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**SPECIAL FEATURE**

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# The Evolution Handwashing to Hand Hygiene Guidance

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Handwashing is a fundamental principle and practice in the prevention, control, and reduction of healthcare-acquired infection. Advocated by Semmelweis (Nursing, *The Finest Art: An Illustrated History*. St Louis: Mosby; 1985:204) from the 1800s to resolve an obstetric morbidity and mortality occurrence, the simple act of hand cleansing portrays the intuitive benefits to basic hygiene, health continuum, and, most important, disease prevention. According to recently published guidance (*MMWR Morb Mortal Wkly Rep*. October 25, 2002;51:32-34), the term *handwashing* is replaced by the new term *hand hygiene*, which includes hand cleansing, hand disinfecting, and surgical hand scrub. This article focuses on the published guidance, blending the salient aspects of hand hygiene practices from noted champions, reinforcing the aesthetics of meticulous cleansing, to guidance on its practice in healthcare settings. In healthcare, the principle of "clean hands are healing hands" bears value and demands compliance in order to prevent and control infectious processes while protecting the person from acquiring infectious diseases. **Key words:** *antiseptic handrub, antiseptic handwash, hand antisepsis, hand disinfecting, handwashing, surgical hand scrub*

## BACKGROUND

The single most effective means to prevent, control, and reduce infection is handwashing. This mantra is fundamental to the field of infection prevention and control, public health, and epidemiology. As a specialized healthcare professional, infection control professionals (ICPs) are the modern day champions of this principle. They are clean hand advocates for patient and occupational safety. In their role as change agents, the art and science of persuasion are honed daily through encounters with healthcare personnel who demonstrate and share rationale for noncompliance with consistent hand cleansing. ICP colleagues struggle with trial and error approaches to achieve improved hand hygiene compliance for everyone's health. The ongoing challenge remains an underlying concern and focus for

ICPs as they strategize to minimize patient and worker risks in delivery of care.

This article summarizes the hand cleansing evolution as evident in published Centers for Disease Prevention and Control (CDC) guidelines, Association for Professionals in Infection Control and Epidemiology (APIC) guidance, and the most current Healthcare Infection Control Practices Advisory Committee (HICPAC) guideline. As with any and all published guidance within healthcare, the adoption and/or modification of these latest recommendations rest solely with the healthcare facility, its focus of care delivery, beneficiary population, and personnel commitment. However, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) cites the implementation of the HICPAC hand hygiene guidelines as a major step toward accreditation and compliance with their new National Safety Goal initiative.

The evidence supporting causality between dirty hands and infection originates with the

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puerperal fever accounts from Vienna. Born in Budapest in 1818, Dr Ignaz Philipp Semmelweis applied his knowledge of medicine and midwifery at the Obstetric (OB) Clinics in the Lying-in Hospital in Vienna.<sup>1</sup> As the 1846 documentation recounts, Dr Semmelweis was appalled by the high maternal mortality rates resulting from puerperal sepsis or childbed fever. Medical students conducted an OB First Clinic that had a significantly higher patient mortality incidence than did the OB Second Clinic manned by midwives. As a budding epidemiologist, Dr Semmelweis' astute assessment of observed behavior among healthcare personnel led to his data analysis of disease causality. Medical students were performing autopsies in the morgue before going to the labor, delivery, and postpartum rooms where they contacted female patients. Despite washing hands, the students' hands remained odorous from caviaric particles. Dr Semmelweis concluded that dirty hands, a careless habit of medical students, were vehicles of cross contamination and thus, disease transmission. He initiated the intervention of hand cleansing with soap and water followed by a handwash in chlorinated lime. True to form, keen postimplementation monitoring of the outcome revealed a remarkable reduction in mortality from 10% to 1%. Although Dr Semmelweis published his research study "The Cause, Concept, and Prophylaxis of Childbed Fever" in 1861, his work was ridiculed and discounted by the medical profession. The resulting mental anguish for Dr Semmelweis eventually resulted in his demise in 1865.<sup>1</sup>

An earlier pioneer fighting to cease the puerperal fever occurrence and its escalating mortality figures was Oliver Wendell Holmes. A Harvard graduate, Holmes devoted his energies to elimination of puerperal fever and published his essay "The Contagiousness of Puerperal Fever" in 1829. Medical colleagues attacked Holmes' work, but he republished this same essay in 1855, after Dr Semmelweis proved his theory and effective intervention.<sup>1</sup> As time passed, both men were recognized for their work.

