

Nasal carriage of methicillin-resistant *Staphylococcus aureus* among health-care workers at a tertiary care hospital in Northern India

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ABSTRACT

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) is resistant to all beta-lactam antibiotics, including penicillins, cephalosporins, carbapenems, and betalactamase inhibitors. MRSA remains a public health problem globally. MRSA infection increases morbidity, risk of mortality, increased financial burden, and loss of productivity. A major source of MRSA in the hospital environment can be asymptotically colonized health-care workers (HCWs). **Objectives:** The aim of the study is to screen nasal swabs collected from HCWs of our hospital for colonization with *S. aureus* and detect methicillin resistance among them. **Materials and Methods:** In this cross-sectional study, consenting HCWs were consecutively enrolled. Nasal swabs were collected aseptically from study participants and processed using standard microbiological protocols for the recovery of *S. aureus* and MRSA. Methicillin resistance was detected by cefoxitin disc diffusion method according to the CLSI guidelines. **Results:** Out of a total of 184 HCWs studied, the prevalence of *S. aureus* carriage in anterior nares was 14.6%. The overall MRSA prevalence was 3.8%. Highest carriage rates for MRSA were found in laboratory technicians (7.1%) followed by nursing staff (4.4%). The ophthalmology department had the highest MRSA carriage rate of 22%. **Conclusions:** Our findings demonstrate that nasal carriage of MRSA among HCWs is relatively low in this study compared to other Indian studies done in tertiary care centres. Further studies are needed to evaluate the incidence of infections due to MRSA in this population.


KEY WORDS: Nasal Swab; Culture; *Methicillin-Resistant Staphylococcus Aureus*

INTRODUCTION

Staphylococcus aureus is the etiological organism in many serious pyogenic infections, particularly among those which are acquired as fomite borne infections from the hospital environment.^[1] An increasing population of *S. aureus* cultured from clinical specimens are resistant to common antibiotics, especially methicillin.^[2] Methicillin-resistant *S. aureus*

(MRSA) due to the presence of *mecA* gene is able to alter the target enzyme of beta-lactam antibiotics. The result is that MRSA is not inhibited by any penicillin, cephalosporin, or carbapenem. Betalactamase inhibitors are also of no use against MRSA. MRSA has also been differentiated into community-associated MRSA (CA-MRSA) and health-care-associated MRSA (HA-MRSA). HA-MRSA is infamous for harboring additional genes for antimicrobial resistance.^[3,4]

Worldwide, researchers have reported a varying range of rates of *S. aureus* colonization of nasal cavity from <20% to above 80%.^[5,6] In India, nasal carriage of MRSA among health-care workers (HCWs) ranges from 1.8 to 14.28%.^[7,8] Factors in favor of increased acquisition of MRSA have been found to be lengthy antibiotic regimens, contact with medical and paramedical personnel colonized with MRSA, and indoor stay in a medical facility.

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Thus as is amply clear, HCWs carrying MRSA may inadvertently deposit the pathogen on the patients, especially when hand hygiene is not being well implemented.^[9] The significance of mass screening of HCWs for MRSA has been a topic of extensive debate with questions pertaining to ethical rights and advantages *per se*.^[10] However, there are studies which have indicated specific transmission of MRSA from caregivers to the patients. The actual estimates of the extent of this process are not known and need to be researched.^[11] Colonization of nasal cavity with *S. aureus* does not give rise to any clinical symptoms. Therefore, to detect carriers, proximal part of nasal cavity is rubbed with a swab which is cultured in a microbiological laboratory. This study aims to establish the pattern of colonization with *S. aureus*, especially MRSA on nasal mucosa of HCWs of our hospital. The inputs can be of immense benefit for putting in place an MRSA prevention and control policy for our institution.

MATERIALS AND METHODS

Study Design

This cross-sectional study was conducted at a tertiary care hospital of a medical college situated in Lucknow for a duration of 6 months from January 2017 to June 2017.

