Prevalence And Current Antibiogram Of Staphylococci Isolated From Various Clinical Specimens In A Tertiary Care Hospital In Pondicherry

S Kumar, N Joseph, J Easow, S Umadevi, G Kumari, S Rangaraj, S Pramodhini, R Singh

INTRODUCTION

Staphylococcus aureus causes a wide range of infections. These can be broadly divided into community and hospital-acquired infections. Community acquired infections include the following: toxin mediated disease (e.g. food poisoning and toxic shock syndrome), infections affecting the skin and soft tissue (boils, impetigo, cellulitis and myositis), infection of bones and joints, infections relating to other deep sites (endocarditis, abscess formation in liver, spleen and other sites) and infections of the lung and urinary tract. Nosocomial or hospital acquired infections include the disease already mentioned and more commonly surgical wound infections, ventilator associated pneumonia, bacteraemia associated with intravenous devices and other prosthetic material such as CSF shunts, prosthetic joints and vascular graft. Infection due to S. aureus imposes a high and increasing burden on health care resources. The increase in the incidence of infections due to S. aureus is partially a consequence of advances in patient care and also of the pathogen's ability to adapt to a changing environment. The most prevalent Staphylococcal species and subspecies in human infection are S. aureus, S. epidermidis, S. haemolyticus, S. saprophyticus followed by S. hominis, S. warneri and S. lundeesies. Methicillin introduced in 1961 was the first of the semi-synthetic penicillinase resistant penicillin developed in response to widespread penicillin resistance in S. aureus. Its introduction was soon followed by emergence of methicillin resistance, which spread in...
waves across hospital in many countries. In S. aureus, methicillin resistance is defined as resistance to the isoxazoyl penicillins such as methicillin, oxacillin and flucloxacillin. The frequency of Methicillin resistant S. aureus (MRSA) infections continues to grow in hospital-associated settings, and more recently, in community settings globally. Methicillin resistance is not confined to S. aureus. Several species of staphylococcus show methicillin resistance including S. epidermidis, S. haemolyticus, S. hominis, S. capitis, S. warneri, S. caprae, S. sciuri. Only a few reports regarding the antimicrobial susceptibility of S. aureus in Pondicherry are available. This study was therefore carried out to determine the local prevalence of methicillin resistance in various clinical isolates of staphylococci and to study the current antibiogram of staphylococci isolated from patients at Mahatma Gandhi Medical College and Research Institute, Pondicherry.

MATERIAL AND METHODS

STUDY SETTING

This cross-sectional study was conducted in the Department of Microbiology of Mahatma Gandhi Medical College and Research Institute, a 750-bedded tertiary care super-specialty hospital with teaching facility, located in Pondicherry, India. It serves as a referral centre for tertiary specialist care for a catchment population of approximately 10 lakh people from Pondicherry and adjoining areas.

BACTERIAL IDENTIFICATION AND ANTIBIOTIC SUSCEPTIBILITY TESTING

The study comprised of 550 coagulase-positive and coagulase-negative staphylococci isolated from various clinical specimens (pus, sputum, tracheal aspirate, body fluids and high vaginal swab). These isolates were subjected to methicillin resistance screening using conventional microbiological methods. The clinical specimens were inoculated on 5% sheep blood agar, Mac Conkey agar and incubated at 37°C aerobically for 24h. S. aureus was identified based on Gram’s stain morphology, colony characteristics, and positive catalase and coagulase tests. The isolates were subjected to susceptibility testing by Kirby Bauer disc diffusion method on Mueller Hinton agar plates using erythromycin (15 µg), clindamycin (2 µg), penicillin (10 IU), ciprofloxacin (5 µg), gentamicin (10 µg), cefoxitin (30 µg) and vancomycin (30 µg) as per Clinical Laboratory Standards Institute (CLSI) guideline.

DETECTION OF METHICILLIN RESISTANCE

All the confirmed S. aureus isolates and coagulase negative staphylococci (CoNS) were tested for methicillin resistance using oxacillin disc diffusion method (< 35°C), cefoxitin (35°C) and oxacillin screen agar (5% NaCl, 6 µg/ml oxacillin).

QUALITY CONTROL

S. aureus ATCC 25923 was used for quality control of Kirby Bauer disc diffusion method. S. aureus ATCC 25923 and S. aureus ATCC 43300 were used for quality control of the methods for detection of methicillin resistance.

