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Prevalence and Antimicrobial Resistance Pattern of Methicillin-Resistant Staphylococcus aureus in a Tertiary Care Hospital in South India: A Four-Year Retrospective Study

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Abstract

Background: Methicillin-resistant Staphylococcus aureus (MRSA) is an important cause of healthcare-associated and community-associated infections and is frequently associated with resistance to multiple antimicrobial agents. The increasing prevalence of multidrug-resistant MRSA limits therapeutic options and highlights the importance of continuous local antimicrobial surveillance. Aim: To determine the prevalence, demographic and specimen-wise distribution, hospital distribution and antimicrobial susceptibility pattern of MRSA isolates recovered from clinical specimens in Velammal Medical College Hospital in South India over four years. ***Materials and Methods***: A hospital-based retrospective study was conducted in the Department of Microbiology from January 2022 to December 2025. Data pertaining to clinical specimens yielding S. aureus, along with available demographic details, were analysed. Specimens included blood, sterile body fluids, pus, wound swabs, urine, tissue and respiratory samples obtained from outpatient and inpatient departments. S. aureus was identified using colony morphology, Gram staining, catalase and coagulase tests and VITEK 2 Compact. Antimicrobial susceptibility testing was performed using Kirby-Bauer disk diffusion and VITEK 2 Compact according to Clinical and Laboratory Standards Institute guidelines. Standard quality-control strains were used. Statistical analysis was performed using SPSS version 25. ***Results***: Of 60,324 clinical specimens processed, 6,501 were culture positive and 815 (12.54%) yielded S. aureus. Among these, 349 (42.8%) were MRSA and 466 (57.2%) were methicillin-sensitive S. aureus. Male patients accounted for 63.3% of MRSA isolates, with a male-to-female ratio of 1.72:1. The 41–60-year age group contributed the highest proportion of isolates (42.4%), followed by 19–40 years (24.9%). Pus and tissue-related specimens accounted for 77.2% of MRSA isolates. Inpatient wards contributed 56.3%, followed by intensive care units (13.4%), outpatient departments (18.3%) and emergency departments (12.0%). Resistance was highest to β-lactam agents (100%) and fluoroquinolones (83.4%). High susceptibility was observed to vancomycin (97.3%), tigecycline (93.6%), teicoplanin (92.7%) and linezolid (89.1%). ***Conclusion***: MRSA represented a substantial proportion of S. aureus isolates in this tertiary care hospital and demonstrated extensive resistance to several commonly used antimicrobial agents. Continuous surveillance, culture-directed therapy, antimicrobial stewardship and effective infection-prevention measures are essential for limiting the burden and transmission of MRSA.

Keywords: Methicillin-resistant Staphylococcus aureus; MRSA; antimicrobial resistance; antimicrobial susceptibility; tertiary care hospital; multidrug resistance.

INTRODUCTION

Staphylococcus aureus is an important human pathogen capable of causing a broad spectrum of infections, ranging from skin and soft-tissue infections to severe invasive diseases such as bacteraemia, pneumonia, osteomyelitis, endocarditis and postoperative infections. Its ability to colonise humans, survive in healthcare environments and acquire resistance to multiple antimicrobial agents has made it an important pathogen in both hospital and community settings. Methicillin-

resistant S. aureus (MRSA) remains particularly important because resistance to methicillin is generally associated with resistance to most β-lactam antimicrobial agents, thereby restricting therapeutic choices.

MRSA emerged as a major healthcare-associated pathogen following the introduction of methicillin and subsequently became established in hospitals worldwide. Over time, MRSA epidemiology has become increasingly complex, with healthcare-associated and community-associated strains circulating in overlapping populations. Community-associated MRSA has emerged as an important cause of skin and soft-tissue infections and can also contribute to healthcare-associated infections, making the traditional distinction between community and hospital strains increasingly difficult on clinical grounds alone.

The burden of MRSA varies considerably between geographical regions and healthcare institutions. A systematic review and meta-analysis of Indian studies reported a pooled MRSA prevalence of approximately 26.8%, with substantial heterogeneity between studies. A multicentre Indian study involving 15 tertiary care centres reported an overall methicillin resistance rate of approximately 41% among S. aureus isolates. These findings demonstrate that MRSA remains a significant problem in India, although prevalence varies according to location, patient population, specimen type and hospital characteristics.

South Indian hospitals have also reported considerable MRSA burdens. A study from Mangalore reported MRSA in 29.1% of S. aureus isolates, with greater multidrug resistance among MRSA compared with MSSA. Pus and wound specimens were the predominant sources of isolates, and vancomycin retained excellent activity in that study. Such findings emphasise the importance of institution-specific surveillance because antimicrobial susceptibility patterns can differ substantially even between hospitals within the same geographical region.

