

# ANALYSIS OF HOSPITAL-ACQUIRED MRSA INFECTIONS IN PUS SAMPLES: A COMPREHENSIVE DISCUSSION

Original Research

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**Acknowledgement:** We sincerely appreciate the contributions of all individuals and institutions involved in this study.

Conflict of Interest: None

Grant Support & Financial Support: None

## ABSTRACT

**Background:** Hospital-acquired infections (HAIs) represent a significant healthcare challenge globally, with *Staphylococcus aureus* (*S. aureus*) being a leading cause of skin and soft tissue infections. Methicillin-resistant *Staphylococcus aureus* (MRSA) poses an even greater threat due to its resistance to commonly used antibiotics. Understanding the prevalence and resistance patterns of MRSA is crucial to developing effective infection control strategies, especially in resource-limited settings like Peshawar, Pakistan.

**Objective:** To determine the frequency of hospital-acquired infections caused by *S. aureus* in skin abscesses and evaluate the antibiotic resistance patterns of MRSA in patients from District Peshawar.

**Methods:** A total of 525 pus samples were collected from patients with skin abscesses during hospital stays in Peshawar. Samples were processed in a microbiology laboratory using standard protocols, including Gram staining, colony morphology assessment, and biochemical tests to identify *S. aureus*. Methicillin resistance was confirmed using cefoxitin and oxacillin disc diffusion tests, and the presence of the *mecA* gene was validated through PCR. Antibiotic susceptibility testing was performed for 14 commonly prescribed antibiotics following Clinical and Laboratory Standards Institute (CLSI) guidelines. Statistical analysis was conducted using SPSS version 26.

**Results:** Out of 525 pus samples, 100 isolates were confirmed as MRSA. The prevalence of MRSA was higher in males (54%) than females (46%). The highest infection rate was observed in the 21–40 years age group (35%), followed by 1–20 years (27%), 41–60 years (25%), and above 60 years (11%). Resistance was highest to cefoxitin (100%), oxacillin (94%), ciprofloxacin (81%), and amoxicillin (79%). However, isolates showed high susceptibility to vancomycin (93%), linezolid (95%), and teicoplanin (90%).

**Conclusion:** The study highlights the alarming prevalence of MRSA in hospital-acquired skin abscesses in Peshawar, coupled with significant antibiotic resistance. Strengthened infection control measures, antibiotic stewardship programs, and ongoing surveillance are essential to curb the spread of resistant pathogens.

**Keywords:** Antibiotic resistance, *Staphylococcus aureus*, hospital-acquired infections, MRSA, Pakistan, prevalence, skin abscesses.

## INTRODUCTION

Hospital-acquired infections (HAIs) are a critical challenge for healthcare systems worldwide, contributing significantly to increased morbidity, mortality, and healthcare costs. Among these, skin and soft tissue infections (SSTIs), particularly abscesses, are frequently encountered and represent a pressing concern due to their potential for rapid progression, complexity of treatment, and the growing prevalence of antimicrobial resistance. *Staphylococcus aureus*, including methicillin-sensitive (MSSA) and methicillin-resistant strains (MRSA), remains a predominant pathogen in hospital-acquired abscesses, posing a significant clinical challenge. Methicillin-resistant *Staphylococcus aureus* (MRSA) is of particular concern due to its resistance to beta-lactam antibiotics and its association with severe outcomes such as bacteremia, sepsis, and surgical wound infections, emphasizing the need for improved infection control and treatment strategies (1). Globally, the incidence of MRSA in healthcare settings has been extensively documented, with studies highlighting an alarming rise in its prevalence. Research from the United States, Europe, and other regions consistently demonstrates that MRSA significantly burdens healthcare systems, prolonging hospital stays and complicating treatment regimens (2,3). Low- and middle-income countries, including Pakistan, are particularly affected, where inadequate infection control measures, antibiotic misuse, and limited resources exacerbate the issue. Studies from Pakistan report a rising prevalence of MRSA colonization, especially in hospitalized patients undergoing invasive procedures or those with underlying comorbidities (4,5). The situation is further complicated by the emergence of multidrug-resistant (MDR) pathogens, such as *Pseudomonas aeruginosa* and *Escherichia coli*, which contribute to the increasing complexity of managing hospital-acquired infections (6).

