

## ORIGINAL ARTICLE

# Evaluation of bacterial and fungal contamination in the health care workers' hands and rings in the intensive care unit

S. KHODAVAISY, M. NABILI\*, B. DAVARI\*\*, M. VAHEDI\*\*\*

Department of Medical Mycology and Parasitology, School of Medicine, Kurdistan University of Medical Sciences & Student Research Committee, Sanandaj, Iran; \* Departments of Medical Mycology and Parasitology, School of Medicine, Mazandaran University of Medical Sciences & Student Research Committee, Sari, Iran; \*\* Department of Medical Mycology and Parasitology, School of Medicine, Kurdistan University of Medical Sciences & Environment Health Research Center, Sanandaj, Iran; \*\*\* Department of Medical Microbiology and immunology Mazandaran University of Medical Sciences, Sari, Iran

## Key words

Bacterial • Fungal • Health care workers • Intensive care unit

## Summary

**Introduction.** Nosocomial infections remain a major challenge to the health care system and result in significant mortality, morbidity, and economic burden. Intensive care unit (ICU) patients are at great risk of acquiring nosocomial infections. The objective of this study was to determine the contamination rate (bacterial and fungal) of the health care workers' (HCWs') hands and ring in ICU.

**Methods.** All health care workers were screened during the day shift in Emam hospital ICU. After obtaining informed consent, convenience samples of HCWs' hands and rings were cultured on specific media during their routine work hours, always after a patient care episode. The fungal and bacterial isolates were identified using standard microbiological procedures.

**Results.** A total of 40 subjects were selected in this study (28 females, 12 males). The rate of contamination of hands and rings was observed in 73.1%. Most of isolates are known to cause nosocomial infections which included: 23% staphylococci, 7.9% *Klebsiella* spp., 4.7% *Enterobacter* spp., 3.9% *Escherichia coli*, 3.1% *Acinetobacter* spp., 2.3% *Pseudomonas* spp., and 27.7% were colonized with fungi. The fungal isolates were 16.6% *Candida* spp., 3.9% *Rhodotorula* spp., 3.1% *Aspergillus niger*, and 3.9% *Aspergillus flavus*.

**Conclusion.** According to these results HCWs' hands and their rings were contaminated with various types of microorganisms. Medical and hospital personals must follow careful hand-washing techniques to minimize transmission of disease and should remove rings, watches, and bracelets before washing their hands and entering the ICU.

## Introduction

Nosocomial infection is a major challenge to the health care system and results in significant mortality, morbidity, and economic burden [1]. These infections may result in substantial morbidity and higher health care costs [2]. Intensive care unit (ICU) patients are at great risk of acquiring nosocomial infections because of breaches in host defense included as a result of trauma, invasive medical devices, and/or corticosteroid therapy [3-5]. Therefore ICU is the workplace where number of direct contacts between the hands of the health care workers (HCWs') and the patients highly need the best hygiene standards, also the same standard is requirement for the ICU personals and the equipment used by them [6]. Some epidemiological studies have implicated environmental surfaces in the transmission of bacteria and fungi [7-9]. Total bacterial counts of bacteria on the hands of medical staff have ranged from  $3.9 \times 10^4$  to  $4.6 \times 10^6$  [10]. Their number increases with the duration of clinical activities [11]. Some clinical situations are associated with a higher bacterial load on the hands of HCWs' such as direct contact with patients, respiratory

tract care, contact with body fluids, and after being interrupted while caring for a patient [12, 13]. In general, however, it is difficult to clearly assign a specific risk of hand contamination to certain patient care activities. Fungi are less commonly found than bacteria as the causative agent of ICUs, but their frequency and importance are increasing [14]. Fungi may cause septicemia, urinary tract infections, or surgical site infections [15, 16]. HCWs' hands and rings frequently are contaminated with these pathogens [17, 18]. Rings are used in more HCWs' hand and it is in close contact with the body of patients. It is generally accepted that appropriate hand hygiene is an effective means in reducing the risk of transmission of nosocomial pathogens [19, 20]. Hand washing by HCWs' is the most important measure to prevent hospital acquired infection [21, 22]. Unfortunately, HCWs' attention to hand hygiene recommendations is often poor [23]. Gloving is recommended as a barrier in protecting the health care workers (HCWs) to reduce the risk of contamination during contact with body fluids, mucous membranes or the injured skin of patients [24, 25]. Recently, the Health Care Infection Control Practices Advisory Committee of the Centers for Disease Control and Prevention released new

