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Prevalence of MRSA and Antimicrobial Susceptibility *Staphylococcus aureus* in Clinical Samples in National Capital Region, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Infections caused by Staphylococci are frequently linked to indwelling medical equipment. These are extremely difficult to treat with antibiotics. In India, the prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) varies from 30 to 70%, resulting in high mortality, increased economic burden, and high treatment failure in tertiary care hospitals. Rapid and reliable identification of MRSA is critical for infection management and avoiding the needless use of antibiotics.
Materials and Methods: This prospective study was carried out in the Department of Microbiology, Santosh Medical College, Ghaziabad, from the 1st of August 2020 to the 31st of January 2021. MRSA isolates were screened and confirmed using standard methods recommended by the Clinical and Laboratory Standards Institute (CLSI). Methicillin resistance, in *Staphylococcus aureus* strains, was evaluated using oxacillin/cefoxitin. The Kirby-Bauer disc diffusion technique was used to assess the antibiotic susceptibility pattern of all MRSA strains.
Results: In this investigation, MRSA was identified in 29.4% of the 384 *Staphylococcus aureus* strains. When compared to females, men outnumbered females. Cefoxitin detects a greater

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amount of MRSA than oxacillin. In this investigation, the majority of MRSA was found in pus samples.
Conclusion: MRSA prevalence is known to vary depending on geographical region, hospital type, investigated population, and technique of detection used. Given the clinical implications of MRSA infection and its fast transmission capability, MRSA strains must be monitored on a regular basis.

Keywords: MRSA; MSSA Prevalance; Cefoxitin disc; Oxacillin disc; phenotypic method.

1. INTRODUCTION

Staphylococcus aureus is a multilateral bacterial pathogen capable of causing a wide range of infections in humans and animals, ranging from mild skin infections to severe systemic diseases such as pneumonia, and has been recognised as a significant cause of human disease for more than 100 years [1]. It is commonly found in human skin or nasal colonisation. [2]. It is one of the top three major pathogens responsible for community and hospital acquired infections, causing diseases ranging from minor skin and soft tissue infections to life-threatening systemic infections that can be toxin or non-toxin mediated, resulting in high morbidity and mortality worldwide [3,4]. Staphylococci Infections are frequently linked to indwelling medical equipment. These are extremely difficult to treat with antibiotics. Penicillin and its derivatives, particularly methicillin, have been used to treat *S. aureus* infections [5]. Certain strains of *S. aureus*, however, acquired resistance and were known as methicillin resistant *Staphylococcus aureus* (MRSA).

Most medicines used to treat infections are resistant to some hospital-acquired strains. Glycopeptides are the only antibiotics left to treat drug-resistant *Staphylococcus aureus* infections [2, 6, 7]. With the exception of Vancomycin, MRSA isolates are typically resistant to other anti-staphylococcal drugs (Clindamycin, Erythromycin, Tetracycline, and occasionally Gentamicin and Trimethoprim/ Sulphomethoxazole) [8]. The resistance to methicillin is caused by the mecA gene, which codes for the penicillin-binding protein (PBP 2A). Recently, a novel methicillin resistance mechanism gene, mecC, was discovered in *S. aureus* and reported MRSA isolates containing mecC gene from humans and animals highlighted the public health risk of mecC-positive MRSA isolates as it has been found in human cases and livestock [9, 10, 11, 12].

Methicillin-resistant other -lactam agents, such as Cephalosporins, appear to be sensitive to *Staphylococcus aureus* in vitro; nevertheless, they are clinically ineffective [3]. Because MRSAs are resistant to all -lactam antibiotics, treatment choices are severely restricted. In India, the prevalence of MRSA varies from 30 to 70% [13, 14]. MRSA infections must be treated and prevented through laboratory diagnostics and susceptibility testing. As a result, techniques used to identify MRSA in clinical samples must be very sensitive and specific, and the results must be accessible in a timely manner. Various techniques for fast detection of methicillin-resistant staphylococci have emerged, however the best method remains debatable [15].

The purpose of this study was to investigate the antibiotic susceptibility of *S. aureus* in a Tertiary Care Hospital in Ghaziabad, as well as the current status of methicillin resistance *S. aureus* in our hospital setting.

2. MATERIALS AND METHODS

2.1 Place of Study

This study was carried out in the Department of Microbiology at Santosh Medical College, Ghaziabad over the time span of six months, from August 1st, 2020 to January 31st, 2021.

2.2 Sample Collection

A total of 384 clinical isolates of *Staphylococcus aureus* were isolated from diverse clinical specimens such as pus, wound or vaginal swabs, blood, pleural fluid, urine, Throat Swab, and so on from different wards including surgery, obstetrics and Gynaecology, medicine, orthopaedics and ICU of Santosh Hospital.

2.3 Statistical Analysis

All the collected data was prepared on MS-Excel. By means of chi-square test all the statistical data was calculated. A p value <0.5 was considered statistically significant. Statistical software SPSS (Statistical Package of social sciences) version 23.0 for windows was used for statistical analysis.

