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Original Article

SCREENING OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS AMONG HEALTHCARE WORKERS AND THEIR ANTIBIOTIC SUSCEPTIBILITY PATTERN IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Objective: Colonization of Staphylococcus aureus in the nasal flora has been proven to play an important role in the transmission of infections. Health care workers carrying Staphylococcus aureus in their nose or skin play an important role in cross-contamination and thus result in Methicillin-resistant Staphylococcus aureus (MRSA) related hospital-acquired or community-acquired infections. Implementation of hand hygiene methods and standard precautions are helpful in reducing transmission and controlling spread. Screening for carriage of MRSA is fundamental step in nosocomial infection control. The present study was undertaken to determine the prevalence of MRSA carriage rate and study their antibiogram.

Methods: A cross-sectional study was conducted for a period of six months and samples from 185 HCWs working in high-risk areas were processed by standard protocols. As per CLSI guidelines, MRSA detection by disc diffusion method using Cefoxitin disc (30µg) and further determined by Epsilometer test (E-test) by interpreting Minimum inhibitory concentration (MIC) values (mcg/ml).

Results: Out of 185 nasal swabs, 53 were Staphylococcus aureus isolates. MRSA colonization is seen in (8.64%) samples. Preponderance was seen in staff nurses (10.16%). Antibiogram of MRSA isolates showed sensitivity to Vancomycin and linezolid.

Conclusion: The present study was undertaken to screen nasal carriage of MRSA among healthcare workers, as they pose a potential risk factor for nosocomial transmission leading to MRSA outbreaks. The strengthening of Infection prevention and control measures institutionalization of antimicrobial stewardship programs helps in curbing the spread of MRSA.

Keywords: MRSA, Hand hygiene, Healthcare workers, Nosocomial infection

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INTRODUCTION

Staphylococcus aureus is a major pathogen in skin and soft tissue infections. It also causes abscess in deep organs and is responsible for toxin-mediated diseases [1]. Staphylococcus aureus has overcome most of the therapeutic agents that have been developed in recent years and hence the antibiotic chemotherapy of this species has always been empirical. The most notable example of this phenomenon was the emergence of Methicillin-resistant Staphylococcus aureus (MRSA) [2]. Following the introduction of Penicillin in the 1940s, strains of *S. aureus* unaffected by penicillin were reported in 1945. Methicillin was introduced in 1959 to treat these infections, but in 1961, shortly after the introduction of Methicillin, *S. aureus* isolates that had acquired resistance to methicillin (Methicillin-resistant *S. aureus*, MRSA) were reported [3]. The bacterial cell wall contains penicillin-binding proteins (PBPs), which have an enzymatic role in the synthesis of peptidoglycan. Normally, PBPs have a high affinity for beta-lactam antibiotics; in MRSA this affinity is reduced resulting in antibiotic resistance. In MRSA, a low-antibiotic affinity PBP known as PBP2a is encoded by the mec A gene [4, 5]. Humans are the natural reservoirs of Staphylococcus aureus and asymptomatic colonization is far more common than infection [6]. Nasal carriage seems to play a key role in the pathogenesis of infection. The ecological niche of Staphylococcus aureus are the anterior nares [7]. Nasal flora of MRSA has been proven to play an important role in the pathogenesis and transmission of infections. Healthcare workers (HCWs) carrying *S. aureus* in their nose or skin can play an important role in cross-contamination and thus MRSA-related hospital-acquired or sometimes community-acquired infections [8, 9]. Screening and eradication of MRSA in hospital workers have been recommended as an important step in the prevention of MRSA infection [10]. Moreover, proper knowledge about the prevalence and anti-microbial profile of this organism also helps to decide proper empirical antibiotics in suspected patients infected with MRSA [11]. Many studies have shown that nares are the most consistent area from which this organism can be isolated. Because its primary habitat is moist squamous epithelium of the anterior nares, most invasive Staphylococcus aureus infections are assumed to arise from nasal carriage [12]. Colonized or infected healthcare workers may serve as reservoir and dissemination of MRSA, combined with other precautions and taking care of hand hygiene, have been helpful in reducing transmission and controlling spread [13]. MRSA has recently emerged worldwide as a major cause of healthcare-associated infections that cause significant morbidity and mortality. Prevalence of nasal carriers of Staphylococcus aureus strains among hospital staff has been estimated to range from 16.8% to 90% [14-17].

