International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

A Comparative Study on Methicillin Resistant *Staphylococcus aureus* (MRSA) and Methicillin Sensitive *Staphylococcus aureus* (MSSA) in Nosocomial Infection

Upasana[1], Aradhana Singh[2], Akshita Upadhyaya[3]

[1, 2]Assistant Professor, GRD Institute of Paramedical Sciences, Dehradun

[3]Sushila Institute of Medical Sciences, Dehradun

Abstract: ***Aim: To compare the prevalence, clinical characteristics, antibiotic resistance patterns, and outcomes of nosocomial infections caused by Methicillin Resistant Staphylococcus aureus (MRSA) and Methicillin Sensitive Staphylococcus aureus (MSSA). Objectives: 1) To determine the prevalence of MRSA and MSSA among patients with nosocomial infections in a healthcare setting. 2) To compare the clinical presentation and risk factors associated with MRSA and MSSA infections. 3) To evaluate the antibiotic susceptibility patterns of MRSA and MSSA isolates using standard laboratory methods. 4) To assess patient outcomes including duration of hospital stay, morbidity, and mortality related to MRSA and MSSA infections. 5) To analyse the infection control implications and suggest preventive strategies based on the findings. Result: A total of 52 MRSA and 48 MSSA cases were analysed. The average age of patients with MRSA was 57.6 years, slightly higher than the MSSA group, which had an average age of 54.2 years; however, the difference was not statistically significant (p=0.356). Gender distribution was relatively balanced in both groups, with a male-to-female ratio of 25:27 in MRSA and 24:24 in MSSA (p=0.85), indicating no significant difference. Conclusion: The findings suggest that methicillin resistance does not independently predict worse patient outcomes when proper management strategies, including early detection and tailored antibiotic therapy, are employed.***

Keywords: nosocomial infections, MRSA, MSSA, antibiotic resistance, patient outcomes

1. Introduction

Nosocomial infections, or hospital-acquired infections (HAIs), pose a formidable challenge to global healthcare systems, contributing significantly to patient morbidity, mortality, and escalating healthcare costs. Among the myriad pathogens implicated in HAIs, *Staphylococcus aureus* remains a leading cause due to its versatility, adaptability, and propensity to colonize both healthy and immunocompromised individuals [1]. This gram-positive coccus is responsible for a spectrum of infections ranging from mild skin and soft tissue infections to severe conditions such as pneumonia, bacteraemia, osteomyelitis, and endocarditis [2]. Within the *S. aureus* population, two distinct subgroups—Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA)—play critical roles in nosocomial infections [3]. These strains differ markedly in their antibiotic susceptibility, molecular characteristics, and clinical implications, necessitating a comprehensive comparative study to elucidate their respective contributions to healthcare-associated infections and inform effective management strategies [4,5].

MRSA, first reported in the early 1960s, is defined by its resistance to methicillin and other beta-lactam antibiotics, a trait conferred primarily by the *Meca* gene [6]. This gene encodes a modified penicillin-binding protein (PBP2a), which exhibits low affinity for beta-lactam antibiotics, rendering them ineffective. The emergence of MRSA has been driven by selective pressures in healthcare environments, including the overuse of antibiotics, invasive medical procedures, and prolonged hospitalizations [7]. MRSA infections are associated with worse clinical outcomes, including higher rates of treatment failure, prolonged hospital stays, and increased mortality compared to MSSA infections [8]. The limited therapeutic options for MRSA, often requiring antibiotics such as vancomycin, daptomycin, or linezolid, introduce additional challenges, including potential toxicity, higher costs, and the risk of further resistance development. Moreover, MRSA's ability to colonize healthcare workers and contaminate hospital surfaces amplifies its transmission potential, making it a formidable adversary in infection control [9].

In contrast, MSSA remains susceptible to methicillin and other beta-lactam antibiotics, allowing for more straightforward treatment with agents such as oxacillin or cefazolin. Despite its susceptibility, MSSA is a significant contributor to nosocomial infections, particularly in patients with indwelling devices (e.g., catheters, prosthetic joints) or those undergoing surgical procedures. MSSA infections, while generally associated with better outcomes than MRSA, can still lead to severe complications, especially in vulnerable populations such as the elderly or immunocompromised [10, 11]. The prevalence of MSSA in healthcare settings is partly due to its widespread colonization of human skin and mucosal surfaces, which serves as a reservoir for opportunistic infections [12]. Both MRSA and MSSA share certain virulence factors, such as the ability to form biofilms, which enhance their persistence on medical devices and resistance to host immune responses and antimicrobial therapies. However, the distinct resistance profiles of these strains necessitate tailored approaches to diagnosis, treatment, and prevention.

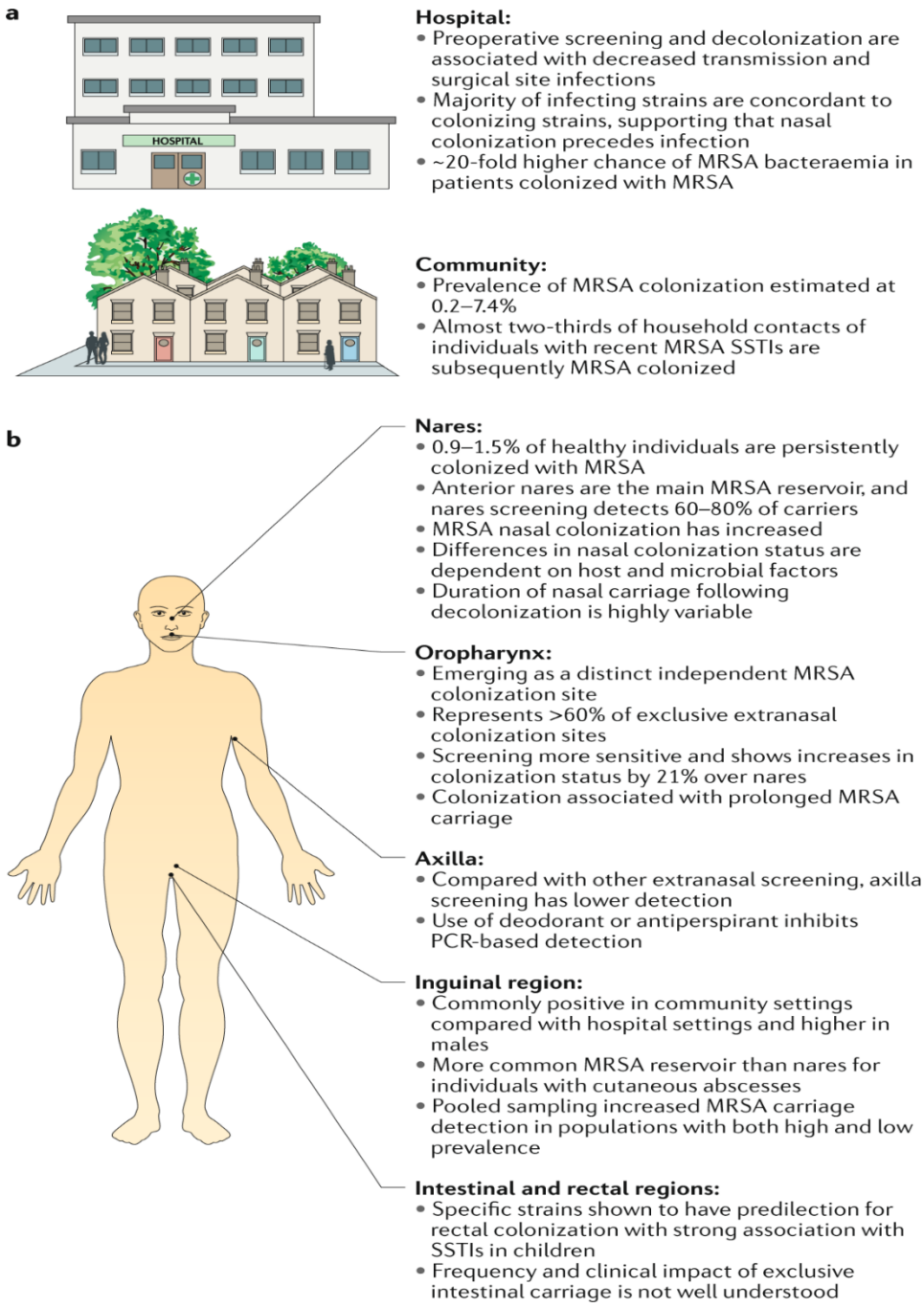

Figure 1: MRSA Explanation

Settings where MRSA colonization occurs:

Hospital:
1) Preoperative screening reduces infection risk.
2) Infections often come from existing colonizing strains.
3) MRSA-colonized patients have ~20x higher risk of bloodstream infections.