## BASIC PRINCIPLE AND TERMS

The fundamental principle of hand hygiene is the single most effective measure to break the chain of infection. The goal of hand hygiene is to suspend and remove soil, debris, bioburden, and transient microorganisms; to inhibit, kill, and remove transient and resident skin flora; and to inhibit regrowth of microbes. Hand hygiene is the new term encompassing the methods of hand cleansing and handwashing, hand disinfecting with antimicrobials, and surgical hand scrub. Each of these cleansing procedures have basic elements that include anatomical area, agent, mechanical friction, and time while the use of a sink, water, devices, drying methods, and lotions are adjuncts applicable to the specific hand hygiene method.

*Handwashing* or handwash is a process of hand cleansing with soap and water and vigorous rubbing of hands together for 10 to 15 seconds to remove soil and transient microorganisms<sup>2</sup> (see Table 1).

*Hand disinfecting* or hand antisepsis is accomplished with an antimicrobial or antiseptic agent applied to the hands and arms for removal, inhibition, and/or destruction of transient microbes.<sup>2</sup> *Antiseptic handwash* is cleansing hands and arms with water and detergent-antimicrobial agent to remove and destroy microbes. *Antiseptic handrub* is the descriptor for waterless alcohol-based antimicrobial agents applied to visibly clean hands and arms to quickly kill organisms.

*Surgical hand scrub* is a process employing an antimicrobial agent to remove and/or kill transient microbes and reduce resident flora in preparation for invasive procedures.<sup>2</sup>

## THE EVOLUTION

The evolution of handwashing to hand hygiene is described through the published guidance on this strategy in infection prevention and control. The salient element of each guideline is presented to illustrate the expansion of information on the basis of common

**Table 1.** Types of hand care<sup>2</sup>

Type	Purpose	Method
Handwash	To remove soil and transient microorganisms	Soap or detergent for at least 10 to 15 sec
Hand antisepsis	To remove or destroy transient microorganisms	Antimicrobial soap or detergent or alcohol-based handrub for at least 10 to 15 sec
Surgical hand scrub	To remove or destroy transient microorganisms and reduce resident flora	Antimicrobial soap or detergent preparation with brush to achieve friction for at least 120 sec or alcohol-based preparation for at least 20 sec

sense, microbiology, epidemiology, and scientific research.

### Chain of infection

As a review, the chain of infection is comprises 6 links. The interruption of this chain at any link arrests the infectious process development. The ultimate intervention is handwashing; simply cleansing the skin surface on the hand and 10 dirty digits is the most economical measure, easiest act, and fastest tactic in infection prevention and control. Morbidity and mortality statistics validate this result, particularly from outbreak investigations where hand transmission contributed to an increase in patient infections. The hand hygiene challenge is the consistent application of this fundamental practice by all healthcare personnel in daily performance of their direct and/or indirect patient care delivery activities. Basic hand hygiene knowledge with its diverse aspects for situational application is inherent in healthcare core curricula. The transition to clinical arenas may wax and wane, depending on a litany of excuses from lack of facilities to no time to skin irritations. Despite the creativity of educators and teachers to motivate persons to just do it, hand hygiene practices are seldom internalized behaviors on a routine basis when duty calls. This neglect positions the caregiver for exposure and jeopardizes the patient with a potential life-impairing and/or life-threatening preventable complication. The morbidity and mortality of infections, especially healthcare-acquired in-

fections, are associated with enormous statistical realities, escalating expenditures, excessive consumption of limited healthcare resources, and altered patient lives. Medical interventions for infectious processes are miracle antimicrobial agents. Once thought to be the ultimate solution of preventable and non-preventable infections, these agents, specifically antibiotics, are rapidly becoming ineffective because of resistance. The suspicion that germs are winning the infection war is becoming truer with each new resistant microbial strain to a previously susceptible antimicrobial agent. This global phenomenon demands a multidimensional strategy of prevention, which includes hand hygiene compliance by all healthcare personnel and providers everywhere, irrespective of their proximity to the patient.

