

ORIGINAL ARTICLE

Evaluation of Handwashing Behaviors and Analysis of Hand Flora of Intensive Care Unit Nurses

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Purpose The aim of this study was to evaluate the handwashing behaviors of intensive care nurses based on personal statements, and to identify the microorganisms represented in the hand flora preshift and postshift.

Methods This prospective study was performed with 60 intensive care nurses between January and December 2008, at a training and research hospital at a university in Turkey. Samples were taken from the hands of the nurses for bacteriological culture, using the bag-broth method, at the beginning and end of the shift. The samples were cultured aerobically and the colonies that grew were counted and identified. The nurses completed a self-report questionnaire, and their answers were evaluated.

Results The frequency of handwashing by participants during each shift was 32.8 ± 13.9 . Overall, 65% of the nurses preferred alcohol-based antiseptic solutions for handwashing, 95% used paper towels to dry their hands, and 98.3–100% of the nurses washed their hands after performing care procedures. The *Escherichia coli* and coagulase negative *Staphylococcus* species were found to be at significantly higher levels in the postshift hand culture samples when compared to the preshift hand culture sample values. *Enterobacter cloacae* was the only species found in the postshift hand culture samples of the nurses.

Conclusions The number of colonies of the microorganisms in the hand flora of the nurses increased postshift. The handwashing behavior of intensive care nurses must be improved as they nurse critical patients. [*Asian Nursing Research* 2011;5(2):99–107]

Key Words handwashing, intensive care, nurse



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INTRODUCTION

The most common cause of healthcare-associated infections is person-to-person transmission of nosocomial pathogens via the hands of healthcare personnel (Sickbert-Bennett, Weber, Gergen-Teague, & Rutala, 2004). Nursing practices, such as direct touching, contact with bodily fluids, and wound care, can result in high levels of microorganism contamination. Even during relatively clean procedures, such as taking the pulse, measuring arterial blood pressure and taking temperature, nurses' hands can become contaminated with anywhere from 100–1000 colony forming units (CFU) of *Klebsiella* spp. (Boyce & Pittet, 2002; Lucet et al., 2002; Pittet et al., 2006). Noguera, Marinsalta, Roussell, and Notario (2001) detected colonization of the hands with *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis* after patient contact and physical examination. Hugonnet and Pittet (2000), and Lijima and Ohzeki (2006) determined that the number of microorganisms found on the hands of nurses increased significantly after they had performed care procedures. The microorganisms that colonize the external layer of the skin temporarily are eradicated when hands are washed with antiseptic and antimicrobial agents (Boyce & Pittet; Siegel, Rhinehart, Jackson, & Chiarello, 2007). Lijima and Ohzeki found that the number of bacteria was reduced considerably after hands had been washed with soap and alcohol-based agents. The handwashing habits of nurses are thought to be poor for many reasons, which include the complicated structure of intensive care units, the characteristics of the patients in intensive care, the heavy workload in such units, and an insufficient number of nurses (Creedon, 2005; Çelik & Koçalışlı, 2008; Karabey, Ay, Derbentli, Nakipoğlu, & Esen, 2002). The rate of handwashing is below 50% (Hugonnet & Pittet; Rumbaua, Yu, & Pena, 2001). In previous studies, Pittet, Mourouga, and Perneger (1999) found that the rate of handwashing in intensive care nurses was 36% in a teaching hospital in Switzerland, whereas Mc Ardle, Lee, Gibb, and Walsh (2006) found that the rate of handwashing after direct contact was 43% in an adult

general intensive care unit admitting >600 mixed medical/surgical patients annually in the United Kingdom. The handwashing rate of nurses in intensive care has also been found to be low in studies conducted in Turkey. Karabey et al. (2002) determined the frequency of handwashing by intensive care nurses to be 15%, whereas Kuzu, Özer, Aydemir, Yalcın, and Zincir (2005) and Makay, Icöz, Yılmaz, and Kolcu (2008) found that the rate was between 32.2% and 34%. Other researchers found that the rate of handwashing in surgical intensive care nurses was 48% (Yorgancı, Ekler, & Kaynaroğlu, 2002). In her study, Akyol (2007) reported that the quality of handwashing by nurses was poor, with a rate of 68.9%.