2.4 Inclusion Criteria

All *Staphylococcus aureus* strains isolated from various clinical specimens, were included in the study.

2.5 Exclusion Criteria

Clinical specimen's yielding growth of Gram positive cocci other than *Staphylococcus aureus* and all gram negative bacteria were excluded.

3. METHODOLOGY

3.1 Bacterial Identification and Antimicrobial Susceptibility Testing

Clinical specimens were inoculated on 5% sheep blood agar, MacConkey's agar, and CLED agar (Only for Urine), incubated at 37°C for 24 hours, and bacterial growth was observed. Standard techniques for identifying *Staphylococcus aureus* were used, including colony morphology, Gram's stain, catalase test, and coagulate test. *S. aureus* was identified in 384 different isolates. They were evaluated for methicillin resistance using the Kirby-Bauer disc diffusion technique, which included oxacillin and cefoxitin. The isolates were considered methicillin-resistant if the zone of inhibition using oxacillin disc diffusion. was 10 mm or less. Isolates obtained using cefoxitin disc diffusion that had an inhibition zone diameter of 19 mm were categorised as methicillin resistant, whereas isolates that had an inhibition zone diameter of >20mm were classed as methicillin susceptible.

The other antibiotics were also put to the test. Linozoline, Teicoplanin, Gentamycin, Tetracycline, Erythromycin, Clindamycin, Ciprofloxacin, Vancomycin, Cotrimoxazole, Amoxyclave, and Rifampicin are some of them. The collected data was then recorded and evaluated using proper statistical procedures.

4. RESULTS

A total no. of 384 *staphylococcus aureus* strains were found, in which both Methicillin resistant *staphylococcus aureus* (MRSA) as well as Methicillin-sensitive *staphylococcus aureus* (MSSA) were identified. The characteristics of *S. aureus* include golden yellow colour colonies on Nutrient agar, lactose fermentation on MacConkey agar, gram positive cocci arranged in clusters seen in gram staining and positive catalase test, tube coagulase and mannitol fermentation test (Table-1 & 2).

In total 384 samples there were total 223 male sample and 161 samples from females. Out 223 samples from there 65 samples were of MRSA and rest 158 were of MSSA. Similarly in 161 female's samples there were 48 samples of MRSA and remaining 113 of MSSA. Most number (61.71%) of *staphylococcus aureus* were found in 20 to 50 years of age group. Out of which highest number of cases were found from 31 to 40 years (85) of age followed by 21 to 30 years (81) and 41 to 50 years (71). (Table-3).

In this study incidence of MRSA from clinical sample *S. aureus* were more in pus 39(31.45%) followed blood 18(29.5%), urine 30 (28.8%), Sputum 4 (21%), pleural fluid 3 (33.3%), wound swab 10 (26.3%), Vaginal swab 4 (28.5%), CSF 1 (100%), Throat swab 4 (40%). (Table-4).

The antibiotic sensitivity pattern of *S. aureus*. The majority of isolates MRSA from cefoxitin 113 (29.4%) and disc diffusion oxacillin 99 (25.8%). However, we observed a high incidence of resistance to other antibiotics such as Erythromycin 265 (69.0%), followed by Clotrimozole 228 (59.4%), Tetracyclin 144 (37.5), Vancomycin 102 (26.6%) and Refampicin 102 (26.6%). We also observed highly sensitivity to the Linezolid 354 (92.2%) followed by Tiecoplanin 325 (84.6%), Gentamycin 272 (70.8%), Clindamycin 249 (64.8%) and Amoxyclave 281 (73.2%). (Table-5).

Table 1. Identification of colony morphology of *S. aureus*

Identification media	Testing feature
Nutrient Agar	Colonies are 2-4mm in diameter, circular, smooth, convex, opaque and easily Emulsifiable and most of the strains produce golden yellow pigment.
Blood Agar	Colonies are 2-4mm in diameter, circular, smooth, convex, opaque and easily emulsifiable and a beta type of hemolysis is seen.
MacConkey's Agar	Colonies are very small and pink due to lactose fermentation.
In liquid media	Uniform turbidity is produce.

Table 2. Biochemical characteristics of *S. aureus*

S. No.	Biochemical test	Reaction (+/-)
1	Catalase	+
2	Oxidase	+
3	Slide coagulase	+
4	Tube coagulase	+
5	Mannitol fermentation	+
6	NADase	+

Table 3. Sex wise distribution of MRSA

Age	MRSA (N=113)		MSSA (N=271)		Total (n=384)
	Male (65)	Female (48)	Male (158)	Female (113)	
≤10	6	4	13	7	30 (7.8)
11- 20 years	2	2	18	17	39 (10.2)
21- 30 years	17	13	27	24	81 (21.1)
31- 40 years	12	10	32	31	85 (22.1)
41- 50 years	14	11	29	17	71 (18.5)
51- 60 years	8	6	21	9	44 (11.5)
>61 years	6	2	18	8	34 (8.9)

