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Frequency and Sensitivity Patterns of Staphylococcus Aureus in a Tertiary Care Setting

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Authors' contributions

This work was carried out in collaboration among all authors. Author AK Conceptualization of study design, Data Analysis, Result Compilation. Author AE Statistical analyses and data interpretation, FA Methodology, Discussion. Author ZS Literature Review. Author UF Help in article writing. Author SA Data interpretation and analyses. All authors read and approved the final manuscript.

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ABSTRACT

Background: *Staphylococcus aureus* (SA) is a major etiological pathogen causing multiple infections and broadly known as a serious public health challenge faced due to antibiotic resistance. It is the need of time that infection prevention and control strategies; and antibiotic stewardship policies have to be employed conjointly to minimize the extended rise of antibiotic resistance.
Objectives: To determine the frequency and sensitivity patterns of *Staphylococcus aureus* in tertiary care setting.
Study Design: Descriptive study
Place & Duration of Study: Pathology Laboratory of tertiary care center from 1st March' 2020 till 28th February' 2021.
Materials & Methods: A total 643 *Staph. aureus* isolated from various clinical specimens received

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in a tertiary care hospital; were processed and identified by culture, staining and bench tests. Sensitivity testing was done by Disc Diffusion method. Resistance to cefoxitin(30µg) was labelled as Methicillin Resistant *Staphylococcus aureus* (MRSA). Constitutive and Inducible Clindamycin resistance was also evaluated. (CLSI, 2020-21).

Results: During the study period 125 (19.44%) MRSA were recovered. Statistically, gender distribution regarding MRSA was significant, most of SA was recovered from blood (53.68%), while 46.31% from pus and wound swabs. The frequency of MRSA from Surgical and allied wards was higher (52.63%) than Medicine and allied wards (47.36%). Sensitivity to vancomycin, linezolid and tigecycline was noted 100% by all the isolates. Sensitivity to clindamycin and Doxycycline was 68.42% and 64.81% respectively; while resistance to erythromycin, ciprofloxacin and trimethoprim/sulfamethoxazole was 73.68%, 60% and 57.89%, respectively.

Conclusion: The hazardous infections due to *Staphylococcus aureus* are worrisome in the present therapeutic scenario. A levelheaded prescription of sensitive antibiotics has to be ensured to minimize the rising frequency of resistant strains of SA.

Keywords: Antimicrobial sensitivity; frequency; staphylococcus aureus.

1. INTRODUCTION

Staphylococcus aureus has been surfaced as a major virulent pathogen prevailing in a series of ailments including septicemia, pneumonia, wound sepsis, burn infections, septic arthritis, endocarditis, meningitis, urinary tract infections, food poisoning, scalded skin syndrome, toxic shock syndrome, and postsurgical infections [1]. Antibiotic sensitivity patterns are heading towards resistance and becoming an abnormal perplexing threat throughout the world as it is can place the patients in high-risk situations in coming days. Bacterial resistance to many antimicrobial agents represents unavoidable and nonstop evolution of bacterial population. This biological phenomenon results in emergence of "Superbugs" among which methicillin resistant *Staphylococcus aureus* (MRSA) is well known for infections associated with hospital setting. MRSA related issues are one of the primary burdens to patient's well-being in addition to treatment expenses and lengthened hospitalization [2].

The prevalence of MRSA has universally raised. It varies from < 1% in Netherlands to > 40% North, South and Western European regions, Canada and Philippines < 6%, in Latin America and US hospitals 33-55%, in Malaysia 17-44% in recent years [3], in Taiwan 39-75%, Korea 64%, Hong Kong 79.5%, in India 7-87% [4,5] and in Pakistan 5-68% [6,7].

Periodic surveillance practices, effective implementation of equipment sterilization and disinfection of surfaces along with antimicrobial stewardship have reported a substantial decline in MRSA rates [8]. Detection of MRSA carriers (symptomatic/asymptomatic) and /or infection in the inpatient or outpatient settings is essential for MRSA screening [9]. Successful prevention of *Staphylococcus aureus* infections can be attained by effective decontamination and decolonization regimens [10] Transmission of pathogenic infections and hospital-acquired infections can be curtailed by isolating the patients having resistant infections like MRSA [11].

