RESEARCH PAPER

# Comparative Antibiotic Resistance Patterns and Clinical Epidemiology of MRSA and MSSA Isolates in a Tertiary Care Hospital

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**Abstract**

**Background-** *Staphylococcus aureus* remains one of the most important causes of hospital-acquired and community-acquired infections worldwide. The emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) has created major therapeutic and infection-control challenges because of its multidrug-resistant nature. Continuous surveillance of antibiotic susceptibility patterns and epidemiological characteristics is essential for guiding empirical therapy and antimicrobial stewardship.

**Aim-** To compare the antibiotic resistance patterns and clinical epidemiology of methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-susceptible *Staphylococcus aureus* (MSSA) isolates obtained from various clinical samples in a tertiary care hospital.

**Materials and Methods-** A hospital-based cross-sectional study was conducted over 18 months in the Department of Microbiology of a tertiary care hospital. A total of 246 non-duplicate clinical isolates of *Staphylococcus aureus* obtained from various specimens were included. Identification was performed using standard microbiological methods. MRSA and MSSA were differentiated using cefoxitin disc diffusion according to CLSI guidelines. Antimicrobial susceptibility testing was carried out by Kirby–Bauer disc diffusion method. Demographic characteristics, ward distribution, clinical sample distribution, and associated comorbidities were analyzed.

**Results-** Out of 246 isolates, 95 (38.6%) were MRSA and 151 (61.4%) were MSSA. The majority of isolates were recovered from pus and wound swab samples. MRSA isolates demonstrated significantly higher resistance to erythromycin, clindamycin, ciprofloxacin, gentamicin, and cotrimoxazole compared to MSSA isolates. Resistance to penicillin was high in both groups. All isolates remained susceptible to linezolid and vancomycin. MRSA isolates were more commonly isolated from surgery wards and intensive care units. Diabetes mellitus, chronic kidney disease, and prolonged hospitalization were common associated risk factors.

**Conclusion-** A substantial burden of MRSA was observed in the tertiary care setting, with significantly higher multidrug resistance compared to MSSA isolates. Continuous surveillance, rational antibiotic use, and strict infection-control practices are necessary to prevent dissemination of resistant strains and preserve the efficacy of available antimicrobial agents.

**Keywords-** *Staphylococcus aureus*, MRSA, MSSA, antimicrobial resistance, epidemiology, hospital infection, multidrug resistance

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## Introduction

*Staphylococcus aureus* is a versatile human pathogen responsible for a wide range of infections varying from superficial skin and soft tissue infections to life-threatening invasive diseases such as septicemia, pneumonia, osteomyelitis, endocarditis, meningitis, and toxic shock syndrome [1,2]. The organism is capable of causing both community-acquired and hospital-acquired infections and remains a major cause of morbidity and mortality worldwide.

The clinical significance of *S. aureus* has increased substantially following the emergence of methicillin-resistant *Staphylococcus aureus* (MRSA), which has become one of the most important multidrug-resistant pathogens globally [3]. Methicillin resistance is primarily mediated by the mecA gene that encodes an altered penicillin-binding protein (PBP2a) with low affinity for β-lactam antibiotics [4]. As a result, MRSA strains are

resistant to nearly all β-lactam agents and frequently exhibit resistance to multiple non-β-lactam antibiotics as well [5].

The prevalence of MRSA varies considerably across geographical regions and healthcare settings. In India, MRSA prevalence ranges between 25% and 50% in tertiary care hospitals, reflecting the growing burden of antimicrobial resistance [6]. Risk factors associated with MRSA infection include prolonged hospitalization, prior antibiotic exposure, invasive procedures, indwelling medical devices, intensive care unit admission, diabetes mellitus, and chronic illnesses [7].

The increasing resistance among *S. aureus* isolates has made empirical treatment difficult and has emphasized the need for periodic surveillance of antimicrobial susceptibility patterns [8]. Monitoring local resistance trends is essential for guiding empirical antibiotic therapy, implementing antimicrobial stewardship programs, and reducing the spread of resistant strains within healthcare institutions.

