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Incidence of clinical isolates and its antimicrobial resistance pattern among the nasal and hand swabs of operation theatre staff in tertiary and secondary care hospitals.

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Abstract

The aim of this study is to identify antimicrobial resistance patterns among bacterial isolates causing nosocomial infection among staff of the surgical units of two hospitals in the north Indian setting. This was a cross sectional study design. Samples were obtained from health care givers with the selection criteria of: No previous history of hospitalization, no history of likely contact with patients of *Staphylococcus aureus*, and the health personnel available in the operation theatre at the time of sample collection. All the specimens were inoculated on sheep blood agar and MacConkey agar media and thereafter incubated at 37°C for 24 h for the bacterial identification. The MRSA was lower among nasal (8.1%) and hand swabs (6.7%) than MSSA (nasal=33.9%, hand=28.3) among surgeons. However, MSSA was 30% among nasal swabs and 24.1% among hand swabs in tertiary care hospital. Gram positive bacterial isolates were highly resistant to ampicillin (98.3%), amoxy/clav (95.4%), active ingredient (82.3%) and tetracycline (77.1%) in nasal swab of surgeons and OT health staffs in tertiary care hospital while these were ampicillin (84.3%), amoxy/clav (79.9%), active ingredient (68.7%) and tetracycline (65.7%) resistant in secondary care hospital. Gram negative bacterial isolates were highly resistant to ampicillin (88.0%), amoxy/clav, ceftazidime and cefepime (80.0%) each in nasal swab of surgeons and OT health staffs in tertiary care hospital while these were ampicillin (83.0%), amoxy/clav (68.8%), active ingredient (61.1%), ceftazidime and tobramycin (60.0%) each resistant in secondary care hospital. The data of the present study demonstrate the widespread problem of antibiotic resistance among staff of surgical units in the two hospitals. Continued surveillance is necessary to guide appropriate empirical therapy for these infections. It is imperative that all professionals take an active role in infection control within their establishments. More resources should be provided to encourage good antibiotic practice and good hygiene in hospitals.

Keywords: Nosocomial infection, Bacterial isolates, Antimicrobial resistance, Operation theatre.

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Introduction

Microbial contamination of hospital environment, especially the operating theatre and other specialized units had continued to increase prevalence of nosocomial infection [1-4]. Nosocomial infections are an important cause of mortality and morbidity in any hospital setting [5]. Of them, infections contracted from doctors occupy a sizeable proportion. Person-to-person contact among medical staff and between medical staff and patients appears to be the most common route of transmission of virulent strains like *Staphylococcus aureus* (including methicillin-resistant *Staphylococcus aureus*, i.e. MRSA) and pseudomonas [6].

Hospital represents a special environment, providing health care to patients and as a work environment for medical and other staff. One of the important sources of staphylococcus for nosocomial infections is nasal carriage among hospital personnel [7]. Studies on nasal carriage of Coagulase-Negative Staphylococci (CoNS) in Health Care Workers (HCWs) are much lacking. There are a lot of studies on nasal carriage of *Staphylococcus aureus* and methicillin resistance in *S. aureus*

among health care workers. Since CoNS are now increasingly recognized as nosocomial pathogens in recent years [7,8].

The infection is usually acquired during the operation itself; either exogenously (e.g. from the air, medical equipment, surgeons and other staff), endogenously from the flora on the skin or in the operative site or, rarely from blood used in surgery. The infecting microorganisms are variable, depending on the type and location of surgery, and antimicrobials received by the patient. The main risk factor is the extent of contamination during the procedure (clean contaminated), which is to a large part dependent on the length of the operation, and the patient's general condition [9]. Personnel and patients can acquire MRSA by coming into contact with a contaminated environment or objects in the environment [10].

Organizational risk factors include contaminated air-conditioning systems, contaminated water systems, staff and physical layout of the facility (e.g., nurse-to-patient ratio, open beds close together). Patient risk factors include the severity of illness, underlying immune-compromised state, and length of stay [11,12].

