An evaluation of hand hygiene in an intensive care unit: Are visitors a potential vector for pathogens?

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Summary Patients in an intensive care unit (ICU) are frequently immunocompromised and might be highly susceptible to infection. Visitors to an ICU who do not adequately clean their hands could carry pathogenic organisms, resulting in risk to a vulnerable patient population. This observational study identifies pathogens carried on the hands of visitors into an ICU and investigates the effect of hand hygiene.

Two observers, one stationed outside and one inside the ICU, evaluated whether visitors performed hand hygiene at any of the wall-mounted alcohol-based hand sanitizer dispensers prior to reaching a patient’s room. Upon reaching a patient’s room, the dominant hand of all of the participants was cultured.

Of the 55 participating visitors, 35 did not disinfect their hands. Among the cultures of those who failed to perform hand hygiene, eight cultures grew Gram-negative rods and one grew methicillin-resistant Staphylococcus aureus. Of the cultures of the 20 individuals who performed hand hygiene, 14 (70%) had no growth on the cultures, and the remaining six (30%) showed only the usual skin flora.
Introduction

Multidrug-resistant organisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* and carbapenem-resistant *Enterobacteriaceae*, present a significant challenge in the current healthcare environment [1]. Whereas these infectious agents are most commonly transmitted from patient to patient on the hands of healthcare workers, the involvement of visitors in patient-centered care in intensive care units (ICU) has major implications for healthcare-associated infections (HAI) [2]. If visitors carry certain pathogenic organisms on their hands and do not practice hand hygiene (HH) upon entry to the ICU, a vulnerable patient population might be at increased risk for infection [3]. These pathogens could include MRSA, *Escherichia coli*, *Proteus*, and *K. pneumoniae*, all of which are capable of causing life-threatening infections.

Although alcohol-based hand sanitizer (ABHS) is readily available throughout hospitals, its use among visitors is rarely evaluated or enforced [4,5]. For this study, we hypothesized that visitors might be colonized with pathogens that are potentially dangerous, particularly to immunocompromised patients [6]. Therefore, we assessed the potential role of visitors as a vector of pathogenic organisms by culturing their hands upon entry to an intensive care unit (ICU) in an academic medical center.

Materials and methods

Study design

This observational study was granted exemption by the University’s Institutional Review Board as part of a safety and quality assurance initiative in an ICU of a tertiary care teaching hospital. The ICU has a central nurses’ station and individual patient rooms. The entrance door to the closed unit must be electronically unlocked by an ICU staff member for a visitor to gain entry. Directly adjacent to the call button for ICU entry is a wall-mounted alcohol-based hand sanitizer dispenser.

Two observers, one stationed outside and one inside the ICU, evaluated whether visitors performed HH at any of the wall-mounted ABHS dispensers prior to reaching the patient’s room. The observers were unobtrusively located, and visitors were not told that they were being observed. All of the visitors who sought admission to the unit during an observation period were asked to participate if they had not previously participated. Upon reaching the patient’s room, each visitor was asked if he or she had performed HH before entry to the ICU and if he or she would volunteer to have his or her hand cultured as part of a hospital-wide initiative to reduce infection. The study was performed during visiting hours over a four-week period in the morning, afternoon, and evening. To ensure that there was no duplication on different days, the same observer approached the visitors and excluded anyone who had been previously cultured. In addition, each visitor was asked if he or she had already participated in the initiative and was not included if he or she had been previously cultured.

The cultures were taken from the visitor’s dominant hand using the following imprint technique: first, four fingers (second through fifth) were imprinted (approximately 2 inches) for 3 s, followed by the thumb pad for another 3 s (all on the same plate). We selected the dominant hand because previous studies have shown that this hand tends to be the more contaminated [7,8]. The culture was a solid blood agar plate (trypticase soy agar with 5% sheep blood [TSA II]-BD) which is non-selective.

