Methicillin-Resistant *Staphylococcus aureus* (MRSA): Prevalence and Antimicrobial Susceptibility Profile among Patients Attending Tertiary Care Hospital in Northern India

Munzali Hamisu Umar[*1] Ghayas uddin[2], Karuna Katiyar[3]*

*[*1,2]Department of Paramedical Sciences, Integral University, Lucknow, India*

[3]Department of Medical Microbiology, Integral Institute of Medical Sciences and Research, Lucknow, India

Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most important causative agents of hospital and community associated bacterial infections. The increasing rate of prevalence indicates the need to study the antimicrobial susceptibility profile patterns. This study was aimed to determine the prevalence and antibiotic susceptibility profile pattern of methicillin-resistant *Staphylococcus aureus* (MRSA) isolates among patients attending a tertiary care hospital in northern India. 150 clinical isolates of *S. aureus* were included in the study. Kirby–Bauer disc diffusion method was performed to identify antibiotic susceptibility profile, phenotypically methicillin-resistant *Staphylococcus aureus* (MRSA) was identified by using cefoxitin disc (30 μg). Characteristics of the isolates in this study were determined by traditional biochemical tests including catalase, coagulase, and test for DNAse, and fermentation of mannitol. Antibiotic susceptibility tests were carried out by disc agar diffusion test. *Staphylococcus aureus* ATCC 25923 was used as a reference control organism. Out of 150 clinical isolates of *S. aureus*, 97 (64.67%) were methicillin-resistant *Staphylococcus aureus* (MRSA), and 53 (35.33%) were methicillin-sensitive *Staphylococcus aureus* (MSSA). 21-30 years age group has the highest percentage of the isolates (28.00%) and the age group with lowest percentage was found in the age groups 71-80 years. The source of isolates with the highest frequency was pus (56.67%), followed by urine (20.00%), and the source with the least number of isolates was serous fluid (0.67%). Teicoplanin, Linezolid, Vancomycin, Gentamicin and Tetracycline were found to be the most effective antibiotics against MRSA isolates. The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) was 64.67%. Teicoplanin, Linezolid, Vancomycin, Gentamicin and Tetracycline found to be the most effective antibiotics against the MRSA isolates. Thus, it is believed that these antibiotics can be used in the treatment of infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) in the study area.

Keywords: *Staphylococcus aureus*, MRSA, MSSA, Methicillin.

1. Introduction

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a strain of *S. aureus* that is resistant to multiple drugs and depicts resistance to methicillin. It was initially described in 1961 [1]. In the last decade, MRSA has emerged as one of the most important causative agents of nosocomial infections, responsible for rapidly progressing fatal diseases such as life-threatening pneumonia, endocarditis, osteomyelitis, necrotizing fasciitis, toxic shock syndrome, and severe sepsis [2]. Antimicrobial resistance in *Staphylococcus aureus* has become a major global health concern. From the mid-1970s to the late 1990s, methicillin-resistant *S. aureus* (MRSA) emerged as a severe threat to human life. Since then, *Staphylococcus aureus* has shown an increasing trend of resistance towards β-lactam antibiotics along with other classes of drugs like glycopeptides [3]. One

of the most common causes of hospital-acquired infections (HAIs) or nosocomial infections worldwide is Methicillin-resistant *Staphylococcus aureus* (MRSA) [4].

The rate of *Staphylococcus aureus* colonization among healthcare personnel was 45.78%, and carriage of MRSA was 13.25%, indicating the potential spread of methicillin-resistant *Staphylococcus aureus* (MRSA) among patients in the hospital [5]. Methicillin-resistant *Staphylococcus aureus* (MRSA) infected and colonized patients in hospitals facilitate the dissemination of MRSA strains among the population. This lead to serious endemic and epidemic MRSA infections [6]. Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are very difficult to treat due to multi-drug resistance seen in the organism. Constant monitoring of these strains is essential to control its spread, reduce the incidence, and create awareness about the

proper use of antibiotics to minimize antimicrobial resistance (AMR). This study aims to determine the current incidence, prevalence and antibiogram profile of the isolates of MRSA in the samples received at department of Medical Microbiology of Integral Institute of Medical Sciences & Research Hospital in Lucknow, India.

2. Materials and Methods

The study took place from May 23 to November 2023 at the Integral Institute of Medical Sciences & Research Hospital in Lucknow, India. 150 clinical isolates of *S. aureus* were examined. The isolates were identified using phenotypic methods and then tested using the Kirby-Bauer disk diffusion method. Cefoxitin 30µg discs used to detect methicillin resistance in all the isolates. Antibiotic susceptibility test (AST) was performed using Mueller-Hinton agar plate and evaluated using Clinical and Laboratory Standards Institute (CLSI) guidelines. The isolates were tested for Cefoxitin (30 µg), Vancomycin (30 µg), Linezolid (30 µg), Clindamycin (2 µg), Gentamicin (10 µg), Ciprofloxacin (10 µg), Teicoplanin (30 µg), Tetracycline (30 µg) and Erythromycin (15 µg). *Staphylococcus aureus* ATCC 25923 was used as a reference control organism.