The rate of development of healthcare-associated infection is high in intensive care. Inal, Memiş, Çelik, and Yıldız (2008) found the infection rate in an intensive care unit of the hospital in which the current study was conducted to be 40%. No previous study has assessed the microorganisms that contaminate the hands of nurses who work in intensive care units in conjunction with low handwashing rates and high rates of healthcare-associated infection. The aim of this study was to evaluate the handwashing behavior of intensive care nurses based on personal statements, and to identify the microorganisms represented in the hand flora preshift and postshift.

The study questions were as follows: What are the handwashing behaviors of nurses in intensive care units? Which microorganisms can be detected in the hand flora of intensive care nurses preshift and postshift?

METHODS

Setting and sampling

The research was conducted between 1 January, 2008 and 31 December, 2008 at a university training and research hospital in Turkey. This prospective study was conducted in five intensive care units, and a total of 66 nurses were recruited. Six nurses were excluded from the study because they had visible

wounds on the surface of their hands, and thus the resulting total was 60. The nurses who participated in the study worked between the hours of 8 a.m. and 4 p.m., had no observable skin injuries, used no topical or systemic steroid or antibiotics, and were involved in direct patient care. Information regarding the inclusion criteria was obtained through verbal communication from the nurses before the study. During the shift, all the nurses used hygiene products supplied by the hospital to wash and dry their hands.

Data collection

Hand cultures

Two samples for bacteriological culture (preshift and postshift) were taken from both hands to evaluate the hand flora of the nurses. The preshift culture samples were taken at the beginning of the shift. The nurses involved in the study were asked to wash their hands with water and soap before the preshift hand culture samples were taken to reduce the amount of transient flora on their hands. The preshift samples were taken after they had washed their hands. Since the nurses were working in five different intensive care units, we could not provide any recommendations to them regarding handwashing behavior and their handwashing behavior was not observed. The nurses continued their routine until the second (postshift) hand culture samples were taken. The postshift culture samples were taken at least 4 hours after the nurses had begun work, because, owing to the working practices on the intensive care unit, patient care procedures were carried out more frequently during the first 4 hours. The nurses would have experienced sufficient hand contact with the patients during this period for the results to demonstrate the type and amount of colonizing bacteria acquired during the working period in the intensive care unit. The participants did not wash their hands immediately before the postshift hand culture samples were collected. The preshift and postshift samples were compared to assess which bacteria had colonized the hands of the participants during the working period and which corresponded to resident microbial flora.

Hand culture samples were taken by researchers at the intensive care units in which intensive care nurses were working. Both the preshift and postshift culture samples were taken by using the bag-broth method. For this purpose, the nurses were asked to put on sterile, powder-free surgical gloves into which 20 mL of brain heart infusion (BHI) broth had been poured. When the gloves containing the BHI broth were in place on both hands, the hands were rubbed together vigorously for approximately 30 seconds. After the hands had been rubbed all over, the gloves were removed and tied loosely. The samples were transferred to the laboratory within 2 hours. Aliquots of 100 μ L of the broth were inoculated onto BHI agar with 5% sheep's blood using the colony count method (Frukawa, Tajiri, Suzuki, & Norose, 2005; Rawool, Malik, Shakuntala, Sahare, & Barbuddhe, 2007; Strausbourgh et al., 1996). After incubation for 24 hours at 37°C, colony counts were obtained and the bacterial species were identified using conventional methods.

