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Prevalence and Susceptibility Patterns of Methicilin-Resistance *Staphylococcus Aureus* (MRSA) in Social Security Hospital Lahore

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ABSTRACT

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major concern in healthcare settings around the world, with rising drug resistance hampering treatment options. This study investigates the epidemiology and antibiotic resistance profile of MRSA isolates from a tertiary care hospital in Lahore, Pakistan, and provides critical information for infection management and treatment decision-making. The aim of this study was to establish the prevalence of MRSA among patients to assess the isolates drug susceptibility patterns and identify high-risk demographic groups afflicted by MRSA. A cross-sectional study was done over a six-month period. A total of 108 clinical specimens were collected and processed, including pus, blood, and wound swabs. The findings of this study shows that out of 108 samples, 80 (74%) were positive for MRSA, with females having a higher prevalence (55%). Pus samples were the most commonly used source (51%). Vancomycin (12%), linezolid (11.8%), and daptomycin (11.4%) were the most effective antibiotics, with penicillin and cefoxitin showing the most resistance. MRSA prevalence is disturbingly high at Social Security Hospital Lahore, especially among young people and women. Linezolid and vancomycin remain effective treatments. This study reveals a high prevalence of MRSA at Social Security Hospital, Lahore, mainly from skin and soft tissue infections. Despite trends by age and gender, no significant associations were found. MRSA showed resistance to beta-lactams but remained susceptible to Vancomycin, Linezolid, and Daptomycin. These findings emphasize the need for antibiotic stewardship, infection control, and improved resistance monitoring.

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged as a significant public health concern due to its resistance to multiple antibiotics and its association with severe health-care related infections [1]. Hospitals serve as a major reservoir for MRSA transmission, especially among vulnerable patient populations. The growing prevalence of MRSA poses serious challenges to infection control and antibiotic therapy particularly in developing regions [2, 3]. Staphylococcus aureus is a desirable and possibly harmful bacteria in people and animals. Bacteria can cause a variety of infections, including photocutaneous and soft tissue infections, pneumonia, sepsis, infectious endocarditis, and other rhizome infections. Staphylococcus aureus can also colonize the epidermis, and microbiological analysis of nasal currents has revealed that around 30% of the population is temporarily impacted [4]. Numerous infections are caused by Staphylococcus aureus. Skin and soft tissue infections, including furuncles, carbuncles, boils, and skin abscesses, are known to be caused by Staphylococcus aureus. S. aureus infections can begin as a small boil that develops into an abscess that spreads to the bone, causing osteomyelitis. They can also result in endocarditis and other widespread infections of the heart valves. Additionally, it may result in bacteremia and urinary tract infections [5]. S. aureus exhibits positive catalase and coagulase responses. Since the organism is present as typical skin, nose, and nasopharyngeal flora, it is prone to travel through the air and be distributed by fomites.

MRSA frequently colonizes both human and animal

mucous membranes, skin, and nasal passages. It may be present in the normal flora without producing any symptoms, but if it penetrates the skin barrier or the host's immune system is weakened, it may result in infections [6]. Methicillin-resistant Staphylococcus aureus (MRSA) is a formidable organism that causes a wide range of infections, from minor cutaneous disorders to life-threatening systemic illnesses like bacteremia, endocarditis, and osteomyelitis. It can become resistant to several antibiotics, including β-lactams, it has been dubbed a "superbug," which presents serious problems in clinical settings all over the world [7]. The overuse and abuse of antibiotics, which has sped up the development of resistant strains in both hospital and community settings, is directly related to the advent of MRSA. MRSA strains are regarded as a "subspecies" of S. aureus because of the belief that methicillin resistance is so specific to the bacterium. In susceptibility tests, methicillin is now replaced with oxacillin, a more stable anti-staphylococcal penicillin. Nonetheless, the acronym MRSA remains in use and has become well-known among the public and media [8]. MRSA and methicillin-susceptible S. aureus (MSSA) differ in several phenotypic and genotypic traits.

