

Original Article

Nasal carriage of Methicillin- and Mupirocin-resistant *S. aureus* among health care workers in a tertiary care hospital

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ABSTRACT

Objective: Methicillin-resistant *Staphylococcus aureus* (MRSA) ranks top among the nosocomial pathogens. Nasal formulation of mupirocin is found to eradicate MRSA from colonized individuals, but the emergence of resistant strains is a matter of concern.

Methods: Nasal swabs were collected from 200 health care workers (HCWs) who were screened for MRSA. Kirby–Bauer disc diffusion method was used to perform antibiotic susceptibility test. MRSA detection was done using a cefoxitin 30 µg disc and interpreted according to the Clinical and Laboratory Standards Institute guidelines. Determination of mupirocin resistance was performed using Epsilon meter test (E-test).

Findings: About 14% of HCWs showed nasal carriage of MRSA. Nursing orderlies were the predominant carriers. E-test showed four mupirocin resistant isolates. The antibiogram of the MRSA isolates revealed the higher resistance to antibiotics as compared to methicillin-sensitive *Staphylococcus aureus*. All the MRSA isolates were sensitive to linezolid.

Conclusion: HCWs in our hospital showed high nasal carriage rate of MRSA, particularly the nursing orderlies which is statistically significant. It is advisable to detect mupirocin resistance among the isolates obtained from the HCWs so that in case of resistance, alternative treatment should be sought.

Keywords: Health care workers; methicillin-resistant *Staphylococcus aureus*; mupirocin-resistant *S. aureus*; nasal carriage

INTRODUCTION

Staphylococcus aureus and its resistant form methicillin-resistant *S. aureus* (MRSA), is one of the most common nosocomial pathogens which not only causes increased morbidity and mortality but also increases the length of hospital stay and cost.^[1,2] The health care workers (HCWs) serve as a link between hospitals, long-term care facilities, and nursing homes on one hand and the community on the other. They may serve as reservoirs, vectors, or victims of MRSA cross-transmission.^[3]

S. aureus is a member of commensal microflora and many body sites such as hands, rectum, perineum, axillae, vagina, gastrointestinal tract, and intact or inflamed skin are frequently colonized for varying time periods, and the main reservoir of MRSA is the anterior nares.^[4] The main sources of MRSA in the hospital environment are the asymptotically colonized patients and HCWs.^[5]

The drug of choice for the treatment of serious MRSA infection is vancomycin till date.^[6] With the emergence of vancomycin-resistant MRSA, treatment,

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options have become more limited. Mupirocin, a topical glycopeptide antibiotic is now commonly used for nasal decolonization of the HCWs as part of a routine surveillance to prevent the emergence and transmission of MRSA in health care facilities.^[7] The increased pressure of antibiotic use has led to the emergence of mupirocin resistant *S. aureus* (MupRSA), and the clinicians are left with few alternatives to prevent the spread of MRSA.^[8]

The aim of the present study is to estimate the nasal carriage of MRSA as well as MupRSA among the HCWs of our hospital. Thus, a real-time prevalence of MRSA carriage and its resistance to mupirocin will help the institution to develop a better MRSA control and infection control policy by instituting use of alternative options to prevent the colonization and spread of infection in case of resistance.

METHODS

Nasal swabs from HCWs working in different departments of Mayo Institute of Medical Sciences, Barabanki, Uttar Pradesh, were collected after obtaining their informed consent. Those hospitalized within the previous 1-year or on antibiotics within last 1-week of collection of the swabs were excluded from the study. Ethical clearance was obtained prior to commencement of the study. Data, including demographic profile, work profile, and medical history, were recorded in a preformed questionnaire.

Sample collection

Nasal swabs were collected using a sterile cotton swab with transport tube. The swab was rotated in the anterior nares for 3 s. In case of sneezing, resampling was done. After collecting swabs were re-inserted in the transport tube, labeled properly, and transported to the laboratory for further processing.

Sample processing

All the swabs were inoculated on 5% sheep blood agar and mannitol salt agar and incubated at 37°C for 24 h. After incubation, growth was identified as *S. aureus* on the basis of colony morphology, Gram stain, catalase, dimethyl sulfoxide oxidase, DNase, and coagulase test (slide and tube).

Determination of methicillin-resistant *Staphylococcus aureus*

All confirmed *S. aureus* isolates were further tested for detection of methicillin resistance by Kirby–Bauer disc diffusion method using cefoxitin 30 µg discs (HiMedia Laboratories, Mumbai, Maharashtra, India) as per Clinical and Laboratory Standards Institute (CLSI) 2013 guidelines.^[9] Zone of inhibition of size of ≤21 mm was taken as resistant and ≥22 mm as sensitive.