Ethical Consideration

Approval by the institutional ethics committee was taken (IEC approval no: IEC/IIMSR/2017/28). In this study, HCWs were consecutively enrolled and screened for MRSA after obtaining informed consent. An information sheet explaining the salient features of MRSA was given to the participants of the study.

Inclusion Criteria

HCWs consisted of any staff member (doctors, nurses, laboratory technicians, housekeeping staff, and any other staff) working in the management of outpatient and admitted patients were included in the study.

Exclusion Criteria

HCWs with a history of recent nasal surgery, fever, upper respiratory tract infection, and on any topical nasal medication and those who did not agree to participate in the study were excluded from the study.

Sample Collection

Saline premoistened swab was inserted into nostrils and gently rotated for a few seconds. It was withdrawn and again inserted into another nostril and the process repeated. The swab was returned to the collection tube and closed tightly. The plastic tube was labeled properly with name, age, and

sex and sent without delay to the microbiology laboratory for bacteriological analysis. Transport medium was used in case of delay.

Laboratory Methods

The swabs were cultured on blood agar and MacConkey agar. Blood agar was used to look for β -hemolysis of *S. aureus*, and MacConkey agar was used as differential media for the differentiation of coliforms species, non-fermenters, and staphylococci. Specimens were also inoculated into a tube of cooked meat broth for the enrichment and also on mannitol salt agar. The culture plates were examined after incubation at 37°C for 18 to 24 h. After the bacterial culture, isolate was obtained in pure subculture, and identification was done on the basis of colony size and shape, gram staining property, catalase test, and coagulase test (slide and tube). A mannitol fermentation test and DNase test were also put up. The isolates were identified as MRSA by conducting disk diffusion for cefoxitin disc (30 μ g).^[12] Cefoxitin is a surrogate marker for oxacillin resistance, and all isolates showing a zone size \leq 21 mm were taken as MRSA. The Kirby–Bauer method for antimicrobial sensitivity was utilized.

Statistical Analysis

Data collected about the HCWs included sociodemographic variables such as gender, age, ward, duration of professional experience, literacy status, and occupation (doctor, nurse, attendants, or non-medical personnel). All the categorical variables were analyzed for any correlation with MRSA carriage by performing the Chi-square test. Microsoft excel was utilized for data analysis, and final calculations were done through statistical software SPSS (version 16.0). If a “*P*” < 0.05 was obtained for any parameter, it was taken as statistically significant.

RESULTS

Of the 184 HCWs enrolled, 27 (14.6%) persons were carrying *S. aureus* in their anterior nares, and within them, 7 (3.8%) were colonized by MRSA. Nursing staff was most colonized by *S. aureus* (17.6%) while highest carriage of MRSA was detected in laboratory technicians (7.1%) and nurses (4.4%) [Table 1]. HCWs of ophthalmology department had the highest *S. aureus* colonization rates of 44.4% while medicine and medical intensive care unit (MICU) had rates of 29% and 28.6%, respectively. MRSA carriage rate was highest (22%) in ophthalmology department as shown in Table 2. Colonization by *S. aureus* was almost equal in female (14.7%) and male (14.4%) while MRSA was found to colonize men more than women. About 16.6% participants in the age group of <20 years harbored *S. aureus* while most MRSA carriage was 12.5% among persons more than 40 years. Those who had been working in the hospital for <1 year were found to have more

Table 1: Prevalence of *S. aureus* and MRSA among health-care workers

Health-care workers	Number of samples (184) n (%)	<i>S. aureus</i> (27) n (%)	MRSA positive (7) n (%)
Doctor	6 (3.3)	0 (0)	0 (0)
Nurses	113 (61.4)	20 (17.6)	5 (4.4)
Attendant	8 (4.3)	0 (0)	0 (0)
Laboratory technicians	14 (7.6)	1 (7.1)	1 (7.1)
Cleaning staff	38 (20.6)	6 (15.7)	1 (2.6)
Others	5 (2.7)	0 (0)	0 (0)