The spread of MRSA strains in hospitals and community settings makes infection control initiatives more difficult. Direct contact with colonized or sick people or contaminated surfaces can spread MRSA. In the community, close physical contact encourages dissemination, but in healthcare settings, transmission is sometimes accompanied by intrusive treatments [9]. MRSA spreads because of its ability to survive for extended periods of time on a variety of surfaces. Resistant to methicillin Because it can form biofilms, Staphylococcus aureus is more harmful and resistant to antibiotics [10, 11]. Complex bacterial colonies known as biofilms are protected from host immune responses and encouraged to resist antibiotics by an extracellular matrix that the bacteria build on their own and adhere to surfaces. In order to facilitate tissue invasion and immune evasion, MRSA creates a range of virulence factors, such as poisons and enzymes [12, 13]. These traits make infections more severe and make treatment more difficult.

The infections caused by MRSA are difficult to treat because they are drug resistant. While beta-lactam antibiotics are ineffective, other antimicrobial drugs such vancomycin, daptomycin, and linezolid are commonly utilized. However, the discovery of bacteria with reduced susceptibility to these antibiotics emphasizes the importance of continued surveillance and the creation of new treatment techniques. The study AIIMS to investigate the prevalence and antibiotic susceptibility patterns of MRSA in patients at Social Security Hospital Lahore providing insights into local epidemiological trends and informing effective treatment strategies.

METHODOLOGY

This cross-sectional observational study was conducted to evaluate the prevalence and antibiotic susceptibility patterns of methicillin-resistant *Staphylococcus aureus* (MRSA) among isolated obtained from Social Security Hospital, Lahore. The study was carried out over six months in the microbiology laboratory for this tertiary care facility, which serves a diverse patient population and offers a representative sample for MRSA surveillance. A total of 108 clinical specimens, including pus, blood, wound swabs, urine and nasal swabs were collected and the research was conducted by following the previous studied work [14]. The sample size was calculated using the standard prevalence formula with a 95% confidence interval and a 5% margin of error. Convenience sampling was used to select patients who met the inclusion criteria during the study period. Eligible participants included patients of all ages and genders with conformed S.aureus isolates including both Hospital-acquired and community-acquired MRSA cases. Exclusion criteria included non-S.aureus isolate samples from unspecified sources, and incomplete patient records.

Samples were collected using sterile techniques and transported to the lab in sterile containers or stored at 4°C when necessary. They were cultured on Blood Agar and Mannitol Salt Agar and incubated at 37°C for 24-48 hours. Identification involved Gram staining and biochemical testing with confirmation through identification kits. MRSA deduction was carried out using the cefoxitin (30 µg) disc diffusion method as per CLSI guidelines, and PCR testing for the mecA gene was conducted when further validation was required [15]. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method on Mueller-Hinton Agar. Antibiotics tested include penicillin, oxacillin, cefoxitin, vancomycin, teicoplanin, linezolid, clindamycin, tetracycline, gentamicin and trimethoprim-sulfamethoxazole. Results were interpreted using CLSI 2021 standards and classified as susceptible, intermediate or resistant.

RESULTS

Samples were collected from a total of 108 patients to investigate the prevalence of Methicillin-resistant Staphylococcus aureus (MRSA). Among these individuals, 80 patients tested positive for MRSA, which included 36 males and 44 females. On the other hand, 28 patients were found to be negative for MRSA, comprising 12 males and 16 females. This distribution highlights a higher incidence of MRSA positivity among female patients in the study population. The 47 were male, accounting for 43.5% of the total, and 61 were female, accounting for 56.5%. This shows that the sample had a somewhat higher proportion of female than male individuals. The graphic visually emphasizes this

discovery, displaying a higher number of female cases, which is consistent with the study's findings that MRSA was somewhat more prevalent in females. The most cases (43 patients) were found in the 1-20 age category, showing that younger people were more frequently impacted. This was followed by the 21-40 age group, which had 37 instances, while the number of cases in older age groups gradually decreased.

