LEARNING OBJECTIVES

Upon completion of this chapter, the reader will be able to:

1. Define hand hygiene.
2. Identify various hand hygiene agents, as well as the benefits and downfalls of each.
3. Describe hand hygiene technique for soap and water and alcohol-based hand rub.
4. Define surgical hand antisepsis.
5. Discuss the factors that influence the choice of hand hygiene agents.
6. List the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) recommendations relating to hand hygiene.
7. Understand the transmission of pathogens on hands, normal skin flora, and consequences of poor hand hygiene in the healthcare setting.
8. Discuss healthcare worker compliance with hand hygiene and WHO/CDC recommendations to improve compliance.
9. Identify circumstances that require hand hygiene in the healthcare setting.
10. Explain the difference between seasonal and pandemic influenza.
11. Understand the public health importance of both seasonal and pandemic influenza.
Introduction

Hand hygiene is widely considered the most effective means of preventing the spread of infectious diseases, including healthcare-associated infections (HAIs). Both the World Health Organization (WHO) and the CDC have issued guidelines for hand hygiene in the healthcare setting. The ranking systems for those recommendations are identical and defined in Table 2.1. This chapter will focus primarily on category IA and IB recommendations.

Defining Hand Hygiene

The practice of hand hygiene in reducing the rates of transmission of disease-causing organisms was demonstrated as early as 1847 when an intervention trial at the General Hospital of Vienna (Austria) showed that the mortality rate of postpartum mothers was substantially lower when hospital staff washed their hands with an antiseptic agent rather than plain soap. Since that time, knowledge about the techniques and agents used to perform hand hygiene has grown substantially. Box 2.1 defines common terminology.

Agents

The Over-the-Counter (OTC) Drug Products Division of the United States Food and Drug Administration (FDA) publishes detailed specifications for required efficacy testing of all healthcare personnel (HCP) hand wash products and surgical hand scrubs. There are benefits and disadvantages for each type of product or formulation, and the appropriate agent should be chosen based on the situation at hand.

Table 2.1 WHO and CDC Recommendation Ranking System

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Recommendation</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category IA</td>
<td>Strongly recommended for implementation</td>
<td>Strongly supported by well-designed experimental, clinical, or epidemiologic studies</td>
</tr>
<tr>
<td>Category IB</td>
<td>Strongly recommended for implementation</td>
<td>Supported by some experimental, clinical, or epidemiologic studies and by a strong theoretical rationale</td>
</tr>
<tr>
<td>Category IC</td>
<td>Required by state or federal regulations</td>
<td>N/A</td>
</tr>
<tr>
<td>Category II</td>
<td>Suggested for implementation</td>
<td>Supported by suggestive clinical or epidemiologic studies or by a theoretical rationale</td>
</tr>
<tr>
<td>No recommendation</td>
<td>Unresolved issue</td>
<td>May include practices for which insufficient evidence or no consensus exists</td>
</tr>
</tbody>
</table>

### Box 2.1 Definitions of Commonly Used Hand Hygiene Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol-based hand rub</td>
<td>An alcohol-containing preparation designed for application to the hands for reducing the number of viable organisms on the hands.</td>
</tr>
<tr>
<td>Antimicrobial soap</td>
<td>Soap containing an antiseptic agent.</td>
</tr>
<tr>
<td>Antiseptic agent</td>
<td>Antimicrobial substances that are applied to the skin to reduce the number of microbial flora.</td>
</tr>
<tr>
<td>Antiseptic hand wash</td>
<td>Washing hands with water and soap or other detergents containing an antiseptic agent.</td>
</tr>
<tr>
<td>Antiseptic hand rub</td>
<td>Applying an antiseptic hand-rub product to all surfaces of the hands to reduce the number of microorganisms present.</td>
</tr>
<tr>
<td>Decontaminate hands</td>
<td>To reduce bacterial counts on hands by performing antiseptic hand rub or antiseptic hand wash.</td>
</tr>
<tr>
<td>Detergent</td>
<td>Compound that possesses a cleaning action. Although products used for hand washing or antiseptic hand wash in healthcare settings represent various types of detergents, the term soap is used to refer to such detergents in this text.</td>
</tr>
<tr>
<td>Hand antisepsis</td>
<td>Refers to either antiseptic hand wash or antiseptic hand rub.</td>
</tr>
<tr>
<td>Hand hygiene</td>
<td>A general term that applies to hand washing, antiseptic hand wash, antiseptic hand rub, or surgical hand antisepsis.</td>
</tr>
<tr>
<td>Hand washing</td>
<td>Washing hands with plain (i.e., nonantimicrobial) soap and water.</td>
</tr>
<tr>
<td>Plain soap</td>
<td>Detergents that do not contain antimicrobial agents or contain low concentrations of antimicrobial agents that are effective solely as preservatives.</td>
</tr>
<tr>
<td>Surgical hand antisepsis</td>
<td>Antiseptic hand wash or antiseptic hand rub used preoperatively by surgical personnel to eliminate transient hand flora and reduce resident hand flora.</td>
</tr>
<tr>
<td>Visibly soiled hands</td>
<td>Hands showing visible dirt or visibly contaminated with proteinaceous material, blood, or other body fluids (e.g., fecal material or urine).</td>
</tr>
<tr>
<td>Waterless antiseptic agent</td>
<td>An antiseptic agent that does not require use of water. After applying the agent, hands are rubbed together until the agent has dried.</td>
</tr>
</tbody>
</table>


