Major Article

Hand hygiene compliance in a universal gloving setting

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Background: The use of gloves for every patient contact (ie, universal gloving) has been suggested as an infection prevention adjunct and alternative to contact precautions. However, gloves may carry organisms unless they are changed properly. In addition, hand hygiene is required before donning and after removing gloves, and there are scarce data regarding glove changing and hand hygiene in a universal gloving setting.

Methods: This nonrandomized observational before-after study evaluated the effect of education and feedback regarding hand hygiene. Compliance with hand hygiene and glove use was directly observed in a universal gloving setting at a 10-bed intensive care unit in a Japanese tertiary care university teaching hospital.

Results: A total of 6,050 hand hygiene opportunities were identified. Overall, hand hygiene compliance steadily increased from study period 1 (16.1%) to period 5 (56.8%), although there were indication-specific differences in the baseline compliance, the degree of improvement, and the reasons for noncompliance. There were decreases in the compliance with universal gloving and the incidence of methicillin-resistant *Staphylococcus aureus*.

Conclusion: It is difficult to properly perform glove use and hand hygiene in a universal gloving setting, given its complexity. Direct observation with specific feedback and education may be effective in improving compliance.

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Health care-associated infections (HAIs) are a major threat to patient safety, and the estimated 1.7 million HAIs each year in the United States are associated with significant health care costs and numbers of deaths.[1] Although there are no clear data regarding the overall effects of HAIs in Japan, Uematsu et al[2] recently reported that patients who received antimethicillin-resistant *Staphylococcus aureus* (MRSA) drugs had a longer median hospitalization (21 days vs 14 days) and higher in-hospital mortality rate (22.6% vs 12.2%), compared with patients who did not receive these drugs. The Centers for Disease Control and Prevention guidelines recommend a well-known 2-tier approach to infection control: standard precautions and transmission-based precautions.[3] However, the success of these precautions is limited by several factors, such as contact protection measures only being implemented after a patient has been colonized and diagnosed with a multidrug-resistant organism (MDRO) infection. Thus, active surveillance cultures are used to help limit the transmission of MDROs, although its sensitivity is limited

for specific MDROs and it may be prohibitively expensive for some health care facilities.[4-6] Furthermore, even if contact precautions are used, reports have described low rates of adherence to glove use, gown use, and hand hygiene.[7-9]

The use of gloves and gowns for all patient contacts (universal gloving and gowning) may help reduce the spread of microorganisms, including MDROs. For example, the Benefits of Universal Gloving and Gowning study, which was led by Harris et al,[10] demonstrated that universal gloving and gowning reduced MRSA acquisition by 40% at 20 medical and surgical intensive care units (ICUs) in 20 American hospitals. Furthermore, Yin et al[11] reported that universal gloving during the respiratory syncytial virus season was associated with significantly lower rates of bacteremia and central line-associated bloodstream infections in pediatric ICUs and bone marrow transplant units.

Although gloves are effective for protecting the hands of health care workers (HCWs) from contamination with MDROs, Girou et al[12] reported that failure to change or remove contaminated gloves was associated with a high risk of microbial transmission. Furthermore, in 2009, the World Health Organization (WHO) published guidelines regarding hand hygiene in health care settings[13] that clearly state that "in no way does glove use modify hand hygiene indications or replace hand hygiene." Therefore, removing and

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changing gloves plus appropriate hand hygiene are needed to make universal gloving successful. The WHO hand hygiene guidelines also indicate that direct observation is the gold standard for evaluating compliance, although the Benefits of Universal Gloving and Gowning study only evaluated compliance at room entry and exit. The present study is the first to evaluate hand hygiene compliance at all 5 of the WHO My 5 Moments for Hand Hygiene in a universal gloving setting using direct observation. We also evaluated the relationship between hand hygiene and gloving, as well as the effect of education on hand hygiene and glove use improvements.

MATERIALS AND METHODS

Study design and outcome

This nonrandomized, observational, before-after study evaluated hand hygiene compliance in an ICU using direct observation, as well as the effects of education and feedback. The primary outcome was hand hygiene compliance and the secondary outcomes were glove use compliance and MRSA incidence.