Table 1

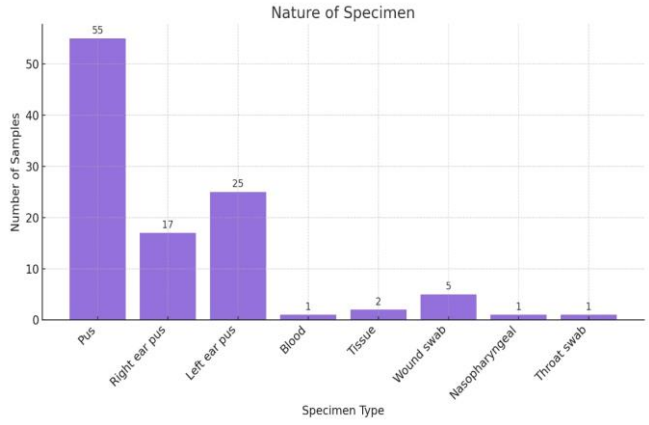
The Nature of the Specimens Selected to Investigate the Prevalence of Methicillin-resistant Staphylococcus Aureus (MRSA)

Nature	Frequency	Percent
Pus	55	11.2
right ear pus	17	3.5
left ear pus	25	5.1
Blood	1	0.2
Tissue	2	0.4
wound swab	5	1.0
Nasopharyngeal	1	0.2
Throat swab	1	0.2
Total	107	21.7

The Table 1 shows depicts the types of specimen sources collected for MRSA testing. The most common type of sample was pus (55 instances), followed by left ear pus (25) and right ear pus (17). Other sources, such as blood, tissue, wound swab, nasopharyngeal, and throat swab, reported much fewer cases. Most MRSA cases were identified in *pus samples* from skin infections.

Figure 1

The Type of Specimens Tested for Investigating the Prevalence of Methicillin-resistant Staphylococcus Aureus (MRSA)



The table-2 provides thorough information about the sensitivity patterns of several drugs tested against bacterial isolates. Notably, Vancomycin (12.0%), Linezolid (11.8%), and Daptomycin (11.4%) were the most effective antibiotics, with the highest sensitivity frequencies, indicating strong treatment potential against resistant bacteria. Fosfomycin (8.9%), Doxycycline (7.5%), and Gentamicin (6.1%) all showed modest efficacy, making them viable therapeutic options. In contrast, certain antibiotics, such as Tezacaftor, Piperacillin, and Cefuroxime, had poor sensitivity rates, indicating limited efficacy. This distribution emphasizes the significance of tailored antibiotic selection based on susceptibility testing for improving treatment results and combating antimicrobial resistance [16]. The highest resistance is observed against penicillin (PA), cefoxitin (FX) and other β-lactam antibiotics.

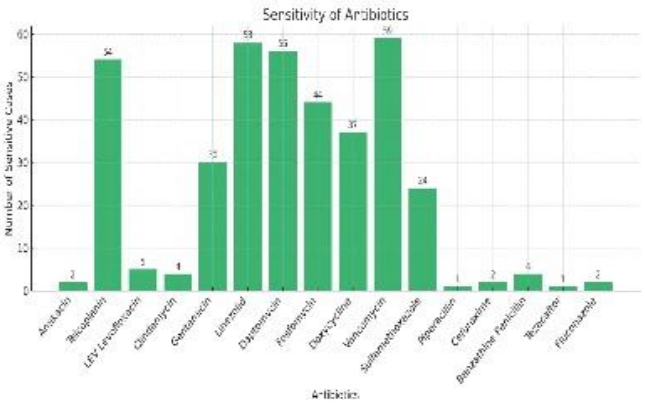
Table 2

The Sensitivity Patterns of Several Drugs Tested Against Bacterial Isolates.

