Current Infectious Disease Reports (2023) 25:123–129
https://doi.org/10.1007/s11908-023-00806-8

HEALTHCARE ASSOCIATED INFECTIONS (ME DOLL AND B RITTMANN, SECTION EDITORS)

# Healthcare Personnel Hand Hygiene Compliance: Are We There Yet?

JoDee Armstrong-Novak[1] · Hui Yu Juan[1] · Kaila Cooper[1] · Pamela Bailey[2,3]

Accepted: 25 April 2023 / Published online: 26 May 2023


## Abstract

**Purpose of Review** Poor hand hygiene is well documented as a factor in healthcare-associated infections and excellent rates of hand hygiene remains elusive.

**Recent Findings** There is increased use of universal or increased gloving to minimize hand contamination, but its use does not replace hand hygiene opportunities. There is significant interest in electronic hand hygiene monitoring systems, but they are not without their unique issues. Behavioral psychology remains a significant factor in motivating hand hygiene behaviors; even in COVID-19, hand hygiene rates initially improved but trended down back to baseline while still dealing with the pandemic.

**Summary** More emphasis should be placed on the how to properly perform hand hygiene and why it is so important, as well as the role of gloves, is needed. Continued investment and awareness of their status as role models from both system leadership and senior healthcare providers are needed.

**Keywords** Hand hygiene · Healthcare-associated infections · Infection prevention

## Introduction

Healthcare personnel's (HCP) hands are microscopically contaminated and are a vector for transmission of diseases within the healthcare environment [1, 2]. Healthcare-associated infections (HAIs) affect 1 in 31 patients hospitalized in the USA, and hand hygiene remains a critical component of infection prevention for all types of HAIs: central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), ventilator-associated pneumonia (VAP), and *Clostridioides difficile* [2]. Transmission of pathogens between the healthcare environment, healthcare workers, and patients, is facilitated by contaminated hands [1, 3•, 4]. In the outpatient setting, HCP in a wound care clinic acquired at 1 least pathogen on their hands during 28.3% of all patient care encounters [5]. An estimated 20% of HAIs from HCP hands are related to direct or indirect hand-to-mucosa contact, with the hands of HCP being the dynamic vector for transfer—though the "transfer efficiency" varies by organism, as well as other factors such as humidity and contact surface [6]. Of the multiple practices implemented in hospitals to prevent the spread of infections, hand hygiene (HH) is the simplest and most important. However, noncompliance with hand hygiene continues to plague healthcare centers and may represent a major contributor to further propagation of HAIs and the spread of antimicrobial resistance [1, 3•].

Evidence to support the importance of hand hygiene dates back to the 1860s in the time of Ignaz Semmelweis, the Hungarian physician who established the link between contaminated provider hands and puerperal sepsis in a maternity ward, even before Lister established antisepsis [7, 8]. Florence Nightingale is oft quoted "Every nurse ought to be

✉ Pamela Bailey
Pamela.bailey@uscmed.sc.edu

JoDee Armstrong-Novak
Jo.armstrongnovak@vcuhealth.org

Hui Yu Juan
juanhy@vcu.edu

Kaila Cooper
kaila.cooper@vcuhealth.org

[1] Virginia Commonwealth University Health System, Richmond, VA, USA

[2] Prisma Health Midlands, Columbia, SC, USA

[3] University of South Carolina School of Medicine, 2 Medial Park, Suite 205, Columbia, SC 29203, USA

careful to wash her hands very frequently during the day" [9]. Nevertheless, high levels of hand hygiene compliance are difficult to achieve and maintain among healthcare workers. Behavioral theory indicates that healthcare personnel (HCP) will perform "inherent" HH when hands are visibly soiled, sticky, or gritty; it is "elective" HH opportunities that abound in healthcare settings, as they do not trigger the intrinsic need to clean the hands [1]. This behavioral aspect of HH is difficult to address due to its complexity.

