR (relative risk); RSV (respiratory syncytial virus); VAP (ventilator-associated pneumonia); and VRE (vancomycin-resistant enterococci).

# PART B
# HAND HYGIENE PROGRAMS AND CONTINUOUS QUALITY IMPROVEMENT

## 1. HAND HYGIENE PROGRAMS

The goal of a comprehensive hand hygiene program is to improve HCW adherence to hand hygiene to reduce HAI. The authors of a 2007 Cochrane review set out to establish whether there are effective strategies to improve hand hygiene compliance, whether such strategies are effective over the short or long term and whether increased compliance reduces HAI. They determined that there is insufficient evidence to be certain what strategies are most effective in improving hand hygiene[143]. Most studies had inadequate control groups. Although some strategies to improve adherence have been successful, none were found to have achieved lasting improvement. This review was updated in 2010. The authors reported multifaceted campaigns with social marketing or staff involvement appears to have an effect although there remains insufficient evidence to draw a firm conclusion[144]. Temporary increases in adherence to hand hygiene have been demonstrated with repeated and multimodal strategies[6]. Further discussion on strategies can be found in Table I.20.1 (Strategies for successful promotion of hand hygiene in health-care settings) in the *WHO Guidelines on Hand Hygiene in Health Care*[5].

## 2. CONTINUOUS QUALITY IMPROVEMENT PROCESS AND HAND HYGIENE PROGRAMS

The application of continuous quality improvement processes may be helpful in achieving a successful hand hygiene program. A variety of improvement processes are available for use in health care[145-147]. Continuous quality improvement processes that aid in performance improvement include the following:

- planning and defining expectations, goals and desired outcomes
- measuring and collecting performance information
- changing defective processes

## 3. MEASURING ADHERENCE TO HAND HYGIENE RECOMMENDATIONS

Measuring and reporting (i.e., surveillance and/or audits) of hand hygiene behaviour and hand hygiene-related outcomes can be used to assess HCWs' adherence to hand hygiene recommendations, evaluate the impact of promotion interventions, determine whether rates of adherence influence HAI and provide feedback to HCWs. Publications that have demonstrated a reduction in HAI when hand hygiene is improved are outlined in Table 1.

Whether audit and feedback can be a useful intervention was the subject of a 2006 Cochrane review[148]. The authors concluded that audit and feedback can be effective in improving professional practice, although the effects are generally small to moderate. They noted that the

relative effectiveness of audit and feedback is likely to be greater when baseline adherence to recommended practice is low and when feedback is delivered more intensively. Several authors have reported that providing results of monitoring to HCWs improved adherence to hand hygiene recommendations[6;21-24;29;33;149-155].

Adherence to hand hygiene recommendations can be measured directly, indirectly or with self-reports. The advantages and disadvantages of different methods of measurement should be considered[31;156]. For example, in a study conducted to determine hand hygiene frequency, Van de Mortel and Murgo[157] investigated how well outcomes correlated with covert observation and audit of hand hygiene solution use. In a specific phase of the study, the amount of solution used appeared to demonstrate that hand hygiene frequency doubled; however, the observation data showed a marked decline in hand hygiene adherence. The authors concluded that an observational study may only sample a small number of actual interactions and may provide a skewed version of what is actually happening.

In the United States, some states have legislated public disclosure of HAI rates and related quality improvement efforts will also be disclosed[158]. To ensure appropriate data collection for performance indicators such as hand hygiene, the Society for Healthcare Epidemiology of America recommends the following[158]:

- the ideal valid indicator be clearly defined with numerator and denominator
- the indicator variables be easy to identify and collect
- the data collection method selected be sensitive enough to capture the data
- once selected, the method be used across all facilities in the organization

As of January 2009, hospitals and healthcare organizations seeking accreditation in Canada have had to evaluate hand hygiene compliance. Accreditation Canada has directed individual organizations to determine how they will conduct hand hygiene compliance audits[159]. Methods of measuring compliance with hand hygiene have been reviewed. The authors of these reviews report there is no validated and standardized method for measuring compliance[156;160]. See Part B, Section 3.4 for further discussion of monitoring tools.

## 3.1 DIRECT MONITORING

Credible rates of hand hygiene adherence can only be achieved through direct monitoring by trained observers using a standardized validated tool. Accurate evaluation of hand hygiene adherence is important for feedback purposes. It is important to note that the definition of non-adherence needs to be clearly defined and applied by observers to achieve high inter-rater reliability[30;31;156]. McAteer et al.[30] have published a validated, standardized observational tool to measure hand hygiene behaviour with clear standard operating procedures and good evidence of inter-rater reliability and sensitivity to change. Methods to prevent HCWs from knowing they are being observed should be used to avoid a “Hawthorne Effect” (i.e., improved behaviour when being observed)[37;161-164]. Although direct observation by trained observers is more time-consuming and expensive than indirect methods, appropriate direct observation methods may give more credible results. In a review of observational studies on improving adherence to handwashing using direct monitoring, Gould et al.[31] determined that the methodology of most studies was so poorly described that the findings were difficult to accept as reliable or as valid indicators of HCW hand hygiene behaviour. The authors reported that direct observation should be timed to capture 24 hours of hand hygiene behaviour and included the following details for data collection:

- the vantage of data collectors (i.e., the location of data collectors in relation to those being observed)
- the identity of the data collectors
- the training received by the data collectors
- the inter-rater reliability when more than one person was involved
- the indication of how the data were documented
- the mechanisms for coping with lost data

## 3.2 INDIRECT MONITORING

Indirect monitoring methods involve monitoring hand hygiene-related indicators. Although these methods do not necessitate a trained observer and are less time-consuming, they can be affected by variables such as patient mix and workload[165] and cannot determine whether hand hygiene was performed with the correct technique or for an appropriate indication. Examples of indirect monitoring include calculating the amount of hand hygiene product used[6;23;36;108;141;161;166], the number of towels used[163], the number of times a sink is used[166], or the amount of hand hygiene product required[167]. Some studies have demonstrated that the consumption of products correlates with observed hand hygiene adherence[6;108;161;168], indicating that consumption may be a useful marker[157]. Further investigation is warranted.

## 3.3 HEALTHCARE WORKER SELF-REPORTS

Compared with observation, self-reporting is less expensive; however, careful assessment of the data for validity is necessary[169-171].

## 3.4 MONITORING TOOLS

A variety of tools used in research studies for monitoring hand hygiene behaviour are available[156;159;172]. The Just Clean Your Hands program is in use throughout Ontario acute care facilities and, as of April 2009, public reporting of hand hygiene compliance has been mandated in Ontario. The mandate includes using the audit tool (available at http://www.oahpp.ca/services/jcyh/). Other jurisdictions have initiated similar programs.

The hand hygiene observational tool developed by McAteer et al.[30] specifically addresses deficiencies in audit tools reported in the 2006 Cochrane review[148], including providing adequate standard operating procedures, inter-rater agreement testing and evidence of sensitivity to change. Further information is available on the cleanyourhands campaign website (available at www.npsa.nhs.uk/cleanyourhands).

A standardized tool for measuring hand hygiene compliance was developed as part of the DeBug Infection Prevention Program in Australia (available at www.debug.net.au/handhygiene.html) [173]. This tool is an integral part of the culture change program that encouraged the increased use of bedside alcohol/chlorhexidine gluconate (CHG) hand rubs. The program was associated with a sustained improvement in hand hygiene and a reduction in the rate of MRSA.

Work on this subject is evolving and additional publications are expected[160]. The reader is encouraged to follow the available literature for alternative approaches to measuring compliance with hand hygiene.

## 3.5 HAND HYGIENE AND PATIENT SAFETY

Improving HCW adherence to hand hygiene is one goal of patient safety initiatives. Global research endorsed by WHO reported that improvements in hand hygiene could reduce HAI by up to 50%[10]. Promotional activities to raise awareness of HAI as a priority for patient safety include WHO's Clean Care is Safer Care challenge (available at http://www.who.int/gpsc/en/index.html) which was launched worldwide in October 2005.

The Canadian Patient Safety Institute launched Canada's national hand hygiene campaign in October 2007 under the theme STOP! Clean Your Hands (available at: http://www.handhygiene.ca/English/Events/StopCleanYourHandsDay/Pages/default.aspx). A key element of the campaign is a series of toolkits that focus on awareness-raising, education, training, communication and promotion. It is aimed at responding to the needs of healthcare organizations for capacity building, leadership development and the production of tools to help promote hand hygiene and reduce the occurrence of HAI. The Ontario Ministry of Health and Long-Term Care/Public Health Division/Provincial Infectious Diseases Advisory Committee Just Clean Your Hands program (available at http://www.oahpp.ca/services/jcyh) audit tool and training component has been adopted by the Canadian Patient Safety Institute as part of its national hand hygiene campaign strategy.

The cleanyourhands campaign (available at www.npsa.nhs.uk/cleanyourhands) is one of several strategies developed by the National Patient Safety Agency to reduce avoidable infections in the United Kingdom. The campaign is being evaluated independent of the National Patient Safety Agency by the Department of Health's Patient Safety Research Programme. This four-year research project is assessing the campaign's impact on a range of outcomes, with a particular focus on rates of infection.

# PART C
# HAND HYGIENE PRODUCTS, TECHNIQUES AND BARRIERS TO EFFECTIVE HAND HYGIENE

## 1. SELECTION OF HAND HYGIENE AGENTS

### 1.1. CHARACTERISTICS OF HAND HYGIENE AGENTS

Antiseptic agents are designed to rapidly kill the majority of transient skin flora. The characteristics of specific agents should be taken into consideration when assessing the effectiveness of an agent for hand hygiene. Characteristics vary among agents, including immediate bactericidal action against both resident and transient bacterial flora, action against non-bacterial microbes (including viruses), persistence of action preventing regrowth of skin microorganisms, cumulative effect resulting from regular use, and the possibility of incompatibilities when used with other products. In addition, the agents should retain their activity in the presence of organic material and be acceptable to the user[174]. Products that tend to cause skin irritation and dryness negatively influence their acceptance and ultimate use by HCWs[14;18;34]. For these reasons, potential users of hand hygiene agents should be included in the evaluation and selection of hand hygiene agents.

Alcohol preparations, including ethanol (ethyl), isopropanol (iso-) and *n*-propanol[175], are the most effective antimicrobial agents, followed by chlorhexidine gluconate (CHG) and povidone-iodine preparations. All are significantly more effective than unmedicated soap[11;18].

The hand hygiene agents most commonly employed today are alcohols and detergent preparations containing CHG (Table 2).

Lodophors, triclosan, chloroxylenol, and quaternary ammonia products are not commonly used[11], but may have a role in specific situations (Table 3).

#### 1.1.1. Agents commonly used for hand hygiene

##### *1.1.1.1. Alcohol*

The following three types of alcohol have been shown to be effective for use on the skin: ethanol (ethyl), isopropanol (iso-) and *n*-propanol[175]. The antimicrobial action of alcohol comes from its ability to denature proteins[176], and the presence of a minimal amount of water in the preparation is necessary to provide maximal antimicrobial activity.

Alcohols vary in the concentrations necessary to reduce the number of microorganisms on the hands and in their efficacy against different types of microorganisms (e.g., bacteria or viruses)[11;177;178]. ABHRs with an alcohol (i.e., ethanol, isopropanol or *n*-propanol) concentration from 60% to 90% are appropriate for clinical care[11;38;175;177;179]. Product formulation may influence product efficacy (i.e., gels vs. rinses vs. foams)[180;181].