STATISTICAL ANALYSIS

Data entry and analysis were done using SPSS for Windows Version SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Percentages were calculated for categorical variables. The Chi-square test or Fisher’s exact test was used to compare two groups. All p values < 0.05 were considered statistically significant.

RESULTS

The distribution pattern of 550 Staphylococcal isolates from various samples and wards is shown in Table 1. Most of the Staphylococcal isolates were from patients admitted in surgery wards, followed by orthopedics and obstetrics and gynecology. Methicillin resistance was seen in 17.2% (59/343) isolates of S. aureus and 23.2% (48/207) of CoNS. S. aureus and CoNS isolated from various clinical samples are shown in Table 2. The prevalence of MRSA was significantly different among various clinical specimens (Table 2). It was found that 93.22% (55/59) of the MRSA were from pus, 5.08% (3/59) were from ET and 1.69% (1/59) was from HVS. In body fluid and sputum, methicillin resistance was not seen. Of the 48 MR-CoNS isolated from various clinical specimens, it was found that 70.8% were from pus followed by ET and HVS with 8.3% isolates each, sputum with 4.2% and body fluid with 2.1% isolates.

Of the 550 isolates of Staphylococci, 318 (57.8%) were collected from males and 232 (42.2%) from females (Table 3). Susceptibility pattern of the staphylococcal isolates to common antibiotics is shown in (Table 4). Drug resistance pattern to several antimicrobials was significantly different among Coagulase positive and coagulase negative isolates (Table 4). Besides their lack of susceptibility to β-lactam drugs, the MRSA and methicillin resistant CoNS (MR-CoNS) also showed decreased susceptibility to various other
antibiotics. There was a significant reduction in the proportion of MRSA that were susceptible to erythromycin, clindamycin, gentamicin, ciprofloxacin and co-trimoxazole, compared to methicillin sensitive S. aureus (MSSA). Similarly, there was a significant reduction in the proportion of MR-CoNS that were susceptible to erythromycin, gentamicin, ciprofloxacin and co-trimoxazole, compared to methicillin sensitive coagulase negative staphylococci (MS-CoNS). All the staphylococcal isolates tested exhibited susceptibility to vancomycin and teicoplanin. Among 59 MRSA screened from clinical specimens, 78.0% were sensitive to clindamycin, 47.5% to tetracycline, 40.7% to gentamicin and 20.3% to erythromycin. The resistance of MRSA was very high for co-trimoxazole (88.1%) and ciprofloxacin (81.4%). Among 48 MR-CoNS isolates from clinical specimens, 83.3% were sensitive to tetracycline, 79.2% to clindamycin, 75% to gentamicin., 27.1% to erythromycin. The resistance was very high for co-trimoxazole (79.2%) and erythromycin (72.9%).

**Figure 1**
Table 1. Distribution of various samples from different wards

<table>
<thead>
<tr>
<th>Body Fluid</th>
<th>ET</th>
<th>HVS</th>
<th>Pus</th>
<th>Sputum</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENT</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Eye</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Medicine</td>
<td>3</td>
<td>0</td>
<td>9</td>
<td>5</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>ICU</td>
<td>10</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>1</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>OB</td>
<td>0</td>
<td>21</td>
<td>79</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Orthopedics</td>
<td>4</td>
<td>0</td>
<td>103</td>
<td>0</td>
<td>1</td>
<td>108</td>
</tr>
<tr>
<td>Skin</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Surgery</td>
<td>1</td>
<td>1</td>
<td>248</td>
<td>0</td>
<td>1</td>
<td>251</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>12</td>
<td>495</td>
<td>5</td>
<td>9</td>
<td>550</td>
</tr>
</tbody>
</table>

ENT – ear, nose and throat (oto- Rhino Laryngology), ICU – intensive care unit, OB – obstetrics and gynaecology, ET – endotracheal aspirate, HVS – high vaginal swab