Although many studies have been conducted on the prevalence of Staphylococcus aureus strains in our country but there is little research in the field associated with nasal carriers. Hence the present study was undertaken to find out the nasal carriage rate of MRSA among healthy hospital staff, as they could pose a potential risk factor for nosocomial transmission leading to MRSA outbreaks. Therefore, screening for carriage of MRSA is fundamental to modern-day nosocomial infection control, both for epidemiologic investigation and day-to-day decisions on barrier isolation [18, 19].

Aim: To determine the prevalence of Methicillin-Resistant Staphylococcus aureus carriage among healthcare workers and to study the antibiogram of the MRSA strains isolated.

METHODS AND MATERIALS

Study design

The cross-sectional study was conducted in Department of Microbiology, Government Medical College, Srikakulam for a period of six months from January 2022 to July 2022. Samples from 185

healthcare workers working in high-risk areas were included from various clinical departments of Government General Hospital, Srikakulam. The study was approved by Institutional Ethics Committee.

Statistical analysis

Data analysis was done using the statistical software SPSS v 23. Percentages were calculated for qualitative variables. Chi-square test was used for the comparison of the frequency of MRSA and MSSA between different KCWs by assuming p-Value ≤ 0.05 as significant difference.

Methodology

Under strict aseptic conditions, samples were collected from both anterior nares using sterile swabs with a standard rotating technique. Samples were immediately transported to Laboratory for microbiological isolates.

Processing of samples

The cross-sectional study was carried out in Bacteriology section of the Department of Microbiology. The study was conducted on 185 healthcare workers who volunteered for the study. The healthcare workers were enrolled after written informed consent was obtained from them. Samples were collected from both anterior nares using sterile swabs with a standard rotating technique. The swab was returned to the plastic tube and closed tightly. The plastic tube was labelled properly and immediately transported to the laboratory for bacteriological analysis. The samples were processed immediately. The swabs were inoculated onto Mannitol salt agar and incubated at 37 °C temperature for 24 h. Yellow colored colonies on mannitol agar that were coagulase-positive and catalase-positive were identified as *S. aureus* [20]. For identification of MRSA, we used Mueller-Hinton agar with Cefoxitin disc (30 μ g) by Kirby-Bauer disc diffusion method. After incubation for 24 h, diameter of colony size was measured for confirmation of MRSA, colony size ≤ 21 mm was labeled as MRSA and ≥22 mm was labeled as *methicillin-sensitive S. aureus* (MSSA). The resistance patterns were further determined by E-test by interpreting Minimum inhibitory concentration (MIC) values (mcg/ml) [20-22]. Kirby-Bauer diffusion disc technique as defined by CLSI guidelines, was used for anti-biotic sensitivity testing [23].

RESULTS

A total of 185 healthcare workers were recruited during the study, of which 59 (33.90%) were Staff nurses, 32 (28.12%) were Doctors, 43 (23.24%) were Paramedical staff and 51 (27.56%) were housekeeping staff. Of them, 112 (60%) were females and 73 (40%) were males.