Alcohols have excellent bactericidal and fungicidal activity and are the most rapidly active of all agents used in hand disinfection.[11] They also have excellent activity against *Mycobacterium* spp.[176;182] Alcohols have activity against a variety of viruses, including respiratory viruses (e.g., severe acute respiratory syndrome coronavirus [SARS-CoV],[183]

influenza), bloodborne viruses (e.g., human immunodeficiency virus,[184;185] hepatitis B virus),[186] rotaviruses,[187;188] adenovirus, rhinovirus[188] and herpes simplex virus.[176] ABHRs are effective against a norovirus surrogate, but the optimal alcohol concentration necessitates further evaluation.[189-193] One study suggests that norovirus is inactivated by alcohol concentrations ranging from 70% to 90%.[189]

ABHRs may have greater activity than antiseptic detergents against antibiotic-resistant microorganisms, such as vancomycin-resistant enterococci and MRSA[6;26;175;194-198].

Alcohols are considered to have little or no activity against bacterial spores[199;200]. *C. difficile* infection is spread by bacterial spores, and concern about whether increased infection rates are associated with increased use of ABHR has been raised[201;202]. In a study to determine whether there is an association between the increasing use of ABHRs and the increased incidence of *C. difficile* infection, Boyce et al.[201] reported that a ten-fold increase in the use of ABHR over three years in a 500-bed university-affiliated community teaching hospital did not increase the incidence of infection. Others have reported similar findings over a one-[141] and three-year[198] period.

The 2009 WHO *Guidelines on Hand Hygiene in Health Care*[5] and a systematic review of publications between 1992 and 2002 on the effectiveness of ABHRs for hand hygiene confirmed that ABHRs remove microorganisms more effectively, require less time to use, and irritate skin less often than handwashing with soap and water or other antiseptic agents[175]. Several studies confirm that alcohol-based solutions reduced bacterial counts on the hands of HCWs significantly better than plain soap and water and are as effective or more effective than an antimicrobial soap[11;12;15;16;18;19;80;82;203]. Alcohols are preferred as a hand rub because of their effectiveness, immediate activity, excellent spreading on the surfaces of hands and quick evaporation[11]. Alcohols can be used when there is insufficient time to effectively wash hands[20]. Alcohols are less drying to the skin than water-based products, do not need a sink for use, and are useful when proper facilities for handwashing are lacking or unsafe.

In the past, poor acceptance of alcohols has been related to the misconception by HCWs that alcohols cause drying of the skin[12;204]. Incorporating glycerol or emollients into alcohol-based products has helped to reduce dryness[11-14;16;205;206]. ABHRs have been demonstrated to be better tolerated by HCWs than water-based soaps or antiseptics[16;175;207-211]. Acceptance of different ABHRs by users may be influenced by consistency (feel), scent, skin-conditioning agents, propensity to become sticky while drying, evaporation times, amount of residual buildup and effects on the skin of the user[16;34;107;212-214].

Introducing ABHRs as part of a hospital-wide hand hygiene promotional program has been demonstrated to be cost-effective and has resulted in reduced infections[215]. Boyce[216] noted that the cost of changing to an ABHR is minimal when compared to the excess costs related to HAI. The availability of ABHRs has been shown to increase compliance with hand hygiene among HCWs[6;161;175] in all healthcare settings, including home care. ABHRs can be placed at the point-of-care using one or more of the following means: attached to the patient bedside, attached to patient equipment, or carried by the HCW[11;108;161;217-219].

ABHRs are available as gels, rinses, or foams. Gels are thicker in consistency than rinses, and may produce a feeling of emollient buildup with repeated use. Rinses have a consistency similar to water, are less likely to produce a feeling of emollient buildup, and dry more quickly. However, they are more awkward to use because of dripping. Although

foams are least likely to drip from the hands during application, they too may produce a feeling of buildup with repeated use, but this buildup is easily removed by washing with soap and water.

Reports of contamination of alcohol solutions are rare[220].

The antimicrobial efficacy of alcohols is sensitive to dilution with water; therefore, alcohol preparations should be rubbed onto dry hands[11;207] to avoid diluting the concentration of alcohol. The activity of alcohol does not appear to be significantly affected by small amounts of blood; however, further studies are needed to determine activity in the presence of large amounts of organic material[11;174;221]. For these reasons, hands should be washed with soap and water when visibly soiled with organic material.

Alcohols are flammable and should be stored according to local fire regulations. It is important to mount dispensers of ABHR away from electrical outlets and points of ignition. Fire incidents due to ABHRs were recently investigated in Germany[222] and in the United States[223]; and were found to be extremely rare. These incidents were found to be related to HCWs or hospital construction workers who did not wait for the alcohol to evaporate from their hands before proceeding with other activities. This emphasized that individuals using ABHRs need to be educated regarding the importance of allowing the product to dry, particularly prior to entering oxygen-rich environments or being near open flames[224;225]. One report noted that a flash fire occurred when a spark of static electricity ignited alcohol hand gel on the palm of a HCW who had just removed a 100% polyester isolation gown. The gel had not yet been rubbed onto the hands and had not yet evaporated[226]. Another fire incident occurred in a NICU as the result of a HCW touching items in an oxygen-rich environment near an isolette before hands were dry after applying an ABHR[225].

The potential for unintentional ingestion (e.g., by confused or very young individuals) or illicit ingestion (e.g., by individuals with alcohol dependency) of ABHR products should be considered when choosing the type of products, type and location of dispensers and the need for monitoring the dispensers[227-229].

There are reports that some Muslim HCWs are unable to comply with recommendations for the use of ABHRs because they are forbidden to consume alcohol[5;230;231]. The potential for systemic diffusion of alcohol or its metabolites through dermal absorption or airborne inhalation related to the use of ABHRs was investigated by Kramer et al.[231]. They found that ethanol absorption of three different ABHRs is negligible. Moreover, alcohol taken as a medicinal agent (used to prevent illness or aid health) is permitted in Islam[5;230;231].

Suggestions for in-house or local production of alcohol-based formulations in resource-limited settings are outlined in the WHO *Guidelines on Hand Hygiene in Health Care* (2009)[5].

#### *1.1.1.2. Other hand rub products*

Other types of hand rub products may contain either no alcohol or alcohol in concentrations of less than 60%. There are no efficacy data on these products and they should not be used for hand hygiene in healthcare settings.

#### *1.1.1.3. Plain soaps*

Soaps are detergent-based products that contain esterified fatty acids and sodium or potassium hydroxide. Handwashing with soap and water is necessary to remove visible soil or organic material, or when a buildup of an ABHR product feels uncomfortable on the hands following multiple uses. The detergent properties of soaps result in the removal of lipid and adhering dirt, soil and various organic substances from the hands. They have limited, if any, antimicrobial activity[11]. Soaps are available in various forms, including bar, tissue, leaf and liquid preparations. Handwashing with soap and water removes loosely adherent transient flora[11;204]. Refillable soap dispensers are prone to bacterial contamination, and handwashing with contaminated soap is a recognized risk in healthcare settings due to the outbreaks that can result from its use.[123;232-235] Bar soap can also become contaminated while in use[236-238]; however, there have been no reports of bar soap being associated with transmission of microorganisms[237;238].

#### *1.1.1.4. Antimicrobial soaps*

The routine use of antimicrobial soaps for hand hygiene is not necessary. However, antimicrobial soap with residual antimicrobial activity should be used for surgical procedures[239]. ABHR should be used before any procedure requiring aseptic technique[6;16;19;82;108;112;211]. When ABHR is not available, antimicrobial soap is an appropriate replacement[11;13;15-19;80]. For further information, see Table 3.

**Table 2: Antimicrobial activity of agents commonly used for hand hygiene[11;177;240]**

| Agent | Antimicrobial Activity | | | | | | Speed of action | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|---|---|
| | Gram-negative | Gram-positive | Mycobacteria species | Viruses | Fungi* | Bacterial spores | | | |
| Alcohol | +++ | +++ | ++ | ++ Enveloped viruses<br>+ Non-enveloped viruses | +++ | Ø | Fast | Superior efficacy compared with other HH agents.<br>Fast kill of transient microorganisms.<br>Residual activity when combined with CHG. | Activity affected by organic material.<br>No residual activity.<br>Flammable. |
| Chlorhexidine | + | ++ | – | ++ Enveloped viruses<br>Ø Non-enveloped viruses | + | Ø | Intermediate | Residual activity.<br>Activity not affected by organic material.<br>Fast kill if combined with alcohol. | No immediate activity. |
| *****Fungal spores are much more sensitive and are included with fungi in this table | | | | | | | Antimicrobial activity: +++, Excellent; ++, Good;+, Fair; –, Poor; Ø, None<br>Speed of kill: Fast, seconds; Intermediate, 1–2 minutes | | |

#### *1.1.1.5. Chlorhexidine gluconate*

Chlorhexidine gluconate, a cationic bisbiguanide, was developed in the United Kingdom in the 1950s[240]. Its antimicrobial activity appears to be related to the attachment and subsequent disruption of cytoplasmic membranes, resulting in the precipitation of cellular contents[11]. Compared with alcohol, the antimicrobial activity of CHG is intermediate in onset (i.e., activity within one to two minutes rather than seconds)[241]. The antimicrobial activity of CHG is mainly directed toward vegetative Gram-positive and Gram-negative bacteria; it is inactive against bacterial spores except at elevated temperatures, and acid-fast bacilli are inhibited but not killed by aqueous solutions. Yeasts (including *Candida albicans*) and dermatophytes are usually sensitive, although, as with other agents, CHG's fungicidal action in general is subject to species variation[240]. Chlorhexidine has in vitro activity against enveloped viruses, such as cytomegalovirus, herpes simplex virus, human immunodeficiency virus, influenza and respiratory syncytial virus, but significantly less activity against non-enveloped viruses, such as adenovirus, enteroviruses and rotavirus[242-245]. The use of CHG to remove *C. difficile* from hands has been studied with conflicting results[246;247]. One study demonstrated that 4% CHG did not differ from unmedicated soap in removing spores[246]; another reported 4% CHG to be more effective[247].

Chlorhexidine is a cationic molecule. Therefore, its activity can be reduced by products containing anionic emulsifying agents, such as natural soaps, various inorganic anions, non-ionic surfactants and hand creams[240;248]. The presence of organic material, including blood, does not significantly affect the antimicrobial activity of CHG[240].

Excellent residual activity is an important characteristic[13;221;249-253] of CHG. Chlorhexidine binds to the superficial layer of the skin, producing a prolonged antiseptic effect. The addition of CHG to alcohol, which has no residual activity, results in a solution with both immediate and residual activity[11;252;254].