**Plain (Nonantimicrobial) Soap**

Plain soaps are detergent based. The properties associated with these detergents result in the removal of dirt, soil, and various organic substances from the hands.\(^\text{1(p8)}\) Despite the fact that plain soaps have little to no antimicrobial activity, hand washing with plain soap can remove transient flora loosely adhered to the skin.\(^\text{1(p8)}\) Disadvantages of plain soap include 1) failure to remove pathogens from the hands of hospital personnel\(^\text{3,4}\); 2) paradoxical increases in bacterial counts on the skin\(^\text{3}\); and 3) the potential for skin irritation and dryness.\(^\text{5,6}\)

**Alcohol**

Alcohols such as isopropanol and ethanol have antimicrobial properties because they denature the proteins that are in pathogens.\(^\text{1(p8)}\) Alcohols are mixed with water to create a mixture of...
65%–95% alcohol to create alcohol-based hand antiseptics. Concentrations of alcohol greater than 95% are not as effective, as the absence of water decreases the ability of the alcohol to denature proteins. In the laboratory setting, alcohols have excellent germicidal properties with gram-negative and gram-positive bacteria, including multidrug resistant organisms, *Mycobacterium tuberculosis* (TB), and various fungi. Most enveloped viruses, such as herpes simplex, human immunodeficiency virus (HIV), influenza, syncytial respiratory virus, and vaccinia, are effectively killed by alcohols. There is some question about the efficacy of alcohol based antiseptic agents with hepatitis B and hepatitis C virus, but there is evidence that concentrations of 60%–70% of alcohol are effective against these viruses.

Multiple studies demonstrate that alcohol-based products (such as hand rub) are more effective for routine hand washing or hand antisepsis by HCP than other agents, including soaps and detergents containing povidone-iodine, 4% chlorhexidine, and triclosan. Alcohol-based antiseptics and hand rub have also been shown to be more effective in killing the number of multidrug-resistant pathogens on the hands of HCP than hand washing with soap and water.

Alcohols are not optimal against all pathogens and have very poor efficacy against bacterial spores (such as *Clostridium difficile*), protozoan oocysts (such as *Giardia lamblia*), and some nonenveloped viruses. Another disadvantage of alcohol-based antiseptics is that they have no appreciable persistent or residual activity. Persistent activity means that after the agent is used, it continues to kill microorganisms for a period of time. The efficacy of alcohol is decreased in the presence of proteinaceous material (e.g., blood). There are multiple factors that influence the effectiveness of alcohol-based products, including the type of alcohol used, concentration of alcohol, length of time the agent is in contact with skin, volume of alcohol used, and whether the hands are wet when the agent is used.

Skin-conditioning agents, such as emollients or humectants, can be added to alcohol-based products to reduce skin drying and cracking associated with frequent use of alcohol-based products. Other undesirable effects include stinging when there are cuts or scrapes in the skin, exacerbation of allergies for individuals sensitive to fragrances, and a rash in persons who are sensitive to alcohols or other additives in the product. Alcohols are flammable and must be stored away from high temperatures or flames. Containers that hold alcohol-based products should be designed to minimize evaporation, because alcohols are volatile.

**Chlorhexidine Gluconate**

Chlorhexidine gluconate has been in use in the United States since the 1970s and is used in a number of hand hygiene agents, including aqueous or detergent formulations, antiseptic detergents, and alcohol-based hand lotions. This antimicrobial takes longer to work than other agents, but is only minimally affected by organic material, such as blood.

Chlorhexidine works well against gram-positive bacteria and fungi, and is only minimally effective against *M. tuberculosis* (the germ that causes TB). Like the alcohols, chlorhexidine does not kill spores. In the laboratory setting, chlorhexidine is effective against enveloped viruses (e.g., herpes simplex, HIV, influenza, and syncytial respiratory virus), but is much less effective against nonenveloped viruses (e.g., rotavirus, adenovirus, and enteroviruses). Chlorhexidine has substantial residual activity; it continues to provide some antimicrobial activity after the initial use.
The main disadvantage of chlorhexidine is that its antimicrobial properties can be reduced by a variety of compounds, including natural soaps and hand creams containing anionic emulsifying agents.\textsuperscript{15,16} Chlorhexidine has a generally good safety record, but it can cause conjunctivitis and severe corneal damage if concentrations of equal to greater than 1% chlorhexidine come in contact with eye tissue.\textsuperscript{1(p14)} It is toxic to the ears and cannot be used in surgeries involving the inner or middle ear.\textsuperscript{1(p14)}

**Chloroxylenol**

Chloroxylenol, also referred to as parachlorometaxylenol or PCMX, has been used in antimi-
crobial soaps in the United States since the 1950s.\textsuperscript{17} In the laboratory setting, PCMX has good activity against gram-negative bacteria, mycobacteria, and certain viruses.\textsuperscript{17}

