

Methicillin-resistant *Staphylococcus aureus*: Carriage Rate, Knowledge, Attitude, and Practice Levels Among Healthcare Workers

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Abstract

Background: Ever-increasing numbers of infections by methicillin-resistant *Staphylococcus aureus* (MRSA) strains are being reported in the hospitals. Healthcare workers (HCWs) become colonized with MRSA and act as source as well as vectors for the transmission of MRSA infections to the patients. **Aim and Objectives:** The aim of this article is to detect the carrier rate of methicillin-sensitive *Staphylococcus aureus* (MSSA) and MRSA among the HCWs and to determine the antimicrobial susceptibility of the isolates to commonly used antimicrobial agents. **Materials and Methods:** Nasal swabs from 265 HCWs were collected between October 2018 and April 2019. The swabs were processed using standard laboratory techniques. **Results:** Of the 265 samples collected from HCWs, 46 (17.35%) showed the growth of *S. aureus* and among them 38 were found to be MRSA. The overall carrier rate of MRSA was 14.33%. The maximum carriage rate for MRSA was seen among nursing staff and that for MSSA among undergraduate medical students. Overall knowledge and attitude levels of HCWs though were found to be better proper preventive practices were not followed. Most of the MRSA strains were sensitive to vancomycin and linezolid, but more than 50% were resistant to commonly used antimicrobial agents in our hospital. **Conclusion:** Along with strict enforcement of infection control practices, regular surveillance of HCWs for MRSA colonization is necessary to limit the spread of MRSA by HCWs to susceptible patients.

Keywords: Carriage rate, HCWs, MRSA, MSSA

INTRODUCTION

Staphylococcus aureus is known to cause a variety of diseases ranging from skin and soft-tissue infections to invasive diseases such as pneumonia, osteomyelitis, endocarditis, etc. Nowadays, infection due to methicillin-resistant *Staphylococcus aureus* (MRSA) is a growing concern as it leads to serious disease, expensive treatment, extended and even doubles the hospital stay, and increased mortality.^[1-3]

Nasal, axillary, or inguinal colonization with MRSA poses a risk factor for MRSA infection.^[4] Higher nasal colonization of MRSA among healthcare workers (HCWs) than the general population makes HCW an important source of nosocomial transmission.^[5-7]

Literature shows wide variation in the MSSA and MRSA carriage rates in different HCWs depending upon the country, hospital settings, and the specialty which it caters.^[8-11] Such type of study has not been published in the recent past from our tertiary care hospital from North Karnataka, India.

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This study aimed to determine the nasal carriage rate of MSSA and MRSA among HCWs, to find out the antibiotic susceptibility pattern of the isolates, and to know the knowledge, attitude, and practice (KAP) levels regarding MRSA among various HCW groups.

MATERIALS AND METHODS

After taking approval from the Institutional Ethical Committee, a cross-sectional study was designed for the collection of nasal swab specimens from HCWs.

The study period was from October 2018 to April 2019. Doctors, nurses, laboratory technicians, and intern students were included in the study.

Nasal swab collection

For sample collection, sterile cotton swabs were used. The sample was collected by rotating the swabs gently four to five times in both nares of the participating HCW. The swabs were transported to the laboratory in Stuart Transport media. Inguinal and axillary swabs were collected from HCWs who showed nasal colonization with MRSA and processed similarly.

Repeat nasal swabs were collected from all MRSA-positive staff after 1 week of first swab collection for the confirmation of their MRSA persistent carrier state.

Isolation and identification

Swabs were inoculated onto mannitol salt agar and blood agar plates within 1 h of collection. Culture plates were incubated at 37°C overnight. Slide coagulase test was performed for suspected staphylococcal colonies (β -hemolytic, golden yellow colonies that were mannitol fermenter on MRSA).^[12] Slide coagulase-positive isolates were presumptively considered to be *S. aureus*. Confirmatory tube coagulase test and antibiotic sensitivity test were performed.

