Chapter 10
Hand Hygiene

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Key points

- Hand hygiene is the most effective single measure to prevent transmission of healthcare-associated pathogens.
- Compliance with hand hygiene recommendations is often sub-optimal and is influenced by many factors, including equipment/supplies, time constraints, and behavioural factors.
- Hand hygiene can be performed either by washing with soap and water or by rubbing with an alcohol-based hand rub. The World Health Organization recommends the preferred use of alcohol-based hand rub for routine hand hygiene in health care, if available.
- Hand hygiene promotion and multimodal improvement strategies have a great impact on healthcare worker practices and can reduce healthcare-associated infections and the spread of resistant microorganisms.
- Effective strategies include: provision of alcohol-based hand rubs and clean water, soap, and disposable towels; staff education; monitoring of hand hygiene practices and performance feedback; reminders in the work place; and promotion of a patient safety climate.

Background

Hand washing with soap and water has been considered a measure of personal hygiene for centuries. In the mid-1800s, studies by Ignaz P. Semmelweis in Vienna, Austria, and Oliver Wendell Holmes in Boston, US, established that hospital-acquired infections were transmitted via the hands of healthcare workers (HCW).[1] Following the observation of high maternal mortality rates due to puerperal fever, Semmelweis made physicians wash their hands in a chlorinated lime solution before every patient contact. Now our knowledge of the transmission of pathogens through hands and of infection prevention has greatly evolved, and the first international guidelines on hand hygiene published in 2009 recommend a range of evidence-based actions.[1]

Resident or transient microbial flora is present on normal human skin. The resident flora is protective and less likely to be associated with healthcare-associated infections (HAI), but can cause contamination of sterile body cavities, eyes, or non-intact skin. The transient flora colonise the superficial layers of the skin and frequently cause HAIs as they are acquired and passed on by HCWs during direct contact with patients or contaminated environmental surfaces. Contaminated HCWs' hands are the commonest route of transmission of HAIs. Hand hygiene is therefore the most effective measure to prevent HAIs.[1]

Hand Contamination

HCWs can contaminate their hands or medical gloves with pathogens, such as *Staphylococcus aureus*, *enterococci*, *Clostridium difficile*, Gram-negative bacilli, and some viruses (e.g., respiratory syncytial virus and rhinovirus), by touching infected sites and draining wounds, as well as patient skin or contaminated surfaces within the health care environment, especially surrounding the patient.[1] Some activities (e.g., direct patient contact, contact with body fluid or waste, diaper change, and respiratory care) lead to heavier hand contamination. In addition, HCWs with dermatitis or skin lesions on their hands may remain colonised with acquired microorganisms for a long time.[1]

Subungual (beneath the nails) areas of the hand carry high concentrations of bacteria and yeasts. Artificial nails may also contribute to the transmission

of pathogens as wearers are more likely to harbour Gram-negative pathogens on their fingertips than those with natural nails, despite hand washing or rubbing with an alcohol-based product. Diseased fingernails reduce the efficacy of hand hygiene.[1] The skin underneath rings (including wedding rings) is more heavily colonised than that on other fingers. Rings with sharp and voluminous surfaces and long, sharp fingernails, either natural or artificial, can puncture gloves and limit HCWs' hand hygiene performance.[1]

Compliance Among Healthcare Workers

Without adequate hand hygiene, hand contamination increases and contaminated HCWs' hands have been associated with endemic HAIs.[1] Therefore, hand hygiene is the primary measure to prevent HAIs and will help decrease the spread of antimicrobial resistance. However, many determinants, such as lack of time, lack of equipment/supplies, and behavioural factors, often result in HCWs neglecting hand hygiene. Although many HCWs perceive their performance as high,[2-4] their hand hygiene compliance is usually < 40% in the absence of interventions.[1, 5]

Hand hygiene performance varies according to work intensity, type of ward, professional category, and time of day/week. Compliance is usually lower in settings with high care intensity (e.g., intensive care units), among physicians, and before rather than after touching a patient.[1,5] Indeed, HCWs tend to comply more frequently with indications that protect themselves (e.g., after exposure to body fluids, after glove use, after contact with the patient or the patient's environment).[1, 6]