### Prevention

Historically, the initial handwashing guidelines appeared in 1981 and addressed the most pressing issues through practical preventive measures. The emphasis on handwashing as "the most important single procedure for preventing nosocomial infections" countered the observed reality that "hospital personnel are believed to be the mode of transmission for most preventable nosocomial infections, and, in many outbreaks, hands of personnel have been identified as the probable means of cross-infection."<sup>3</sup> The 1988 handwashing guidance reinforced the reduction of nosocomial morbidity and mortality associated

with consistent hand cleansing whether with a plain soap or antiseptic, regardless of geographic healthcare locations (ie, intensive care units, surgery, patient's room, etc), type of patient care procedure (ie, isolation, device insertion, etc), and amount of contamination present.<sup>4</sup>

### Handwashing facilities

The significant importance of handwashing facilities, namely quantity and location of *sinks*, led the 1981 recommendations: "...conveniently located for frequent use; preferably a sink should be located in or just outside every patient room or cubicle with fixed walls. More than one sink per room may be necessary if a large room is used for several patients."<sup>3</sup> In the 1985 guidance, expanded locations were advocated, "located in or adjacent to rooms where diagnostic or invasive procedures that require handwashing be performed (eg, cardiac catheterization, bronchoscopy, sigmoidoscopy, etc)."<sup>5</sup> This list extends today even further because of the myriad healthcare facilities with specialized patient services in existence. However, not until construction guidance for healthcare facilities contains this same recommendation does this issue become resolved.<sup>6</sup> Functioning sinks with temperature-controlled water via operational faucets or electronic sensors are fundamental equipment for handwashing. Innovations such as fully automated hand cleansing machines and dispensing devices continue to be invented with varying degrees of acceptance by healthcare workers.

*Faucet aerators* decrease splashing of water in sinks and may be employed to conserve water, but these aerators become contaminated with water-adapted gram-negative bacteria and mineral residue. If aerators are used, routine and periodic removal and cleaning reduces contamination.<sup>3</sup>

Cloth *towels*, hanging or roll type, are not recommended for use in healthcare facilities. Paper towels or hand blowers should be within easy reach of the sink, but beyond splash contamination. Lever-operated or button-activated dispensing systems have a re-

contamination risk when touched post cleansing to obtain a towel, whereas operational electronic sensor dispensers eliminate that risk.<sup>3,7</sup> Paper towel and hand cleansing or disinfecting *agent dispensers* plus a *waste receptacle* complete the handwashing facilities. Automated sensory devices at handwashing facilities are appropriate when they are operational as they are reminders to personnel, are timed for adequate washing time, dispense sufficient agent dose, and air-dry by a timer or dispense disposable towels for use. Automation has enhanced the convenience of performing the cleansing or disinfecting act.

### Hand hygiene agents

The plethora of products available for hand hygiene has increased through advanced technologies as industry seeks the answer(s) to the healthcare arenas' needs. Once again, the guidance has historically given choices to astute healthcare personnel who know the indications and what options can satisfy those activities safely.

Routine handwashing is accomplished with *soap* and water for suspension of soil, bioburden, and other debris. The soap is available as bar, nonantimicrobial liquid, granule, powder, or soap-impregnated tissues/towelettes/leaflets. If bar soap is used, it should be changed frequently and kept on a rack for drainage of water; small bar soap is preferred, especially for patient's personal use. All liquid soaps should be removed from dispensers at least monthly, preferably more often; containers cleaned, dried, and refilled with fresh solution; disposable containers are preferred.<sup>3</sup> Today disposable containers of agent are removed from dispensing devices to prevent this "topping off" practice frequently seen with reusable containers.

*Antimicrobial and antiseptic agents* inhibit (bacteriostatic) or kill (bactericidal) microbes, are US Food and Drug Administrations (FDA) cleared for market as over-the-counter Category 1 safe and efficacious products, and have varying characteristics of efficacy.<sup>8</sup> The characteristics of antiseptic agents have evolved from 1981 to 2004 as a result of more

sophisticated testing and research in vivo and in vitro findings. The efficacious antiseptics are alcohol followed by iodine and iodophors because of their rapid bactericidal ability; the remaining antiseptics are chlorhexidine gluconate, quaternary ammonium, chloroxylenol, triclosan, hexachlorophene, and others. Versions of antiseptic characteristics continue to be an integral component of subsequent guidance on this topic; Appendix Table 1 is the most recent comparative summary.<sup>7</sup> Hexachlorophene is restricted from use for pregnant women and for routine infant bathing unless a staphylococcal outbreak is occurring<sup>3</sup> and is not recommended for routine use because of toxic effects.<sup>4</sup> Quaternary ammonium products (eg, benzalkonium chloride) are not recommended antiseptics because of poor antiseptic qualities.<sup>4</sup>

Indications for antiseptic use are surgery or any invasive procedure, including device insertions; isolation; high-risk, critical care units; patient care activities where exposure to bioburden occurs, to name a few.<sup>9</sup>

The antiseptic media is generally liquid, foam, rinse, gel, and impregnated sponge/brush or applicator or swab; a disposable container is the norm. Some dispensers are hands free; some require pumping action.