hand hygiene guidelines that promote increased use of alcohol based hand rubs [26]. The aim of the present study was to determine the bacterial and fungal contamination rate of the HCWs' hands and ring with particular emphasis on has determined risk factors for hand carriage of several potential nosocomial pathogens.

## Material and method

This study was conducted in general ICU with 11 beds of Imam Khomeini hospital from May 1 to July 15, 2010. A total 40 staff nurses, nurse assistant, physician, and stretcher-bearer were screened. Gender, profession and duration of their profession, the wearing of rings, hands of HCWs, health care procedure, and Gloving during procedure were recorded. After obtaining informed consent, cultures were subsequently obtained from the dominant hand and the rings of participants during their routine work hours at the before and after performance of patient care at the day shift. A sterile swab moistened with sterile saline was rotated over the surface of all sides of rings; second swab was rubbed over the entire ventral surface of the dominant hand (including ventral surfaces of the thumb and the fingers) of HCW's. The sampling of the dominant hand and rings swabs were immediately streaked onto sheep blood agar, eosin methylene blue agar, and sabouraud dextrose agar. Plates were incubated aerobically at 28°C and 37°C for 48 h. The fungal and bacterial isolates recovered from cultures were identified using standard microbiological procedures (colony characteristics gram staining, colony counts, catalase and oxidase reaction) and all isolates were identified to the appropriate genera. To identify yeast, Chrom agar Candida (ChromAgar) was inoculated incubated at 35 C for 48 h. Statistical analyses were done by Chi square

and T test using SPSS and P values < 0.05 were considered significant.

## Results

In this study of 40 HCWs (28 females, 12 males) were monitored and 126 specimens (80 hands and 46 rings) were obtained before and after health care procedure were analyzed. More details concerning the number of the categories are given in the Table I.

The Bacterial and Fungal contamination were recovered from 73.1% of HCWs hands and rings that were recovered from 52.5% of males and 68.6% of females. There was no sex related significant difference of contamination in the study subjects (P = 0.043). Though the nurses have higher microbial growth but there was no significant difference in the rates of specific types of microbial growth on all groups. Lack gloving during health care procedure was the factor associated with hands and rings contamination and the contamination was also reduced with gloving (P = 0.00). The microbial flora was higher in ring using HCWs, thus ring wearing was found to be a risk factor for contamination of microorganisms recovered from HCWs hands. Factors associated with increased hand contamination before and after health care procedure and the routine clinical work are shown in Table II.

The isolated microorganisms from hands and rings were similar. Some of them are known to cause nosocomial infections (Tab. III). Most of isolates known to cause nosocomial infections are as follow: 23% *staphylococci*, 7.9% *Klebsiella* spp., 4.7% *Enterobacter* spp., 3.9% *Escherichia coli*, 3.1% *Acinetobacter* spp., 2.3% *Pseudomonas* spp., and 27.7% were colonized with fungi. The species of fungi were as follow: 16.6% *Candida*

Tab. I. Number of HCWs based on categories.

Category	Sex		Ring wearing		Shift			Total
	Male	Female	Yes	No	Morning	Afternoon	Night	
Nurse	3	19	12	10	10	6	6	22
Nurse assistant	4	4	6	2	3	3	2	8
Stretcher-bearer	2	2	3	1	2	1	1	4
Physician	3	3	2	4	2	2	2	6
Total	12	28	23	17	17	12	11	40

Tab. II. Risk factor associated with bacterial and fungal contamination of the HCWs' hands and ring hand.