## Defining Indications for Hand Hygiene in the Healthcare Setting: 5 Moments

In 2005, WHO launched the Patient Global Safety Challenge, with the introduction of the "5 Moments of Hand Hygiene" in 2009 to reduce the spread of hospital-acquired infections [10]. The "5 moments" informs HCP of five different times that they should cleanse their hands during patient care: before patient contact, before aseptic procedure, after body fluid exposure, after patient contact, and after contact with patient environment [10]. This expanded on previous guidance from the Healthcare Infection Control Practices Advisory Committee (HICPAC) for HH before and after entering a patient's room [8]. In 2009, the WHO subsequently expanded the Patient Global Safety Challenge by launching a global campaign called "SAVE LIVES: Clean Your Hands," which helped translate pledges to improve HAI rates to real action at the point of care complete with a HH improvement toolkit [11, 12]. The campaign aims to unify individuals through promoting the improvement in HH and implementation of HH in healthcare in both high and low resourced settings.

## Compliance Targets

Neither the WHO or CDC define optimal HH compliance targets, but rather suggest each hospital define goals and aggressively monitor and feedback performance. Regulatory bodies have at times imposed a specific target, but current Joint Commission requirements for hospitals include being obligated to have a HH program that follows CDC and/or WHO HH guidelines, setting goals for improving compliance with HH guidelines, and improving compliance with guidelines based on those goals [13]. It is important to regulate HH compliance goals based on needs and ability of each participating hospital, while recognizing that no facility or personnel has achieved perfection in HH despite its importance to infection prevention.

One review notes that maximal use (95th percentile) may occur at around 140 uses of ABHR in a 12-hour shift, with peak of around 15 applications/hour [14]. The number of HH opportunities is highest in ICUs (11.4 per patient hour) and lowest in mother-baby units (3.4 per patient hour); mean and median numbers of medical and surgical units are 71.6 and 73.9 opportunities per patient day, with a median of 46.7 on day shift compared to 28.0 on night shift [3•]. This wide-ranging number of opportunities adds complexity to how to appropriately address the various motivators and barrier for HH.

Given the focus on HH as a critical patient safety effort, regulatory scrutiny, and all the efforts aimed at improving compliance, it would be expected that reported HH compliance in the literature may be improving over the last decade. While interventions can improve HH adherence, sustained and progressive improvement over time is not convincingly occurring in the healthcare setting. A 2015 systematic review noted HH compliance with median of 40%; unadjusted rates were lower in ICUs (30–40%) compared to other settings (50–60%). Physicians had lower compliance (32%) than nurses (48%), and lower HH rates were reported before patient contact (21%) compared to after patient contact (47%). Greater compliance is noted after dirty tasks [15]. A 2022 meta-analysis and systematic review using 2010 as the earliest point of analysis noted rates of 52% for nurses and 45% for doctors; there was significant heterogeneity in the analysis [16]. Some units/areas may have lower HH rates; for example, HH rates are lowest around anesthesia care, ranking at 2–18% [17].

A quasi-experimental study in 2006–2008 regarding implementation of the "5 moments" prior to its endorsement by the WHO in 2009 showed increased compliance with HH opportunities. Compliance was independently associated with gross national income (per head), with greater effect of the intervention (increasing HH compliance and knowledge) in low- and middle-income (LMIC) countries compared to high-income countries [18]. High-income countries went from 54.3 to 68.5% after the intervention; in LMIC, HH compliance was approximately 22.4% before intervention and 46.1% after; it did not vary significantly by category of health professional [18].

There are significant infrastructure issues in LMIC that add additional barriers to HCP compliance with ideal HH. In settings where basic knowledge and resources are scarcer than in high-income countries, innovation may be needed to bridge gaps which could lead to immediate and substantial progress, as well as significant return on investment—as seen in the pilot program for the WHO's "5 moments" [18].

## Measuring Compliance

Compliance is frequently measured through self-reporting, observation, or interventional approaches, all of which have biases (recall bias, observer bias, or Hawthorne effects)

[19•]. Perspectives matter: in a review of operating room and endoscopy staff, self-reported HH rates were 73% in the OR staff and 95% in the endoscopy staff, but in observation of the same staff, only 11% adherence was noted [20]. Direct observation is generally limited to entering and exiting the room, as observers wishing to remain anonymous cannot follow HCP into the room to ensure compliance with all "5 moments"; only 32.3% of episodes allowed for all "5 moments" to be reviewed [21]. Remote or video auditing can significantly increase HH compliance: from pre-implementation rates of 10% to post-implementation of 87.9%; from 30 to > 80% [22, 23]. There are ethical and legal concerns in some of these instances: in covert observation, patient harm can occur if lapses are not corrected; video recording has privacy issues [3•].

