



Evaluation of Hand Hygiene Compliance among Adult Intensive Care Units' Visitors and Their Role as a Vector of Pathogens

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General Note



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ABSTRACT

Background: Patients admitted to intensive care units (ICUs) show an increased rate of health care-associated infections. Visitors play important role in the well-being of hospitalized patients, but unfortunately, they occasionally expose them to infection. Hand hygiene (HH) is considered the most important measure for preventing health care-associated infections. **Objective:** The aim of this study was to investigate HH compliance among ICU visitors, the role of visitors in transmission of infection, and the types of pathogens involved. **Methods:** The observers stationed outside and inside the ICU evaluated whether visitors performed hand hygiene at any of the wall-mounted alcohol-based hand sanitizer dispensers prior entering the ICU room. At entry of the ICU, a hand swab was taken from the welling visitor and another one was taken after existing in the ICU. The swabs were sent to the microbiology laboratories. **Results:** A total of 356 visitors were observed and participated in this study. Approximately one-fourth (26.4 %) of the study participants washed their hands with the existing alcoholic solution before entering the ICU. Among the 16 visitors who were positive for pathogenic organisms after exiting in the ICU, 13 did not perform hand hygiene before entering the ICU. Methicillin-resistant staphylococcus aureus was the only isolated Gram-positive organism either before or after the ICU entry. Antibiotic sensitivity testing revealed resistance to benzylpenicillin, erythromycin, and clindamycin. The patterns of antibiotic sensitivity/resistance of the isolated Gram-negative organisms revealed multidrug resistance. **Conclusions:** These results indicate poor hand hygiene compliance among ICU visitors. The visitors who did not perform hand hygiene before entering the ICU frequently showed pathogenic organisms and they posed a risk for ICU patients. In addition, the spectrum of the isolated bacterial species was diverse, and they showed a multidrug resistance pattern to different classes of antibiotics.

Keywords: intensive care unit, hand hygiene, compliance, visitors, hand swab, multidrug resistance.

1. INTRODUCTION

Health care-associated infections are important public health issue that represents a major threat to the patient's safety (Haque et al., 2018). They result in greater hospital stay, unfavorable outcomes including increased morbidity and mortality, and higher health care costs (Loftus et al., 2019). Patients admitted to intensive care units (ICUs) show an increased rate of health care-associated infections both in high and low-income countries. This has been attributed to the critical underlying disease, low immunity, and the invasive nature of life saving procedures (Plachouras et al., 2018). Visitors play important role in the well-being of hospitalized patients. Unfortunately, they occasionally expose them to infection (Hei et al., 2018). Microorganisms accumulate on visitors' hands over time after contact with their secretions, mucous membranes, and/or surfaces, which can transmit them to susceptible patients (Siegel et al., 2007; Albassri et al. 2020; Faghani et al. 2020).

The most important measure to prevent health care-related infections is considered to be hand hygiene (HH), (Raffa et al., 2018; Vu & Le, 2020). Though, reports regarding HH compliance among hospital visitors are limited (Birnbach et al., 2012). Furthermore, surveillance studies are useful for detecting the prevalence and types of pathogenic organisms as well as the pattern of antibiotic resistance in order to take an infection control alarms and to reach higher rates of appropriate initial antibiotic therapy (Souli et al., 2008).

Therefore, the aim of this study was to investigate HH compliance among ICU visitors, the role of visitors in transmission of infection, and the types of pathogens involved.

2. METHODS

This was a cross-sectional, observational, hospital-based study that was conducted at adult ICUs at King Fahad Specialist Hospital, Tabuk city, Saudi Arabia. Tabuk City is a capital city located in Northwest Saudi Arabia. It contains three secondary hospitals. King Fahad Specialist Hospital is a secondary hospital and it is one of the main hospitals in Tabuk, with a bed capacity of 500 beds.

The adult ICU has a central station and each patient in a separate room. The entrance door to the closed unit was unlocked by an ICU security for a visitor to allow entry. The ICU's security has a list of patients' names, and they allow only two from their relatives to enter. We obtained the list from security to avoid hand swab duplications. Besides the ICU entry, there was a wall-mounted manual alcoholic solution.