2.1. Data Analysis

Descriptive data analytics was obtained using SPSS version 21.0 statistical analysis software. The values were represented in number (percentage) and mean ± SD. The statistical tools used were mean, standard deviation, Chi-Square test, analysis of variance (ANOVA, F ratio), level of significance, $p < 0.05$ was considered significant.

2.2. Ethical Clearance

Ethical approval was obtained from the Institutional ethical committee of Integral Institute of Medical Sciences and Research (IIMSR), Lucknow, India.

3. Results and discussion
3.1. Results

Of the 150 tested isolates, 97 (64.67%) were methicillin-resistant *Staphylococcus aureus* (MRSA), and 53 (35.33%) were methicillin-sensitive *Staphylococcus aureus* (MSSA). Sixty-eight samples (45.33%) were from male and

eighty-two (54.67%) from female (Figure 1). The age group 21-30 years has the highest percentage of the isolates (28.00%). This followed by age group 11-20 years (22.67%) then 31-40 (15.33%) and the age group with lowest percentage found in the age group 71-80 (1.33%) and followed by 81-90 years (2.00%) (Table 1). The source of isolates with the highest frequency was pus (56.67%), followed by urine (20.00%), and the source with the least number of isolates was serous fluid (0.67%) (Figure 2). Screening of all the isolates for methicillin-resistance was performed using Cefoxitin 30µg disc (Cx) using disc diffusion method, in which 97 (64.67%) were methicillin resistant (MRSA) and 53 (35.33%) were susceptible (MSSA) (Table 2). The isolates (MRSA and MSSA) identified and characterized according to their catalytic ability to degrade hydrogen peroxide (H_2O_2), DNAse production and Mannitol fermentation. For both MRSA and MSSA isolates, 100 % were Catalase and DNAse positive. For MRSA, 97.93 % were Mannitol positive and 2.06 % were negative for Mannitol fermentation. 92.45% of MSSA isolates were Mannitol positive and 7.55 % were Mannitol negative (Table 3). The susceptibility patterns of MRSA against the tested antibiotics were Teicoplanin (100 %), Linezolid (100.00%), Vancomycin (95.88%), Gentamicin (70.10%), Tetracycline (60.82%), Clindamycin (44.33%), and the least susceptible was Ciprofloxacin (2.06%) (Table 4).

3.2. Discussion

In this study, the prevalence of Methicillin-resistant *Staphylococcus aureus* (MRSA) was found to be 64.67%, which is slightly lower than the rate reported in a study conducted in Lucknow (66.40%) [3]. Comparatively, the prevalence is higher than studies conducted in Nepal (57.00%) by Pradhan et al. [7] , Northern India (45.00%) by Imran et al. [8], and Nigeria (30.40%) by Adetayo et al. [9]. However, it is lower than the prevalence reported in a study conducted in Eriteria, East Africa, where it was 72.00% [2]. Regarding antibiotic sensitivity, MRSA isolates in the present study showed sensitivity to Teicoplanin (100%), Linezolid (100.00%), Vancomycin (95.88%), Gentamicin (70.10%), and Tetracycline (60.82%). Conversely, the isolates were found to be resistant to Ciprofloxacin (97.94%), Erythromycin (79.38%), and Clindamycin (55.67%).
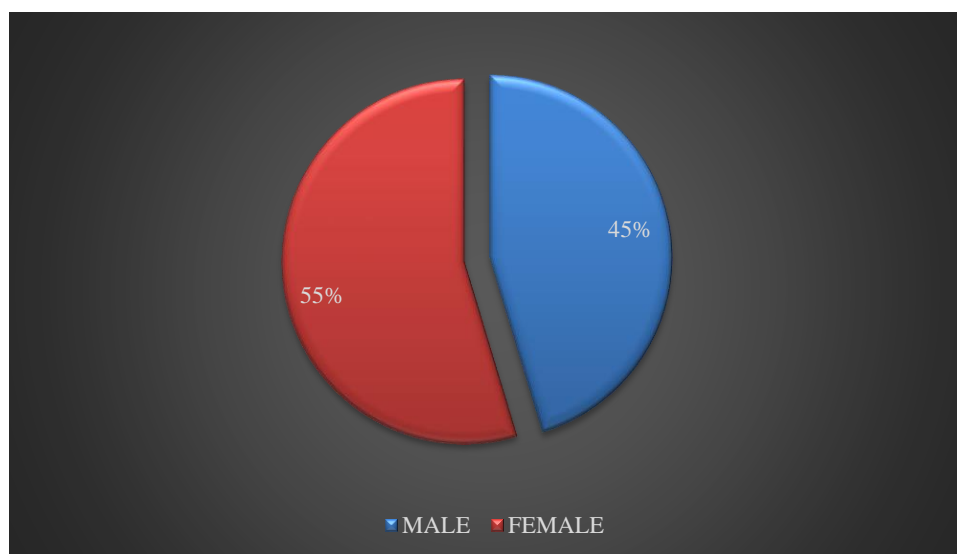
Figure 1: Distribution of *S. aureus* isolates according to gender (N=150)
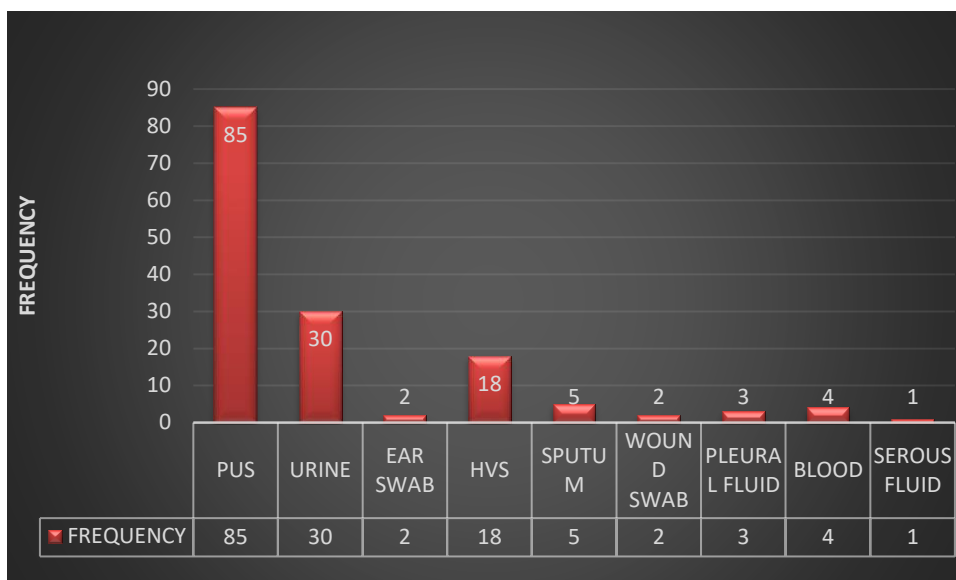
Figure 2: Distribution of *S.aureus* isolates according to the samples received