Determination of antibiotic susceptibility pattern of *Staphylococcus*

It was done by Kirby–Bauer disc diffusion method; antibiotic discs used were penicillin (10 units), ciprofloxacin (5 µg), clindamycin (2 µg), erythromycin (15 µg), levofloxacin (5 µg), linezolid (30 µg), rifampin (5 µg), tetracycline (30 µg), and cotrimoxazole (1.25/23.75 µg). Zone diameter interpretation for determining sensitive, intermediate or resistant was done as per CLSI guidelines.^[9]

Determination of mupirocin resistant *Staphylococcus aureus*

Mupirocin resistance was determined by Epsilometer test (E-test) using HiComb mupirocin strip and interpreted as per CLSI guidelines.^[9] Isolates with minimum inhibitory concentrations (MICs) ≥512 µg/ml were considered as high-level resistant (MuH), those with MICs 8–256 µg/ml were considered as low-level resistant (MuL), and with ≤4 µg/ml were considered as mupirocin sensitive.

Statistical analysis

The results were recorded and analyzed statistically in Microsoft office Excel Sheet 2010. Chi-square test was used for statistical analysis. $P \leq 0.05$ was considered as statistically significant.

RESULTS

In the present study, 200 HCWs working in our hospital were included in the study. Out of these HCWs, 92 (46%) were females and 108 (54%) were males. The age ranged between 18 and 65 years. Of the 200 nonduplicate nasal swabs processed in the laboratory, *Staphylococcus* spp. was isolated in 162 (81%) samples which comprised of 96 (48%) *S. aureus* isolates.

Table 1 shows the distribution of various samples on the basis of the source. HCWs of various categories such as doctor, nurse, technician, nursing orderlies, nursing student, and others (included pharmacists, receptionists, and security guards) working in our hospital were taken in nearly equal representation.

The distribution percentage of MRSA and methicillin-sensitive *S. aureus* (MSSA) strains in the total specimens received is documented in Table 2. In both Tables 1 and 2, the P value was determined by comparing each category of HCWs with the total number of HCWs. Of 96 *S. aureus* isolates, 28 (14%) were detected as MRSA strains. Nursing orderlies showed a higher carrier rate of MRSA as compared to other HCWs which was statistically significant ($P < 0.05$).

Table 1: Distribution of samples on the basis of source

Source	Number of samples	Number of <i>S. aureus</i>	P
Doctors	28	12	0.609
Nurses	30	12	0.412
Technicians	28	8	0.053
Nursing students	28	18	0.106
Nursing orderlies	28	22	0.002
House keeping	28	8	0.053
Others*	30	16	0.585
Total	200	96	

*Includes pharmacists, receptionists, and security guards. The P value was determined by comparing each category of HCWs with the total number of HCWs. HCWs=Health care workers, *S. aureus*=*Staphylococcus aureus*

Table 2: Distribution of MRSA and MSSA isolates on the basis of source

Source	MRSA	MSSA	P
Doctors	2	10	0.362
Nurses	4	8	0.734
Technicians	0	8	NA
Nursing students	0	18	NA
Nursing orderlies	12	10	0.002
Housekeeping	4	4	0.175
Others*	6	10	0.421
Total	28	68	

*Includes pharmacists, receptionists, and security guards. The P value was determined by comparing each category of HCWs with the total number of HCWs. NA=Not applicable, HCWs=Health care workers, MRSA=Methicillin-resistant *S. aureus*, MSSA=Methicillin-sensitive *S. aureus*, *S. aureus*=*Staphylococcus aureus*

Table 3: Antibiotic resistance pattern of MRSA and MSSA isolates

Antibiotic	MRSA* (%)	MSSA* (%)	P
Penicillin	28 (100)	52 (76)	0.005
Erythromycin	16 (57)	20 (29)	0.010
Clindamycin	18 (64)	10 (15)	<0.05
Cefoxitin	28 (100)	0	-
Ciprofloxacin	14 (50)	8 (12)	<0.05
Levofloxacin	6 (21)	4 (6)	0.02
Linezolid	0	0	-
Rifampin	14 (50)	4 (6)	0
Cotrimoxazole	16 (57)	20 (29)	0.010
Tetracycline	12 (43)	16 (23)	0.058

*Percentage in parenthesis represent out of total respective isolates. MRSA=Methicillin-resistant *S. aureus*, MSSA=Methicillin-sensitive *S. aureus*, *S. aureus*=*Staphylococcus aureus*

Table 3 displays the antibiotic susceptibility pattern of MRSA and MSSA strains for different group of antibiotics effective primarily against the Gram-positive organism. None of MRSA isolates was sensitive to penicillin, nearly 60% were resistant to clindamycin and erythromycin and around 50% were resistant to tetracycline and cotrimoxazole. All MRSA isolates were susceptible to linezolid. MSSA

isolates sensitive to penicillin were 23%, nearly 60% were sensitive to clindamycin, ciprofloxacin and levofloxacin and around 50% were sensitive to tetracycline and cotrimoxazole. All MSSA isolates were susceptible to linezolid. Resistance to most of the antibiotics was significantly associated with MRSA strains ($P < 0.05$).