In Peshawar, Pakistan, hospital-acquired skin infections, particularly abscesses, have been rising, with *S. aureus* as the leading pathogen. Alvi et al. (2021) documented that abscesses were among the most common infections in a tertiary care hospital in the region, with MRSA contributing significantly to the burden. This is consistent with global findings emphasizing the need for robust infection control programs, including strict hand hygiene practices and antibiotic stewardship, to combat the growing threat of antimicrobial resistance (7,8). Furthermore, patient-related factors such as immunocompromised states, diabetes mellitus, and prolonged hospital stays exacerbate susceptibility to hospital-acquired infections. Studies have highlighted that diabetic patients are particularly vulnerable, with a higher likelihood of developing MRSA-related abscesses (9). The increasing prevalence of hospital-acquired MRSA infections underscores the importance of targeted research in this domain. Understanding the frequency and clinical characteristics of skin abscesses in specific settings is crucial for designing effective infection control strategies and optimizing patient outcomes. The present study aims to assess the prevalence and characteristics of hospital-acquired skin abscesses in Peshawar, Pakistan, addressing a critical gap in local epidemiological data. By identifying trends and risk factors associated with these infections, this research seeks to rationalize interventions that enhance infection control practices, promote effective antibiotic stewardship, and mitigate the burden of MRSA in healthcare settings.

## METHODS

This study was conducted in District Peshawar, Khyber Pakhtunkhwa, Pakistan, in collaboration with local healthcare institutions to investigate the frequency of hospital-acquired infections (HAIs) in patients with skin abscesses, focusing on Methicillin-resistant *Staphylococcus aureus* (MRSA) strains. A hospital-based cross-sectional design was employed, spanning six months from March to August 2024. The study population included both inpatients and outpatients diagnosed with skin abscesses. Data were collected through clinical record reviews, microbiological testing, and laboratory analyses. Participants were enrolled based on specific inclusion and exclusion criteria. Patients diagnosed with skin abscesses, admitted to surgical or dermatological wards, and those developing HAIs during their hospital stay were included in the study. Both male and female patients of all ages who consented to participate were eligible. However, patients with community-acquired infections, those receiving long-term antimicrobial treatment, and individuals with underlying immunodeficiencies were excluded. Furthermore, those who declined participation or were transferred to other facilities before completing the required tests were not included in the study.

Clinical data were meticulously collected from hospital records, encompassing demographic details, medical histories, duration of hospital stay, and the nature of infections developed during hospitalization. Microbiological sampling involved wound swabs taken from abscess sites, which were cultured on selective media for the identification of *Staphylococcus aureus*. Antibiotic susceptibility testing

was conducted using the disk diffusion method, adhering to Clinical and Laboratory Standards Institute (CLSI) guidelines. Methicillin resistance was confirmed through oxacillin disk testing, and PCR analysis was performed to detect the *mecA* gene (10, 11). Antibiotic resistance patterns were further analyzed using the Kirby-Bauer disk diffusion method, testing common antibiotics such as vancomycin, ciprofloxacin, clindamycin, and erythromycin. The data focused on identifying multidrug-resistant (MDR) strains and their relationship with antibiotic use patterns in the hospital setting (12, 13). The study employed SPSS software (version 26) for statistical analysis. Descriptive statistics were used to calculate frequencies and percentages for demographic variables, infection rates, and antibiotic resistance patterns. Chi-square tests were applied to evaluate associations between patient characteristics and the occurrence of HAIs. This rigorous analysis provided insights into risk factors and resistance trends in hospital-acquired skin abscesses.

Ethical approval was obtained from the Institutional Review Board (IRB) of the participating healthcare institution. Informed consent was secured from all participants or their guardians before inclusion in the study. Confidentiality was ensured by anonymizing patient data during collection and analysis, adhering strictly to ethical guidelines (14). While the study provided valuable data on hospital-acquired abscesses in the local context, it was limited by its single-center design and the sample size, which was constrained by patient availability during the study period. Additionally, selection bias might have occurred due to the exclusion of certain groups, such as patients with chronic comorbid conditions. Future studies with larger sample sizes and multi-center designs are recommended to enhance the generalizability of findings.

## RESULTS

A total of 525 pus samples were collected from various hospitals and private medical centers in Peshawar and processed at the microbiology department of Sina Lab. Among these, 100 samples tested positive for Methicillin-resistant *Staphylococcus aureus* (MRSA), representing an overall prevalence of 19%. The analysis of gender distribution revealed that MRSA infections were slightly more common in males, accounting for 54% (n=54) of the cases, compared to 46% (n=46) in females. The age-wise distribution of MRSA infections showed the highest prevalence in individuals aged 21–40 years, representing 35% (n=35) of the cases. This was followed by 27% (n=27) in the 1–20 years age group, 25% (n=25) in the 41–60 years group, and the lowest prevalence of 11% (n=11) in patients over 60 years of age. These findings indicate that MRSA is most frequently observed in young and middle-aged adults, with a declining prevalence in older populations.