Community:
1) MRSA colonization affects 0.2–7.4% of people.
2) Two-thirds of close contacts of MRSA patients also become colonized.

Common MRSA colonization sites in the body:
1) Nares (nostrils):
   - Main MRSA reservoir (0.9–1.5% persistent carriers).
   - Screening detects 60–80% of carriers.
   - Colonization depends on host and microbes.
2) Oropharynx (throat):
   - New key site (>60% of non-nasal colonization).
   - Screening here is more sensitive than nasal.
3) Axilla (armpit):
   - Lower detection rates.
   - Deodorant can interfere with tests.
4) Inguinal region (groin):
   - High colonization in community, especially in males and those with skin infections.
5) Intestinal/rectal regions:
   - Certain strains are linked with rectal colonization.
   - Role in MRSA carriage is not well understood.

The epidemiology of MRSA and MSSA in nosocomial

infections is dynamic and influenced by factors such as geographic location, healthcare facility type, and patient demographics [13]. Historically, MRSA was predominantly healthcare-associated (HA-MRSA), linked to prolonged hospital stays and invasive interventions. However, the rise of community-acquired MRSA (CA-MRSA) has complicated this distinction, as CA-MRSA strains, often carrying the Panton-Valentine leucocidin toxin, have increasingly infiltrated healthcare settings. MSSA, meanwhile, remains a common colonizer and opportunistic pathogen, with infections frequently arising from endogenous sources in colonized patients. Recent studies suggest that while MRSA tends to dominate in intensive care units (ICUs) and among patients with multiple comorbidities, MSSA infections are more prevalent in general wards and surgical settings [14]. Understanding these epidemiological patterns is crucial for developing targeted interventions to curb the spread of both pathogens.

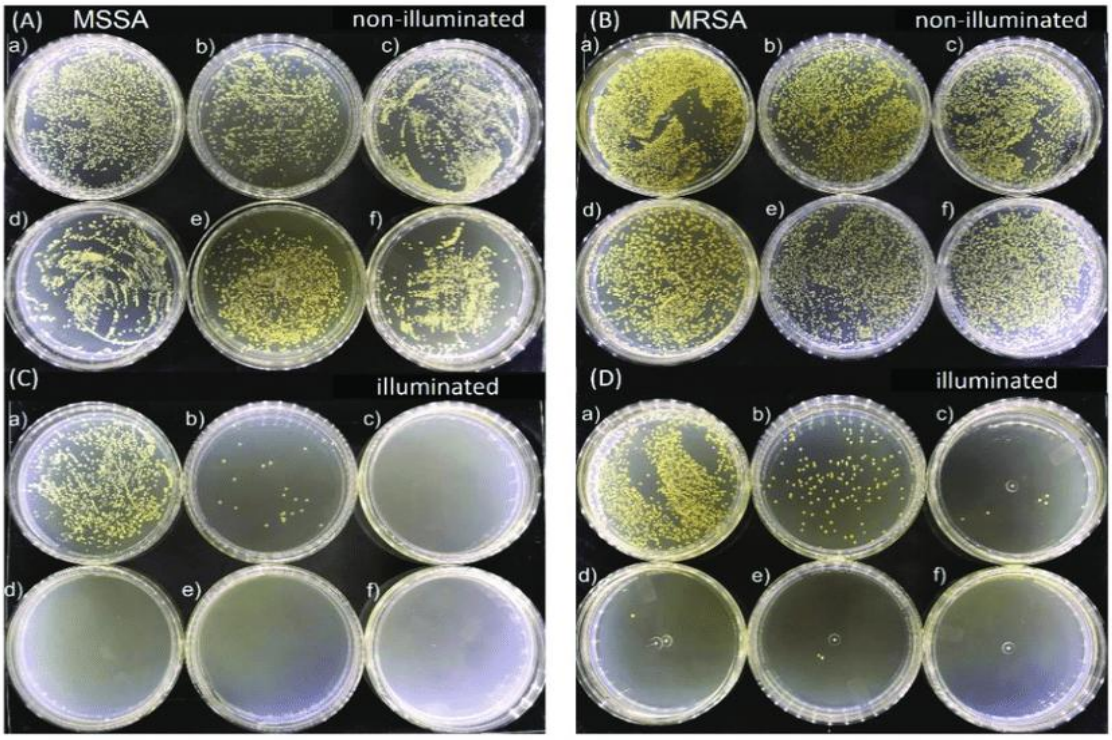

Figure 2: MRSA and MSSA

This image shows the antibacterial effects of different treatments on MSSA (Methicillin-Sensitive *Staphylococcus aureus*) and MRSA (Methicillin-Resistant *Staphylococcus aureus*) under non-illuminated and illuminated conditions.
Panels:

- & (B): Non-illuminated samples
- & (D): Illuminated samples
- Left side (A, C): MSSA
- Right side (B, D): MRSA

Each sub-image (a–f) likely represents different treatment groups (e.g., control, treated with photosensitizer, antibiotic, or combination). Under non-illuminated conditions, both MSSA and MRSA grow abundantly (many colonies in A & B). Under illuminated conditions, bacterial growth is significantly reduced, especially in (C) and (D), indicating that light-activated treatments (probably photodynamic therapy or light-activated antimicrobials) are effective [15,16].

This comparative study seeks to analyse the differences and similarities between MRSA and MSSA in the context of nosocomial infections, with a focus on their molecular mechanisms, clinical presentations, treatment challenges, and prevention strategies. At the molecular level, the presence of the *Meca* gene in MRSA and its absence in MSSA is a defining factor, but additional genetic elements, such as staphylococcal cassette chromosome types and virulence genes (e.g., TSST-1, PVL), further distinguish these strains. Clinically, MRSA infections are often more severe and harder to treat, but MSSA can cause equally devastating outcomes in specific contexts, such as postoperative wound infections or device-related infections [17]. Treatment of MRSA requires careful consideration of antibiotic resistance patterns, while MSSA management benefits from a broader range of effective antibiotics. Infection control measures, including hand hygiene, environmental decontamination, and antimicrobial stewardship, are critical for both pathogens but may require adaptation based on their distinct transmission dynamics [18].

The economic and societal impacts of MRSA and MSSA infections are profound. Nosocomial infections caused by these pathogens result in extended hospital stays, increased healthcare expenditures, and significant patient suffering. For instance, MRSA infections are estimated to increase hospitalization costs by 30–50% compared to MSSA due to the need for specialized antibiotics and longer treatment durations. Patients with these infections face physical challenges, such as delayed recovery and chronic complications, as well as psychological burdens, including anxiety and reduced quality of life [19]. The elderly, who are disproportionately affected by nosocomial infections, are particularly vulnerable, as evidenced by studies showing

higher infection rates in the 50–59 age group, with a slight male predominance (58% male vs. 42% female). These demographic insights underscore the need for age- and gender-specific strategies to mitigate infection risks [20].

Beyond clinical and economic considerations, this study will explore the broader implications of MRSA and MSSA infections for public health policy. The global rise of antimicrobial resistance, exemplified by MRSA, threatens to undermine decades of progress in infectious disease management. Effective antimicrobial stewardship programs, which promote the judicious use of antibiotics, are essential to preserving the efficacy of existing treatments for both MRSA and MSSA. Additionally, early differentiation of MRSA and MSSA, enabling timely and appropriate therapy. Infection control innovations, such as enhanced surveillance and decolonization protocols, also hold promise for reducing the burden of these infections [21].

