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Screening of methicillin-resistant *Staphylococcus aureus* in healthcare workers and students and its susceptibility to mupirocin in a tertiary care teaching hospital in South India

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Abstract:

BACKGROUND: *Staphylococcus* is the most common pathogen causing infection in hospitals. They also colonize the healthcare workers who serve as reservoir of infection. Emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) is a burning issue throughout the world contributing to significant morbidity and mortality. Use of mupirocin to eradicate the carrier state is the need of the hour.

OBJECTIVES: To screen healthcare workers (HCWs) and medical students for MRSA and to know the susceptibility of mupirocin in this group.

MATERIALS AND METHODS: A total of 432 students, nursing staff, doctors and house-keeping staff were screened for MRSA for 4 months. The MRSA and methicillin-resistant coagulase-negative *Staphylococcus* (MRCoNS) isolates were then tested for mupirocin resistance.

RESULTS: Out of 432 samples, 24 (5.55%) were MRSA and 104 (24.07%) were MRCoNS. Only 4.16% ($n = 1$) showed high-level resistance to mupirocin among the MRSA isolates, while resistance among MRCoNS was higher at 6.7% ($n = 7$) for low-level resistance and 17.30% ($n = 18$) for high-level resistance.

CONCLUSION: MRSA colonization of HCWs may serve as a source of infection and mupirocin resistance should be screened for all whether working in Intensive Care Units or not and if detected, alternative treatment should be used which will result in appropriate use of this antibiotic for decolonization.

Key words:

Healthcare workers, methicillin-resistant coagulase-negative *Staphylococcus*, methicillin-resistant *Staphylococcus aureus*, mupirocin, *Staphylococcus aureus*

Introduction

Staphylococcus aureus is the most important cause of wound and skin infections. Originally, penicillin was the drug of choice for treatment of serious *S. aureus* infections, but resistance due to the acquisition of plasmid-borne genetic elements coding for β-lactamase production occurred. Then, semisynthetic penicillinase-resistant penicillins such as oxacillin and methicillin became the drug of choice. Resistance to these also noticed due to the presence of an altered penicillin-binding protein called PBP 2a or PBPs that results from acquisition of chromosomal gene called mec A. The *S. aureus* strains expressing the mec A determinant are termed methicillin-resistant *S. aureus* (MRSA). The mec A determinant of *S. aureus* is also found in methicillin-resistant coagulase-negative *Staphylococcus* (MRCoNS).[1]

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MRSA can colonize the nose and other skin sites without causing infection. MRSA can spread by airborne route but is most commonly spread by the colonized hands of healthcare workers (HCWs). Colonized health workers and students in teaching hospitals may subsequently develop clinical infections and act as reservoirs for infection among vulnerable individuals.[2] Standard MRSA decolonization therapy includes the use of topical application of mupirocin 2%, bacitracin, tea tree oil of *Melaleuca alternifolia* plant, retapamulin of the pleuromutilins group of antibiotics, chlorhexidine gluconate and sodium hypochlorite. Oral therapies such as tetracyclines, folate inhibitors, quinolones, rifamycins and macrolides are usually in combination with topical therapy.[3]

Eradication of MRSA colonizers by mupirocin can bring down the infection rate among patients drastically. However, unrestricted over-the-counter use, treatment of wounds and pressure sores, and routine use in peritoneal dialysis with mupirocin are especially strongly associated with resistance which has been reported worldwide, and prevalence of such resistance will be a major setback for future use of mupirocin.[4] The study was also carried out to screen HCWs and medical students for MRSA and to know the susceptibility of mupirocin in this group. The results of the study will benefit the medical fraternity and society as whole by knowing the rate of MRSA prevalence and if any mupirocin resistance is present in our hospital. Hence, this study was conducted to know the prevalence of MRSA and MRCoNS from nasal swab of students and HCWs and also to determine the rates of high level and low level of mupirocin resistance in MRSA and MRCoNS spp. by disc diffusion.