Antibiotic susceptibility profiles of MRSA and MSSA differ considerably, with MRSA strains generally demonstrating higher resistance to macrolides, aminoglycosides, fluoroquinolones, and other commonly used antibiotics [9]. However, agents such as vancomycin and linezolid continue to remain effective against most resistant isolates [10].

In addition to antibiotic resistance, understanding the clinical epidemiology of MRSA and MSSA isolates with respect to demographic characteristics, ward distribution, specimen type, and associated comorbidities is important for infection-control planning and prevention strategies.

The present study was undertaken to compare the antibiotic resistance patterns and clinical epidemiology of MRSA and MSSA isolates obtained from various clinical samples in a tertiary care hospital.

## Materials and Methods Study

### Design and Setting

A hospital-based cross-sectional study was conducted in the Department of Microbiology of a tertiary care teaching hospital over a period of 18 months after obtaining institutional ethical clearance.

### Study Population

A total of 246 non-duplicate clinical isolates of *Staphylococcus aureus* recovered from various clinical samples including pus, wound swabs, blood, urine, respiratory samples, body fluids, and catheter tips were included in the study.

### Identification of Isolates

Identification of *Staphylococcus aureus* was carried out using standard microbiological methods including:

- Gram staining
- Catalase test
- Slide and tube coagulase tests
- DNase test

### Detection of MRSA

Methicillin resistance was detected using cefoxitin (30 µg) disc diffusion on Mueller–Hinton agar according to CLSI guidelines. Isolates showing zone diameter ≤21 mm were considered MRSA. **Antimicrobial Susceptibility Testing**

Antimicrobial susceptibility testing was performed by Kirby–Bauer disc diffusion method using the following antibiotics:

- Penicillin
- Erythromycin
- Clindamycin
- Ciprofloxacin
- Gentamicin
- Cotrimoxazole
- Linezolid
- Vancomycin

Interpretation of results was performed according to CLSI guidelines.

### Data Collection

Demographic characteristics including age, gender, ward distribution, type of clinical specimen, and associated comorbidities were recorded and analyzed.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical methods. Categorical variables were expressed as frequencies and percentages. A p-value <0.05 was considered statistically significant.

## Results

A total of 246 non-duplicate clinical isolates of *Staphylococcus aureus* were included in the study. The isolates were analyzed for demographic distribution, methicillin resistance, clinical epidemiology, and antimicrobial susceptibility patterns.

### Age-wise Distribution of Study Population

The highest number of *S. aureus* isolates was observed in patients belonging to the 41–60 years age group followed by the 21–40 years age group. Elderly patients showed relatively higher MRSA prevalence compared to younger individuals.

**Table 1: Distribution of Study Population According to Age Group**

| Age Group (Years) | Number of Isolates | Percentage (%) |
|---|---|---|

| | | |
|---|---|---|
| **0–20** | 38 | 15.4 |
| **21–40** | 76 | 30.9 |
| **41–60** | 92 | 37.4 |
| **>60** | 40 | 16.3 |
| **Total** | 246 | 100 |

The increased isolation rate among middle-aged and elderly individuals may be related to higher rates of hospitalization, comorbidities, and invasive procedures.

**Gender-wise Distribution**

Among the study population, male patients constituted the majority of cases.

**Table 2: Gender-wise Distribution of Study Population**

| Gender | Number of Isolates | Percentage (%) |
|---|---|---|
| **Male** | 148 | 60.2 |
| **Female** | 98 | 39.8 |
| **Total** | 246 | 100 |

Male predominance may be associated with greater occupational exposure, trauma-related infections, and increased hospitalization rates.

**Distribution of Clinical Samples**

Pus and wound swabs represented the most common clinical samples yielding *S. aureus* isolates.

**Table 3: Distribution of Clinical Samples**

| Clinical Sample | Number of Isolates | Percentage (%) |
|---|---|---|
| **Pus/Wound Swab** | 118 | 48.0 |
| **Blood** | 36 | 14.6 |
| **Respiratory Samples** | 32 | 13.0 |
| **Urine** | 24 | 9.8 |
| **Catheter Tips** | 18 | 7.3 |
| **Body Fluids** | 18 | 7.3 |
| **Total** | 246 | 100 |

The predominance of pus and wound swab samples reflects the major role of *S. aureus* in skin and soft tissue infections.

