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ANTIMICROBIAL SUSCEPTIBILITY PATTERN OF STAPHYLOCOCCUS AUREUS OVER 5 YEARS: A RETROSPECTIVE STUDY FROM A SOUTH INDIAN TERTIARY REFERRAL CENTRE

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ABSTRACT

Staphylococcus aureus is a part of the commensal nasal flora in about 30% of individuals. However, it has the potential to cause serious community and healthcare-associated infections. This retrospective study was conducted to analyse the changing antimicrobial susceptibility pattern of *Staphylococcus aureus* over 5 years from 2019 to 2023. 3210 isolates from different clinical samples were analysed. Susceptibility testing was performed by Kirby-Bauer and automated (Vitek-2) methods. Our study revealed that penicillin resistance continued to increase while azithromycin sensitivity did not change significantly over this period. Cotrimoxazole and Clindamycin resistance showed a declining trend. Tetracycline has retained good susceptibility profiles over time. No resistance to Linezolid was noted.

KEYWORDS: *Staphylococcus aureus*, Penicillin, Clindamycin, Azithromycin, Linezolid.

INTRODUCTION

Staphylococcus aureus (S. aureus), a common nasal commensal in 30% individuals, is a Gram-positive bacterium known to cause a wide variety of clinical diseases, including community-acquired as well as hospital-acquired infections.[1] With the increased incidence of MRSA (*Methicillin-Resistant Staphylococcus aureus*), treatment and clinical cure remain a huge challenge.[1] Though *S. aureus* does not normally cause infection on healthy skin, nasal colonisation has been a cause of worry, as it often serves as a continuous focus and a potential source of infection.[1] Bloodstream infections caused by *S. aureus* carry a high mortality, ranging between 15 and 40%.[2]

MATERIALS AND METHODS

Staphylococcus aureus isolates obtained from different clinical samples during 5 years (2019- 2023) were included in the study. Sensitivity testing was performed by the Kirby-Bauer (manual) and Vitek-2 (automated) methods. The data was retrieved from the Laboratory Information System of the hospital retrospectively and subsequently analysed. To avoid duplication, whenever multiple samples from the same patient yielded growth, only one sample per patient was considered for statistical analysis.

RESULTS

3210 *Staphylococcus aureus* isolates were reported during the study period. The samples were predominantly from the ear, nose & throat, followed by pus. Of the isolates, 2312 (72%) were MSSA (*Methicillin-Sensitive Staphylococcus aureus*) and the remaining 898 (28%) were MRSA (Table. 1). Among the *Staphylococcus aureus* isolates obtained from a total of 249 blood cultures, 152 (61%) did not have any obvious source, whereas 97 (39%) cases were secondary to other sources of infection, such as Skin and Soft Tissue Infections (SSTI), pyelonephritis, sinusitis, and pneumonia. Of the blood culture isolates, 188 (75.5%) were MSSA and the remaining 61 (24.5%) were MRSA.

Table 1: Distribution of MSSA and MRSA isolated from various clinical samples, 2019-2023.

	MSSA	MRSA
2019	405/558 (72.6%)	153/558 (27.4%)
2020	441/622 (71%)	171/622 (29%)
2021	413/579 (71.3%)	166/579 (28.7%)
2022	488/672 (72.7%)	184/672 (27.3%)
2023	565/779 (72.5%)	214/779 (27.5%)

Of the 97 Central Line Associated Blood Stream Infections (CLABSI) that occurred during the study period, only 5 (5.15%) were caused by *S. aureus*. The major contributors to CLABSI were non-fermenters and Enterobacterales.

Penicillin resistance increased by almost 10% from 74.6% (416/558) to 84% (654/779) in the period between 2019 and 2023 (Fig.1). The susceptibility to penicillin which was a dismal 25.4% (142/558) in 2019, further fell to 16% (125/779) in 2023.

