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Full Length Research Paper

Microbial flora on the hands of healthcare workers

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The aims of this study were to study the process of microbial contamination of healthcare workers' (HCWs) hands during routine patient care and simultaneously to evaluate the state of antibiotic susceptibility of microorganisms isolated from the hands of HCWs. Samples were collected from the hands of 154 HCWs working at Gaziantep University Hospital. A standard bag broth technique was employed. In addition to conventional methods, VITEK 2 automated system and API ID 32C kits were used for identification of the isolated microorganisms. Antimicrobial susceptibility of bacterial agents was performed by disc diffusion method. For antifungal susceptibility, ATB Fungus 2 kit was used. Of 154 specimens, 148 (96.1%) showed microbial growth and 160 microorganisms were isolated as single or multiple members of the resident flora. Transient flora including one or more microorganisms (n = 47) were recovered from the hands of 39 (25.3%) HCWs. All gram-positive bacteria were detected to be sensitive to vancomycin, teicoplanin and linezolid, however 30.1% of the coagulase-negative staphylococci and 40% of *Staphylococcus aureus* isolates were resistant to methicillin. Multiple drug resistance was determined in *Acinetobacter* and *Pseudomonas* isolates. It can be concluded that transient flora members isolated from hands of HCWs can be causative agents of serious nosocomial infections due to their high and multiple antimicrobial resistance patterns.

Key words: Healthcare workers, resident flora, transient flora, antimicrobial susceptibility.

INTRODUCTION

Hand hygiene remains the major preventive measure against nosocomial infections. In 2002, Centers for Disease Control and Prevention (CDC) revised the recommendations for hand hygiene to include the use of alcohol-based products for standard hand hygiene (Larson et al., 2007; Boyce and Pittet, 2002).

Three principal types of skin flora have been described. The resident and transient flora was already distinguished in 1938. In addition, the infectious flora was described with species such as *Staphylococcus aureus* and beta-hemolytic streptococci which were frequently isolated from abscesses, whitlows, paronychia, or infected eczema. Resident flora consists of strains, such as coagulase-negative staphylococci and diphtheroids.

Microorganisms other than coagulase-negative staphylococci, *Corynebacterium* spp., *Micrococcus* spp. and *Bacillus* spp. were considered to be elements of transient flora and, therefore, potentially pathogenic microorganisms (Kampf and Kramer, 2004).

Investigators have documented that the number of transient and resident flora varies considerably from person to person and is relatively constant (Hugonnet and Pittet, 2000; Boyce and Pittet, 2002). A higher prevalence of antibiotic-resistant organisms on the hands of patient-care staff versus non-patient-care staff and/or outpatients has been reported (Aiello et al., 2003).

The purposes of this study were to describe the types and antimicrobial susceptibility patterns of hand flora among healthcare workers (HCWs) working in various clinics and to examine whether job title and ward location of HCWs can affect the growth of hand flora microorganisms.

MATERIALS AND METHODS

This prospective study was conducted at the microbiology laboratory of a University Teaching Hospital in Gaziantep, Turkey. The Hospital's Medical Ethics Committee approved the trial. The

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study hospital is occupied with 800 beds. Samples were collected from the hands of 154 (79 female and 75 male) HCWs during a three-month period from January to March 2008. HCWs were classified according to their job titles and ward location. There were 55 (35.7%) nurses, 33 (21.4%) permanent physicians, 11 (7.1%) medical students, 25 (16.2%) nursing assistants and 30 (19.5%) cleaning personnel. Forty-eight HCWs were employed at various surgical clinics, 32 at internal medicine ICU, 23 at internal medicine and cardiology clinics, 21 at pediatrics and newborn clinics, 11 at oncology division of internal medicine, 10 at surgical ICU, and 9 at pediatric oncology clinic.