Products and Techniques

Hand hygiene can be performed either by rubbing with an alcohol-based formulation or by washing with soap and water. Soaps are available as bar, leaf, powder, and liquid, but must be placed alongside running water, and re-stocked when needed to achieve compliance. Plain soap has minimal antimicrobial activity, however it can be used for hand washing because mechanical friction removes many transient microorganisms. (See Table 10.1)[1, 7]

The commonest antimicrobials in hand hygiene products are: alcohols, chlorhexidine, chloroxylenol, hexachlorophene, iodine and iodophors, quaternary ammonium compounds, and triclosan. All are effective against Gram-positive and Gram-negative bacteria with maximal efficacy demonstrated by alcohols and iodophors.[1] Mycobacteria and fungi are most effectively eliminated by alcohols, and less so by chlorhexidine, chloroxylenol, and hexachlorophene.

Enveloped viruses (e.g., herpes simplex virus, human immunodeficiency virus, influenza virus, respiratory syncytial virus) are highly susceptible to alcohols;[1, 8] hepatitis B and C viruses require high concentrations (70-80% [volume/volume(v/v)].[1] Alcohols have also shown *in vivo* activity against some non-enveloped viruses (rotavirus, adenovirus, rhinovirus, hepatitis A virus, and enteroviruses).[1] *In vitro* virucidal activity against surrogate strains of norovirus was demonstrated by 70% alcohol-based formulations and several norovirus outbreaks were controlled with preventive measures, including alcohol-based hand rubs.[1, 9-10] In general, ethanol has a greater activity against viruses than isopropanol.

Iodophors and chlorhexidine have some activity against enveloped and some non-enveloped viruses.[1] None of these antiseptics has activity against bacterial spores or protozoan oocysts although the mechanical effect of washing with soap and water allows their partial removal.[1, 7, 11]

According to WHO, alcohol-based hand rubs should be the preferred method for hand hygiene (See Table 10.1)[1, 7] as they have the broadest antimicrobial spectrum, require a short time (20-30sec) for effective antimicrobial decontamination (See Figure 10.1), have better skin tolerance, and are readily available at the point of care (i.e., where care is provided).[1, 12]

The efficacy of an alcohol-based hand rub depends on its quality, the amount used, the time spent rubbing, and complete coverage of the hands' surfaces (See Figure 10.2). These parameters also apply to washing with soap and water (See Figure 10.3). Hand rubs containing 60–80% alcohol are satisfactory, provided that they meet recommended standards (European Norms [EN] or American Society for Testing and Materials [ASTM] standards).[1, 13] 75-87% ethanol, isopropanol, or n-propanol, or a combination of these products guarantee the optimal antimicrobial

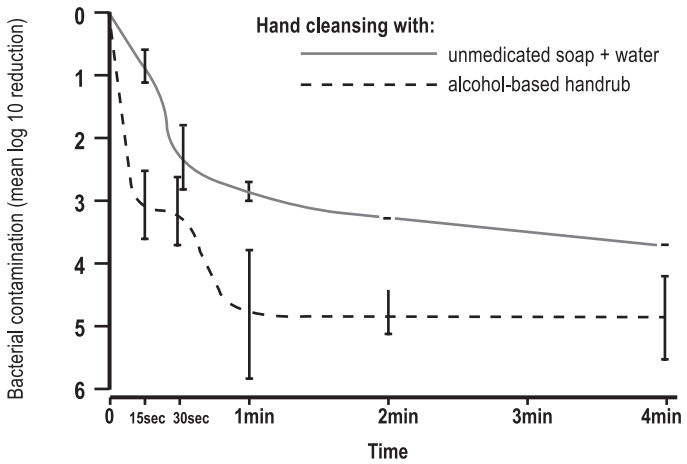

Figure 10.1 Time-course of efficacy of unmedicated soap and water and alcohol-based hand rub in reducing the release of test bacteria from artificially-contaminated hands.