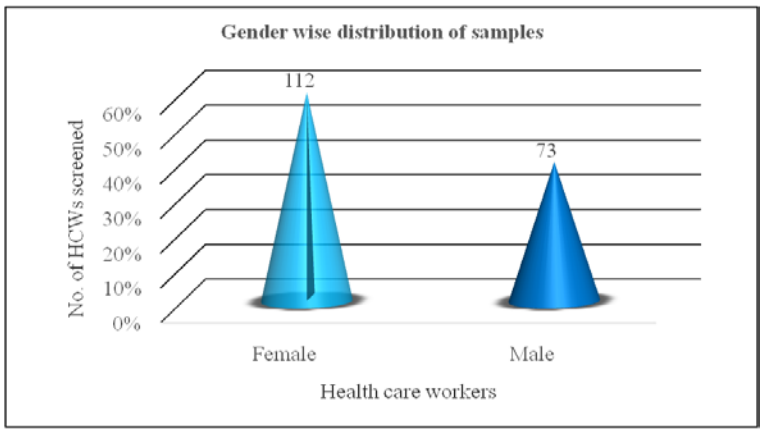

Fig. 1: Gender wise distribution of samples (n= 185)

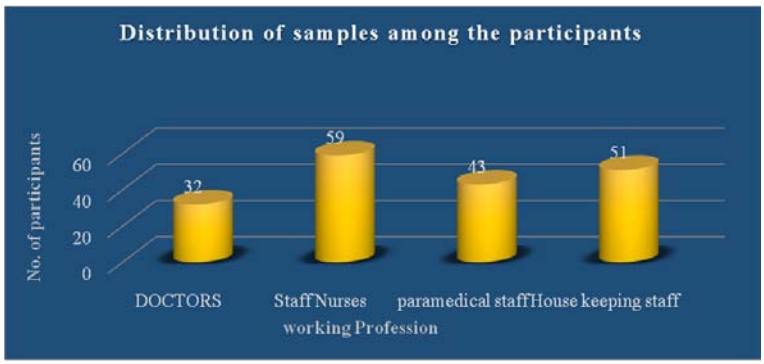

Fig. 2: Distribution of samples among the participants (n= 185), out of 185 nasal swabs from the healthcare workers, 53 (28.65%) samples showed growth, and 132 (71.35%) samples showed no growth

Table 1: Culture positivity among total samples (n= 185)

Samples	Number of HCWs	Percentage
Culture positive samples	53	28.65%
Culture negative samples	132	71.35%
Total samples	185	100%

Out of 185 nasal swabs 53 healthcare workers were positive for nasal carriage of *S. aureus*. Sixteen healthcare workers were positive for nasal carriage of MRSA. The carriage rate of MRSA among males was 6 (3.2%), whereas it was 10 (5.4%) among females.

Table 2: Profession/Cadre-related distribution of *S. aureus* and MRSA carriage status

Designation	No. of samples screened (n=185)	No. of positive samples (n=53)	No. of MRSA samples (n=16)	No. of MSSA samples (n= 37)
Doctors	32 (17.29%)	9 (28.12%)	3 (9.37%)	6 (18.75%)
Staff nurses	59 (31.89%)	20 (33.89%)	6 (10.16%)	14 (23.72%)
Paramedical staff	43 (23.24%)	10 (23.25%)	3 (6.97%)	7 (16.27%)
Housekeeping staff	51 (27.56%)	14 (27.45%)	4 (7.84%)	10 (19.60%)
Total	185 (100%)	53 (28.64%)	16 (8.64%)	37 (20%)