The available studies regarding PCMX provide contradictory information about its effectiveness.\textsuperscript{1(p14)} It has been shown that PCMX requires a longer period of time to work than chlorhexidine or iodophor and has less residual activity than chlorhexidine.\textsuperscript{17} The efficacy of PCMX is only minimally affected by the presence of blood and other organic matter, but the agent is neutralized in the presence of nonionic surfactants, such as some detergents and emulsifiers.\textsuperscript{17} In 1994, the FDA determined that not enough information was available to classify the agent as safe and effective.\textsuperscript{17,18}

**Hexachlorophene**

This agent was widely used in the 1950s and 1960s in a 3% emulsion for hand washing, surgical
scrubs, and routine bathing of infants in hospital nurseries.\textsuperscript{1(p14)} Hexachlorophene has bacterio-
static properties (it slows the growth of bacteria within the solution) and good antimicrobial activity against \textit{Staphylococcus aureus}.\textsuperscript{1(p14)} This agent is less effective against gram-negative bacteria, fungi, and mycobacteria.\textsuperscript{1(p14)}

Hexachlorophene is unusual in that it is only modestly effective after a single use, but had a cumulative effect which causes it to become more effective with multiple uses.\textsuperscript{19–21} The agent has residual activity for several hours after use and gradually reduces the bacterial counts on hands with multiple uses.\textsuperscript{1(p14)}

The main disadvantage to hexachlorophene is related to toxicity. The agent is absorbed through the skin, particularly with multiple uses. Due to instances of neurotoxicity in infants who had been bathed in hexachlorophene, the FDA issued a warning in 1972 that hexachloro-
phene should no longer be used in routine bathing of infants.\textsuperscript{1(p14)} The agent is currently listed by the FDA as not generally recognized as safe and effective for use as an antiseptic hand wash.\textsuperscript{18}

**Iodine and Iodophors**

Iodine was recognized as an antimicrobial agent as early as the 1800s but causes irritation and discoloration of the skin. Iodophors contain elemental iodine, iodide, or triiodide, and a polymer carrier and tend to cause less skin irritation and fewer allergic reactions than iodine.\textsuperscript{1(p15)} The level of antimicrobial activity of the iodophor is determined by the amount of molecular iodine present. However, the antimicrobial activity of iodophors can also be affected by pH, temperature, exposure time, and the number and type of inorganic compounds present.\textsuperscript{1(p15)}
Both iodine and iodophors are effective against gram-positive, gram-negative, some spore-forming bacteria, mycobacteria, viruses, and fungi. A common antiseptic formulation for hand hygiene includes 7.5%–10% povidone-iodine.1(p15)

**Quaternary Ammonium Compounds**

Quaternary ammonium compounds, or “quat.,” are a large group of compounds that contain a nitrogen atom linked to four alkyl groups. Alkyl benzalkonium chlorides are the quaternary ammonium compounds most commonly used in antiseptics.1(p15) Quat. slow the growth of bacteria and fungi, but can kill certain microbes at high concentrations.1(p15) These compounds are more effective against gram-positive bacteria than gram-negative bacteria, are minimally effective against mycobacteria and fungi, and have some activity against lipophilic viruses (e.g., herpes simplex virus, HIV, and influenza).1(p15)

The efficacy of quat. is decreased by the presence of organic matter, such as blood, and they are not compatible with anionic detergents.1(p15) The FDA has classified several quaternary ammonium compounds (e.g., benzalkonium chloride, benzethonium chloride) as having insufficient data to classify them as safe and effective for use as an antiseptic hand wash.18

**Triclosan**

Triclosan is a nonionic, colorless substance that has been used in concentrations of 0.2%–2% in antimicrobial soaps for healthcare workers. Triclosan is most effective against gram-positive organisms, including methicillin-resistant *S. aureus*.1(p16) It is less effective against gram-negative organisms, particularly *Pseudomonas aeruginosa*, but reasonably effective against mycobacteria and *Candida* species. Triclosan has some persistent antimicrobial activity on the skin after hand washing.1(p16)

Triclosan’s antimicrobial properties can be affected by pH, the presence of surfactants, emollients, or humectants (moisturizing agents), or the ionic properties of the formulation.1(p16) Triclosan is not substantially affected by the presence of organic matter, e.g., blood, and is generally well tolerated.

In 1994, the FDA concluded that there was insufficient data existing to classify the agent as safe and effective for use as an antiseptic hand wash.1(p16) Recently, triclosan has come under scrutiny due to concerns about the possibility of development of resistance among certain pathogens, as well as the potential that they may disrupt hormones in humans or that repeated use may induce an allergic response.22 The FDA has begun an inquest into the safety and efficacy of the antiseptic.22 These efforts and subsequent recommendations have primarily focused on antibacterial products, such as hand soap, marketed to the general public.22,23

**Hand Hygiene Technique**

The CDC and WHO outline the steps to take in order to perform effective hand hygiene.1(p22) When using an alcohol-based hand rub, follow the manufacturer’s recommendations for the volume of product to use.1(p22) Apply the product to the palm of one hand and rub hands together, covering all surfaces of hands and fingers, until hands are dry.1(p22)24(p152) [CDC and WHO IB] (Figure 2.1).