Many in infection prevention turn to electronic hand hygiene monitoring systems (EHHMS), but there remain significant pros and cons of their deployment. While EHHMS can guide focused interventions, maximize adherence, and therefore prevent transmission of nosocomial pathogens, there is a significant financial and time commitment in their deployment and maintenance. There is no debate about the sheer volume of data—hundreds of thousands if not millions of observations in one month depending on the size of the healthcare system; however, the presumed increase in compliance has yet to be linked to a decrease in HAIs. In an era of staffing difficulties, the initial costs of an EHHMS may be mitigated by the alleviation of training and paying observers; however, there are significant ongoing costs associated with maintaining the system as well [24, 25].

In the outpatient setting, a patient-as-observer audit card system noted that HCP HH compliance was 96.8% prior to direct contact. There was concordance with auditing by trained HCP, indicating that patient auditor data may be reliably used [26]. Using this method helps engage the patient in their care, is cost-effective, and is appropriate for settings where observers may not be unobtrusive [3•].

Whichever method or methods are utilized, it should be implemented in a way that enhances the culture of safety, results in credible and actionable data, and improves performance to the facility's HH goals. Suboptimal execution of any of these methods can result in biased data, failure to improve adherence, and potential workplace bullying [3•].

## Barriers: Their Motivators

Broadly, compliance with HH derives into motivational factors and perceptions of the work environment. Motivational factors include role modeling from peers and others in the organization. Students are influence by qualified staff, junior doctors by senior staff, and qualified staff also follow the practices of their peers—either compliance or noncompliance [19•]. Self-protection and how the individual perceives the need for protection at a specific task or additionally protecting their loved ones [19•]. Considering perceptions around the work environment, noted aspects that may influence HH compliance include resources, knowledge, information, and organizational culture. Resources include time available as well as facilities and appropriate staffing. Knowledge of both techniques around HH as well as the understanding of the importance is critical; audits also provide knowledge, particularly if given in real time or weekly [19•].

When evaluating HH compliance through qualitative research, themes emerged around social influence, acuity of patient care, self-protection, use of cues, resources, knowledge, information, and organizational culture [19•]. Barriers to compliance include high workload, specific tasks (particularly those of short duration, like dropping off a tray or only asking a question), or the "constant" use of sanitizer drying their hands [27].

Additional barriers noted are sex, being a physician rather than a nurse, working in an ICU, working during weekdays rather than the weekend, lack of time, lack of organizational support, and organizational culture [19•]. Prior studies in the OR and endoscopy suites have noted "inconvenience" and "forgetfulness" as HH barriers, as well as poor role modeling from senior staff [20]. Operational procedures may need to be targeted to special settings, like the OR [17].

Again emphasizing psychology, HCP were more likely to perform HH after a contaminating task than after other tasks, indicating that habit and a feeling of disgust may influence HH compliance [28•]. Of all the possible moments of HH, some may be more important than others. Chang et al. developed the concept of HH at "critical points of care" or critical HH [28•]. They looked at HH opportunities occurring between specific paired consecutive healthcare workers tasks, and found that omissions of HH often occurred prior to critical tasks such as moving to touch sterile sites or invasive devices. In fact, HCP were more likely to perform HH before non-critical tasks than critical or contaminated tasks [28•].

## Barriers: Data

Comparison of studies on HH is difficult, given variability in methods of evaluation, region, quality, indications or moments of HH included in the study, types of HCP, types of units, and types of facilities. Interventions in HH studies are seldom described in sufficient details, with appropriate context and theory of interventions to inform work done at other institutions; there is lack of consistent and standardized approaches to research in HH [17, 19•]. A 2022 meta-analysis in HH noted significant heterogeneity across the

studies, with moderate or high-risk bias in 96 of the 105 studies included [16]. Studies frequently do not report length of observation by trained observers or number of observations per observation period [16].

The variability and seemingly stagnant overall compliance rates raise the question of what a realistic target for HH compliance for healthcare facilities should be, which HH indications it should represent, and whether HCP are collectively on track to meet these goals.