The widespread use of antimicrobials for therapy or prophylaxis (including topical) is the major determinant of resistance. Antimicrobial agents are, in some cases, becoming less effective because of resistance. As an antimicrobial agent becomes widely used, bacteria resistant to this drug eventually emerge and may spread in the health care setting. Multi-resistant *Klebsiella* and *Pseudomonas aeruginosa* are prevalent in many hospitals. This problem is particularly critical in developing countries where more expensive second-line antibiotics may not be available or affordable [13].

This study aimed to identify antimicrobial resistance patterns among bacterial isolates causing nosocomial infection among staff of the surgical units of two hospitals in the north Indian setting.

Material and Methods

Study design and study area

This was the cross sectional study which was conducted in tertiary care hospital (King George's Medical University) and secondary care hospital (Dr. Shyama Prasad Mukherji Hospital (Civil Hospital) of Lucknow.

Determination of the hospital acquisition of nasal carriage and palm of hand of MRSA isolates

Samples were obtained from health care givers with the selection criteria of:

1. No previous history of hospitalization.
2. No history of likely contact with patients of *Staphylococcus aureus*.
3. The health personnel available in the operation theatre at the time of sample collection.

Nasal swab

Nasal swabs were collected from health care givers. The swab was inserted in anterior nasal chamber, 2 cm into the nares by rotating the swab against the nasal mucosa pre-moistened with saline [14]. This process was repeated on the other side also.

Hand swabs

Hand swabs were collected from palm of hands of health care givers. This was done by rubbing a sterile swab, on palm of hands [14].

Culture of specimen

All the specimens were inoculated on sheep blood agar and MacConkey agar media and thereafter incubated at 37°C for 24 h, for the bacterial identification [15].

Identification of isolates

Bacterial isolates was identified with the help of Gram staining and biochemical tests such as catalase, coagulase, oxidase test, IMViC, sugar fermentation, methyl red, voges proskauer and sugar fermentation test etc. Mainly, facultative anaerobes and aerobic bacteria such as *Staphylococcus aureus* including MRSA, coagulase-negative Staphylococci (CoNS), Acinetobactor species and *Pseudomonas aeruginosa* were taken into consideration as per guidelines of CLSI [16]. Antimicrobial susceptibility testing was done by the Kirby-Bauer disc diffusion method [17,18].

Statistical analysis

The data collected was entered in the Microsoft Excel computer program and checked for any inconsistency. The results are presented in proportions/percentages. The unadjusted and adjusted logistic regression analysis was carried out to find out the relative importance of the factors associated with the NI. The p-value<0.05 was considered as significant. All the analysis was carried out by using SPSS 16.0 version.

Ethical clearance and consent

Ethical clearance was taken from Institutional Ethical Committee of King George's Medical University UP, Lucknow. The consent was taken from the staff of the operation theatre before the collection of specimen.

Results

Staff of operation theater

Distribution of different types of isolates among staff of operation theater specimen is depicted in the Table 1. The occurrence of MRSA was higher among nasal (9.4%) than hand swabs (6.5%) among surgeons in tertiary care hospital. Similar observation was found among OT staff in tertiary care hospital. However, the occurrence of MRSA was lower among

nasal (6.7%) than hand swabs (6.9%) among surgeons in secondary care hospital. Similar observation was found among OT staff in secondary care hospital.

