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DRUG PATTERN OF HOSPITAL AND COMMUNITY-ACQUIRED METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS

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ABSTRACT

Background: *Methicillin resistant Staphylococcus aureus becomes one of the most common causes of nosocomial infections and serious hospital-acquired infections in developing countries.*

Objectives: *The objective of this study was to determine the drug pattern of hospital and community-acquired methicillin resistant Staphylococcus aureus.*

Methodology: *This cross-sectional study was conducted from June 2024 to November 2024. This study enrolled one hundred and seventy two patients having MRSA infection and both males and females of all age groups. After obtaining verbal informed consent, different clinical samples were collected from patients from the infectious site. MRSA isolates were recovered from the clinical specimens from patients presented to the tertiary care hospital. Further antimicrobial susceptibility testing was done according to the CLSI 2024 guidelines by Kirby-Bauer disc diffusion method. The collected data was analyzed by the IBM SPSS software.*

Results: *From total 172 patients, 59.30% were males and 40.69% were females. In total MRSA, 70.34% were hospital acquired while 29.65% were community acquired. Most HA-MRSA was isolated from pus (57.85%), and wound swab (24.79%) followed by others. The most CA-MRSA also isolated from pus (60.78%), and (27.45%) followed by other clinical specimens. Pencillin, amoxicillin, ciprofloxacin, cotrimoxazole, erythromycin, were highly resistant against HA-MRSA and CA-MRSA.*

Conclusion: *The present study found that the HA-MRSA is more prevalent than CA-MRSA. The MRSA infections are more prevalent in males and originated from pus samples.*

Keywords: *Methicillin resistant Staphylococcus aureus, hospital acquired MRSA, community acquired MRSA, antimicrobial pattern*

INTRODUCTION

Staphylococcus aureus (S. aureus) is a bacterium that is natural to the human flora and is widely distributed in the environment. The majority of healthy people have S. aureus on their skin and mucous membranes (mostly the nares) (1). In a healthy human with intact skin membranes, this bacterium normally does not cause illness; nevertheless, once S. aureus spreads in the circulation or internal soft tissues, potentially life-threatening infections can arise. Staphylococcus aureus plays a range of roles in disease. Skin infections, food poisoning, bone infections, bacteremia, and implanted device infections are the common one caused by S. aureus (2).

S. aureus was discovered by the German scientist Friedrich Julius Rosenbach in 1884; nevertheless, it was not until the 1930s that enzyme testing was utilized to diagnose a Staphylococcal infection caused by the bacteria's ability to produce coagulase. This approach, together with penicillin, was used by physicians to diagnose and treat S. aureus. Prior to 1940, before the use of penicillin, 75% of individuals infected with S. aureus perished. Unfortunately, by the end of the 1940s, a resistant strain [Methicillin resistant Staphylococcus aureus (MRSA)] had arisen, rendering standard penicillin ineffective for treating S. aureus. Today, this resistant strain is found in both hospital settings (HA-MRSA) and in the general population (CA-MRSA) (3).

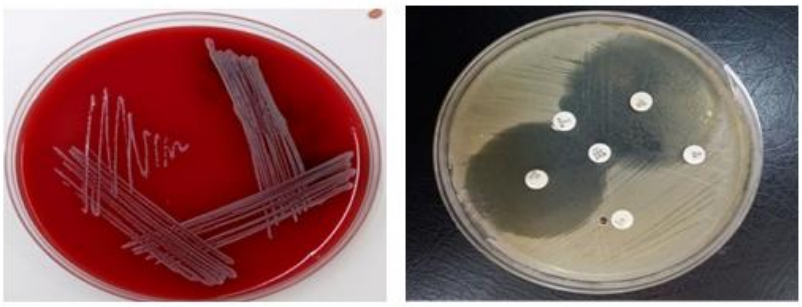
To better understand the distinctions between HA-MRSA and CA-MRSA, as well as their resistance levels, an examination of their genetic and structural arrangement is required. The resistance genes, virulence factors, and toxins help to explain why S. aureus is resistant to most traditional therapeutic drugs, contributing to increased morbidity and death among patients (4). There are many genes in which two gens are more important for the existence of MRSA included the Staphylococcal cassette cartridge mecA resistance gene (SCCmec) and the Panton-Valentine Leukocidin toxin gene (PVL) (5).

Because of its resistance, S. aureus becomes one of the most common causes of nosocomial infections and serious hospital-acquired infections (6) in developing countries like Pakistan. Various studies have shown an increased prevalence of S. aureus infections which may be attributed to its carriage in anterior nares and hands of health care workers and patients (7, 8). The drug resistance seen in cases of S. aureus infections is also a great concern for the clinicians to prevent spread of infections (9). The objective of this study was to determine the drug pattern of hospital and community-acquired methicillin-resistant S. aureus.