Materials and Methods

A prospective, cross-sectional study was carried out in the Department of Microbiology of a tertiary care teaching hospital for 4 months from March 2015 to June 2015, after obtaining approval from the Institutional Ethics Committee (FMMC/FMIEC/2177/2015). Written informed consent was obtained from all the participants willing to participate in the study. A total of 432 students, nursing staff, doctors and house-keeping staff participated in the study. The demographic data including work profile and medical history were recorded. Only those persons who have entered hospital set-up for more than 1 year were included in the study. Persons with upper respiratory tract infections were excluded from the study.

Nasal swabs prewetted with sterile saline were collected from the vestibule of the anterior nares of both the nostrils and immediately placed back on the screw cap polypropylene tubes. These nasal swabs were streaked on Mueller-Hinton agar and kept for incubation at 37°C for 24 h. Identification of *S. aureus* was done by standard microbiological procedures. For detection of MRSA and MRCoNS, the isolates were tested for antimicrobial susceptibility testing by modified Kirby-Bauer disc diffusion method on Mueller-Hinton agar plates. Cefoxitin disc (30 µg) showing zone size of <22 mm was considered to be MRSA in case of tube coagulase-positive *Staphylococcus*, <25 mm zone size was considered MRCoNS in case of tube coagulase-negative *Staphylococcus* (CoNS) and zone size of <10 mm for bacitracin disc (0.04 units) was considered resistant.

The MRSA and MRCoNS isolates were then tested for mupirocin resistance, which was done by Kirby-Bauer disc diffusion method using 5 µg and 200 µg mupirocin discs to determine low- and high-level resistance.

Criteria of zone diameter breakpoints for susceptible and resistant isolates were set at >14 and <13 mm, respectively.[5] Three different phenotypes:

- Mupirocin susceptible – zone diameter of ≥14 mm for both 5 µg and 200 µg discs
- Low-level resistance – zone diameter of <14 mm in the 5 µg disc but ≥14 mm in the 200 µg disc
- High-level resistance – isolates with zone diameter <14 mm for both 5 µg and 200 µg.

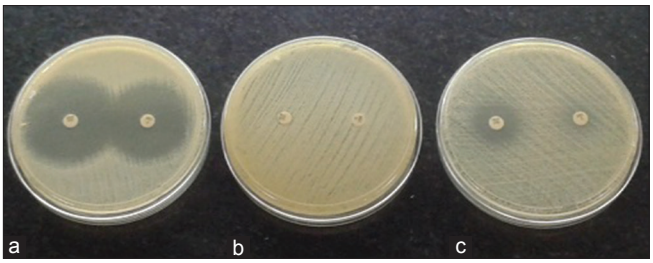

Figure 1: (a) Mupirocin susceptible – for both 5 µg and 200 µg disc, (b) high-level resistance – for both 5 µg and 200 µg disc, (c) low- level resistance – resistance in the 5 µg disc but susceptible in the 200 µg disc

Table 1: Category, culture results and the isolates from all the participants

Category	Total number of participants	*Staphylococcus aureus*	MRSA	CoNS	MRCoNS	Others
Staff nurse (%)	209 (48.38)	56 (26.80)	14 (6.70)	76 (36.36)	56 (26.80)	7 (3.34)
Students (%)	124 (28.70)	30 (24.20)	1 (0.81)	71 (57.26)	20 (16.13)	2 (1.6)
Doctors (%)	57 (13.20)	8 (14.04)	8 (14.04)	26 (45.61)	15 (26.31)	0
House-keeping staff (%)	42 (9.72)	11 (26.2)	1 (2.38)	15 (35.71)	13 (30.95)	2 (4.76)
Total (%)	432 (100)	105 (24.31)	24 (5.55)	188 (43.52)	104 (24.07)	11 (2.55)

MRSA = Methicillin-resistant *Staphylococcus aureus*, CoNS = Coagulase-negative *Staphylococcus*, MRCoNS = Methicillin-resistant coagulase-negative *Staphylococcus*

Table 2: Methicillin-resistant *Staphylococcus aureus* and methicillin-resistant coagulase-negative *Staphylococcus* tested for mupirocin resistance