Questionnaire

The nurses were supplied with a self-report questionnaire that included questions about their age, working periods, their educational background, the frequency with which they washed their hands during each shift, the materials that they preferred to use to wash and dry their hands and 15 additional questions about handwashing. The questions were prepared in accordance with the Fulkerson scale and other literature (Akyol 2007; Kuzu et al., 2005; Larson et al., 1998; Pittet, Dharan, Touveneau, Sauvan, & Perneger 1999). The items included questions about intravenous or arterial interventions, contact with body fluids, care procedures, hygienic care of patients, contact with each patient, and the wearing of gloves. These questions asked for information both before and after these procedures. Contact with materials near the patient was queried in a single question. The intensive care nurses were asked to indicate whether they washed their hands or not for each condition. Self-reported questionnaires were given to the intensive care nurses after taking the preshift hand culture samples. Intensive

care nurses filled the self-reported questionnaires in 15 minutes by themselves. Then, the researchers took the forms by visiting the nurses.

Data analysis

The results are reported as a $M \pm SD$ or number (percentage). The distribution of the isolates in the samples a (CFU/mL) collected preshift and postshift was analyzed using the chi-square test. A value of $p < 0.05$ was accepted as the limit for statistical significance. The Statistica 7.0 statistical program (Statistica, Tulsa, OK, USA) was used for the statistical analysis.

Ethical considerations

This study was approved by the Ethics Committee of the Trakya University Medical Faculty. Permission to conduct the research during the shift was obtained

from the Director of Nursing Services and the Clinical Director.

RESULTS

Sixty nurses in the intensive care unit participated in the study. The number of times that they washed their hands during each shift was determined to be 32.8 ± 13.9 (range: 10–65) (Table 1).

Most nurses (65%, $n = 39$) stated that they preferred to cleanse their hands with an antiseptic solution that contained alcohol rather than use a soap-based product, and 95% ($n = 57$) of them used paper towels to dry their hands rather than use a cloth towel or hand dryer (Table 1).

The self-reported rates of handwashing were 65–93% before and 96–100% after patient care procedures (Table 2). The microorganisms that were isolated from the preshift and postshift hand culture samples were *E. faecalis*, methicillin-sensitive *S. aureus* (MSSA), *Corynebacterium diphtheriae*, and alpha hemolytic *Streptococcus* spp. (Table 3). Test statistics could not be calculated.

E. coli and coagulase negative *Staphylococcus* (CNS) spp. were found to be at significantly higher levels in the postshift hand culture samples of nurses who worked in coronary intensive care units than in the preshift hand culture samples ($\chi^2 = 67.651$, $\chi^2 = 1151.8$, respectively, $p < .001$; Table 3).

Enterobacter cloacae was the only species found after, but not before, the shift. No significant differences were determined from the demographic characteristics of nurses (age, length of work, educational background), hand washing characteristics (no. of hand washes in each shift, their preferred agents for hand washing, preferred materials for hand-drying), microorganism species reproducing in hand cultures and CFU numbers.

DISCUSSION

In this study, the handwashing behavior of intensive care nurses was evaluated based on their personal

Table 1

Variables Reported by Intensive Care Nurses ($N = 60$)

Variables	$M \pm SD$ or n (%)
Age (yr)	26.1 ± 3.3
Length of work (yr)	5.2 ± 3.1
No. of hand washes in each shift	32.8 ± 13.9
Educational background	
Occupational health HS	12 (20.0)
2-yr degree	16 (26.7)
Undergraduate and postgraduate	32 (53.3)
Internal medicine ICU	12 (20.0)
Reanimation	14 (23.3)
Department	
Coronary intensive care	11 (18.3)
Cardiovascular intensive care	9 (15.0)
Neonatal intensive care	14 (23.3)
Soap	10 (16.7)
Preferred agents for handwashing	
Soap + antiseptic solution	11 (18.3)
Alcohol-based hand antiseptic	39 (65.0)
Paper towel	57 (95.0)
Preferred materials for hand drying	
Dry-air machine	1 (1.7)
Cloth towel	2 (3.4)

Note. HS = high school, ICU = intensive care unit.

statements and the microorganisms that were identified in the hand flora preshift and postshift.

