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Original Research Article

Prevalence of nasal carriage of methicillin resistant Staphylococcus aureus among health care workers in a teaching hospital in Eastern India

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Abstract

Introduction: Methicillin-resistant Staphylococcus aureus (MRSA) is a strain of antibiotic-resistant Staphylococcus aureus that has acquired resistance to beta-lactam antibiotics. The emergence of MRSA has significantly enhanced the morbidity and mortality of infected people. It has threatened healthcare facilities in many countries, including India. Healthcare workers can colonize the bacteria and serve as reservoirs of infection. Therefore, it is important to evaluate the problem of MRSA colonization in HCWs to develop preventive measures.
Aim and Objective: This study aimed to determine the prevalence of nasal colonization with *S. aureus* and MRSA among the HCWs and test antibiotic susceptibility.
Materials and Methods: It was a prospective observational study. Nasal swabs were taken from 190 ICU workers as per the study protocol. The swabs were inoculated in Mannitol Sugar Agar (MSA). MRSA were detected according to CLSI guidelines followed by antibiotic susceptibility testing.
Results: Among 190 samples from HCWs, 19 were detected to be MRSA carriers. The carriage rate is the highest in House-Keeping staff. Female (10.31%) have a slightly higher propensity to carry MRSA than male (9.37%). All MRSA in this study were sensitive to Bacitracin and Linezolid followed by Mupirocin (89.4%) and Minocycline (84.21%). All the MRSA were resistant to Penicillin followed by Erythromycin (73.68%), Ciprofloxacin (63.15%), Co-trimoxazole (57.8%), and Amikacin (47.36%).
Conclusion: MRSA colonization in HCWs may serve as a source of infection both in community as well as in hospitals. Utmost maintenance of hygiene, aseptic measures and judicious use of antibiotics are of paramount importance to prevent morbidity and mortality from this potential threat.

Keywords: Health care Workers (HCWs). MRSA, Carrier, Antibiotics.

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1. Introduction

Staphylococcus aureus is not an unusual bacterium that acts as a pathogen and commensal organism. It can be isolated from many body structures, normally the nasal cavity, and can survive on inanimate items such as beds, trays, and lavatory seats.[1] The primary site of *S. aureus* carriage is the anterior nares of the nostril, which may be brief (hours or days) or persistent.[2] Approximately 30% of the human population is a persistent carrier of *S. aureus*.[3,4] The chance of carriage is even higher in healthcare providers.[5] Factors that decide colonization without displaying symptoms and signs are largely unknown.[3,4] Nasal carriage of *S. aureus* seems to be the key factor in the epidemiology and pathogenesis of infection.[6] There may be ongoing controversy regarding health-care workers' role in transmitting methicillin-resistant Staphylococcus aureus (MRSA).[7] HCWs who are at the interface between the health facility and the community may additionally function as transmission tools of infection between the health facility and community-acquired MRSA.[7] The average nasal carriage rate of *S. aureus* and MRSA in hospital caregivers are 23.7% and 4.6% respectively.[7] Knowledge of the antimicrobial sensitivity pattern of MRSA is important for choosing the

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optimal empirical antimicrobial treatment for *S. aureus* infections.[8] Particularly, screening and eradication of MRSA from colonized HCWs were recognized and considered as a critical part of complete infection control coverage for this organism. All the strains of Methicillin-resistant Staphylococcus aureus (MRSA) are resistant to the penicillin group of drugs along with other beta-lactam antibiotics like cephalosporins and carbapenems. Less options are available for the control of MRSA-related infections, with clindamycin being a good alternative because of its first-rate pharmacokinetics, mainly for pores and skin and soft tissue infections. It also works in penicillin-allergic patients.[9] However, with time and overuse *S. aureus* is obtaining resistance against MLSB too. Resistance to MLSB can either be constitutive (cMLSB) or inducible (iMLSB), the cMLSB phenotype is resistant to both Erythromycin and Clindamycin. However, iMLSB strains are resistant against Erythromycin but sensitive to Clindamycin. During antimicrobial therapy iMLSB phenotype can mutate into cMLSB phenotype.[10] Unlike cMLSB resistance, iMLSB resistance cannot be detected using conventional susceptibility testing. The inducible clindamycin resistance can be detected by the D-test by placing an erythromycin disk.[11] Therefore, it is vital to discover the iMLSB resistance for proper control of *S. aureus*.[12] Otherwise, clindamycin treatment can result in failure of treatment by inducing intrinsic resistance.[13]

2. Aims & Objective

This study aimed at:

1. Determining the prevalence of nasal carriage of Staphylococcus aureus and MRSA among HCW
2. Comparing the antimicrobial sensitivity profiles of methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-sensitive *Staphylococcus aureus* (MSSA) isolates from HCWs

3. Materials and Methods

3.1. Study design

A cross-sectional observational study. Clinical history and demographic data of all the participants in the study were collected in a pre-structured questionnaire.