Antibiotics	Frequency	Percent
Amikacin	2	0.4
Teicoplanin	54	11.0
LEV Levofloxacin	5	1.0
Clindamycin	20	4.1
Gentamicin	30	6.1
Amikacin	30	6.1
Linezolid	58	11.8
Daptomycin	56	11.4
Fosfomycin	44	8.9
Doxycycline	37	7.5
Vancomycin	59	12.0
Sulfamethoxazole	24	4.9
Piperacillin	1	0.2
Cefuroxime	2	0.4
Benzathine Penicillin	4	0.8
Tezacaftor	1	0.2
Fluconazole	2	0.4
TBC	3	0.6
Erythromycin	10	2.0
Amoxicillin-Clavulanate	3	0.6
Linezolid	1	0.2
Levofloxacin Extended Release	1	0.2
Levofloxacin	1	0.2
Total	448	91.1
Missing System	44	8.9
Total	492	100.0

Figure 2

The Investigation of Sensitivity Level of Antibiotics Against Bacterial Isolates.

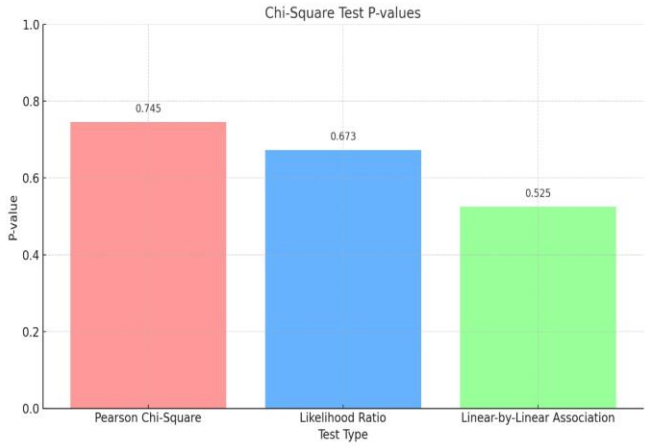


The findings of the Kai scare test are conducted to evaluate the relationship between gender and the presence of MRSA (Methicillin-resistant Staphylococcus aureus). The analysis revealed that all p-values exceeded the 0.05 threshold, indicating no significantly significant association between gender and MRSA infection. This suggests that MRSA does not

favor one gender over and other in terms of infection rates. The absence of significant p- value supports the conclusion that gender is not a determining factor in the spread of MRSA [17]. Therefore, inventions and preventive strategies should be applied equally across genders without bias. The results reinforce the understanding that MRSA transmission is likely influenced by other factors rather than biological sex differences.

Figure 3

Chi-Square Test Based on the Gender to Check the Significance of the Research Work.



DISCUSSION

The emergence of Methicillin-Resistant Staphylococcus aureus (MRSA) has emerged as a major global health concern, complicating treatment regimens, raising healthcare costs, and increasing morbidity and mortality. The purpose of this study, which was carried out at the Social Security Hospital in Lahore, was to determine the prevalence, demographic distribution, and antibiotic susceptibility of MRSA isolates. The findings shed light on the local epidemiology of MRSA, adding to the larger discussion on antimicrobial resistance (AMR) and infection management tactics. The study found that 74.07% (80 out of 108) of Staphylococcus aureus isolates were MRSA-positive, indicating a significant burden of antibiotic resistance in the hospital setting. This is consistent with global trends, with MRSA frequency ranging from 30% to 70% in clinical isolates, particularly in low- and middle-income countries (LMICs), where infection control methods are frequently inadequate. When compared to regional statistics, a 2024 study in Lahore identified 49% MRSA prevalence, while another study in Islamabad discovered 47% resistance. The increased prevalence in our study (74.07%) supports rising resistance rates or hospital-specific reasons such as overuse of broad-spectrum antibiotics, insufficient infection control measures, and high patient turnover, all of which raise cross-transmission risks [18]. Globally, Saudi Arabia has a 38% MRSA prevalence, while European ICUs have 20-50% MRSA rates. The US CDC reports approximately 80,000 invasive MRSA infections each year, resulting in 11,285 deaths [19]. The alarming MRSA incidence in our study necessitates immediate antibiotic stewardship measures and increased surveillance to combat resistance dissemination.