**Figure 2**
Table 2. and coagulate negative staphylococci isolated from various clinical samples

<table>
<thead>
<tr>
<th>Specimen</th>
<th>MS-CoNS</th>
<th>MR-CoNS</th>
<th>MSSA</th>
<th>MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Fluid</td>
<td>1 (6.5%)</td>
<td>2 (1.2%)</td>
<td>6 (2.1%)</td>
<td>0</td>
</tr>
<tr>
<td>ET</td>
<td>2 (1.9%)</td>
<td>3 (8.3%)</td>
<td>2 (0.7%)</td>
<td>3 (5.08%)</td>
</tr>
<tr>
<td>HVS</td>
<td>14 (8.8%)</td>
<td>4 (8.3%)</td>
<td>2 (0.7%)</td>
<td>1 (1.69%)</td>
</tr>
<tr>
<td>Pus</td>
<td>133 (83.6%)</td>
<td>34 (70.8%)</td>
<td>273 (96.1%)</td>
<td>55 (93.2%)</td>
</tr>
<tr>
<td>Sputum</td>
<td>3 (1.9%)</td>
<td>2 (4.2%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>5 (3.1%)</td>
<td>3 (6.3%)</td>
<td>1 (0.4%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>48</td>
<td>284</td>
<td>50</td>
</tr>
</tbody>
</table>

ET – endotracheal aspirate, HVS – high vaginal swab

MS-CoNS – methicillin sensitive coagulate negative staphylococci, MR-CoNS – methicillin resistant coagulate negative staphylococci, MSSA – methicillin sensitive S. aureus, MRSA – methicillin resistant S. aureus

**Figure 3**
Table 3: Characteristic of patients with Staphylococcal infection

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total cases (%) (n=550)</th>
<th>MRSA cases (%) (n=59)</th>
<th>MSSA cases (%) (n=284)</th>
<th>MR-CoNS cases (%) (n=48)</th>
<th>MS-CoNS cases (%) (n=159)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≤ 45 yrs</td>
<td>599 (54.4%)</td>
<td>30 (50.8%)</td>
<td>167 (58.8%)</td>
<td>24 (50.0%)</td>
<td>78 (49.1%)</td>
</tr>
<tr>
<td>Age &gt; 45 yrs</td>
<td>251 (45.6%)</td>
<td>29 (49.2%)</td>
<td>117 (41.2%)</td>
<td>24 (50.0%)</td>
<td>81 (50.9%)</td>
</tr>
<tr>
<td>Gender Male</td>
<td>318 (57.8%)</td>
<td>37 (62.7%)</td>
<td>137 (55.3%)</td>
<td>27 (56.3%)</td>
<td>97 (61.0%)</td>
</tr>
<tr>
<td>Gender Female</td>
<td>232 (42.2%)</td>
<td>22 (37.3%)</td>
<td>127 (44.7%)</td>
<td>21 (43.7%)</td>
<td>62 (39.0%)</td>
</tr>
<tr>
<td>total</td>
<td>550 (100%)</td>
<td>59 (100%)</td>
<td>284 (100%)</td>
<td>48 (100%)</td>
<td>159 (100%)</td>
</tr>
</tbody>
</table>

MS-CoNS – methicillin sensitive coagulate negative staphylococci, MR-CoNS – methicillin resistant coagulate negative staphylococci, MSSA – methicillin sensitive S. aureus, MRSA – methicillin resistant S. aureus

IP— inpatient, OP— outpatient
DISCUSSION

S. aureus is a highly versatile and adaptable pathogen capable of causing a diverse array of infections in hospital and community settings. S. aureus has been reported to be the cause of most wound infections among hospitalized patients elsewhere.\(^5\) The growing problem in the Indian scenario is that MRSA prevalence has increased from 12% in 1992 to 80.83% in 1999.\(^6\) In our study the prevalence of MRSA was 17.2 %. In major southern districts of Tamilnadu, out of 906 strains of S. aureus isolated from clinical samples, 250 (31.1%) were found to be methicillin resistant. A study from Mumbai, reports that the incidence of MRSA was 15.87%.\(^7\) All the MRSA strains isolated, however, were found to be sensitive to vancomycin corresponding to our finding.\(^7\) In the USA, Canada and Europe, available statistics indicate that MRSA accounts for up to 40% of nosocomial S. aureus infections in large hospitals and 25% - 30% of such infections in smaller hospitals.\(^8\) Rate of methicillin resistance among clinical isolates of S. aureus vary from less than 1% in Norway and Sweden, 5-10% in Canada, 25-50% in the United states to more than 50% in Hong Kong and Singapore.\(^9\) In a study done by Mshana et al., MRSA was observed in 16.2% of isolates.\(^10\) In Europe, the highest prevalence of MRSA in the hospitals was seen in Portugal (54%), Italy(43%-58%) and Netherlands(2%).\(^11\)

The variation in MRSA prevalence might be because of several factors like efficacy of infection control practices, healthcare facilities and antibiotic usage that vary from hospital to hospital.