*Throughout this text, these categories will frequently be shown in brackets, such as [CDC and WHO IB].
Figure 2.1  Hand Hygiene Technique With Alcohol-Based Hand Rub

Surgical Hand Antisepsis

Since the 1800s, surgeons and other surgical personnel have performed a preoperative cleansing of their hands and forearms with antiseptic agents. Typically, this procedure involved scrubbing with a small brush and antiseptic agent for a prescribed amount of time.\(^1\)\(^{17}\) Antiseptic formulations of 60%–95% alcohol alone or 50%–95% when combined with limited amounts of quaternary ammonium compound, hexachlorophene, or chlorhexidine gluconate are most effective in immediately lowering the bacterial counts on hands following scrubbing.\(^1\)\(^{17}\) These agents are used in aqueous surgical scrub, or one involving water and an antiseptic agent. More recently, waterless, alcohol-based rubs have been introduced as an alternate method of surgical hand antisepsis.\(^1\)\(^{18,25,26}\)

Historically, preoperative hand scrubs lasted for 10 minutes, but studies have shown that properly performed hand scrubs of 2 to 3 minutes, with an appropriate antiseptic agent, are as effective in reducing the microbial count on the skin of surgical personnel.\(^1\)\(^{18,25}\) Recent studies have also addressed the likelihood that using a sponge-brush, rather than a brush (rubbing versus scrubbing) is an effective means of reducing bacterial counts on hands without causing the skin damage associated with scrubbing with a brush.\(^1\)\(^{18,27}\)

WHO guidelines prohibit the use of artificial nails for HCP in settings that require surgical hand antisepsis [WHO IB]\(^24\)\(^{152}\). In addition, brushes are not recommended for use in surgical hand antisepsis [WHO IB].\(^24\)\(^{152}\)

An antimicrobial soap or an alcohol-based hand rub with persistent activity should be used before donning sterile gloves to perform surgical procedures [CDC and WHO IB]; that the hands and forearms should be scrubbed for the length of time suggested by the manufacturer (typically 2–6 minutes) [CDC and WHO IB]; and that long scrub times (e.g., 10 minutes) are not necessary [CDC and WHO IB].\(^1\)\(^{33},24\)\(^{152}\) Before applying an alcohol-based surgical hand-scrub product with persistent activity, the hands and forearms should be prewashed with nonantimicrobial soap and then dried [CDC IB].\(^1\)\(^{33}\) Use a sufficient amount of alcohol-based hand rub to keep hands and forearms wet with the product throughout the surgical hand preparation procedure [WHO IB].\(^24\)\(^{152}\) After the alcohol-based product is applied, hands and forearms should be dried thoroughly prior to donning sterile gloves [CDC& WHO IB].\(^1\)\(^{15}\)

Choosing a Hand Hygiene Agent

It’s important to choose a hand hygiene agent that HCP will like and use, as well as one that is effective and has negligible side effects. The selected product should have a low potential for causing irritation, even when used multiple times per shift [CDC and WHO IB].\(^1\)\(^{33},24\)\(^{153}\)
Facilities should obtain input from HCP regarding the feel, fragrance, and skin tolerance of any products considered for use in the facility [CDC and WHO IB]. The selected agent should also have a low potential for causing irritation, even when used multiple times per shift [CDC and WHO IB]. The cost of the product should not be the primary deciding factor [CDC IB and WHO II].

Soap should not be added to a partially filled soap dispenser, as the soap can become contaminated with bacteria [CDC and WHO IA]. For this reason, hand hygiene products that come in prefilled bags (as opposed to large containers to be poured into the dispenser) are optimal. When choosing a hand hygiene product, facilities should solicit information from the manufacturer about the risk of contamination of the soap or hand hygiene product [WHO IB].

HCP should have access to hand lotions or creams to offset the possibility of skin irritation and dryness caused by hand hygiene [CDC and WHO IA] and HCP educational programs should include information regarding hand hygiene practices designed to reduce the risk of irritant contact dermatitis and other skin damage. Facilities should collect information from the manufacturer of the hand hygiene agents to ensure that any hand lotions, creams, or alcohol-based antiseptics do not have deleterious effects when used in conjunction with the hand hygiene agent [CDC and WHO IB].

Transmission of Pathogens on Hands

In the absence of adequate hand hygiene, organisms acquired by the HCP can be transmitted from one patient to another. This type of transmission requires a series of events which are depicted in Figure 2.2.

There are several recommendations from the CDC that do not directly involve hand hygiene, but are intended to reduce the likelihood of transmission of pathogens via the hands of HCP. Artificial fingernails, such as acrylics, can become contaminated with bacteria. Therefore, the CDC recommends that HCP who have direct contact with at-risk patients do not wear artificial fingernails or extenders [IB] and WHO recommends that HCP who have direct contact with any patients do not have artificial fingernails or extenders [IA]. Use of gloves does not reduce the need for hand hygiene [WHO IB] HCP should remove gloves after caring for the patient, dispose of gloves after use, not use the same pair of gloves with more than one patient, and not wash gloves for reuse [CDC and WHO IB].