Variables		Number of samples with microbial flora/ all samples	Percentage (%)	P-value
Sex	Male	21/40	52.5	0.043
	Female	59/86	68.6	
Job title	Nurse	44/68	64.7	0.83
	Nurse assistant	17/28	60.7	
	Stretcher-bearer	10/14	71.4	
	Physician	9/16	56.2	
Gloving during procedure	Yes	19/58	32.7	0.00
	No	61/68	89.7	
Ring wearing	Yes	40/46	86.9	0.05
	No	23/80	28.7	

Tab. III. The types of bacteria and fungi isolated from hands and rings of HCWs at intensive care unit.

Microorganisms		Time of sampling subjects and the number %				Total (n = 126)
		before performance of patient care		after performance of patient care		
		Hands (n = 40)	Ring(s) (n = 29)	Hands (n = 40)	Ring(s) (n = 17)	
Bacteria	<i>Staphylococci</i>	6 (15)	8 (27.5)	10 (25)	5 (29.4)	29 (23)
	<i>Klebsiella</i> spp.	2 (5)	1 (3.4)	5 (12.5)	2 (11.7)	10 (7.9)
	<i>Escherichia coli</i>	-	2 (6.8)	-	3 (17.6)	5 (3.9)
	<i>Pseudomonas</i>	2 (5)	-	1 (2.5)	-	3 (2.3)
	<i>Enterobacter</i> spp.	-	1 (3.4)	4 (10)	1 (5.8)	6 (4.7)
	<i>Acinetobacter</i> spp.	-	-	2 (5)	2 (11.7)	4 (3.1)
Fungi	<i>Candida</i> spp.	6 (15)	2 (6.8)	8 (20)	5 (29.4)	21 (16.6)
	<i>Rhodotorula</i> spp.	-	2 (6.8)	1 (2.5)	2 (11.7)	5 (3.9)
	<i>Aspergillus niger</i>	-	2 (6.8)	-	2 (11.7)	4 (3.1)
	<i>Aspergillus flavus</i>	1 (2.5)	-	2 (5)	2 (11.7)	5 (3.9)

spp., 3.9% *Rhodotorula* spp., 3.1% *Aspergillus niger*, and 3.9% *Aspergillus flavus*. Most of the *Candida* species isolates included: *C.albicans* (65%), *C.tropicalis* (18%), *C.glabrata* (12%), and *C. krusei* (5%).

## Discussion

Our study was carried out in ICU, during the routine hospital practices. High rate of contamination was demonstrated with potential nosocomial pathogens. Seventy three percent of HCWs hands and rings samples were found contaminated with at least one pathogen during clinical routine work. Almost all studies concerning hand hygiene have indicated the frequent contamination of HCWs hands [5, 12, 27, 28]. Our findings agree with the other data indicating that an increased number of microbe species is associated with the wearing of rings. Trick et al., showed that ring wearing is associated with 10-fold higher than the median skin bacterial counts; contamination with *Staphylococcus aureus*, gram-negative bacilli, or *Candida* species; and a step-wise increased risk of contamination with any transient organism as the number of rings worn increased [28]. Ulger et al., reported that mean colony count is higher in ring using staffs [29]. The degree of contamination was significantly greater on the hands of nurses who wore rings and contamination with any transient organism was twice as likely when rings were worn and important findings implicated rings as a major contributor to hand contamination [28, 30]. Although it seems impossible in the light of all these findings, we should be aware of limiting the rings usage, because it has high risk for spreading of infections. Knowing the strong association

