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## Research Article

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# Correlation between Bacterial Pathogens Transfer in Healthcare Workers and Patients: A Study from Paediatric ICU and Nursery of a Tertiary Care Hospital

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### Abstract

**Background:** Cross transmission of microorganisms by the hands of healthcare workers is the main route of spread of health care associated infections (HCAI) as they provide essential services to the patients. HCAI has increased the morbidity and mortality of hospitalized patients especially the ones admitted in Paediatric ICU and nursery.

**Objectives:** The present study was undertaken to isolate bacteria from hands of resident doctors and nursing staff from Paediatric ICU and nursery and to correlate them with the patients sample isolates from same Paediatric ICU and Nursery during the same time period.

**Material and Methods:** Fingertips of subjects were directly stabbed on MacConkey agar and Blood agar plates. AntibioGram of isolated pathogens was also determined by standard methods.

**Observations:** Hands of 60% healthcare workers were culture positive. Predominant isolate were Coagulase negative *Staphylococcus* spp. (73.3%), followed by *Staphylococcus aureus* (10%), *Enterococcus* and *Acinetobacter* spp. (each 6.6%). Methicillin resistant *Staphylococcus aureus* (50%) were also observed.

**Conclusion:** Implementation and improving the compliance to hand hygiene may result in order to reduce cross infection from health care workers to patients.

**Keywords:** Health care associated infection; Health care workers; Antibiotic resistance; Paediatric ICU

## Introduction

Usually skin carries two major groups of microorganisms such as resident flora (organism that reside on the skin) and the transient flora (contaminants). Transient flora or contaminants cause most of the health care associated infections (HCAI) due to cross transmission. Transmission of health care associated pathogens from one patient to another occurs via hands of health care workers (HCWs) [1]. This route of spread of infections through health care workers have been identified as a critical health problem, which affects the quality of health care provided in hospitals. It becomes more complicated especially in ICU's and speciality wards, and may result in high rate of morbidity and mortality [2]. Among various factors, hand hygiene of health care workers is of utmost importance since spread of antimicrobial resistant pathogens has been usually shown to be associated with hand hygiene, and hence is important in HCAI. Despite of awareness, practice of proper hand washing and disinfection by healthcare workers is unacceptably low [3]. In addition to direct contact with patients or their body fluids, contact with environmental surface contaminated with pathogen result in acquisition of pathogen on hands [4].

It has been demonstrated that transmission of pathogens to hands during the patient care activities can occur in sequential steps as (1) organisms present on patients skin/or immediate environment (2) transfer of organism on health-care workers hands (3) its survival on hands (4) defective hand cleansing and (5) cross-transmission of organisms [1]. This indicates the possible events in transmission of pathogen from hands to susceptible host, and hence highlights the importance of hand cleaning. Recently, WHO guidelines have also

delineated indications for hand cleansing on the basis of microbiologic contamination acquired during routine patient care. Most of the time transmission of the pathogens from one patient to another through hands of health care workers remains undetected. Therefore, the present study was carried out to ascertain the microbiological load associated with health care workers hands during patient care so as to provide evidence for need to improve the hand hygiene practices and other intervention strategies in critical care centres.

## Materials and Methods

100 HCWs (60 doctors and 40 nurses) working in paediatric ICU and nursery of Kalawati Saran Children Hospital, New Delhi were recruited in study. The Hospital Ethical Clearance Committee approved the study protocol. Samples were collected and processed as given by Pittet et al. [2]. Fingertip impressions (hand washing followed by hand disinfectant prior to patient care and after patient care without hand disinfectant) were taken directly on Blood agar and MacConkey agar plates from each participant after obtaining informed consent. Plates

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were incubated at 37°C overnight, and were examined for bacterial growth after 24 hours. The microorganisms were identified using standard procedures [5]. Antibiotic susceptibility testing of isolated organisms was done by Kirby Bauer disk diffusion method. Out of total isolates, methicillin resistant *Staphylococcus aureus* (MRSA) were also detected by using Mueller Hinton agar with 30 µg cefoxitin and 1µg oxacillin disk following CLSI guidelines [6]. Bacterial strains isolated from 311 cultures positive patient samples of paediatric ICU and nursery during study period, were used as reference for correlation. All the experiments were repeated three times to confirm the reproducibility of experiments, and results were analysed statistically by Student's t test using SPSS 11.05.