Study setting

This study was performed in the ICU of a tertiary care teaching university hospital with 992 beds in Nara, Japan. This ICU is a 10-bed unit that houses patients with acute-onset life-threatening diseases such as cardiopulmonary arrest, stroke, severe burns, and multiple trauma. All rooms have a single bed, with 1 alcohol gel dispenser near the bed and 1 sink with antiseptic soap and paper towels. Alcohol-based handrub was also available beside the personal computers that are located outside each room, the desk for preparing infusions, and the portable radiograph machine. Gowns and each size of disposable latex gloves were available in racks outside each private room. This ICU performed active screening for MRSA at admission for all inpatients using nasal swabs and the conventional culture technique, and had a policy of universal gloving (staff wore gloves whenever they entered all patient rooms). This policy had been implemented 3 years before this study because of an increase in the incidence of MRSA at that time.

Interventions

The study periods consisted of a baseline observational period (period 1: June 24, 2011-November 28, 2011) and 4 intervention periods (period 2: April 9, 2012-August 10, 2012; period 3: August 13, 2012-November 2, 2012; period 4: November 5, 2012-July 22, 2013; and period 5: July 26, 2013-November 18, 2013). During each period, direct observation of nurses' hand hygiene was performed by NK twice per week (at 9-10 a.m. and 1-2 p.m.) using the modified WHO direct observation method, which evaluates 5 opportunities for hand hygiene (before touching a patient, before clean/aseptic procedures, after body fluid exposure/risk, after touching a patient, after touching patient surroundings). Although the WHO hand hygiene technical reference manual recommends recording glove use only when hand hygiene is not performed, glove use in our ICU was always recorded to facilitate the evaluation of universal gloving compliance.

NK is a registered nurse who received a degree of master of science in infection control from the Tokyo Healthcare University. NK learned about direct observation using the WHO guidelines regarding hand hygiene in health care, a hand hygiene technical reference manual, and training films.[14] The nurses in the study ICU were informed that their clinical practices would be observed, and NK was given strict instructions to maintain a distance that would not interfere with the observed nurses' clinical care duties.

Several educational sessions were administered by NK or KK between each period to maximize the number of staff members who could attend, although not all staff members attended each session. The sessions involved a slide presentation of approximately 30 minutes' duration regarding the WHO My 5 Moments of Hand Hygiene, correct hand hygiene indications and techniques, and feedback based on the results of the direct observation. The educational sessions before period 4 and period 5 were specifically focused on appropriate hand hygiene before donning and after removing gloves.

Calculations

Hand hygiene compliance was calculated as the number of hand hygiene performances divided by the number of hand hygiene opportunities, according to the WHO definition. Universal gloving compliance was calculated as the number of glove uses divided by the number of hand hygiene opportunities. The relationship between glove use and hand hygiene was closely monitored and classified as hand hygiene noncompliance without wearing gloves (universal gloving noncompliance); hand hygiene noncompliance because of unchanged gloves; hand hygiene noncompliance when donning or removing gloves; hand hygiene compliance without wearing gloves (universal gloving noncompliance); and hand hygiene compliance with appropriate glove donning, removal, or changing. The overall incidence of MRSA infection or colonization was calculated by dividing the total number of MRSA-positive patients by the total number of patient-days at the ICU and multiplying the resulting value by 1,000.

Ethical considerations

This study was performed as a part of an infection control program in the hospital, and the requirement for ethical approval was waived.

RESULTS

During the study period, 6,050 hand hygiene opportunities were identified (period 1: 1,221, period 2: 1,611, period 3: 711, period 4: 1,696, and period 5: 811). Overall hand hygiene compliance increased from period 1 (16.1%) to period 5 (56.8%) ($P < .05$ based on χ^2 test for trend), and this increase was mainly related to handrubbing (from 7.0%-45.7%), rather than handwashing (from 9.1%-11.1%) (Fig 1).

