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Major Article

Hand hygiene before donning nonsterile gloves: Healthcare workers' beliefs and practices

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Background: Understanding the perceptions and beliefs of health care workers (HCWs) regarding glove use and associated hand hygiene (HH) may be informative and ultimately improve practice. Research in this area is limited. This study examined the practices and beliefs of HCWs surrounding the use of nonsterile gloves and HH before gloving.

Methods: The study was conducted at 3 large academic US hospitals using a parallel convergent mixed-method design. To estimate compliance rates, the gloving and HH practices of HCWs were observed at entry to patient rooms for 6 months. Interviews were conducted with 25 providers, nurses, and nursing assistants to investigate their beliefs and perceptions of these practices.

Results: Observed HH compliance rates before gloving were 42%, yet in the interviews most HCWs reported 100% compliance. Observed compliance with gloving before entering contact precaution rooms was 78%, although all HCWs reported always gloving for standard and contact precautions. Most HCWs described using gloves more often than necessary. HCWs generally use gloves for their own safety and sanitize hands before gloving for patient safety. Numerous barriers to compliance with HH before gloving were discussed, including beliefs that gloves provide enough protection.

Conclusions: HH and glove use are highly intertwined in clinical practice and should be considered jointly in infection prevention improvement efforts.

Hand hygiene (HH) is an important strategy for preventing health care–associated infections.[1] However, compliance rates with HH among health care workers (HCWs) are in the range of 40%-60% and are typically lower at entry to patient rooms or before patient contact.[2,3]

Use of nonsterile gloves has been associated with lower HH compliance rates at entry to patient rooms or before patient contact[4,5] and when gloves are used inappropriately during patient care (eg, worn when not necessary, worn without changing when necessary).[4,6-8] The literature on the association between glove use and HH compliance after patient care or at room exit is mixed, with studies finding both better[9-13] and worse[4,5,7,14] HH compliance.

In a review of the qualitative literature on HH compliance, Smiddy et al[15] identified several factors associated with HH noncompliance and grouped them into a theoretical model of motivational factors (social influences, acuity of patient care, self-protection, and use of cues) and perceptions of work environment (resources, knowledge, information, and organizational culture). The qualitative literature on glove use is more limited but growing. Loveday et al[8,16] developed a framework of two categories of factors influencing the decision for the HCWs to wear gloves; emotions (fear, disgust, and self-interest) and socialization (professional, organizational, and empathic).

Although the literature on HH and glove use highlight some potential overlap in the factors influencing the two practices, qualitative research examining the two practices in tandem is limited.

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Understanding the perceptions, beliefs, and attitudes of the HCWs regarding glove use and associated HH practices may be informative and ultimately help improve practice. The purpose of this study was to examine the practices and beliefs of HCWs regarding their use of nonsterile gloves and HH before gloving at entry to patient rooms. Specifically, this study (1) compared observed and perceived (self-reported) compliance with glove use and HH before gloving, (2) examined HCWs' reasons for the practices, and (3) enumerated barriers to complying with HH before gloving.

METHODS

Study context and design

This study was part of a larger cluster-randomized trial of a time-saving strategy for HH before gloving—direct-gloving versus HH before donning gloves—conducted at 3 large teaching hospitals in the Eastern and Midwestern United States. The trial provides the context for this study; however, the results of the trial are not reported here. A convergent parallel mixed-method design was used to assess and compare compliance with glove use and HH.[17] The quantitative strand was based on the baseline data collected in preparation for the trial and included observed compliance rates with gloving and HH guidelines. The qualitative strand was based on interviews with HCWs and included self-reported compliance. There was minimal interaction between the two strands, and the results were compared only in the last stage of the analyses. The interviews were also used to examine the reasons of the HCWs for gloving and performing HH before gloving, and to assess barriers to complying with HH before gloving. Institutional review boards at the 3 institutions reviewed and approved the study protocol.