Normal Bacterial Skin Flora

Two types of bacteria are commonly found on skin: transient and resident. Transient flora colonize the superficial layers of the skin, are likely to be removed by routine hand washing, but are most often associated with HAIs. The hands of HCP can pick up transient flora during patient care or by contact with contaminated environmental surfaces, such as patient bedside tables. In contrast, resident flora are more difficult to remove with routine hand washing because they are attached to the deeper layers of skin. Fortunately, resident flora are less likely to be associated with HAIs.
Several factors impact the likelihood that transient flora are transmitted: the species present, the number of microorganisms on the skin or surface, and the level of skin moisture.\textsuperscript{24(p10)}

**Organisms Present**

Clearly, pathogens involved in HAIs can be found in infected or draining wounds, but there are other areas of patient skin that have been identified as at high risk for colonization with healthcare-associated pathogens.\textsuperscript{24(p12)} The perineal area (the area between the genitals and anus) and the inguinal areas (the fold between the genital areas and legs) are typically the most heavily

---

**Figure 2.2  Transmission of Pathogens on Hands in the Healthcare Setting**


Several factors impact the likelihood that transient flora are transmitted: the species present, the number of microorganisms on the skin or surface, and the level of skin moisture.\textsuperscript{24(p10)}

**Organisms Present**

Clearly, pathogens involved in HAIs can be found in infected or draining wounds, but there are other areas of patient skin that have been identified as at high risk for colonization with healthcare-associated pathogens.\textsuperscript{24(p12)} The perineal area (the area between the genitals and anus) and the inguinal areas (the fold between the genital areas and legs) are typically the most heavily
colonized.\textsuperscript{24(p12)} The axillae (armpits), trunk (torso), and upper extremities are also frequently colonized with these organisms.\textsuperscript{24(p12)}

\textbf{Consequences of Poor Hand Hygiene in the Healthcare Setting}

As discussed elsewhere in this text, HAIs are a well-established concern in the healthcare setting. Hand hygiene is widely recognized as the most effective means of prevention of the spread of infectious diseases, including HAIs.

In the 19th century, Ignaz Semmelweis first theorized that diseases were transmitted via the hands of healthcare workers. Dr. Semmelweis noted that the maternal mortality rates at the General Hospital in Vienna were significantly higher in one labor and delivery ward than the other.\textsuperscript{24(p9)} Medical students were assigned to the first ward, while midwives were assigned to the second. Semmelweis observed that doctors and medical students performed autopsies and then went directly to the ward where they treated the patients. In fact, these healthcare providers were noted to have a foul odor on their hands, despite washing with soap and water.\textsuperscript{24(p9)} After implementation of Semmelweis’s recommendation to wash hands with chlorinated lime solution before every patient contact and after each autopsy, the maternal mortality rate decreased from 16\% to 3\%.\textsuperscript{24(p9)}

Since Semmelweis’ initial hand hygiene intervention, multiple studies have shown the link between hand hygiene and decreased rates of transmission of HAIs.\textsuperscript{24(p9)} In 1995–1996, the CDC/Healthcare Infection Control Practices Advisory Committee (HICPAC) issued hand hygiene recommendations in the United States.\textsuperscript{24(p9)} These recommendations were updated in 2002 to include alcohol-based hand rubs as the standard of care for hand hygiene in healthcare settings.\textsuperscript{24(p9)} The WHO guidelines issued in 2009 were partly based on the HICPAC’s 2002 recommendations.\textsuperscript{24(p9)}

\textbf{Healthcare Worker Compliance With Hand Hygiene}

Despite the proven link between poor hand hygiene and increased HAI rates, HCP compliance with hand hygiene recommendations is less than optimal. Observation studies of HCP compliance report rates from 5\% to 81\%, with an average of 40\%.\textsuperscript{1(p22),28–30} There is an abundance of studies regarding the factors that HCP are noncompliant with hand hygiene guidelines, yet there are few factors that are consistently demonstrated among studies.\textsuperscript{31–34} Selected examples of factors negatively influencing compliance with hand hygiene recommendations and policies are shown in \textbf{Box 2.2}.

Monitoring the compliance of HCP with hand hygiene practices and policies and providing feedback to personnel regarding those observations is one step in improving rates of hand hygiene [CDC and WHO IA].\textsuperscript{1(p33),24(p154)} Facilities must make hand hygiene compliance an institutional priority with the appropriate administrative support and funding to conduct programs to monitor and improve compliance [CDC and WHO IB].\textsuperscript{1(p33),24(p154)} Hand hygiene education and promotion programs should focus on factors currently found to influence HCP behavior and not just on the type of hand hygiene products [WHO IA].\textsuperscript{24(p154)} This type of hand hygiene program should be multifaceted and multimodal and include support from senior executives of the facility [WHO IA].\textsuperscript{24(p154)}
Box 2.2  Selected Factors Influencing Noncompliance With Hand Hygiene Recommendations

**Observed Factors**
- Physician status (rather than nurse or technical staff)
- Support staff (rather than nurse or technical staff)
- Male gender
- Working during the week (rather than the weekend)
- Working at night (rather than the daytime)
- Presence of an automatic sink
- High number of opportunities or tasks requiring hand hygiene per hour of patient care
- When entering patient room versus leaving patient room
- Completing a clean versus dirty task