Waterless antiseptics are mentioned in the 1981 recommendations: "... , such as alcohol or hexachlorophene foams or chlorhexidine-alcohol rinse, can be used for handwashing in emergency situations in areas where no sinks are available."<sup>3</sup> In Larson's 1988 guidance, the waterless alcohol agents are "an adjunct to handwashing in settings in which personnel have very frequent contact with a number of different patients and limited time for traditional handwashing. . . Such products should not be used as an alternative to handwashing when the hands are soiled with organic matter."<sup>4</sup> The effect of antiseptic handrubs (mainly alcohol-based products) is only to inhibit flora, without any effect on soil.<sup>2</sup> When soil is present, the use of "detergent-containing towelettes should be used to cleanse the hands" and "alcohol-based handrubs can then be used to achieve

hand antiseptics."<sup>2</sup> The current advocacy for alcohol-based handrubs as the ultimate agent for hand hygiene as touted in the 2002 HICPAC guideline evoked a major competitive marketing frenzy.<sup>7</sup> With such diverse patented chemical ingredients and formulations, antiseptic selection is a complex decision-making situation for healthcare institutions and personnel. These waterless agents are available in rinses, foams, wipes, and now gels and are not limited to healthcare settings.

When discussing an occupational risk associated with antiseptics, "antiseptics are more irritating to skin than soap and water, and frequent washing with them often results in dry skin and dermatitis; paradoxically, . . . cause an increase in microbial skin colonization and also discourage frequent handwashing."<sup>3</sup> As a result of more study, Larson states that the additional skin damage with antiseptics is due to the harsh detergent base in the antiseptic formulations, not the antimicrobial itself.<sup>4</sup>

The antimicrobial attribute of persistence/substantivity/residual activity is related to the ability of antiseptics to bind to stratum corneum. Persistence is desired in prolonged glove-wearing situations when hands become moist under the gloves and the ability to cleanse hands frequently is restricted all the while organisms are proliferating.<sup>4</sup>

Recommendations on antiseptic storage-state store in closed containers; alcohols in bulk containers are stored in approved cabinets or areas for flammables and filtered before use because of possible spore contamination.<sup>4</sup> The same procedure for reusable soap dispensers mentioned previously applies to antiseptic dispensers. Advocacy for disposable containers is recommended.<sup>2</sup>

Lotions and creams are included in this section, as these products have continually been used by healthcare personnel as a means to rehydrate their damaged skin from frequent hand cleansing activities. Skin integrity is essential to prevent microbial invasion. The therapeutic emollient intervention has greater reconditioning benefit when consistently applied to "the hands *after* hospital duty rather than during the workday . . . in

preventing dermatitis . . .”<sup>3</sup> This skin reconditioning act maintains the integrity of skin as an effective barrier by preventing skin dryness associated with hand cleansing and disinfecting activity. Lotion is selected for its compatibility with antiseptic agents and glove materials. If institutional hand lotions or creams are not provided to minimize the occurrence of irritant contact dermatitis as recommended in the 2002 guidance,<sup>7</sup> disposable small individual or pump dispenser containers are recommended for healthcare personnel’s use.<sup>2</sup>

### Hand hygiene product selection

Handwashing, antiseptics, surgical hand scrubs, and hand care products are chosen by persons knowledgeable about the purpose of use, advantages, disadvantages, cost, and user acceptance.<sup>2</sup> These agents are efficacious, have low irritancy potential, especially with repetitious use, and perform as marketed.<sup>7</sup> Product evaluation criteria are subjective: feel, fragrance, and skin tolerance. Objective criteria as cost are not primary factor considerations according to the most recent guidance.<sup>7</sup> However, most predetermined, written objective criteria developed by multidisciplinary product evaluation teams focus on regulatory compliance (eg, FDA clearance as Category 1 safe and efficacious over-the-counter handwash or antiseptic or surgical hand scrub, FDA new drug application), designated uses, performance characteristics, counter indications or cautions, supply availability, company servicing conditions, accessories, compatibility, and storage, to name a few. Manufacturer information on the products under consideration is required to narrow the quantity of products to trial. Objective criteria lend more easily to an unbiased analysis of trialed products before a critical informed decision is reached. Personnel acceptance is stressed when adequate education, evaluation input, and ongoing use of the selected product occurs. Skin conditions related to the agents used in the facility are evaluated and documented by allergy and immunology physicians with a subsequent order for a safer

product or procedural approach to remedy the skin condition.