Table 1. *Distribution of different types of isolates among staff of Operation Theater (OT).*

Types of isolates	Surgeon				OT staff			
	Nasal		Hand		Nasal		Hand	
	No.	%	No.	%	No.	%	No.	%
Tertiary care	**n=36**		**n=38**		**n=178**		**n=179**	
Bacillus spp.	3	9.4	12	38.7	11	6.2	51	28.5
CoNS[1]	11	34.4	6	19.4	55	30.9	37	20.7
Acinetobacter lwoffi	1	3.1	2	6.5	6	3.4	19	10.6
Acinetobacter baumannii	1	3.1	3	9.7	7	3.9	12	6.7
MRSA	3	9.4	2	6.5	20	11.2	12	6.7
MSSA	12	37.5	10	32.3	74	41.6	56	31.3
Klebsiella ozaenae	5	15.6	1	3.2	25	14	8	4.5
Pseudomonas aeruginosa[2]	0	0	2	6.5	5	2.8	22	12.3
Secondary care	**n=30**		**n=29**		**n=143**		**n=138**	
Bacillus spp.	2	6.7	8	27.6	9	6.3	35	25.4
CoNS[1]	13	43.3	12	41.4	47	32.9	41	29.7
Acinetobacter lwoffi	1	3.3	3	10.3	11	7.7	11	8
Acinetobacter baumannii	1	3.3	1	3.4	5	3.5	13	9.4
MRSA	2	6.7	2	6.9	10	7	10	7.2
MSSA	9	30	7	24.1	53	37.1	49	35.5
Klebsiella ozaenae	5	16.7		0	25	17.5	7	5.1
Pseudomonas aeruginosa[2]	1	3.3	4	13.8	4	2.8	18	13
Total	**n=62**		**n=60**		**n=321**		**n=317**	
Bacillus spp.	5	8.1	20	33.3	20	6.2	86	27.1
CoNS	24	38.7	18	30	102	31.8	78	24.6
Acinetobacter lwoffi	2	3.2	5	8.3	17	5.3	30	9.5
Acinetobacter baumannii	2	3.2	4	6.7	12	3.7	25	7.9
MRSA	5	8.1	4	6.7	30	9.3	22	6.9
MSSA	21	33.9	17	28.3	127	39.6	105	33.1
Klebsiella ozaenae	10	16.1	1	1.7	50	15.6	15	4.7
Pseudomonas aeruginosa	1	1.6	6	10	9	2.8	40	12.6

[1]Surgeon: Hand p<0.0001; [2]Surgeon: Hand p=0.001.

Table 2. *Percentage of gram positive and negative bacterial isolate resistant to antimicrobial agents among surgeon and OT health staff-Nasal swab.*

Antimicrobial agents	Gram positive			Gram negative		
	Tertiary care	Secondary care	p-value	Tertiary care	Secondary care	p-value

	No. of isolates	No. resistant (%)	No. of isolates	No. resistant (%)	No. of isolates	No. resistant (%)	No. of isolates	No. resistant (%)		
Ampicilin	175	172 (98.3)	134	113 (84.3)	0.04*	50	44 (88.0)	53	44 (83.0)	0.12
Amoxy/Clav	175	167 (95.4)	134	107 (79.9)	0.03*	45	36 (80.0)	48	33 (68.8)	0.05
Piperacillin/Tazobactum	-	-	-	-		20	7 (35.0)	23	6 (26.1)	0.03*
Cefotaxime	-	-	-	-		45	29 (64.4)	48	27 (56.3)	0.06
Ceftriaxone	-	-	-	-		30	21 (70.0)	30	16 (53.3)	0.02*
Ceftazidime	-	-	-	-		5	4 (80.0)	5	3 (60.0)	0.01*
Cefepime	-	-	-	-		5	4 (80.0)	5	2 (40.0)	0.01*
Cefaperazone/Sulbactum	-	-	-	-		50	28 (56.0)	53	21 (39.6)	0.01*
Imipenem	-	-	-	-		50	18 (36.0)	53	10 (18.9)	0.01*
Gentamicin	-	-	-	-		50	33 (66.0)	53	31 (58.5)	0.09
Amikacin	-	-	-	-		50	29 (58.0)	53	23 (43.4)	0.06
Ciprofloxacin	-	-	-	-		15	8 (53.3)	18	8 (44.4)	0.05
Levofloxacin	175	83 (47.4)	134	47 (35.1)	0.03*	35	22 (62.9)	35	18 (51.4)	0.05
Vancomycin	175	0 (0.0)	134	0 (0.0)	-	-	-	-	-	
Active ingredient	175	144 (82.3)	134	92 (68.7)	0.01*	15	10 (66.7)	18	11 (61.1)	0.11
Tetracycline	175	135 (77.1)	134	88 (65.7)	0.04*	15	10 (66.7)	18	9 (50.0)	0.12
Erythromycin	175	121 (69.1)	134	73 (54.5)	0.06	-	-	-	-	
Meropenem	-	-	-	-		50	19 (38.0)	53	10 (18.9)	0.01*
Clindamycin	175	113 (64.6)	134	62 (46.3)	0.01*	-	-	-	-	
Oxacillin	175	51 (29.1)	134	30 (22.4)	0.11	-	-	-	-	
Linezolid	175	11 (6.3)	134	2 (1.5)	0.06	-	-	-	-	
Tobramycin	-	-	-	-		5	3 (60.0)	5	3 (60.0)	1
Colistin	-	-	-	-		5	2 (40.0)	5	2 (40.0)	1
Norfloxacin	175	80 (45.7)	134	55 (41.0)	0.13	50	28 (56.0)	53	24 (45.3)	0.09