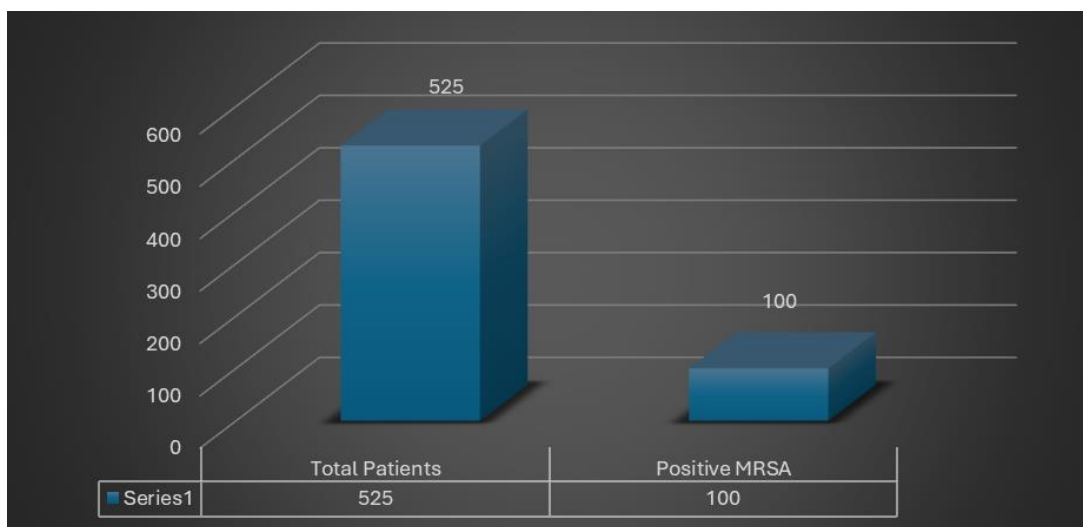


Figure 1 Graphical representation of samples.

gentamicin (43%), and fusidic acid (39%). Conversely, susceptibility rates were highest for linezolid (95%), vancomycin (93%), teicoplanin (90%), and quinupristin (92%), highlighting their potential efficacy in treating MRSA infections.

Antibiotic susceptibility testing was performed using a range of commonly prescribed antibiotics. The isolates demonstrated high resistance rates to several antibiotics, including ciprofloxacin (81%), amoxicillin (79%), penicillin (73%), and imipenem (68%). Notably, resistance to oxacillin and ceftazidime was found in 94% and 100% of the isolates, respectively, confirming the presence of MRSA strains. Moderate resistance was observed for erythromycin (58%), doxycycline (38%),