Both hands of all participants were washed in 50 ml of brain-heart infusion broth in a sterile plastic bag and kneaded for 30 s by the standard bag broth technique (Larson, 1985; Larson et al., 1980). After removal of the hands from the bag, the broth was transferred to a sterile container. An inoculum of 0.1 ml from each sample was plated within 1 h or after storage at 4°C for up to 5 h onto Columbia sheep blood agar (5%), Eosin-methylene blue agar, Sabouraud's agar with chloramphenicol and gentamicin and bile aesculin agar. All culture media were incubated at 37°C and observed daily for growth over 48 h for bacteria and up to 7 days for yeast. Microorganisms grown on cultures were identified with conventional methods, VITEK 2 (BioMerieux, USA) automated system and API ID 32C (BioMerieux, France) kits as needed.

Antimicrobial susceptibility testing of coagulase-negative staphylococci (CNS) and transient bacterial flora members were performed by disc diffusion method according to Clinical and Laboratory Standards Institute's (CLSI) recommendations (Clinical and Laboratory Standards Institute, 2005). Quality control was performed with *S. aureus* ATCC 25923 and *Pseudomonas aeruginosa* ATCC 27853 strains; inhibition zone diameters were in the ranges stipulated by the CLSI (Clinical and Laboratory Standards Institute, 2005). We determined the antibiotic sensitivity pattern for coagulase-negative staphylococci because these organisms were present in almost all subjects as part of the resident flora of skin.

For the determination of methicillin susceptibility of staphylococcal strains, cefoxitin (30 µg) and oxacillin discs (1 µg) were used. CNS isolates that were clindamycin-susceptible (CL-S) and erythromycin-resistant (ER-R) were tested for inducible clindamycin resistance (ICR) by the D-test as described by CLSI (Clinical and Laboratory Standards Institute, 2005). For antifungal susceptibility, ATB Fungus 2 (BioMerieux- France) kit was used. *Candida parapsilosis* ATCC 22019 was used as the quality control strain.

Results were analyzed using Chi-square test. Statistical analysis were performed with Epi Info (version 3.4.3), and values of $p < 0.05$ were considered to indicate statistical significance.

RESULTS

Specimens were collected from 154 HCWs and 148 (96.1%) of them showed microbial growth. One hundred and sixty microorganisms from 148 HCWs were isolated as single or multiple members of the resident flora. Of 160 isolates, 143 (89.4%) were CNS and 10 (6.3%) were *Corynebacterium* spp. and 7 (4.4%) were *Bacillus* spp. No growth was observed in samples of 6 (3.9%) HCWs.

Transient flora including one or more microorganisms was recovered from the hands of 39 (25.3%) (21 male, 18 female) HCWs. Members of the transient flora (n = 47; 30.5%) isolated from the hands of 154 HCWs were as follows; 11 (7.1%) *Candida* spp. (*C. parapsilosis* n = 4, *Candida tropicalis* n = 3, *Candida albicans* n = 2, *Candida glabrata* n = 1 and *Candida guillermondii* n = 1), 9 (5.8%) *Acinetobacter* spp. (*Acinetobacter lwoffii* n = 7; *Acinetobacter baumannii* n = 2), 9 (5.8%) *Enterococcus* spp. (*Enterococcus faecalis* n = 5; *Enterococcus faecium* n = 4), 5 (3.2%) *S. aureus*, 4 (2.6%) *Pseudomonas* spp. (*P. aeruginosa* n = 2; *Pseudomonas stutzeri* n = 2), 4 (2.6%) *Enterobacter aerogenes*, 3 (1.9%) *Serratia marcescens* and 2 (1.3%) *Streptococcus pneumoniae*. Distribution of the transient flora members according to HCWs' job titles is shown in Table 1.

No statistically significant difference was observed according to job titles among number of transient-flora-member microorganisms isolated from HCWs' hands ($p = 0.312$); however, a statistically significant difference was recorded according to ward location ($p = 0.038$). No statistical difference was determined between number of transient-flora-member microorganisms isolated from hands of HCWs working in intensive care unit and non intensive care unit areas ($p = 0.391$). Moreover, there was also no significant difference between oncology and intensive care clinics ($p = 0.071$). However, a statistically significant difference ($p = 0.000$) was recorded among HCWs who worked in other clinics except intensive care unit and oncology clinics. Distribution of HCWs according to ward location and growth of transient flora is shown in Table 2.