**Distribution of MRSA and MSSA**

Out of 246 isolates, 95 (38.6%) were identified as MRSA and 151 (61.4%) as MSSA.

**Table 4: Distribution of MRSA and MSSA Isolates**

| Isolate Type | Number (n) | Percentage (%) |
|---|---|---|
| **MRSA** | 95 | 38.6 |
| **MSSA** | 151 | 61.4 |
| **Total** | 246 | 100 |

The high prevalence of MRSA highlights the growing burden of methicillin resistance in tertiary care hospitals.

**Ward-wise Distribution of Isolates**

The highest number of MRSA isolates was recovered from surgery wards and intensive care units.

**Table 5: Ward-wise Distribution of MRSA and MSSA Isolates**

| Ward/Department | MRSA | MSSA | Total |
|---|---|---|---|
| **Surgery** | 28 | 22 | 50 |
| **Medicine** | 24 | 41 | 65 |
| **ICU** | 18 | 12 | 30 |
| **Orthopedics** | 12 | 28 | 40 |
| **Pediatrics** | 8 | 27 | 35 |
| **Obstetrics & Gynecology** | 5 | 21 | 26 |
| **Total** | 95 | 151 | 246 |

The higher MRSA burden in surgery wards and ICUs may be due to prolonged hospitalization, invasive procedures, and increased antibiotic pressure.

**Associated Comorbidities**

Diabetes mellitus was the most common associated comorbidity followed by chronic kidney disease and prolonged hospitalization.

**Table 6: Associated Comorbidities Among Patients**

| Comorbidity | Number of Patients | Percentage (%) |
|---|---|---|
| **Diabetes Mellitus** | 64 | 26.0 |
| **Chronic Kidney Disease** | 38 | 15.4 |
| **Prolonged Hospitalization** | 52 | 21.1 |
| **Chronic Respiratory Disease** | 24 | 9.8 |
| **Malignancy** | 18 | 7.3 |
| **No Significant Comorbidity** | 50 | 20.4 |

The presence of comorbid conditions increases susceptibility to infection and contributes to antibiotic exposure.

**Antibiotic Susceptibility Pattern**

MRSA isolates exhibited significantly higher resistance to most antibiotics compared to MSSA isolates.

**Table 7: Comparative Antibiotic Resistance Pattern of MRSA and MSSA**

| Antibiotic | MRSA Resistant (%) | MSSA Resistant (%) | p-value |
|---|---|---|---|
| **Penicillin** | 94.8 | 86.8 | <0.05 |
| **Erythromycin** | 68.4 | 33.8 | <0.01 |
| **Clindamycin** | 42.1 | 20.5 | <0.01 |
| **Ciprofloxacin** | 70.5 | 27.2 | <0.001 |
| **Gentamicin** | 52.6 | 23.8 | <0.001 |
| **Cotrimoxazole** | 63.2 | 28.5 | <0.001 |
| **Linezolid** | 0 | 0 | — |
| **Vancomycin** | 0 | 0 | — |

Resistance to penicillin was extremely high in both MRSA and MSSA isolates. MRSA isolates showed markedly higher resistance to erythromycin, ciprofloxacin, gentamicin, and cotrimoxazole, indicating multidrug-resistant behavior.

Notably, all isolates remained susceptible to linezolid and vancomycin, suggesting that these antibiotics continue to be reliable therapeutic agents for resistant *S. aureus* infections.

**Discussion**

*Staphylococcus aureus* continues to be one of the leading causes of healthcare-associated infections worldwide [1]. The emergence of MRSA has significantly complicated treatment protocols because of its multidrug-resistant nature and ability to disseminate rapidly within healthcare environments [3].

In the present study, MRSA accounted for 38.6% of all *S. aureus* isolates. Similar prevalence rates have been reported in several Indian tertiary care centers [6]. The high MRSA burden observed in the study highlights the continuing challenge posed by methicillin resistance in hospital settings.

The majority of isolates were recovered from pus and wound swab specimens, indicating the predominant role of *S. aureus* in skin and soft tissue infections. Similar findings have been documented in previous Indian and international studies [2,8].

