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-affinity PBP known as PBP2a is encoded by the meca gene [4, 5]. Humans are the natural reservoirs of Staphylococcus aureus strains among hospital staff 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 [2]. 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 Infection prevention and control measures institutionalization of antimicrobial stewardship programs helps in curbing the spread of MRSA.
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 μg) 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)](image)

[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](image)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Number of HCWs</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture positive samples</td>
<td>53</td>
<td>28.65%</td>
</tr>
<tr>
<td>Culture negative samples</td>
<td>132</td>
<td>71.35%</td>
</tr>
<tr>
<td>Total samples</td>
<td>185</td>
<td>100%</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>MRSA (16)</th>
<th>MSSA (37)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitive</td>
<td>Resistant</td>
</tr>
<tr>
<td>Ampicillin (AMP) (10 mg)</td>
<td>2</td>
<td>13%</td>
</tr>
<tr>
<td>Amikacin (AK) (30µg)</td>
<td>14</td>
<td>87%</td>
</tr>
<tr>
<td>Telocoplanin (TEL) (30µg)</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>Tobramycin (TOB) (10µg)</td>
<td>11</td>
<td>69%</td>
</tr>
<tr>
<td>Clindamycin (CD) (2µg)</td>
<td>12</td>
<td>75%</td>
</tr>
<tr>
<td>Cefotaxime (CTX) (30µg)</td>
<td>3</td>
<td>19%</td>
</tr>
<tr>
<td>Cefoxitin (CX) (30µg)</td>
<td>16</td>
<td>0%</td>
</tr>
<tr>
<td>Linezolid (LZ) (30µg)</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>Ciprofloxacin (CIP) (5µg)</td>
<td>9</td>
<td>56%</td>
</tr>
<tr>
<td>Vancomycin (VA) (30µg)</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>Azithromycin (AZM) (15µg)</td>
<td>14</td>
<td>87%</td>
</tr>
<tr>
<td>Levofloxacin (LE) (5µg)</td>
<td>15</td>
<td>94%</td>
</tr>
</tbody>
</table>

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%).

**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, Tressirichod A et al. 2013 (29.7%) [29], Telangana, Banerjee et al. 2018 (20%) [30], Assam, Rongphari SR et al. 2013 (22.2%) [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. 2017 staff 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 Banerjee et al. 2018 [30], MRSA isolates were resistant to Cefoxitin (100%), which correlated with studies of Banerjee et al. 2019 [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 (86.4%) 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 and maintenance of hygiene and basic infection control measures and the healthcare professionals regarding the potential consequences of 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.

CONFICT OF INTERESTS

Declared none

REFERENCES