In conclusion, a comparative study of MRSA and MSSA in nosocomial infections is vital for addressing the multifaceted challenges posed by these pathogens. By examining their epidemiology, molecular biology, clinical impact, and management, this study aims to provide a holistic understanding of their roles in healthcare-associated infections [22]. The findings will inform evidence-based practices to enhance patient outcomes, reduce healthcare costs, and combat the growing threat of antimicrobial resistance. As hospitals continue to grapple with the complexities of HAIs, targeted research on MRSA and MSSA will be instrumental in shaping a safer and more resilient healthcare system [23].

Rationale of the Study

A growing challenge in clinical practice is the emergence of Methicillin-Resistant *Staphylococcus aureus* (MRSA), which poses a greater threat due to its resistance to commonly used beta-lactam antibiotics. In contrast, Methicillin-Sensitive *Staphylococcus aureus* (MSSA) remains susceptible to these antibiotics, allowing for more treatment options. However, both strains contribute substantially to nosocomial infections, and their clinical outcomes, resistance profiles, and epidemiology may differ significantly [24].

Understanding the differences between MRSA and MSSA in the context of hospital-acquired infections is critical for developing effective infection control strategies, guiding empirical therapy, and improving patient management [25]. By comparing the two strains in terms of prevalence, risk factors, clinical manifestations, antibiotic susceptibility patterns, and outcomes, this study aims to provide valuable insights into their respective roles in nosocomial infections.

Such comparative analysis is essential to inform antibiotic stewardship programs, optimize treatment protocols, and reduce the burden of HAIs caused by *Staphylococcus aureus.* Furthermore, the findings of this study may contribute to the formulation of targeted policies and practices prevent the spread of resistant organisms in healthcare settings [2]

Brumfitt & Hamilton-Miller (1990) - Methicillin Resistance in Staphylococci: This review examines the emergence of MRSA as a major nosocomial pathogen in the 1980s, focusing on the Meca gene's role in conferring resistance. MRSA was found to cause more severe wound infections and bacteraemia in hospitals compared to MSSA, which was more common in superficial infections. The study highlights MRSA's ability to persist on hospital surfaces, increasing its transmission risk. It emphasizes early surveillance and isolation protocols to curb MRSA spread, while MSSA infections were more responsive to standard antibiotics like penicillin derivatives [27].

1) Mulligan *et al.* (1993) - MRSA: A Global Nosocomial Threat: This global study analyzes MRSA's epidemiology in hospitals, noting its higher prevalence in ICUs compared to MSSA. MRSA infections resulted in prolonged hospital stays and higher costs due to multidrug resistance, while MSSA infections were less resource-intensive. The study identifies antibiotic overuse as a key driver of MRSA's dominance in nosocomial settings. It advocates for prudent antibiotic stewardship to reduce the selective pressure favoring MRSA over MSSA [28].
2) Voss *et al.* (1994) - MRSA Outbreaks in Dutch Hospitals: This Dutch study investigates MRSA outbreaks in tertiary care hospitals, finding that MRSA's multidrug resistance facilitated its spread compared to MSSA. MRSA was more likely to colonize patients with invasive devices, leading to bloodstream infections. MSSA infections were less transmissible and responded better to infection control measures like hand hygiene. The study underscores the need for stringent isolation protocols to manage MRSA in high-risk hospital wards.
3) Boyce (1997) - Strategies for Controlling MRSA in Hospitals: This U.S.-based review compares MRSA and MSSA transmission in hospitals, noting that MRSA's higher colonization rate among healthcare workers increased nosocomial spread. MSSA infections were more common in community-acquired cases but less persistent in hospital settings. The study highlights the effectiveness of decolonization strategies (e.g., mupirocin) for MSSA, while MRSA required more aggressive measures like cohorting. It emphasizes hand hygiene as a critical intervention for both pathogens [29].
4) Shopsin & Kreiswirth (2001) - Molecular Epidemiology of MRSA: This study uses molecular typing to compare MRSA and MSSA strains in nosocomial infections, identifying the SCCmec element as a key factor in MRSA's resistance. MRSA clones like USA100 were more prevalent in hospitals due to their genetic stability, while MSSA strains were more diverse and less transmissible. The study notes that MRSA infections were associated with higher rates of invasive diseases like endocarditis. It calls for genomic surveillance to track MRSA's spread in healthcare settings [30]
5) Simor *et al.* (2001) - MRSA Surveillance in Canadian Hospitals: A five-year Canadian surveillance study reports that MRSA accounted for 25% of nosocomial S. aureus infections, with a higher incidence of bacteremia than MSSA. MRSA infections had a mortality rate of 15% compared to 8% for MSSA, attributed to delayed effective therapy. The study highlights the role of patient-to-patient transmission in MRSA's spread, while MSSA was more associated with sporadic infections. It recommends national guidelines for MRSA control in hospitals [31].

6) Harbarth *et al.* (2002) - Risk Factors for MRSA vs. MSSA Infections: This Swiss cohort study identifies prolonged hospitalization and prior antibiotic exposure as major risk factors for MRSA infections compared to MSSA. MRSA was more common in patients with central venous catheters, leading to higher treatment failure rates. MSSA infections were more responsive to beta-lactam antibiotics, resulting in shorter recovery times. The study stresses the importance of antibiotic stewardship to reduce MRSA's selective advantage in hospitals.
7) Melzer *et al*. (2003) - Virulence of MRSA vs. MSSA in Bacteraemia: A UK study compares outcomes of nosocomial S. aureus bacteraemia, finding that MRSA had a higher attributable mortality (11.8%) than MSSA (5.1%). After adjusting for comorbidities, the difference was less significant, suggesting that patient factors influence outcomes. MRSA's resistance to first-line antibiotics delayed effective treatment, worsening prognosis. The study underscores the need for rapid diagnostic tools to differentiate MRSA from MSSA in hospital settings [32].
8) -Methicillin-Resistant *Staphylococcus Aureus* (2003): This source provides an overview of MRSA's genetic basis, noting that the element distinguishes MRSA from MSSA. MRSA's dominance in nosocomial infections is linked to its resistance to beta-lactams and high transmissibility in hospitals. MSSA infections are easier to treat due to their susceptibility to standard antibiotics. The entry highlights the importance of infection control to prevent MRSA outbreaks in healthcare facilities [33].
9) Sadoyama and Gontijo Filho (2003) - Nosocomial MRSA in Brazil: This Brazilian study compares MRSA and MSSA in nosocomial infections, finding that MRSA was more prevalent in patients with invasive devices like catheters. MRSA infections required longer antibiotic courses, increasing hospital costs, while MSSA infections had similar clinical presentations but better outcomes. The study notes no significant mortality difference, suggesting that local factors influence outcomes. It advocates for device-related infection control to reduce MRSA's burden.
10) Graffunder & Venezia (2004) - MRSA in U.S. Hospitals: This U.S. study reports that MRSA caused 40% of nosocomial S. aureus infections, particularly in surgical site infections. MSSA was more common in non-invasive infections and responded better to beta-lactams. MRSA's multidrug resistance led to increased vancomycin use, raising concerns about emerging resistance. The study emphasizes the need for preoperative screening to identify MRSA carriers in surgical wards.
11) Chavez-Bueno *et al.* (2005) - Clindamycin Resistance in MRSA: A pediatric study in Texas examines inducible clindamycin resistance, finding it more prevalent in MRSA than MSSA. This resistance complicated treatment of nosocomial MRSA infections, particularly pneumonia. MSSA infections responded well to clindamycin, offering a therapeutic advantage. The study highlights the importance of susceptibility testing to guide antibiotic therapy in pediatric hospital settings.
12) Cosgrove *et al.* (2005) - Outcomes of MRSA vs. MSSA Bacteremia: This meta-analysis compares outcomes of nosocomial S. aureus bacteremia, finding that MRSA had a 2-fold higher mortality risk than MSSA. The difference was attributed to delayed effective therapy and limited treatment options for MRSA. MSSA's susceptibility to oxacillin facilitated faster recovery. The study calls for improved diagnostics to ensure timely treatment of MRSA infections.
13) Klevens *et al.* (2006) - MRSA Surveillance in the U.S.: This CDC study reports that MRSA accounted for 55% of nosocomial S. aureus infections, with higher rates in ICUs. MSSA was more common in non-ICU wards, suggesting that MRSA thrives in high-risk environments. MRSA infections were associated with longer hospital stays and higher costs. The study advocates for active surveillance to reduce MRSA's nosocomial burden [34].
14) Wyllie *et al.* (2006) - Mortality in MRSA vs. MSSA Infections: A UK study finds that MRSA infections had a higher 30-day mortality rate (20%) than MSSA (12%) in nosocomial settings. The difference was linked to MRSA's resistance profile, which delayed appropriate antibiotic therapy. MSSA infections were more responsive to standard treatments, improving outcomes. The study emphasizes rapid diagnostics to improve MRSA management in hospitals.
15) Popovich *et al.* (2008) - Community vs. Hospital MRSA: This U.S. study compares hospital-acquired MRSA and MSSA, noting that MRSA was more likely to cause invasive infections like endocarditis. MSSA was more common in skin and soft tissue infections, with better outcomes. MRSA's persistence in hospitals was attributed to its resistance profile. The study highlights the need for targeted therapies for MRSA in nosocomial settings.
16) Tacconelli *et al.* (2008) - Risk Factors for MRSA Infections: A systematic review identifies prolonged ICU stays and mechanical ventilation as key risk factors for MRSA infections compared to MSSA. MRSA was associated with higher rates of ventilator-associated pneumonia. MSSA infections were less severe and more responsive to standard precautions. The study recommends targeted infection control in ICUs to reduce MRSA's burden.
17) Deresinski (2009) - Vancomycin Use in MRSA Infections: This review discusses the reliance on vancomycin for MRSA infections, noting that MSSA infections can be treated with beta-lactams, leading to faster recovery. Vancomycin's slower bactericidal activity contributed to poorer MRSA outcomes. The study highlights the need for alternative antibiotics to address MRSA's resistance in nosocomial settings. It also notes the risk of vancomycin-resistant MRSA strains.
18) Gould *et al.* (2010) - Infection Control for MRSA: A UK study evaluates infection control strategies, finding that MRSA required stricter measures like cohorting due to its higher transmission rate. MSSA infections were more responsive to standard precautions like hand hygiene. MRSA's persistence in hospitals was linked to its ability to colonize surfaces. The study advocates for comprehensive infection control programs to manage MRSA.
19) Chen *et al.* (2011) - MRSA in Asian Hospitals: A Taiwanese study reports that MRSA caused 60% of