Category	Mupirocin						*Z*	*P*
	MRSA			MRCoNS				
	Sensitive	Resistance		Sensitive	Resistance			
		5 µg	200 µg		5 µg	200 µg		
Staff nurse	13	0	1	45	3	8	1.11	0.134
Students	1	0	0	17	2	1	0.418	0.338
Doctors	8	0	0	6	2	7	2.81	0.002
House-keeping staff	1	0	0	11	0	2	0.424	0.336
Resistant strains		0	1		7	18		
Sensitive and resistant strains	23	1		79	25		2.18	0.015
Total		24			104			

MRSA = Methicillin-resistant *Staphylococcus aureus*, MRCoNS = Methicillin-resistant coagulase-negative *Staphylococcus*

Statistical analysis

All the data were analyzed statistically using Chi-square test to calculate significant levels.

$P < 0.05$ was considered statistically significant.

Results

Out of the 432 who participated in the study, majority were staff nurses followed by students, doctors and house-keeping staff. Figure 1 shows mupirocin susceptibility.

The category, culture results and isolates isolated are shown in Table 1. Predominant among 432 isolates, 24 (5.55%) were MRSA and 104 (24.07%) were MRCoNS.

The MRSA and MRCoNS isolates tested for mupirocin resistance and significance of the study are shown in Table 2. Among 24 isolates of MRSA, only one showed high-level resistance to mupirocin, whereas out of 104 isolates of MRCoNS, 25 were resistant to mupirocin with 7 (28%) Mup^L and 18 (72%) Mup^H.

Discussion

In our study of 432 HCWs, we found that CoNS ($n = 292$) was more common than *S. aureus* ($n = 129$) of which 5.55% ($n = 24$) were MRSA and 24.07% ($n = 104$) were MRCoNS. The MRSA and MRCoNS tested for Mup^H and Mup^L showed only 4.16% ($n = 1$) to have high-level resistance among the MRSA isolates while resistance among MRCoNS was higher at 6.7% ($n = 7$) for low-level resistance and 17.30% ($n = 18$) for high-level resistance among the MRCoNS isolates.

Previous studies have shown that nasal carriers of MRSA are prevalent in HCWs. In a study by Golia *et al*., they revealed that HCWs were potential colonizers of MRSA and they found 13.37% in their study group.[6] In a study by Rongpharpi *et al*., they also found that the prevalence of *S. aureus* nasal carriers does exist with MRSA being reported at 11.43% and was higher among male HCWs.[7] Both the studies have reported a higher prevalence of MRSA than our study (5.5%) which may be due to the fact that hospital infection control committee of our hospital performs screening for MRSA in intensive care units and stringent measures are taken.

A study related to mupirocin resistance in HCWs in our country was previously studied by Kaur *et al*., where 140 HCWs were randomly selected. They isolated 38 *S. aureus* and 73 CoNS. Twenty MRSA and 34 MRCoNS were identified, of which two MRSA and five MRCoNS were mupirocin resistance.[8] Another study by Agarwal *et al*. reported 28 out of 200 HCWs showing nasal carriage of MRSA and mupirocin resistance was seen in four of them, of which three isolates were Mup^H and one was Mup^L.[9]

However, most of the studies done in our country are related to clinical isolates of *S. aureus* and its resistance to mupirocin. Chaturvedi *et al*. in their study showed that both high and low levels of mupirocin resistance MRSA were observed in patient population.[10] Oommen *et al*. also found that high-level mupirocin resistance was prevalent in clinical isolates.[11] Singh *et al*. in their study also reported presence of mupirocin resistant in MRSA isolates.[12]

We noticed that both low- and high-level resistance of mupirocin to MRCoNS is a disturbing fact as MRCoNS are known to cause hospital infections. Most of these isolates are found in staff nurses and doctors. We recommend strict vigilance by the Hospital Infection Control Committee to control this problem before it becomes a major health problem.

Conclusion

In our study, we conclude that MRSA colonization which may serve as a source of infection and mupirocin

resistance is present among HCWs in our hospital setting though at a lower level when compared to other studies.

We suggest that screening for MRSA in HCWs should be performed for all whether working in Intensive Care Units or not, with susceptibility testing for mupirocin and if detected, alternative treatment should be used which will result in appropriate use of this antibiotic for decolonization.

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Conflicts of interest
There are no conflicts of interest.

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