The study demonstrated significantly higher resistance among MRSA isolates to erythromycin, clindamycin, ciprofloxacin, gentamicin, and cotrimoxazole compared to MSSA isolates. These findings are consistent with previous reports showing that MRSA strains frequently exhibit multidrug resistance due to acquisition of multiple resistance determinants [5,9].

Resistance to penicillin was extremely high in both MRSA and MSSA isolates, reflecting widespread β-lactamase production among *S. aureus* strains. However, all isolates remained susceptible to vancomycin and linezolid. Similar observations have been reported in several studies where glycopeptides and oxazolidinones retained excellent activity against resistant isolates [10].

Ward-wise analysis demonstrated higher MRSA prevalence in surgery wards and intensive care units. Increased antibiotic exposure, invasive procedures, prolonged hospitalization, and cross-transmission contribute significantly to MRSA dissemination in these high-risk areas [7].

Among associated comorbidities, diabetes mellitus and chronic kidney disease were common. Patients with chronic illnesses are more susceptible to *S. aureus* colonization and infection because of impaired immunity, frequent healthcare exposure, and repeated antibiotic use.

The findings of the present study emphasize the importance of continuous antimicrobial surveillance, rational antibiotic prescribing, and implementation of strict infection-control measures to reduce the spread of resistant strains.

**Conclusion**

The present study demonstrated a substantial prevalence of MRSA among clinical isolates of *Staphylococcus aureus* in a tertiary care hospital. MRSA isolates exhibited significantly higher multidrug resistance compared to MSSA isolates.

Pus and wound swabs were the predominant clinical specimens, while surgery wards and ICUs showed higher MRSA prevalence. Linezolid and vancomycin remained highly effective against all isolates.

Continuous surveillance of antibiotic resistance patterns, rational antimicrobial use, and strict infection-control practices are essential to prevent dissemination of resistant *S. aureus* strains and improve patient outcomes.

**References**

1. Wertheim HFL, Melles DC, Vos MC, van Leeuwen W, van Belkum A, Verbrugh HA, et al. The role of nasal carriage in *Staphylococcus aureus* infections. Lancet Infect Dis. 2005;5(12):751-62.
2. Kluytmans J, van Belkum A, Verbrugh H. Nasal carriage of *Staphylococcus aureus*: epidemiology, underlying mechanisms, and associated risks. Clin Microbiol Rev. 1997;10(3):505-20.
3. Chambers HF. The changing epidemiology of *Staphylococcus aureus*? Emerg Infect Dis. 2001;7(2):178-82.
4. Hartman BJ, Tomasz A. Low-affinity penicillin-binding protein associated with beta-lactam resistance in *Staphylococcus aureus*. J Bacteriol. 1984;158(2):513-6.
5. Rodvold KA, McConeghy KW. Methicillin-resistant *Staphylococcus aureus* therapy: past, present, and future. Clin Infect Dis. 2014;58(Suppl 1):S20-7.
6. Joshi S, Ray P, Manchanda V, Bajaj J, Chitnis DS, Gautam V, et al. Methicillin resistant *Staphylococcus aureus* (MRSA) in India: prevalence and susceptibility pattern. Indian J Med Res. 2013;137(2):363-9.
7. Graffunder EM, Venezia RA. Risk factors associated with nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) infection including previous use of antimicrobials. J Antimicrob Chemother. 2002;49(6):999-1005.
8. Rayner C, Munckhof WJ. Antibiotics currently used in the treatment of infections caused by *Staphylococcus aureus*. Intern Med J. 2005;35(Suppl 2):S3-16.
9. Patil NR, Ghorpade MV. Phenotypic and genotypic methods for detection of methicillin resistant *Staphylococcus aureus*: a comparative study. Int J Curr Microbiol Appl Sci. 2015;4(7):689-98.
10. Howden BP, Davies JK, Johnson PDR, Stinear TP,

Grayson ML. Reduced vancomycin susceptibility in *Staphylococcus aureus*, including VISA and VRSA: resistance mechanisms, laboratory detection, and clinical i
11. mplications. Clin Microbiol Rev. 2010;23(1):99-139.