Mupirocin resistance was seen in 4 (7%) of 28 MRSA isolates by E-test; 3 (75%) isolates were MuH, and 1 (25%) isolate was MuL. No mupirocin resistance was detected in MSSA. The MuH strains were isolated from the nasal swabs of nursing orderlies whereas the MuL strain was isolated from a nurse.

DISCUSSION

Nasal carriage of *S. aureus* acts as an important reservoir of infection among the colonized HCWs and may transmit the infection to co-workers and in the community. The prevalence of *S. aureus* nasal carriage among HCWs is 48% in the present study which is higher than the study conducted by Truong *et al.* (35.8%) and Yazgi *et al.* (34.9%) and comparable to other studies conducted by Singh *et al.* (47.5%) and Al-Abdli and Baiu.^[10-13] Norazah *et al.*, in a study conducted in Malaysia in 2002, reported a higher prevalence of *S. aureus* nasal carriage which varied from 45% to 76%.^[14]

MRSA strains are well known for their high tendency to spread among the HCWs and from the HCWs to the patients which may in-turn lead to the increase in the treatment cost burden by prolonging the duration of hospital stay and or administration of expensive medications. In our study, nasal carriage of MRSA was found in 14% of the HCWs. This is consistent with the study conducted in different hospital setting worldwide which has been reported in the range of 5.8% to 17.8%.^[15-18] Lower percentage of MRSA carriage has been reported from Nepal.^[19] This difference in prevalence of *S. aureus* and MRSA in various hospitals may be attributed to the inter-laboratory variation in the methods of detection as well as the effectiveness of hospital infection control policy.

In our study, the MRSA carriage was particularly high among the nursing orderlies (6%), which was statistically significant ($P < 0.05$) [Table 2]. The higher prevalence of MRSA among this group of HCWs could be due to their lack of knowledge with regard to hand hygiene, contact precautions, and infection control policies.

In this study, all the isolates were susceptible to linezolid. As expected, most of the MRSA isolates were resistant to penicillin. But, the clinically

significant observation of the study is the significant association of resistance shown by MRSA to other antibiotics used for the treatment of staphylococcal infections. Other studies report a higher resistance rates for fluoroquinolones and aminoglycosides such as the Pulimood *et al.*, that has reported a high ciprofloxacin resistance of 90% and Qureshi *et al.*, had reported a resistance of 98.9%.^[20,21] In contrast, this study has demonstrated 50% of the strains resistant to ciprofloxacin and rifampin and a further lower resistant rate to tetracycline (42%) and levofloxacin (21.4%).

Nasal formulation of mupirocin, a topical antibiotic agent that interferes with bacterial protein synthesis, is recommended by the Food and Drug Administration of United States for use in the eradication of nasal carriage of *S. aureus* in adult patients and HCWs. Though the use of mupirocin is limited for infection control and other prophylactic measures, emergence of MupRSA is being reported from across the globe with the prevalence of 0.5% in Nigeria to 14.6% in India.^[22,23] In our study, 4 (2%) isolates were found to be mupirocin resistant of which three isolates were high levels resistant. In the presence of mupirocin resistance strains, treatment with mupirocin may be ineffective, especially with high-level resistance strains. Although low-level mupirocin resistant strains can be controlled by normal dosage schedule of mupirocin but few studies suggest that treatment failure may occur after few weeks. This emphasizes the importance of identification of both high and low-level resistant strains.^[24-26]

MRSA nasal colonization of HCWs in our hospital is high, particularly among the nursing orderlies, who are in prolonged contact with the patient leading to the high possibility of nurse-to-patient transmission of these bacteria and dissemination of them in hospital setting. As a routine, screening and treatment of HCWs should be done for MRSA status in every hospital. It is also advisable to detect mupirocin resistance among the isolates obtained from the HCWs so that in case of resistance, alternative treatment options should be initiated.

AUTHORS' CONTRIBUTION

Conceived and designed the experiments: LA, AKS. Performed the experiment in the laboratory: LA, CS. Analyzed the data: LA, AKS, AA. Wrote the first draft of the manuscript: LA. Contributed to the writing of the manuscript: LA, AKS, AA. Agree with manuscript

results and conclusions: LA, AKS, CS, AA. Made critical revisions and approved final version: LA, AKS. All authors reviewed and approved of the final manuscript.

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Conflicts of interest

There are no conflicts of interest.

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