The same experienced investigator performed all of the cultures and was blinded to whether the specimens were from visitors who had or had not disinfected their hands. After 24 h of incubation at 37 °C, the total number of colony forming units (CFU) was counted and the organisms were determined based on the color and morphology. The microbiological workup was performed by the microbiology technologist assigned by the Infection Control Department to work on quality improvement projects pertaining to hands or environmental contamination. The organisms were identified by gross morphology, including Gram staining; rapid tests, such as those for catalase, coagulase, and oxidase; the Kirby Bauer susceptibility test; and
Vitek®2 (bioMérieux, Inc., Durham, NC, USA). The final species identification was performed using Vitek®2 by a technologist who was blinded to the HH group. Microorganisms considered to be typically associated with serious healthcare-associated infections (e.g., MRSA, Escherichia coli, Klebsiella pneumoniae, Proteus, S. maltophilia, and Enterobacter spp.) were determined and quantified.

Statistical methods

The outcomes were dichotomized based on positive hand cultures (yes/no) and the presence of pathogenic organisms (yes/no). A Chi-square test for equality of proportions was used to determine whether the proportions in the group that performed HH were significantly different from those of the group that did not perform HH. Fisher’s exact test was used when the expected values in any cell dropped below five. The 0.05 significance level was considered statistically significant. SAS 9.2 (SAS Institute, Inc., Cary, NC, USA) was used for all of the analyses. This study was observational, with a convenience sample of 55 ICU visitors, and no a priori power analysis was performed.

Results

A total of 55 individual visitors were observed entering the ICU. Twenty performed HH, and 35 did not.

All 55 visitors agreed to have their dominant hand cultured. No visitor declined to participate. All of the cultures of those who did not perform hand hygiene were positive for bacterial growth. Those who did not perform HH had significantly higher average CFU counts compared to those who did perform HH (89.3, range: 1—310 vs. 0.9, range: 0—6; \( p < 0.001 \)) and were more likely to have positive cultures (100% (35/35) vs. 30% (6/20); \( p < 0.001 \)). Of the 35 visitors who did not perform hand hygiene, nine visitors (26%) had cultures that were positive for 12 pathogenic organisms frequently associated with HAI, as follows: eight grew Gram-negative rods and four grew Staphylococcus aureus. One visitor who did not perform HH was positive for MRSA.

Of the 20 visitors who performed hand hygiene, none were positive for growth of pathogens typically associated with HAI, and six (30%) had no growth on the cultures. The mean number of colony forming units (CFU) per plate was 89.3 in the group that did not perform HH (range 1—310) and 0.9 in the group that performed HH (range 0—6) \( (p < 0.001) \) (Table 1).

Among the 35 visitors who failed to perform HH, 15 (42.8%) stated that they had performed HH. No visitor was challenged on their failure to clean their hands.

Discussion

ICU patients are particularly vulnerable to infections, which might lead to increased morbidity and mortality [4]. It has been suggested that HAI are becoming increasingly resistant to standard treatment and that hand hygiene programs targeted to patients and their families should be promoted as a collaborative effort to improve compliance.

This study attempts to quantify the types and amounts of pathogenic organisms of ICU visitors who did not perform HH and to compare them with those of visitors who did perform HH. In particular, the evaluation of the number of CFUs and the presence of microorganisms considered to be typically associated with HAI (such as MRSA, E. coli, Enterobacteriaceae, and K. pneumoniae) were quantified. Whereas there were considerable and statistically significant differences in the culture results between those visitors who did and did not perform HH, hand hygiene compliance with ABHS did not totally eliminate bacterial colonization of the hands. However, of the cultures of the 20 visitors who performed hand hygiene, none grew pathogens commonly associated with HAI, and six of these cultures from HH-compliant visitors grew no bacteria at all on the cultures.

Table 1  Culture results from the dominant hand of fifty-five visitors to a surgical intensive care unit.

<table>
<thead>
<tr>
<th></th>
<th>( n )</th>
<th>CFU/cult(^a)</th>
<th>Positive cultures(^b)</th>
<th>Pathogenic organisms(^c,d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hand hygiene</td>
<td>35</td>
<td>89.3 ± 14.3</td>
<td>35 (100%)</td>
<td>9 (25.7%)</td>
</tr>
<tr>
<td>Hand hygiene</td>
<td>20</td>
<td>0.9 ± 0.3</td>
<td>6 (30%)</td>
<td>0</td>
</tr>
<tr>
<td>( p ) value</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
<td>0.019</td>
</tr>
</tbody>
</table>

\(^a\) Mean ± SE; CFU/culture analyzed with a negative binomial regression.