The incidence of skin irritation and hypersensitivity is low and, when used according to the manufacturer's instructions, CHG is a safe product[240]

**Table 3: Antimicrobial activity of agents less commonly used for hand hygiene[11;255;256]**

| Agent | Antimicrobial Activity | | | | | | Speed of action | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|---|---|
| | Gram-negative bacteria | Gram-positive bacteria | Mycobac-terium species | Viruses | Fungi | Spores | | | |
| Chloroxylenol parachloro-metaxylenol (PCMX) | + | +++ | + | +<br>Enveloped and non-enveloped | + | Ø | Slow | Activity not affected by organic material. | Neutralized by non-ionic surfactants. |
| Hexachloro-phene | + | ++ | – | –<br>Enveloped and non-enveloped | – | Ø | Slow | Cumulative and residual activity.<br>Can be used to control outbreaks due to *S. aureus* when other antiseptics fail. | Potential for neurotoxic effects and not to be used for routine bathing of newborns.<br>Only available by prescription. |
| Iodophors | ++ | ++ | + | +<br>Enveloped and non-enveloped | + | Ø | Intermediate | | In vivo activity significantly reduced in the presence of organic material.<br>Persistent activity controversial.<br>Skin irritation may increase as the amount of free iodine increases. |
| Triclosan | ++ | +++ | – | Unknown<br>Enveloped and Non-enveloped | – | Ø | Intermediate | Persistent and cumulative activity.<br>Activity not affected by organic material.<br>Mild to the skin. | Incompatible with lecithin and some non-ionogenic detergents. |

| Agent | Antimicrobial Activity | | | | | | Speed of action | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|---|---|
| | Gram-negative bacteria | Gram-positive bacteria | Mycobac-terium species | Viruses | Fungi | Spores | | | |
| Quaternary ammonium compounds | – | ++ | No activity | +<br>Enveloped<br>Unknown<br>Non-enveloped | – | Ø | Slow | | Reduced activity in presence of organic material.<br>Weak activity against Gram-negative bacteria<br>Incompatible with anionic detergents. |
| **Note:** Because there is no universally accepted standard grading of activity, this table is provided as a general guide only. | | | | | | | Antimicrobial activity: +++, Excellent; ++, Good;+, Fair; –, Poor; Ø, None<br>Speed of kill: Fast, seconds; Intermediate, 1–2 minutes; Slow, more than 2 minutes | | |

## 1.2. INTERACTION BETWEEN HAND HYGIENE PRODUCTS

Hand hygiene products can interfere with the effect or integrity of other products. A reduction in the antimicrobial effect of CHG was reported when used with non-ionic-based hand creams[248]. The integrity of latex gloves may be affected by using petroleum-based lotions or creams[257;258]. Some ABHRs may interact with powder remaining on a HCW's hands after the removal of powdered gloves and may produce gritty particles on the hands[259;260].

## 1.3. SELECTION AND DISPENSING OF HAND HYGIENE PRODUCTS

User acceptability of hand hygiene products (including dispensers) is extremely important; therefore, users should be included when evaluating products. The design and function of a dispenser is also important. It has been reported that a faulty dispenser can deliver a smaller than required volume of product, or none at all[261]. Problems can also occur with dispensers such as clogging or drying of the product (i.e., gels) and dripping. In a study assessing the effect of different quantities of handwashing products, Larson et al.[17] demonstrated that a sufficient quantity of antiseptic soap is necessary to reduce microorganisms on the hands. Consequently, when using ABHRs, sufficient product has to be dispensed to adequately cover all surfaces of the hands, including the fingers and fingernails.

A towel dispenser should be designed to allow for removing towels without having to touch it. Design flaws resulting in contamination when removing towels have been reported[119].

Oie and Kamiya[262] outlined the following three main factors contributing to microbial contamination of antiseptics in use: contamination during production; use of unsterilized distilled water or tap water for dilution; and repeated addition of antiseptics into a single container over a long period of time (i.e., topping up). Several reports of outbreak investigations have implicated inappropriate handling of dispensers, including topping up of partially filled dispensers, as a risk for extrinsic contamination of soap/antiseptic products or lotions[123;233-236;263-265]. One outbreak in a NICU setting may have been related to contaminated lotion[266].

Intrinsic contamination has also been reported[232;267]. Brooks et al.[232] described the intrinsic contamination with *Klebsiella pneumoniae* of multiple lots of hand soap containing 2% CHG.

Appendix IV provides a description of the indications for the advantages and disadvantages of hand hygiene products. Special considerations related to their usage are also covered in this Appendix.

## 1.4. FACILITY DESIGN, PRODUCT DISPENSER PLACEMENT AND DESIGNATED HANDWASHING SINKS

It is important to place ABHR products at the point-of-care in the vicinity of the following three elements: the patient, the HCW and the location where patient contact occurs. Products should be accessible without leaving the zone of care/treatment (e.g., attached to the patient bedside or carried by the HCW)[6;108;217;218;268-270]. ABHR products can also be placed on medication carts, at entrances to patient care units, in hallways, at nurses' stations and in ambulances. Such placement facilitates hand hygiene adherence while saving the HCW time[8;20]. Products and dispensers specific to specialized settings (e.g., paediatric settings, settings with cognitively impaired individuals) are available. To promote the use of ABHR and to avoid confusion between products, dispensers should not be located alongside handwashing sinks.

There is evidence that accessible hand hygiene stations influence the frequency of hand hygiene[8;106;108;218;271-275]. HCWs may be discouraged from performing hand hygiene because of poorly designed patient care rooms and inconveniently located handwash sinks or crowded, cluttered rooms[276]. Automated handwashing machines[277;278] and handwashing monitoring systems[166], on their own, have not demonstrated a practical or sustainable improvement in hand hygiene[277;278].

Sinks and nearby surfaces can be sources of pathogenic bacteria that can be transferred to hands during hand hygiene[88;125;279-282]. Therefore, it is important that HCWs wash their hands in sinks designated for this purpose only. Patient sinks should be used for patient hygiene only (e.g., not for emptying bedpans, intravenous solutions). Patient sinks should be considered contaminated and, whenever possible, should not be used for HCW handwashing.

In the laboratory setting, there should also be designated handwash sinks. The investigation of an outbreak of *Shigella sonnei* in a clinical microbiology laboratory implicated a laboratory student using a handwashing sink rather than a processing/clinical sink to discard concentrated *Shigella*, subsequently contaminating the sink and faucet handles. In that case, 22% of laboratory technologists developed infection with *S. sonnei*[282].

Automatic taps and/or automated sinks have the potential to reduce the risk of contamination of sinks and faucets. However, design or maintenance problems related to automatic taps may contribute to contamination, and they should be evaluated before they are recommended for routine use[283-287]. Valves that can be operated without hands, such as single-lever or elbow-, wrist or knee-blade devices are available for use[288].

Recommendations for design, location and number of designated handwashing sinks are outlined in healthcare facility design publications[268;288-290].

## 2. EFFECTIVE HAND HYGIENE TECHNIQUES

Without instruction, there is a wide variation in hand hygiene technique, with the finger tips and thumbs being the areas most often missed when applying a product[291-293]. Effective technique is important to remove microorganisms from the hands.

### 2.1. ALCOHOL-BASED HAND RUBS

When an ABHR is used, the hands should not be visibly soiled and they should be dry so as not to dilute the alcohol. It is important to follow the manufacturer's product information and to apply an adequate amount of alcohol to ensure all surfaces of the hands are covered with the product to achieve antisepsis[13;17].

In a review of infection prevention and control measures to limit the spread of *C. difficile*, the authors noted ABHR should not be the only hand hygiene measure when caring for suspected or proven *C. difficile*-positive patients[202]. Following contact with a patient with *C. difficile* infection, hands should be washed with soap and water after glove removal if a handwashing sink is immediately available. If a handwashing sink is not immediately available, ABHR at the point-of-care should be used after glove removal. The use of ABHR in this instance should be followed with handwashing as soon as a handwash sink is available.

The Society for Healthcare Epidemiology of America has published a compendium of *Strategies to Prevent Healthcare-Associated Infections in Acute Care Hospitals*, which includes an article titled, *Strategies to Prevent Clostridium difficile Infections in Acute Care Hospitals*. This group and others recommend the preferential use of soap and water over ABHR after caring for patients with *C. difficile* infection in outbreak settings or settings of endemicity[202;294;295]. In a review of the evidence, Hsu et al.[296] also recommended the preferential use of soap and water over ABHR after caring for patients with *C. difficile* infection in outbreak settings or settings with high transmission of *C. difficile.*

Effective hand hygiene technique for the use of ABHR is outlined in Appendix V, Section A.

## 2.2. HANDWASHING

Handwashing should be performed to remove visible soil or organic material, or when a buildup of an ABHR product feels uncomfortable on the hands after multiple uses. The technique and duration of handwashing is important to ensure the removal of microorganisms. Frequent handwashing is known to increase skin dryness and roughness[297]. Handwashing with soap and water may be preferable for the mechanical removal of spores when hands are contaminated or potentially contaminated with *C. difficile* spores[202;240;246]. However, if a handwashing sink is not available at the point-of-care to wash hands after the removal of gloves, hand hygiene with an ABHR at the point-of-care should be performed (see Part C, Section 2.1).

Rotter[11] noted that the efficacy of handwashing depends on the time taken and the technique. Several authors reported the average duration to be between eight and 20 seconds, not including the time needed to go to and return from the handwashing station. One study reported that the proper handwashing technique takes from 40 to 80 seconds, which includes the time to go to and return from the handwashing station[20]. The time required for removal of transient bacteria from artificially contaminated hands has been documented,[11] and the greatest reduction of transient bacteria was noted to be within the first 30 seconds.

Noskin et al.[87] studied the removal of vancomycin-resistant enterococci by handwashing with water alone or with two different soap preparations (plain and antibacterial soap). The authors determined that a 30-second handwash with either soap preparation was necessary to completely remove the bacteria from hands.

A randomized controlled study compared the efficiency of various hand hygiene techniques, including duration of handwashing with antiseptic agents and with unmedicated soap[82]. Bacterial counts were assessed after the following three different durations of handwashing: 30 seconds for handwashing with unmedicated soap, and 60 seconds and 10 seconds for antiseptic handwashing (10 seconds was used because this is the duration usually observed in clinical environments). The longer duration of washing with antiseptic soap led to a greater reduction in bacterial counts[82], perhaps as a result of bacteria from deeper layers of the epidermis being mobilized after prolonged handwashing[11]. Effective handwashing technique is outlined in Appendix V, Section B.

## 2.3. HAND WIPES

Hand wipes impregnated with plain soap, antimicrobials or alcohol may be used to remove visible soil or organic material but should not be used as a substitute for ABHR or antimicrobial soap for hand antisepsis because they are not as effective at reducing bacterial counts on HCWs' hands [5;110;298-300]. When hands are not visibly soiled, hand wipes may be considered as

an alternative to washing hands with soap and water in settings where designated handwashing sinks are not available or when handwashing sinks are unsuitable (e.g., contaminated sinks, sinks used for other purposes, no running water, no soap). Hand wipes may also be used to remove visible soil or organic material on hands in settings where designated handwashing sinks are not available or when handwashing sinks are unsuitable (e.g., contaminated sinks, sinks used for other purposes, no running water, no soap). The use of hand wipes when hands are visibly soiled should be followed by an ABHR, and hands should be washed once a suitable sink is available.

## 2.4. DRYING METHODS

It is important to dry hands thoroughly as wet hands provide better conditions for the transmission of microorganisms. Drying with single-use towels rather than reusing or sharing towels is necessary because of the risk of cross-infection[301]. In addition, care should be taken to avoid recontamination of hands during drying (e.g., by touching faucet handles, doorknobs)[302]. Single-use paper or cloth towels used for drying hands may be used to turn the faucets off after handwashing[303] (see Part C, Section 1.3 for information on towel dispensers).