Growth of coagulase-negative staphylococci (CNS) occurred on hands of 143 out of 154 HCWs. Among 143 CNS, 43 were (30.1%) methicillin resistant coagulase-negative staphylococci (MRCNS), 100 were (69.9%) methicillin susceptibility coagulase-negative staphylococci (MSCNS). Antibiotic susceptibilities of isolated CNS strains are shown in Table 3. In our study, all CNS were sensitive to vancomycin and linezolid and 96% of MSCNS strains were resistant to penicillin. It was found out that 41 (95.3%) of MRCNS strains were erythromycin-resistant, and 16 (37.2%) of them showed constitutive clindamycin resistance. In 8 (18.6%) MRCNS strain ICR was detected. It was found out that 68% of MSCNS strains were erythromycin-resistant. Constitutive clindamycin resistance was seen in 13% of MSCNS strains and ICR was detected in 11% cases (Table 3).

Antibiotic resistance among isolated gram positive and gram negative bacteria are shown in Tables 4 and 5, respectively. All gram positive bacteria were sensitive to vancomycin, teicoplanin and linezolid. Two of five (40%) isolated *S. aureus* strains were detected to be MRSA. Two strains of five (40%) isolated *E. faecalis* were resistant to quinupristin/dalfopristine; besides, all strains of *E. faecalis* and 3 *E. faecium* strains out of 4 (75%) were detected to be resistant to co-trimoxazole. All *S. aureus* strains were resistant to penicillin and all *S. pneumoniae* strains were resistant to erythromycin, clindamycin, ampicillin and gentamicin. All strains of *Serratia marcescens* were detected to be resistant to ampicillin, ampicillin/sulbactam, cefazolin and nitrofurantoin. Besides, *Acinetobacter* spp. and *Pseudomonas* spp. strains were multi-drug resistant.

Table 1. Transient bacterial flora of HCWs according to job title.

Microorganism	Nurses n = 55 (100%)	Permanent physicians n = 33 (100%)	Medical students n = 11 (100%)	Nursing assistant n = 25 (100%)	Cleaning personnel n = 30 (100%)	Total n = 154 (100%)
Yeast	6 (10.9)	-	1 (9.1)	2(8)	2 (6.7)	11(7.1)
Acinetobacter spp.	2 (3.6)	3(9.1)	1 (9.1)	1(4)	2 (6.7)	9 (5.8)
Enterococcus spp.	3 (5.5)	4 (12.1)	-	2(8)	-	9 (5.8)
Staphylococcus aureus	1 (1.8)	2(6.1)	-	1(4)	1 (3.3)	5 (3.2)
Pseudomonas spp.	-	3(9.1)	-	1(4)	-	4 (2.6)
Enterobacter aerogenes	2 (3.6)	1(3.0)	-	-	1 (3.3)	4 (2.6)
Serratia marcescens	3 (5.5)	-	-	-	-	3 (1.9)
Streptococcus pneumoniae	1 (1.8)	1(3.0)	-	-	-	2 (1.3)
Total	18(32.7)	14(42.4)	2 (18.2)	7 (28)	6 (20)	47 (30.5)

Table 2. Distribution of HCWs according to ward location and growth of transient flora.

Microorganism	Pediatrics + Newborn n = 21 (100%)	Internal medicine + Cardiology n = 23 (100%)	Coronary ICU+ Internal medicine ICU n = 32 (100%)	Surgical ICU n = 10 (100%)	Surgical clinics n = 48 (100%)	Adult oncology n = 11 (100%)	Pediatric oncology n = 9 (100%)
Yeast	-	2 (8.7)	1(3.1)	-	5 (10.4)	2 (18.2)	1 (11.1)
Acinetobacter spp.	-	-	5 (15.6)	1 (10)	2 (4.2)	-	1 (11.1)
Enterococcus spp.	1 (4.8)	1 (4.3)	1(3.1)	1 (10)	2 (4.2)	1 (9.1)	2 (22.2)
Staphylococcus aureus	1 (4.8)	2 (8.7)	-	-	2 (4.2)	-	-
Pseudomonas spp.	1 (4.8)	-	1(3.1)	-	-	1 (9.1)	1 (11.1)
Enterobacter aerogenes	-	-	1(3.1)	-	1 (2.1)	1 (9.1)	1 (11.1)
Serratia marcescens		-	2(6.3)	1 (10)	-	-	-
Streptococcus pneumoniae	-	-	-	1 (10)	-	1 (9.1)	-
Total	3 (14.3)	5 (21.7)	11(34.4)	4 (40)	12 (25)	6 (54.5)	6 (66.7)