**Self-Reported Factors**
- Hand-washing agents that cause irritation and dryness
- Inconveniently located sinks or shortage of sinks
- Lack of soap and paper towels
- Lack of time
- Conditions that are understaffed or wards that are overcrowded
- Patients classified as high-priority or urgent
- Patients with a low-risk of acquiring infections from other patients or HCP
- Belief that gloves negate the need for hand hygiene
- Lack of knowledge/awareness of guidelines and protocols
- Forgetfulness
- Lack of a role model from peers or supervisors
- Skepticism regarding the value of hand hygiene
- Disagreement with established recommendations/policies

**Perceived Barriers**
- Lack of active participation in hand hygiene promotion at the individual or institutional level
- Lack of role models for hand hygiene
- Lack of positive feedback for compliance or negative feedback for noncompliance
- Lack of institutional safety climate

**Compiled from:**

Multidisciplinary programs to improve hand hygiene compliance should be implemented [CDC IB] and include provision of an easily accessible alcohol-based hand-rub product [CDC IA]. In areas with high workload or high intensity of patient care, the alcohol-based hand-rub product should be available at the entrance to the patient's room, at the bedside, in other convenient locations, and in individual pocket-sized containers to be carried by HCP [CDC IA]. Steps should be taken to ensure that dispensers of hand hygiene products are available at the point of care (e.g., at sinks in the patient room) [WHO IB] and that there is easy access to alcohol-based hand rub at the point of care [WHO IA].

**Circumstances That Require Hand Hygiene**

Thorough hand hygiene should be practiced before and after every patient contact or suspected contact with blood, body fluids, or other potentially infectious materials. However, there are some types of contact that are likely to result in higher levels of bacterial contamination of the hands of HCP. For example, in the neonatal nursery setting, contact with respiratory secretions, diaper changes, and direct skin contact with patients have all been documented to result in high levels of hand contamination. However, some procedures one might consider clean, such as taking a blood pressure or lifting a patient not visibly soiled can result in hand contamination. Both the CDC and WHO provide detailed recommendations regarding the circumstances in which hand washing or hand antisepsis is warranted. The category IA and IB recommendations are summarized in Box 2.3.

WHO developed a hand hygiene education and promotion campaign that has been implemented in healthcare settings globally. “Five Moments for Hand Hygiene” specifies that hand hygiene should occur before touching a patient; before a clean or antiseptic procedure; after experiencing or encountering a risk for body fluid exposure; after touching a patient; and after touching the patient's surroundings (Figure 2.3).

**Box 2.3 Indications for Hand Hashing and Hand Antisepsis—CDC and WHO Category IA and IB Recommendations**

Before eating and after using the bathroom, wash hands with soap and water (either antimicrobial or plain soap) [CDC and WHO IB].

When hands are visibly dirty or contaminated with proteinaceous material or are visibly soiled with blood or other body fluids, wash hands with soap and water (either antimicrobial or plain soap) [CDC IA].

If hands are not visibly soiled, use an alcohol-based hand rub for routinely decontaminating hands in all clinical situations according to the recommendations that follow. Alternatively, wash hands with an antimicrobial soap and water in all clinical situations described shortly [CDC IB]. Perform hand hygiene for the situations described next:

- Decontaminate hands before having direct contact with patients [CDC and WHO IB].
- Decontaminate hands before donning sterile gloves when inserting a central intravenous catheter [CDC IB].
- Decontaminate hands before inserting indwelling urinary catheters, peripheral vascular catheters, or other invasive devices that do not require a surgical procedure [CDC IB].

(Continues)
Box 2.3  Indications for Hand Hashing and Hand Antisepsis—CDC and WHO Category IA and IB Recommendations (Continued)

Decontaminate hands after contact with a patient’s intact skin (e.g., taking a pulse or blood pressure, lifting a patient) [CDC and WHO IB].
Decontaminate hands after contact with body fluids or excretions, mucous membranes, nonintact skin, and wound dressings if hands are not visibly soiled [CDC and WHO IA].
Decontaminate hands after removing gloves [CDC and WHO IB].
Before handling an invasive device for patient care, regardless of whether or not gloves are used [WHO IB].
If moving from a contaminated body site to another body site during care of the same patient [WHO IB].
After contact with inanimate surfaces and objects (including medical equipment) in the immediate vicinity of the patient [WHO IB].
Before handling medication or preparing food [WHO IB].

Adapted from:

Figure 2.3  WHO’s Five Moments for Hand Hygiene

Main Messages

Hand hygiene, either as hand washing with soap and water or use of alcohol-based hand rub, is widely considered the most effective infection prevention strategy. Both the CDC and WHO have formulated guidelines regarding hand hygiene in the healthcare settings.1,24 There are a variety of hand hygiene agents available, each with its own advantages and disadvantages.