This study was applied through visiting periods between September 2019 and October 2019. The observers were distributed inside and outside the ICU, the outside observers were distributed at the elevator, and follow visitors to ICU entry to ensure that if participants were washing their hands or not.

At entry of the ICU, a hand swab was taken before entering the patient's rooms from visitors who agreed to participate in the study. Prior hand swab, the procedure and the purpose from the study were explained to the participants and were asked if they agree to participate in this study or not. Another hand swab was taken after existing in the ICU. All hand swaps were collected from the dominant hand.

Microbiology laboratories

The collected hand swabs from the visitors were sent to the microbiology laboratories. The Vitek 2 Compact system uses a fluorogenic methodology for organism identification and a turbidimetric method for susceptibility testing. The agar plates used for cultures were blood agar, chocolate agar, MacConkey agar and CLED agar. Harmful microorganisms included (*Acinetobacter* Baumann complex, *staphylococcus aureus*, *Acinetobacter lwoffii*, *Enterobacter cloaca* complex, *Pantoja agglomerans*) were selected, and sensitivity and resistance to antibiotics was tested.

Data collection

A datasheet was used to collect and organize the study variables, which included participant's age, gender, educational level, if he/she performed hand hygiene before and after entering the ICU, pre-hand swab sample, and post-hand swab sample. Serious organisms including *Acinetobacter* Baumann complex, *staphylococcus aureus*, *Acinetobacter lwoffii*, *Enterobacter cloaca* complex, *Pantoja agglomerans* were tested for sensitivity and resistance to drugs.

Ethical considerations

To ensure confidentiality and anonymity, each participant was assigned a numeric code on his respective data collection sheet. We obtained ethical approval from the Ethical Research Committee, University of Tabuk, Tabuk, Saudi Arabia.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences, version 22 (SPSS Inc., Chicago, ILL, USA). Categorical variables were presented as the frequency and percentage, and Chi-Square or Fisher's exact test was used. *P*-values ≤ 0.05 were considered statistically significant.

3. RESULTS

A total of 356 visitors were observed and participated in this study. Approximately two-thirds of visitors didn't use alcoholic solution before entering the ICU, while only 94 out of 356 used alcoholic solution (Table 1).

Table 1. Attitude toward hand hygiene during ICU visits (n = 356)

	N	%
Did the visitor use antiseptic solution before entering to ICU?		
Yes	94	26.4
No	262	73.6

The majority (63.5%) of participants were males. The minimum age of ICU visitors was 18 and the maximum was 80, whereas the mean age was 36.69 ± 12.98 years-old. Regarding educational level, most participants either had high school education (40.45%) or bachelor or diploma education (34%) (Table 2).

Table 2. Demographic profile of the participants (n = 356)

Demographical characteristics	n	%
<i>Gender</i>		
Male	226	63.50
Female	97	27.20
Not registered	33	9.30
<i>Educational Level</i>		

Uneducated	12	3.37
Elementary & Intermediate	69	19.38
High school	144	40.45
Bachelor / Diploma	121	34.00
PhD / Master	10	2.80
Age		
Minimum	18	
Maximum	80	
Mean	36.69	
Standard deviation	12.98	

Most cultures performed from ICU visitors before ICU entry showed either no growth (10.96%) or CoNS (87.60%). Cultures were positive for some pathogenic organisms. *Aspergillus Spp*, *Staph. Aureus* (MSSA), *Aci. Radioresistens*, and *Enterobacter Cloacae* were observed in 11 (3.1%), two (0.56%), one (0.28%), and one (0.28%) cultures, respectively. After ICU exiting, 70 (19.7%) participants were not present for taking the second sample. The obtained cultures revealed no growth (21.67%), CoNS (73.42%), and were positive (5.59%). The detected pathogens were *Aci. Baumannii* (MDR) (2.79%), *Aspergillus Spp* (1.04%), *Staph. Aureus* (MSSA) (0.35%), *Aci. Lwoffii* (0.35%), *Pantoea Agglomerans* (0.35%), and *Aci. Baumannii* (sensitive) (0.70%) (Table 3).