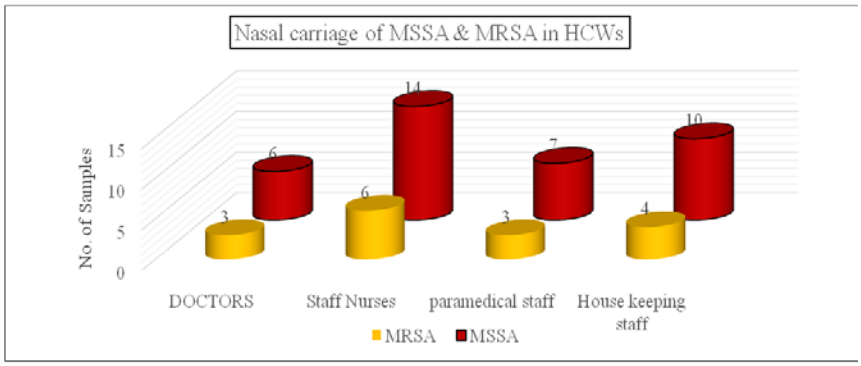

Fig. 3: Distribution of nasal carriage of MSSA and MRSA among healthcare workers; the nasal carriage of MRSA was reported highest among Staff nurses (6) followed by housekeeping staff (4), Doctors (3) and paramedical staff (3)

Table 3: Antibiogram of MRSA and MSSA isolates

Antibiogram of MRSA and MSSA isolates								
Antibiotics	**MRSA (16)**				**MSSA (37)**			
	Sensitive	**%**	**Resistant**	**%**	**Sensitive**	**%**	**Resistant**	**%**
Ampicillin (AMP) (10 mg)	2	13%	14	87%	28	75%	9	25%
Amikacin (AK) (30µg)	14	87%	2	13%	33	89%	4	11%
Teicoplanin (TEI) (30µg)	16	100%	0	0%	37	100%	0	0%
Tobramycin (TOB) (10µg)	11	69%	5	31%	30	82%	7	18%
Clindamycin (CD) (2µg)	12	75%	4	25%	31	85%	6	15%
Cefotaxime (CTX) (30µg)	3	19%	11	69%	24	65%	13	35%
Cefoxitin (CX) (30µg)	16	0%	16	100%	20	55%	17	45%
Linezolid (LZ) (30µg)	16	100%	0	0%	36	97%	1	3%
Ciprofloxacin (CIP) (5µg)	9	56%	7	44%	15	42%	22	58%
Vancomycin (VA) (30µg)	16	100%	0	0%	35	95%	2	5%
Azithromycin (AZM) (15µg)	14	87%	2	13%	34	93%	3	7%
Levofloxacin (LE) (5µg)	15	94%	1	6%	29	79%	8	21%

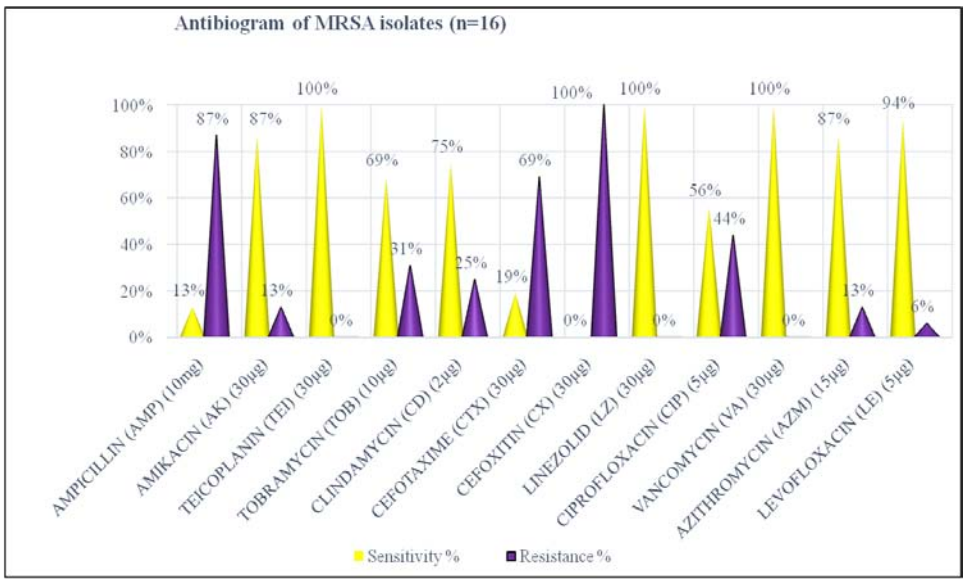

Fig. 4: Antibiogram of MRSA isolates

In the present study, out of 53 (28.65%) Staphylococcus aureus isolates, 16 (8.6%) were Methicillin resistant Staphylococcus aureus and 37 (20.14%) were Methicillin sensitive Staphylococcus aureus.