## Barriers: Built Environment

Sanitizing stations are frequently empty, broken, hard to find, or obstructed—in addition to being awkwardly placed [27]. Qualitative research notes that if the dispensers are broken, empty, or at a distance, HCP do not seek out functioning dispensers [19•]. In a survey of Canadian and United States-based HCP, participants identified the most significant deterrents to HH as dispenser/sinks not in a convenient location (41%), being busy (36%), empty product dispensers (33%), and products drying out hands (32%). > 50% of the participants agreed or strongly agreed that they would be more likely to clean their hands when recommended if hand sanitizer was closer to the patient [29].

Many constraints exist around the built environment and access to dispensers for alcohol-based hand sanitizer as well as soap, water, and sinks. The visibility and accessibility of the dispensers improves HH occurrences [30]. Cues, like visibly seeing the dispensers, trigger memory, attention, and decision process to then trigger behaviors, are noted to have a varying degree of positive effect on HH compliance [19•].

## Contamination of Hands: to Glove or Not?

Nonsterile glove use reduces hand contamination during patient care activities, but also introduces risk of hand contamination during doffing as well as increased contamination of the patient care environment [3]. Universal gloving has been shown to decreased transmission of MDROs as well as viruses and other HAIs [31, 32]. However, in the 2009 guidance from the WHO, guidelines clearly stated "in no way does glove use modify hand hygiene indications or replace hand hygiene."[12] Rates of compliance with hand hygiene are noted to be lower in gloved encounters [33].

The decision to wear gloves generally related to emotions (fear, disgust, self-interest) and socialization (professional, organizational, and empathic), which varied from the motivation to perform HH (social influences, acuity of patient care, self-protection, and use of cues) as well as perception of the work environment (resources, knowledge, information, organizational culture) [27]. In discussion around gloving and hand hygiene, HCP indicated primarily gloving for their own protection and secondarily for patient safety [27].

There was less contamination of hands in ungloved encounters (14.6%) than in gloved encounters (19.6%), showing that gloves are not the protection that many may feel they are [5]. In one study, only 34% of HCP removed gloves in the CDC-endorsed method, and there was an overall contamination rate of 37% [34]. A mean decrease in colony forming units (CFU) was noted with gloved contact compared to ungloved contact in a laboratory experiment; however, gloves generally induce less forceful touch by wearers which may affect transfer of microorganisms and gloves facilitate transfer from fingers to surfaces more readily than ungloved hands [6].

There is ongoing discussion about the utility of HH prior to donning nonsterile gloves; it is associated with moment 1 of the "5 moments." A prospective randomized controlled trial of HCP showed no differences in CFU on agar plates of palm prints from those who donned gloves vs. those who performed HH and then donned gloves [35]. There was also increased time associated with HH prior to donning gloves, at 53.3 seconds compared to 21.8 seconds for direct gloving, which would add up throughout the shift—approximately 19 minutes for an ICU nurse in a contact precaution room they enter 1.5–3 times per hour in a twelve hour shift [35].

Clarity is key; take the example of a trauma setting with video-review of HH opportunities: only 3% were compliant with prior to patient contact, 0% before clean procedure, 15% after patient contact, and 2% after contact with the environment. Glove use was more common, occurring 69% of the time before patient contact and 47% after patient contact; HCP donned new gloves 75% of the time before bedside procedures. If glove use was incorporated into "appropriate" HH, compliance increased to 57% [36].

## Are HCP Improving Over Time? Look to COVID-19

COVID-19 should have emphasized the importance of HH in contamination of the healthcare environment (and the community environment) as well as emphasized the importance to self-protect via cleaning the hands. Self-protection is a driver of improved HH behaviors; however, even during the high-risk early days of the COVID-19 pandemic, sustained improvement in HH rates were not seen [37]. In a review of HH during the March–June 2020 period of the COVID-19 pandemic, COVID-specific units saw 10% increase in overall HH but the rest of the hospital saw 6% increase, when measured in direct observership to a pre-COVID period [38]. However, in a study of nine hospitals, this initially improved HH rate declined over time until by May 2020 rates were back to baseline, noting that

even during pandemic conditions, it is difficult to sustain improvements in HH performance [37]. In a comparison in HH from September 2019 through August 2020, daily compliance peaked in HH at 92.8% across all units on March 29, 2020, however declined to a daily nadir of 51.5% by August 15, 2020. This study suggests that high compliance is possible, yet difficult to sustain [39].

