Frequency of *Staphylococcus aureus* and Methicillin Resistance

*Staphylococcus aureus* Colonization in Anterior Nares of School Children of Esfahan in 2013 and Their Pattern of Antibiotic Resistance

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Abstract: *Staphylococcus aureus* (*S. aureus*) frequently causes infections in both hospital and community settings. Individuals who are nasal carriers of *S. aureus* are at a greater risk of acquiring an infection with this pathogen. Infection with methicillin-resistant *S. aureus* (MRSA) is challenging because of its prevalent resistance to antibiotics in addition to methicillin. We planned a study to determine the colonization rates of *S. aureus* in the anterior nares of school children and evaluate the antimicrobial resistance of such isolates against various antibiotics. Specimens to be used for culture were taken from both anterior nares of 215 healthy school children with rayon swabs. Antimicrobial susceptibility was evaluated by the Kirby-Bauer disk diffusion method as per the guidelines of the Clinical and Laboratory Standards Institute. Among the children enrolled in our study, we found a 26% *S. aureus* colonization rate, with 41% of this population representing MRSA colonization. Resistance rates to clindamycin, erythromycin, clarithromycin, tetracycline, rifampin, trimethoprim/sulfamethoxazole, gentamicin, ciprofloxacin and vancomycin were 47.8, 73.9, 69.6, 43.4, 13, 26.1, 17.4, 52.2 and 4.3%, respectively. *S. aureus* and MRSA colonization rates in the current study are much higher than previous studies on schoolchildren in other regions. In addition, the MRSA species identified herein had high resistance rates to different antibiotics, further emphasizing the need to eradicate *S. aureus* reservoirs.

Key words: *Staphylococcus aureus* • Methicillin-Resistant *Staphylococcus aureus* • MRSA • Vancomycin Resistance • VRSA

INTRODUCTION

*Staphylococcus aureus* (*S. aureus*) frequently causes infections in both hospital and community settings. Its increasing resistance to different antibiotic classes makes treatment of *S. aureus* infections challenging [1]. Typically, methicillin-resistant *S. aureus* (MRSA) infections are caused by exposure in health care settings, but there have been reports of high MRSA infection rates in non-medicine related persons. These infections are called community-acquired MRSA (CA-MRSA) [2]. Soft tissue infections are still the most common manifestation of CA-MRSA, however, more severe conditions such as necrotizing fasciitis, necrotizing pneumonia and osteomyelitis have been previously reported as a result of CA-MRSA infection [3, 4]. The nose is the main ecological habitant of *S. aureus* in human [5] and nasal carriers are at a greater risk of acquiring an infection with this pathogen [1, 3]. Importantly, eradication of *S. aureus* from nasal carriers has been shown to prevent such infections [1, 5].

In the past few years, the prevalence of MRSA colonization has increased drastically among healthy hosts during CA-MRSA epidemics [6, 7]. Living with young children is considered as a risk factor for MRSA colonization in adults [8]. These data indicate that young children may be the major reservoir of MRSA in the community and, by extension; they may be responsible for the accelerated transmission of CA-MRSA. In contrast, very little is known regarding MRSA nasal carriage rates among school children in Esfahan.
We developed a study to determine the colonization rates of *S. aureus* in the anterior nares of school children. Furthermore, we sought to evaluate the resistance of such isolates against various antibiotics.

**MATERIALS AND METHODS**

Between June 2013 and December 2013, all healthy 7-13-year-old school children in Esfahan who visited as a part of health check-up entered our study. This study was approved by the Avicenna Research and Ethics Committee of Esfahan. Informed consent was obtained from their parents or legal guardians. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. Children with the following conditions were excluded from the study: chronic renal failure, dialysis, indwelling devices, thalassemia major, chronic cardiovascular diseases, chronic lung disease, nephrotic syndrome, liver cirrhosis, diabetes mellitus, congenital immunodeficiency, human immunodeficiency virus infection, asplenia, or malignancy or if they were receiving immunosuppressant agents. After recording the children’s age and sex, specimens were taken from both anterior nares with rayon swabs to be used for culture. The swabs were plated directly onto 5% sheep’s blood agar plates, which were incubated at 35°C under 5% CO₂ for 48 hours. *S. aureus* was identified systematically as previously described [8]. Antimicrobial susceptibility was evaluated by the Kirby-Bauer disk diffusion method following the guidelines of the Clinical and Laboratory Standards Institute [9]. An oxacillin disk was used to demonstrate the methicillin resistance of *S. aureus* isolates and *S. aureus* ATCC 25923 was used as a control strain.