MRSA isolates were sensitive to Teicoplanin (100%), Linezolid (100%), Vancomycin (100%), Levofloxacin (94%), Amikacin and Azithromycin (87%), Clindamycin (75%).

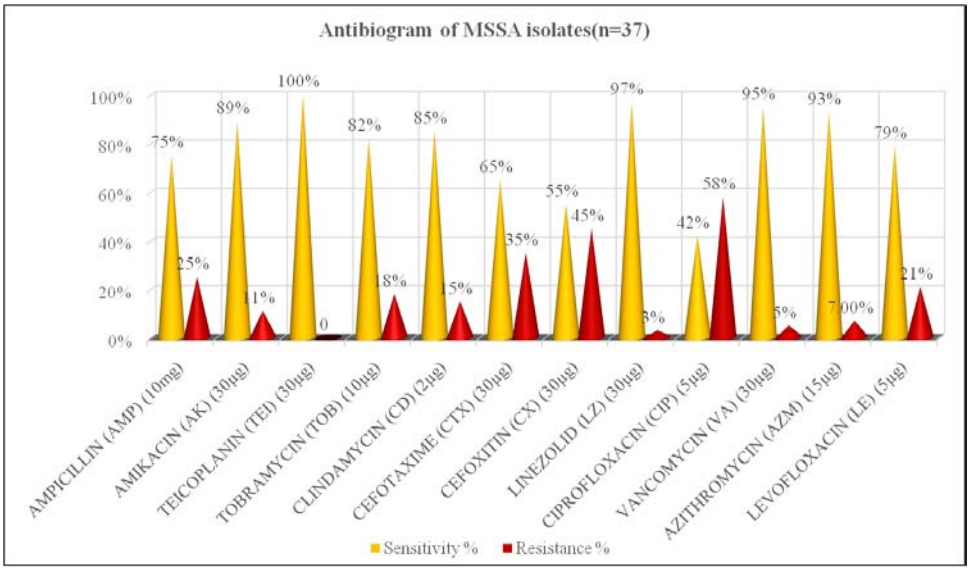

Fig. 5: Antibiogram of MSSA isolates, MSSA isolates were sensitive to Teicoplanin (100%), Linezolid (97%), Vancomycin (95%), Linezolid (93%), Amikacin (89%), Clindamycin (85%) and Tobramycin (82%)

DECOLONIZATION

All the colonizers were treated with Mupirocin ointment 3 times a day into both nostrils for 10 d, oral Clindamycin for 10 d [24, 25]. Decolonization is proven with control samples obtained on three occasions with two days intervals between collections. Initially, only previously positive samples are collected. 48 h after first collection and before second set of samples are collected, enquire if all samples of the first collection are negative for MRSA. If all samples of the initial collection are negative for MRSA, a second set of samples are collected. If all samples of the second collection are negative 48 h after collected, third set of samples are collected.

Decolonization is successful when all samples of all three collections are negative for MRSA.

DISCUSSION

S. aureus can colonize multiple sites in the body like the anterior nares, axilla, perineum, pharynx, and gastrointestinal tract. But the most common site of colonization of *S. aureus* are the anterior nares [1].

MRSA is now playing an important role in causing infections in hospitalized patients as well as in the community at large and the main sources of spread of infection in the hospital setup are health care workers and the patients colonized with MRSA mainly in nose or on the skin and patients themselves through their hands are through nasal secretions [26]. If proper hand hygiene and other infection control measures are not adapted then these infections can spread very fast among the patients and this could increase their duration of stay in the hospital and increased financial burden on both the patient and the hospital authorities; therefore routine screening methods must be followed for detecting the colonization of MRSA in the health care workers and the patients [27, 28].