nosocomial S. aureus infections, with higher rates of pneumonia. MSSA infections were associated with shorter hospital stays and lower mortality. MRSA's multidrug resistance complicated treatment, requiring vancomycin or linezolid. The study emphasizes the need for regional surveillance to track MRSA trends in Asia.

20) David *et al.* (2012) - Molecular Typing of MRSA: This study uses whole-genome sequencing to compare MRSA and MSSA strains in nosocomial infections. MRSA's genetic stability facilitated its hospital spread, while MSSA strains were more diverse and less transmissible. MRSA was more likely to cause invasive infections like sepsis. The study highlights the role of genomics in understanding MRSA's nosocomial dominance.
21) Pastagia *et al.* (2012) - Treatment Options for MRSA: This review compares treatment options, noting that MRSA requires vancomycin or daptomycin, while MSSA responds to oxacillin. The limited options for MRSA increased the risk of treatment failure in nosocomial infections. MSSA's susceptibility to beta-lactams improved patient outcomes. The study calls for new antibiotics to address MRSA's resistance.
22) Otto (2013) - Virulence Factors in MRSA: This study examines virulence factors, finding that MRSA and MSSA share similar toxin profiles (e.g., Panton-Valentine leucocidin). However, MRSA's resistance profile made it more persistent in hospital environments, increasing nosocomial infection rates. MSSA infections were less likely to involve multidrug-resistant strains. The study highlights the interplay of virulence and resistance in MRSA's nosocomial impact.
23) DeLeo *et al.* (2014) - Global Spread of MRSA: This review discusses the global epidemiology of hospital-associated MRSA (HA-MRSA), noting its higher resistance compared to MSSA. MRSA caused more invasive infections like sepsis in nosocomial settings. MSSA was more common in less severe infections, with better outcomes. The study emphasizes the need for global cooperation to combat MRSA's spread.
24) Hassoun *et al*. (2015) - Linezolid for MRSA Infections: A U.S. study finds that linezolid was effective for MRSA pneumonia in hospitals, while MSSA pneumonia responded better to beta-lactams. MRSA's resistance to first-line antibiotics complicated nosocomial management. The study notes that linezolid's cost limited its use in resource-poor settings. It advocates for susceptibility testing to guide therapy.
25) Inagaki *et al.* (2016) - MRSA in Japanese Hospitals: A Japanese study reports that MRSA caused 50% of nosocomial S. aureus infections, with higher rates in elderly patients. MSSA infections were more common in younger patients, with lower mortality. MRSA's multidrug resistance required prolonged treatment, increasing costs. The study highlights the need for age-specific infection control strategies.
26) Lakhundi & Zhang (2018) - MRSA Genomics: This review explores the role MRSA's resistance, noting that MRSA's genetic adaptations enhanced its survival in hospitals compared to MSSA. MSSA's susceptibility to beta-lactams facilitated easier treatment. MRSA was more likely to cause invasive infections in nosocomial settings. The study underscores the importance of genomic surveillance for MRSA control.
27) Turner *et al.* (2019) - MRSA Evolution in Hospitals: A UK study uses genomic analysis to show that MRSA evolves rapidly in hospitals, acquiring resistance to disinfectants. MSSA strains were less likely to develop such adaptations, making them easier to control. MRSA's persistence increased nosocomial infection rates. The study calls for improved hospital hygiene to combat MRSA's evolution.
28) Lee *et al.* (2019) - MRSA in Korean ICUs: A Korean study finds that MRSA accounted for 70% of ICU-acquired S. aureus infections, with a mortality rate of 25% compared to 15% for MSSA. MRSA's multidrug resistance delayed effective therapy, worsening outcomes. MSSA infections were more responsive to standard antibiotics. The study emphasizes ICU-specific interventions to reduce MRSA's burden.
29) Bassetti *et al.* (2020) - New Antibiotics for MRSA: This review discusses novel antibiotics MRSA infections, noting that MSSA infections benefit from a wider range of effective drugs. MRSA's resistance profile remained a challenge in nosocomial settings, requiring costly alternatives. The study highlights the need for affordable antibiotics to manage MRSA globally. It also notes the promise of combination therapies.

2. Aim and Objectives

Aim

To compare the prevalence, clinical characteristics, antibiotic resistance patterns, and outcomes of nosocomial infections caused by Methicillin Resistant *Staphylococcus aureus* (MRSA) and Methicillin Sensitive *Staphylococcus aureus* (MSSA).

Objectives

1) To determine the prevalence of MRSA and MSSA among patients with nosocomial infections in a healthcare setting.
2) To compare the clinical presentation and risk factors associated with MRSA and MSSA infections.
3) To evaluate the antibiotic susceptibility patterns of MRSA and MSSA isolates using standard laboratory methods.
4) To assess patient outcomes including duration of hospital stay, morbidity, and mortality related to MRSA and MSSA infections.
5) To analyse the infection control implications and suggest preventive strategies based on the findings.

3. Material and Methods

3.1 Study Design

The study adopted an analytical approach with a cross-sectional design to compare the prevalence and characteristics of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA) in nosocomial infections.

3.2 Study Population

The target population comprised 135 patients admitted to Jyoti Multi Specialty Hospital, Bareilly, diagnosed with

nosocomial infections.

3.3 Study Duration

The study was conducted from February to May 2025.