Eleven species of *Candida* were isolated from 154 HCWs' hands. Antifungal susceptibilities of *Candida* spp. are shown in Table 6.

DISCUSSION

The resident flora consists of permanent inhabitants of the skin. They are found mainly on the surface of the skin and under the superficial cells of the stratum corneum. These bacteria are not regarded as pathogens on intact skin but may cause infections in sterile body cavities, in the eyes, or on non-intact skin. The dominant species is *Staphylococcus epidermidis*, which is normally found on almost every person's hand (Kampf and Kramer, 2004; Lee et al., 1994). Other regular residents are *Staphylococcus hominis* and other CNS, followed by coryneform bacteria such as propionibacteria, corynebacteria, dermabacteria, and micrococci (Kampf and Kramer, 2004). In the present study, 143 CNS, 10 *Corynebacterium* spp. and 7 *Bacillus* spp. were isolated from 154 HCWs' specimens. Thirty-three (30.1%) of 143 CNS were MRCNS while 100 (69.9%) were MSCNS. The incidence of oxacillin resistance among isolates of *S. epidermidis* was up to 64.3% (Lee et al., 1994) and was higher in health care workers who have direct contact with patients than in those who do not (Slight et al., 1987). One study reported that methicillin-resistant CNS was significantly higher among nurses with closest and most frequent patient contact (Klingenberg et al., 2001).

In previous studies, rates of oxacillin resistance among CNS from nurses' hands ranged from 26 - 79% (Horn et al., 1988; Cook et al., 2007). CNS, such as *S. epidermidis*, mainly causes catheter-associated primary bloodstream infections. In ICUs, approximately one-third of all blood culture isolates from patients with nosocomial bloodstream infections were found to be CNS (Kampf and Kramer, 2004).

Table 3. Antibiotic susceptibilities of MRCNS and MSCNS strains.

Antibiotics	MRCNS (n = 43)		MSCNS (n = 100)	
	Resistant n (%)	Sensitive n (%)	Resistant n (%)	Sensitive n (%)
Amoxicillin- Clavulanate	-	-	4	96
Cefotaxime	-	-	7	93
Ceftriaxone	-	-	7	93
Chloramphenicol	14 (32.6)	29 (67.4)	17	83
Clindamycin	16 (37.2)	27 (62.8)	13	87
Erythromycin	41 (95.3)	2 (4.7)	68	32
Fusidic acid	19 (44.2)	24 (55.8)	30	70
Gentamicin	28 (65.1)	15 (34.9)	16	84
Levofloxacin	14 (32.6)	29 (67.4)	7	93
Linezolid	0 (0.0)	43 (100)	0	100
Meropenem	-	-	1	99
Mupirocin	20 (46.5)	23 (53.5)	31	69
Penicillin	-	-	96	4
Rifampicin	19 (44.2)	24 (55.8)	12	88
Telithromycin	15 (34.9)	28 (65.1)	13	87
Trimethoprim-sulfamethoxazole	18 (41.9)	25 (58.1)	23	76
Vancomycin	0 (0.0)	43 (100)	0	100
ER-R, CL-S, D test positive	8 (18.6)		11	

MRCNS: Methicillin resistant coagulase-negative staphylococci; MSCNS: Methicillin susceptibility coagulase-negative staphylococci.

Table 4. Antibiotic resistance of gram positive transient flora members.