3.2. Study period

01.10.2023 – 31.10.2023 (1 month).

3.3. Place of study

Department of Microbiology, ESI-PGIMSR & ESIC Medical College, Joka, Kolkata

3.3. Inclusion criteria

All the hospital staff who are directly related to patient care were included and who are willing to give their consent for participation.

3.4. Exclusion criteria

HCWs presented with a history of skin and upper respiratory tract infection in the last three weeks were excluded from the study. HCW who did not give consent were also excluded from the study

3.5. Nasal swab collection

Swabs were collected from the nose using a sterile cotton swab from both nostrils using the same swab and immediately transported to the laboratory. The swabs were put into nutrient broth for 4 hours of incubation at 37°C and after that inoculated on Nutrient agar and Mannitol salt agar (MSA).

3.6. Identification of S. aureus

S. aureus was isolated using Mannitol salt agar. The isolates were identified by examination of colony features, Gram staining, and other biochemical tests, such as the Coagulase test, catalase test, and oxidase test.

3.7. Detection of MRSA

All *S. aureus* were tested with 30 μg cefoxitin on MHA. The inhibition zone size was interpreted according to CLSI guidelines.[14] An inhibition zone diameter of $\leq$21 mm was treated as MRSA and $\geq$22 mm was reported as methicillin-sensitive *Staphylococcus aureus* (MSSA).

3.8. Antibiotic sensitivity Testing

Antibiotic sensitivity testing was performed as per the recommendation by the Clinical and Laboratory Standards Institute (CLSI) 2015 guidelines.[14] The antibiotics tested were amikacin, ciprofloxacin, clindamycin, cloxacillin, cotrimoxazole, erythromycin, gentamicin, linezolid, and tetracycline. The result was listed in the chart in terms of "sensitive," "resistant," and "intermediate sensitive."

3.9. Detection of iMLSB & cMLSB resistance

Isolates were tested for inducible resistance using the D-test after inoculation into MHA plate. The isolate is said to be cMLSB phenotypes if it was resistant to both erythromycin (zone diameter $\leq$ 13 mm) and clindamycin (zone diameter $\leq$ 14 mm).

The sample size for the study

$$ss \frac{Z\alpha^2 * (p) * (100-p)}{L^2}$$

Where:

Z = Zα value (e.g. 1.96 for 95% confidence level), L is the error

$(1.96)^2$x14.3 x (100-14.3)/6^2 = 130
p taken 14.3 for prevalence of nasal carriage of MRSA[15] and L taken as 6

3.9. Statistical analysis

Descriptive statistics, correlation tests and relative risks were calculated in the IBM-SPSS software.

3.10. Study variable

1. Age
2. Sex
3. Profession in health care
4. Site of duty- ICU, Ward, OPD, Laboratory
5. Any co-morbid illness or any immune-suppression
6. Any history of recent Upper Respiratory Tract Infection

4. Results

4.1. Nasal carrier rate of S. aureus and MRSA

Among the total 190 samples of HCWs included in the study 46 (24.2%) harbour the *S. aureus in* their nares. Of the 46 *S. aureus* isolates, 19 (41.3%) were carriers of MRSA and the rest 27 (58.7%) are carriers of MSSA. Therefore, the overall detection of MRSA nasal carriers among HCWs was 19/190 (10%). The prevalence of Staphylococcus carriage was slightly higher in female (28.12%) than male (22.22%). The same trend is seen for MRSA carrier profile (10.31% in female and 9.37% in male) (**Table 1**).

Table 2 shows the Staphylococcal carriage according to job profile among HCWs. In our study *S. aureus* carriage rate was highest among house-keeping staff (40.5%) followed by doctors (30.43%), nurses (23.6%), nursing orderly (22.8%). Paramedical staff and other HCWs (registration counter personnel, data entry operator etc.) did not show any evidence of Staphylococcal carriage.

Table 3 depicts the comparison of the prevalence of MRSA and MSSA in the different work profiles. Here also we can see that among all HCWs colonization of MRSA is the highest (11 out of 19 or 57.9%) among house-keeping staff and this association is statistically significant (p=0.031).