### Handwashing indications

“Healthcare personnel should *always* wash their hands”<sup>3</sup> for the following indications:

1. *Before* performing invasive procedures, whether or not sterile gloves are worn
2. *Before* and *after* contact with wounds, whether surgical, traumatic, or associated with an invasive device
3. *Before* contact with particularly susceptible patients (eg, immunocompromised and newborns)
4. *After* contact with a source that is likely to be contaminated with virulent microorganisms or hospital pathogens (eg, an infected patient or an object or device contaminated with secretions or excretions from patients); subsequently, the Bloodborne Pathogen Standard mandated this contact with bodily fluids requires gloves and handwashing upon glove removal<sup>10</sup>
5. *Between* contacts with different patients in special care, high-risk units
6. *After* taking care of an infected patient or one who is likely to be colonized with microorganisms of special clinical or epidemiologic significance (eg, multiresistant bacteria)<sup>5</sup>
7. *Thoroughly* with soap and water, when visibly soiled<sup>2,7</sup>
8. *Before* and *after* patient contact<sup>2</sup>
9. *After* removing gloves<sup>2,10</sup>
10. If moving from a contaminated body site to a clean body site during patient care<sup>7</sup>
11. *Before* eating and *after* using a restroom<sup>7</sup>
12. *If* exposure to *Bacillus anthracis* is suspected or proven<sup>7</sup>

The exceptions to *not* cleansing the hands in this original document are most routine, brief patient care activities of *direct* contact (eg, taking a blood pressure or shaking hands) and *indirect* contact (eg, handing a patient medications, food, or other objects)

and true emergencies.<sup>3,5</sup> However, the latest guideline reverses these in part because of the multiresistant microbes, such as methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant *Enterococcus faecium*, colonizing patients and the ease of healthcare personnel transference to others.<sup>7</sup>

Natural disasters and equipment failure can interrupt water supplies; a written contingency plan is worth developing for implementation at such times. In the event that water supply is disrupted and hand soilage occurs, detergent-containing towelettes are used for hand cleansing and alcohol-based handrubs are applied to achieve hand antisepsis.<sup>2</sup>

Although these indications for when to cleanse and/or disinfect hands remain similar throughout the numerous documents, this statement is most striking of common sense: "handwashing should be encouraged when personnel are in doubt about the necessity of doing so."<sup>5</sup>

### Hand hygiene preparation

Another highly argued issue among healthcare personnel and providers and ICPs concerns adornments. Remove hand jewelry and clean fingernails especially well because jewelry and nails can harbor microorganisms, which are not removed with superficial cleaning.<sup>3</sup> Further recommendations state nails should be short enough, less than  $\frac{1}{4}$  in long,<sup>7</sup> to allow thorough cleaning underneath them and not tear gloves. Hands, nails, and surrounding tissue should be inflammation free.<sup>2</sup> Do not wear artificial fingernails or extenders when having direct contact with patients at high risk (eg, those in intensive care units or operating rooms). Remove rings, watches, and bracelets before beginning the surgical hand scrub.<sup>7,11</sup> The bottom line is clean, healthy, natural, short fingernails are polish free and jewelry free and are less likely to be reservoirs for microbes.

### Hand hygiene methods

Routine *handwashing* involves wetting the hands (fingertips to wrist) first with tepid wa-

ter. Moisture in the pores dilutes the agent when applied, facilitates lathering activity, promotes more thorough rinsing of the debris and agent, and reduces the risk of skin irritations. Avoid using hot water because repeated exposure to hot water may increase the risk of dermatitis.<sup>7</sup> Apply a plain, nonantimicrobial soap, in the amount recommended by the manufacturer, to the moistened skin surfaces.<sup>4,7</sup> More is not necessarily better and may contribute to dermatological conditions. Vigorously rub together all surfaces of lathered hands, washing under a stream of water for at least 10 to 15 seconds to remove most transient flora, organic material, and dirt.<sup>2-5</sup> Mechanical friction is essential to suspend and remove the accumulated contamination present. The specified timeframe frequently is stated on the manufacturer's product label. Rinse from fingertips to wrists under a stream of running water. Because of the patented formulations of different agents, rinsing may be repeated several times or for a longer timeframe to decrease potential skin irritation due to residual agent. Dry the cleansed skin surfaces thoroughly with paper towels. Blotting of excess moisture precedes the rubbing dry of the skin surfaces. Towels are discarded in the designated receptacle. Another dry towel is obtained to turn the water faucet off; this towel is an effective barrier against hand recontamination from the contaminated faucet.<sup>3</sup> This step may be eliminated if an electronic sensor is in place or foot- or knee-activated pedal shuts off the water. While the washing timeframe has decreased over time, singing the "Happy Birthday" song is usually the norm for adequate routine hand cleaning time.