Table 3. Pathogens isolated from ICU visitors (n = 356)

Before entering the ICU	n	%
No growth	39	10.96
CoNS	312	87.60
<i>Aspergillus Spp</i>	11	3.10
<i>Staph. Aureus</i> (MSSA)	2	0.56
<i>Aci. Radioresistens</i>	1	0.28
<i>Enterobacter Cloacae</i>	1	0.28
After exiting the ICU		
Sample was not taken	70	19.70
No growth	62	21.67
CoNS	210	73.42
<i>Aci. Baumannii</i> (MDR)	8	2.79
<i>Aspergillus Spp</i>	3	1.04
<i>Staph. Aureus</i> (MSSA)	1	0.35
<i>Aci. Lwoffii</i>	1	0.35
<i>Pantoea Agglomerans</i>	1	0.35
<i>Aci. Baumannii</i> (Sensitive)	2	0.70

Among the 16 visitors who were positive for pathogenic organisms after exiting in the ICU, 13 did not perform HH before entering the ICU, whereas three performed HH. In visitors who didn't perform HH, *Aci. Baumannii* (MDR), *Aci. Baumannii* (sensitive), *Aspergillus Spp*, *Staph. Aureus* (MSSA), *Aci. Lwoffii*, and *Pantoea Agglomerans* were positive in six, two, two, one, one, and one cultures, respectively.

Table 4 demonstrates antibiotics sensitivity assessment of the Gram-positive organisms isolated from the visitors. All the isolated Gram-positive organisms were methicillin-sensitive *Staphylococcus Aureus* (MSSA). Two of them were isolated before ICU entry and one of them was isolated after ICU exiting. The three pathogens displayed identical sensitivity and resistance pattern. Notably, the three organisms displayed resistance to the following antibiotics: benzylpenicillin, erythromycin, and clindamycin.

Gram-negative organisms that were isolated included *Enterobacter Cloaca* Complex, *Acinetobacter lwoffii*, *Pantoea Agglomerans*, and *Aci. Baumanni* Complex. As many *Aci. Baumanni* Complex had been isolated, 10 were randomly selected for assessment of antibiotic sensitivity. The patterns of antibiotic sensitivity/resistance are displayed in Table 5.

Table 4. Antibiotics sensitivity of Gram-positive isolates

Antibiotics	Gram-positive isolates		
	Before ICU entry		After ICU exiting
	MSSA (Isolate 1)	MSSA (Isolate 2)	MSSA (Isolate 3)
Amoxicillin/clavulanic acid			
Piperacillin/tazobactam			
Cefotaxime			
Cefalotin			
Cefoxitin	Negative	Negative	Negative
Ceftazidime			
Ceftriaxone			
Cefepime			
Imipenem			
Meropenem			
Amikacin			
Gentamicin	S	S	S
Ciprofloxacin			
Tigecycline	S	S	S
Nitrofurantoin	S	S	S
Trimethoprim/sulfamethoxazole	S	S	S
Benzylpenicillin	R	R	R
Oxacillin	S	S	S
Tobramycin	S	S	S
Levofloxacin	S	S	S
Moxifloxacin	S	S	S
Inducible clindamycin resistance	Positive	Positive	Positive
Erythromycin	R	R	R
Clindamycin	R	R	R
Linezolid	S	S	S
Teicoplanin	S	S	S
Vancomycin	S	S	S
Tetracycline	S	S	S
Fusidic acid	S	S	S
Rifampicin	S	S	S

4. DISCUSSION

The present study investigated HH compliance among visitors of adult ICUs. Hand rubbing with alcohol has been reported as an effective and rapid procedure of hand disinfection (Picheansathian, 2004). Further, the availability of alcohol-based sanitizers has been assumed to promote the visitor's HH compliance. This was considered in the studied ICU settings, where a wall-mounted manual alcoholic solution was available besides each ICU entry. Despite this, the present study explored poor HH compliance among the ICU visitors. Approximately one-fourth (26.4 %) of the study participants washed their hands with the existing alcoholic solutions before entering the ICUs.