Table 4 displays the antibiotic sensitivity pattern of MRSA and MSSA strains for different groups of antibiotics that are normally active against the Gram-positive organism. None of MRSA isolates was susceptible to penicillin as expected. 77.7% of MSSA were resistant to penicillin. Overall, the majority of *S. aureus* isolates (40/46 or 86.9%) were resistant to penicillin. MRSA isolates showed a significantly high resistance to Erythromycin (73.68%), Ciprofloxacin (63.15%), Amikacin (47.36%) and Cotrimoxazole (57.8%) than MSSA. All *S. aureus* were susceptible to Linezolid and all MSSA were susceptible to Rifampicin.

In our study out of 46 isolates of *S. aureus* 26 (56.52%) were found to have MLSB resistance. In the Inducible Clindamycin Resistance test, 15(32.6%) *S. aureus* were iMLSB phenotypes (D test positive) and 11(23.9%) were cMLSB phenotypes (**Table 5**). The incidence of inducible Clindamycin resistance (iMLSB) was also higher among MRSA (9 out of 19 or 47.3%) than MSSA (6 out of 27 or 22.2%) isolates, although the p-value is not statistically significant (0.24). Therefore, resistance to common antibiotics was significantly higher in MRSA strains.

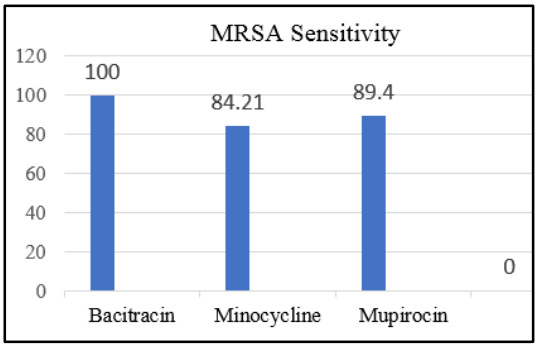

Figure 1: MRSA Sensitivity to different antibiotics

Table 1: Gender-wise distribution of Staphylococcus

	Male (n=64)	Female (n=126)	p-value
Staphylococcus aureus (n=46)	18 (28.12%)	28 (22.22%)	0.378
MRSA (n=19)	6 (9.37%)	13 (10.31%)	
MSSA (n=27)	12 (18.75%)	15 (11.9%)	

Table 2: Isolation of *S. aureus* among HCWs

Healthcare Workers	Samples (n= 190)	Staphylococcus aureus (n=46) (%)	p-value
Doctors	46	13 (28.26)	0.569
Nurse	38	10(26.31)	0.783
Nursing orderly	35	8 (22.8)	0.863
Paramedical	15	0	NA
Housekeeping staff	37	15 (40.5)	0.040
Others	18	0	NA

Table 3: Comparison of the prevalence of MRSA and MSSA in the different work categories

Healthcare Workers	MRSA (n=19)	MSSA (n=27)	P value
Doctors (n=13)	3	10	0.230
Nurse (n=10)	2	8	0.207
Nursing Orderly (n=8)	3	5	0.839
Paramedical	0	0	NA
House-keeping staff (n=15)	**11**	**4**	0.031
Others	0	0	NA

Table 4: Antibiotic resistance pattern

Antibiotic	MRSA (n=19) (%)	MSSA (n=27) (%)	P-value
Penicillin	19 (100%)	21(77.7%)	0.034
Clindamycin	14(73.68%)	12 (44.4%)	0.071
Erythromyin	14(73.68%)	5 (18.5%)	0.0003
Ciprofloxain	12(63.15%)	4 (14.81%)	0.0013
Amikacin	9 (47.36%)	2(7.40%)	0.0036
Linezolid	0(0%)	0(0%)	NA
Rifampicin	2(10%)	0%	NA
Co trimoxazole	11(57.8%)	5 (18.51%)	0.0109
Tetracycine	9(47.3%)	11(40.7%)	0.765

Table 5: Prevalence of Antimicrobial resistance phenotypes among MRSA and MSSA isolates

MLSB Resistance type (n=26)	No. of isolates (n=46)	MRSA (n=19)	MSSA (N=27)	p-value
iMLSB	15 (32.6%)	9 (47.3%)	6 (22.2%)	0.78
cMLSB	11 (23.9%)	6 (31.5%)	5 (18.5%)	

The MRSA isolates were further tested for their sensitivity to Bacitracin, Minocycline and Mupirocin on Muller-Hinton media. All MRSA isolates were sensitive to Bacitracin; 84.21% and 89.4% were sensitive to Minocycline and Mupirocin respectively.(**Figure 1**)