In order to be effective, hand hygiene must be performed effectively. The techniques for both hand washing with soap and water and use of alcohol-based hand rub are detailed by the CDC and WHO.1,24 Recent recommendations regarding surgical hand antisepsis or preoperative cleaning of the hands and forearms indicate that prolonged scrub times and brushes are not necessary.1(p18),24(p152),27

When choosing a hand hygiene agent, facilities need to select one that HCP will use, that is effective, and that has few side effects. Both the CDC and WHO recommend that the agent have low potential to cause irritation, even when used multiple times per shift.1(p33),24(p153) Facilities should include HCP in the selection process in order to find an agent with a feel, fragrance, and effect on skin that is amenable to HCP.1(p33),24(p153) Agents that are provided in prefilled bags for dispensers are preferred, and lotions should be available for HCP to offset any risk of skin irritation or dryness.

In the absence of effective hand hygiene, pathogens can be transmitted on the hands of HCP. Bacteria found on the skin can be either transient or resident. Transient flora are most often implicated in HAIs, but are also likely to be removed by routine hand washing. Resident flora are more difficult to remove with hand hygiene because they become attached to the deeper layers of the skin, but are less likely to cause HAIs.

Because of the less-than-optimal compliance rates of HCP with hand hygiene recommendations, both the CDC and WHO have included recommendations that are intended to increase compliance rates.

Hand hygiene should be completed before and after every patient contact or suspected contact with blood, body fluids, or other potentially infectious materials. "The Five Moments for Hand Hygiene" stresses that hand hygiene should occur before touching a patient; before a clean or antiseptic procedure; after experiencing or encountering a risk for body fluid exposure; after touching a patient; and after touching the patient's surroundings.

Practical Application: Seasonal Versus Pandemic Influenza

Seasonal Influenza

The flu is of public health importance and concern to infection control preventionists due to the large number of the population affected and the potential for an influenza pandemic. A variety of illness and symptoms, such as gastrointestinal ailments, that are not caused by influenza are often termed the flu. A true influenza infection typically affects the upper respiratory tract (but may affect the lower respiratory tract in severe cases), leading to headache, chills, dry cough, body aches, fever, stuffy nose, and sore throat.37(p662) Influenza may also cause extreme fatigue, lead to secondary bacterial infections and pneumonia, and, occasionally, death.37(p662)
Some characteristics of the virus cause unique challenges for prevention and control. Influenza infections are caused by one of three influenza viruses: A, B, or C. The virion, or virus particle, is encased in a protein envelope that has two types of spikes on it: hemagglutinin (H) and neuraminidase (N). The influenza virus undergoes frequent genetic changes that lead to changes in the H and N proteins on the surface of virion. Depending on the degree of changes, existing antibodies in the host (or the exposed human) may provide protection against the virus. If there is a large change, then individuals or the population does not have existing immunity or partial immunity and the infection presents with more severe symptoms. Antigenic drift and shift are defined in Box 2.4.

The H and N proteins are named/numbered and used to track influenza A strains of the virus. Influenza B viruses are not named/numbered in this manner due to small degree of change that occurs to the H and N spikes. Influenza C viruses are not usually of concern to public health officials, as they are believed to only result in mild illness. For example, the influenza A viruses of concern in the 2014-2015 season were strains of H1N1 and H3N2.

There are seasonal fluctuations in the frequency of influenza-related illnesses, which typically peak in January or February. However, the timing and severity of the influenza season can be unpredictable and vary from year to year. Each season, the CDC tracks and categorizes the circulating strains of influenza virus. This information is used to recommend the composition of the next year’s flu shot. The flu shot is considered the most effective way to prevent illness due to the influenza virus, but, due to the changing strains of the virus, an individual must get a new shot every year. There are several types of vaccines available for a variety of manufacturers, including intramuscular (an injection into the muscle), intranasal (a spray into the muscle), and intradermal (a small injection under the skin). Not all types of flu vaccine are appropriate for specific groups of patients. Each year, the CDC issues recommendations regarding the influenza vaccine. Currently, it is recommended that everyone over the age of 6 months receive the vaccine.

The flu vaccine is particularly important for groups that are more likely to experience severe symptoms if they become infected, including individuals with asthma, diabetes, heart disease, or a history of stroke; adults aged 65 years and older; pregnant women; those with human immunodeficiency virus (HIV) or acquired immune deficiency syndrome (AIDS); individuals with cancer, and children younger than 5 years of age (especially children less than 2 years old). Treatment for...
influenza, particularly for these high risk groups, may include the use of antiviral medications, along with general supportive care.\textsuperscript{38}

\textbf{Pandemic Influenza}

An influenza pandemic differs from seasonal influenza in several ways. These include:

- A pandemic has a global reach and affects the health and well-being of individuals within a large geographic area.
- A pandemic is caused by a nonhuman (novel) strain of influenza virus that has adapted in such a way that it has the ability to spread from human to human in an efficient and sustained manner.\textsuperscript{39}
- Because these novel strains are significantly different from strains that have been circulating among the population, there is little to no immunity among the population.\textsuperscript{39}
- Influenza pandemics are rare, but they do reoccur. Pandemics occurred in 1918 (Spanish influenza), 1957 (Asian influenza), and 1968 (Hong Kong Influenza).