Antimicrobial resistance among MRSA is particularly concerning because resistance may extend beyond β-lactams to fluoroquinolones, macrolides, tetracyclines, aminoglycosides and other antimicrobial classes. Consequently, treatment based solely on empirical assumptions may result in inadequate therapy. Local antibiograms and periodic surveillance are therefore important for guiding empirical treatment and supporting antimicrobial stewardship.

The World Health Organization's 2024 Bacterial Priority Pathogens List identifies methicillin-resistant S. aureus as a high-priority antimicrobial-resistant pathogen, reflecting its clinical burden, transmissibility, treatment challenges and public-health importance.

In India, surveillance of MRSA is especially important because considerable variation has been reported in prevalence and susceptibility patterns. Furthermore, high antimicrobial consumption and inappropriate or unnecessary antimicrobial exposure can promote selection of resistant organisms. Effective infection prevention, rational antimicrobial prescribing, microbiological diagnosis and regular monitoring of resistance trends are therefore essential components of MRSA control. The present study was undertaken to determine the prevalence and antimicrobial susceptibility pattern of MRSA among clinical S. aureus isolates obtained over a four-year period in a tertiary care hospital in South India. The study also assessed the demographic distribution, specimen-wise distribution and hospital-area distribution of MRSA isolates, thereby providing institution-specific data that may assist in antimicrobial policy and infection-control planning..

MATERIALS AND METHODS

Study Design and Setting

A hospital-based retrospective observational study was conducted in the Department of Microbiology of a tertiary care hospital in South India.

Study Period

The study included clinical microbiology data generated over four years, from January 2022 to December 2025.

Study Population and Clinical Specimens

All clinical specimens received in the microbiology laboratory during the study period that yielded S. aureus were considered for analysis. Specimens were obtained from both outpatient and inpatient departments.
The clinical specimens included:

- Blood
- Sterile body fluids
- Pus and wound specimens
- Tissue
- Urine

- Respiratory specimens

Each isolate was considered to have originated from a unique patient, and duplicate isolates were not counted separately according to the study methodology.

Isolation and Identification of Staphylococcus aureus

Clinical specimens were processed using standard microbiological procedures. S. aureus was identified based on colony morphology, Gram staining, catalase testing and coagulase testing. Identification was additionally performed using the VITEK 2 Compact automated identification system (bioMérieux, Marcy-l'Étoile, France).

Detection of Methicillin Resistance

Methicillin resistance was assessed as part of routine antimicrobial susceptibility testing. Oxacillin and cefoxitin were included among the tested antimicrobial agents. Automated susceptibility testing was performed using VITEK 2 Compact.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method and VITEK 2 Compact according to Clinical and Laboratory Standards Institute (CLSI) recommendations. CLSI M100 provides standardised antimicrobial susceptibility-testing methods, breakpoints and quality-control parameters for clinical laboratories.

The antimicrobial agents tested included penicillin, oxacillin, erythromycin, ciprofloxacin/levofloxacin, cotrimoxazole, tetracycline, linezolid, vancomycin, teicoplanin, azithromycin, piperacillin-tazobactam, tigecycline and daptomycin.

Quality Control

Quality control was performed using standard reference strains including S. aureus ATCC 25923 for disk-diffusion testing and S. aureus ATCC 43300 as an MRSA control.

Data Collection

Laboratory records were reviewed for the total number of specimens processed, culture-positive specimens, S. aureus isolates and MRSA isolates. Available demographic information, specimen type and hospital location were recorded.

Statistical Analysis

Data were analysed using SPSS version 25. Categorical variables were analysed using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

During the four-year study period, 60,324 clinical specimens were processed. Of these, 6,501 (10.8%) were culture positive. S. aureus was isolated from 815 specimens, representing 12.54% of culture-positive specimens. Among the S. aureus isolates, 349 (42.8%) were MRSA and 466 (57.2%) were MSSA.

Table 1. Overall distribution of clinical specimens and S. aureus isolates

Parameter	Number	Percentage
Total clinical specimens processed	60,324	100
Culture-positive specimens	6,501	10.8
S. aureus isolates	815	12.54% of culture-positive specimens
MRSA isolates	349	42.8% of S. aureus
MSSA isolates	466	57.2% of S. aureus

Demographic Distribution

MRSA isolates were more frequently recovered from male patients, who accounted for 63.3% of isolates. The male-to-female ratio was 1.72:1. The highest proportion of isolates was observed among patients aged 41–60 years (42.4%), followed by 19–40 years (24.9%). Patients aged >60 years contributed 20.1%, while paediatric patients aged 0–18 years contributed 5.4%. Age was unknown in 7.2% of cases.