COVID-19 also contributed to shortages in alcohol-based hand sanitizer, as well as staffing shortages and chronic stress on HCP and healthcare system that derailed HH programs [3•].

## Are We Focusing on What Matters Most in Our HH Programs?

There are significant knowledge gaps around the importance of HH and its contribution towards HAIs. In some specific contexts, particularly in the OR, there may be lack of knowledge about HAIs and the connection to HH to translate into appropriate motivation and commitment to performing HH [17]. Physicians' reports of noncompliance arise from beliefs that the evidence supporting the effectiveness of HH for prevention of HAIs is not strong; they emphasize that self-protection was a motivating factor for HH [40]. In the global implementation pilot of the WHO's "5 moments" campaign, a knowledge survey about HH showed improvement in scores from 18.7 to 24.7% after education about the importance of HH. Score improvement was seen significantly in nurses, nursing auxiliaries and doctors compared to other professions [18].

Additionally, many HCP may not be aware of how to appropriately wash their hands or how to fully comply with HH standards. In a review of compliance with all surface covered through either hand sanitizer coverage or soap and water, only 7.9% of total providers appropriately covered all hand surfaces; this study was performed while observing and scoring coverage; therefore, the Hawthorne effect was presumably affecting responses and the actual number is even lower [41•]. In some studies, the distinction is made between "compliance" as the number of HH actions per the number of opportunities for HH compared to "fidelity" which describes the extent to which the key elements of intervention (in this case, HH guidelines) are followed: fidelity giving a more precise explanation of evidence-based practice [42]. In a comparison of compliance with fidelity to guidelines, there were discrepancies in fidelity in duration of hand rub as well as in staff education, particularly around jewelry, watches, and artificial nails [42].

Cure and Van Enk have developed a "usability" score to measure how user-friendly a location for a sanitizer dispenser is in terms of room layout and workflow. They evaluate seven usability characteristics: easily visible on entry, easy, and obstructed access, within arm's reach or < 1 step from entrance, visible from the point of care, along the physical workflow path, within arm's reach or < 1 step from the point of care, and placed at optimal height (85–100 cm above the floor) [43]. There was significant correlation between usability score, particularly around visibility and accessibility on entrance and exit to patient rooms, with the hand hygiene compliance rates of staff [43].

## Leadership Support

Leadership support for HH is at all levels; it has previously noted that role modeling of senior staff to more junior staff significantly impacts HH rates. Additionally, in the survey attached to the study of OR and endoscopy suite HH, medical students reported having been *discouraged* from practicing HH; other studies only note that medical students specifically mentioned role modeling can lead to noncompliance [20, 40]. In a qualitative study interviewing nurses and physicians, both attending and in training, as well as medical students, all participants expressed that personal beliefs around efficacy of HH as well as examples or behavior from senior hospital staff are of major importance for HH compliance [40]. Role modeling and peer support are critical pillars to HH accountability.

Accountability begins with the chief executive officer and other senior leaders who provide the organization prioritization of HAI prevention. They are accountable for providing adequate resources, including the necessary personnel and staffing ratios, equipment, and assistance to address noncompliance [3]. Their interventions may be directed towards unit-based managers and departmental leaders to improve team functionality, as unit-based or aggregated feedback, instead of individual feedback, may be better received [3].

## So, Are We There Yet?

All available literature suggests multimodal interventions are most successful at driving improvements to HH [1, 44]. A Cochrane review identified that multimodal approaches may be able to reduce infection rates; in their review, HH compliance appeared to be increased by feedback, education, cues, and intentional placement of alcohol-based hand rub [4].

Years after the introduction of the "5 moments" and the devastation that COVID-19 has wrought on healthcare systems, the time is ripe for renewed initiatives around HH. The increase in HAIs during COVID-19 means we need to emphasize the connection between HH and HAIs. Remember, Semmelweiss had few supporters and his work was almost forgotten, and Florence Nightingale noted, "True nursing ignores infection, except to prevent it" [7, 9]. While

HCP are tired and stretched thin after the last few years, we must continue the fight for improved HH behaviors.

Psychology and nudges are critically important to next iterations of interventions. Note that in a comparison of two hand hygiene health promotion posters, the one emphasizing broad benefits of HH to patients and staff was better received than the other one, which emphasized HH as a longstanding measure of infection control. The broad benefits poster was perceived as having stronger impact of communication, as well as received more attention and was more likeable [46].