S. aureus: *Staphylococcus aureus*, MRSA: Methicillin-resistant *Staphylococcus aureus*

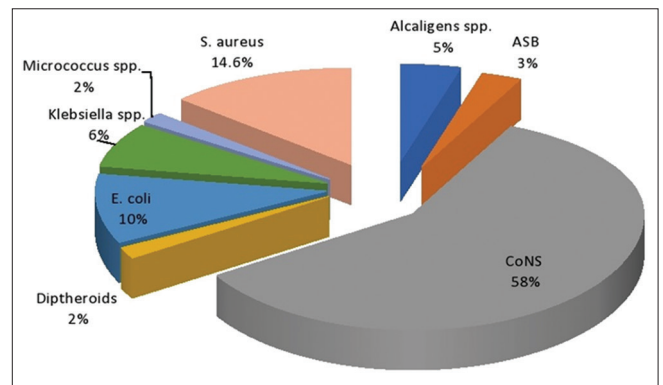


Figure 1: Spectrum of organisms isolated from anterior portion of nares in the nasal swab of health-care workers. ASB: Aerobic spore bearers, CONS: Coagulase-negative staphylococci

Table 2: Distribution of *S. aureus* and MRSA among health-care workers of different wards/department

Ward/Department	Number of samples (184) n (%)	<i>S. aureus</i> (27) n (%)	MRSA (7) n (%)
Emergency	14	2 (14.3)	0 (0)
ENT	7	1 (14.3)	0 (0)
ICU	18	3 (16.6)	0 (0)
Medicine	31	9 (29.0)	3 (9.6)
Obstetrics and gynecology	15	2 (13.3)	0 (0)
Operation theater	12	2 (16.6)	0 (0)
Ophthalmology	9	4 (44.4)	2 (22)
Orthopedics	18	1 (5.5)	0 (0)
Pediatrics	11	0 (0)	0 (0)
Skin	2	0 (0)	0 (0)
Surgery	22	1 (4.5)	1 (4.5)
Tb and chest	11	1 (9)	0 (0)
Others	14	1 (7.1)	1 (7.1)

S. aureus: *Staphylococcus aureus*, MRSA: Methicillin-resistant *Staphylococcus aureus*

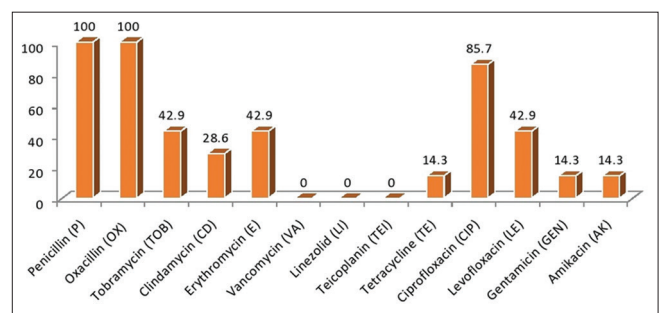


Figure 2: Antibiotic resistance pattern of methicillin-resistant *Staphylococcus aureus* (%)

MRSA carriage (11.9%). Nasal colonization of MRSA was more in HCWs who were college graduates (5%) [Table 3]. From the nasal swabs of 184 hospital personnel, we obtained 187 isolates. Among these, coagulase-negative *Staphylococcus* was the most frequently isolated bacteria (58%). Next was *S. aureus* at 14.6%. Other significant isolates were *E. coli* at 10% and *Klebsiella* spp. at 6% [Figure 1]. Resistance against other antibiotics found in *S.aureus* and MRSA isolates is displayed in Table 4 and Figure 2 respectively.

DISCUSSION

Understanding the sources and modes of spread of nosocomial infections is important for implementing effective control measures. As MRSA is responsible for the major portion of nosocomial infections globally, an effective strategy for preventing its spread requires detection of colonized HCWs and ascertaining the associated risk factors of colonization.

We have screened hospital personnel including doctors, nursing staff, attendants/ward boys, laboratory technicians, and cleaning staff for MRSA carriage in their nasal cavity. This study obtained a prevalence rate of 14.6% for *S. aureus* and 3.8% for MRSA nasal colonizations among HCWs.