Quantitative data collection and analyses

During a 6-month baseline period in 2016, observers trained in World Health Organization methodology for HH observation[18] examined and recorded whether HCWs performed HH and donned gloves at entry to patient rooms. The study included hemodialysis units, pediatric wards, intensive care units (ICUs), and emergency departments (EDs); n = 33. Observations were limited to 15-minute intervals to minimize the Hawthorne effect.[19] Compliance rates for glove use and HH before gloving were calculated as a ratio of observed practices to opportunities for practice. Compliance rates for glove use were calculated only from observations at entry to contact precaution rooms for 2 reasons: (1) the use of gloves is clearly indicated and expected at entry to contact precaution rooms and, (2) in this study, observations at noncontact precaution rooms were recorded only when gloves were used and, thus, show 100% glove compliance.

Qualitative data collection and analyses

Interviews with 25 providers, nurses, and nursing assistants were conducted during site visits in 2017, to collect data on the perceptions of HCWs' practices and beliefs. A purposive sampling approach was used, where participants were recruited from 9 of the units involved in the trial (3 at each site), with a goal to recruit 1 provider, 1 nurse, and 1 nursing assistant on each unit to provide a wide range of perspectives. Interviews were conducted by the medical anthropologist on the research team (H.S.R.) and followed a semistructured format to inquire about key topics, including the gloving and HH practices of HCWs in a typical day, when and why they engage in those practices, and the barriers to complying with HH guidelines. After approaching the participants, providing them with an informational sheet, and obtaining their verbal consent, the interviews were recorded and later transcribed verbatim and anonymized before coding. Two investigators (J.B. and H.S.R.) coded 6 transcripts to develop a codebook, which consisted of priori questions and emergent themes.[20] They reconciled coding differences until agreement was reached. They then tested the codebook with 3 additional transcripts. One investigator (J. B.) coded the remaining 16 transcripts and examined the coded content within each theme to identify patterns of responses pertaining to glove use and related HH practices and beliefs. Using comparative analyses,[21] these response patterns were grouped into subcodes.

Qualitative data were collected after the units had been randomly selected for the trial. HCWs on the intervention units were instructed not to sanitize their hands before donning gloves (ie, direct gloving) and HCWs on the usual care units were instructed to keep sanitizing their hands before donning gloves. To assess whether this created any bias in our qualitative findings, responses between HCWs in the intervention and usual care groups were compared to assess any systematic differences.

Mixed-methods analyses

In the last analytical stage, self-reported compliance was compared with the overall observed compliance rates to identify similarities and differences between the two data sources. Because self-reported compliance did not vary between the units, the observed compliance rates were calculated across all units. To maximize comparability between self-reported and observed compliance, a separate set of rates were calculated in a subsample of the 9 units where interviews were conducted.

RESULTS

A total of 4,957 observations were made across the 3 study sites (33 units); 1,356 in the subsample of the 9 units, from which 25 HCWs were recruited for interviewing. Interview participants included 9 providers (5 physicians, and 4 nurse practitioners or physician assistants), 8 nurses, and 8 nursing assistants (Table 1). Table 2 provides an

Table 1
Description of interview participants and their units

Site	Unit type	Intervention or usual care	HCW types
1	Hemodialysis	Usual care	Physician, nurse, nursing assistant
	ICU	Intervention	Physician, nurse, nursing assistant
	Pediatrics	Intervention	Physician, nurse, nursing assistant
2	ED	Usual care	Physician
	ICU 1	Usual care	Nurse, nursing assistant
	ICU 2	Intervention	Physician assistant, nurse, nursing assistant
3	ED	Intervention	Physician, nurse, nursing assistant
	ICU	Intervention	Nurse practitioners (2), nurse, nursing assistant
	Pediatrics	Usual care	Nurse practitioner, nurse, nursing assistant

ED, emergency department; *HCW*, health care worker; *ICU*, intensive care unit.