The baseline compliance and the degree of improvement varied according to the specific indication (Fig 2). The baseline hand hygiene compliance was lowest before aseptic/clean procedures (3.3%) and highest after contact with a patient's environment (38.2%). Although the compliance improved for each indication over time, the compliances before aseptic/clean procedures and after body fluid exposure were low during period 3 and period 4. Therefore, we
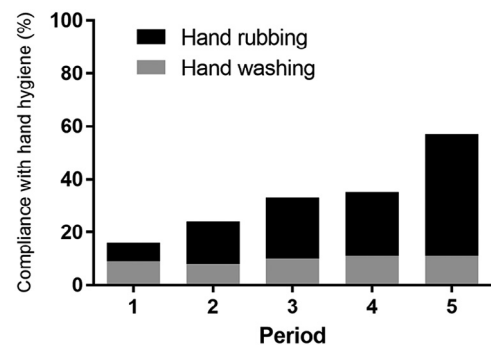

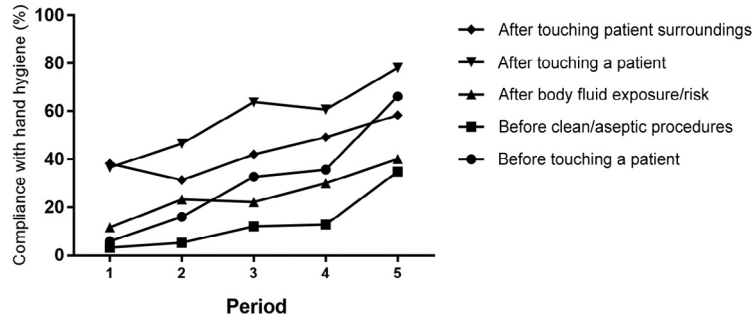**Fig 1.** Overall hand hygiene compliance during the study period.

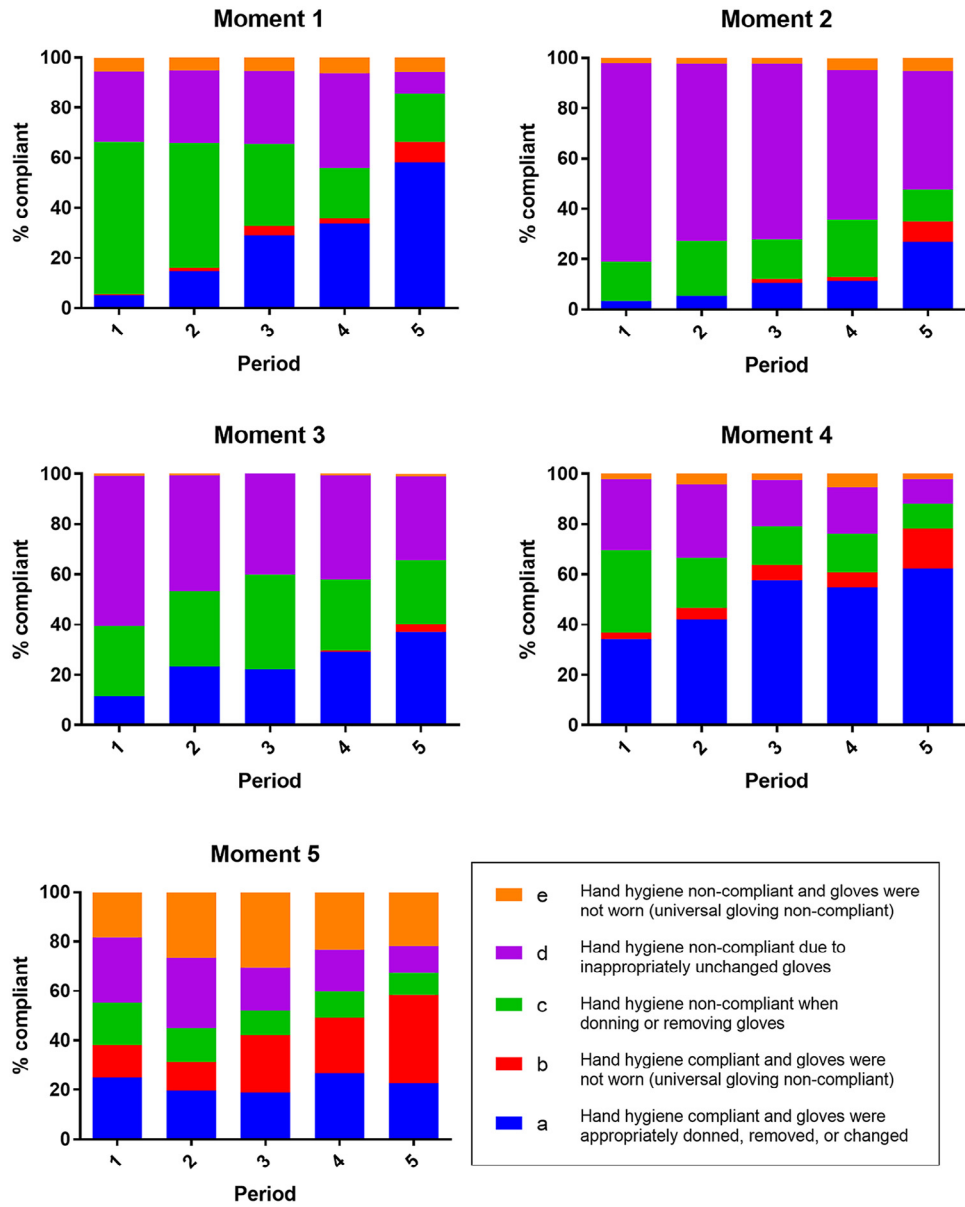**Fig 2.** Indication-specific hand hygiene compliances during the study period.