Materials & Methodology

This cross-sectional study was conducted from June 2024 to November 2024. A non-probability convenient sampling technique was followed. This study enrolled one hundred and seventy two patients having MRSA infection and both males and females of all age groups. A performa was designed to collect the data from every patient. After obtaining verbal informed consent, different clinical samples were collected from patients from the infectious site.

MRSA isolates were recovered from the clinical specimens from patients presented to the tertiary care hospital. Specimens other than urine were inoculated on blood agar and MacConkey agar while urine was inoculated via a sterile calibrated loop on CLED (cysteine lactose electrolyte deficient agar) and incubated for 24 hours. Plates were incubated at 37^{o}C for 48 hours. The S. aureus were identified on the basis of its morphology (Golden yellowish colonies of *Staphylococcus Aureus* showing hemolysis in the inoculum), gram positive cocci on gram stain, coagulase positive test, and DNase positive test.



(A) (B)

Figure 1: Isolate of Staphylococcus *Aureus* on Blood agar Plate

MRSA was detected by using cefoxitin (30 µg) disc as per Clinical and Laboratory Standards Institute (CLSI 2024) guidelines. Zone of inhibition ≥22 mm was considered as sensitive and such isolates were excluded from the study, whereas ≤21 was considered as resistant. Further antimicrobial susceptibility testing was done according to the CLSI 2024 guidelines by Kirby-Bauer disc diffusion method for the following antibiotics: Ciprofloxacin, Erythromycin, Rifampicin, Linezolid, Amikacin, Clindamycin, Vancomycin, Fusidic acid, Gentamycin, Cotrimoxazole, Tigecycline, Penicillin, Doxycycline, Chloramphenicol, and Amoxicillin. The collected data was entered in a excel sheet and analyzed by the Statistical Package for the Social Sciences (IBM SPSS) version 27.0 software. Descriptive statistical analysis was done. The frequencies mean and percentages of study variables were calculated.

Results

From total 172 patients, 102 (59.30%) were males and 70 (40.69%) were females. In total MRSA, 121 (70.34%) were hospital acquired while 51 (29.65%) were community acquired (Figure 1). From 102 males, 73 (60.33%) had HA-MRSA and 29 (56.86%) had CA-MRSA infections. From 70 females, 48 (39.66%) had HA-MRSA and 22 (43.13%) had CA-MRSA infections. The patients were divided into four age groups (Table 1). The mean age was calculated for both HA-MRSA and CA-MRSA and was 33.51±1.76, 35.91±1.66 respectively. The HA-MRSA and CA-MRSA were isolated from pus, wound swab, sputum, fluid, tracheal secretions, blood, CVP tip, High Vaginal Swab (HVS), nasal swab, urine, and tissue. Most HA-MRSA was isolated from pus (57.85%), and wound swab (24.79%) followed by others. The most CA-MRSA also isolated from pus (60.78%), and (27.45%) followed by other clinical specimens (Table 1).

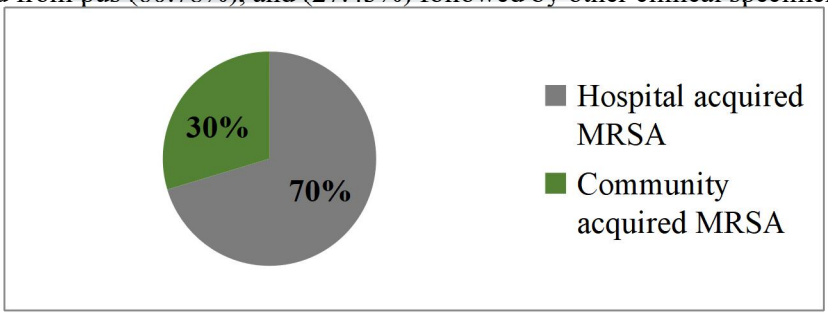


Figure 1: Percentage of hospital and community acquired methicillin resistant Staphylococcus aureus

Table 1: Characteristics of study variables

Study variables	Hospital acquired MRSA n=121	Community acquired MRSA n=51
Gender		
Male	73 (60.33%)	29 (56.86%)