Table 2
Interview themes pertaining to glove use and related hand hygiene practices

Theme	Description	N
Glove use	Use of gloves in a typical day, including descriptions of situations	25
HH before gloving	HH before gloving in a typical day, including descriptions of situations	25
Barriers to compliance	Factors and circumstances that help account for observed noncompliance with HH before gloving	25
Reasons to sanitize hands	The logic and rationale for HH before gloving	24
Reasons to wear gloves	The logic and rationale for wearing gloves in patient rooms	22
Habit	Direct and indirect indications of habituated glove use or HH	13

NOTE. N indicates the number of health care workers (out of 25) that discussed each theme.
HH, hand hygiene.

overview of the 6 overarching themes identified in qualitative analyses. Systematic differences were not identified between the HCWs from the intervention and usual care units, so all findings were combined and reported across the two groups.

The remainder of the results section includes subsections presenting mixed-methods findings on observed and perceived (self-reported) glove use and HH compliance, and qualitative findings on HCWs' perceptions and beliefs about their reasons for the two practices and barriers to performing HH before gloving.

Observed and perceived glove use and HH practices

In 3,821 of the observations at entry to contact precaution rooms (1,043 in the subsample), gloves were donned in 78% of the observations (75% in the subsample), and HH before gloving was performed 42% of the time (39% in the subsample). In the other 1,136 instances of observed glove use at entry into noncontact precaution rooms (313 in the subsample), HH was performed at a similar rate, 42% (38% in the subsample). Because self-reported compliance (presented next) did not vary between units, the observed compliance rates were calculated across all units (range across units: 11%-68% for HH, 40%-88% for glove use).

In contrast to the observations, all HCWs interviewed (n = 25) reported always gloving for standard and contact precautions. The majority of HCWs (n = 19) also reported using gloves in situations where they were not necessary (eg, all patient contacts, handling equipment). Additionally, in contrast to observed compliance rates, most HCWs (n = 22) reported always performing HH before gloving (typically hand sanitation with alcohol-based handrubs), and only 3 HCWs reported being "less than 100%" compliant. The following responses help to characterize the glove use and hand sanitation practices reported in the interviews:

> *"I wear gloves if my patient's on isolation, so gloves and gowns or mask. . .before entering the room. Anytime I'm doing anything with a central line, disconnecting medications, flushing them, things like that. Anytime I'm like changing diapers or like touching the patient directly, I put on gloves, even if they're not on isolation. Anytime touching the patient. Anytime I'm like changing sheets or linens, anytime I'm emptying anything in the bathroom, the toilet. That covers most of it."* (Site 1, pediatric nurse)

> "*I usually just always sanitize my hands before I go. . .in the patient's room, and then the gloves are in the room so, so it's just, it's kind of [in] the order of. . .care.*" (Site 3, ICU nurse practitioner)

Reasons for gloving and HH practices

HCWs reported several beliefs surrounding their own gloving and HH practices. HCWs indicated primarily gloving for their own protection (n = 22) and secondarily for patient safety (n = 19). Beliefs underpinning HH were more varied, where patient safety was the most commonly reported reason (n = 14). Several HCWs recognized the importance of HH for preventing cross-contamination, especially given contamination uncertainty. Other reasons for HH before gloving included the HCWs' own safety (as a "second barrier" to germs; n =2), and a few HCWs simply stated it is necessary to sanitize without specifying why (n = 3). However, other HCWs (n = 5) expressed doubts regarding the necessity of HH before gloving, but it was not clear whether they questioned its efficacy for patient safety or HCW safety. In addition to other rationales for HH, about one-half of the HCWs (n = 13) described HH in terms of "muscle memory" or "habit" (ie, automatically sanitizing when entering a patient room), which they were not consciously thinking about. The following quotes illustrate these responses:

> "*The reminder of that [to wear gloves] is actually me not getting infected with the patient's potential organisms. Once again, human nature, I mean. . .you want to protect yourself.*" (Site 1, ICU physician)