(Reprinted from The Lancet Infectious Diseases, vol 1, Pittet D, Boyce J, Hand hygiene and patient care: pursuing the Semmelweis legacy, page 14, 2001, with permission from Elsevier)

efficacy. The WHO-recommended formulations contain either 75% v/v isopropanol, or 80% v/v ethanol.[1, 14]

Alcohol-based hand rubs are available as rinses (with low viscosity), gels, foams, and impregnated wipes. However, wipes and foams have little supporting evidence.[15] Gels were considered to have a low microbicidal efficacy; however newer formulations are more bactericidal.

Points to consider when selecting a product include: [1, 14]

1. demonstrated antimicrobial efficacy according to ASTM or EN standards for hygienic hand antisepsis and/or surgical hand preparation;
2. proven good dermal tolerance and minimal skin reactions;
3. minimum drying time (products that require longer drying times may affect hand hygiene best practice);
4. cost;
5. aesthetic preferences of HCWs and patients, such as fragrance, colour, texture, “stickiness”, and ease of use; and

Figure 10.2 Hand hygiene technique with an alcohol-based formulation (Based on the hand hygiene technique with an alcohol-based formulation, URL: http://www.who.int/gpsc/5may/tools/system_change/en/index.html

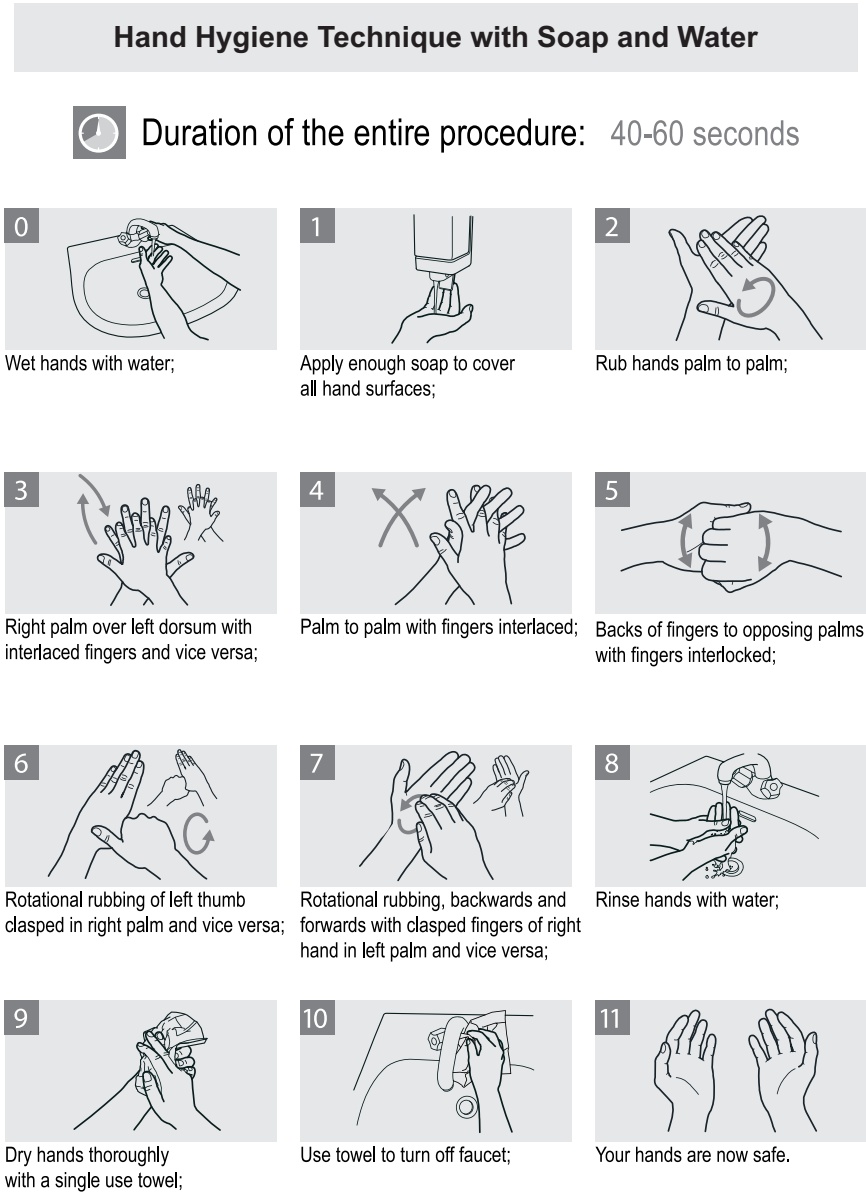

Figure 10.3 Hand washing technique with soap and water (Based on the hand washing technique with soap and water, URL: http://www.who.int/gpsc/5may/tools/system_change/en/index.html © World Health Organization 2009. All rights reserved.)

6. availability, convenience, and functioning of dispensers, and ability to prevent contamination.[12]

A rational location of facilities (sinks, soap, and hand rub dispensers), as well as good maintenance and user-friendliness, are essential. Ideally, different alcohol-based hand rub dispensers, e.g., pocket bottles, wall-mounted, or those placed on carts/trolleys, night stand/bedside table, or affixed to the bed rail, should be used.

When to Perform Hand Hygiene

The "My five moments for hand hygiene" approach [1, 16-17] (See Figure 10.4) merges the hand hygiene indications recommended by the WHO Guidelines[1] into five moments when hand hygiene is required. These are: 1) before touching a patient, 2) before clean/aseptic procedures, 3) after body fluid exposure/risk, 4) after touching a patient, and 5) after touching patient surroundings. This approach proposes a unified vision for HCWs, trainers, and observers to minimise inter-individual variation.

Glove Use

Gloves prevent contamination of HCWs' hands, reduce transmission of pathogens, and help control outbreaks. However, gloves do not prevent microorganism transmission and HAI unless rigorously accompanied by other measures, including hand hygiene.[1] Gloves must be used according to established indications for donning and removal.