Table 2. Age-wise distribution of MRSA isolates

Age group	Percentage
0–18 years	5.4
19–40 years	24.9
41–60 years	42.4
>60 years	20.1
Unknown	7.2

Specimen-wise Distribution

Pus and tissue-related specimens were the predominant sources of MRSA, accounting for 77.2% of isolates. Blood accounted for 13.2%, respiratory specimens for 6.3%, sterile body fluids for 1.8% and urine for 1.5%.

Table 3. Specimen-wise distribution of MRSA isolates

Specimen type	Percentage
Pus/exudate and tissue	77.2
Blood	13.2
Respiratory samples	6.3
Sterile body fluids	1.8
Urine	1.5

Hospital Distribution

The largest proportion of MRSA isolates was obtained from inpatient wards (56.3%), followed by ICU (13.4%), emergency department (12.0%) and outpatient departments (18.3%).

Table 4. Distribution of MRSA isolates according to hospital area

Hospital area	Percentage
Inpatient wards	56.3
Outpatient department	18.3
Intensive care unit	13.4
Emergency department	12.0

Antimicrobial Susceptibility Pattern

All MRSA isolates demonstrated resistance to penicillins, oxacillin and β-lactam/β-lactamase inhibitor combinations. Resistance to fluoroquinolones was 83.4%, followed by sulphonamides (61.8%), macrolides (59.0%), tetracyclines (48.2%) and daptomycin (19.0%). Susceptibility was high to vancomycin (97.3%), tigecycline (93.6%), teicoplanin (92.7%) and linezolid (89.1%). Daptomycin susceptibility was 81%.

Table 5. Selected antimicrobial susceptibility pattern of MRSA isolates

Antimicrobial class/agent	Resistance (%)	Susceptibility (%)
Penicillins	100.0	0
Oxacillin	100.0	0
β-lactam/β-lactamase inhibitor combinations	100.0	0
Fluoroquinolones	83.4	11.9
Sulphonamides	61.8	32.9
Macrolides	59.0	38.8
Tetracyclines	48.2	51.8
Daptomycin	19.0	81.0
Vancomycin	2.7	97.3
Teicoplanin	7.3	92.7
Linezolid	10.9	89.1
Tigecycline	6.4	93.6

DISCUSSION

The present four-year retrospective study demonstrates a substantial burden of MRSA among clinical S. aureus isolates in a tertiary care hospital in South India. Among 815 S. aureus isolates, 349 (42.8%) were MRSA. This proportion is higher than the pooled prevalence of approximately 26.8% reported in an Indian systematic review and meta-analysis, but is close to the approximately 41% prevalence reported in a multicentre Indian study involving 15 tertiary care hospitals. Differences between studies may reflect geographical variation, patient characteristics, hospital type, infection-control practices, specimen composition and laboratory methodology.

The prevalence observed in the present study is also higher than that reported in an earlier study from Mangalore, South India, where 29.1% of S. aureus isolates were MRSA. Such differences reinforce the importance of hospital-specific

surveillance rather than relying solely on national or regional estimates. MRSA epidemiology is dynamic, and changes in antimicrobial prescribing and infection-control practices may alter the local prevalence over time.

A male predominance was observed in the present study, with males accounting for 63.3% of MRSA isolates. The male-to-female ratio was 1.72:1. This observation is broadly consistent with the Indian systematic review, which also reported a higher proportion of MRSA among males. However, the present retrospective dataset does not provide sufficient information to establish sex as an independent risk factor. Differences in healthcare utilisation, underlying disease, exposure patterns and specimen distribution may contribute to the observed sex difference.

The 41–60-year age group represented the largest proportion of MRSA isolates. The substantial contribution from older adults may reflect increased healthcare exposure, chronic illness, repeated antimicrobial exposure and invasive procedures, although these potential risk factors were not specifically evaluated in the current study. Previous Indian studies have similarly reported substantial MRSA burden among adult patients.

Pus and tissue-related specimens accounted for 77.2% of MRSA isolates. This predominance is clinically relevant because S. aureus is an important cause of skin and soft-tissue infections. A previous South Indian study similarly found pus and wound specimens to be the major source of S. aureus isolates. The predominance of wound-related specimens in the present study may therefore represent the clinical spectrum of MRSA in the hospital, although it should not be interpreted as a prevalence of MRSA infection among all wound infections because the denominator for each specimen category was not available.

More than half of the isolates were obtained from inpatient wards, with additional isolates from the ICU and emergency department. This distribution suggests a substantial healthcare-associated component. However, it is important to distinguish hospital location from formal epidemiological classification. Because the available dataset did not include detailed information regarding previous hospitalisation, timing of specimen collection, prior antibiotic exposure or individual healthcare-associated risk factors, the present study cannot definitively classify all isolates as healthcare-associated or community-associated MRSA.