Nurses had the most frequent *S. aureus* colonization rate (17.6%) while laboratory technicians (7.1%) and nurses (4.4%) had the highest MRSA carriage rate [Table 1]. Among the clinical departments, staff of ophthalmology department had the highest *S. aureus* colonization rates of 44.4%. HCWs of department of medicine and MICU had rates of 29% and 28.6%, respectively. Ophthalmology also had the highest MRSA colonization rate of 22%. Gender-wise nasal colonization by *S. aureus* was almost same in female (14.7%) and male (14.4%). Highest nasal carriage of *S. aureus* was recorded in younger persons aged <20 years (16.6%) while higher MRSA carriage was seen among persons aged more than 40 years. Those who had been working in the hospital for <1 year were found to have more MRSA carriage (11.9%). MRSA carriage in this study is similar to a rate of 15.7% obtained in a study done in Nepal.^[13] Globally, the rates reported have been higher.^[14,15] Research data available from India suggest that nasal colonization by MRSA among hospital personnel falls between 1.8% and 14.28%.^[7-9,16] A WHO report on South-East Asia also states that MRSA carriage rates in India range from 1.8 to 25% among HCWs at various levels of health care.^[17] Our MRSA data of 3.8%

Table 3: Demographic description of study population and MRSA-positive cases among health-care workers

Variable	Hospital personnel	<i>S. aureus</i> carriage (%)	MRSA positive	P-value
	n=184	n=27	n=7	
Sex				
Female	115 (62.5)	17 (14.7)	3 (2.6)	0.3354
Male	69 (37.5)	10 (14.4)	4 (5.7)	
Age in years				
<20	12 (6.5)	2 (16.6)	0 (0)	0.384
21–30	136 (74)	21 (15.4)	4 (2.9)	
31–40	28 (15.2)	3 (10.7)	2 (7.14)	
>40	8 (4.3)	1 (12.5)	1 (12.5)	
Years of service (year)				
<1	42 (22.8)	11 (26.19)	5 (11.9)	0.321
1–5	131 (71.2)	14 (10.68)	2 (1.5)	
>6	11 (6)	2 (18.2)	0 (0)	
Literacy status				
Graduation	40 (21.7)	4 (10)	2 (5)	0.629
Under graduation	130 (70.6)	22 (16.9)	5 (3.84)	
Illiterate	14 (7.6)	1 (7.1)	0 (0)	

MRSA: Methicillin-resistant *Staphylococcus aureus***Table 4:** Antibiotic susceptibility pattern of *S. aureus* isolates

Antibiotic	Susceptible (%)	Resistant (%)
Penicillin	7.4	92.6
Oxacillin	74	26
Tobramycin	74	26
Clindamycin	92.5	7.5
Erythromycin	81.4	18.6
Vancomycin	100	0
Linezolid	100	0
Teicoplanin	100	0
Tetracycline	92.5	7.5
Ciprofloxacin	40.7	59.3
Levofloxacin	74	26
Gentamicin	77.7	22.3
Amikacin	96.3	3.7

fall in the lower spectrum. This could be due to the fact that we are a relatively new teaching institute and tertiary care center, and nosocomial infections have not gained a foothold here. Globally, the colonization of HCWs has also been variable. A study from Tanzania reported the overall prevalence of MRSA among HCWs to be 2.1%^[18] while a Serbian university hospital reported the figure to be 7.6% in HCWs.^[19] A research in nursing homes in Hamburg, Germany, found that only 1.6% of staff harbored MRSA.^[20] The variability of prevalence between various geographical regions could be due to dissimilar antibiotic usage, sample size, collection and processing of samples, population studied, and accompanying risk factors that play a role in the dynamics of *S. aureus* and MRSA carriage. Among