Use of the same gloves for several hours, while providing care to different patients and touching multiple surfaces, is a very frequent malpractice. Several studies have established an association between inappropriate glove use and low compliance with hand hygiene. Others have found that HCWs wearing gloves were significantly more likely to cleanse their hands following patient care.[1]

Understanding that glove use does not replace hand hygiene is of utmost importance. When there is a need for performing hand hygiene (opportunity) before a care act which also requires glove use, hand washing or hand rubbing must be performed before donning gloves, as well as immediately after glove removal. In addition, gloves must be removed to

Figure 10.4 "My five moments for hand hygiene" (reproduced with permission from reference 12)

perform hand washing or hand rubbing to protect a body site from the flora of another body site or skin area previously touched within the same patient.[1]

Improvement Strategies

Key components of successful strategies are [1]:

1. System change

Ensure that the necessary infrastructure is in place to allow HCWs to practice hand hygiene at the point of care. This includes two essential elements:

- access to a safe, continuous water supply, soap, and disposable towels; and
- provision of alcohol-based hand rub at the point of care.

2. Training/education

Provide regular training on microbial transmission through HCWs' hands and the importance of hand hygiene based on the "My five moments for

hand hygiene" approach. Also include the correct procedures for hand rubbing and hand washing by using presentations, e-learning modules, posters, focus groups, reflective discussion, videos, self-learning modules, practical demonstrations, feedback from assessment, buddy systems, or combinations of these methods. Assess the impact of training on HCWs' knowledge to identify areas for further education.

3. Evaluation and feedback

Monitor hand hygiene practices and knowledge among HCWs and feedback of results to staff. The gold standard for measuring hand hygiene compliance is direct observation; electronic monitoring of hand hygiene actions and evaluation of alcohol-based hand rub consumption can be used as indirect methods and surrogate markers.

4. Reminders in the workplace

Remind HCWs about the importance of hand hygiene and the indications and procedures for performing it.

5. Institutional safety climate

Create an environment and perceptions that raise awareness about patient safety while making hand hygiene a high priority at all levels, including:

- active participation at institutional and individual levels;
- awareness of individual and institutional capacity to change and improve (self-efficacy); and
- partnership with patients and patient organisations (depending on cultural issues and resources available).