The antimicrobial susceptibility profile is an important finding. Complete resistance to penicillins and oxacillin was expected among MRSA isolates and confirms the phenotypic basis of methicillin resistance. High resistance to fluoroquinolones (83.4%), sulphonamides (61.8%), macrolides (59.0%) and tetracyclines (48.2%) indicates that resistance extended substantially beyond β-lactam agents. Similar multidrug resistance has been described among MRSA isolates from Indian hospitals. In the Mangalore study, MRSA isolates demonstrated greater multidrug resistance than MSSA isolates.

The high fluoroquinolone resistance observed in this study is particularly relevant because these agents have historically been used for a variety of bacterial infections. Extensive resistance reduces their value for empirical treatment of suspected MRSA infections and emphasises the importance of culture and susceptibility testing. Antimicrobial stewardship programmes are essential to minimise unnecessary antimicrobial exposure and preserve the effectiveness of remaining active agents.

Vancomycin showed 97.3% susceptibility in the present study, while teicoplanin, tigecycline and linezolid showed susceptibility rates of 92.7%, 93.6% and 89.1%, respectively. These agents therefore retained comparatively high activity against the tested isolates. However, the finding of 2.7% vancomycin resistance requires particular attention and should be verified by the appropriate reference methodology before clinical interpretation. South Indian studies have previously reported concerns regarding reduced vancomycin susceptibility among MRSA isolates, highlighting the importance of careful laboratory surveillance.

Daptomycin demonstrated 81% susceptibility and 19% resistance in the present dataset. This relatively high resistance is noteworthy because daptomycin is an important agent for selected serious Gram-positive infections. Any unexpected resistance to newer or reserve agents should prompt careful verification using appropriate susceptibility methods and should be interpreted in the clinical context.

The WHO currently classifies methicillin-resistant S. aureus as a high-priority antimicrobial-resistant pathogen. The classification reflects the continuing public-health importance of MRSA and the need for surveillance, prevention, diagnosis and appropriate treatment.

The present findings therefore have implications for both antimicrobial policy and infection prevention. A hospital-specific antibiogram should be periodically updated, and empirical therapy should be modified according to local susceptibility

patterns. Appropriate clinical sampling before antimicrobial administration, timely laboratory reporting, contact precautions when indicated, hand hygiene and environmental infection-control practices remain important components of MRSA control.

Overall, the study provides useful four-year institutional data demonstrating a considerable MRSA burden and extensive resistance to several commonly used antimicrobial classes. Nevertheless, prospective multicentre studies incorporating patient-level risk factors, clinical outcomes and molecular characterisation would provide a more comprehensive understanding of MRSA epidemiology in South India.

CONCLUSION

This four-year retrospective study demonstrated that MRSA constituted 42.8% of all S. aureus isolates recovered from clinical specimens in the studied tertiary care hospital. The findings indicate that MRSA represents a substantial component of the local S. aureus burden and warrants continued microbiological surveillance.

MRSA isolates were predominantly obtained from male patients, with the greatest proportion occurring in the 41–60-year age group. Pus and tissue-related specimens constituted the major source of isolates, indicating that skin, wound and soft-tissue infections accounted for a large proportion of the observed MRSA burden. Inpatient wards were the predominant hospital location, followed by the ICU, outpatient department and emergency department.

The antimicrobial susceptibility pattern demonstrated extensive resistance. Complete resistance to penicillins, oxacillin and β-lactam/β-lactamase inhibitor combinations was observed. High resistance was also demonstrated to fluoroquinolones, sulphonamides, macrolides and tetracyclines. These findings indicate that several commonly used antimicrobial agents may have limited utility for empirical treatment of suspected MRSA infections in this setting.

Comparatively high susceptibility was observed to vancomycin, teicoplanin, tigecycline and linezolid. However, the presence of reported resistance to some of these agents, particularly vancomycin and daptomycin, highlights the need for careful laboratory verification and continued surveillance.

The findings emphasise the importance of obtaining appropriate clinical specimens for microbiological examination and using culture and antimicrobial susceptibility results to guide definitive treatment. Regular institutional antibiograms can assist clinicians in selecting appropriate empirical therapy, while antimicrobial stewardship programmes can reduce unnecessary antimicrobial exposure and slow the development of further resistance.

Effective infection prevention and control is equally important. Hand hygiene, appropriate isolation or contact precautions where indicated, environmental cleaning, early identification of resistant organisms and adherence to institutional infection-control policies can help limit transmission within healthcare facilities.

Because MRSA is recognised by WHO as a high-priority antimicrobial-resistant pathogen, continued surveillance is necessary at both institutional and regional levels. The present study provides important local data for antimicrobial policy and infection-control planning. Future prospective multicentre studies should evaluate temporal trends, patient-specific risk factors, treatment outcomes and molecular characteristics of MRSA isolates to better define the epidemiology and transmission dynamics of MRSA in South India.

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