Ansari et al.[301] compared the efficiency of three methods of hand drying (paper, cloth and electric warm air drying) in eliminating rotavirus and *Escherichia coli* contamination after washing with 70% isopropanol, a medicated liquid soap, an unmedicated liquid soap or tap water alone. The authors reported that, irrespective of the handwashing agent used, all methods of drying washed finger pads resulted in a further reduction of test microorganisms.

The potential for aerosolization of waterborne microorganisms when using air dryers in healthcare settings has been suggested[304]. Blackmore reviewed hand drying methods and determined that electric hand dryers could not be recommended for use in clinical areas because they are relatively slow and noisy, and hygienic efficiency was questionable[305]. Automatic dryers are acceptable in public bathrooms, non-clinical areas/offices and assisted living facilities. If automatic air dryers are installed, hands-free faucets should also be installed to avoid recontaminating clean hands when turning faucets off.

## 2.5. HAND CARE (INCLUDING FINGERNAILS)

Hand and fingernail care is an important component of a hand hygiene program[306]. Damaged skin, including cuticles, is known to shed microorganisms[307;308], and painful cracked hands and cuticles negatively affect adherence to hand hygiene. It is important that hand care policies and procedures be developed by Occupational Health, in collaboration with Infection Prevention and Control, to prevent and manage HCW skin problems that may potentially impede adherence to hand hygiene. These policies should include the assessment of skin conditions, consultation with a dermatologist, as necessary, provision of alternative products when allergies are identified, and prevention of irritant contact dermatitis[306;309].

### 2.5.1. Dermatitis

Irritant contact dermatitis results from frequent use of hand hygiene products, especially soaps and other detergents, and is an important cause of dermatitis among HCWs[306;310-312]. In some surveys, about 25% of nurses have reported symptoms or signs of dermatitis involving their hands, and as many as 85% report a history of skin problems[313]. The symptoms of irritant contact dermatitis can be mild to debilitating, and can include dryness, irritation, itching, and even cracking and bleeding. In acute dermatitis, the horny layer of the epidermis is partly shed, and tissue fluids are excreted freely to the skin surface[314].

Iodophors are the most common hand hygiene agent to cause irritant contact dermatitis[212]. Other antiseptic agents that may cause irritant contact dermatitis, in order of decreasing frequency, are CHG, chloroxylenol, triclosan and alcohol-based products[315;316]. Detergents, solvents, and even plain water to some extent, dissolve the lipids from the epidermal barrier of the skin. Frequent use of plain soaps and other detergents, as opposed to alcohol-based products, has been associated with increased skin damage, dryness and irritation[17;208;209;317]. Other factors that may contribute to dermatitis associated with frequent hand cleansing[17] include using water that is too hot[318;319], applying soap before wetting hands[303], working in low relative humidity environments (most common in winter months in the northern hemisphere), failing to use supplementary hand lotion or cream (Part C, Section 2.5.2,), and using poor quality paper towels. Glove use has also been reported to contribute to irritant contact dermatitis[320].

Skin that is damaged by repeated exposure to detergents may be more susceptible to irritation by all types of hand antisepsis formulations, including ABHR[315]. Damage to skin also changes skin flora, resulting in more frequent colonization by staphylococci and Gram-negative bacilli[206;307], and may be linked to outbreaks of nosocomial infection[321]. Chronic dermatitis may also put the HCW at risk of occupational acquisition of blood-borne pathogens.

Allergic contact dermatitis—an allergy to an ingredient in a hand hygiene product—is rare and results in inflamed skin. The most common causes include fragrances, preservatives and, less commonly, emulsifiers[322-325]. Antiseptic agents, including povidone-iodine preparations[326] and triclosan[327], can also cause allergic reactions.

### 2.5.2. Prevention of dermatitis

Moisturizing improves and maintains skin health[297;307;311;314] and reduces the harbouring and shedding of microorganisms[307]. The addition of glycerol or other emollients to ABHR preparations prevents dryness, and these products are reported to be well tolerated by HCWs[6;108;207-209;211;328]. Frequent application of oil-containing or barrier creams may prevent or treat skin breakdown[309;311;329-331]. In a randomized controlled trial, McCormick et al.[311] determined that scheduled use of oil-containing lotion substantially improved protection of the hands of HCWs who already had skin irritation. More frequent handwashing occurred as the condition of the skin improved. The efficacy of barrier creams to prevent irritant contact dermatitis by forming a protective layer on the skin that is not removed during handwashing has not been determined[311;331;332].

Innovative products to prevent skin damage are available. In one study, the use of gloves dry-coated with aloe vera gel demonstrated positive improvement in skin integrity in a group of factory workers[333]. However, it is important to note that the participants in the study were factory workers, not HCWs. In the healthcare setting, removal of gloves necessitates the practice of routine hand hygiene, which would remove the aloe vera gel.

# 3. BARRIERS TO EFFECTIVE HAND HYGIENE

Barriers resulting in poor adherence to hand hygiene can be organizational or individual. As such, both organizations and HCWs have a responsibility to address these barriers.

## 3.1. ORGANIZATIONAL BARRIERS TO EFFECTIVE HAND HYGIENE

An organizational risk assessment should be performed to identify organizational barriers to adherence to hand hygiene. Examples of organizational barriers include lack of support for a hand hygiene program (e.g., lack of organizational priority, lack of active participation at the organizational level and/or lack of role model) and lack of infrastructure to support hand hygiene (e.g., ABHR not organization's preferred method of hand hygiene - unless exceptions apply as noted in Part D, Section 1.2, ABHR not at point-of-care, insufficient number of handwashing sinks or inconvenient access, insufficient hand hygiene products, and lack of time to handwash due to overcrowding/workload)[32]. Organizations should strive for the following:

- promote and support hand hygiene programs([6;21])
- modify hand hygiene behaviour (e.g., education, training and motivation)([130;334;335])
- improve infrastructure (ABHR at point-of-care, accessibility and maintenance of hand hygiene facilities and access to hand hygiene products)([20;34;269])
- address overcrowding and understaffing([101-103;117;133;336;337])

## 3.2. HEALTHCARE WORKER BARRIERS TO EFFECTIVE HAND HYGIENE

HCWs have reported barriers to their ability to adhere to hand hygiene recommendations. Examples include lack of time, inaccessibility of designated handwashing sinks, inadequate supplies for handwashing (such as ABHR, hand towels, soap), hand hygiene products not accepted by users and concern over the deleterious effect of frequent handwashing or use of ABHR[7;8;29;34;335]. These barriers may be related to a lack of knowledge or misconceptions about the following:

- the ways hands directly contribute to the transmission of microorganisms in the healthcare setting (see Part A, Section 2)
- the way hand hygiene can reduce the risk of HAI (see Part A, Section 4) and reduce HCW respiratory and gastrointestinal infections
- the indications for hand hygiene (see Part D, Section 1)
- the need for hand hygiene even if gloves are worn (see Part D, Section 1.5)
- the practice of ABHR being the preferred method of hand hygiene unless exceptions apply (i.e., when hands are visibly soiled with organic material, if exposure to norovirus and potential spore-forming pathogens such as Clostridium difficile is strongly suspected or proven, including outbreaks involving these organisms) (see Part C, Section 1.1)
- the use of ABHR not being contradictory to religious teachings (see Part C, Section 1.1.1)
- the consistent use of ABHR being less drying on hands than washing with soap and water (see Part C, Section 2.5.2)
- the regular use of hand lotion to prevent dermatitis and maintain healthy hands (including fingernails) and skin (see Part C, Section 2.5.2)
- the presence of long fingernails, nail enhancements, hand and arm jewellery (see Part C, Sections C.3.3 and C.3.4), and upper extremity support devices (e.g., casts, splints

and hand dressings) representing impediments to effective hand hygiene (see Part C, Section 3.5).

## 3.3. NATURAL FINGERNAILS AND NAIL ENHANCEMENTS AS BARRIERS TO EFFECTIVE HAND HYGIENE

The subungual areas (beneath the fingernail) of the hand harbour high concentrations of microorganisms, most frequently coagulase-negative staphylococci, Gram-negative rods (including *Pseudomonas* spp.), *Corynebacteria* and yeasts[338-340]. Substantial numbers of potential pathogens in the subungual spaces remain even after careful handwashing[111;341;342]. Because artificial fingernails may harbour pathogenic microorganisms more frequently than natural nails, they may contribute to transmission of microorganisms to patients[92;128;343-345]. Whether the length of natural or artificial nails is an important risk factor is not clear as most bacterial growth occurs along the proximal 1 mm of the nail, adjacent to the subungual skin[111;341]. In a food safety study done to identify best practices for fingernail sanitation of food handlers, the efficacy of different handwashing methods to remove microbes from natural and artificial fingernails of different lengths was assessed[346]. The authors reported that longer fingernails (artificial and natural) harboured more microbes or viruses than short nails.

Several outbreaks of infection caused by Gram-negative bacilli or yeast[92;128;343-345] implicated HCWs artificial nails and/or long nails. A *Pseudomonas aeruginosa* outbreak in a NICU was attributed to colonization of the implicated strains of Pseudomonas spp. on the hands of a nurse with long natural nails and another nurse with long artificial nails. [345] Colonization of the long natural and artificial nails with *Pseudomonas* spp. was considered to have played a role in causing the outbreak, as case patients were significantly more likely than controls to have been cared for by the two nurses. It is important to keep fingernails healthy, because fingernail disease may reduce the efficacy of hand hygiene and result in transmission of pathogens, as evidenced by a report of a cluster of *P. aeruginosa* surgical site infections resulting from colonization of a cardiac surgeon's fingernails[347].

Kennedy et al.[348] surveyed neonatal HCWs and found that their knowledge about the relationship between Gram-negative bacterial hand contamination and long or artificial fingernails was limited. It was noted that 8% of HCWs wore artificial nails at work. Long, sharp nails (artificial or natural) may puncture gloves or scratch the neonate. Hand hygiene may be compromised as HCWs protect artificial nails, nail art or long natural nails from damage by reducing hand hygiene.

The impact of other forms of nail art and technology on hand hygiene has been reviewed[349]. The authors identified possible limitations of care practices and potential fingernail health issues in individuals who had undergone some form of nail technology. Wynd et al[350] reported that there is statistically significant evidence that chipped fingernail polish worn for more than four days increased the number of bacteria on the fingernails of nurses after surgical hand scrubs. These results suggest freshly applied fingernail polish does not contribute to bacterial carriage on the fingernails. Other investigators have reported no evidence of an increase in bacterial load in the presence of intact nail polish on natural short nails[351].

## 3.4. JEWELLERY AS A BARRIER TO EFFECTIVE HAND HYGIENE

Effective hand hygiene may be prevented by the presence of bracelets and wrist watches. Skin underneath rings has been reported to be more heavily colonized than comparable areas of skin on fingers without rings[352-354]. Trick et al.[110] reported an increased risk of contamination with *Staphylococcus aureus*, Gram-negative bacilli or *Candida* spp. as the number of rings worn

increased. Jacobson et al.[353] reported that mean bacterial colony counts on hands after handwashing among individuals wearing rings were similar to those not wearing rings in a controlled laboratory setting. Whether wearing rings results in greater cross-transmission of pathogens to patients is not known. Concern remains that wearing rings allows pathogens to remain around the fingers, prevents effective hand hygiene and potentially transmits healthcare-associated pathogens. Rings may also carry pathogens[110] and/or puncture gloves[355].