The overall adherence by the visitors of hospital clinics is poor, but it seems that the visitor's compliance with the HH guidelines is highly variable. An audit of 180 visitors to a hospital clinic showed a comparable compliance of 25%, whereas, Birnbach et al., (2012) reported that HH practices of families and visitors as low as 10% in the hospital lobby. Compton and Davenport reported that performance of the basic HH guidelines among visitors was 0.5% to 11% at the main entrance door of the hospital, 9% to 35% for general and surgical units, and it 7% to 94% for ICU (Compton and Davenport, 2018).

The reported poor HH adherence among visitors has been attributed to inadequate knowledge and incorrect experiences and perceptions of visitors about their role in preventing infection (Wilmont et al., 2018). Another study reported that the location of the

sanitizers is the most important factor associated with improvement of HH adherence. When dispensers were placed in the center of the lobby with minimal barriers or landmarks, visitors were 5.28 times more likely to use alcohol-based hand sanitizers (Hobbs et al., 2016).

Table 5. Antibiotics sensitivity of Gram-negative isolates

Antibiotics	Gram-positive isolates												
	Before ICU entry		After ICU exiting										
	Enterobacter Cloaca Complex	Acinetobacter Iwoffii	Pantoea Agglomerans	Aci. Baumanni Complex (Isolate 1)	Aci. Baumanni Complex (Isolate 2)	Aci. Baumanni Complex (Isolate 3)	Aci. Baumanni Complex (Isolate 4)	Aci. Baumanni Complex (Isolate 5)	Aci. Baumanni Complex (Isolate 6)	Aci. Baumanni Complex (Isolate 7)	Aci. Baumanni Complex (Isolate 8)	Aci. Baumanni Complex (Isolate 9)	Aci. Baumanni Complex (Isolate 10)
Amoxicillin/clavulanic acid	R		S										
Piperacillin/tazobactam	S	S	S	R	R	R	R	R	R	R	R	S	S
Cefotaxime													
Cefalotin	R		S										
Cefoxitin	R		S										
Ceftazidime	S	S	S	R	R	R	R	R	R	R	R	S	S
Ceftriaxone	S	S	S	R	R	R	R	R	R	R	R	R	R
Cefepime	S	S	S	R	R	R	R	R	R	R	R	S	S
Imipenem	S	S	S	R	R	R	R	R	R	R	R	S	S
Meropenem	S	S	S	R	R	R	R	R	R	R	R	S	S
Amikacin	S	S	S										
Gentamicin	S	S	S	S	R	S	S	S	R	R	R	S	S
Ciprofloxacin	S	S	S	R	R	R	R	R	R	R	R	S	S
Tigecycline	S	S	S	S	S	S	S	S	S	S	I	S	S
Nitrofurantoin	I		S										
Trimethoprim/sulfamethoxazole	S	S	S	R	R	R	R	R	R	R	R	S	R

Different interventions have been investigated to improve the visitor's HH compliance. A study evaluated the efficacy of an electronic motion sensor-triggered audible hand hygiene reminder showed a significant increase in the adherence of visitors from 10.6% to 63.7% (Fakhry et al., 2012). Recently, audio-visual stimulus compared to visual stimulus alone be more effective significantly increased HH compliance among visitors of pediatric wards (Kim and Lee, 2019). Furthermore, a multifaceted approach including education of visitors, reminder signs, and family and visitors screening by staff before neonatal ICU entry for any symptoms has been implemented and was significantly effective in raising HH adherence from 27% to 85% (Linam et al., 2019).

Visitors play an important role in improving the ill and the stressful condition of the patients admitted to the ICU (Khaleghparast et al., 2015). However, the crucial role of visitors is unknown in the spread of pathogens. Hence, the role of visitors in transmission of infection to and from the ICU and the specific types of pathogen has been clarified in this study.

In the current study, the cultures that were obtained from the visitors before the ICU entry revealed no growth (10.9%), CoNS (87.60%), and were positive (4.22%). The pathogenic organisms included *Aspergillus* Spp (3.1%) *Staph. Aureus* (MSSA) (0.56%), *Aci. Radiorensistens* (0.28%) and *Enterobacter Cloacae* (0.28%), whereas after ICU exiting, the cultures revealed no growth (21.67%), CoNS (73.42%), and were positive (5.59%). The detected pathogens were *Aci. Baumanni* (MDR) (2.79%), *Aspergillus* Spp (1.04%), *Staph.*