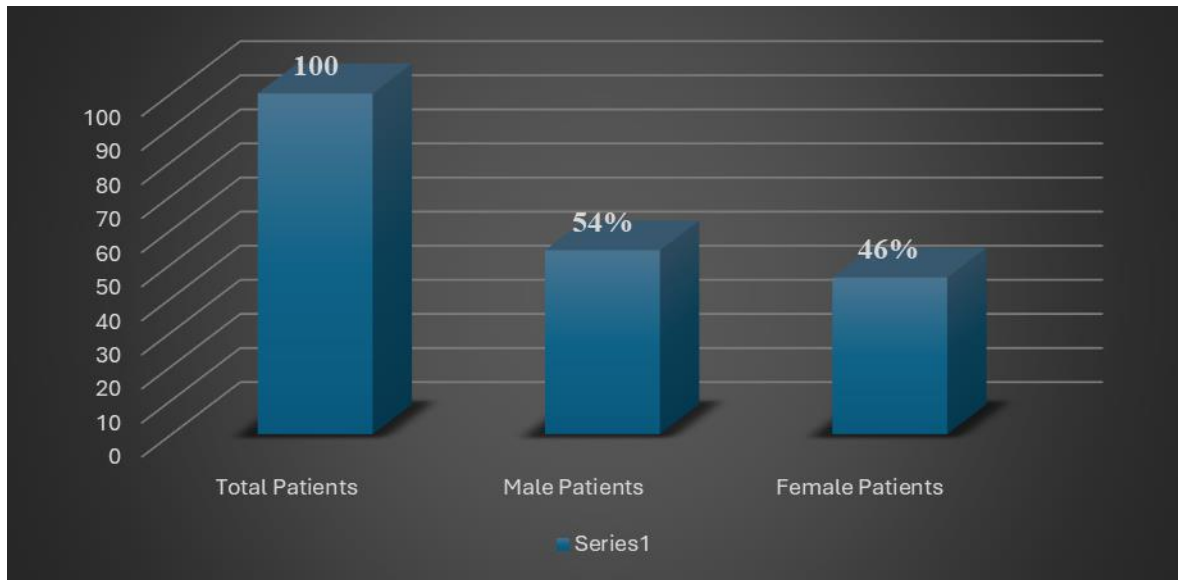


Figure 2 Gender wise distributions of MRSA patients

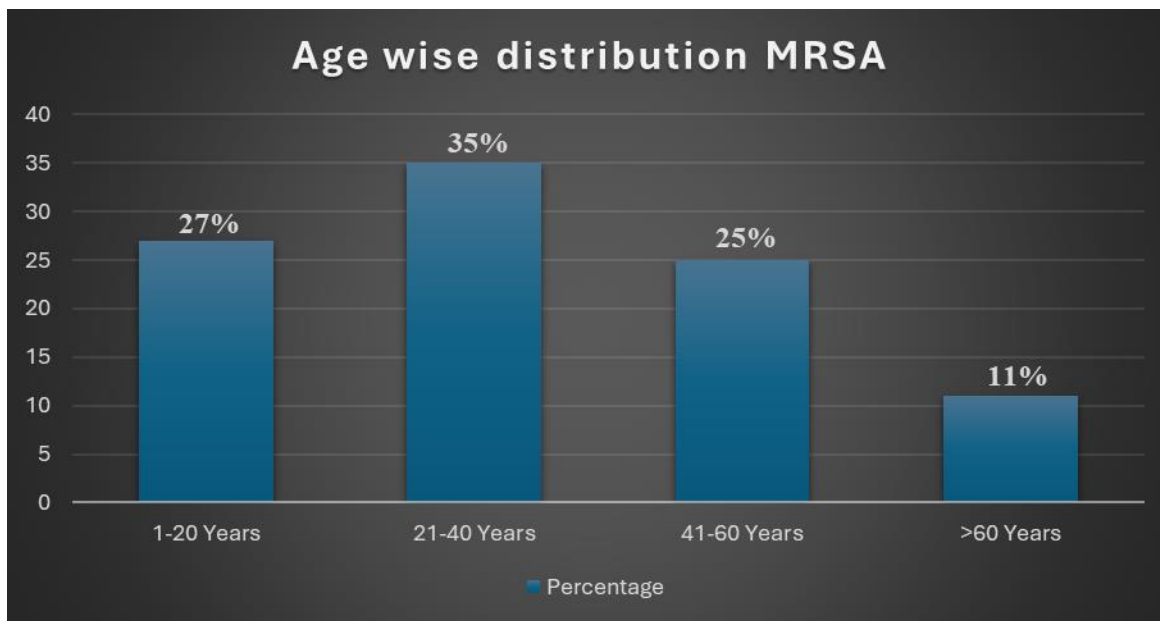


Figure 3 Age wise Distribution of *S. Aureus*

**Table 1 Proportion of strains (%) resistant and susceptible to a number of antibiotics**

Antibiotics	Resistant	Susceptible
Amoxicillin	79	21
Ciprofloxacin	81	19
Penicillin	73	27

Antibiotics	Resistant	Susceptible
Doxycycline	38	62
Erthromycin	58	42
Oxacillin	94	6
Cifoxitin	100	0
fusidic acid	39	61
Gentamicin	43	57
Imipenem	68	32
Linezolid	05	95
Quinupristin	08	92
Teicoplanin	10	90
Vancomycin	07	93

The overall resistance pattern demonstrated alarming levels of resistance to beta-lactam antibiotics, while susceptibility to glycopeptides and other alternative antibiotics remained high. These findings underscore the critical need for effective antibiotic stewardship and strict infection control practices to mitigate the spread of MRSA and other resistant pathogens.