> "*In between patients, while you're out on the unit, I think you come in contact with a lot of different things that you're not aware of. They could potentially be harmful to a patient who is immunocompromised. I think it's just necessary [to] take that extra step [and sanitize hands before gloving.*" (Site 2, ICU nursing assistant)

> "*We're constantly like in and out of patient rooms, sanitizing our hands, so I mean it's like we're doing it countless times like throughout the day. So, like, I don't think it's 100% necessary to do it before putting gloves on.*" (Site 1, pediatric nurse)

> "*The hand sanitizer is right outside the room and you just kind of grab it on your way in and. . . I would have to make a mental note not to do that, like it would be very difficult for me, I think, to change that habit.*" (Site 3, ICU nurse practitioner)

Perceived barriers to compliance with HH before gloving

Interviewees also described several possible explanations for low compliance with HH before gloving that have been reported in the literature. These were their observations (eg, of their colleagues) and were typically not given as reasons for their own noncompliance. The various barriers may be related and influence compliance simultaneously (ie, co-occur in practice); however, they were analytically separated for clarity.

Workload (n = 16): HCWs reported noncompliance can occur when they are in a rush or because of high workloads. Because donning gloves on wet hands is unpleasant and hand sanitizer takes time to dry, HCWs may skip HH and just don gloves. HCWs may also simply forget HH, either because they are rushing or because they are preoccupied with patient care tasks or other things. For example, one physician said:

> "*A lot of the time, with the hand sanitizers, they can make your hands sticky, and it makes getting the gloves on the hands after that to be a*

little difficult. People are in a rush; they don't want the hands to dry before they put the gloves on." (Site 2, ED physician)

Task (n = 7): Specific tasks or process sequences (including the timing of the decision to perform HH) can also contribute to noncompliance. Chiefly, HCWs may skip HH if their visit to the patient room is of short duration or if they do not intend to have direct patient contact (eg, going in to ask a question). Some HCWs also noted that certain task sequences may prevent them from sanitizing before entering (eg, if they carry a food tray at room entry) or they decide to sanitize their hands and don gloves after they have entered the room and started talking to the patient. One nursing assistant described the influence of the task on noncompliance:

"Then, they might just be running in the room real quick, just to do something minor. So, they'll just put on the gown and gloves and run in and do what they have to and then sanitize when they come out." (Site 2, pediatric nursing assistant)

Context (n = 10): Both physical and cultural context can influence noncompliance. In terms of the physical context, sanitizers are sometimes unavailable, either because they are empty, broken, hard to find, or covered. Furthermore, several HCWs reported that placement of sanitizers before gloves (ie, outside patient rooms vs inside) serves as a prompt and necessitates that HH occurs before gloving. When gloves are outside the room or in a different location, HCWs may already be wearing gloves by the time they pass the sanitizer. In terms of the cultural context, some HCWs stressed the importance of role models, because they influence how others behave. Their absence (or noncompliant role models) may contribute to the culture of noncompliance. The following examples illustrate the importance of contextual factors:

"I really think it has a lot, honestly, to do with how things are set up. Like what we were just saying, where the gloves are placed. I mean if they're outside the patient's room, I could see how that would be a lot easier to grab the gloves, go inside a patient's room, and not [sanitize]." (Site 3, ICU nurse practitioner)

"*I think it's an environment thing, like hey, if the one person noticed it, you just have to say 'hey, foam in, foam out' or, you know... If you see someone foaming in or foaming out, then typically you are more likely to do it also... That's what I mean by like the environment."* (Site 3, ED nurse)

Individual-level factors (n = 14): HCWs may believe it is not necessary to perform HH before gloving, often because they believe gloves are protective enough or because they recently sanitized or they think it does not matter (ie, it is only about guideline compliance, not patient care). Some HCWs may experience skin problems because of frequent HH, which dries their skin, leading to cracking and at times to infections. These quotes highlight how individual-level factors may influence noncompliance:

"*They [HCWs] may not think that it's necessary since they're already putting the gloves on, so... Although the gloves are non-sterile, they may see them in their mind as sort of more sterile.*" (Site 1, pediatrics physician)

"[Sanitizer] is really irritating to the skin with excessive use, so people might not enjoy constantly [sanitizing] their hands and then becoming dry and cracked and painful." (Site 1, ICU nurse)

Several HCWs also recognized that emergencies (eg, when a patient is coding or about to fall) sometimes necessitate breaking the protocol, where there is insufficient time to perform HH (and often gloving, too) before attending to the emergency. Although HCWs generally do not consider such situations as opportunities for HH (and thus should not be considered noncompliance), several HCWs said that even in emergencies they often have time for HH or other protective measures.

DISCUSSION

Glove use is prominent among HCWs and can potentially undermine HH practices.[4,6-8] This study examined practices and beliefs surrounding glove use and HH before gloving, chiefly at entry to the hospital rooms of patients. The findings indicate high rates of glove misuse (overuse when not necessary, underuse for contact precautions), low rates of HH before gloving and highlight gaps between self-reported and observed practices. Furthermore, HCWs' rationales for the two practices indicate that HCWs wear gloves primarily for their own protection and sanitize hands largely for patient protection. Finally, HCWs enumerated several possible barriers to compliance, including workload and task characteristics, physical and cultural context, as well as the beliefs, attitudes, and knowledge of the individual.

These findings contribute to the literature indicating that glove use can reduce compliance with HH guidelines, particularly at entry to patient rooms.[4,5] Glove misuse, described in this study reflects the rates reported in the literature[4,7,8] and indicates that glove use may contribute substantially to HH noncompliance. There are several ways that glove use can undermine HH. First, glove use may undermine the motivation of HCWs to perform HH by shifting the motivation of self-protection to gloves. Qualitative studies for both HH[15] and glove use[8,16] indicate that fear and disgust (ie, self-protection) are strong motivators for the two practices. However, if wearing gloves satisfies this motivation, the motivation of the HCWs to sanitize their hands can diminish and then largely depend on the motivation to reduce cross-contamination and to protect patients. Second, HCWs also indicated that they (or their colleagues) are skeptical of the guidelines and the necessity to sanitize hands as frequently as required, particularly when gloves are also used. Although some may comply with the requirements regardless of their skepticism, glove use provides a convenient alternative. Finally, HCWs may find wearing gloves without sanitizing more acceptable because they do not need to don gloves on wet hands or wait for hands to dry, and it reduces the risk of skin dryness and irritation.

Our data indicate a large gap between observed and self-reported HH practices, whereas the gap is much smaller for gloving. Assuming that observer and recall biases are similar for gloving and HH, the difference between the gaps indicates that HCWs over-report or over-estimate their HH practices. Over-reporting can occur because of social desirability biases (ie, to conform to norms and ideals, HCWs report higher compliance than they know to be true) because HH is a prominent issue in debates about quality and safety of care. However, HCWs may also over-estimate their own compliance (beyond recall bias occurring at the time of the interview), where they think they are more compliant than is the case (ie, their HH intentions do not necessarily translate into actions). That may happen for various reasons, including the barriers identified in this study, such as high workloads and rushing, interruptions in sequences of tasks, and changes in the workplace environment (eg, location of gloves, availability of hand sanitizers). This may be particularly relevant for HCWs who have developed HH habits. Contextual cues (eg, characteristics of physical environment, other people, and action sequences) are essential drivers of habitual responses, and changes in the context can thus influence habit performance.[22]