We determined that the nurses washed their hands an average of 33 times during each shift. In previous studies, Akyol (2007) determined that the participants in the study washed their hands no fewer than 30 times during each shift, whereas Larson et al., (2000) determined that nurses on neonatal units washed their hands between 21 and 23 times during each shift. The frequency of handwashing of the intensive care nurses in this study was similar to that reported in previous studies. McArdle et al. (2006) stated that all medical staff require 100 minutes per patient per day for handwashing before and after direct contact with patients. The intensive care nurses who participated in this study were providing care to four patients a day, which made it difficult for them to wash their hands more frequently.

The selection of handwashing agents is important in decreasing the amount and types of microorganisms on hands, whereas the selection of hand drying materials is important in preventing contamination (i.e., the continuous usage towels made of fabric; World Health Organization, 2009). Most of the nurses in the study preferred to use an alcohol-based hand antiseptic for handwashing, and paper towels for hand drying. Kac et al. (2005) stated that medical staff clean their hands more frequently by

rubbing them with alcohol-based hand products than by washing with soap. The use of disposable paper towels to dry the hands reduces contamination. The availability of alcohol-based hand antiseptics and paper towels in units at all times, and the emphasis on the importance of this practice during in-service training might have influenced the preference of the nurses (Sickbert-Bennett et al., 2004; Winnefeld, Richard, Drancourt, & Grob, 2000).

The nurses who participated in the study stated that all nurses always washed their hands after every patient care procedure. The rate of handwashing was found to be statistically significant in other research; for example as reported by Korniewicz and El-Masri (2010) after contact with blood products, by Creedon (2005) after touching objects that were likely to be contaminated, and by Larson, Bryan, Adler and Blane (1997) after procedures that were likely to involve contamination. Consistent with other studies, the current work suggests that nurses on intensive care wards wash their hands after contact with a patient.

The isolation of CNS from the postshift culture samples of the participants as compared to the preshift samples was in agreement with the findings of previous studies. Pittet, Dharan, et al. (1999), Larson et al. (2000), and Rumbaua et al. (2001) all reported a high incidence of CNS in the hand flora of nurses after hand hygiene procedures. CNS is found

Table 2

Self-reported Handwashing Behavior of Intensive Care Nurses

Handwashing indications	Before				After			
	Yes		No		Yes		No	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Every intravenous and arterial intervention	49	84.5	9	15.5	58	100.0	–	–
Contact with body fluids	45	80.4	11	19.6	56	100.0	–	–
Every injury care procedure	56	93.3	3	5.0	59	100.0	–	–
Every catheter care procedure	51	85.4	8	13.6	59	100.0	–	–
Hygienic care of every patient	52	89.7	6	10.3	58	100.0	–	–
Contact with every patient	47	82.5	10	17.5	55	96.6	2	3.4
Wearing gloves	36	65.5	19	34.5	53	96.3	2	3.7
Contact with the materials near the patient					59	98.3	1	1.7

Table 3

Microorganism Isolated: Species and Colony Numbers

Species	Preshift samples (CFU in mL/n ^a)					Postshift samples (CFU in mL/n ^a)					χ^2 & p ^c		
	Internal medicine	Reanimation	Coronary intensive care	CV ICU	Neonatal	Total CFU/ mL	Internal medicine	Reanimation	Coronary intensive care	CV ICU		Neonatal	Total CFU/ mL
<i>Escherichia coli</i>	8/1	4/2	30/1	-	1/1	43	-	-	190/1	16/1	-	206	$\chi^2 = 67.651$ $p < .001$
<i>Klebsiella pneumoniae</i>	3/1	- ^b	25/1	-	4/1	32	-	-	-	-	-	-	-
<i>Enterococcus faecalis</i>	289/1	-	-	-	-	289	-	-	-	7/1	-	7	-
<i>Enterobacter cloacae</i>	-	-	-	-	-	-	-	10/2	-	-	-	10	-
MSSA	12/2	2/1	198/3	7/1	-	219	-	-	40/3	-	-	40	-
CNS	2302/9	365/11	6513/11	988/7	23/2	10191	1384/9	1038/6	8804/11	2735/8	14/2	13975	$\chi^2 = 1151.8$ $p < .001$
<i>Corynebacterium diphtheriae</i>	-	4/2	20/1	-	8/1	32	2/1	-	165/3	10/1	-	177	-
Alpha hemolytic streptococcus	513/4	-	-	4/1	1/1	518	-	80/3	-	91/3	-	171	-