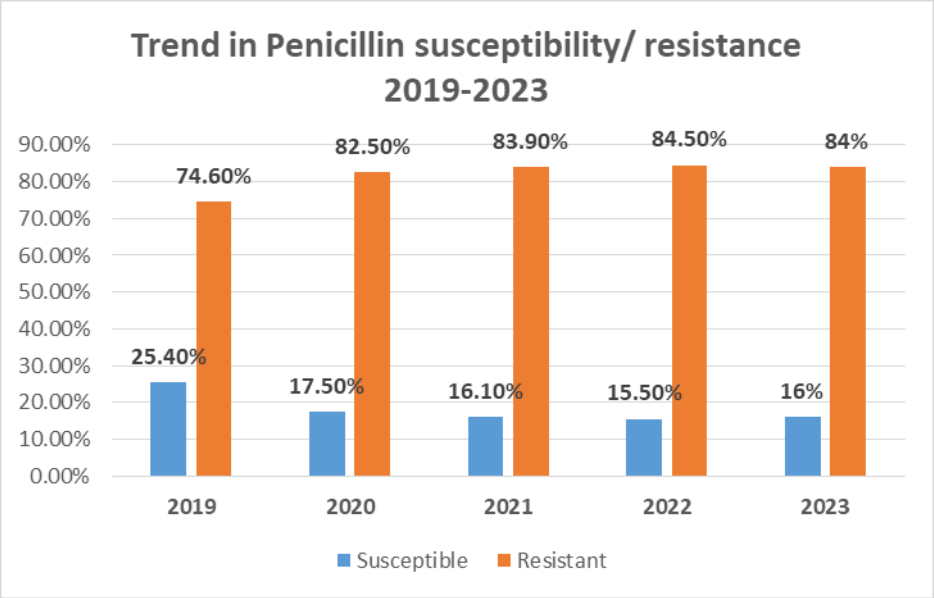

Fig. 1: Changing pattern of Penicillin susceptibility and resistance from 2019 to 2023.

No significant increase in the resistance to azithromycin was noted, which ranged from 63.6% (355/558) in 2019 to 65.46% (510/779) in 2023 (Table 2). For *S. aureus* isolates, clindamycin resistance was seen to be 36.2% (202/558) in 2019 which later dropped to 29.1% (227/779) in 2023. The resistance pattern showed a falling trend in 2020 and 2021, reaching 19.9% in 2021 before rising again to 25.6% in 2022 and 29.1% in 2023(see Table 2).

Table 2: Susceptibility and resistance patterns of azithromycin and clindamycin, 2019-2023.

	AZITHROMYCIN		CLINDAMYCIN	
	Susceptible	**Resistant**	**Susceptible**	**Resistant**
2019	203/558 (36.4%)	355/558 (63.6%)	356/558 (63.8%)	202/558 (36.2%)
2020	266/622 (42.77%)	356/622 (57.23%)	486/622 (78.14%)	136/622 (21.86%)
2021	234/579 (40.41%)	345/579 (59.59%)	464/579 (80.1%)	115/579 (19.9%)
2022	265/672 (39.5%)	407/672 (60.5%)	499/672 (74.4%)	173/672 (25.6%)
2023	269/779 (34.54%)	510/779 (65.46%)	552/779 (70.9%)	227/779 (29.1%)

The average susceptibility to cotrimoxazole and tetracycline were 83.83% and 94.73% (2691 and 3041 out of 3210 respectively) (Fig. 2). While the resistance to cotrimoxazole was 28% (156/558) in 2019, this gradually declined to 8.9% (69/779) in 2023. On the other hand, there was not much difference in the resistance to tetracycline which was 2.3% (11/558) in 2019 and 2% (17/779) in 2023. 100% of the isolates were susceptible to Linezolid during the study period.