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed using the modified Kirby-Bauer disc diffusion method as per the Clinical and Laboratory Standards Institute (CLSI) guidelines.^[12]

Detection of methicillin resistance

Cefoxitin disc diffusion method was used to identify MRSA.^[13] *S. aureus* ATCC 25923 was used as the control strain.

Decolonization

After confirming the persistent carrier state, all the MRSA carrier HCWs were asked to follow the decolonization protocol, which included intranasal application of mupirocin ointment and gargle with an octenidine-based solution, both thrice a day for 6 days. They were also instructed to change and wash the clothes and bed-linen on daily basis.

HCWs with skin colonization along with nasopharyngeal colonization (positive inguinal or axillary swabs for MRSA) were advised to use octenidine-based soap for bathing. Repeat swabs were collected after completion of decolonization protocol from MRSA-positive HCWs.

Knowledge, attitude, and practice level determination

All the HCWs enrolled in the study were assessed for basic knowledge regarding MRSA carriage, its mode of transmission, and threats posed. Attitude toward MRSA as a problem and practice followed to prevent spread of MRSA during patient care and collection of specimens for investigation were evaluated.

RESULTS

Nasal swabs from 265 HCWs were collected for the study. The age ranged between 21 and 54 years (mean = 31.59 ± 6.99); 155 (58.5%) were males and 110 (41.5%) were females. The mean number of years in service was 9.11 ± 0.36 . Overall, 17.35% (46) of HCWs were healthy carriers for *S. aureus*, of which 38 (82.6%) were MRSA and 8 (14.8%) were MSSA [Table 1]. Inguinal and axillary swabs from all the staff with MRSA nasal colonization also grew MRSA. Similarly, the second nasal swabs collected after 1 week from all the positive staff revealed the presence of MRSA, indicating the persistent MRSA carrier status.

Overall KAP levels of HCWs toward MRSA are shown in Table 2. Comparison of KAP scores and pairwise comparisons among various categories of HCWs has been described in Tables 3 and 4.

Antibiotic sensitivity pattern of MRSA isolates is depicted in Figure 1. None of the staff was found positive for MRSA, 1 week after the completion of decolonization protocol indicating 100% sensitivity to mupirocin in this area.

DISCUSSION

MRSA is a major healthcare-associated pathogen causing significant morbidity and mortality. In the past two decades, these MRSA strains have become endemic in many hospitals across the globe leading to a significant increase in the incidence of MRSA infections.^[14-17]

Anterior nares of the HCWs are known niche for *S. aureus* strains, which then may get transferred to the patients within and between the wards.^[9] Depending upon the time period for which *S. aureus* colonizes the nares, three types of carriers are known: persistent carriers, intermittent carriers, and non-carriers.

The nasal carriage rate varying between 2% and 24.84% for MRSA among the HCWs has been reported in Indian studies.^[17-20] Our study results demonstrate nasal carriage

Table 1: Distribution of MRSA and MSSA carriage among HCWs

Feature	No MRSA/MSSA	MRSA	MSSA	P-value
Sex				
Male	120	30	6	0.026
Female	91	8	2	Significant association
Age				0.569
<25	32	2	2	No significant association
25–30	74	13	2	
31–35	52	10	3	
36–40	31	6	0	
>40	22	7	1	
Profession				0.610
Consultant (doctor)	39	4	1	No significant association
Medical interns	33	02	02	
Laboratory technicians	13	02	00	
Nursing staff	180	30	05	
Department/ward				
Special clinic	25	2	0	0.007
OPD	56	6	1	Significant association
Pediatric ward	19	1	2	
Surgical ward	19	9	4	
Medical ward	35	6	1	
Emergency ward	19	2	0	
Obs and Gyne ward	27	10	0	
Laboratory	11	2	0	