From the beginning of HICPAC/CDC and WHO guidelines, behavioral psychology has been emphasized, but appears to be unevenly applied in interventions. Knowledge gaps are significant in how to appropriately wash hands, how to doff gloves without contamination of HCP hands, in how the hands of HCP are vectors (however transiently) for transmission of organisms, and the subsequent connection to HAIs. It is worth noting that significant HH campaigns began circa 2009, and said campaigns have not necessarily—even fourteen years later—reached all HCP. Any intervention needs to reach every single HCP, as a single noncompliant HCP can disproportionately disseminate pathogens within a unit or ward [47].

The role of gloves is worth further exploration, as prevalence of multidrug resistant organisms increases, so does glove use. Current literature does not support gloves replacing HH; however, their utility and motivating factors behind use needs further exploration.

Incentives work to induce compliance with HH: a study that bundled direct observation with accountability processes and financial incentives (through rebates) showed sustained improvement in HH for at least 2 years; they also saw decreases in standardized infection rates (SIR) for their HAIs [45].

## Conclusions

We have not achieved adequate compliance with HH opportunities; however, we have long had the tools that we need to get there—we just need to apply them appropriately and continue to chip away to improved patient safety and delivery of safe healthcare. More emphasis should be placed on the how to properly perform hand hygiene and why it is so important. Better understanding of the role of gloves, when to perform hand hygiene and change them, is needed. Continued investment and awareness of their status as role models from both system leadership and senior healthcare providers is needed.

### Compliance with Ethical Standards

**Conflict of Interest** The authors declare no competing interests.

## References

Papers of particular interest, published recently, have been highlighted as:
• Of importance


1. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect. 2009;73(4):305–15.
2. Current Report | Antibiotic Use | CDC [Internet]. 2021 [cited 2022 Oct 25]. Available from: https://www.cdc.gov/antibiotic-use/stewardship-report/current.html.
3.• Glowicz JB, Landon E, Sickbert-Bennett EE, Aiello AE, deKay K, Hoffmann KK, et al. SHEA/IDSA/APIC Practice Recommendation: strategies to prevent healthcare-associated infections through hand hygiene: 2022 Update. Infect Control Hosp Epidemiol. 2023;1–22. **A 2023 update to the hand hygiene compendium from a collaboration of national groups based in the United States.**
4. Gould DJ, Moralejo D, Drey N, Chudleigh JH, Taljaard M. Interventions to improve hand hygiene compliance in patient care. Cochrane Database Syst Rev [Internet]. 2017 [cited 2023 Mar 3];(9). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD005186.pub4/full.
5. Bingham J, Abell G, Kienast L, Lerner L, Matuschek B, Mullins W, et al. Health care worker hand contamination at critical moments in outpatient care settings. Am J Infect Control. 2016;44(11):1198–202.
6. King MF, López-García M, Atedoghu KP, Zhang N, Wilson AM, Weterings M, et al. Bacterial transfer to fingertips during sequential surface contacts with and without gloves. Indoor Air. 2020;30(5):993–1004.
7. Loudon I. Ignaz Phillip Semmelweis' studies of death in childbirth. J R Soc Med. 2013;106(11):461–3.
8. Morbidity and Mortality Weekly Report. MMWR. Recommendations and reports. U.S. Department of Health and Human Services: Public Health Service, Centers for Disease Control, Epidemiology Program Office; 2002. p. 336.
9. Lim F. Why Florence Nightingale still matters. Nursing 2023. 2010;40(11):46.
10. Hand Hygiene: Why, How & When? [Internet]. [cited 2023 Feb 16]. Available from: https://www.who.int/publications/m/item/hand-hygiene-why-how-when.
11. Storr JA, Engineer C, Allan V. Save lives: clean your hands: a WHO patient safety initiative for 2009. World Hosp Health Serv Off J Int Hosp Fed. 2009;45(1):23–5.
12. WHO guidelines on hand hygiene in health care [Internet]. [cited 2023 Feb 16]. Available from: https://www.who.int/publications-detail-redirect/9789241597906.
13. The Joint Commission. National patient safety goals effective January 2023 for the hospital program. [Internet]. [cited 2023 Mar 17]. Available from: https://www.jointcommission.org/-/media/tjc/documents/standards/national-patient-safety-goals/2023/npsg_chapter_hap_jan2023.pdf.
14. Boyce JM, Polgreen PM, Monsalve M, Macinga DR, Arbogast JW. Frequency of use of alcohol-based hand rubs by nurses: a systematic review. Infect Control Hosp Epidemiol. 2017;38(2):189–95.
15. Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol. 2010;31(3):283–94.
16. Bredin D, O'Doherty D, Hannigan A, Kingston L. Hand hygiene compliance by direct observation in physicians and nurses: a systematic review and meta-analysis. J Hosp Infect. 2022;1(130):20–33.