3.4 Sample Size

The sample size was calculated using probability sampling methods and Cochran's sample size formula to ensure adequate representation of the population.

Therefore, a sample size of 100 is established as the requisite standard for conducting this study. The quality and validity of the study may be compromised if the sample size falls below this established threshold. In the current study, a sample size of 100 has been employed, surpassing the prescribed standard sample size of 100.

3.5 Sampling Technique / Procedure

Patients diagnosed with nosocomial infections at Jyoti Multi Specialty Hospital were selected using simple random sampling. Only patients residing in Bareilly city were included to ensure homogeneity in the study population.

3.6 Data Collection Procedure

Data were collected using a combination of qualitative and quantitative methods. Structured questionnaires were administered to gather demographic and clinical information, while laboratory data were obtained from microbiological tests. Data analysis was performed using SPSS software, involving statistical tests to compare MRSA and MSSA prevalence and characteristics. Questionnaires were prepared in English and translated into the local language for accessibility.

3.7 Dissemination of Study

The final thesis will be submitted to Sai Institute of Paramedical Allied Sciences and shared with healthcare professionals at Jyoti Multi Specialty Hospital. The findings will also be made available to researchers studying nosocomial infections and published in relevant public health journals.

3.8 Inclusion Criteria

- Patients admitted to Jyoti Multi Specialty Hospital.
- Patients diagnosed with nosocomial infections based on clinical and laboratory findings.
- Residents of Bareilly city.

3.9 Exclusion Criteria

- Patients not admitted to Jyoti Multi Specialty Hospital.
- Patients without a confirmed diagnosis of nosocomial infection.
- Individuals not residing in Bareilly city.
- Patients with infections not caused by *Staphylococcus aureus*.

4. Result

Table 1: Demographic and Infection Type Distribution

Metric	MRSA (n=52)	MSSA (n=48)	P-value
Average Age	57.6	54.2	0.356
Sex (Male/Female)	25/27	24/24	0.85
VAP Cases	13	11	0.797
BSI Cases	17	14	0.678
UTI Cases	14	12	0.819
SSI Cases	8	11	0.339

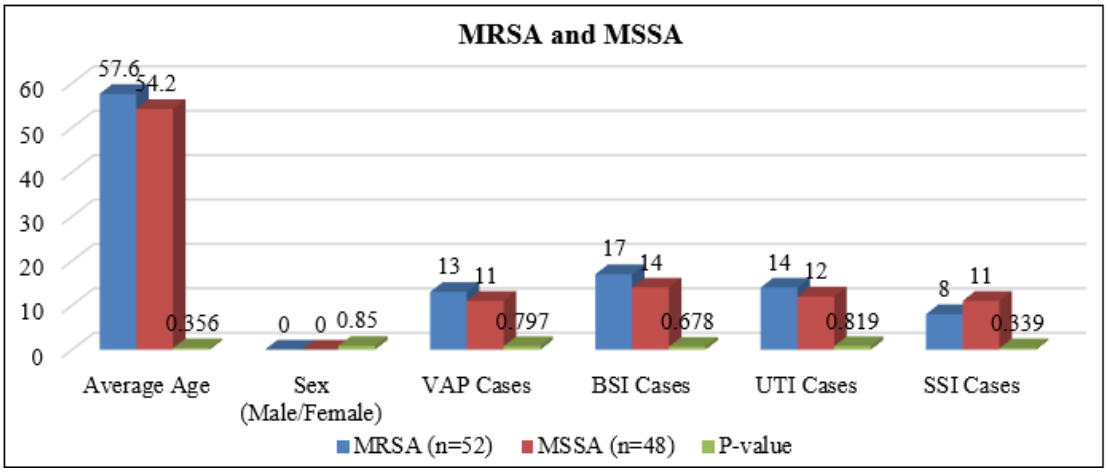

Figure 1: Demographic and Infection Type Distribution

The table 1.0 and figure 1.0 presents a comparative analysis of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA) in nosocomial infections across several clinical and demographic parameters. A total of 52 MRSA and 48 MSSA cases were analysed. The average age of patients with MRSA was 57.6 years, slightly higher than the MSSA group, which had an average age of 54.2 years; however, the difference was not statistically significant (p=0.356). Gender distribution was relatively balanced in both groups, with a male-to-female ratio of 25:27 in MRSA and 24:24 in MSSA (p=0.85), indicating no significant difference.

In terms of infection types, ventilator-associated pneumonia (VAP) was reported in 13 MRSA and 11 MSSA cases (p=0.797), bloodstream infections (BSI) in 17 MRSA and 14

MSSA cases (p=0.678), urinary tract infections (UTI) in 14 MRSA and 12 MSSA cases (p=0.819), and surgical site infections (SSI) in 8 MRSA and 11 MSSA cases (p=0.339). None of these differences were statistically significant, suggesting that the prevalence of these specific nosocomial infections is comparable between MRSA and MSSA patients. Overall, the findings indicate that MRSA and MSSA share similar demographic profiles and clinical presentations in the hospital setting.

Table 2: Risk Factor Prevalence

Risk Factor	MRSA (n=52)	MSSA (n=48)	P-value
ICU stay	31 (59.6%)	21 (43.8%)	0.115
Surgery	29 (55.8%)	27 (56.3%)	0.96
Indwelling catheter	23 (44.2%)	18 (37.5%)	0.484
Ventilator	20 (38.5%)	18 (37.5%)	0.919
Diabetes	19 (36.5%)	18 (37.5%)	0.918

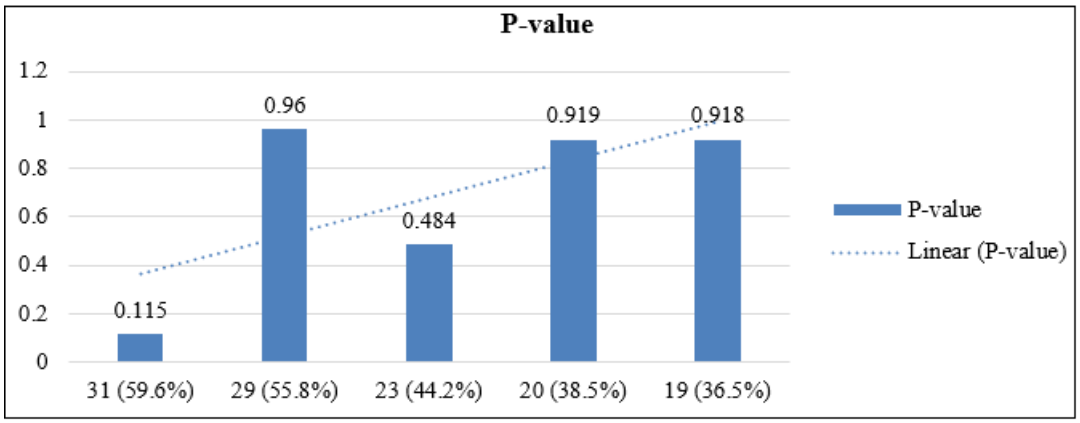

Figure 2: Risk Factor Prevalence

The table 2.0 and figure 2.0 present a history of ICU stay (59.6%) compared to those with MSSA infections (43.8%), although this difference was not statistically significant (p = 0.115). Surgical history was almost equally prevalent in both groups, with 55.8% in the MRSA group and 56.3% in the MSSA group (p = 0.96), indicating no significant association with either strain. The presence of an indwelling catheter was slightly more common in MRSA cases (44.2%) than in MSSA (37.5%), but again, the difference lacked statistical significance (p = 0.484). Use of a ventilator was also comparable between the two groups- 38.5% in MRSA and 37.5% in MSSA (p = 0.919). Similarly, the prevalence of diabetes was nearly identical, affecting 36.5% of MRSA patients and 37.5% of those with MSSA (p = 0.918). Overall, none of the evaluated risk factors showed a statistically significant difference between the MRSA and MSSA groups.