*Hand disinfecting* or hand antisepsis is accomplished with an antimicrobial or antiseptic agent to reliably eliminate possibly contaminating and virulent microorganisms.<sup>3</sup> Hand antisepsis can occur simultaneously with handwashing when soaps containing antiseptics are used.<sup>2</sup> The anatomical surface is extended from fingertips to forearms as a minimum. The antiseptic product may or may not require water, the quantity of agent differs

among products, and manufacturers identify specific time and other factors on their labels; thus, reading the product label is essential to proper disinfecting. There are 2 specific procedures that accomplish hand disinfection: antiseptic handwash and antiseptic handrub.

For an *antiseptic handwash*, lukewarm water is applied from fingertips to forearm before the selected antiseptic is applied in the manufacturer's recommended dose. Lather with abundant mechanical friction for the manufacturer's specified time period, covering all moistened skin surfaces. Thoroughly rinse the disinfected fingertips to forearms under a stream of running tepid water to remove the residue. Completely dry with a disposable towel(s) and discard the towel(s) in the receptacle. With another dry towel, turn the contaminated water faucet off unless some other hands-free or electronic sensor terminates the water flow.

An *antiseptic handrub* is a waterless alcohol-based antimicrobial agent. Because an abundance of these novel products exist in the marketplace, careful reading of the manufacturer's label is essential for proper product use. Alcohol handrubs disinfect fingertips to forearms with a single or multiple applications of the product to skin surfaces absent of visible debris with a thorough air-drying after each application. It is important to reiterate that alcohol is not a good cleaning agent and not recommended in the presence of physical dirt and bioburden.<sup>2</sup> To degerm hands, apply the manufacturer's recommended quantity of alcohol-based handrub as stated on the label to the palm of one hand. Rub both hands together for the time specified by the manufacturer, covering all surfaces of fingertips to forearms, until the skin is dry. Perform repeat applications if recommended by the label instructions. Some products require a water-aided cleansing after a specified quantity of applications because of build up of residual product ingredients.

*Surgical hand scrub* is a more extensive hand disinfection process performed before invasive procedures to remove soil,

bioburden, and transient microbes and to decrease resident flora.<sup>2</sup> Although traditionally attributed to operating room environments, surgical hand scrub procedures are practiced in diverse invasive practice settings, which includes, but are not limited to, cardiac catheterization suites, ambulatory and specialized surgical centers, interventional radiology departments, labor and delivery rooms, to name a few. Additionally, reducing resident skin flora on the hands of the surgical team for the duration of a procedure decreases the microbial contamination risk of the surgical field if the gloves become punctured or torn during the operation.<sup>7</sup>

The anatomical area encompasses fingertips to above the elbows with special attention to the fingernails. The surgical hand scrub commences with an antimicrobial-handwash of fingertips to above the elbows. Fingernails are cleaned with a disposable pick under running water to remove accumulated debris.<sup>11</sup> After a thorough rinse of the washed surfaces under a tepid water stream, a disposable antimicrobial-impregnated brush/sponge releases the required quantity of antiseptic during mechanical friction when applied to the same washed surfaces.

Surgical hand scrub agents are nonirritating antimicrobial preparations with broad-spectrum activity, fast-acting, and persistent attributes. Generally, chlorhexidine or iodophor surgical hand scrub antiseptics are selected because of their persistence, especially under gloves.<sup>4,9</sup> The adage that more antiseptic is better when added to an already dose-impregnated brush/sponge device may actually contribute to skin irritation. Repeated use of antiseptic agents is a primary cause of chronic irritant contact dermatitis<sup>7</sup>; thus, alternating between 2 choices often reduces this risk of impaired skin integrity.

Surgical scrub procedures are either a timed or stroked method. The timed method has decreased from 10 minutes to a 2- to 6-minute timed procedure of all skin areas, regardless of initial or subsequent scrubs of the day.<sup>9,12</sup> The next step is a thorough rinse of the agent and debris from the disinfected fingertips to

elbow areas under a running stream of tepid water, keeping hands above elbows and away from the uniform after the rinse.<sup>11</sup> Dry the disinfected surface with a sterile towel and don sterile gown and gloves.<sup>9,11,12</sup>

While the brush has evolved from a reusable resterilized bristle to a disposable, single-use soft bristle brush<sup>9</sup> to a disposable combination of brush and sponge, impregnated or not, the notion to advance to a brushless method has been introduced based on the increased skin cell shedding and surface damage.<sup>13</sup>

The use of water-aided, waterless, and water optional alcohol-based surgical hand scrub agents requires a thorough reading of the manufacturer's label for proper use of the product. Prewash, agent quantity, anatomical area, timeframe, and number of applications are just a few of the diverse aspects associated with these products.