17. Erichsen Andersson A, Frödin M, Dellenborg L, Wallin L, Hök J, Gillespie BM, et al. Iterative co-creation for improved hand hygiene and aseptic techniques in the operating room: experiences from the safe hands study. BMC Health Serv Res. 2018;18(1):2.
18. Allegranzi B, Gayet-Ageron A, Damani N, Bengaly L, McLaws ML, Moro ML, et al. Global implementation of WHO's multimodal strategy for improvement of hand hygiene: a quasi-experimental study. Lancet Infect Dis. 2013;13(10):843–51.
19.• Smiddy MP, O' Connell R, Creedon SA. Systematic qualitative literature review of health care workers' compliance with hand hygiene guidelines. Am J Infect Control. 2015;43(3):269–74. **This gives guidance to the motivating factors which should inform quality improvement efforts.**
20. Pedersen L, Elgin K, Peace B, Masroor N, Doll M, Sanogo K, et al. Barriers, perceptions, and adherence: hand hygiene in the operating room and endoscopy suite. Am J Infect Control. 2017;45(6):695–7.
21. Chang NCN, Reisinger HS, Jesson AR, Schweizer ML, Morgan DJ, Forrest GN, et al. Feasibility of monitoring compliance to the My 5 Moments and Entry/Exit hand hygiene methods in US hospitals. Am J Infect Control. 2016;44(8):938–40.
22. Armellino D, Hussain E, Schilling ME, Senicola W, Eichorn A, Dlugacz Y, et al. Using high-technology to enforce low-technology safety measures: the use of third-party remote video auditing and real-time feedback in healthcare. Clin Infect Dis. 2012;54(1):1–7.
23. Armellino D, Trivedi M, Law I, Singh N, Schilling ME, Hussain E, et al. Replicating changes in hand hygiene in a surgical intensive care unit with remote video auditing and feedback. Am J Infect Control. 2013;41(10):925–7.
24. Schaffzin JK. Electronic hand hygiene monitoring systems are the wave of the future. Antimicrob Steward Healthc Epidemiol. 2022 ed;2(1):e89.
25. Doll ME, Pierce JW. Electronic hand hygiene monitoring systems: not worth the costs. Antimicrob Steward Healthc Epidemiol. 2022 ed;2(1):e126.
26. Le-Abuyen S, Ng J, Kim S, De La Franier A, Khan B, Mosley J, et al. Patient-as-Observer Approach: an alternative method for hand hygiene auditing in an ambulatory care setting. Am J Infect Control. 2014;42(4):439–42.
27. Baloh J, Thom KA, Perencevich E, Rock C, Robinson G, Ward M, et al. Hand hygiene before donning nonsterile gloves: healthcare workers' beliefs and practices. Am J Infect Control. 2019;47(5):492–7.
28.• Chang NCN, Reisinger HS, Schweizer ML, Jones ichael, Chrischilles E, Chorazy M, et al. Hand hygiene compliance at critical points of care. Clin Infect Dis. 2021;72(5):814–20. **It is important to note that while we focus on the 'Five moments,' there may be more nuance than that.**
29. Kirk J, Kendall A, Marx JF, Pincock T, Young E, Hughes JM, et al. Point of care hand hygiene—where's the rub? A survey of US and Canadian health care workers' knowledge, attitudes, and practices. Am J Infect Control. 2016;44(10):1095–101.
30. Cai H, Tyne IA, Spreckelmeyer K, Williams J. Impact of visibility and accessibility on healthcare workers' hand-hygiene behavior: a comparative case study of two nursing units in an academic medical center. HERD Health Environ Res Des J. 2021;14(2):271–88.
31. Yin J, Schweizer ML, Herwaldt LA, Pottinger JM, Perencevich EN. Benefits of universal gloving on hospital-acquired infections in acute care pediatric units. Pediatrics. 2013;131(5):e1515-1520.