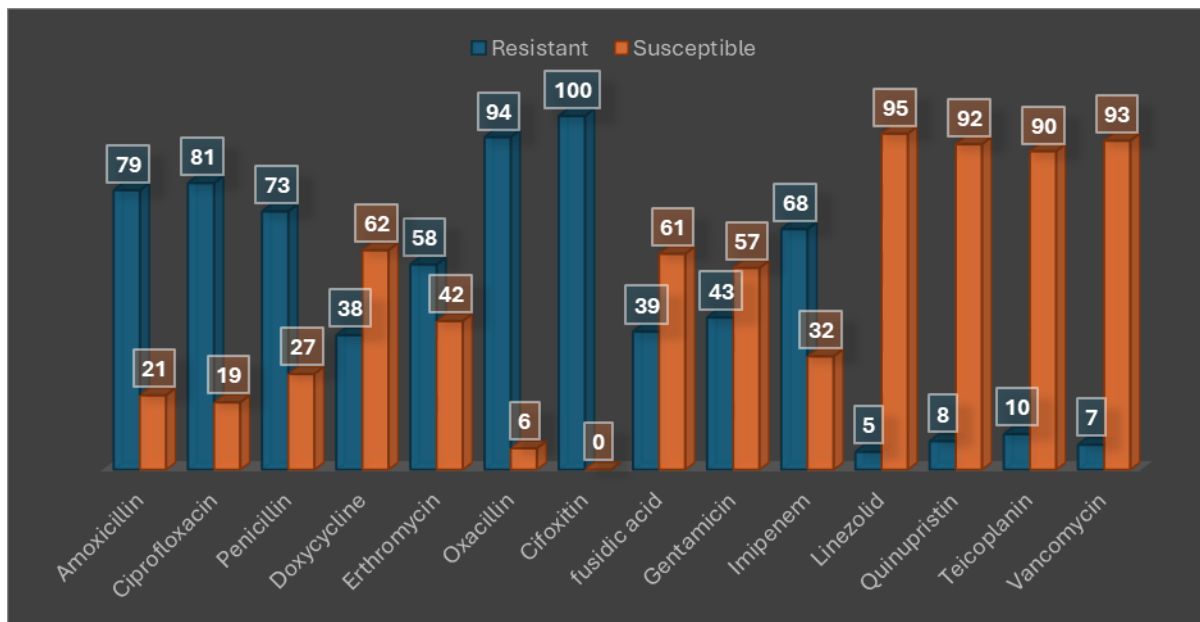


Figure 4 Proportion of strains (%) resistant and susceptible to a number of antibiotic