\(^b\) % of visitors with positive hand cultures analyzed with Fisher’s exact test.

\(^c\) % of visitors with pathogenic organisms analyzed with Fisher’s exact test.

\(^d\) MRSA, E. coli, K. pneumoniae, Proteus, S. maltophilia, and Enterobacter spp.
We hypothesize that these data support policies that should require HH among visitors to ICUs. Appropriate and validated signage, with visitor and family education, might be important if higher rates of HH among ICU visitors are to be achieved. It has been reported that visitors who receive specific instructions regarding the importance of hand washing from ICU nurses have very high compliance rates, as measured by video surveillance [9].

It is possible that many ICU visitors do not understand the importance and rationale for HH in hospitals. One of our findings, however, suggests that some of our visitors who did not wash their hands might know that they should be performing hand hygiene or, alternatively, might be confused regarding this activity. When asked, 43% of those who had not performed HH stated that they had. It is possible that they misunderstood the question and thought that HH was required only when first entering the hospital. Although it is unknown whether the visitors performed HH in the hospital lobby or in the hallways leading to the ICU, hand hygiene in the lobby among hospital visitors has been shown to be very low [10]. In addition, the positive culture results suggest that they had not cleaned their hands at any point prior to reaching the ICU. Although they were not directly questioned, it is possible that visitors who did not perform HH might not have understood the implications of hand hygiene in an ICU, or based on non-specific signage, might have thought that HH need only be performed by healthcare workers.

Recent evidence suggests that visitors do not appropriately perform hand hygiene [3] but do frequently make contact with the patient’s skin and blood or body fluids, potentially leading to infection [11,12]. Frequent hand washing is a protective factor for infection and could theoretically reduce this risk via contaminated hands [13]. This finding underscores the importance of specific hand hygiene education, particularly in an ICU setting, and reinforces the need for a "multimodal, multidisciplinary" approach [14]. Additionally, it is possible that increasing HH compliance among visitors might influence healthcare workers to engage in appropriate hand hygiene compliance as well [11]. Future studies should include interviews with ICU visitors to better understand why they do or do not perform hand hygiene.

This study has several limitations. First, we did not follow the visitors from their point of entry into the hospital and are therefore unaware of whether they performed HH in the hospital lobby prior to arrival at the ICU. Second, we did not attempt to culture the patients to determine whether they became colonized or infected by the bacteria isolated from their visitors’ hands, nor did we evaluate the potential transmission from patient to visitor. Third, the imprint method used in this study is a gross measure of hand contamination and colonization and merely serves as a screen. Fourth, we did not collect data with regard to variables that might have been associated with the degree of hand contamination among visitors such as age, relationship to the patient, point of origin (e.g., home, work), or mode of transportation to the hospital. We did not obtain this information because we wanted to interfere as little as possible with the normal flow of the unit. Fifth, because ICU environmental cleaning occurs throughout the day and our visitors had hand cultures performed before they had contact with any ICU surfaces, we did not attempt to correlate the time of the culture with environmental cleaning. Last, we did not evaluate seasonal variations because the study was performed during one month in the same season, and the temperature variations in southern Florida were minimal and considered to be non-contributory.

It has previously been reported that hospital visitors might play a role in infection prevention. Furthermore, it has been suggested that to win the battle against HAI, we need a coordinated effort to enforce hand hygiene that includes patients, families, and visitors [14]. In addition to better signage and visitor education, other ICU approaches, such as forced functionality (i.e., ICU doors that will not open if ABHS is not used) or a concierge/gatekeeper who directly places ABHS on visitors’ hands upon ICU entry, might be considered.

Conclusions

The lack of hand hygiene compliance among visitors in this study is clear, and the bacterial culture results suggest that visitors might pose a risk to ICU patients. We suggest that it is time to safeguard our most vulnerable patients by engaging their families and visitors in the fight against HAI.

Funding

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Competing interests

None declared.
Evaluation of visitor hand hygiene in an ICU

Ethical approval

Granted exempted status.

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References