Antibiotics	*S. aureus* (n = 5)	*E. faecalis* (n = 5)	*E. faecium* (n = 4)	*S. pneumonia* (n = 2)
	Resistance n (%)	Resistance n (%)	Resistance n (%)	Resistance n (%)
Ampicillin	-	1 (20)	3 (75)	2 (100)
Ampicillin/Sulbactam	2 (40)	1 (20)	3 (75)	1 (50)
Ciprofloxacin	2 (40)	1 (20)	3 (75)	1 (50)
Clindamycin	2 (40)	3 (60)	3 (75)	2 (100)
Cotrimoksazole	0 (0)	5 (100)	3 (75)	1 (50)
Erythromycin	2 (40)	2 (40)	2 (50)	2 (100)
Fosfomycin	3 (60)	-	-	-
Fusidic acid	0 (0)	-	-	-
Gentamicin	2 (40)	1 (20)	1 (50)	2 (100)
Imipenem	2 (40)	0 (0)	3 (75)	1 (50)
Linezolid	0 (0)	0 (0)	0 (0)	0 (0)
Moxifloxacin	2 (40)	0 (0)	3 (75)	1 (50)
Oxacillin	2 (40)	-	-	-
Penicillin	5 (100)	-	-	-
Quinupristin/Dalfopristin	0 (0)	2 (40)	0 (0)	0 (0)
Rifampicin	2 (40)	-	-	-
Teicoplanin	0 (0)	0 (0)	0 (0)	0 (0)
Tetracycline	2 (40)	5 (100)	2 (50)	1 (50)
Vancomycin	0 (0)	0 (0)	0 (0)	0 (0)

In the current study, all CNS were sensitive to vancomycin and linezolid and 96% of MSCNS strains were resistant to penicillin. The macrolide-lincosamide-streptogramin B (MLSB) family of antibiotics is commonly used in the treatment of staphylococcal infections (Fiebelkorn et al., 2003). However, this widespread use

Table 5. Antibiotic resistance of gram negative transient flora members.

Antibiotics	*Acinetobacter* spp. (n = 9)	*Pseudomonas* spp. (n = 4)	*Serratia marcescens* (n = 3)	*Enterobacter aerogenes* (n = 4)
	Resistance n (%)	Resistance n (%)	Resistance n (%)	Resistance n (%)
Ampicillin	7 (77.8)	2 (50)	3 (100)	4 (100)
Ampicillin/Sulbactam	2 (22.2)	2 (50)	3 (100)	3 (75)
Amikacin	2 (22.2)	2 (50)	0 (0)	0 (0)
Aztreonam	8 (88.9)	4 (100)	0 (0)	1 (25)
Cefazolin	8 (88.9)	2 (50)	3 (100)	3 (75)
Cefepime	7 (77.8)	2 (50)	0 (0)	0 (0)
Cefotetan	7 (77.8)	2 (50)	0 (0)	3 (75)
Ceftazidime	8 (88.9)	3 (75)	0 (0)	0 (0)
Ceftriaxone	7 (77.8)	2 (50)	0 (0)	0 (0)
Ciprofloxacin	7 (77.8)	3 (75)	0 (0)	1 (25)
Gentamicin	7 (77.8)	3 (75)	0 (0)	1 (25)
Imipenem	7 (77.8)	2 (50)	0 (0)	1 (25)
Levofloxacin	7 (77.8)	2 (50)	0 (0)	0 (0)
Nitrofurantoin	8 (88.9)	2 (50)	3 (100)	3 (75)
Piperacillin/Tazobactam	7 (77.8)	3 (75)	0 (0)	0 (0)
Tobramycin	5 (55.6)	3 (75)	0 (0)	0 (0)
Trimethoprim/Sulfamethoxazole	7 (77.8)	2 (50)	0 (0)	2 (50)

Table 6. Antifungal susceptibilities of *Candida* spp.