OPD = outpatient department, Obs and Gyne = obstetrics and gynecology

Table 2: Overall knowledge, attitude, and practice levels of HCWs toward MRSA

No Question—Knowledge	Yes	No	Not sure
1 Anterior nares are the most common site of MRSA colonization	78.7	1.1	21.1
2 MRSA possesses a threat to health workers and patients	83.4	1.1	15.1
3 Asymptomatic MRSA carriers can spread MRSA	70.6	6.4	23
4 MRSA most often spread via HCWs' hands	69.4	5.7	24.9
5 MRSA can survive on a surface for days	69.8	0	30.2
6 Adherence to standard precautions is sufficient while treating MRSA carriers/patients	97.7	0	2.36
Attitude			
1 Regular infection control education programs are needed	87.5	5.7	6.8
2 Would you participate in the infection control education programme	90.2	1.1	9.4
3 MRSA transmission can be prevented through hand hygiene and use of gloves	97.7	0	2.3
4 MRSA is a serious problem in your hospital	63.4	10.2	26.4
5 It is necessary to inform concerned staff when an MRSA-positive patient is being admitted or transferred from another ward?	83.4	4.2	12.5
Practice			
1 Do you perform hand hygiene before touching a patient?	10.2	83.8	6
2 Do you perform hand hygiene after touching a patient?	100	0	0
3 Do you regularly wear gloves while touching/examining a patient?	58.1	37	4.9
4 Do you perform hand hygiene before and after wearing gloves?	16.2	60.8	23
5 Do you inform concerned staff when an MRSA-positive patient is being admitted or transferred from another ward?	73.6	0	26.4

of *S. aureus* among HCWs to be 17.35% and that of MRSA was 14.33%.

Across the sex comparison, nasal carriage rate showed a significant difference with male preponderance ($P = 0.026$), which is in contrast to the studies by Abimana *et al.*^[11] who did not find significant difference and by

Singh *et al.*^[21] who have reported female preponderance. No relation could be found between age group and MRSA carriage rate in our study as has been noted by some studies.^[11,21] Significant association was seen between the working ward and MRSA carrier state. Majority of the carriers were from surgery ward (47.4%), followed by obstetrics and gynecology ward (37%).

Table 3: Comparison of KAP scores among various categories of health workers

	Consultants (n=39)	Medical interns (n=33)	Nursing staff (n=180)	Laboratory technicians (n=13)	P-value*
Knowledge	5.794	4.9393	4.53853	3.112	0.000
Attitude	3.5382	4.121	4.41652	3.84582	0.002
Practice	2.6151	1.909	2.5443	4.6922	0.000

Test used non-parametric Kruskal–Wallis H test. P-value <0.05 is considered statistically significant

Table 4: Pairwise comparisons of KAP levels

Knowledge				
	Consultant	Intern	Staff nurse	Technician
Intern	0.01734	—	—	—
Staff nurse	0.00071	1.00000	—	—
Technician	0.000000039	0.00768	0.01032	—
Attitude				
	Consultant	Intern	Staff nurse	Technician
Intern	1.000	—	—	—
Staff nurse	0.054	0.071	—	—
Technician	1.000	1.000	0.055	—
Practice				
	Consultant	Intern	Staff nurse	Technician
Intern	0.00243	—	—	—
Staff nurse	1.00000	0.00083	—	—
Technician	0.00000642	0.00000011	0.00000010	—

Statistical test used: Mann–Whitney U-test and P-value <0.05 was considered statistically significant