The present study was conducted over a period of 6 mo to evaluate the nasal carriage of *S. aureus* in healthcare workers and their antibiotic sensitivity pattern. According to our study, the prevalence of *S. aureus* colonization in the anterior nares is 28.64% (53/185) which correlated with study conducted in Thailand, Treesirichod A *et al.* 2013 (29.7%) [29], Telangana, Banerjee *et al.*; 2018 [20] (26%) [30], Assam, Rongpharpi SR *et al.* 2013 (22.22%) [31]; Rutvi V *et al.*, 2016 (22%) [32] among the health care workers. Majority of the samples in the present study were obtained from Staff nurses 59 (31.89%) followed by housekeeping staff 51 (27.56%). This correlated with Singh N SS *et al.* 2018 (41.7%) [33], Kausar Rawani *et al.* 2020 (31.42%) [34] and Perika Sharma *et al.* 2021 (40%) [35].

In the present study, out of the total Positive samples 53 (28.64%) in HCWs, MRSA colonization is seen in 16 (8.6%) and MSSA are 37 (20%) samples. These findings correlated with Sujatha *et al.* 2009 (8.5%) [35], Salman MK *et al.* (9.3%) [37], Malini *et al.* 2012 (8%) [38] and Al Wahaibi *et al.* 2021 (7.5%) [39]. Out of 16 MRSA samples, preponderance of MRSA carriage rate was seen in staff nurses 6 (10.16%), followed by doctors 3 (9.3%) which supports study of Singh N SS *et al.* 2018 [33], who reported 41.7% in staff nurses and 20% in doctors Shibabaw *et al.* 2013 staff nurses (21.2%) and doctors (12.5%) [40] and El Aila *et al.* 2017staff nurses (30.4%) and doctors (16%) [41].

The Antibiogram patterns for MRSA (16), shows sensitivity to Teicoplanin (100%), Linezolid (100%), Vancomycin (100%), Levofloxacin (94%), Amikacin and Azithromycin (87%), Clindamycin (75%), which correlated with study of Perika Sharma *et al.* 2021 [35], Singh N SS *et al.* 2018 [33] Radhakrishna M *et al.* 2013 [42] and Banerji *et al.* 2018 [30]. MRSA isolates were resistant to Cefoxitin (100%), which correlated with studies of Banerjee *et al.* 2018 [29], Perika Sharma *et al.* 2021 [35]. MSSA isolates were sensitive to Teicoplanin (100%), Linezolid (97%), Vancomycin (95%), Amikacin (89%) and Clindamycin (85%) which correlated with studies of Singh N SS *et al.* 2018 [33], Banerjee *et al.* 2018[30] and Perika Sharma *et al.* 2021 [35].

CONCLUSION

The high rate of nasal MRSA carriage (8.64%) among healthcare workers with the rate being highest among nurses (10.96%). Since, nurses are more involved in patient care activities, it is necessary that they should be sensitized regarding this issue and the importance of hand washing should be emphasized upon them this study necessitates the importance of improved infection control measures to prevent MRSA transmission. Appropriate measures should include laboratory-based periodic surveillance, regular screening of HCWs, giving an early warning in the presence of antimicrobial-resistant pathogens, treatment of MRSA-positive HCWs (carriers), isolation of colonized and infected patients and the use of barrier precautions. The most important factor is to educate

the healthcare professionals regarding the potential consequences of nosocomial infections, to provide them periodic training about the maintenance of hygiene and basic infection control measures and the effects of the use or rather, the misuse of antibiotics. Surveillance for MRSA and eradication of the carrier state reduces the rate of MRSA infections and mupirocin was found to be effective in decolonizing nasal MRSA colonization in our study.

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AUTHORS CONTRIBUTIONS

All the authors listed have made a substantial direct and intellectual contribution to the work and approved it for publication.

CONFLICT OF INTERESTS

Declared none

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