We observed that the many of the MRSA isolates, besides their resistance to β-lactam drugs, showed resistance to co-trimoxazole, ciprofloxacin, erythromycin, gentamicin and tetracycline. Researchers in other part of the globe also observed that many of these MRSA isolates were becoming multidrug resistant and were susceptible only to glycopeptide antibiotics such as vancomycin. The mobile genetic element termed staphylococcal cassette chromosome mec (SCCmec), which carries the mecA gene responsible for methicillin resistance, also contains several other genetic elements involved in the expression and regulation of resistance to other classes of antibiotics.\(^1\) This is the reason for the multi-drug resistance of MRSA. However, the type IV SCCmec present in many community-acquired MRSA strains is characterized by the absence of non-beta-lactam genetic-resistance determinants. Clindamycin is usually advocated for the treatment of infections by such community-acquired MRSA strains if they are found to be susceptible to clindamycin.\(^12\) In our study about 78% of the MRSA were susceptible to clindamycin. In a similar study, 63% of the MRSA isolates were observed to be susceptible to clindamycin.\(^12\) Therefore, clindamycin has an important role in the management of MRSA infections, especially, the community-acquired. However, the glycopeptide vancomycin has been regarded as the drug of choice for the treatment of infections due to methicillin-resistant strains as majority of them are hospital-acquired and are usually resistant to many classes of antibiotics including macrolides.\(^13\) The MRSA isolated in our study showed 100% susceptibility to vancomycin and Teicoplanin. Although, the MRSA isolates are usually considered as susceptible to vancomycin, recently there is an emergence of low level resistance to vancomycin.\(^13\) Assadullah et al have observed that 40% of the 120 MRSA isolates showed intermediate susceptibility (MIC: 4-8 μg/mL) to vancomycin based on the MIC determination by macrobroth dilution method.\(^14\) They have also reported that 3.3% of the 120 MRSA isolates were resistant to vancomycin (MIC≥ 16 μg/mL).\(^14\) The other drugs approved for the treatment of MRSA infections such as linezolid, daptomycin, quinupristine-dalfopristine and...
tigecycline may be useful in treatment of infections caused by the MRSA isolates with reduced susceptibility to vancomycin.13

In our study the MR-CoNS which showed resistance to oxacillin and cefoxitin accounted for 23.2% of CoNS, which is similar to that reported from North India by Uma et al.,15 according to which 25% of all CoNS isolated were methicillin resistant. In a similar study from Aligarh, India, it was shown that 22.5% of coagulase-negative staphylococcal isolates were resistant to methicillin. The Methicillin resistance observed in CoNS is also mediated by the mecA gene carried on the SCCmec, similar to the MRSA. Therefore, the treatment of MR-CoNS is also similar to that of MRSA.

CONCLUSION

We conclude that MRSA and MR-CoNS are prevalent in our hospital. Our study shows sensitivity of MRSA to vancomycin is 100% which further emphasizes that it is still the drug of choice for MRSA infections. In our study about 78% of the MRSA were susceptible to clindamycin. Therefore, clindamycin has an important role in the management of MRSA infections, especially, the community-acquired. The resistance of MRSA was very high for co-trimoxazole (88.1%) and ciprofloxacin (81.4%). The MR-CoNS showed very high resistance for co-trimoxazole (79.2%) and erythromycin (72.9%). We recommend that frequent monitoring of susceptibility patterns of MRSA and MRCONS and the formulation of a definite antibiotic policy may be helpful in decreasing the incidence of MRSA and MRCONS infection.

References

Author Information

Shailesh Kumar
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

Noyal Mariya Joseph
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

Joshy. M. Easow
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

Sivaraman Umadevi
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

G. Kandha Kumari
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

S. Rangaraj
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

S. Pramodhini
Department of Microbiology, Mahatma Gandhi Medical College and Research Institute

Reecha Singh
Department of Pathology, Indira Gandhi Medical College and Research Institute