These elements were included either as a single intervention (mostly staff education and the introduction of an alcohol-based hand rub) or in an integrated approach in studies demonstrating that improved hand hygiene significantly reduces HAI and cross-transmission rates of potential pathogens.[1, 18] Multimodal interventions are considered the most effective.

Applicable Guidelines

The WHO Multimodal Hand Hygiene Improvement Strategy and the WHO Implementation Toolkit[19] have been developed to assist health care facilities to implement improvements in hand hygiene in accordance with

the WHO Guidelines on Hand Hygiene in Health Care. They have been pilot tested by the WHO in settings with different levels of resources and in a multicultural environment and produced significant improvement of practices, as well as HCWs' perception of HAI and its prevention, and their knowledge about hand transmission and hand hygiene. Furthermore, a substantial improvement was achieved in the facilities and equipment available for hand hygiene, including the low-cost provision of alcohol-based hand rubs through local production of the WHO-recommended formulations [14] where these were not available commercially.

Summary

Healthcare workers' hands play a crucial role in the transmission of microorganisms during the sequence of care and contact with environmental surfaces and patients' skin. Hand hygiene is the single most effective measure to prevent healthcare-associated infection. However, hand hygiene practice at the right moment with proper technique is usually sub-optimal among HCWs due to many constraints and behavioural factors. Improvement of practices can be achieved and lead to substantial reduction of transmission by multimodal strategies aimed at strengthening infrastructure, knowledge, and the institutional patient safety culture. The preferred use of alcohol-based hand rubbing as the gold standard for hand hygiene and the identification of the right moments for hand hygiene during patient care are essential elements for success. The World Health Organization has promoted innovative concepts and strategies to achieve hand hygiene improvement worldwide in close collaboration with other key players and stakeholders in the field of infection prevention and control, such as the International Federation of Infection Control.

Acknowledgement

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Table 10.1 World Health Organization Consensus Recommendations Hand Hygiene in Health Care, 2009

Recommendation by topic and grade according to the HICPAC ranking system*
1. Indications for hand hygiene
A. Wash hands with soap and water when visibly dirty or visibly soiled with blood or other body fluids (IB) or after using the toilet (II).
B. If exposure to potential spore-forming pathogens is strongly suspected or proven, including outbreaks of *C. difficile*, hand washing with soap and water is the preferred means (IB).
C. Use an alcohol-based handrub as the preferred means for routine hand antisepsis in all other clinical situations described in items D(a) to D(f) listed below if hands are not visibly soiled (IA). If alcohol-based handrub is not obtainable, wash hands with soap and water (IB).
D. Perform hand hygiene:
a. before and after touching the patient (IB);
b. before handling an invasive device for patient care, regardless of whether or not gloves are used (IB);
c. after contact with body fluids or excretions, mucous membranes, non-intact skin, or wound dressings (IA);
d. if moving from a contaminated body site to another body site during care of the same patient (IB);
e. after contact with inanimate surfaces and objects (including medical equipment) in the immediate vicinity of the patient (IB);
f. after removing sterile (II) or non-sterile gloves (IB).
E. Before handling medication or preparing food perform hand hygiene using an alcohol-based handrub or wash hands with either plain or antimicrobial soap or water (IB).
F. Soap and alcohol-based handrub should not be used concomitantly (II).

2. Hand hygiene technique

A. Apply a palmful of alcohol-based handrub and cover all surfaces of the hands. Rub hands until dry (IB).

B. When washing hands with soap and water, wet hands with water and apply the amount of product necessary to cover all surfaces. Rinse hands with water and dry thoroughly with a single-use towel. Use clean, running water whenever possible. Avoid using hot water, as repeated exposure to hot water may increase the risk of dermatitis (IB). Use a towel to turn off tap/faucet (IB). Dry hands thoroughly using a method that does not recontaminate hands. Make sure towels are not used multiple times or by multiple people (IB).