5. Discussion

Nasal carriage of Staphylococcus aureus acts as an important reservoir in a number of the colonized HCWs leading to transmission of the same to the patients as well as co-workers spreading to the community. MRSA strains have an excessive propensity to spread among the various HCWs and from the HCWs to the patients which may result in an increase in the health Care associated infection burden, the length of hospital stay or the administration of high-priced drugs. An overview of published works highlights that the carriage rate of MRSA and MSSA varies in different set up and nations. There's no easy method to predict the carrier rate based on certain variables.[16-18] In this study the prevalence of nasal carriage of *S. aureus* amongst healthcare personnel was found to be 24.2% of whom 41.3% accounted for MRSA and overall MRSA carrier was 10%. The data are almost comparable to a study conducted in Peru in which overall *S. aureus* and MRSA carriage rate were 22.7% and 8.7% respectively.[19] A study by Boncompain et al confirmed almost similar result in which 30% and 6.3% were the prevalence of *S. aureus* and MRSA respectively.[20] Yazgi et al in 2003 and Salman et al in 2018 showed comparable outcome in their studies.[21,22] The prevalence of nasal carriage of *S. aureus* and MRSA is much lower in our study if we compare it with a study performed by Truong et al (35.8% and 22.6% respectively).[23] A lower percentage of MRSA carriage (2.32%) has been stated from Nepal.[24] This diversity in the prevalence of *S. aureus* and MRSA in different hospitals may be attributed to the inter-laboratory variations including the methods of detection in addition to the effectiveness of infection control measures in the set up. An observational study in Nigeria stated an excessive occurrence of MRSA (15.6%) in which the writer attributed it to the shortage of infection control policy in concerned health care facility.[25] In the study conducted, the MRSA carriage turned out to be specifically high among the conservancy staff (11/37 or 29.7%), which was statistically significant ($P < 0.05$) [Table 3]. In a study conducted by El Aila et al in 2017 showed that MRSA carriage became highest among nurses (30.4%) followed by doctors (16%).[26] Gebreyesus A et al also found this trend in their study (nurses 13.6% and docs 2.3%).[27] The higher incidence of MRSA among the housekeeping staff in our study could be due to their lack of understanding of infection control measures like hand

hygiene, contact precautions etc. In this study it is observed that all the isolates were sensitive to Linezolid.

As predicted, all the MRSA isolates have been resistant to penicillin. The study has significantly proven the resistance to Erythromycin, Ciprofloxacin, Amikacin and Cotrimoxazole. These findings have similarities with another research works carried out by Joachim et al.[28] According to this study MRSA have high resistance to Co-trimoxazole, Ciprofloxacin, Gentamicin, Kanamycin, Clindamycin and Amikacin ($p<0.001$). Other studies document increased resistance against Fluoroquinolones and Aminoglycosides. Pulimood et al., had reported a high ciprofloxacin resistance of 90%.[29] Kot B et al have reported that MRSA isolates have higher resistance to Levofloxacin (83.9%), Ciprofloxacin (83%), Erythromycin (77.7%) and Clindamycin (72.3%) [30]. Much less resistance of MRSA to Tetracycline was noted in our study. Even though it is more than MSSA (47.3% vs 40.7%) but it isn't statistically significant. This is also proved by Kot B et al (10.7% Tetracycline resistance).[30]

Numerous investigational strategies to decolonize *S. aureus* from humans are currently being pursued to minimize the adverse effects of oral antibiotics on the body microbiome. Nostril and skin are the focal point of such efforts and implemented for the patients who carry the infection for a short period, like before surgical interventions. Nasal decolonisation is done via topical Mupirocin whereas topical chlorhexidine is used for pores and skin decolonisation.[31] Topically applied Bacitracin and Minocycline have activity toward S. aureus, but they're not as good as Mupirocin in human studies.[32] The study showed 100% sensitivity of *S. aureus* to Bacitracin and 89.4% sensitivity to Mupirocin ointment.

6. Conclusion

This study gives an overview of *S. aureus* nasal carriage among healthcare workers in our hospital. We observed a high prevalence of asymptomatic carriers of *S. aureus* in conjunction with MRSA. It also showed different antimicrobial resistance patterns. Most of the MRSA are significantly resistant to commonly used antibiotics, however, resistance to topical antibiotics and Linezolid was low. These suggest that these antibiotics can be used for effective decolonization and treatment of MRSA infection. These data alert us for continuous surveillance against *S. aureus* and MRSA carriers. Thus, the ultimate goal to improve infection control will be achieved and the outbreak of potentially dangerous MRSA will be effectively controlled.

7. Ethical Approval

Ethical approval was taken from the Institutional Research Board (IRB) of ESI-PGIMSR ESIC Medical College Joka, Kolkata and Department of Microbiology, of ESI PGIMSR ESIC Medical College Joka, Kolkata.

Written informed consent was taken from all the participants involved in the study.

8. Source of Funding

None.

9. Conflicts of Interest

The authors declare that there are no conflicts of interest.

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