Larson recommended a surgical hand scrub with an alcohol product in 1988. Wash hands and arms, clean fingernails thoroughly, and dry completely. Apply 3 to 5 mL alcohol solution containing an emollient, rubbing until dry; application should last for at least 20 seconds. Repeat this process for approximately 5 total minutes until a total of 9 to 25 mL of alcohol is consumed. Considered a European scrub, this technique maintains lower bacterial counts under gloves.<sup>2,4</sup> The current HICPAC hand hygiene recommendations advocate alcohol-based handrub with persistent activity before donning sterile gloves.<sup>7</sup>

The glove discussion is expanded to emphasize handwashing after glove removal "because gloves may become perforated during use and because bacteria can multiply rapidly on gloved hands."<sup>12</sup> This statement is significant as it reinforces the mandated glove wearing<sup>10</sup> in response to the pandemic of human immunodeficiency virus. Larson recommended gloves as an adjunct, not substitute, to handwashing when contamination with body substances is anticipated; changing gloves and washing hands with antimicrobial handwashing product between patients, when moving from one infected or colonized site to another in the same person, and

when glove integrity is in doubt.<sup>2,4,7</sup> Disposable gloves are discarded after a single use; never washed and reused unless a thin, special material utility glove for chemicals and in decontamination activities is reusable as long as the glove integrity is maintained. Known as rubber gloves, multiple uses are possible as long as the gloves are washed in between uses.

### Hand hygiene compliance

The literature resounds with the recognition of poor compliance to handwashing protocols by healthcare personnel, especially physicians. Failure to comply with hand cleansing is a complex problem with a litany of identified excuses that remain very accurate nearly 2 decades later. These include lack of motivation or knowledge, obstacles as understanding, inconveniently located sinks, absence of paper towels, an unacceptable handwashing product, or the presence of dermatitis. Multifaceted efforts to improve compliance range from ongoing education, reported surveillance incidence to healthcare personnel, work center-based strategies to enhance the compliance, patient and family intervention to remind personnel, and institutional support and resources. Personnel are provided with readily accessible alcohol-based handrubs to improve hand hygiene adherence by positioning these agents at the entrance to the patient's room or at the bedside, in other convenient locations, and in personal pocket-sized containers.<sup>7</sup> The whole focus of the most recent guidance is to improve hand hygiene compliance with alcohol-based handrubs. To this end, ongoing monitoring and reporting will provide the answer to the rubs' ability to enhance worker compliance.

Additionally, the 2002 guidance recommends performance indicators as a means of monitoring compliance incidence before and after alcohol handrubs are implemented. These indicators are monitored on product quantity consumed, not observed process surveillance results. The consensus group is requesting published measurable data from

users to strengthen their evidence-based guidance.

### Research

Both APIC guidelines stress the importance of research studies to valid evidence-based recommendations, focusing on the microbial effect sustained from use of detergent soap versus antiseptic agents. The listed research agenda in the HICPAC guidance includes 3 major categories: education and promotion, hand hygiene agents and hand care, and laboratory-based and epidemiologic research and development.<sup>7</sup> Answers to the unresolved issues will hopefully provide evidence-based resolution for more clarifying future guidance.

### Hand hygiene issues

Although the focus of the 2002 guidance document is to improve hand hygiene compliance, there are a number of issues that have surfaced concerning the alcohol handrubs. These issues include implementation requirements for accreditation and reimbursement status, fire code compliance, and procedural issues driven by manufacturer's label instructions.

The 2002 HICPAC guidance states that alcohol-based handrub dispensers do not require plumbing and should not be placed adjacent to sinks to avoid any confusion between soap and alcohol handrub selection. The alcohol handrub dispensers can be made available adjacent to each patient's bed and at many other locations in patient care areas.<sup>7</sup>

Boyce and Pittet and JCAHO ([www.jcaho.org](http://www.jcaho.org)) issued communiqués, recommending use of the alcohol handrubs to enhance patient safety, to improve personnel hand hygiene compliance, and to decrease healthcare-acquired infections while making it imperative to ensure compliance with fire codes for proper handling and storage.<sup>7,14</sup>

Because of the high volume of alcohol (approximately 60% by weight) and its flashpoint of nearly 75° F, alcohols are classified as a Class I flammable liquid. Therefore, these agents are

subject to National Fire and Protection Association Code limitations on placement of dispensers, volume of solution in storage, and disposal of containers. Applicable building codes are also enforced by national agencies (eg, JCAHO, Centers for Medicare and Medicaid Services), state licensing agencies and fire marshals, and local fire marshal authorities having jurisdiction.