Note. CV = cardiovascular; ICU = intensive care unit; CFU = colony-forming unit; MSSA = Methicillin-sensitive *Staphylococcus aureus*; CNS = coagulase negative *Staphylococcus*.

^aThe number of nurses from whom microorganisms were isolated in their hand culture samples; ^bno microorganisms were isolated; ^csome of the test statistics could not be calculated owing to missing data.

in the normal microflora of the skin, nasal mucosa, and lower respiratory tract, and they are transmitted amongst patients via the hands. Unless they penetrate and invade the body, they have low potential pathogenicity (Agvald-Öhman, Lund, & Edlund, 2004; Hugonnet & Pittet, 2000; Larson et al., 1998).

When isolation rates of preshift and postshift culture samples were compared, the second microorganism that increased in this study was *E. coli*. Similarly, Kac et al. (2005) and Nogueras et al. (2001) reported that the hands of nurses were contaminated with *E. coli* after physical treatment and contact with patients and before hand hygiene procedures. *Escherichia coli*, which is among the microorganisms that are commonly isolated from hands, indicates fecal contamination (Ansari, Sattar, Springthorpe, Wells, & Tostowaryk, 1989; Cook, Cimiotti, Della-Latta, Saiman, & Larson, 2007).

Similarly, Pittet, Dharan, et al. (1999) found that patient care activities associated with higher contamination levels were direct patient contact, respiratory care, handling of body fluid secretions, and rupture in the sequence of patient care.

The other types of microorganisms that were isolated from the preshift and postshift culture samples of the nurses were *E. faecalis*, MSSA, *Corynebacterium diphtheriae* and alpha hemolytic streptococci. These microorganisms were the same as those isolated from hand cultures obtained in previous studies (Agvald-Öhman et al., 2004; Aiello, Cimiotti, Della-Latta, & Larson, 2003; Borges, Silva, Filho, & Gerais, 2007; Cook et al., 2007; Winnefeld et al., 2000).

Enterobacter cloacae is the only microorganism that contaminated the hands of nurses from the intensive care flora. Cook et al. (2007) isolated *E. cloacae* from the hands of nurses on a neonatal unit. This bacterium is found in clinical samples such as phlegm, blood, and urine. *Enterobacter cloacae* was isolated from the postshift culture samples of two of the participants, and although the isolation was not statistically significant, it is thought that these nurses did not wash their hands thoroughly after contact with body fluids. Even though intensive care nurses wash their hands, the microorganisms present on the hands increase by postshift. The results

emphasize the importance of effective handwashing among nurses who work in the intensive care unit.

Limitation

Nurses knowing before that their hand washing behaviors would be assessed and hand culture samples would be retrieved was a limitation of the study. It would be more beneficial to collect data without informing the nurses.

Conclusions

Although the intensive care nurses reported that they washed their hands according to indications, the amount and types of microorganisms on their hands had increased by postshift. Intensive care nurses should be aware that the microorganisms on their hands increase and should wash their hands more effectively. Institutions should take precautions to ensure that intensive care nurses wash their hands effectively. Further observational studies of the handwashing behavior of nurses are required, and it will be beneficial to evaluate the effect of handwashing on the number of microorganisms isolated from the hands of nurses.

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