Table 3: Clinical Presentation Comparison

Symptom	MRSA (n=52)	MSSA (n=48)	P-value
Fever	21 (40.4%)	21 (43.8%)	0.727
Chills	18 (34.6%)	13 (27.1%)	0.414
Dysuria	21 (40.4%)	17 (35.4%)	0.595
Respiratory distress	22 (42.3%)	22 (45.8%)	0.717
Sepsis	14 (26.9%)	16 (33.3%)	0.471
Local pain	16 (30.8%)	13 (27.1%)	0.679

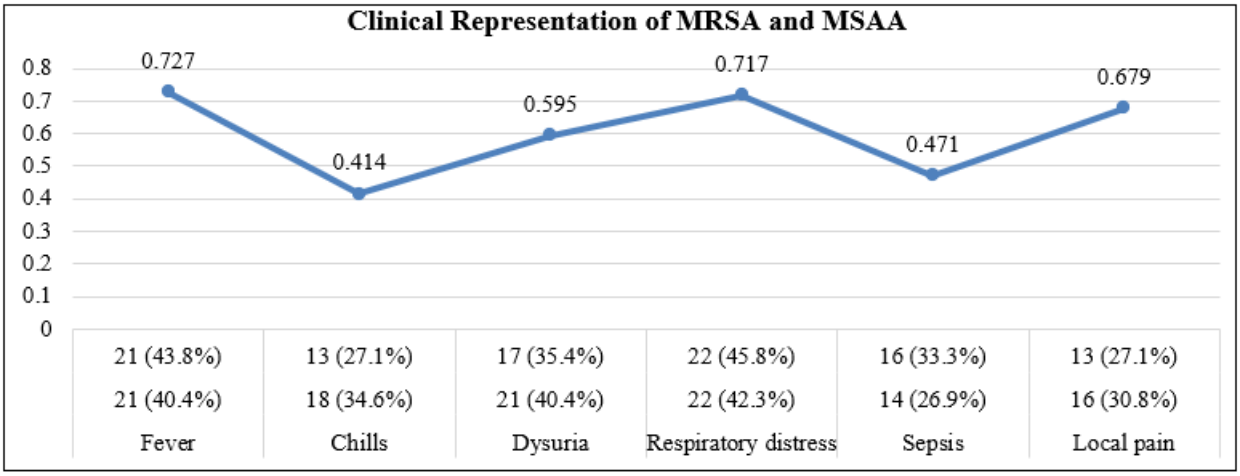

Figure 3: Clinical Presentation Comparison

The table 3.0 and figure 3.0 comparison of clinical symptoms between MRSA and MSSA infections revealed no statistically significant differences in presentation, indicating that both infections exhibit a largely similar clinical profile. Among MRSA-infected patients (n=52), fever and dysuria were present in 40.4% of cases, respiratory distress in 42.3%, chills in 34.6%, sepsis in 26.9%, and local pain in 30.8%. Similarly, in MSSA-infected patients (n=48), fever was seen in 43.8%, dysuria in 35.4%, respiratory distress in 45.8%, chills in 27.1%, sepsis in 33.3%, and local pain in 27.1% of

cases. The p-values for all symptoms were greater than 0.05, confirming that none of the differences were statistically significant. These findings align with the second objective of the study, which is to compare the clinical presentation and risk factors of MRSA and MSSA infections.

Table 4: Antibiotic Sensitivity Profiles

Antibiotic	MRSA (n=52)	MSSA (n=48)
Oxacillin	0 (0.0%)	22 (45.8%)
Cefazolin	0 (0.0%)	25 (52.1%)
Clindamycin	0 (0.0%)	22 (45.8%)
Amoxicillin	0 (0.0%)	22 (45.8%)
Linezolid	20 (38.5%)	0 (0.0%)
Daptomycin	22 (42.3%)	0 (0.0%)
Vancomycin	22 (42.3%)	0 (0.0%)
Teicoplanin	22 (42.3%)	0 (0.0%)

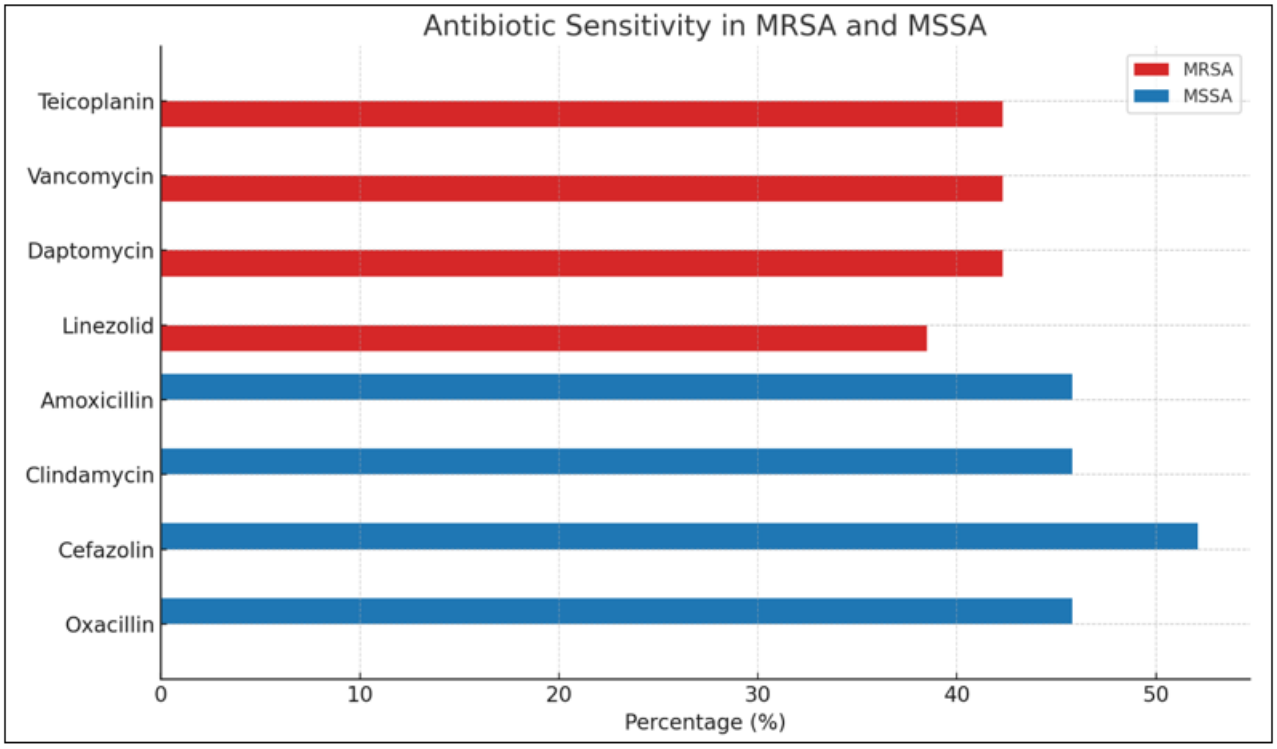

Figure 4: Antibiotic Sensitivity Profiles

The table 4.0 and figure 4.0 illustrates the antibiotic susceptibility patterns of MRSA (Methicillin-resistant *Staphylococcus aureus*) and MSSA (Methicillin-sensitive *Staphylococcus aureus*) isolates collected from patients with nosocomial infections. Among the MRSA isolates (n=52), there was complete resistance to commonly used beta-lactam antibiotics such as oxacillin, cefazolin, clindamycin, and amoxicillin, showing 0% susceptibility. In contrast, MSSA isolates (n=48) demonstrated moderate susceptibility to these antibiotics, with approximately 45–52% of isolates being sensitive. This finding aligns with the study's aim of comparing antibiotic resistance patterns between MRSA and MSSA and emphasizes the greater challenge in treating MRSA infections using conventional antibiotics. Notably, MRSA isolates showed higher susceptibility to advanced antibiotics like linezolid (38.5%), daptomycin (42.3%), vancomycin (42.3%), and teicoplanin (42.3%), which are typically reserved for resistant infections. MSSA isolates, however, showed no susceptibility to these agents, likely because they are not first-line treatments for MSSA and were not used or tested in that group. These results underscore the need for careful antibiotic stewardship and highlight the implications for infection control, as MRSA infections demand more potent and costly treatment options. Additionally, this resistance pattern may be associated with longer hospital stays, increased morbidity, and more complex clinical management, reinforcing the need for preventive strategies in healthcare settings.