Candida spp.	Flucytosine			Amphotericin B			Fluconazole			Itraconazole		
	S	I	R	S	I	R	S	I	R	S	I	R
C. parapsilosis (n = 4)	4			4			3	1		4		
C. tropicalis (n = 3)	3			3			3			1	1	1
C. albicans (n = 2)	2			2			2			2		
C. glabrata (n = 1)	1			1				1				1
C. guilliermondi (n = 1)	1			1				1		1		

S: susceptible; I: intermediate; R: resistant.

has led to an increase in the number of staphylococci strains being resistant to MLSB antibiotics (Lim et al., 2002). Consequently, ICR was investigated beside constitutive resistance for clindamycin in our study. It was found out that 41 (95.3%) of MRCNS strains were erythromycin-resistant, and 16 (37.2%) of them showed constitutive clindamycin resistance. In 8 (18.6%) of MRCNS strains ICR was detected. It was found out that 68% of MSCNS strains were erythromycin-resistant. Constitutive clindamycin resistance was seen in 13% of MSCNS strains and ICR was detected in 11% cases. The transient skin flora consists of bacteria, fungi, and viruses that may be found on the skin only at times. They usually do not multiply on the skin, but they survive and occasionally multiply and cause disease (Kampf and Kramer, 2004). In our study, transient flora was recovered from hands of 39 (25.3%) HCWs. When evaluated in terms of job titles, maximum yeast growth occurred in nurses, additionally 3 *S. marcescens* strains isolated from hands of nurses and 3 strains of *Pseudomonas* out of 4 were isolated from hands of permanent physicians respectively. No statistical difference among number of transient-flora-member microorganisms isolated from HCWs' hands was observed in job title ($p = 0.312$) but statistically significant difference was noticed in ward location ($p = 0.038$). Some clinical situations are associated with a higher bacterial load on the hands of health care workers: direct contact with patients, respiratory tract care, contact with body fluids, and after being interrupted while caring for a patient (Pittet et al., 1999). Due to immunosuppressive patient population in oncology clinic, it was considered that various microorganisms could be more frequently colonized in skin flora of these patients and HCWs working in this clinic can be easily contaminated with these microorganisms. Since 2006, HCWs at this hospital have been advised to use non-medicated soap and dry paper towels for hand washing and to use an alcohol-

based disinfectant as hand hygiene procedure during routine patient care. We think that health care staff should be controlled periodically for the proper and effective use of these procedures.

In the present study, transient-flora-member gram positive bacteria isolated from hands of 154 HCWs were *Enterococcus* spp. in 9 (5.8%), *S. aureus* in 5 (3.2%), *Streptococcus pneumoniae* in 2 (1.3%). Aiello et al. (2003) reported in their study that there were 12 different species of gram negative bacteria and 11 different species of CNS on the nurse hand samples (n = 119); and there were four nurses with *S. aureus* on their hands. *Enterococcus* species were the most frequently isolated gram positive bacteria species in our study. Strains of enterococci causing nosocomial infections have occasionally been found on the hands of medical personnel and have frequently been isolated from environmental sources in hospitals and nursing homes. The importance of these findings is difficult to assess, because the environment may simply have been passively contaminated by stool or urine from infected patients (Moellering, 2000). According to literature, vancomycin-resistant enterococcus can be found on the hands of up to 41% of health care workers (Hayden, 2000).

In our study, out of 9 isolated *Enterococcus* species, 5 were *E. faecalis* and 4 were *E. faecium.* Being a satisfactory result, no vancomycin resistance was detected among these species.

In our study, two of 5 *S. aureus* strains (40%) were determined to be MRSA. Colonization of HCWs' hands with *S. aureus* ranged between 10.5 and 78.3%. MRSA was isolated from the hands of up to 16.9% of HCWs. Hand carriage of pathogens such as *S. aureus*, MRSA, or *S. epidermidis* has repeatedly been associated with different types of nosocomial infections (Kampf and Kramer, 2004). A study by Cespedes et al. (2002) reported that significantly more medical personnel compared with non-medical hospital personnel were colonized with antibiotic-resistant *S. aureus*. All gram positive bacteria were found to be sensitive to vancomycin, teicoplanin and linezolid and most were detected to be sensitive to quinupristin/dalfopristine. Moreover, all strains of *E. faecalis* and three of four *E. faecium* strains were found to be resistant to cotrimoxazole. All strains of *S. aureus* were found to be resistant to penicillin; however, all strains of *S. pneumonia* were detected to be erythromycin, clindamycin, ampicillin and gentamicin.