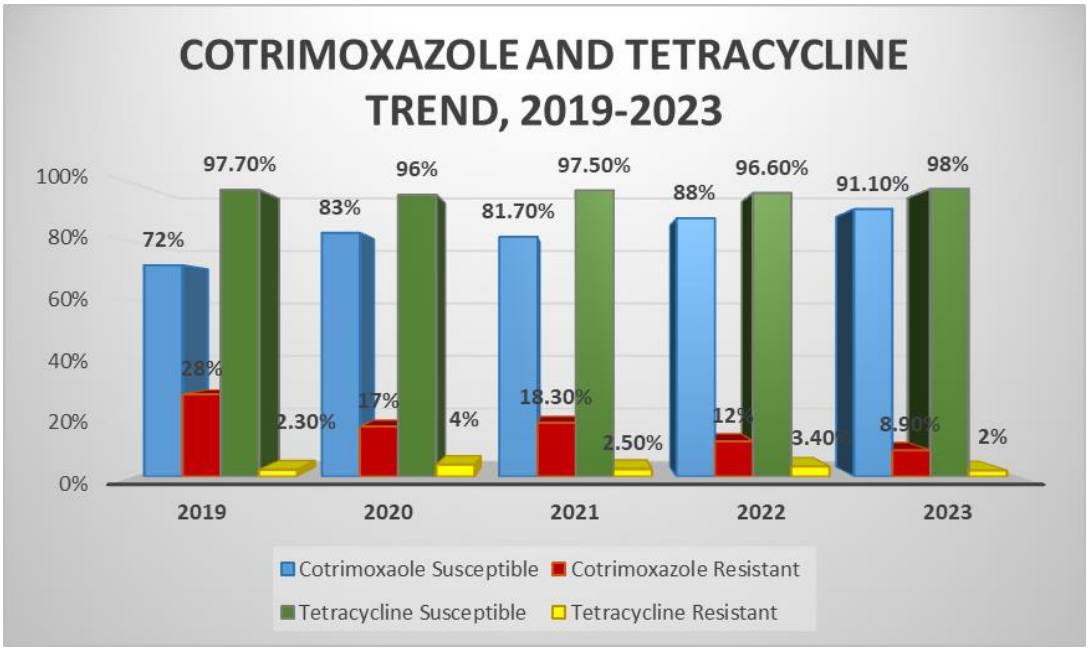

Fig. 2: Susceptibility and Resistance trends of Cotrimoxazole and Tetracycline from 2019 to 2023.

DISCUSSION

Out of the 3210 S. aureus isolates that were included in our study, 72% (2312) were MSSA and 28% (898) were MRSA. This is very similar to the findings of a single centre study from northern India by Kumar et al, which showed 29.4% of all *Staphylococcus aureus* isolates were MRSA.[3] Among the cases of CLABSI, only 5 out of 97 (5.15%)

cases over the 5 years were caused by *Staphylococcus aureus*. The incidence is lower than the findings of a study published from Jammu & Kashmir in 2024, where 6 out of 27 CLABSIs (22%) were caused by *Staphylococcus aureus.*[4]

Our study showed an increase in penicillin resistance from 74.6% to 84% from 2019 to 2023. Another Indian study published in 2016 from a tertiary care hospital reported penicillin resistance to be around 80% among 371 *S. aureus* isolates.[5] A study published from Nigeria in 2011 revealed penicillin resistance among 92.9% of *S. aureus* isolates when 150 samples were analysed.[6] The *S. aureus* isolates from a centre in Canada were found to show increased penicillin susceptibility and this was mentioned in a letter published in 2018 by Laporte et al.[7]

The COVID 19 pandemic saw unprecedented increase in the consumption of azithromycin, almost thrice that of pre COVID period.[8] This created an assumption that resistance to azithromycin among *S. aureus* isolates would increase. However, our study did not show a significant increase in the resistance. It was 63.6% in 2019, fell to 57.23% in 2020 and then slowly rose to 65.46% in 2023. A sub-study of a trial published in 2021 that investigated the impact of adding azithromycin to the antimalarial drugs used for seasonal Malaria chemoprevention in children in Burkina Faso and Mali found the *S. aureus* isolated from nasal swabs before and after administration of azithromycin to not be significantly different from each other.[9]

Clindamycin holds promise in the treatment of severe, toxin-mediated *S. aureus* infections.[10] In our study, clindamycin resistance rates varied from 20% to 36.2%. The overall sensitivity pattern of our isolates matched that from the ICMR Antimicrobial Resistance Research and Surveillance Network (AMRSN) Annual report. Clindamycin susceptibility was noted among 74.4% of our isolates in 2022, whereas it was 73.9% according to the data published by ICMR in the same year.[11] (Fig. 3).