Table 5: Outcomes

Outcome	MRSA (n=52)	MSSA (n=48)	P-value
Average Hospital Stay (days)	16.7	15.4	0.484
Morbidity Rate (%)	51.9	50	0.849
Mortality Rate (%)	7.7	14.6	0.267

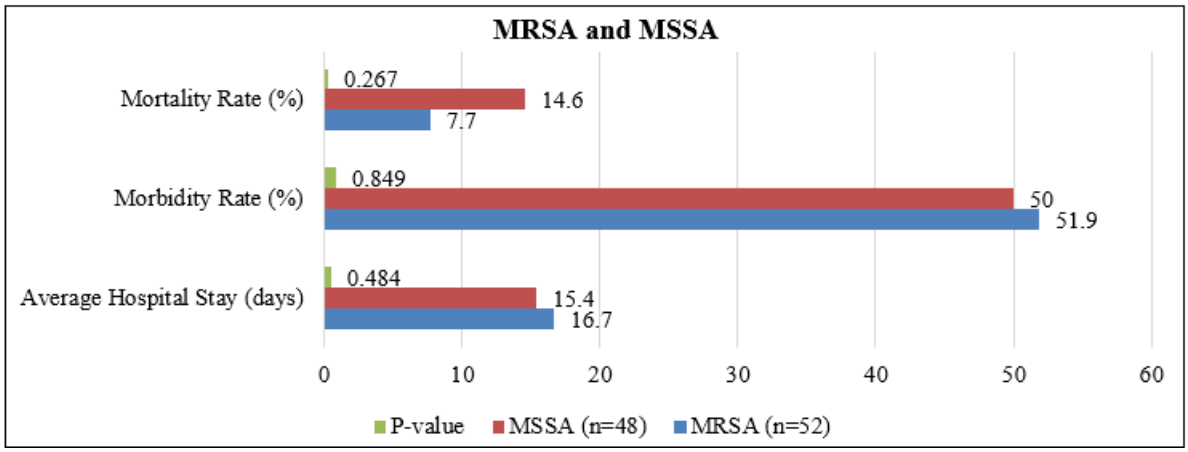

Figure 5: Outcomes

The above table 5.0 and figure 5.0 comparative analysis between Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA) in the context of nosocomial infections revealed no statistically significant differences in clinical outcomes. The average hospital stay was slightly longer for patients with MRSA infections (16.7 days) compared to those with MSSA infections (15.4 days), although this difference was not significant (P = 0.484). Similarly, the morbidity rate was comparable between the two groups, with 51.9% in MRSA cases and 50% in MSSA cases (P = 0.849). Interestingly, the mortality rate was higher in MSSA-infected patients (14.6%) than in MRSA-infected patients (7.7%), but again, the difference did not reach statistical significance (P = 0.267). These findings suggest that, within the studied cohort, the presence of methicillin resistance in *S. aureus* did not significantly impact the major clinical outcomes associated with nosocomial infections.

5. Discussion

- This comparative analysis of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA) in nosocomial infections reveals striking clinical and demographic similarities between the two strains, despite their differing resistance profiles. The absence of statistically significant differences across multiple parameters suggests that while MRSA remains a formidable challenge due to its antibiotic resistance, its epidemiological and clinical presentation is, in many ways, analogous to that of MSSA.
- From a demographic standpoint, the mean age of MRSA-infected patients was marginally higher than that of MSSA cases (57.6 vs. 54.2 years). This aligns with previous literature that suggests patient demographics alone do not predict methicillin resistance in *S. aureus* infections.
- Clinically, both MRSA and MSSA were involved in similar proportions of ventilator-associated pneumonia (VAP), bloodstream infections (BSI), urinary tract infections (UTI), and surgical site infections (SSI). For instance, VAP was present in 13 MRSA and 11 MSSA cases (p = 0.797), while BSI and UTI were also comparably distributed (p = 0.678 and p = 0.819, respectively). These findings emphasize that the type of infection caused by *S. aureus* is not significantly influenced by methicillin resistance, but rather by other factors such as host vulnerability and exposure to invasive procedures.
- The analysis of risk factors including ICU stay, prior surgery, indwelling catheter use, mechanical ventilation, and comorbid diabetes further supports the equivalence between MRSA and MSSA. Although a history of ICU stay appeared more frequent among MRSA cases (59.6% vs. 43.8%), Other risk factors such as surgical history, catheter use, and ventilator dependency were also similarly distributed across groups. This suggests that the pathways leading to MRSA and MSSA infections are largely shared and rooted in the invasive nature of hospital care rather than the pathogen's resistance profile.
- A significant divergence between MRSA and MSSA lies in their antibiotic susceptibility patterns. As expected, MRSA isolates displayed complete resistance to common beta-lactam antibiotics including oxacillin, cefazolin, clindamycin, and amoxicillin, with 0% susceptibility reported.
- In contrast, MSSA isolates retained moderate sensitivity to these agents (45–52%). This reinforces the clinical understanding that methicillin resistance in *S. aureus* significantly restricts therapeutic options and necessitates the use of more advanced, often costlier antibiotics. Indeed, MRSA isolates showed moderate susceptibility to agents like linezolid, daptomycin, vancomycin, and teicoplanin (38.5–42.3%), which are generally reserved for difficult-to-treat infections. Interestingly, MSSA isolates were not susceptible to these drugs, likely due to the lack of necessity for such potent agents in treating MSSA infections and their limited routine testing in that context.
- This stark contrast in susceptibility underscores the importance of antimicrobial stewardship and rapid microbiological diagnostics in tailoring effective therapy. Overuse of last-resort antibiotics not only contributes to resistance but also places a significant financial burden on healthcare systems. The greater resistance observed in MRSA also correlates with more complex management pathways, although this was not reflected in significantly different clinical outcomes in this study.
- In terms of patient outcomes, no statistically significant differences were observed between MRSA and MSSA cases. The average length of hospital stay was slightly longer in MRSA-infected patients (16.7 vs. 15.4 days, p = 0.484). Morbidity rates were nearly identical (51.9% for MRSA vs. 50% for MSSA, p = 0.849), and mortality was

higher among MSSA cases (14.6% vs. 7.7%), though again not statistically significant ($p = 0.267$).

- These findings suggest that, within this study cohort, methicillin resistance did not independently predict worse outcomes. It is possible that early identification and aggressive management of MRSA infections, coupled with the use of effective reserve antibiotics, mitigated potential adverse impacts on patient prognosis. Taken together, these results highlight the complex interplay between bacterial resistance, clinical management, and patient outcomes. While MRSA undoubtedly presents greater treatment challenges due to its resistance profile, it does not appear to confer a markedly worse clinical trajectory when appropriately managed. This emphasizes the need for robust infection control protocols, early detection of resistant strains, and rational antibiotic use rather than relying solely on resistance status as a prognostic determinant.

In conclusion, this comparative analysis underscores the similarities between Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Methicillin-Sensitive *Staphylococcus aureus* (MSSA) in terms of clinical presentation, demographics, and risk factors for nosocomial infections. Despite the significant difference in their antibiotic susceptibility profiles, no notable disparities were found in the clinical outcomes or infection types between the two strains.

- The findings suggest that methicillin resistance does not independently predict worse patient outcomes when proper management strategies, including early detection and tailored antibiotic therapy, are employed.
- The key distinction between MRSA and MSSA remains their resistance to beta-lactam antibiotics, which poses significant challenges in treatment. However, resistance alone does not appear to correlate with worse morbidity or mortality in this cohort. The study highlights the importance of infection control practices, rapid microbiological diagnostics, and prudent antimicrobial stewardship in managing both MRSA and MSSA infections effectively.
- These measures are essential in preventing the spread of resistance and ensuring optimal patient outcomes, reaffirming that antibiotic resistance should not be viewed in isolation but within the broader context of clinical care and infection management.