between ring wearing and hand contamination, removal of rings from HCWs hands should result in decreased frequency of hand carriage of several potential pathogens, both before and after performance of hand hygiene. In this study, we also analyzed the factors could influence hand contamination in routine practice. Glove wearing during the procedure was associated with reduction in the total microbiological load recovered on hands and rings. The effectiveness of gloving in prevention of hand contamination has been observed [18, 19, 30]. The frequency of using glove during patient care was similar, and has been reported by other investigators (21%-55%), [28, 33, 34]. However, when gloves are not removed after each contact, they become a "second skin" and expose patients to cross transmission of micro organisms [32]. The results of our study showed that HCWs' hands and rings were contaminated with various types of microorganisms. Some authors showed that HCWs' hands were contaminated with nosocomial pathogens (19,27,28,35). The major of fungal isolates were *Candida* spp. (16.6) that may cause septicemia, urinary tract infections, or surgical-site infections. In an ICU, in 67 (46%) of the 146 health care workers' hands were colonized with a yeast. Respiratory therapists were found to have the highest colonization rate (69%) of contamination [36]. In another study, yeasts quite often also colonized artificial finger nails [37]. Acquisition of *C. albicans* on the hands of health care workers immediately after attending, systemically infected patients was reported to occur in 2 of 17 nurses [38]. In conclusion, the HCWs must follow careful hand washing techniques to minimize transmission of disease and should remove rings, watches, and bracelets before washing their hands and entering the ICU.

## References

- [1] Jarvis WR. *Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention*. Infect Control Hosp Epidemiol 1996;17:552-7.
- [2] Stosor V, Peterson LR, Postelnick M, et al. *Enterococcus faecium bacteremia: does vancomycin resistance make a difference?* Arch Intern Med 1998;158:522-7.
- [3] Carling PC, Von Beheren S, Kim P, et al. *Intensive care unit environmental cleaning: an evaluation in sixteen hospitals using a novel assessment tool*. J Hosp Infect 2008;68:39-44.
- [4] Alonso-Echanove J, Gaynes RP. *Scope and Magnitude of No-*