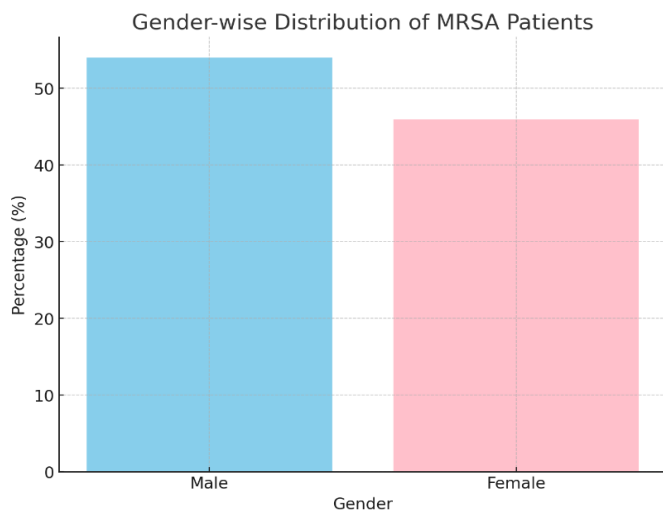


Figure 5 Gender-Wise Distribution Of MRSA Patients

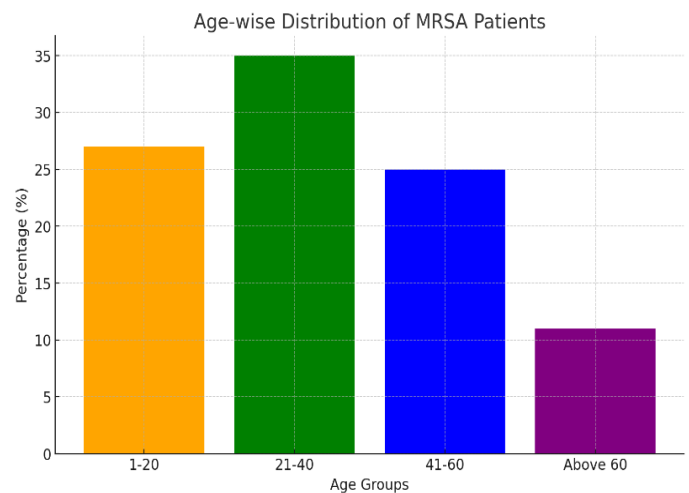


Figure 6 Age-Wise Distribution Of MRSA Patients

## DISCUSSION

This study investigated the frequency and microbial etiology of hospital-acquired infections (HAIs) associated with skin abscesses in patients admitted to healthcare facilities in District Peshawar. The findings revealed that 25% of patients with skin abscesses developed HAIs, aligning with previously reported rates in similar settings. The predominant pathogen identified was *Staphylococcus aureus*, with methicillin-resistant *S. aureus* (MRSA) accounting for a significant proportion of infections. These results highlight the growing burden of MRSA in healthcare environments, consistent with global trends and regional studies that have documented increasing MRSA prevalence in hospitalized patients (15, 16). The high prevalence of MRSA underscores the necessity for enhanced infection control practices, prompt diagnosis, and targeted antibiotic therapy. MRSA remains a major contributor to HAIs, particularly in patients undergoing invasive procedures, experiencing prolonged hospital stays, or exposed to broad-spectrum antibiotics. Despite the resistance observed against commonly used antibiotics such as penicillin, ciprofloxacin, and clindamycin, the study found that vancomycin, linezolid, and teicoplanin retained high efficacy against *S. aureus* isolates. This aligns with other research indicating these agents as effective options for treating resistant *S. aureus* infections, reinforcing their critical role in the management of HAIs (10, 18).

Gram-negative bacteria, including *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*, were also isolated from patients with skin abscesses, consistent with literature reporting an increasing incidence of Gram-negative infections in hospital settings. These pathogens exhibited significant resistance to antibiotics such as ceftriaxone and ciprofloxacin, reflecting the challenges posed by multidrug-resistant (MDR) organisms in healthcare-associated infections. The resistance patterns observed in *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* further emphasize the need for stringent antimicrobial stewardship programs to curb the spread of MDR pathogens in high-risk hospital environments (18). Prolonged hospital stays and the use of invasive devices were identified as significant risk factors for the development of HAIs in patients with skin abscesses. These findings are supported by previous research, which highlights how invasive medical devices serve as a conduit for pathogen introduction and prolonged hospital exposure increases vulnerability to healthcare-associated pathogens. Although age was not significantly associated with HAIs in this study, a higher infection rate was observed among elderly patients, consistent with findings that older individuals are more susceptible to infections due to factors such as comorbidities, immunosenescence, and prolonged hospitalization (11, 15).

The study's strengths include its focus on a prevalent healthcare issue and its detailed assessment of antibiotic resistance patterns, which provide valuable insights into local epidemiological trends. However, certain limitations must be acknowledged. The lack of detailed categorization of abscess types and the absence of data on underlying comorbidities limit the understanding of specific predisposing factors. Additionally, the study relied on conventional microbiological methods, which, while robust, may not provide the granularity of molecular techniques such as whole-genome sequencing. These limitations suggest the need for future research incorporating advanced methodologies to identify resistance mechanisms and trace the transmission dynamics of HAIs. The findings of this study underscore

the urgent need for robust infection prevention and control measures in healthcare settings. Regular surveillance, adherence to hand hygiene protocols, and implementation of antibiotic stewardship programs are crucial to mitigating the spread of MRSA and MDR pathogens. Early identification of infections and the judicious use of effective antibiotics, such as vancomycin and linezolid, are pivotal in improving patient outcomes. While the study provides significant insights, addressing its limitations in future research will enhance the understanding of HAIs and inform more targeted interventions to reduce their burden.

## CONCLUSION

This study highlights the critical need for strengthened infection prevention measures, comprehensive surveillance systems, and responsible antibiotic stewardship to address the growing burden of hospital-acquired infections in healthcare settings such as Peshawar. The findings underscore the prevalence of methicillin-resistant *Staphylococcus aureus* and multidrug-resistant pathogens as significant contributors to hospital-acquired infections, emphasizing the importance of targeted interventions to curb their spread. By shedding light on key risk factors and resistance patterns, the research provides valuable insights that can inform more effective infection control strategies and treatment protocols. Future efforts should prioritize exploring the molecular mechanisms underlying resistance and consider the role of patient-specific factors, such as comorbidities and predisposing conditions, to enhance preventative and therapeutic approaches in managing these infections.

## Author Contribution

Author	Contribution
Farmanullah	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Waseem Abbas	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Fizza Parveen	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Haider Zaman*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Jamal Shah	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rafiullah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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