Results of a survey to determine the understanding and beliefs of NICU HCWs regarding nosocomial infections and jewellery provided information that these HCWs were not aware of the relationship between bacterial hand counts and rings, and did not believe that rings increased the risk of nosocomial infections. Of these NICU HCWs, 61% regularly wore at least one ring to work[348].

### 3.5. OTHER BARRIERS TO EFFECTIVE HAND HYGIENE

Upper extremity support devices, such as casts, splints, and complex bandages, on the hands and forearms of HCWs may impede effective hand hygiene. HCWs who wear such devices should be assessed by Occupational Health services in collaboration with Infection Prevention and Control to investigate whether they are able to perform adequate hand hygiene to continue to provide patient care.

# PART D
# RECOMMENDATIONS FOR HAND HYGIENE PRACTICES IN HEALTHCARE SETTINGS

Please note that the rating of these recommendations differ from those used in previous PHAC Infection Prevention and Control Guidelines (see Appendices II and III for further information).

## 1. PERFORMANCE OF INDICATIONS FOR HAND HYGIENE

1.1. Alcohol-based hand rub is the preferred method of hand hygiene in all healthcare settings[6;16;19;82;108;112;211] with the exceptions outlined in Part D, Section 1.2.

1.2. Hand hygiene using soap and water, instead of alcohol-based hand rubs, should be performed as follows:

1.2.1. To remove visible soil and/or organic material[11;174;177;178;192]. **BII**

1.2.2. When a buildup of alcohol-based hand rub product feels uncomfortable on the hands after multiple applications. (Note: alcohol-based hand rub remains effective in this situation). **Manufacturer's recommendation**

1.2.3. At the point-of-care after caring for a patient with norovirus or *C. difficile* infection. If a designated handwashing sink is not available at the point-of-care, alcohol-based hand rub should be used and hands should be washed with soap and water as soon as a suitable handwash sink is available[199;201;202;294;356]. (Note: Patients with norovirus or *C. difficile* infection are on contact precautions[357]. This includes wearing gloves for the care of the patient and/or contact with the patient environment. Hand hygiene with soap and water should be performed following the removal of gloves at the point-of-care). **AII**

1.2.4. During outbreaks or in settings with high transmission of norovirus or *C. difficile* infection[202;294-296;358]. **BII**

1.2.5. With suspected or documented exposure to *B. anthracis*-contaminated items[199]. **BII**

1.2.6. Immediately after using toilet facilities[11;51;76;77;79;80;88;120;122;178;359-361]. **AI**

1.3. Hand hygiene should be performed with alcohol-based hand rub preferably at the point-of-care in all healthcare settings[6;108;218;219]. **AII**

1.4. Alcohol-based hand rubs with an alcohol (i.e., ethanol, isopropanol or *n*-propanol) concentration above 60% and up to 90% should be used for clinical care[11;38;175;177;179;362]. **AII**

1.4.1. Alcohol concentrations above 80% may be necessary for gels[180;181]. **BII**

1.4.2. Alcohol concentrations with a minimum of 70% should be considered during outbreaks or in settings with a high transmission of norovirus[189]. **BII**

1.4.3. Hand rubs that contain either no alcohol or alcohol in concentrations lower than 60% for hand hygiene should not be used. **AII**

1.4.4. Hand hygiene products purchased for use in Canadian healthcare settings should be approved for professional use and have either a Health Canada Natural Product Number or a Drug Identification Number.

1.4.5. Hand hygiene products that are compatible with each other and do not adversely affect glove integrity should be used[248;257;363;364]. **AII**

1.5. Hand hygiene, preferably with an alcohol-based hand rub, should be performed as follows:

1.5.1. Before and after contact with a patient, even if gloves are worn[19;51;79;81;122;247]. **AI**

1.5.2. After contact with the patient environment (e.g., inanimate objects in the patient's vicinity, including medical equipment and environmental surfaces, such as bed tables or door handles) or after contact with items known or considered likely to be contaminated (e.g., bedpans, urinals, wound dressings), even if gloves are worn[76;77;79;80;88;120;122;359;360]. **AI**

1.5.3. Before moving to a clean-body site from a contaminated-body site during care of the same patient[51;122]. **BII**

1.5.4. After known or potential contact with blood, body fluids, respiratory and/or other secretions and excretions, exudates from wounds, mucous membranes or non-intact skin, even if gloves are worn and regardless of whether the source is the patient or healthcare worker[79-82;360;365]. **AI**

1.5.5. Immediately after removing gloves to prevent contaminating other patients, patient-care items or environmental surfaces[79;260;359;360;365;366]. **AI**

1.6. Hand hygiene with alcohol-based hand rub should be performed before any procedure requiring aseptic technique[76;77;79;80;88;120;122;359;360], including invasive procedures (e.g., placing central intravascular catheters, placing catheters or injecting into the spinal canal or subdural spaces)[367;368]. **AII**

1.6.1. Handwashing with antimicrobial soap and water should be performed before procedures requiring aseptic technique when alcohol-based hand rub is not accessible[11;13;15-19;80]. **AII**

1.7. Hand hygiene, preferably with alcohol-based hand rubs, should be performed before feeding patients or preparing food or oral medications[369-371]. **AII**

1.8. Hand wipes impregnated with plain soap, antimicrobials, or alcohol should not be used as an alternative to alcohol-based hand rub or antimicrobial soap for hand antisepsis[110;298-300]. **AII**

1.8.1. Hand wipes may be used as an alternative to soap and water when hands are visibly soiled and a designated handwashing sink is not

immediately available (e.g., prehospital care), or when the handwashing sink is unsuitable (e.g., contaminated sink, no running water, no soap). In this instance, alcohol-based hand rub should be used after the use of hand wipes—and hands should be washed with soap and water once a suitable handwashing sink is available.

1.8.2 Hand wipes may be used as an alternative to soap and water when hands are not visibly soiled and a designated handwashing sink is not immediately available (e.g., prehospital care), or when the handwashing sink is unsuitable (e.g., contaminated sink, no running water, no soap).

1.9. Effective hand hygiene should be performed by ensuring the following appropriate technique for the use of alcohol-based hand rubs (see Appendix V, Section A for details)[13;17;292;372-374]: **All**

i. Long sleeves should be rolled up and wrist watch pushed up.

ii. Product should not be applied to wet hands, as they will dilute the alcohol.

iii. Manufacturer's instructions should be followed.

iv. Enough product should be applied to wet the fingers, finger tips, between fingers, palms, backs of hands and thumbs, base of thumb, and if a ring is worn, on and under the ring.

v. All hand surfaces should be rubbed until product has dried.

vi. Alcohol-based hand rub should be allowed to dry prior to contact with an oxygen-rich environment, prior to putting gloves on, and prior to proceeding with patient care.

1.10. Effective hand hygiene should be performed by ensuring the following appropriate handwashing technique (see Appendix V, Section B for details)[11;13;17;20;87;125;212;246;282;291;292;302;303;305;318;372;373;375-378]: **All**

i. Long sleeves should be rolled up and wrist watch pushed up.

ii. Running water of a comfortable temperature should be used to wet hands.

iii. Enough soap should be used to lather all surfaces of the hands, including fingers, finger tips, between fingers, palms, backs of hands and thumbs, base of thumb, and if a ring is worn, on and under the ring.

iv. The palms and backs of each hand should be rubbed vigorously, interlocking and interfacing fingers to ensure that fingers and thumbs are rubbed to remove visible soil and/or organic material (this task should take 15 to 30 seconds).

v. Hands should be rinsed thoroughly in a downward position under running water.

vi. Hands should be dried thoroughly by patting with a single-use towel; electric hand dryers should not be used in clinical areas.

vii. Manual faucets should be turned off with paper towels, ensuring that hands are not recontaminated in the process.

viii. Skin products, such as hand lotion, should be applied regularly to maintain healthy skin (Part D, Section 4.4).

ix. The complete handwashing procedure (going to a sink, wetting hands, applying soap, lathering, rinsing and drying) should take 40 to 80 seconds.

## 2. ROLE OF HEALTHCARE ORGANIZATIONS

2.1. A hand hygiene program should be developed, maintained and actively supported. Resources should be provided to ensure that adherence to hand hygiene is an organizational priority and an expectation of all healthcare workers[6;21;25;155;161;218]. **AII**

2.2. An organizational risk assessment should be performed annually to identify organizational barriers that impede adherence to hand hygiene and to make modifications to the hand hygiene program that address the identified barriers. Organizational barriers may include, but are not limited to, lack of organizational priority for hand hygiene, lack of active participation at the organizational level and/or lack of role models[21;32;218], lack of infrastructure to support hand hygiene, alcohol-based hand rub not being the preferred method of hand hygiene - unless exceptions apply as noted in Part D, Section 1.2, alcohol-based hand rub not being located at the point-of-care, and inaccessible or insufficient numbers of designated handwashing sinks (Part D, Sections 2.7, 2.7.1, 2.9). **CII**

2.3. Multimodal strategies (e.g., administrative support, role models, education, audit and feedback, patient/family involvement) should be used to improve adherence to hand hygiene recommendations[6;21-26;35;36;135;144;334;379-382]. **BII**

2.4. A hand hygiene education and training program appropriate to all healthcare workers (including physicians and volunteers) and to patients, families and visitors should be developed and maintained. This program should also be evaluated regularly (e.g., annually)[27;155;159;167;197;383-385]. **BII**

2.4.1. The content of the education and training program should include the following: **CII**

i. The importance of indications for hand hygiene (Part D, Sections 1.5 to 1.8)

ii. Effective techniques for hand hygiene (Part D, Sections 1.9 and 1.10)

iii. The importance of strategies to maintain healthy hands (including fingernails) (Part D, Section 4.4)

iv. The appropriate use of gloves (e.g., removal after indication for use, the perception that wearing gloves eliminates need for hand hygiene)

v. Individual healthcare worker's barriers (e.g., alcohol-based hand rub not effective, hand hygiene takes too much time, religious/cultural beliefs about alcohol) and other barriers that impede effective hand hygiene (Part D, Section 2.5).

2.5. Services, such as Occupational Health, should be provided to address individual healthcare worker's barriers that impede effective hand hygiene (e.g., dermatitis, skin sensitivities, upper extremity supportive devices, such as splints, casts or bandages)[32;34;130;307;311]. **CII**

2.6. The effectiveness of the hand hygiene program should be monitored as follows[6;21-31;107;136;143;144;148;149;156;159;160;172;385-387]: **CII**

i. use validated methods to conduct audits and surveillance

ii. monitor according to the frequency appropriate to the healthcare setting and the needs of the organization

iii. apply process and outcome measures according to published recommendations

iv. ensure that individual results are provided to audited individuals and aggregate results are provided to management

v. ensure that recommendations are made to the hand hygiene program to improve effectiveness.

2.7. The selection and placement of hand hygiene infrastructure (e.g., products, product dispensers, designated handwashing sinks and appropriate hardware, such as faucets and hands-free paper-towel waste containers) should be assessed according to the following[6;34;100;108;119;124;125;206;208;218;219;227-229;232;233;261;268;273;282-284;287-290;378;388;389]: **BI**

i. workflow patterns

ii. placement at point-of-care (including, but not limited to, entrances, exits, triage areas, reception desks, waiting areas, entrances to patients' rooms, hallways between patients' rooms, nursing stations, medication preparation areas, ambulances and wherever sinks are unavailable)

iii. healthcare worker input (including product acceptability, such as allergenic potential, type of emollients, scent, residual buildup, effects on skin)

iv. potential of incompatibilities between hand hygiene products

v. risk of contamination (Part D, Section 2.7.1)

vi. patient care needs

vii. healthcare settings

viii. healthcare facility design standards.