- socomial ICU Infections*. Boston: Kluwer Academic Publishers 2002.
- [5] Albert RK, Condie F. *Hand washing patterns in the medical intensive care units*. N Engl J Med 1981;304:1465-6.
- [6] Zobeiri M, Karami-Matin B. *Determination of microbial contamination and its related factors in hands of ICU staff in the hospitals of Kermanshah*. 2002. Journal Behbood 2005;9:52-7.
- [7] Bruetti L, Santoro E, Decaro F, et al. *Surveillance of nosocomial infections: a preliminary study on hand hygiene compliance of healthcare workers*. J Prev Med Hyg 2006;47:64-8.
- [8] Manning ML, Archibald LK, Bell LM, et al. *Serratia marcescens transmission in a pediatric intensive care unit: a multifactorial occurrence*. Am J Infect Control 2001;29:115-119.
- [9] Ciragil P, Gul M, Aral M. *Bacterial contamination of computers and telephones in a university hospital in Turkey*. J Hosp Infect 2006;62:247-8.
- [10] Larson EL, Norton Hughes CA, Pyrak JD, et al. *Changes in bacterial flora associated with skin damage on hands of health care personnel*. Am J Infect Control 1998;26:513-21.
- [11] Pittet D, Dharan S, Touveneau S, et al. *Bacterial contamination of the hands of hospital staff during routine patient care*. Arch Intern Med 1999;159:821-6.
- [12] Vahdat K, Rezaei R, Gharibi D. *Nosocomial infection in Alzahra hospital, Boshehr*. Tebbe Jonoub 2003;7:135-40.
- [13] Carling PC, Parry MF, Von Beheren SM. *Identifying opportunities to enhance environmental cleaning in 23 acute care hospitals*. Infect Control Hosp Epidemiol. 2008;29:1-7.
- [14] Snyderman DR. *Shifting patterns in the epidemiology of nosocomial Candida infections*. Chest 2003;123:500-3.
- [15] Sawyer RG, Raymond DP, Pelletier SJ, et al. *Implications of consecutive surgical infections entering the year 2000*. Ann Surg 2001;233:867-74.
- [16] Richards MJ, Edwards JR, Culver DH, et al. *Nosocomial infections in medical intensive care units in the United States. National Nosocomial Infections Surveillance System*. Crit Care Med 1999;27:887-92.
- [17] Pittet D, Boyce JM. *Hand hygiene and patient care: pursuing the Semmelweis legacy*. Lancet Infect Dis 2001;1:9-19.
- [18] Tenorio AR, Badri SM, Sahgal NB, et al. *Effectiveness of gloves in the prevention of hand carriage of vancomycin-resistant Enterococcus species by health care workers after patient care*. Clin Infect Dis 2001;32:826-9.
- [19] Kampf G, Kramer A. *Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs*. Clinical Microbiology Reviews 2004;17:863-93.
- [20] Trick WE, Vernon MO, Hayes RA, et al. *Impact of ring wearing on hand contamination and comparison of hand hygiene agents in a hospital*. Clin Infect Dis 2003;36:1383-90.
- [21] Ng LSY, Teh WT, Ng SK, et al. *Bacterial contamination of hands and the environment in a microbiology laboratory*. J Hosp Infect 2011;78:231-3.
- [22] Kampf G, Kramer A. *Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs*. Clin Microbiol Rev 2004;17:863-93.
- [23] O'Boyle CA, Henly SJ, Larson E. *Understanding adherence to hand hygiene recommendations: the theory of planned behavior*. Am J Infect Control 2001;29:352-60.
- [24] Garner JS. *Guideline for isolation precautions in hospitals*. Infect Control Hosp Epidemiol 1996;17:53-8.
- [25] Goldman DA. *The role of barrier precautions in infection control*. J Hosp Infect 1991;18:515-23.
- [26] Boyce JM, Pittet D. *Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force*. Infect Control Hosp Epidemiol 2002;23:3-40.
- [27] Brunetti L, Santoro E, Decaro F, et al. *Surveillance of nosocomial infections: a preliminary study on hand hygiene compliance of healthcare workers*. J Prev Med Hyg 2006;47:64-8.
- [28] Trick W, Vernon MO, Hayes RA, et al. *Impact of Ring wearing on hand contamination and comparison of hand hygiene agents in a hospital*. Clin Infect Dis 2003;36:1383-90.
- [29] Ulger F, Esen S, Dilek A, et al. *Are we aware how contaminated our mobile phones with nosocomial pathogens?* Ann Clin Microbiol Antimicrob 2009;8:7-11.
- [30] Hoffman PN, Cooke EM, McCarville MR, et al. *Microorganisms isolated from skin under wedding rings worn by hospital staff*. BMJ 1985;290:206-7.
- [31] Pittet D, Dharan S, Touveneau S, et al. *Bacterial contamination of the hands of hospital staff during routine patient care*. Arch Intern Med 1999;159:821-6.
- [32] Lund S, Jackson J, Leggett J, et al. *Reality of glove use and handwashing in a community hospital*. Am J Infect Control 1994;22:352-7.
- [33] Lankford M, Zembower TR, Trick WE, et al. *Influence of role models and hospital design on hand hygiene of healthcare workers*. Emerg Infect Dis 2003;9:217-23.
- [34] Lund S, Jackson J, Leggett J, et al. *Reality of glove use and hand washing in a community hospital*. Am J Infect Control 1994;22:352-7.
- [35] Zohorinia M, Soleimani A, Nobari H, et al. *Frequency comparison of nasal and hand carriage of Staphylococcus aureus among the medical and non-medical staffs in Iranian Air Force Be'saat Medical Center*. JAUMS 2006;43:901-4.
- [36] Huang YC, Lin TY, Leu HS, et al. *Yeast carriage on hands of hospital personnel working in intensive care units*. J Hosp Infect 1998;39:47-51.
- [37] Hedderwick SA, McNeil SA, Lyons MJ, et al. *Pathogenic organisms associated with artificial fingernails worn by health care workers*. Infect Control Hosp Epidemiol 2000;21:505-9.
- [38] Burnie JP, Lee W, Williams JD. *Outbreak of systemic Candida albicans in intensive care units caused by cross infection*. Br Med J 1985;290:746-8.

■ Received on June 20, 2011. Accepted on November 30, 2011.

■ Correspondence: Sadegh Khodavaisy, Department of Medical Mycology and Parasitology, School of Medicine, Kurdistan University of Medical Sciences & Student Research Committee, Sanandaj, Iran - Tel. 009188772102 - E-mail: sadegh\_7392008@yahoo.com