Table 4. Distribution of MRSA in various clinical samples Total n. 384

S. No	Samples	MRSA	MSSA	Chi-square	p-value
1.	Blood	18(29.5%)	43(71.4%)		
2.	Urine	30(28.8%)	74(71.1%)		
3.	Sputum	4(21%)	15(78.9%)		
4.	Pus	39(31.45%)	85(68%)		
5.	Pleural fluid	3(23.07%)	10(76.92%)	0.489	0.974
6.	Wound swab	10(26.3%)	28(73.68%)		
7.	Vaginal swab	4(28.5%)	10(71.4%)		
8.	CSF	1(100%)	0		
9.	Throat swab	4(40%)	6(60%)		

Table 5. Antibiotics resistance pattern from clinical specimens (Total n. 384)

Antibiotics	n (%) (MRSA)	n (%) (MSSA)
Linezolid	30 (7.8)	354 (92.2)
Tiecoplan	59 (15.4)	325 (84.6)
Gentamycin	112 (29.2)	272 (70.8)
Tetracyclin	144 (37.5)	240 (62.5)
Erythromycin	265 (69.0)	119 (31.0)
Clindamycin	135 (35.2)	249 (64.8)
Ciprofloxcin	141 (36.7)	243 (63.3)
Cefoxitin	113 (29.4)	271 (70.6)
Oxacillin	99 (25.8)	285 (74.2)
Clotrimozole	228 (59.4)	156 (40.6)
Amoxyclave	103 (26.8)	281 (73.2)
Vancomycin	102 (26.6)	282 (73.4)
Refampicin	102 (26.6)	282 (73.4)

5. DISCUSSION

MRSA has been linked to considerable morbidity and death, and it is a serious public health concern across the world. Data on MRSA transmission patterns remain poor in underdeveloped countries like as India. Antibiotics produced against *S. aureus* have three targets: cell envelope, ribosomes, and nucleic acids. Methicillin belongs to the beta

lactamase class, which attacks the cell envelope. Methicillin resistance develops through the acquisition of genes that are less sensitive to antibiotic action [16]. In this investigation, 113 of the 384 *S. aureus* isolates were MRSA. MRSA was determined to be prevalent at our hospital at 29.4%, according to our research. Other investigations have found a significant incidence of MRSA in various regions of the nation, such as 32% in a study by Bilal Ahmad et al [17] similar to this study. Another research conducted by Karem H. Alzoubi in Jordan found that the total prevalence of MRSA was 34% [18]. In support to the above findings, Rajaduraipandi et al. also found 31.1% MRSA strains in their investigation, [19]. Various studies from different regions of India including Mumbai, Haryana and Greater Noida, presented the prevalence of MRSA similar to the present study [20-22]. More than 50% prevalence of MRSA was observed in MRSA from different states of India.[23-25]. Around 5 year's back from low prevalence to high prevalence was observed from different study from different places of India [26-29]. In the inpatient setting, a compromised immune system is one of the major risk factors for MRSA. Those most at risk for infection were infants, the elderly, the chronically ill, burn survivors, steroid users, diabetic patients [30]. In this investigation, the pus sample had the greatest number of MRSA cases (31.45%) followed blood (29.5%), urine (28.8%), Sputum (21%), pleural fluid (33.3%), wound swab (26.3%), Vaginal swab (28.5%), CSF (100%), Throat swab (40%). Although the result was not statistically significant but the highest prevalence of MRSA was observed in pus samples compared to other samples. In Support to this, Goel A et al stated in their study that the highest prevalence was detected in pus samples (66.03%), followed by urine (11.45%), and blood and tips (9.16%) in Agra region [31]. MRSA isolates resistant to three or more types of antibiotics were discovered in this investigation. As showed in the table-5, MRSA presented with highly resistant (Erythromycin-69.0) to lowest resistant (Linozolid-7.8). Another research also found that 44.4 percent of MRSA isolates were resistant to cefotaxime, 40.7% to gentamicin, 86.4% to ciprofloxacin, 40.7 percent to clindamycin, 66.7% to erythromycin, and 49.4% to ofloxacin [32].

6. CONCLUSION

Finally, it may be stated that the routine monitoring of MRSA's antimicrobial susceptibility pattern and the establishment of a clear antimicrobial policy may be beneficial in reducing the incidence of these infections in hospitals. MRSA prevalence is known to vary depending on geographical region, hospital type, investigated population, and technique of detection used. Due to the prevalence of MRSA, people infected with MRSA must visit the clinic; therefore, it is important for health care providers to identify potential MRSA skin infections. Because MRSA infection can mimic other lesions, appropriate precautions and clinical suspicion are warranted. Furthermore, given the clinical implications of MRSA infection and its fast transmission capability, MRSA strains must be monitored on a regular basis.

ETHICAL APPROVAL & CONSENT

This study was ethically approved (SU/2021/2131[6]) by the institutional ethical committee of Santosh Medical College, Ghaziabad. Patient consent was obtained from each participant.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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