2.7.1. Hand hygiene products should be provided in non-refillable, appropriately labelled, tamper-proof containers[123;234;235;263;390;391]. **CI**

2.8. The safe handling and storage of alcohol (flammable) products should be in accordance with provincial or territorial fire regulations[222-225]. **Regulated**

2.9. The following system should be developed to ensure prompt correction[6;108;119;124;218;261;282] when: **BII**

i. hand hygiene equipment is not functioning properly (e.g., plugged dispensers)

ii. handwashing sinks are unclean or are being used for purposes other than handwashing

iii. supplies are low.

## 3. ROLE OF ORGANIZATIONS THAT EDUCATE, TRAIN AND LICENSE HEALTHCARE WORKERS

3.1. Healthcare educational and training bodies should educate and train students about hand hygiene recommendations.

3.2. Licensing bodies and colleges of regulated health professions should support adherence to hand hygiene recommendations as a standard of practice.

## 4. ROLE OF HEALTHCARE WORKERS

4.1. Indications and techniques for effective hand hygiene (Part D, Sections 1.5 to 1.10) should be followed.

4.2. Hand hygiene education and training sessions (Part D, Sections 2.4 and 2.4.1) should be attended.

4.3. Professional, federal, provincial and territorial occupational health and safety recommendations, as well as regulations and legislation regarding hand hygiene, should be followed. **Regulated**

4.4. Skin lotion or barrier cream provided by the organization and compatible with the facility's hand hygiene products should be used regularly to prevent and/or treat hand skin breakdown[130;297;307;311;330-332]. **BII**

4.5. Organizational policies should be followed for the management of healthcare workers:

i. with dermatitis and skin sensitivities

ii. wearing an upper extremity supportive device (e.g., splint, cast) or a bandage that impedes effective hand hygiene

iii. with other individual barriers (e.g., concerns about personal ability to comply with hand hygiene recommendations) (Part D, Sections 2.4, 2.4.1, and 2.5). **BII**

4.5.1. Open cuts or sores on hands/wrists should be covered with waterproof bandages. **CII**

4.6. Artificial fingernails, fingernail enhancements or extenders should not be worn when providing patient care or working with sterile linen/supplies, medical device reprocessing, or in the clinical laboratory. Natural nails should be kept short, and nail polish, if worn, should not be chipped[92;111;128;338;341;343-345;349-351]. **BI**

4.7. Hand jewellery other than a simple ring (i.e., band) should not be worn when providing patient care or working in reprocessing or in the laboratory[110;392;392-396]. **BII**

4.8. Patients and families should be educated about the importance of indications and the correct technique for hand hygiene (Part D, Sections 1.2.1, 1.5,1.9 and 1.10), and should be assisted as necessary[135;382]. **AII**

# PART E
# APPENDICES

## APPENDIX I
## PHAC INFECTION PREVENTION AND CONTROL GUIDELINE DEVELOPMENT PROCESS

**Literature Search – Inclusions/Exclusions**

A thorough literature search was performed by the Public Health Agency of Canada covering the period from 1996 onward. Details of the literature search are available upon request.

**Formulation of Recommendations**

This guideline provides evidence-based recommendations that were graded to differentiate from those based on strong evidence to those based on weak evidence. Grading did not relate to the importance of the recommendation, but to the strength of the supporting evidence and, in particular, to the predictive power of the study designs from which that data were obtained. Assignment of a level of evidence and determination of the associated grade for the recommendation were prepared in collaboration with the chair and members of the Guideline Working Group. When a recommendation was not unanimous, the divergence of opinion, along with the rationale, was formally recorded for the information audit trail. It is important to note that no real divergence of opinion occurred for this guideline; however, when a difference of opinion did occur, discussions took place and a solution was found and accepted.

Where scientific evidence was lacking, the consensus of experts was used to formulate a recommendation. The grading system is outlined in Appendix II and Appendix III.

**External Review by Stakeholders**

Opportunity for feedback on the quality and content of the guideline was offered to external stakeholder groups before its release. The list of stakeholders is as follows:

- Accreditation Canada
- *Association des Infirmières en Prévention des Infections du Québec*
- *Association des Médecins Microbiologistes Infectiologues du Québec*
- Association for Emergency Medical Services
- Association of Medical Microbiology and Infectious Disease Canada
- Canadian Association of Schools of Nursing
- Canadian Federation of Nurses Unions
- Canadian College of Health Service Executives
- Canadian Healthcare Association
- Canadian Home Care Association
- Canadian Medical Association
- Canadian Nurses Association

- Canadian Occupational Health Nurses Association Incorporated
- Canadian Patient Safety Institute
- Canadian Public Health Association
- Community and Hospital Infection Control Association – Canada
- Community Health Nurses Association of Canada
- Emergency Medical Services Chiefs of Canada
- Victorian Order of Nurses

**Editorial Independence**

This guideline was funded by the Public Health Agency of Canada.

All members of the Guideline Working Group have declared no competing interest in relation to the guideline. It was incumbent upon each member to declare any interests or connections with relevant pharmaceutical companies or other organizations if their personal situation changed.

This guideline is part of a series that has been developed over a period of years under the guidance of the 2008 Steering Committee on Infection Prevention and Control Guidelines. The following individuals formed the Steering Committee:

- Dr. Lynn Johnston (Chair), *Professor of Medicine, QEII Health Science Centre, Halifax, Nova Scotia*
- Ms. Sandra Boivin, BScN, *Agente de planification, programmation et recherche, Direction de la Santé publique des Laurentides, St-Jérôme, Québec*
- Ms. Nan Cleator, RN, *National Practice Consultant, VON Canada, Huntsville, Ontario*
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- Dr. Dorothy Moore, *Division of Infectious Diseases, Montreal Children's Hospital, Montréal, Québec*
- Dr. Donna Moralejo, *Associate Professor, Memorial University School of Nursing, St. John's, Newfoundland and Labrador*
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- Ms. Filomena Pietrangelo, BScN, *Occupational Health and Safety Manager, McGill University Health Centre, Montréal, Québec*
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- Dr. Pierre St-Antoine, *Health Science Centre, Centre hospitalier de l'Université de Montréal, Hôpital Notre-Dame, Microbiologie, Montréal, Québec*
- Dr. Geoffrey Taylor, *Professor of Medicine, Division of Infectious Diseases, University of Alberta, Edmonton, Alberta*
- Dr. Mary Vearncombe, *Medical Director, Infection Prevention & Control, Sunnybrook Health Sciences Centre, Toronto, Ontario*

# APPENDIX II
# DEFINITION OF TERMS USED TO EVALUATE EVIDENCE[397]

| | | |
|---|---|---|
| **Strength of study design** Note: "x > y" means x is a stronger design than y | Strong | Meta-analysis > Randomized controlled trial > controlled clinical trial = lab experiment > controlled before–after |
| | Moderate | Cohort > case–control > interrupted time series with adequate data collection points > cohort with non-equivalent comparison group |
| | Weak | Uncontrolled before–after > interrupted time series with inadequate data collection points > descriptive (cross-sectional > ecological) |
| **Quality of the study** | High | No major threats to validity (bias, chance and confounding have been adequately controlled and ruled out as alternate explanation for the results) |
| | Medium | Minor threats to validity that do not seriously interfere with ability to draw a conclusion about the estimate of effect |
| | Low | Major threat(s) to validity that interfere(s) with ability to draw a conclusion about the estimate of effect |
| **Number of studies** | Multiple | Four or more studies |
| | Few | Three or fewer studies |
| **Consistency of results** | Consistent | Studies found similar results |
| | Inconsistent | Some variation in results but overall trend related to the effect is clear |
| | Contradictory | Varying results with no clear overall trend related to the effect |
| **Directness of evidence** | Direct evidence | Comes from studies that specifically researched the association of interest |
| | Extrapolation | Inference drawn from studies that researched a different but related key question or researched the same key question but under artificial conditions (e.g., some lab studies) |

**Note**: Some *outbreak investigations* and reports include a group comparison/study within the report, and thus are analytic studies. Such studies should be assigned a "strength of design" rating and appraised using the Analytic Study Critical Appraisal Tool Kit. The majority of outbreak studies do not involve group comparisons, and thus are descriptive studies. *Case series, case reports and outbreak reports* that do not include a group comparison are not considered studies and therefore are not assigned a "strength of design" rating when appraised. *Modelling studies* are not considered in this ranking scheme, but appraisers need to look at the quality of the data on which the model is based.

# APPENDIX III
# PHAC CRITERIA FOR RATING EVIDENCE ON WHICH RECOMMENDATIONS ARE BASED [397]

| Strength of evidence | Grades | Type of evidence |
|---|---|---|
| Strong | **AI** | Direct evidence from meta-analysis or multiple strong design studies of high quality, with consistency of results |
| | **AII** | Direct evidence from multiple strong design studies of medium quality with consistency of results<br>*or*<br>At least one strong design study with support from multiple moderate design studies of high quality, with consistency of results<br>*or*<br>At least one strong design study of medium quality with support from extrapolation from multiple strong design studies of high quality, with consistency of results |
| Moderate | **BI** | Direct evidence from multiple moderate design studies of high quality, with consistency of results<br>*or*<br>Extrapolation from multiple strong design studies of high quality, with consistency of results |
| | **BII** | Direct evidence from any combination of strong or moderate design studies of high/medium quality, with a clear trend but some inconsistency of results<br>*or*<br>Extrapolation from multiple strong design studies of medium quality or moderate design studies of high/medium quality, with consistency of results<br>*or*<br>One strong design study with support from multiple weak design studies of high/medium quality, with consistency of results |
| Weak | **CI** | Direct evidence from multiple weak design studies of high/medium quality, with consistency of results<br>*or*<br>Extrapolation from any combination of strong/moderate design studies of high/medium quality, with inconsistency of results |
| | **CII** | Studies of low quality, regardless of study design<br>*or*<br>Contradictory results, regardless of study design<br>*or*<br>Case series/case reports<br>*or*<br>Expert opinion |