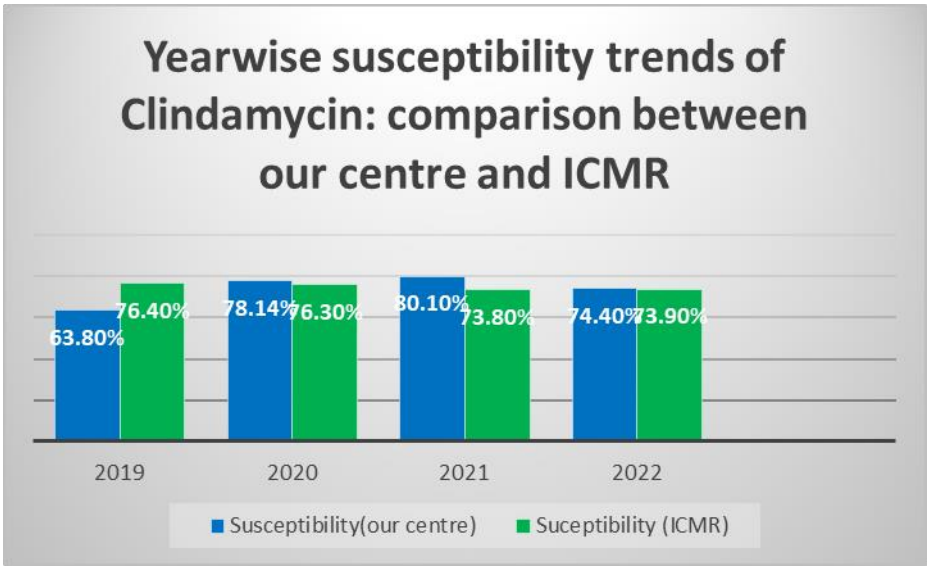

Fig. 3: Comparison of Clindamycin susceptibility data from our centre and ICMR, 2019-2022.

Cotrimoxazole and tetracycline are excellent treatment options for skin and soft tissue infections caused by *S. aureus*.[12,13] The average susceptibility to these drugs was 83.83% and 94.73% respectively, as per our study. This is slightly higher than the ICMR 2022 data, where the susceptibility to cotrimoxazole and tetracycline was 73.9% and

85.5% respectively.[11] Geographical variations in sensitivity were also reported. According to a study published from Nigeria in 2011, the susceptibility to these drugs were only 15.5% and 31.2% respectively.[6]

Linezolid resistance was not reported in any of the isolates in our study. However, the ICMR 2022 report stated linezolid resistance among 2.1% of the isolates. [11] Linezolid resistance was reported in both MSSA and MRSA as per the ICMR study.[11]

CONCLUSION

S. aureus is a highly virulent organism known to cause many community-acquired as well as health care-associated infections, which significantly contribute to morbidity and mortality. Treatment options depend on the site of infection, presence or absence of drug-resistant strains, and adequate source control. In our study of 3210 isolates, penicillin susceptibility showed a falling trend while azithromycin susceptibility did not show any significant change over 5 years. Clindamycin and cotrimoxazole resistance have reduced during the study period. Tetracycline also remains a very good option for treatment, as resistance rates were low compared to other drugs for *S aureus*. No resistance to linezolid was detected in the studied isolates. The MRSA prevalence remained around 28% during the period from 2019 to 2023 and no increase in the incidence of MRSA was noted during this period. MRSA prevalence reported in our study was below the national average of 44.5% reported by ICMR in 2022. The COVID-19 pandemic did not seem to have influenced the drug susceptibility pattern of a predominant pathogen like *S. aureus* despite the excessive use of antibiotics like azithromycin.

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