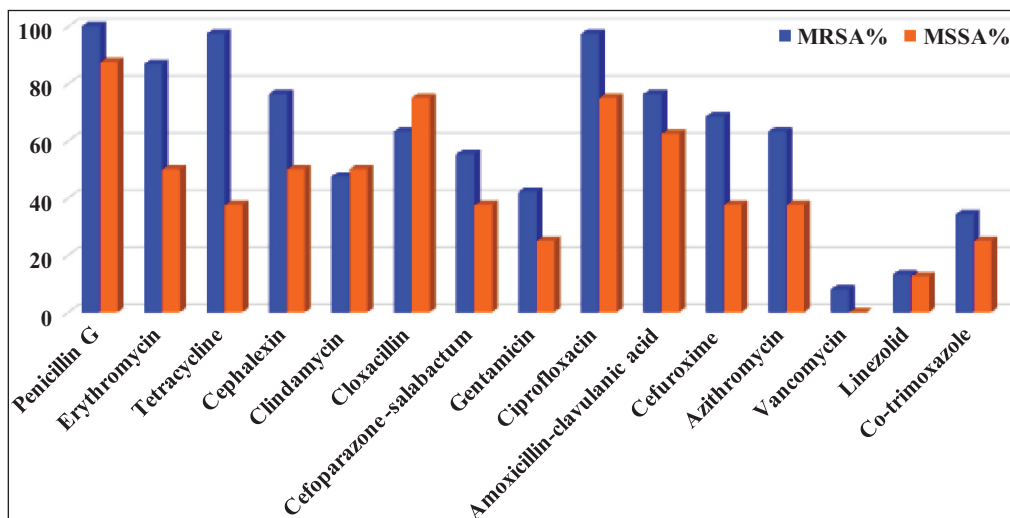


Figure 1: Antibiotic resistance pattern of MRSA and MSSA isolated from HCWs

When professional designation was considered, MRSA carriage was particularly high among nursing staff (16.7%) followed by laboratory workers (15.4%) indicating that the nursing staff were the potential colonizers of MRSA. Similar findings have been reported by few other studies.^[10,11,22] Frequent patient contact, lack of knowledge regarding hand hygiene, contact precautions, and infection control policies might be the reasons for high prevalence of MRSA among the nursing staff. Doctors showed the carriage rate of 12.8% which is in contrast to the study by Agarwal *et al.*^[18] and Radhakrishna *et al.*^[19]

who have reported highest positivity of 42.9% and 50%, respectively.

Overall knowledge and attitude levels though were better in HCWs, proper preventive practices were not followed. Most of the HCWs did not perform hand hygiene before touching a patient and also before and after wearing gloves. About 40% of HCWs did not wear gloves regularly while touching/examining a patient. Statistically significant difference was noted in knowledge, attitude, and practice scores among various categories of

health workers using the Kruskal–Wallis H test. Similar results have been reported by Yoo *et al.*^[23] among dental healthcare professionals.

Pairwise comparison showed statistically significant difference with respect to knowledge and practice levels among the various pairs, whereas for attitude the difference was not significant.

In the studies by Khanal *et al.*^[10] and Radhakrishna *et al.*,^[19] all the isolates were sensitive to vancomycin, whereas in our study 3 out of 38 (7.9%) strains were resistant to vancomycin. Many studies have reported 100% sensitivity to linezolid but in our study 13.2% of the strains were resistant to linezolid.^[19,21,22]

All our MRSA isolates were resistant to penicillin which is in accordance with studies by Abimana *et al.*^[11] and Agarwal *et al.*^[18] Study by Agarwal *et al.*^[18] has demonstrated 50% of the MRSA strains to be sensitive to ciprofloxacin. In contrast, in our study, only 2.6% of the strains were sensitive to ciprofloxacin and tetracycline.

Major finding of the study is that more than 50% of the MRSA isolates showed resistance to commonly used antibiotics for the treatment of staphylococcal infections in our hospital. Our findings of antibiotic resistance for MRSA and MSSA correlate with the findings of few other studies.^[10,18,19] Though knowledge and attitude of HCWs toward MRSA were better, the practices followed were not up to the mark.

CONCLUSIONS

MRSA nasal colonization in our hospital is particularly high among the nursing staff. To control the spread of MRSA in the hospital, screening of HCWs could be adopted as a protocol. Also, regular awareness programmes regarding hand hygiene, contact precautions, and strict enforcement of infection control practices might help to address the issue of MRSA.

Authors' contributions

SSM—concept, design, data acquisition, literature search, manuscript preparation

AA—experimental studies, data acquisition

AGS—manuscript editing and manuscript review

MM—statistical analysis

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Conflicts of interest

There are no conflicts of interest.

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