The controversy prompted the American Society of Healthcare Engineers (ASHE) to commission Gage-Babcock and Associates, Inc, an independent fire protection consultant, to perform computer-based modeling of flammability and associated hazards from alcohol-based hand hygiene solutions. Using 11 modeling fire scenarios to capture a reasonable range of potential fire risk in a typical patient care environment, the results indicate that installing hand rub dispensers is acceptable in both corridor and suite location. The spacing of dispensers at or near each patient room entrance is not a significant risk for additional ignition and involvement of more than 1 dispenser. On the basis of these results, ASHE recommends:

1. Single containers installed in an egress corridor should not exceed a maximum capacity of 1.2 L (40.6 oz) for alcohol-based hand rub solutions in gel/liquid form. Single containers installed in a suite should not exceed a maximum capacity of 2 L of alcohol-base hand rub solutions in gel/liquid form.
2. Dispensers should not be installed over electrical receptacles or near other potential sources of ignition.
3. Dispensers that project more than 3.5 in (4.5 in where 2003 Life Safety Code is adopted) into the corridors should be noted in the facility's Fire Plan and Training Program.
4. All storage of replacement alcohol-based hand rub containers on patient floors, regardless of the quantity, should be within an approved flammable liquid storage cabinet.
5. The quantity of replacement alcohol-based hand rub containers stored and

used on any floor, including bulk storage in central supply rooms, should not exceed the maximum quantity permitted by the local prevailing building and fire codes ([www.ashe.org](http://www.ashe.org)).<sup>15</sup>

Some state fire safety officials require dispenser placement inside patient's rooms, avoiding corridor obstruction, away from electrical switches and receptacles, minimizing heat source contact and required storage for large quantities in designated labeled flammable cabinets.

FDA specifies label requirements that manufacturers must comply with for clearance to market products. At the current time, these manufacturer-driven labels on the alcohol hand hygiene products are dictating hand hygiene procedural techniques, particularly since professional organizations have or may not publish revised hand hygiene guidance.

Surgical hand scrub procedures have traditionally included a preantimicrobial wash and fingernail cleansing before the actual scrub phase. Many surgical centers and invasive practices using alcohol products are simply following the application instructions by the manufacturer without a critical reassessment of the facility's written procedure; thus, practice is being dictated by industry. The use of

these alcohol handrubs is not without hazard. An operating room fire and personnel's damaged skin was reported.

Facility-performed monitoring of personnel compliance before and after implementing alcohol handrubs spans the spectrum of improved to stable to worse. This novel gel media of alcohol handrubs is yet to be assessed for its true impact on improving health-care personnel and provider hand hygiene compliance.

In the meantime, ICPs are collaboratively assessing what is the best strategy of implementation, balancing all the requirements while promoting increased compliance with hand hygiene practices.

## SUMMARY

Hand hygiene is a dynamic, ever evolving practice based on a fundamental cornerstone—handwashing effectively interrupts microbial transmission from person-to-person and person-to-object-to-person. Published guidance evolves historically, microscopically, and epidemiologically. But the challenge remains changing adult behavior to enhance more routine performance of hand cleansing and disinfecting activities.

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Appendix Table 1  
Antimicrobial Spectrum and Characteristics of Hand Hygiene  
Antiseptic Agents<sup>\*,†</sup>

Group	Gram-positive bacteria	Gram-negative bacteria	Mycobacteria	Fungi	Viruses	Speed of action	Comments
Alcohols	+++	+++	+++	+++	+++	Fast	Optimum concentration 60% to 95% no persistent activity
Chlorhexidine (2% and 4% aqueous)	+++	++	+	+	+++	Intermediate	Persistent activity: rare allergic reactions
Iodine compounds	+++	+++	+++	++	+++	Intermediate	Causes skin burns: usually too irritating for hand hygiene
Iodophors	+++	+++	+	++	++	Intermediate	Less irritating than iodine; acceptance varies
Phenol derivatives	+++	+	+	+	+	Intermediate	Activity neutralized by nonionic surfactants
Triclosan	+++	++	+	—	+++	Intermediate	Acceptability on hands varies
Quaternary ammonium compounds	+	++	—	—	+	Slow	Used only in combination with alcohols: ecologic concerns

\* Hexachlorophene is not included because it is no longer an accepted ingredient of hand disinfectants.

† ++++ indicates excellent; ++, good; +, fair; and —, no activity or not sufficient.