# APPENDIX IV
# HAND HYGIENE PRODUCTS

| Product | Indications | Advantage | Disadvantage | Special considerations |
|---|---|---|---|---|
| ABHR<br>Most ABHRs contain either ethanol, isopropanol or *n*-propanol, or a combination of two of these products.<br>Alcohol solutions containing more than 60% and up to 90% alcohol are appropriate for clinical care. | Following any direct patient contact or contact with the patient's environment (with or without gloves), when no visible soiling of the hands has occurred. | Superior efficacy to other HH agents.<br>Rapid kill of transient microorganisms.<br>Quick and convenient to use:<br>– does not need designated sink, soap, running water or single-use towels.<br>– do not need to leave the patient's bedside to perform HH.<br>Residual activity if combined with CHG. | When applied to wet hands, alcohol is diluted.<br>Flammable.<br>Less effective in the presence of visible soil, organic debris or when exposure to potential spore-forming pathogens is strongly suspected or proven, including outbreaks of *C. difficile* , norovirus.<br>Gloving hands that have not yet dried following the use of an ABHR may result in glove perforations. | Product should be applied to dry hands.<br>All surfaces of hands and fingernails should be rubbed until dry – before proceeding with other care activities and/or before going near oxygen-rich environments.<br>Dispensers should be mounted away from points of ignition.<br>Dispensers should not be mounted near handwashing sinks.<br>Containers should not be refilled or topped up.<br>Dispensers should be positioned to avoid dripping onto the patient's bed or the floor.<br>WHO guidelines should be followed if considering local production.[5] |
| ABHR foams | | Less likely to drip. | May produce a feeling of "buildup." | |
| ABHR rinses | | Less likely to have a feeling of "buildup". | More apt to drip. | |
| ABHR gels | | | First-generation formulations had less antimicrobial efficacy than solutions and required higher concentrations of alcohol.<br>May produce a "buildup" feeling.<br>May clog dispensers. | |

| Product | Indications | Advantage | Disadvantage | Special considerations |
|---|---|---|---|---|
| Plain soap preparations (bar, tissue, leaflet or liquid) | Removal of organic material.<br>Removal of potential contamination by *C. difficile* spores.<br>Removal of a buildup of ABHR product. | Physical and mechanical removal of visible soil, spores, organic material and transient microorganisms | Requirements include designated sink, time to get to the sink, correct amount of soap, sufficient time to rub all surfaces of hands and rinse under running water and single-use towels.<br>Minimal if any antimicrobial activity.<br>Frequent use may be associated with skin irritation and dryness.<br>Hands can become recontaminated if towel not used to turn faucet off or to open doors. | All surfaces of hands/fingernails should be covered with product.<br>Containers should not be refilled or topped up.<br>Use individual bar soaps for patient use, no sharing between patients or HCWs. |
| Antimicrobial soaps | Surgical antisepsis.<br>Hand antisepsis for prolonged invasive procedures. | Residual action for surgical procedures and prolonged invasive procedures.<br>Achieves hand cleansing, handwashing and hand antisepsis.<br>Physical and mechanical removal of soil and transient microorganisms. | Requirements include designated sink, time to get to the sink, correct amount of soap, sufficient time to rub all surfaces of hands and rinse under running water and single-use towels.<br>Frequent use may be associated with skin irritation and dryness. | All surfaces of hands/fingernails should be covered with product.<br>Containers should not be refilled or topped up.<br>Product should be compatible with lotion and gloves. |

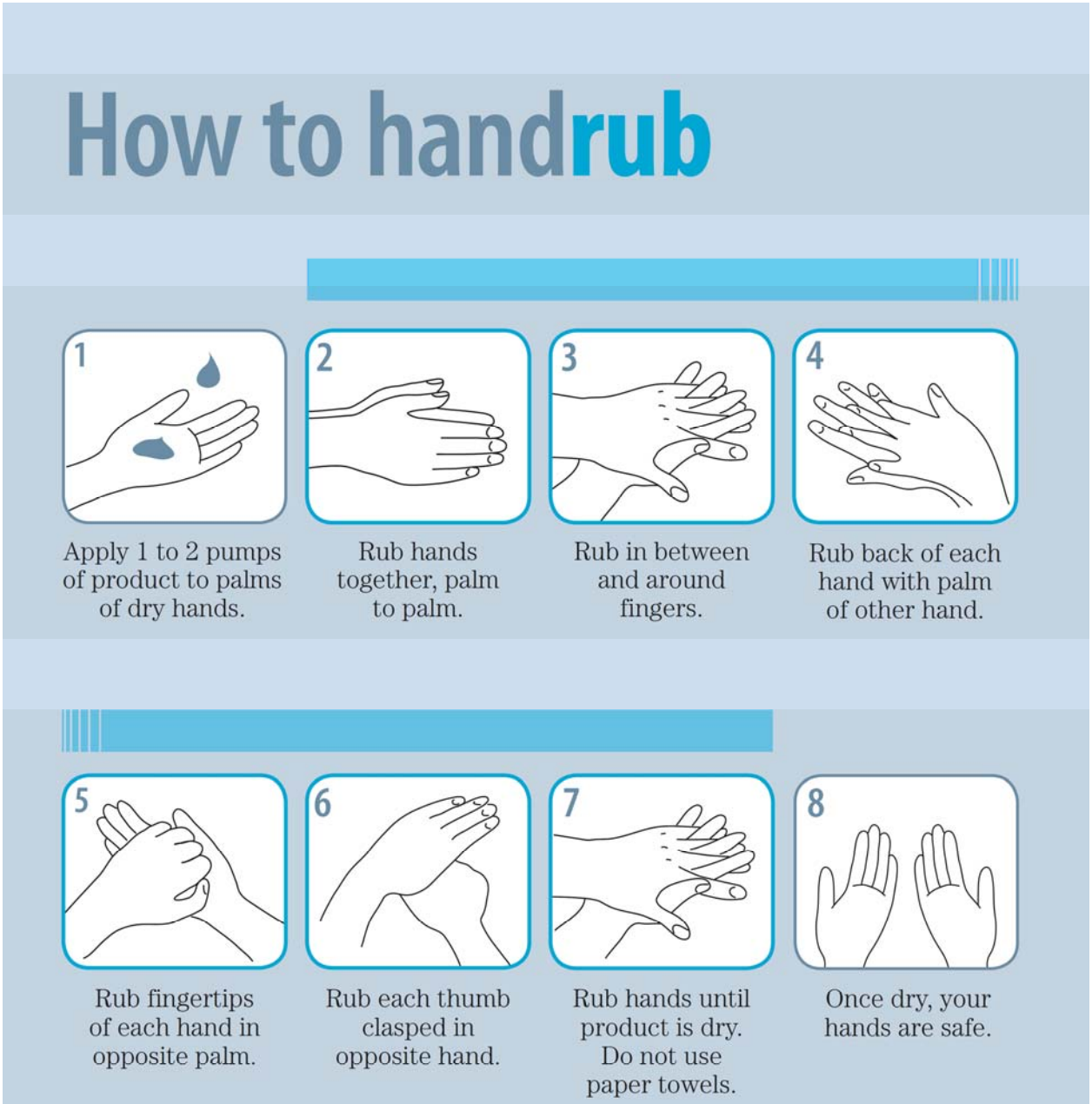
| Product | Indications | Advantage | Disadvantage | Special considerations |
|---|---|---|---|---|
| Hand wipes impregnated with plain soap, antimicrobial soap or alcohol. | An alternative to soap and water to remove visible soiling or organic material when designated handwashing sinks are not available or sinks are unsuitable (e.g. contaminated sink, no running water, no soap)*.<br>An alternative to soap and water when hands are not visibly soiled when designated hand washing sinks are not available or sinks are unsuitable (e.g. contaminated sink, no running water, no soap). | See indications | Insufficient for hand antisepsis. | *ABHR should be used after the use of hand wipes on *visibly soiled hands, and handwashing with soap and water should be performed as soon as possible when a suitable handwashing sink is available.<br>Hand wipes should not be used as an alternative to ABHR |
| Skin lotion, skin cream | Hand care. | Regular use will prevent dermatitis and maintain hand integrity. | | Compatibility with antimicrobial soap and gloves should be ensured.<br>Containers should not be refilled or topped up. |

# APPENDIX V
# EFFECTIVE HAND HYGIENE TECHNIQUES

| **A. Proper Technique for Using Alcohol-Based Hand Rub** |
|---|
| 1. Long sleeves should be rolled up and wrist watch pushed up. |
| 2. Product should not be applied to wet hands, as they will dilute the alcohol. |
| 3. Manufacturer's instructions should be followed. |
| 4. Enough product should be applied to wet the fingers, finger tips, between fingers, palms, backs of hands and thumbs, base of thumb, and if a ring is worn, on and under the ring. |
| 5. All hand surfaces should be rubbed until product has dried. |
| 6. Alcohol-based hand rub should be allowed to dry prior to contact with an oxygen-rich environment, prior to putting gloves on, and prior to proceeding with patient care. |

**Points of Emphasis**

- Alcohol-based hand rubs (ABHR) are the preferred method of hand hygiene in healthcare settings unless exceptions apply (i.e., when hands are visibly soiled with organic material, if exposure to norovirus and potential spore-forming pathogens such as *Clostridium difficile* is strongly suspected or proven, including outbreaks involving these organisms).
- When hands are contaminated or potentially contaminated with *C. difficile* spores, handwashing may be theoretically more effective than ABHR.
- The time necessary for effective hand hygiene using ABHR is significantly less than that required for handwashing.



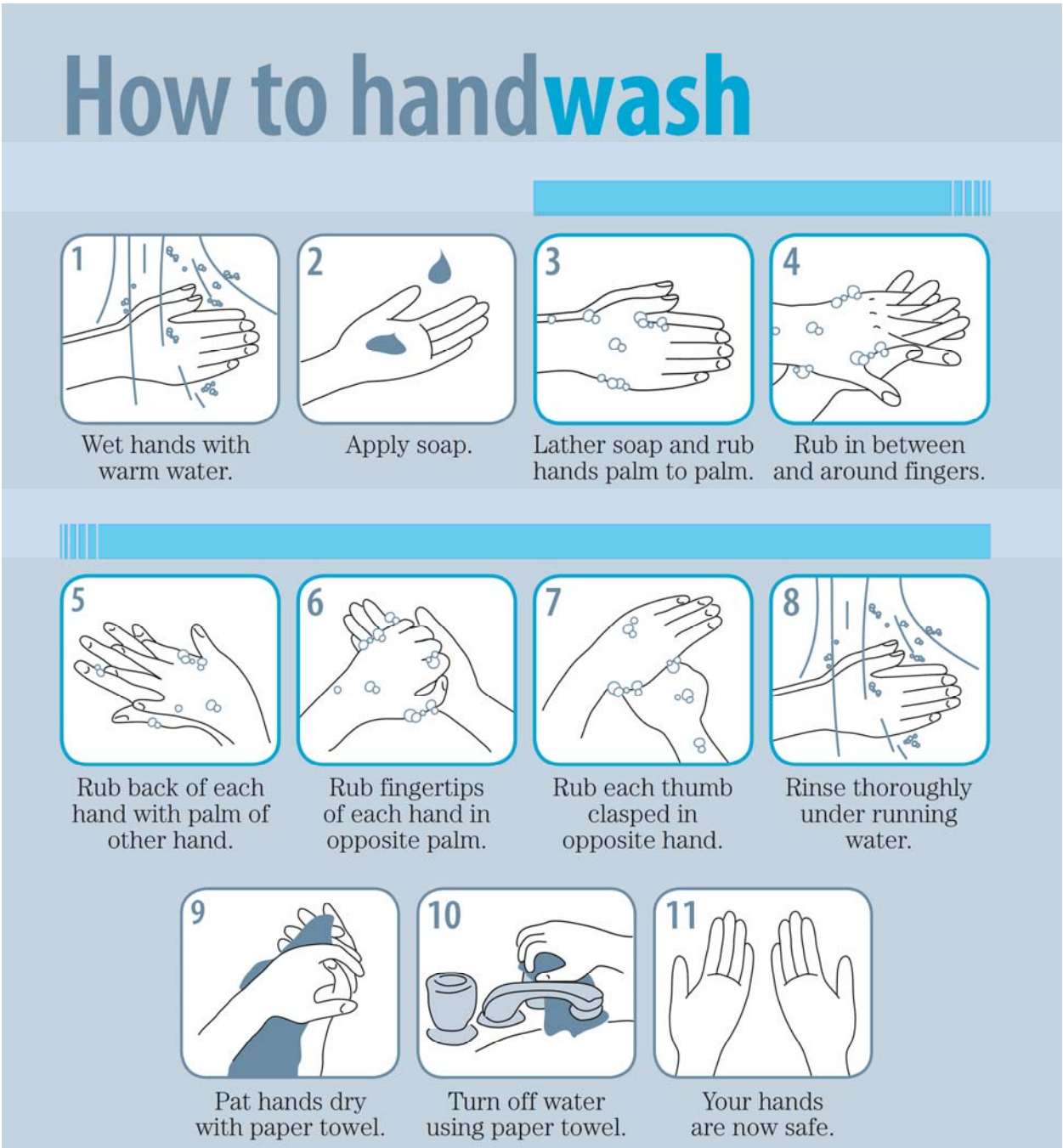

Adapted with permission from the Ministry of Health and Long-Term Care of Ontario – Just Clean Your Hands Campaign poster