*Significant between tertiary and secondary care hospital.

Table 3. *Percentage of gram positive and negative bacterial isolate resistant to antimicrobial agents among surgeon and OT health staff-Hand swab.*

Antimicrobial agents	Gram positive					Gram negative				
	Tertiary care		Secondary care		p-value	Tertiary care		Secondary care		p-value
	No. of isolates	No. resisters (%)	No. of isolates	No. resisters (%)	No. of isolates	No. resistant (%)	No. of isolates	No. resisters (%)		
Ampicillin	123	115 (93.5)	121	98 (81.0)	0.1	69	64 (92.7)	57	47 (82.4)	0.04*
Amoxy/Clav	123	109 (88.6)	121	91 (75.2)	0.02	45	34 (75.5)	35	21 (60.0)	0.03*
Piperacillin/Tazobactum	-	-	-	-		60	31 (51.6)	50	21 (42.0)	0.06
Cefotaxime	-	-	-	-		45	32 (71.1)	35	20 (57.1)	0.01*
Ceftriaxone	-	-	-	-		9	6 (66.6)	7	3 (42.8)	0.01*

Ceftazidime	-	-	-	-		24	17 (70.8) (72.4)	22	13 (59.0)	0.01*
Cefepime	-	-	-	-		24	16 (66.6)	22	12 (54.5)	0.05
Cefaperazone/Sulbactum	-	-	-	-		69	39 (56.5)	57	24 (42.1))	0.04*
Imipenem	-	-	-	-		69	26 (37.6)	57	11 (19.3)	0.01*
Gentamicin	-	-	-	-		69	50 (72.4)	57	36 (63.1)	0.11
Amikacin	-	-	-	-		69	32 (46.3)	57	22 (38.6)	0.07
Ciprofloxacin	-	-	-	-		36	19 (52.7)	28	12 (42.8)	0.04*
Levofloxacin	123	62 (50.4)	121	57 (47.1)	0.11	33	18 (54.5)	29	13 (44.8)	0.04*
Vancomycin	123	0 (0.0)	121	0 (0.0)	-	-	-	-	-	
Active ingredient	123	95 (77.2)	121	77 (63.6)	0.1	36	25 (69.4)	28	18 (64.2)	0.09
Tetracycline	123	91 (74.0)	121	73 (60.3)	0.02*	45	34 (75.5)	35	22 (62.8)	0.04*
Erythromycin	123	84 (68.3)	121	49 (40.5)	0.01*	-	-	-	-	
Meropenem	-	-	-	-		69	22 (31.8)	57	14 (24.5)	0.03*
Clindamycin	123	74 (60.2)	65	23 (35.4)	0.01*	-	-	-	-	
Oxacillin	123	22 (17.9)	121	19 (15.7)	0.23	-	-	-	-	
Linezolid	123	1 (0.8)	121	1 (0.8)	1	-	-	-	-	
Tobramycin	-	-	-	-		24	17 (70.8)	22	13 (59.0)	0.02*
Colistin	-	-	-	-		24	11 (45.8)	22	6 (27.2)	0.01*
Norfloxacin	123	63 (51.2)	121	53 (43.8)	0.12	69	38 (55.0)	57	25 (43.8)	0.04*