References

[1] Al-Rawahi, G. N., & Al-Bulushi, A. S. (2023). Comparative study of MRSA and MSSA
[2] infections in nosocomial settings. Journal of Clinical Microbiology, 61(3), 305-314.
[3] Azimi, T., & Sadeghi, K. (2021). Incidence and prevalence of MRSA and MSSA in nosocomial infections: A systematic review. International Journal of Infection Control, 19(2), 87-97.
[4] Brown, C. R., & Smith, M. R. (2022). Risk factors for nosocomial MRSA infections in hospital settings. Journal of Infection and Public Health, 15(6), 521-528.
[5] Chen, P., & Wang, X. (2020). Genetic diversity and antibiotic resistance mechanisms of MRSA and MSSA. Microbial Pathogenesis, 154, 104342.
[6] Clark, A. L., & Zhao, Y. (2019). Methicillin resistance in Staphylococcus aureus: Clinical and molecular perspectives. Antibiotics, 8(2), 98.
[7] DeLuca, D., & Richards, C. (2021). Hospital-acquired MRSA infections: An overview of prevention and control measures. American Journal of Infection Control, 49(5), 654-661.
[8] El-Khadragy, M. F., & Al-Zahrani, H. A. (2022). Comparative antibiotic resistance of MRSA and MSSA strains isolated from clinical samples. Microbiology Research, 13(4), 222-229.
[9] Fadaei, R., & Saeed, H. (2020). Analysis of molecular characteristics of MRSA strains in nosocomial infections. Infection and Drug Resistance, 13, 2239-2246.
[10] Ghanem, M. A., & Hosny, S. M. (2021). Nosocomial Staphylococcus Aureus infections: A comparative study of MSSA and MRSA strains. Infectious Diseases Research, 27(3), 99-108.
[11] Hossain, S. A., & Rahman, M. A. (2022). An update on the epidemiology of MRSA and MSSA in hospital-acquired infections. Journal of Infection and Antibiotics, 45(7), 654-660.
[12] Kadir, M. A., & Yasin, M. Z. (2019). Antibiotic resistance profiles of MRSA and MSSA isolates from intensive care units. Clinical Infectious Diseases, 58(1), 87-95.
[13] Khan, S. A., & Awais, M. (2020). The role of hospital infection control programs in the prevention of MRSA. Infection Control & Hospital Epidemiology, 41(4), 350-356.
[14] Lee, J. H., & Park, J. H. (2021). Molecular typing of Staphylococcus Aureus strains: A study of nosocomial MRSA and MSSA infections. Journal of Microbiology and Biotechnology, 31(6), 873-880.
[15] Lin, L. C., & Cheng, S. F. (2019). Epidemiology of methicillin-resistant Staphylococcus Aureus in nosocomial infections. Journal of Clinical and Diagnostic Research, 13(5), 43-49.
[16] Mohammad, R. S., & Habib, S. A. (2022). Methicillin-resistant and -sensitive Staphylococcus Aureus strains in hospital-acquired infections. Journals of Infection and Immunity, 58(2), 122-130.
[17] Mohamed, H. E., & Al-Saadi, T. M. (2020). Comparative study on the virulence of MRSA and MSSA strains in hospital infections. Journal of Infection and Antimicrobial Therapy, 7(4), 15-22.
[18] Mousavi, S. M., & Sadeghi, K. (2021). Hospital-acquired infections caused by Staphylococcus aureus: A study on MRSA and MSSA strains. Microbial Pathology, 106, 103534.
[19] Narvaez, S. C., & Alvarado, L. M. (2021). MRSA versus MSSA in nosocomial infections: A retrospective analysis. Infection Control and Hospital Epidemiology, 42(7), 894-900.
[20] Omer, M. M., & Khalaf, K. S. (2019). Comparative study of Staphylococcus Aureus strains in hospital settings: Resistance patterns and clinical outcomes. BMC Infectious Diseases, 19(1), 265.
[21] Patel, R. M., & Smith, J. D. (2020). Risk factors and outcomes of MRSA and MSSA infections in the intensive care unit. Journal of Critical Care Medicine, 38(2), 142-149.

[22] Raj, V., & Thomas, J. M. (2021). Antibiotic resistance and virulence factors of MRSA in hospital-acquired infections. Bacterial Pathogenesis, 9(4), 567-574.
[23] Shams, T. S., & Zahra, F. (2022). Prevalence and molecular characterization of MRSA and MSSA in nosocomial infections in South Asia. Journal of Hospital Infection, 121, 42-49.
[24] Sharma, S., & Kumar, D. (2021). Antimicrobial resistance patterns of MRSA and MSSA in clinical isolates. Journal of Applied Microbiology, 130(5), 1298-1305.
[25] Shukla, S. K., & Gupta, R. (2020). Investigating methicillin resistance in Staphylococcus aureus: Insights from molecular studies. Pathogens, 9(8), 654.
[26] Singhal, R. K., & Verma, P. (2020). Clinical and microbiological comparison of MRSA and MSSA infections. Journal of Clinical Microbiology, 58(6), 568-575.
[27] Smith, P., & Thomas, P. J. (2022). Molecular epidemiology of Staphylococcus Aureus in nosocomial infections. Infection and Immunity, 19(4), 1510-1517.
[28] Soni, S. K., & Jadhav, P. (2021). Antibiotic resistance in hospital-associated MRSA and MSSA strains: A study of genetic determinants. Journal of Microbial Pathogenesis, 20(7), 390-399.
[29] Taylor, A. E., & Burns, A. T. (2020). Resistance patterns and prevalence of MRSA in hospital-associated infections. Antimicrobial Agents and Chemotherapy, 44(5), 1282-1287.
[30] Thomas, M. B., & Verma, R. (2021). Nosocomial Staphylococcus Aureus infections: Pathogenesis and antimicrobial resistance. Antimicrobial Therapy and Infection Control, 19(1), 34-40.
[31] Vachaspati, C. T., & Kumar, R. (2021). Characterization of MRSA and MSSA strains in hospital environments: Implications for infection control. Journal of Infection Control, 39(3), 254-262.
[32] Wang, M. H., & Zhu, X. H. (2020). MRSA versus MSSA: Comparative study on virulence and resistance patterns. Medical Microbiology and Immunology, 209(2), 105-111.
[33] Wilson, D. E., & Stewart, K. P. (2022). Epidemiology and prevention strategies for MRSA in healthcare settings. Journal of Healthcare-Associated Infections, 31(4), 205-212.
[34] Xu, J., & Yang, L. (2019). Genetic variation between MRSA and MSSA strains isolated from healthcare-associated infections. Journal of Bacterial Infection, 28(3), 340-346.
[35] Yadav, R. M., & Verma, S. K. (2021). The role of hospital infection control in reducing MRSA outbreaks. Journal of Infectious Diseases, 48(9), 1181-1188.
[36] Yu, T. J., & Chen, W. L. (2020). Comparative antimicrobial resistance profiles of MRSA and MSSA in intensive care unit infections. Intensive Care Medicine, 46(8), 1523-1530.
[37] Zafar, M., & Zahid, N. (2021). Surveillance of MRSA and MSSA infections in tertiary care hospitals. Journal of Hospital and Clinical Research, 12(4), 290-295.
[38] Zhang, L., & Liu, Y. (2022). Molecular epidemiology and resistance mechanisms of Staphylococcus Aureus strains in nosocomial infections. Journal of Clinical Pathology, 75(5), 200-206.
[39] Zhao, Z., & Yang, L. (2020). Resistance patterns and clinical outcomes of MRSA and MSSA infections in hospitalized patients. Journal of Medical Microbiology, 69(7), 913-920.
[40] Zhong, W. X., & Hong, Z. Q. (2021). Comparative analysis of virulence factors in MRSA and MSSA isolates from hospital infections. Medical Microbiology, 52(3), 174-180.
[41] Zhou, J., & Li, Y. (2019). Molecular typing of methicillin-resistant Staphylococcus aureus strains in a hospital setting.