C. Liquid, bar, leaf or powdered forms of soap are acceptable. When bar soap is used, small bars of soap in racks that facilitate drainage should be used to allow the bars to dry (II).

3. Recommendations for surgical hand preparation

A. Remove rings, wrist-watch, and bracelets before beginning surgical hand preparation (II). Artificial nails are prohibited (IB).

B. Sinks should be designed to reduce the risk of splashes (II).

C. If hands are visibly soiled, wash hands with plain soap before surgical hand preparation (II). Remove debris from underneath fingernails using a nail cleaner, preferably under running water (II).

D. Brushes are not recommended for surgical hand preparation (IB).

E. Surgical hand antisepsis should be performed using either a suitable antimicrobial soap or suitable alcohol-based handrub, preferably with a product ensuring sustained activity, before donning sterile gloves (IB).

F. If quality of water is not assured (as described in Table I.11.3) in the operating theatre, surgical hand antisepsis using an alcohol-based handrub is recommended before donning sterile gloves when performing surgical procedures (II).

G. When performing surgical hand antisepsis using an antimicrobial soap, scrub hands and forearms for the length of time recommended by the manufacturer, typically 2–5 minutes. Long scrub times (e.g. 10 minutes) are not necessary (IB).

H. When using an alcohol-based surgical handrub product with sustained activity, follow the manufacturer's instructions for application times. Apply the product to dry hands only (IB). Do not combine surgical hand scrub and surgical handrub with alcohol-based products sequentially (II).

I. When using an alcohol-based handrub, use sufficient product to keep hands and forearms wet with the handrub throughout the surgical hand preparation procedure (IB).

J. After application of the alcohol-based handrub as recommended, allow hands and forearms to dry thoroughly before donning sterile gloves (IB).

4. Selection and handling of hand hygiene agents

A. Provide HCWs with efficacious hand hygiene products that have low irritancy potential (IB).

B. To maximize acceptance of hand hygiene products by HCWs, solicit their input regarding the skin tolerance, feel, and fragrance of any products under consideration (IB). Comparative evaluations may greatly help in this process.

C. When selecting hand hygiene products:

a. determine any known interaction between products used to clean hands, skin care products and the types of glove used in the institution (II);

b. solicit information from manufacturers about the risk of product contamination (IB);

c. ensure that dispensers are accessible at the point of care (see Part I.1 of the Guidelines for the definition) (IB);

d. ensure that dispensers function adequately and reliably and deliver an appropriate volume of the product (II);

e. ensure that the dispenser system for alcohol-based handrubs is approved for flammable materials (IC);

f. solicit and evaluate information from manufacturers regarding any effect that hand lotions, creams or alcohol-based handrubs may have on the effects of antimicrobial soaps being used in the institution (IB);

g. cost comparisons should only be made for products that meet requirements for efficacy, skin tolerance, and acceptability (II).

D. Do not add soap (IA) or alcohol-based formulations (II) to a partially empty soap dispenser. If soap dispensers are reused, follow recommended procedures for cleansing.

5. Skin care

A. Include information regarding hand-care practices designed to reduce the risk of irritant contact dermatitis and other skin damage in education programmes for HCWs (IB).

B. Provide alternative hand hygiene products for HCWs with confirmed allergies or adverse reactions to standard products used in the healthcare setting (II).

C. Provide HCWs with hand lotions or creams to minimize the occurrence of irritant contact dermatitis associated with hand antisepsis or handwashing (IA).

D. When alcohol-based handrub is available in the healthcare facility for hygienic hand antisepsis, the use of antimicrobial soap is not recommended (II).

E. Soap and alcohol-based handrub should not be used concomitantly (II).

6. Use of gloves

A. The use of gloves does not replace the need for hand hygiene by either handrubbing or handwashing (IB).

B. Wear gloves when it can be reasonably anticipated that contact with blood or other potentially infectious materials, mucous membranes or non-intact skin will occur (IC).

C. Remove gloves after caring for a patient. Do not wear the same pair of gloves for the care of more than one patient (IB).