32. Harris AD, Pineles L, Belton B, Johnson JK, Shardell M, Loeb M, et al. Universal glove and gown use and acquisition of antibiotic-resistant bacteria in the ICU: a randomized trial. JAMA. 2013;310(15):1571–80.
33. Fuller C, Savage J, Besser S, Hayward A, Cookson B, Cooper B, et al. "The dirty hand in the latex glove": a study of hand hygiene compliance when gloves are worn. Infect Control Hosp Epidemiol. 2011;32(12):1194–9.
34. Alhmidi H, Gonzalez-Orta M, Cadnum JL, Mana TSC, Jencson AL, Wilson BM, et al. Contamination of health care personnel during removal of contaminated gloves. Am J Infect Control. 2019;47(7):850–2.
35. Rock C, Harris AD, Reich NG, Johnson JK, Thom KA. Is hand hygiene before putting on nonsterile gloves in the intensive care unit a waste of health care worker time?—A randomized controlled trial. Am J Infect Control. 2013;41(11):994–6.
36. Haac B, Rock C, Harris AD, Pineles L, Stein D, Scalea T, et al. Hand hygiene compliance in the setting of trauma resuscitation. Injury. 2017;48(1):165–70.
37. Moore LD, Robbins G, Quinn J, Arbogast JW. The impact of COVID-19 pandemic on hand hygiene performance in hospitals. Am J Infect Control. 2021;49(1):30–3.
38. Hess OCR, Armstrong-Novak JD, Doll M, Cooper K, Bailey P, Godbout E, et al. The impact of coronavirus disease 2019 (COVID-19) on provider use of electronic hand hygiene monitoring technology. Infect Control Hosp Epidemiol. 2021;42(8):1007–9.
39. Makhni S, Umscheid CA, Soo J, Chu V, Bartlett A, Landon E, et al. Hand hygiene compliance rate during the COVID-19 pandemic. JAMA Intern Med. 2021;181(7):1006–8.
40. Erasmus V, Brouwer W, van Beeck EF, Oenema A, Daha TJ, Richardus JH, et al. A qualitative exploration of reasons for poor hand hygiene among hospital workers: lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection. Infect Control Hosp Epidemiol. 2009;30(5):415–9.
41.• Park HY, Kim SK, Lim YJ, Kwak SH, Hong MJ, Mun HM, et al. Assessment of the appropriateness of hand surface coverage for health care workers according to World Health Organization hand hygiene guidelines. Am J Infect Control. 2014;42(5):559–61. **It is not sufficient to just tell people how to wash their hands, but make sure they know how to do it, as this study effectively demonstrates the poor compliance with the actual technique.**
42. Korhonen A, Ojanperä H, Puhto T, Järvinen R, Kejonen P, Holopainen A. Adherence to hand hygiene guidelines – significance of measuring fidelity. J Clin Nurs. 2015;24(21–22):3197–205.
43. Cure L, Van Enk R. Effect of hand sanitizer location on hand hygiene compliance. Am J Infect Control. 2015;43(9):917–21.
44. Interventions to improve hand hygiene compliance in patient care - Gould, DJ - 2017 | Cochrane Library [Internet]. [cited 2023 Feb 16]. Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD005186.pub4/full.
45. Talbot TR, Johnson JG, Fergus C, Domenico JH, Schaffner W, Daniels TL, et al. Sustained improvement in hand hygiene adherence: utilizing shared accountability and financial incentives. Infect Control Hosp Epidemiol. 2013;34(11):1129–36.
46. Mackert M, Lazard A, Champlin S, Liang MC, Mabry A, Stroever S, et al. Take time. Save lives. Clean hands protect. A comparison of two hand hygiene health promotion posters. Am J Infect Control. 2014;42(5):530–2.
47. Temime L, Opatowski L, Pannet Y, Brun-Buisson C, Boëlle PY, Guillemot D. Peripatetic health-care workers as potential superspreaders. Proc Natl Acad Sci. 2009;106(43):18420–5.