Fig 3. Hand hygiene compliance according to glove use.

further evaluated hand hygiene compliance according to glove use (Fig 3). The reasons for hand hygiene noncompliance also varied according to the specific indication. Before aseptic/clean procedures (moment 2), the major reasons for hand hygiene noncompliance

were unchanged gloves (ie, gloves that were already worn before the aseptic tasks because of the universal gloving policy) and hand hygiene not being performed (Fig 3d, moment 2). After body fluid exposure (moment 3), the major reasons for hand hygiene
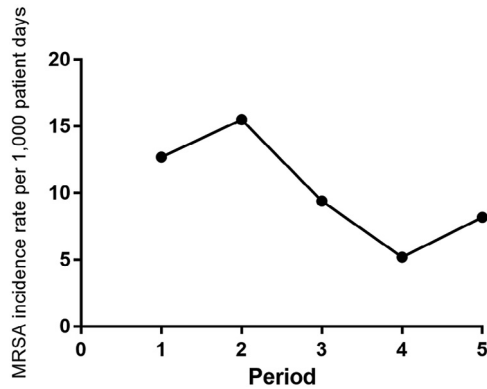
Fig 4. Methicillin-resistant *Staphylococcus aureus* (MRSA) incidence per 1,000 patient-days.

noncompliance were unchanged gloves (ie, gloves were not changed after body fluid exposure) or missed hand hygiene after removing gloves because of body fluid exposure (Fig 3c, moments 3 and 4).

Based on these findings, we focused on the importance of changing gloves during the education sessions after periods 3 and 4, especially in the context of the universal gloving setting and the need for hand hygiene before donning and after removing gloves. Hand hygiene compliance increased after the education sessions, although it was still lower than that for other indications.

Although hand hygiene compliance improved over time, universal gloving compliance decreased over time (Fig 3b, all moments). The incidence of MRSA also exhibited a declining trend during the study period (Fig 4).