Female	48 (39.66%)	22 (43.13%)
Mean Age (Years)	33.51±1.76	35.91±1.66
Age group (Years)		
1-20	23 (19.00%)	03 (5.88%)
21-40	55 (45.45%)	03 (5.88%)
41-60	32 (26.44%)	36 (70.58%)
61-80	11 (9.09%)	09 (17.64%)
Specimens		
Pus	70 (57.85%)	31 (60.78%)
Wound swab	30 (24.79%)	14 (27.45%)
Sputum	07 (5.78%)	-
Fluid	-	01 (1.96%)
Tracheal secretions	05 (4.13%)	01 (1.96%)
Blood	03 (2.47%)	-
Central venous pressure catheter tip	01 (0.82%)	02 (3.92%)
High Vaginal Swab	02 (1.65%)	-
Nasal swab	01 (0.82%)	01 (1.96%)
Urine	01 (0.82%)	01 (1.96%)
Tissue	01 (0.82%)	-

The antimicrobial pattern of MRSA was assessed in both HA-MRSA and CA-MRSA. Pencillin (100%), amoxicillin (100%), ciprofloxacin (95.04%), cotrimoxazole (87.60%), erythromycin (77.68%), and amikacin (57.02%) were highly resistant against HA-MRSA. In comparison pencillin (100%), amoxicillin (100%), ciprofloxacin (90.19%), cotrimoxazole (86.27%), erythromycin (70.58%), and gentamycin (52.94%) were highly resistant against CA-MRSA. (Table 2)

Table 2: Resistant pattern of antibiotics in hospital and community acquired methicillin resistant Staphylococcus aureus

Antibiotics	**Hospital acquired MRSA n=121**	**Community acquired MRSA n=51**
Amikacin	69 (57.02%)	24 (47.05%)
Amoxicillin	121 (100%)	51 (100%)
Cefoxitin*	121 (100%)	51 (100%)
Chloramphenicol	58 (47.93%)	21 (41.17%)
Ciprofloxacin	115 (95.04%)	46 (90.19%)
Clindamycin	67 (55.37%)	26 (50.98%)
Cotrimoxazole	106 (87.60%)	44 (86.27%)
Doxycycline	50 (41.32%)	21 (41.17%)
Erythromycin	94 (77.68%)	36 (70.58%)
Fusidic acid	50 (41.32%)	20 (39.21%)
Gentamycin	59 (48.76%)	27 (52.94%)
Penicillin	121 (100%)	51 (100%)
Rifampicin	17 (14.04%)	08 (15.68%)
Tigecycline	22 (18.18%)	13 (25.49%)

- Diagnostic disc for detecting MRSA

The antimicrobial sensitivity pattern of MRSA was assessed in both HA-MRSA and CA-MRSA. Linezolid (100%), vancomycin (100%), tigecycline (81.81%), fusidic acid (58.67%), doxycycline (58.67%), chloramphenicol (52.06%), and gentamycin (51.23%) were highly sensitive against HA-MRSA. In comparison linezolid (100%), vancomycin (100%), rifampicin (84.31%), tigecycline (74.50%), fusidic acid (60.78%), chloramphenicol (58.82%), and doxycycline (58.82%), were highly sensitive against CA-MRSA. (Table 3)

Table 3: Sensitivity pattern of antibiotics in hospital and community acquired methicillin resistant Staphylococcus aureus

Antibiotics	**Hospital acquired MRSA n=121**	**Community acquired MRSA n=51**
Amikacin	52 (42.97%)	27 (52.94%)
Chloramphenicol	63 (52.06%)	30 (58.82%)
Ciprofloxacin	06 (4.95%)	05 (9.80%)
Clindamycin	54 (44.62%)	25 (49.01%)
Cotrimoxazole	15 (12.39%)	07 (13.72%)
Doxycycline	71 (58.67%)	30 (58.82%)
Erythromycin	27 (22.31%)	15 (29.41%)
Fusidic acid	71 (58.67%)	31 (60.78%)
Gentamycin	62 (51.23%)	24 (47.05%)
Linezolid	121 (100%)	51 (100%)
Rifampicin	104 (85.95%)	43 (84.31%)
Tigecycline	99 (81.81%)	38 (74.50%)
Vancomycin	121 (100%)	51 (100%)

