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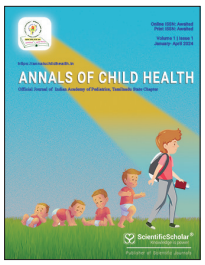

Original Article

Antimicrobial Susceptibility of Methicillin-resistant *Staphylococcus Aureus* and Methicillin-sensitive *Staphylococcus Aureus* in a Pediatric Tertiary Care Hospital in Southern India

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ABSTRACT

Objectives: To determine the current antimicrobial sensitivity profile of MRSA and compare it with the antimicrobial sensitivity of MSSA (Methicillin Sensitive Staphylococcus aureus)

Material and Methods: Antimicrobial resistance in *Staphylococcus aureus* is a global public health concern. Methicillin-resistant *Staphylococcus aureus* (MRSA) is often resistant to the many classes of antibiotics compared to the methicillin-sensitive *Staphylococcus aureus* (MSSA). Five hundred and fifty *S. aureus* isolates obtained from clinical samples of pediatric patients were studied to determine the difference in the antimicrobial susceptibility between MRSA and MSSA.

Results: Out of 550 *S. aureus* isolates, 59.3% were MSSA, and 40.7% were MRSA. The antimicrobial sensitivity to ciprofloxacin, gentamicin, clindamycin, erythomycin, tetracycline of MSSA was 26.4% , 93.6%, 81.5%, 61.2%, 95.4% respectively, and that of MRSA was 4.9%, 56.2%, 58%, 31%, 89.8% respectively.

Conclusion: Antimicrobial sensitivity to ciprofloxacin, gentamicin, clindamycin, erythromycin, and tetracycline were significantly higher in MSSA than in MRSA.

Keywords: *Staphylococcus aureus*, Antimicrobial sensitivity, Methicillin-resistant *Staphylococcus aureus*, Methicillin-sensitive *Staphylococcus aureus*, Pediatric

INTRODUCTION

Antimicrobial resistance (AMR) is one of the major threats in the field of public health.[1] *Staphylococcus aureus* is one such bacterial pathogen, where drug resistance is a global concern.[2] The drug-resistant *S. aureus* and methicillin-resistant *Staphylococcus aureus* (MRSA) cause various infections of the body, from simple skin infections to life-threatening pneumonia or sepsis. MRSA infections can cause poor clinical outcomes,[3] as it is often resistant to the many classes of antibiotics and also due to delay in initiation of effective appropriate antimicrobial therapy. Knowledge of the current antimicrobial sensitivity pattern of the MRSA shall facilitate the initiation of appropriate therapy which can significantly improve their clinical outcomes. Geographic variation is observed in the antimicrobial sensitivity pattern of *S. aureus*.[4,5] Therefore, a retrospective observational study was done on the *S. aureus* isolated from our hospital patients with *S. aureus* infection during the past 4 years (2018–2021) to determine the current antimicrobial sensitivity profile of MRSA and

compare it with the antimicrobial sensitivity of methicillin-sensitive *Staphylococcus aureus* (MSSA).

MATERIAL AND METHODS

A retrospective observational study was performed on all the *S. aureus* isolates obtained from pediatric patient sample cultures at the microbiology laboratory of Kanchi Kamakoti CHILDS Trust Hospital from 2018 to 2021. Ethics approval from our institution's IRB was obtained.

Cefoxitin was tested as a surrogate for oxacillin and was used to differentiate the *S. aureus* into MRSA or MSSA. Cefoxitin testing was done by disc diffusion method using Bio-Rad cefoxitin (30 μg) antibiotic disc (Cat no: 66228) and interpreted based on CLSI M100 standard (those that showed an inhibition zone size ≥22 mm were reported as sensitive, while those that had a zone of inhibition ≤21 mm were reported as resistant). *S. aureus* isolates that tested resistant to cefoxitin were reported as MRSA, and those that tested sensitive were reported as MSSA.

Antimicrobial susceptibility of *S. aureus* for penicillin, gentamicin, ciprofloxacin, erythromycin, clindamycin, linezolid, teicoplanin, vancomycin, tetracycline, and co-trimoxazole was determined by automated antimicrobial susceptibility testing system (VITEK 2 Compact) using AST P628 kit (Cat no: 414534). Antimicrobial susceptibility to chloramphenicol was determined by the Kirby–Bauer disc diffusion method using Bio-Rad chloramphenicol (30 μg) antibiotic disc (Cat no: 66278). Inducible clindamycin resistance (ICR) was also determined by the VITEK 2 compact system based on broth microdilution. Antimicrobial susceptibility to antibiotics was interpreted in accordance with the CLSI M100 standard. For quality control, *S. aureus* ATCC 25923, ATCC 29213 (MSSA), and ATCC 43300 (MRSA) were used.

The statistical analysis of the results was carried out by Pearson's Chi-square test using Microsoft Office Excel. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 550 *S. aureus* strains were isolated from various clinical samples from pediatric patients at the microbiology laboratory of Kanchi Kamakoti CHILDS Trust Hospital during the 4 years (January 2018–December 2021). Out of these 550 *S. aureus* isolates, 326 (59.3%) were MSSA, and 224 (40.7%) were MRSA. Table 1 shows the antimicrobial sensitivity percentage of all the *S. aureus* to the tested antibiotics.

Among the erythromycin-resistant *S. aureus*, inducible clindamycin resistance was observed in 50.3% of the isolates, while it was 46.5% among MSSA and 53.4% among MRSA. The results discussed here are mentioned in Table 2.