In 2009, the H1N1 influenza virus was identified as the strain causing a number of new cases.\textsuperscript{40} On April 15, 2009, the H1N1 virus was detected for the first time in the United States in a 10-year-old patient in California.\textsuperscript{40} Testing at the CDC confirmed that the virus was new to humans. A second infection with this strain was identified 2 days later in another child in California.\textsuperscript{40} The first and second patients lived 130 miles away from each other and had not had any contact with each other.\textsuperscript{40} Both children had been tested during participation in an influenza surveillance project.\textsuperscript{40}

The CDC was immediately involved in the investigation into and response to the presentation of this new strain. Initially, there were similarities between some strains of swine influenza and this novel human strain. However, it was determined that none of the patients had contact with pigs, and, therefore, the virus was circulating among the human population.\textsuperscript{40} As part of their response efforts, the CDC reported the two cases to WHO and the Pan-American Health Organization (PAHO). The CDC also published information about the cases and required local health departments who were unable to identify strains of influenza A virus in samples to submit them to the CDC.\textsuperscript{40}

Within a matter of days, scientists at the CDC were working on development for this novel strain (to be called 2009 H1N1) and released the vaccine to manufacturers so that they could begin production in preparation for the need for a larger number of cases with the 2009 H1N1 strain.\textsuperscript{40} On April 22, 2009, the CDC activated its Emergency Operations Center (EOC) so that response efforts could be coordinated on a national scale.\textsuperscript{40} A variety of teams focused on surveillance, laboratory issues, communications, at-risk populations, antiviral medications, vaccine, and traveler’s health issues.\textsuperscript{40}

Twelve days after identification of the initial case in California, two additional cases were identified from Texas.\textsuperscript{40} Around the same time, the CDC identified seven cases of 2009 H1N1 among twelve samples submitted by public health officials in Mexico.\textsuperscript{40} With this new information, the CDC determined that the virus was spread by human-to-human contact and that it was affecting more than one country.\textsuperscript{40} A press conference was held immediately to disseminate the available information to the public, including public health officials and infection preventionists.

Public health response to the emerging pandemic evolved at a rapid pace, including a WHO declaration of the 2009 H1N1 outbreak as a public health emergency of international concern (April 25, 2009); investigation into a cluster of influenza-like illnesses in a high school in New York City (April 25, 2009); and CDC testing and confirmation of two cases in Kansas and one case in Ohio.\textsuperscript{40} By April 26, 2009, the United States government decided there was a public health emergency at the national level and officials released 25% of the CDC Strategic National Stockpile of medications and supplies that could be used to protect against and treat influenza, including 11 million courses of antiviral medications and 39 million masks and respirators.\textsuperscript{40}

The early days of the pandemic were intense and involved a rapid succession of upgrades in the level of response, including a decision from the WHO director-general to move the alert phase from 3 to 4 once human-to-human transmission and the ability of the virus to cause outbreaks in the
community was shown by epidemiological data (Figure 2.4). The CDC continued to issue messages through media outlets and their website to assist with containment of the spread of the virus, including a recommendation that all nonessential travel to Mexico be postponed and public education regarding the importance of hand hygiene, cough etiquette, and the need to stay home when ill. Cough etiquette is an essential prevention technique for pathogens that are spread through respiratory secretions. Box 2.5 describes the components of cough etiquette.

In the United States, pandemic response plans were implemented at the federal, state, and local levels. The CDC periodically released updates and guidance for how to diagnose and treat cases, guidelines for reporting, and vaccine development and disbursement. On June 11, 2009, approximately 3 months after the initial cases in the United States were identified, WHO announced that a global pandemic was in progress (phase 6). More than 70 countries had reported cases, and there were numerous community level outbreaks occurring. Within 8 days, all 50 states in the United

**Box 2.5 Cough Etiquette**

Cough etiquette is emphasized by the CDC and other public health officials to stop the spread of viruses that are transmitted by the respiratory route or through airborne droplets. Cough etiquette includes:

- Covering your mouth and nose with a tissue when you cough or sneeze;
- Discarding your used tissue in the wastebasket;
- Coughing or sneezing into your upper sleeve or elbow when a tissue is not available;
- Putting on a face mask to protect others when you are experiencing symptoms (usually in a healthcare setting);
- Washing your hands often with soap and warm water for 20 seconds after coughing or sneezing and
- Using an alcohol-based hand rub when soap and water are not available.


---

**Figure 2.4 World Health Organization (WHO) Pandemic Influenza Alert Phases**

States, the District of Columbia, Puerto Rico, and the US Virgin Islands had reported cases, but most ill individuals were not seriously ill and did not require medical treatment. The CDC launched an intensive vaccination campaign, and on August 9, 2009, the first doses of the H1N1 vaccine were available. Many jurisdictions limited the initial vaccine to high-priority groups such as first responders and patients with risk factors. The vaccine was routinely available by November and December of 2009. WHO declared an end to the global H1N1 pandemic on August 10, 2010, and the US Public Health Emergency expired on June 23, 2010. It’s estimated that, by the end of the pandemic, there were over 60 million cases of H1N1; 274,000 hospitalizations; and 12,500 deaths. The influenza A H1N1 strain is now a circulating strain of seasonal influenza and cases are no longer considered indicative as a risk for pandemic.

References