Aureus (MSSA) (0.35%), *Aci. Lwoffii* (0.35%), *Pantoea Agglomerans* (0.35%), and *Aci. Baumannii* (0.70%). These culture results ensure the role of visitors as vectors for microorganism transmission and suggest that they did not clean their hands at any point before reaching the ICU. Moreover, the identification of pathogens that are considered to be typically associated with health acquired infection will help in establishing precautions regarding prevention of spread of infection in the health care setting. These precautions should consider the commonly detected organisms and their means of transmission (Banach et al., 2015). The growth of pathogens after existing in ICU is attributed to the frequent contact of visitors with the patient's skin and blood or body fluids as reported by Cohen et al., (2012).

In the present study, the majority (81.52%) of visitors who were positive for pathogenic organisms after exiting in the ICU did not perform HH before entering the ICU. The most common isolated organisms from these visitors were *Aci. Baumannii* (MDR), *Aci. Baumannii* (sensitive), *Aspergillus Spp*, *Staph. Aureus* (MSSA), *Aci. Lwoffii*, and *Pantoea Agglomerans*. In accordance with these findings, cultures obtained from visitors who failed to perform hand hygiene before entering ICU grew Gram negative rods and methicillin-resistant staphylococcus aureus, whereas the cultures obtained from visitors performed hand hygiene revealed no growth (70%), and the remaining (30%) showed only the usual skin flora (Birnbach et al., 2015). Thus, the visitors who did not adhere to hand hygiene might carry pathogens that constitutes a risk to ICU patients.

In the current study, MRSA was the only isolated Gram-positive organism either before or after the ICU entry, and antibiotic sensitivity testing revealed resistance to benzylpenicillin, erythromycin, and clindamycin. The patterns of antibiotic sensitivity/resistance of the isolated Gram-negative organisms revealed multidrug resistance.

It has been suggested that health-acquired infections are becoming increasingly resistant to standard treatment (Saharman et al., 2019). In fact, improving the HH compliance among the ICU visitors is an effective measure in decreasing the transmission of infections (Saharman et al., 2019). Moreover, HH compliance is very effective in preventing the development of multidrug-resistant Gram-negative bacteria in adult ICU patients (Terawattanapong et al., 2017). These multidrug-resistant organisms such as methicillin resistant staphylococcus aureus (MRSA) represent a significant challenge in the current healthcare management (Pogorzelska et al., 2012). A comparable study in Assiut University, Egypt noticed high incidence of nosocomial blood stream infection in adult ICUs, especially among the trauma ICU patients. Moreover, infections exhibited multidrug resistance in culture and sensitivity, which were associated with high incidence of mortality (Ahmed et al., 2009). Another alarming health care issue has been found in the surgical ICUs of Cairo University Teaching Hospital where the frequency of drug-resistant Gram-negative infections was 65% (Hasanin et al., 2014). Likewise, high level of drug resistance for different classes of antibiotics has been reported in Ethiopia (Bitew, 2019).

5. CONCLUSION

The results of the current study indicate poor hand hygiene compliance among the ICU visitors. The visitors who do not perform hand hygiene before entering the ICU frequently show pathogenic organisms, and they pose a risk for ICU patients. The spectrum of the isolated bacterial species was diverse, and they showed a multidrug resistance pattern to different classes of antibiotics. These data support the need for a coordinated effort to increase the visitors' hand hygiene compliance to counter the challenge of multidrug resistance bacteria and thereby improving the patient's outcomes.

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Authors' contributions

Albaraa Altowjiri: - Primary author read and approved the final manuscript.

Khalid Alfifi: - performed laboratory studies on the swaps and followed the sensitivity and resistance to antibiotics.

Maryam Alenzi, Rabab Aljayani, Ahmad Alanazi, AbeerAsiri, Mastorah Aljuhani, Rama Abu Alez and TahaniAlrashidi: - This work carried out in collaboration among all authors. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that there are no conflicts of interests.

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Informed consent

Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval

The study was approved by the Medical Ethics Committee of the University of Tabuk, Tabuk, Saudi Arabia.(ethical approval code: READ 0049).

Data and materials availability

All data associated with this study are present in the paper.

Peer-review

External peer-review was done through double-blind method.

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