DISCUSSION

Among the *S. aureus* isolated during 4 years (2018–2021) from pediatric patient sample cultures at Kanchi Kamakoti CHILDS Trust Hospital, 40.7% were MRSA. A recent study on the clinical insights for the treatment of MRSA infections in India, states that MRSA prevalence may range between 32% and 80% among the *S. aureus* pool.[6] In our study, the antimicrobial sensitivity of ciprofloxacin, gentamicin, clindamycin, erythromycin, and tetracycline was significantly higher in MSSA compared to MRSA [Table 1], while no significant difference in sensitivity was seen for chloramphenicol, cotrimoxazole, vancomycin, teicoplanin, and linezolid.

In our study, the antimicrobial sensitivity to ciprofloxacin was significantly higher in MSSA (26.4%) compared to MRSA (4.9%). In two studies in India on the antibiotic resistance profile of *S. aureus*, Preeja *et al.*[7,8] reported a higher ciprofloxacin sensitivity of 35.4% in MSSA compared to 15.9% in MRSA.

In our study, the gentamicin sensitivity was 93.6% in MSSA and 56.2% in MRSA, which were similar to Preeja *et al.*,[7,8] which reported a sensitivity of 92.8% in MSSA and 59.8% in MRSA.

Our study showed an erythromycin sensitivity of 61.2% in MSSA and 31% in MRSA. Erythromycin sensitivity in Jayachandiran *et al.*[9] was 80.8% in MSSA and 31.3% in MRSA, while Preeja *et al.*[7,8] reported 56.1% in MSSA and 28% in MRSA.

Clindamycin susceptibility in our study was 81.5% in MSSA and 58% in MRSA. Clindamycin susceptibility in Jayachandiran *et al.*[9] was 84.6% in MSSA and 33.3% in MRSA, while Preeja *et al.*[7,8] reported 79.3% in MSSA and 56.8% in MRSA.

ICR percentage was not significantly different ($P = 0.36$) between MRSA (53.4%) and MSSA (46.5%), while Modukuru *et al.*[10] and Panwala *et al.*,[11] reported a higher ICR among MRSA compared to MSSA.

Tetracycline susceptibility was higher in MSSA (95.4%) than MRSA (89.8%) in our study, and it was comparable with the Indian study by Preeja *et al.*,[7,8] which reported a tetracycline sensitivity of 97.4% in MSSA and 84.8% in MRSA. Tetracycline sensitivity was different when compared to a study conducted in Thailand,[12] which reported a lower tetracycline sensitivity rate and no significant difference in the rate between MSSA (69%) and MRSA (65%).

Our study showed no significant difference in cotrimoxazole susceptibility rate between MSSA (61.2%) and MRSA (59.5%), while Preeja *et al.*[7,8] reported a higher cotrimoxazole susceptibility rate in MSSA (84.6%) than MRSA (67.4%). A study in Nepal by Raut *et al.*[13] reported a significant

Table 1: Antimicrobial sensitivity of all the *S. aureus*, MSSA, and MRSA.

Antibiotic name	Number of isolates tested	% Sensitivity			*P*-value
		All *S. aureus*	MSSA	MRSA	
Penicillin	550	7.3	12.1	0	-
Cefoxitin	550	59.3	100	0	-
Gentamicin	547	78.4	93.6	56.2	<0.00001
Ciprofloxacin	542	17.3	26.4	4.9	<0.00001
Cotrimoxazole	550	60.4	61.2	59.5	0.68
Clindamycin	545	71.7	81.5	58	<0.00001
Erythromycin	545	48.8	61.2	31	<0.00001
Linezolid	541	100	100	100	1
Vancomycin	479	100	100	100	1
Teicoplanin	457	100	100	100	1
Chloramphenicol	534	97.8	97.5	97.7	0.84
Tetracycline	544	93.4	95.4	89.8	0.01

S. aureus: Staphylococcus aureus, MSSA: Methicillin-sensitive *Staphylococcus aureus*, MRSA: Methicillin-resistant *Staphylococcus aureus*

Table 2: ICR among the erythromycin-resistant *S. aureus*.

	All *S. aureus*	MSSA	MRSA	*P*-value
ICR positive	50.3%	46.5%	53.4%	0.36

ICR: Inducible clindamycin resistance, *S. aureus: Staphylococcus aureus,* MRSA: Methicillin resistant *Staphylococcus aureus,* MSSA: Methicillin sensitive *Staphylococcus aureus*

difference in cotrimoxazole susceptibility between MSSA (69.2%) and MRSA (30.8%).

Antibiotic sensitivity for chloramphenicol among *S. aureus* was high in our study and was similar between MSSA (97.5%) and MRSA (97.7%), which was comparable to Preeja *et al.*[7,8] (99% in MSSA and 95.4% in MRSA) and Khan *et al.*[14] (97.6% in MRSA).

CONCLUSION

Almost half of the *S. aureus* isolates from pediatric sample cultures were MRSA. The antimicrobial susceptibility toward ciprofloxacin, gentamicin, clindamycin, erythromycin, and tetracycline was significantly higher in MSSA compared to MRSA; however, no significant difference was observed in susceptibility for chloramphenicol, cotrimoxazole, vancomycin, teicoplanin, and linezolid. Early determination of methicillin resistance among *S. aureus* can facilitate the physician in choosing appropriate empirical antibiotics as there is a significant difference in antimicrobial susceptibility profile between MSSA and MRSA for certain antimicrobials.

Acknowledgment

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Ethical approval

The research/study approved by the Institutional Review Board at Kanchi Kamakoti CHILDS Trust Hospital and the CHILDS Trust Medical Research Foundation, number IEC-91/November 2022, dated November 21, 2022.

Declaration of patient consent

Patient's consent is not required as the patient's identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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