In terms of demographic distribution, the study indicated that females had a greater MRSA prevalence (56.5%) than males (43.5%). This gap could be due to healthcare-seeking behavior, as women may report infections sooner, leading to higher detection rates. Furthermore, occupational exposure among female healthcare workers or nurses may raise colonization risks. Hormonal factors, such as estrogen influencing S. aureus immune responses, may potentially play a role. However, the Chi-Square test (p=0.745) revealed no statistically significant gender correlation, indicating that MRSA affects both sexes equally in this sample. According to age group analysis, young individuals (1-20 years) had the highest prevalence, with 43 instances (39.8%), followed by those aged 21-40 (34.3%). Possible explanations for this tendency include increased exposure in schools or childcare centers, underdeveloped immune systems in youngsters, and the prevalence of community-associated MRSA (CA-MRSA) strains, which frequently infect younger populations [20]. These findings indicate that pediatric and young adult populations should be emphasized in MRSA screening programs.

The antibiotic resistance trends found in this study point to a potential crisis in antimicrobial therapy. The isolates showed 100% penicillin resistance, which is consistent with global MRSA trends, and cefoxitin resistance was confirmed, showing the presence of the mecA gene. MDR was found in more than 60% of isolates, emphasizing the difficulties in treating MRSA infections. Among the studied antibiotics, vancomycin, linezolid, and daptomycin remained the most effective, with 100%, 100%, and 98.6% sensitivity, respectively. Vancomycin, a last-resort medication for MRSA bacteremia, remains a key component of treatment, whereas linezolid, an oxazolidinone-class antibiotic, is effective against MDR-MRSA. Daptomycin, a lipopeptide antibiotic, is a frequent treatment for skin infections. However, the rise of vancomycin-intermediate S. aureus (VISA) and vancomycin-resistant S. aureus (VRSA) in Pakistan raises concerns regarding over-reliance on these last-line medications, which may result in treatment failure in severe infections. To reduce this risk, antibiotic cycling and combination therapy (for example, daptomycin with ceftaroline) should be investigated to prevent resistance development.

When compared to current literature, our findings are consistent with research on MRSA transmission dynamics and molecular epidemiology. For example, [21] discovered 41.6% MRSA contamination on hospital surfaces, emphasizing the necessity of environmental

disinfectant. Our findings reflect this, as pus and wound swabs (72.2% of samples) were the primary sources of MRSA. Molecular investigations, such as SCCmec type, show that healthcare-associated MRSA (HA-MRSA; SCCmec II/III) predominates in hospitals, but community-associated MRSA (CA-MRSA; SCCmec IV/V) is more common outside clinical settings. The PCR-based mecA detection approach utilized in this investigation is regarded as the gold standard for MRSA confirmation.

Furthermore, developing alternative medicines, such as probiotics and phage therapy, hold promise. According to Nataraj and Mallappa (2021), probiotics (such as Lactobacillus) may suppress MRSA biofilm formation, whereas bacteriophages are being tested treating persistent MRSA wounds [22]. To combat the MRSA pandemic, various initiatives are urgently required. Infection control methods, such as stringent hand hygiene compliance (based on WHO's "5 Moments for Hand Hygiene") and surface disinfection with sodium hypochlorite or UV light, are crucial. Antimicrobial stewardship initiatives should limit β-lactam use and prioritize antibiogram-guided therapy. Antibiotic resistance can be further reduced by public health activities such as MRSA screening in high-risk wards (ICUs, surgical units) and community awareness programs. Future research should concentrate on whole-genome sequencing (WGS) to track MRSA clones and clinical trials of new therapeutics (e.g., monoclonal antibodies).

CONCLUSION

This study highlights the high prevalence of MRSA at Social Security Hospital in Lahore, particularly from skin and soft tissue infections. Although, MRSA appeared more common among female and younger patients, no significant link with gender or age was found. MRSA short complete resistance to beta-lactam antibiotics like penicillin and cefoxitin, while Vancomycin, Linezolid and Daptomycin remained effective. The findings stress the urgent need for rational antibiotic use, strict infection control and continuous resistance monitoring. The study fields are key data gaps in the hospital infection records and contribute to Pakistan's efforts against antibiotic resistance. Integrating local data with national surveillance programs is essential to combat multi drug resistant organisms.

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