D. When wearing gloves, change or remove gloves during patient care if moving from a contaminated body site to either another body site (including non-intact skin, mucous membrane or medical device) within the same patient or the environment (II).

E. The reuse of gloves is not recommended (IB). In the case of glove reuse, implement the safest reprocessing method (II).

7. Other aspects of hand hygiene

A. Do not wear artificial fingernails or extenders when having direct contact with patients (IA).

B. Keep natural nails short (tips less than 0.5 cm long or approximately ¼ inch) (II).

8. Educational and motivational programmes for healthcare workers

A. In hand hygiene promotion programmes for HCWs, focus specifically on factors currently found to have a significant influence on behaviour and not solely on the type of hand hygiene products. The strategy should be multifaceted and multimodal and include education and senior executive support for implementation. (IA).

B. Educate HCWs about the type of patient-care activities that can result in hand contamination and about the advantages and disadvantages of various methods used to clean their hands (II).

C. Monitor HCWs' adherence to recommended hand hygiene practices and provide them with performance feedback (IA).

D. Encourage partnerships between patients, their families and HCWs to promote hand hygiene in health care settings (II).

9. Governmental and institutional responsibilities

9.1 For healthcare administrators

A. It is essential that administrators ensure that conditions are conducive to the promotion of a multifaceted, multimodal hand hygiene strategy and an approach that promotes a patient safety culture by implementation of points B–I below.

B. Provide HCWs with access to a safe, continuous water supply at all outlets and access to the necessary facilities to perform handwashing (IB).

C. Provide HCWs with a readily accessible alcohol-based handrub at the point of patient care (IA).

D. Make improved hand hygiene adherence (compliance) an institutional priority and provide appropriate leadership, administrative support, financial resources and support for hand hygiene and other infection prevention and control activities (IB).

E. Ensure that HCWs have dedicated time for infection control training, including sessions on hand hygiene (II).

F. Implement a multidisciplinary, multifaceted and multimodal programme designed to improve adherence of HCWs to recommended hand hygiene practices (IB).

G. With regard to hand hygiene, ensure that the water supply is physically separated from drainage and sewerage within the healthcare setting and provide routine system monitoring and management (IB).

H. Provide strong leadership and support for hand hygiene and other infection prevention and control activities (II).

I. Alcohol-based handrub production and storage must adhere to the national safety guidelines and local legal requirements (II).

9.2 For national governments

A. Make improved hand hygiene adherence a national priority and consider provision of a funded, coordinated implementation programme while ensuring monitoring and long-term sustainability (II).

B. Support strengthening of infection control capacities within healthcare settings (II).

C. Promote hand hygiene at the community level to strengthen both self-protection and the protection of others (II).

D. Encourage healthcare settings to use hand hygiene as a quality indicator (II).

***Ranking system used to grade the recommendations** (Healthcare Infection Control Practices Advisory Committee [HICPAC] of the US Centers for Disease Control and Prevention [CDC]): IA= Strongly recommended for implementation and strongly supported by well-designed experimental, clinical or epidemiological studies. IB=Strongly recommended for implementation and supported by some experimental, clinical or epidemiological studies and a strong theoretical rationale. IC= Required for implementation as mandated by federal and/or state regulation or standard. II=Suggested for implementation and supported by suggestive clinical or epidemiological studies or a theoretical rationale or the consensus of a panel of experts

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Key Web Sites

1. Centers for Disease Control and Prevention: Hand Hygiene in Healthcare Settings. http://www.cdc.gov/HandHygiene/index.html [Accessed July 20, 2011]
2. Germs. Wash your hands of them: http://www.washyourhandsofthem.

com/home.aspx [Accessed July 20, 2011]
3. Hand Hygiene Resource Centre: http://www.handhygiene.org/ [Accessed July 20, 2011]
4. Institute for Healthcare Improvement (IHI): http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/Tools/HowtoGuideImprovingHandHygiene.htm [Accessed July 20, 2011]
5. Resource for Infection Control (NRIC): http://www.nric.org.uk/IntegratedCRD.nsf/CleanYourHands2010?OpenForm [Accessed July 20, 2011]