S. aureus, the percentage of MRSA has ranged from below 1% in Northern Europe to more than 30% in India and other European countries.^[21,22] MRSA was isolated more from men compared to women in our study. The difference was not statistically significant. Higher isolation of *S. aureus* from male HCWs was also seen by other studies.^[9,23,24] The reason for the difference is not clear and needs to be investigated further. In the present study, higher number of MRSA isolates was recovered from older age group hospital personnel of above 40 years (12.5%). Our results are comparable to those reported by other authors. Preponderance of MRSA carriage in the age group of 30–50 years (20%) was seen among HCWs in a study done by Al-Humaidan *et al.*^[23] Another study has found a very high MRSA carriage of 68% in the age group of 30–50 years.^[26] Older age leads to less integrity of mucous membranes and could possibly contribute to more carriage. Higher number of MRSA isolates was obtained from HCWs from ophthalmology department (22.2%). This is in contrast to findings by other workers. El Aila *et al.* found that most of the MRSA carriers were from medicine (41.3%) and surgical branches (35%).^[25] Surgical wards and operating area also had the most number of carriers in other studies.^[15] Surgical wards have a lot of handling of pyogenic samples which could have led to higher rates of colonization. Regarding the occupation type, the highest prevalence rate of MRSA nasal colonization was observed in laboratory technicians (7.1%) followed by nurses (4.4%) and cleaning staff (2.6%). The *S. aureus* carriage was highest in nurses (17.6%) and cleaning staff (15.7%). None of the doctors screened carried MRSA. This is somewhat different to what was reported by other studies. Maroof *et al.* reported a significant carriage of MRSA in nurses (56.3%) and doctors (12.5%).^[26] Many

studies conducted globally have reported more MRSA carriage rates among nurses and doctors.^[24,27] One study from Argentina has also found that laboratory technicians were the most colonized (57%) by *S. aureus* while half of nurses were carrying MRSA (50%).^[28] In our study, we were able to get samples only from six doctors which may be the reason for the skewed result. Nurses were still the second highest carriers and a potential source of MRSA transmission because of their frequent contact with patients. We found a higher number of *S. aureus* (26.1%) and MRSA (11.9%) in HCWs with <1 year of service record as compared to those with 1–5 years. This could be attributed to the lack of knowledge and experience regarding proper infection control practices in them, compared to more senior staff well versed with basic infection control measures. Our results are comparable to those seen by other investigators.^[26] In the present study, higher number of MRSA isolates was obtained from participants with graduate literacy status (6.1%) as compared to postgraduate status of hospital personnel, especially doctors. Similar finding also has been observed by other authors. Askarian *et al.* reported higher number of MRSA in graduate (66.6%) HCWs.^[27] Researchers have observed that persons with secondary level of education had more colonization rates (47%).^[29] Thus, education status per se does not seem to have any bearing on the risk of colonization by MRSA. Overall, the association of sociodemographic factors with MRSA was not statistically significant for any parameter.

All the MRSA strains recovered were 100% sensitive to tigecycline, linezolid, teicoplanin, and vancomycin, whereas resistance to ciprofloxacin was pronounced at 85.7%. The sensitivity to erythromycin, gentamicin, amikacin, and clindamycin was variable (14.3–42.9%). Similar findings have been reported by other investigators.^[30]

Strengths and Limitations of the Study

This is the first study on MRSA colonization of hospital personnel at our institute and provides valuable data for prevention and control of hospital-acquired infections. The limitations of this study are that the duration was only 6 months, and many samples could not be obtained from doctors as the participation was voluntary. Future studies could be done for longer duration and more doctors could be motivated to participate.

CONCLUSION

HCWs in our hospital had a relatively low carriage rate for *S. aureus* and MRSA. Laboratory technicians had the highest rate followed by nurses. HCWs working in the ophthalmology department had the highest MRSA carriage rate. All MRSA strains were sensitive to tigecycline, linezolid, teicoplanin, and vancomycin. To sum up, the MRSA prevalence was although relatively low in the HCWs of our hospital, it still

mandates motivation of staff to practice preventive measures such as hand hygiene and other standard precautions at all times.

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