## Results

Fingertip impressions after applying hand disinfectant prior to patient care did not showed any microbial growth. However, significantly high number of samples after patient cares without hand disinfectant, harboured different types of microorganisms ( $p \leq 0.01$ ). Hands of doctors (66.6%) were found to be more contaminated than that of nurses (33.3%) from the same ward ( $p \leq 0.01$ ). *Staphylococcus* spp (83.3%) was the most common isolate. Coagulase negative *Staphylococcus* spp were isolated from 44 (73.3%) and *S. aureus* from 6 (10%) cases (Table 1). 3 out of 6 *S. aureus* were found to be MRSA and out of 4 *Enterococcus* spp isolated, 1 was found to be vancomycin resistant (VRE). *Acinetobacter* 4 (6.6%) was the predominant Gram-negative bacteria followed by *E. coli* 2 (3.3%). 50% of *Acinetobacter* were resistant to commonly used antibiotics such as ciprofloxacin,

gentamicin, erythromycin, ceftazidime, imipenim and amikacin (Table 2).

Bacterial strains isolated from patient samples such as from surgical site infection (SSI), blood stream infection (BSI), and ventilator-associated pneumonia (VAP) were also observed. In SSI and BSI, majority of the organisms isolated were *S. aureus* (27.4% and 33.3%), CoNS (20.9% and 22.2%) and *Acinetobacter* (22.9% and 11.1%), respectively. Most common organisms from VAP were *Acinetobacter* (48.3%) and *S. aureus* (16.1%). CoNS (73.3%), *S. aureus* (10%) and *Acinetobacter* (6.6%) were isolated most commonly as contaminants from hands of HCWs (Table 3).

## Discussion

In pediatric ICU and nursery, critically ill patients who need to stay for longer duration, are admitted. The longer duration of care can lead to higher degree of contamination, if proper hand washing practices are not followed. Both the duration and the type of patient care, affect the health-care workers hand contamination [2]. In the present study, fingertips of 60 out of 100 doctors and staff nurses, attending pediatric ICU and nursery showed high bacterial lodgment. Out of 60 isolates, CoNS (73.3%) were the predominant pathogen followed by *S. aureus* (10%), *Enterococcus* and *Acinetobacter* Spp. *E. coli* (3.3%) was the least isolated pathogen from hands.

In an earlier study, hands of 90% of HCWs' in NICU were reported to be contaminated with pathogens [1]. Patient care activities such as respiratory care, direct patient contact, and handling of body fluid

Bacterial Pathogen	No. of Isolates (N=60)	Percentage
CoNS	44	73.3%
<i>S. aureus</i>	6	10%
<i>Enterococcus</i>	4	6.6%
<i>Acinetobacter</i> Spp.	4	6.6%
<i>E. coli</i>	2	3.3%

**Table 1:** Table showing the different bacterial strains isolated from hands of health care workers by fingertip impressions on Blood agar and MacConkey agar plates.

Antibiotic	CoNS (N=44)	<i>S. aureus</i> (N=6)	<i>Enterococcus</i> (N=4)	<i>Acinetobacter</i> (N=4)	<i>E. coli</i> (N=2)
P	24 (54.5%)	3 (50%)	1 (25%)	-	-
Ox	24 (54.5%)	3 (50%)	1 (25%)	-	-
G	16(36.3%)	2 (33.3%)	1 (25%)	2(50%)	1 (50%)
CF	16(36.3%)	2 (33.3%)	1 (25%)	2 (50%)	1 (50%)
LE	5(11.3%)	1 (16.6%)	-	2 (50%)	-
E	16(36.3%)	2 (33.3%)	1 (25%)	2 (50%)	1 (50%)
Co	16(36.3%)	2 (33.3%)	1 (25%)	2 (50%)	-
CD	16(36.3%)	2 (33.3%)	1 (25%)	2 (50%)	-
T	16(36.3%)	2 (33.3%)	1 (25%)	-	-
VA	0%	-	1 (25%)	-	-
CA	-	-	-	2(50%)	1(50%)
PIT	-	-	-	1(25%)	0%
I	-	-	-	1(25%)	1(50%)
MRP	-	-	-	1(25%)	0%
TIG	-	-	-	0%	0%
TE	0%	0%	0%	-	-
CL	-	-	-	0%	0%
LZ	0%	0%	0%	-	-
NT	-	-	-	1(25%)	0%
AK	-	-	-	2(50%)	1(50%)

P-penicillin, OX- Oxacillin, G-Gentamicin, CF- Ciprofloxacin, LE- Levofloxacin, E- Erythromycin, CO- Cotrimoxazole, CD- Clindamycin, T- Tetracyclin, VA- Vancomycin, CA- Ceftazidime, PIT- Piperacilline-Tazobactam, I-Imepenem, MRP- Meropenem, TIG-Tigecycline, CL- Colistin, LZ-Linezolid, NT- Netilmicin, AK- Amikacin

**Table 2:** Antibiotic resistance profile as assessed by disc diffusion methods of different bacterial strains isolated from hands of health care workers.