Table 1: Distribution of *Staphylococcus aureus* isolates according to age groups and gender (N=150)

AGE GROUPS (YEARS)	MALE	FEMALE	ISOLATES (*S. aureus*)	PERCENTAGE (%)
0-10	4	2	6	4.00
11-20	24	10	34	22.67
21-30	7	35	42	28.00
31-40	7	16	23	15.33
41-50	7	6	13	8.67
51-60	8	10	18	12.00
61-70	8	1	9	6.00
71-80	2	0	2	1.33
81-90	1	2	3	2.00
Total	**68**	**82**	**150**	100.00

Table 2: Distribution of Methicillin-resistant *Staphylococcus aureus* (MRSA) and Methicillin-susceptible *Staphylococcus aureus* (MSSA) Isolates (N=150)

ISOLATES	FREQUENCY	PERCENTAGE (%)
MRSA	97	**64.67**
MSSA	53	35.33
TOTAL	150	100.00

Table 3: Bio typing characteristic pattern of MSSA and MRSA isolates

	MRSA (n = 97)		MSSA (n = 53)	
	Positive (%)	**Negative** (%)	**Positive** (%)	**Negative** (%)
CATALASE	100.00	0.00	100.00	0.00
DNase	100.00	0.00	100.00	0.00
MANNITOL	97.93	2.06	92.45	7.55

Table 4: Antibiotic susceptibility pattern of MRSA isolates (N=97)

Antibiotics	Susceptible (%)	Resistant (%)
Cefoxitin	0.00	100.00
Gentamicin	70.10	29.90
Ciprofloxacin	2.06	97.94
Clindamycin	44.33	55.67
Erythromycin	20.62	79.38
Vancomycin	95.88	4.12
Tetracycline	60.82	39.18
Linezolid	100.00	0.00
Teicoplanin	100.00	0.00

4. Conclusion

In conclusion, this study found that Methicillin-resistant *Staphylococcus aureus* (MRSA) is still one of the most common bacterial pathogens in the study area. The results of antibiotic susceptibility testing indicated that Vancomycin, Teicoplanin, Linezolid, Gentamicin, and Tetracycline were the most effective antibiotics against MRSA. For Methicillin-sensitive *Staphylococcus aureus* (MSSA), Vancomycin, Teicoplanin, Linezolid, Gentamicin, Clindamycin, and Tetracycline were found to be the most effective. Therefore, it is recommended that these antibiotics should be used to treat MRSA infections in this region.

Recommendations

The following recommendations were made based on the data generated from this study

i. There is a need to intensify the surveillance at both rural and urban hospitals, expand patients' population surveillance and to determine if this prevalence of MRSA infection is similar in other geographic locations in the country.
ii. Antibiotic susceptibility testing should always be carried out before prescribing any antibiotic for effective treatment of infections.
iii. Surveillance should be put in place to keep tract of drug resistant pathogens especially MRSA which develops resistance easily.
iv. Government should put more strict rules on the use and sale of antibiotics.
v. People should be made aware of the danger of taking antibiotics without doctor's prescription.

Conflicts of Interest

The author(s) declare no potential conflicts of interest concerning this article's research, authorship, and/or publication.

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