Although this study cannot disentangle the contribution of the factors identified, it highlights several implications for research and practice. Foremost, glove use and HH are currently highly intertwined

in clinical practice and need to be considered as such when designing and researching infection prevention strategies. Although a combination of HH and glove use may be ideal for infection prevention,[23] this approach may come at a price of low compliance. An alternative approach would be to separate the two practices as much as possible, where either HH or glove use can be used, as appropriate (ie, depending on efficacy and safety shown in rigorously designed studies). Although less optimal, this approach may be more practical, leading to improved compliance and, potentially, provide higher net benefits for infection prevention. For example, donning gloves without prior HH[24] and disinfecting gloved hands during patient care episodes[25] may provide enough protection from cross-contamination. These strategies could be easier to follow in practice, improve underuse of gloves, and contribute to patient safety despite reducing rates of HH. However, reducing the use of gloves—both their overuse and reconsidering when they are necessary—may also be a viable strategy. Compared to usual care, universal gloving may not provide any additional protective effect[15] and appropriate HH may be effective in removing methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus* even when gloves are not used.[26] Furthermore, eliminating mandatory glove use for contact precautions can improve HH compliance, particularly before patient contact,[5] and may, thus, help improve overall patient safety. Although a firm evidence-base for efficacy and safety of such alternatives is needed (including possible unintended consequences, such as reduced compliance in other areas), these approaches may improve compliance by minimizing motivational conflicts and cognitive demands associated with requiring both glove use and HH, simplify work processes, and free up HCWs to focus more time on direct patient care. However, HCWs and patients may have misconceptions and gaps in knowledge of effective and necessary practices,[27] and, thus, future improvement efforts will need to address those gaps and educate all stakeholders, particularly when new evidence may contradict established beliefs.

We also need further research evaluating the role of work and workplace design (ie, contextual cues) on the ability for HCWs to develop appropriate and reliable work routines and HH habits. This may be particularly important for the situations that require both glove use and HH, where several factors may need to coalesce to ensure appropriate glove use and HH compliance. These efforts can include developing reliable systems for ensuring availability and functionality of hand sanitizers, assessing the effects of sanitizer (or sink) placement vis-a-vis gloves as cues for HH before gloving, and examining high-frequency task bundles to identify care sequences that allow HCWs to work efficiently while complying with recommended gloving and HH practices.

Limitations

These findings should be contemplated considering certain limitations. First, this study was part of a randomized trial and qualitative data were collected after randomization, which may have influenced the perceptions of HCWs. HCWs in the intervention and usual care groups received different sets of instructions, which may have led to differences in perceptions. However, we did not identify any systematic differences in responses between participants from the intervention and usual care units.

Second, because interviewees were not recruited randomly, the comparison between self-reported and observed data may have been influenced by selection bias. Although interviewees' units performed similar to other units on observed compliance, the interviewees may not be representative of their units (ie, may be high performers), which could explain the gap between the two data sources. However, several HCWs were recruited from most units (typically 3 from each unit), which partially ameliorated that issue.

Third, our qualitative sample primarily included physicians, nurses, and nursing assistants, and does not represent the whole range of HCWs and the types of work duties they perform in hospitals. This may have limited the variety of perspectives we have obtained, particularly regarding the reasons for glove use and HH and the barriers to complying with the guidelines. Although our results indicate prominent overarching themes, future studies can examine in more detail the patterns of beliefs and practices of the different types of HCWs.

Finally, all data were collected at 3 large academic hospitals from the Eastern and Midwestern United States and focused on compliance at entry to patient rooms, which limits generalizability to other settings and moments in patient care. Although the findings were largely consistent with the published literature, future studies need to validate these findings in other samples, settings, and in more diverse clinical situations.

CONCLUSIONS

Glove use can reduce compliance with HH recommendations at entry to patient rooms by modifying HCWs' motivation for HH and providing a convenient alternative for it. HCWs may not be fully aware of these effects and may overestimate their compliance with HH. Infection prevention improvement efforts need to consider the two practices in tandem and either identify ways to maintain adequate HH when gloves are used or identify situations where either HH or glove use may be enough.

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