HCAI	CoNS	<i>S. aureus</i>	<i>Acinetobacter</i>	<i>Enterococcus</i>	<i>E. coli</i>	<i>Klebsiella</i>	Others	Total
SSI	55 (20.9%)	72 (27.4%)	60 (22.9%)	14 (5.3%)	31 (11.8%)	20 (7.6%)	10 (3.8%)	262
BSI	4 (22.2%)	6 (33.3%)	2 (11.1%)	1 (5.5%)	1 (5.5%)	2 (11.1%)	2 (11.1%)	18
VAP	0	5 (16.1%)	15 (48.3%)	0	4 (12.9%)	4 (12.9%)	3 (9.6%)	31
HCWs	44 (73.3%)	6 (10%)	4 (6.6%)	4 (6.6%)	2 (3.3%)	-	-	60

SSI-Surgical site infection, BSI-Blood stream infection, VAP-Ventilator associated pneumonia

**Table 3:** Table showing the correlation between bacterial strains isolated health care workers and patients samples admitted during the study tenure.

secretions were shown to be associated with higher contamination levels. Further our result corroborates with evidence based model study of Pittet et al. [1] indicating that hands of health care workers are the most common vector responsible for cross infection. No degree of correlation was observed in the isolates from health care workers hands and isolates from patient samples. The number of isolates from hands and patient samples were variable except in case of CoNS. However, the data indicate the possible cross transmission of pathogens from hands to patients. Ehrenkranz and Alfonso [7] also reported the Gram-negative bacilli and *S. aureus* associated with health care workers.

Duration of patient-care activity has been strongly associated with the intensity of bacterial contamination of health-care workers' hands [7]. These findings were comparable to our findings. 10% each of *S. aureus* and Gram-negative bacilli were seen on doctors and nurses hands. In our study, bacterial isolates also showed high degree of resistance towards commonly used antibiotics. Among Gram-positive bacteria, (CoNS, *S. aureus* and *Enterococcus*) showed resistance to Benzyl penicillin, Oxacillin, ciprofloxacin, erythromycin, clindamycin, gentamicin, and cotrimoxazole. However, a small percentage of CoNS and *S. aureus* were resistant to levofloxacin. All the strains were found to be sensitive to colistin and linezolid. Among Gram-negative bacilli, resistance was observed against erythromycin, gentamicin, ciprofloxacin, ceftazidime, levofloxacin, cotrimoxazole, and clindamycin. However, the most important finding of the study was the detection of MRSA, a major nosocomial pathogen, and hence highlighting the importance of surveillance for contamination of hands of health care workers. The other isolates also showed high degree of resistance towards common antibiotics. It is of importance since HCAI in adult and pediatric ICUs rates are approximately three times higher than other facilities in hospitals [8]. The isolation of *S. aureus* and *Acinetobacter* species from surgical site infections further proves the pathogenic potential of these organisms. Therefore, implementation of standard hygiene practices is of utmost importance to handle the high rate of nosocomial infections and antibiotic resistance.

## Conclusion

Multimodal strategies have been shown to be more successful in improving rates of adherence with hand hygiene in HCWs than single interventions [9]. Targeted and multi-faceted approaches such as administrative support, motivation, availability of alcohol-based hand rubs, training and intensive education of HCWs with constant reminders in the workplace have been recommended for improvement in hand hygiene. It needs to be emphasized that wearing gloves does not replace the need for hand hygiene [10]. Recently, a system called

HYGreen has been developed that monitors HCWs' hand hygiene by analyzing sanitizer or soap fumes from their hands [8]. The results of the study suggest that bacterial contamination of hands of health care workers by transient flora may lead to subsequent infections in hospitalized population. Therefore, by improving and adopting good hand sanitizing strategies, rate of infections can be reduced.

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