**B. Proper Handwashing (soap and water)**

1. Long sleeves should be rolled up and wrist watch pushed up.
2. Running water of a comfortable temperature should be used to wet hands.
3. Enough soap should be used to lather all surfaces of the hands, including fingers, finger tips, between fingers, palms, backs of hands and thumbs, base of thumb, and if a ring is worn, on and under the ring.
4. The palms and backs of each hand should be rubbed vigorously, interlocking and interfacing fingers to ensure finger and thumbs are rubbed to remove visible soil and/or organic material (this task should take 15 to 30 seconds).
5. Hands should be rinsed thoroughly in a downward position under running water.
6. Hands should be dried thoroughly by patting with a single-use towel; electric hand dryers should not be used in clinical areas.
7. Manual faucets should be turned off with paper towels, ensuring that hands are not recontaminated in the process.
8. Skin products should be applied regularly to maintain healthy skin (Part D, Section 4.4).
9. The complete handwashing procedure (going to sink, wetting hands, applying soap, lathering, rinsing and drying) should take 40 to 80 seconds.

**Points of Emphasis**

- Hands should be washed with soap and water to remove visible soil or organic material or when a buildup of product feels uncomfortable on the hands after multiple uses of ABHR.
- Theoretically, handwashing with soap and water may be preferable for the mechanical removal of spores when hands are contaminated or potentially contaminated with *C. difficile* spores[202;240;246].
- Hand hygiene with ABHR at the point-of-care after glove removal should be done if a designated handwashing sink is not available. The use of ABHR in this instance should be followed with handwashing as soon as a suitable handwashing sink is available.
- Hand wipes (impregnated with plain soap, antimicrobials, or alcohol) should not be used as an alternative to ABHRs or antimicrobial soaps for hand antisepsis.
- Hand wipes may be used as an alternative to soap and water when hands are visibly soiled and a designated handwashing sink is not immediately available (e.g., prehospital care), or when the handwashing sink is unsuitable (e.g., contaminated sink, sink used for other purposes, patient sink, no running water, no soap). Use of wipes in this instance should be followed by an ABHR and hands should be washed as soon as a suitable handwashing sink is available.

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# APPENDIX VI
# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ABHR(s) | Alcohol-based hand rub(s) |
| CHG | Chlorhexidine gluconate |
| CFU | Colony-forming units |
| HCW(s) | Healthcare worker(s) |
| HH | Hand hygiene |
| HAI(s) | Healthcare-associated infection(s) |
| ICU | Intensive care unit |
| MRSA | Methicillin-resistant *Staphylococcus aureus* |
| NICU | Neonatal intensive care unit |

# APPENDIX VII
# GLOSSARY OF TERMS

| | |
|---|---|
| **Acute care** | A facility where a variety of inpatient services are provided, which may include surgery and intensive care. For the purpose of this document, acute care includes ambulatory care settings, such as hospital emergency departments, and free-standing or facility-associated ambulatory (day) surgery or other invasive day procedures (e.g., endoscopy units, hemodialysis, ambulatory wound clinics). |
| **Alcohol** | An organic chemical containing one or more hydroxyl groups. Alcohols can be liquids, semisolids or solids at room temperature. |
| **Alcohol-based hand rub (ABHR)** | An alcohol-containing preparation (liquid, gel or foam) designed for application to the hands to remove or kill microorganisms. Such preparations contain one or more types of alcohol (i.e., ethanol, isopropanol or *n*-propanol), and may contain emollients and other active ingredients. ABHRs with an alcohol concentration above 60% and up to 90% are appropriate for clinical care (see Other hand rub products). |
| **Ambulatory care** | A location where health services are provided to patients who are not admitted to inpatient hospital units, including but not limited to, outpatient diagnostic and treatment facilities (e.g., diagnostic imaging, phlebotomy sites, pulmonary function laboratories), community health centres/clinics, physicians' offices, and offices of allied health professionals (e.g., physiotherapy). |
| **Antibacterial** | A product that kills or suppresses the growth of bacteria, but not other microorganisms. |
| **Antimicrobial** | A product that kills or suppresses the growth of microorganisms[398]. |
| **Antiseptic** | A product with antimicrobial activity that is designed for use on skin or other superficial tissues; it removes or kills both transient and resident flora. The term is used for preparations applied to living tissue. |
| **Aseptic technique** | The purposeful prevention of transfer of microorganisms from the patient's body surface to a normally sterile body site or from one person to another by keeping the microbe count to an irreducible minimum. Also referred to as sterile technique[399;400]. |
| **Colonization** | The presence of microorganisms in or on a host with growth and multiplication, but without tissue invasion or cellular injury. |

| | |
|---|---|
| **Complex continuing care** | The individual's chronic and complex condition needs continuing medical management, skilled nursing, and a range of interdisciplinary, diagnostic, therapeutic and technological services. The individual requiring complex care will have failure of a major physiological system, which may lead to functional or acute medical problems. Chronicity describes the condition or conditions that are assessed to be long-standing and recurrent or fluctuating through periods of exacerbation. In some cases, the condition will be progressive in nature. An acute condition may accompany the chronic condition. |
| **Contamination** | The presence of microorganisms on inanimate objects (e.g., objects within the vicinity of the patient, patient bedding, medical devices) or microorganisms transported transiently on body surfaces, such as on hands, on fomites, or in substances (e.g., water, food, milk). |
| **Effectiveness** | The measure of the extent to which a specific intervention, procedure, regimen or service, when deployed in the field in routine circumstances, does what it is intended to do for a specified population[401]. To be distinguished from *efficacy* and *efficiency*. |
| **Efficacy** | The extent to which a specific intervention, procedure, regimen or service produces a beneficial result under ideal conditions. Ideally, the determination of efficacy is based on the results of a randomized controlled trial[401]. |
| **Efficiency** | 1. The effects or end results achieved in relation to the effort expended in terms of money, resources and time. The extent to which the resources used to provide a specific intervention, procedure, regimen or service of known efficacy and effectiveness are minimized. A measure of the economy (or cost in resources) with which a procedure of known efficacy and effectiveness is carried out.<br>2. In statistics, the relative precision with which a particular study design or estimator will estimate a parameter of interest[401]. |
| **Fomites** | Objects in the inanimate environment that may become contaminated with microorganisms and serve as a vehicle of transmission[398;402]. |
| **Hand antisepsis** | A process for the removal or killing of transient microorganisms on the hands[398] using an antiseptic; also referred to as antimicrobial or antiseptic handwash, antiseptic hand-rubbing or hand antisepsis/disinfection/decontamination. |
| **Hand hygiene** | A comprehensive term that refers to handwashing, hand antisepsis and actions taken to maintain healthy hands and fingernails. |
| **Hand sanitizer** | See Alcohol-based hand rub, Other hand rub products. |

| | |
|---|---|
| **Handwashing** | A process for the removal of visible soil/organic material and transient microorganisms from the hands by washing with soap (plain or antiseptic) and water[398]. |
| **Hand wipes** | Towelettes impregnated with plain soap, antimicrobials or alcohol. |
| **Healthcare-associated infection (HAI)** | Infections that are transmitted within a healthcare setting (also referred to as nosocomial) during the provision of health care. |
| **Healthcare facilities** | Include, but are not limited to, acute care hospitals, emergency departments, rehabilitation hospitals, mental health hospitals, and long-term care facilities. |
| **Healthcare organizations** | The organizational entity that is responsible for establishing and maintaining healthcare services provided by healthcare workers and other staff in one or more healthcare settings throughout the healthcare continuum. |
| **Healthcare setting** | Any location where healthcare is provided, including emergency care, prehospital care, hospital, LTC, home care, ambulatory care and facilities and locations in the community where care is provided, (e.g., infirmaries in schools, residential or correctional facilities). (**Note**: Definitions of settings overlap, as some settings provide a variety of care, such as chronic care or ambulatory care provided in acute care and complex care provided in LTC).<br><br>See Acute care, Ambulatory care, Complex continuing care, Home care, Long-term care, Prehospital care. |
| **Home care** | Home care is the delivery of a wide range of health care and support services to patients in a variety of settings for health restoration, health promotion, health maintenance, respite, and palliation. Home care is intended to prevent/delay admission to long-term residential care and is delivered where patients reside (e.g., homes, retirement homes, group homes and hospices). |
| **Long-term care** | A facility that includes a variety of activities, types and levels of skilled nursing care for individuals requiring 24-hour surveillance, assistance, rehabilitation, restorative and/or medical care in a group setting that does not fall under the definition of acute care. These units and facilities are called by a variety of terms from province to province and territory to territory, and include, but are not limited to, extended, transitional, subacute, chronic, continuing, complex, residential, rehabilitation, and convalescence care and nursing homes. |
| **Nosocomial** | See Healthcare-associated infection. |
| **Other hand rub products** | Hand hygiene products that contain either no alcohol or alcohol in concentrations of less than 60% alcohol. These products are not appropriate for use in healthcare settings. |

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|---|---|
| **Patient** | For the purposes of this document, the term patient includes patient, resident and client. |
| **Patient environment** | Inanimate objects and surfaces in the proximate environment of the patient that may be a source of, or may be contaminated by, microorganisms. |
| **Patient zone** | Concept related to the "geographical" area containing the patient and immediate surroundings[5]. |
| **Plain soap** | Detergent-based cleansers in any form (bar, liquid, leaflet or powder) used for the primary purpose of physical removal of soil and contaminating or transient microorganisms. Such soaps work principally by mechanical action and have weak or no antimicrobial activity. Although some soaps contain low concentrations of antimicrobial ingredients, these are used as preservatives and have minimal effect on reducing colonizing flora[398]. |
| **Point-of-care** | The place where the following three elements occur together: the patient, the healthcare worker and care or treatment involving contact with the patient or his/her surroundings (within the patient zone). Point-of-care products should be accessible without leaving the patient zone[5]. |
| **Prehospital care** | Acute emergency patient assessment and care delivered in a variety of settings (e.g., street, home, LTC, mental health) at the beginning of the continuum of care. Prehospital care workers include paramedics, firefighters, police and other emergency first responders. |
| **Resident flora** | Microorganisms in or on a host that grow and multiply, but do not cause any symptoms. |
| **Sterile technique** | See Aseptic technique. |
| **Transient flora** | Recent contaminants of the hands acquired from colonized or infected patients, a contaminated environment or contaminated equipment[398]. |
| **Zone** | See Patient zone. |

# PART F
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