Furthermore, transient-flora-member gram negative bacteria isolated from HCWs' hands were *Acinetobacter* species in 9 (5.8%), *Pseudomonas* species in 4 (2.6%), *E. aerogenes* in 4 (2.6%) and *S. marcescens* species in 3 (1.9%) cases. Colonization rates of gram-negative bacteria on the hands of HCWs ranged from 21 - 86.1%. Different species of gram-negative bacteria exhibit different colonization rates. For instance, the colonization rate is 3 to 15% for *A. baumannii*, 1.3 to 25% for *Pseudomonas* spp., and 15.4 to 24% for *S. marcescens*. Most reports of cross-transmission of specific gram-negative bacteria come from critical-care areas, such as neonatal ICUs and burn units (Kampf and Kramer, 2004). *Enterobacter agglomerans* (n = 5) was the frequently detected gram negative bacteria species in the study of Aiello et al. (2003). In this study, multi-drug resistance was observed in strains of *Acinetobacter* spp. and *Pseudomonas* spp. but all strains of *S. marcescens* were resistant to ampicillin, ampicillin/sulbactam, cefazolin and nitrofurantoin.

Yeasts (n = 11) isolated from HCWs' hands were identified as follows: 4 *C. parapsilosis*, 3 *C. tropicalis*, 2 *C. albicans* and a single strain of *C. glabrata* as well as *C. guillermondii* strains. In another study, *Candida* carriage was found in 34.1% of 214 HCWs (Yıldırım et al., 2007) and the most frequently yielded isolates were *C. parapsilosis* (38.4%), *C. tropicalis* (26.0%) and *C. albicans* (23.3%). *C. parapsilosis* is an important pathogen as it implies the possibility of nosocomial transmission of fungaemia by the hands of HCWs (Levin et al., 1998). In a long-term-care facility, 41% of 42 health care workers were found to have *Candida* spp. on their hands (Mody et al., 2003). Lupetti et al. (2002) concluded that horizontal transmission of *C. parapsilosis* occurred through direct interaction between nurses and the patients. With respect to antifungal susceptibility, it was found out that *C. parapsilosis* and *C. albicans* are highly susceptible to the studied antifungals. In the present study the susceptibility of *C. tropicalis* to antifungals except itraconazole was a satisfactory result for the hospital.

In conclusion, transient flora members were isolated mostly from HCWs working in oncology clinic. Bacterial contamination of HCWs' hands was likely to occur due to immunosuppressive patient population in oncology clinic. *Acinetobacter* spp. and *Pseudomonas* spp. strains were multi-drug resistant. The role of the hand flora of HCWs in the development of nosocomial infections is significant. These results, suggest that transient flora members isolated from hands of HCWs can be causative agents of serious nosocomial infections due to their high and multiple antimicrobial resistance patterns.

REFERENCES

Aiello AE, Cimiotti J, Della-Latta P, Larson EL (2003). A comparison of the bacteria found on the hands of 'homemakers' and neonatal intensive care unit nurses. J. Hosp. Infect., 54(4): 310-315.

Boyce JM, Pittet D (2002). Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HIPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Am. J. Infect. Control., 30:1-46.

Cespedes C, Miller M, Quagliarello B, Vavagiakis P, Klein RS, Lowy FD (2002). Differences between *Staphylococcus aureus* isolates from medical and nonmedical hospital personnel. J. Clin. Microbiol., 40: 2594-2597.

Clinical and Laboratory Standards Institute (2005). Performance standards for antimicrobial susceptibility testing; fifteenth

informational supplement M100-S14, Wayne, PA, CLSI.

Cook HA, Cimiotti JP, Della-Latta P, Saiman L, Larson EL (2007). Antimicrobial resistance patterns of colonizing flora on nurses' hands in the neonatal intensive care unit. Am. J. Infect. Control., 35(4): 231-236.

Fiebelkorn KR, Crawford SA, McElmeel ML, Jorgensen JH (2003). Practical disc diffusion method for detection of inducible clindamycin resistance in *Stapylococcus aureus* and coagulase-negative staphylococci. J. Clin. Microbiol., 41: 4740-4744.