Discussion

The present study assessed the frequency of HA-MRSA and CA-MRSA. The patients had different clinical infections were enrolled. In total MRSA, (70.34%) were HA-MRSA while (29.65%) were CA-MRSA. From 121 HA-MRSA, (60.33%) were isolated from males while (39.66%) were isolated from females. From 51 CA-MRSA, (56.86%) were isolated from males while (43.13%) were isolated from females. The mean age was calculated for both HA-MRSA and CA-MRSA and was 33.51±1.76, 35.91±1.66 respectively. The patients were divided into four age groups: [1-20, 21-40, 41-60, and 61-80]. In HA-MRSA the age groups were distributed as: [1-20 (19.00%), 21-40 (45.45%), 41-60 (26.44%), and 61-80 (9.09%)] and in CA-MRSA age groups were distributed as: [1-20 (5.88%), 21-40 (5.88%), 41-60 (70.58%), and 61-80 (17.64%)]. The study of Adhikari et al. recovered S. aureus from 499 (6.71%) of the 7433 clinical specimens. Of the 499 S. aureus isolates, 267 (53.5%) were from males and 232 (46.5%) from females, resulting in a sex ratio of 1.14:1. The study participants ranged in age from 5 days to 93 years, with a mean of 29.17±2.04 years and a median of 26.00 (IQR:14-40) year (10). In Preeja et al. study 520 S. aureus isolated from which, 132 were MRSA. They identified 81 (61.4%) isolates were as CA-MRSA and 51 (38.6%) as HA-MRSA (11). These findings are not in consistent with the present study showing more frequency of HA-MRSA. Many other studies are also showing high frequency of CA-MRSA as compared to HA-MRSA (12-14).

The HA-MRSA and CA-MRSA were isolated from pus, wound swab, sputum, fluid, tracheal secretions, blood, CVP tip, HVS, nasal swab, urine, and tissue. Most HA-MRSA was isolated from pus (57.85%), and wound swab (24.79%). The most CA-MRSA also isolated from pus (60.78%), and (27.45%). In Preeja et al.

study, MRSA was isolated from patients suffering from simple cutaneous infections to severe systemic illness. CA-MRSA was approximately equally isolated from outpatients (44.4%) and inpatients (55.6%), indicating that CA-MRSA is prevalent in both community and hospital settings, whereas inpatients accounted for 96.1% of HA-MRSA (11). According to Adhikari et al. S. aureus was the most commonly isolated from pus/swab samples (74.0%), followed by blood (10.4%), bodily fluid (6.0%), sputum (5.2%), and urine (4.4%) (10).

In present study, the antimicrobial pattern of MRSA was assessed in both HA-MRSA and CA-MRSA. Pencillin (100%), amoxicillin (100%), ciprofloxacin (95.04%), cotrimoxazole (87.60%), erythromycin (77.68%), amikacin (57.02%) were highly resistant against HA-MRSA. In CA-MRSA, pencillin (100%), amoxicillin (100%), ciprofloxacin (90.19%), cotrimoxazole (86.27%), erythromycin (70.58%), gentamycin (52.94%) were highly resistant. The antimicrobial sensitivity pattern shows linezolid (100%), vancomycin (100%), tigecycline (81.81%), fusidic acid (58.67%), doxycycline (58.67%), chloramphenicol (52.06%), and gentamycin (51.23%) were highly sensitive against HA-MRSA. In comparison linezolid (100%), vancomycin (100%), rifampicin (84.31%), tigecycline (74.50%), fusidic acid (60.78%), chloramphenicol (58.82%), and doxycycline (58.82%), were highly sensitive against CA-MRSA. Preeja et al. discovered CA-MRSA isolates that were resistant to three or more antibiotic classes. These isolates were resistant to cefotaxime (44.4%), gentamicin (40.7%), ciprofloxacin (86.4%), clindamycin (40.7%), erythromycin (66.7%), and ofloxacin (49.4%). All MRSA isolates (100%) were resistant to penicillin, ampicillin, cefoxitin, and oxacillin, but none were resistant to amikacin or vancomycin. CA-MRSA was highly susceptible to netilmicin, linezolid, tigecycline, doxycycline, chloramphenicol, rifampicin, and teicoplanin (11). The study of Pathare et al. represented that the antibiotic resistance to erythromycin and clindamycin ranged from 11-35% among CA-MRSA isolates, whereas the majority of isolates were responsive to rifampicin, doxycycline, vancomycin, linezolid, and teicoplanin. However, among the HA-MRSA isolates, a substantially higher antibiotic resistance was detected with both erythromycin and clindamycin, ranging between 42-63%, whereas the sensitivity of HA-MRSA isolates to rifampicin, doxycycline, vancomycin, and linezolid was 95%, 89%, 84%, and 100%, respectively (14).

Conclusion

The present study found that the HA-MRSA is more prevalent than CA-MRSA. The MRSA infections are more prevalent in males and originated from pus samples. MRSA infections can be avoided by maintaining good hygiene, adopting appropriate precautions, and implementing measures in healthcare and community settings.

Conflicts of Interest: There is nothing to declare.

Funding Statement: There is nothing to declare.

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