**RESULTS**

Nasal swabs were taken from 215 healthy children in school during the time interval of the study. The study cohort was comprised of 116 boys (53.9%) and 99 girls (46.1%) with a mean age of 10.4 years (SD = 3.2). Of those 215 children, 56 (26%) were colonized with *S. aureus*, of which 23 (41.1%) were identified as MRSA. The antibiotic susceptibilities of the MRSA isolates are shown in table 1. Of note, the vancomycin-resistant isolate was resistant to all tested antibiotics.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clindamycin</td>
<td>11</td>
<td>47.8</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>17</td>
<td>73.9</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>16</td>
<td>69.6</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>10</td>
<td>43.4</td>
</tr>
<tr>
<td>Rifampin</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>TMP-SMZ</td>
<td>6</td>
<td>26.1</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>4</td>
<td>17.4</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>12</td>
<td>52.2</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>1</td>
<td>4.3</td>
</tr>
</tbody>
</table>

**DISCUSSION**

*S. aureus* mainly colonizes the nose. In the past decades, MRSA strains have become the predominant causative agent in such infections. MRSA strains are difficult to cure, have a more recurrent nature [10] and MRSA-colonized children are at a greater risk of developing an infection. We studied 215 healthy school children for *S. aureus* colonization, MRSA rates and for evaluation of antibiotic resistance rates. Among the children tested, we revealed a 26% *S. aureus* colonization rate, with 41% of these isolates representing the MRSA colonization rate. A study by Chen *et al.* [2] was performed in Taiwan whereby 6057 school children were tested for *S. aureus* and MRSA colonization. They determined that 23.2 and 7.8% of children in their study tested positive for *S. aureus* and MRSA colonization, respectively. The rate of *S. aureus* colonization in their study is in accordance with our results, however, the MRSA colonization rate in our study was 6-fold greater as compared to Chen *et al.* [2].

Miller *et al.* [11] conducted a study on 1163 children in North Carolina and Virginia and revealed even lower *S. aureus* and MRSA colonization rates. These results demonstrated 18.1% and 1.3% for *S. aureus* and MRSA colonization, respectively, each of which are much lower than the results presented here.

In a study in India, Chatterjee *et al.* [12] announced colonization rates of *S. aureus* and MRSA to be 52.3 and 3.16%, respectively. Again, the *S. aureus* colonization rate of their study is in accordance with our results, but their MRSA colonization rate is much lower. Furthermore, they revealed that the MRSA isolates were resistant to erythromycin, clindamycin and gentamicin in 6.3, 5 and 12.5% of study participants, respectively, while all isolates were sensitive to ciprofloxacin and rifampicin. Our results presented herein regarding rifampin resistance are similar.
to Chatterjee et al. [12] however, the isolates in our study show much higher resistance rates (nearly ten-fold) to the other two antibiotics tested.

Ramana et al. [13] demonstrated S. aureus and MRSA colonization rates of 16 and 19%, respectively, both of which are lower than our results. Furthermore, they showed that 25 and 22.2% of isolates were resistant to erythromycin and tetracycline, respectively. Gentamicin was the only antibiotic against which most of the isolates showed sensitivity. The antibiotic resistance rates to these three antibiotics are also greater in our study, which may be due to a higher antibiotic usage in our region.

We encountered one MRSA isolate that was resistant to vancomycin in our study. We have previously reported on additional vancomycin-resistant species [5, 14, 15]. In the current and all previous studies, vancomycin-resistant isolates were resistant to all tested antibiotics. The first reports on vancomycin resistance date back to 1996 in Japan [16, 17]. However, after that, vancomycin-resistant species began to emerge in the United States [18]. Since then, there has been a steady increase in the vancomycin resistance rate, which may be the reason for the ineffectiveness of vancomycin therapy worldwide [19-22]. This may also explain why vancomycin therapy is no longer reliable in severe cases [23].

CONCLUSION

We studied healthy school children for S. aureus and MRSA colonization rates and determined these to be 26% and 41%, respectively. These rates are much higher than those reported in previous studies on school children in other regions. Also, our MRSA species had high resistance rates to different antibiotics, further emphasizing that eradication of reservoirs is necessary.

REFERENCES