DISCUSSION

Hand hygiene is generally considered the most important activity for preventing HAIs, although a WHO review of hand hygiene studies found that the average baseline hand hygiene compliance rate among HCWs was only 38.7% (range, 5%-89%).[13] To the best of our knowledge, our study is the first to evaluate hand hygiene compliance in a universal gloving setting based on direct observation according to the WHO My 5 Moments of Hand Hygiene guideline. The baseline hand hygiene compliance rate in the present study was low (16.1%), although the hand hygiene compliance rates varied significantly according to the specific indication, with the highest rate being observed after a patient's environment. Similarly, several studies have reported better hand hygiene compliance when gloves were used, which may have been related to a simultaneous increase in hand hygiene compliance after room exit and glove removal.[10,15]

The present study also revealed poor hand hygiene compliance before patient contacts, before aseptic/clean procedures, and after body fluid exposure. Furthermore, there was limited improvement before aseptic/clean procedures and after body fluid exposure. However, the reasons for noncompliance varied according to the specific indications. For example, most noncompliance before patient contact was related to the nonperformance of hand hygiene before donning gloves. In contrast, most noncompliance before aseptic/clean procedures was related to gloves not being changed. These findings are useful for understanding hand hygiene noncompliance, and may help develop plans to improve hand hygiene compliance in universal gloving settings.

Improvements in HCW behaviors are best achieved through staff education, including audits and providing feedback, and this approach has been shown in multiple studies to effectively prevent HAIs.[16] Furthermore, hygiene evaluation and training based on audits, feedback, and education are key elements of the WHO multimodal hand hygiene improvement strategy.[13] Moreover, reporting the results of hand hygiene observation based on the WHO My 5 Moments is recommended, because the effect of feedback is improved when the different moments are individually discussed and addressed.[13]

Hand hygiene indications in universal gloving settings are extremely complicated and require specific instructions to increase compliance. For example, the present study revealed limited improvements in compliance before aseptic/clean procedures and after body fluid exposure that were related to the wearing of unchanged gloves because of the universal gloving policy. Thus, the education sessions after periods 3 and 4 focused on the importance of changing gloves and performing hand hygiene before aseptic/clean procedures and after body fluid exposure. We believe that any improvements in hand hygiene would have been impossible without this specific education and feedback. Therefore, in special populations, such as nurses working in a universal gloving setting, feedback and education based on direct observation (with some modifications of the observation sheet) may be effective for improving hand hygiene compliance.

The ultimate aim of hand hygiene is to prevent HAIs, and several studies have demonstrated that hand hygiene may reduce the rates of health care-associated colonization or infections with MRSA, *Clostridium difficile*, and other MDROs.[13] The incidence of MRSA decreased in the present study, which may have been related to the implementation of universal gloving at the start of the intervention. However, no other infection control strategies (other than hand hygiene) were changed during the intervention, which suggests that the decreased MRSA incidence was related to improvements in hand hygiene compliance.

Another interesting finding is that the universal gloving compliance gradually decreased, whereas the hand hygiene compliance increased during the study period. Multiple studies have revealed that glove use is associated with poor hand hygiene compliance, which is related to a failure to change or remove contaminated gloves.[12,17] However, our results indicate that poor glove use compliance was associated with improved hand hygiene compliance. We assume that the improved hand hygiene compliance may have compromised the use of gloves, or may have improved the HCWs' understanding that hand hygiene is more effective than universal gloving.

There are several limitations to this study. First, this study was performed in a single ICU, and the results may not be generalizable to other wards or medical facilities. Second, we only observed nurses because hand hygiene compliance among physicians is generally poor, and further studies are needed to evaluate compliance among various types of HCWs. Third, the observations were only performed during the daytime and the results may not represent hand hygiene compliance throughout the entire day. Fourth, the findings were likely affected by the Hawthorne effect, which is inherent to direct observation studies, and the compliance rates might have been artificially elevated.

CONCLUSIONS

We performed direct observation of hand hygiene compliance in an ICU with a universal gloving policy and provided stepwise feedback and education. The hand hygiene compliance rate gradually increased, with decreases in universal gloving compliance and MRSA colonization. These results indicate that the relationship between hand hygiene and glove use is complicated in universal gloving settings, which highlights the importance of specific and thorough education to ensure the success of universal gloving.

Acknowledgments

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