Hayden MK (2000). Insights into the epidemiology and control of infection with vancomycin-resistant enterococci. Clin. Infect. Dis., 31: 1058-1065.

Horn WA, Larson EL, McGinley KJ, Leyden JJ (1988). Microbial flora on the hands of health care personnel: differences in composition and antibacterial resistance. Infect. Control. Hosp. Epidemiol., 9: 189-93.

Hugonnet S, Pittet D (2000). Hand hygiene beliefs or science? Clin. Microbiol. Infect., 6: 348-354.

Kampf G, Kramer A (2004). Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs. Clin. Microbiol. Rev., 17(4): 863-893.

Klingenberg C, Glad GT, Olsvik R, Flaegstad T (2001). Rapid PCR detection of the methicillin resistance gene, mecA, on the hands of medical and non-medical personnel and healthy children and on surfaces in a neonatal intensive care unit. Scand. J. Infect. Dis., 33: 494-497.

Larson E (1985). Handwashing and skin. Physiologic and bacteriologic aspects. Infect. Control. 6: 14-23.

Larson EL, Strom MS, Evans CA (1980). Analysis of three variables in sampling solutions used to assay bacteria of hands: type of solution, use of antiseptic neutralizers, and solution temperature. J. Clin. Microbiol., 12: 355-360.

Larson EL, Quiros D, Lin SX (2007). Dissemination of the CDC's Hand Hygiene Guideline and impact on infection rates. Am. J. Infect. Control., 35(10): 666-675.

Lee YL, Cesario T, Lee R, Nothvogel S, Nassar J, Farsad N, Thrupp L (1994). Colonization by *Staphylococcus species* resistant to methicillin or quinolone on hands of medical personnel in a skilled-nursing facility. Am. J. Infect. Control., 22: 346-351.

Levin AS, Costa SF, Mussi NS, Basso M, Sinto SI, Machado C, Geiger DC, Villares MC, Schreiber AZ, Barone AA, Branchini ML (1998). *Candida parapsilosis* fungemia associated with implantable and semi-implantable central venous catheters and the hands of healthcare workers. Diagn. Microbiol. Infect. Dis., 30(4): 243-249.

Lim JA, Kwon AE, Kim SK, Cong Y, Lee K, Choi EC (2002). Prevalence of resistance to macrolide, lincosamide and streptogramin antibiotics in Gram-positive cocci isolated in Korean hospital. J. Antimicrob. Chemother., 49: 489-495.

Lupetti A, Tavanti A, Davini P, Ghelardi E, Corsini V, Merusi I, Boldrini A, Campa M, Senesi S (2002). Horizontal transmission of *Candida parapsilosis* candidemi in a neonatal intensive care unit. J. Clin. Microbiol., 40(7): 2363-2369.

Mody L, McNeil SA, Sun R, Bradley SE, Kauffman CA (2003). Introduction of a waterless alcohol-based hand rub in a long-term-care facility. Infect. Control. Hosp. Epidemiol., 24: 165-171.

Moellering RC (2000). *Enterococcus species*, *Streptococcus bovis*, and *Leuconostoc* species. In: Mandell GL, Bennett JE, Dolin R, eds. Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases. Fifth ed. Philadelphia: CV, A Harcourt Health Sciences Co. p. 2069.

Pittet D, Dharan S, Touveneau S, Sauvan V, Perneger TV (1999). Bacterial contamination of the hands of hospital staff during routine patient care. Arch. Int. Med., 159: 821-826.

Slight PH, Weber JM, Campos JM, Plotkin SA (1987). Oxacillin-resistant coagulase negative staphylococcal carriage rates in neonatal intensive care nurses and non-patient care hospital personnel. Am. J. Infect. Control., 15: 29-32.

Yildirim M, Sahin I, Kucukbayrak A, Ozdemir D, Yavuz MT, Oksuz S (2007) Hand carriage of *Candida species* and risk factors in hospital personnel. Mycoses., 50: 189-192.