*Significant between tertiary and secondary care hospital.

Table 2 shows that Gram positive bacterial isolates were highly resistant to ampicillin (98.3%) and amoxy/clav (95.4%) in nasal swab of both surgeons and OT staff in tertiary care hospital. Almost similar observation was found in secondary care hospital. Gram negative bacterial isolates were also highly resistant to ampicillin and amoxy/clav in nasal swab of both surgeons and OT staff in tertiary and secondary care hospitals.

Table 3 shows that gram positive bacterial isolates were highly resistant to ampicillin (93.5%) and amoxy/clav in hand swab of surgeons and OT health staffs in tertiary care hospital. Almost similar observation was found in secondary care hospital. Gram negative bacterial isolates were also highly resistant to ampicillin and amoxy/clav in hand swab of both surgeons and OT staff in tertiary and secondary care hospitals.

Discussion

In that countries where resources are limited, surgical site infections remain a major cause of nosocomial infections [19]. This study therefore mainly targeted on the staff of surgery units. The study presents evident limitations but, since samples were collected by staff from the staff of the institute to ensure their rapid delivery to the laboratory.

Gram negative bacteria cause thousands of hospital acquired infections each year. It is estimated that approximately 30% of all the hospital acquired infections are caused by gram negative bacteria and that they are responsible for approximately 70% of all hospital acquired infections in the Intensive Care Unit [20].

In the present study, MRSA was lower among nasal and hand swab than MSSA among surgeons. Similar observation was found among OT staff in this study. The MRSA was 6.7% among nasal swab and 6.5% among hand swab in tertiary care hospital in the present study. However, MSSA was 30% among nasal swab and 24.1% among hand swab in tertiary care hospital in this study. Almost similar pattern was found in secondary care hospital. The CoNS was statistically significantly ($p<0.0001$) different among hand swab of surgeon between tertiary and secondary care hospitals. However, *Pseudomonas aeruginosa* was significantly different among the hand swab of surgeons between tertiary and secondary care hospitals in this study.

MRSA was found on uniforms and gowns of 65% of healthcare workers performing care activities for patients with MRSA and 42% of healthcare workers having contact only with the environment in an MRSA patient's room had MRSA on their gloves [2]. In a study, it was reported that only 6.67% (4 out of 60 samples) of the positive swabs were from samples that were collected from hospital personnel [21]. It had been

reported that 73% staff members of a hospital were using gloves including 67% of physicians and 78% of nurses [22].

This study provides insights into the problem of resistance in bacterial pathogens among the staff of surgical units in the tertiary and secondary care hospitals. Our results demonstrated that, in general, isolates have high rates of resistance to antibiotics commonly used in developing countries. We also found a high rate of resistance to penicillin, first generation cephalosporins and cotrimoxazol. Therefore, cheap antibiotics such as amoxicillin, tetracyclin and cotrimoxazol are now of limited benefit in the treatment of infections in the hospitals. These results, probably due to overuse of broad-spectrum antibiotics, confirm those of previous studies [23,24].

Conclusions

The data of the present study demonstrate the widespread problem of antibiotic resistance among staff of surgical units in the tertiary and secondary care hospitals. Continued surveillance is necessary to guide appropriate empirical therapy for these infections. It is imperative that all professionals take an active role in infection control within their establishments. More resources should be provided to encourage good antibiotic practice and good hygiene in hospitals.

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