Systematic surveillance strategies need to be devised, to disable the ongoing difficult condition, financial and environmental challenge posed by the "Super Bugs". Local /institutional antibiogram has to be documented, according to the current dominance of the pathogens, regular surveillance of health care institute (theaters, ICUs, wards, emergency and procedure rooms, hospital labs, etc.) have to be planned periodically. This study is conducted to identify the frequency and antimicrobial sensitivity patterns of *Staphylococcus aureus* in tertiary health care.

2. MATERIAL AND METHODS

Clinical specimens received from patients of different clinical departments of a tertiary care hospital in Lahore. All the samples were inoculated and incubated aerobically at 35^{o}C for 24 hours on selective and differential media (prepared as manufacturer's instructions). *Staphylococcus aureus* isolates were preliminary identified by gram staining and conventional biochemical tests Sensitivity checked according to 0.5 McFarland turbidity standards, and interpretated as per CLSI criteria (2020). Antibiotic discs belonging to 1st, 2nd and 3rd line drugs were applied by disc diffusion technique and inhibition zones read after 24 hours

incubation at 35°C. Screening for MRSA was done by 30µg cefoxitin (Oxoid) on Muller Hinton agar. ATCC 33591 (MRSA) and ATCC 25923 (MSSA) were used as positive and negative controls, respectively. Identification for Inducible and constitutive clindamycin resistance was done through D-test by placing erythromycin and clindamycin discs at a distance of 15-20 mm. A flattened zone of inhibition around clindamycin proximal to erythromycin (D-shaped zone of inhibition) specifies "Inducible clindamycin resistance". A circular zone of inhibition to both erythromycin and clindamycin discs indicates "Constitutive clindamycin resistance".

2.1 Statistical Analysis

Data was managed and analyzed using SPSS Version 23.0. Categorical variables were shown in tables as frequency and percentages. Pi charts and bar graphs used for graphical presentation of data. Significant difference among qualitative variables determined by Chi - square test. p-value of < 0.05, $p>0.05$ and < 0.001 were considered significant, insignificant and highly significant, respectively.

3. RESULTS

During one year study period, a total of 27604 samples were received in the microbiology section of pathology laboratory, and 7019 (25.42%) samples gave positive cultures. A total of 643 (9.16%) *Staphylococcus aureus* were cultured from blood, pus and wound swabs. Initial screening for methicillin resistance by cefoxitin (30µg) disc, phenotypically recovered 125 MRSA isolates. and overall frequency was 19.44%. According to gender, the p-value was highly-significant. Gender based distribution of MRSA in different age groups is also shown in Table 1.

The overall frequency of MRSA (n=125) isolates in surgical and allied and in medicine and allied is shown in Fig. 1.

All the SA isolates showed 100% sensitivity to linezolid (30µg), vancomycin (30µg) and tigecycline (15µg), while all the MRSA strains were completely (100%) resistant to penicillin 10U (P). The drugs which were tested for each sample were erythromycin 15 µg (E), clindamycin 2µg (DA), gentamycin 10µg (CN), ciprofloxacin 5µg (CIP), doxycycline 30µg (DOX) and Trimethoprim sulfamethoxazole 25µg (SXT).

Overall, Erythromycin resistance was seen in 73.68% isolates, followed by CIP (60%) and SXT (57.8%) (Fig. 2). Inducible clindamycin resistance (positive D-test) was seen in 31(24.8%) isolates, while constitutive clindamycin resistance was present in 27 isolates (21.6%). Statistically, the overall difference of sensitivity pattern for all isolates was significant (p-value <0.001).

Table 1. Gender distribution of MRSA from isolated *Staphylococcus aureus* (n=643)

Gender	*S. aureus* (%)	MRSA (%)	Age in years		
			0-15 (%)	15-50 (%)	≥ 50 (%)
Male	350 (54.43)	86 (24.57)	22 (25.58)	49 (56.97)	15 (17.44)
Female	293 (45.57)	39 (13.31)	9 (23.07)	18 (46.15)	12 (30.76)
Total	643	125 (19.44)	31 (24.8)	67 (53.6)	27 (21.6)

Chi-square = 12.91, Probability = .0003 (p-value significant)

Table 2. Distribution of *Staphylococcus aureus* (n=643) and MRSA isolates (n=125) in different clinical samples

Specimen	S. aureus	MRSA (%)
Blood	132	67 (50.75)
Pus	322	33 (10.24)
Wound Swab	189	25 (13.22)

Chi-square = 104.69, Probability = < .00001 (p-value highly significant)

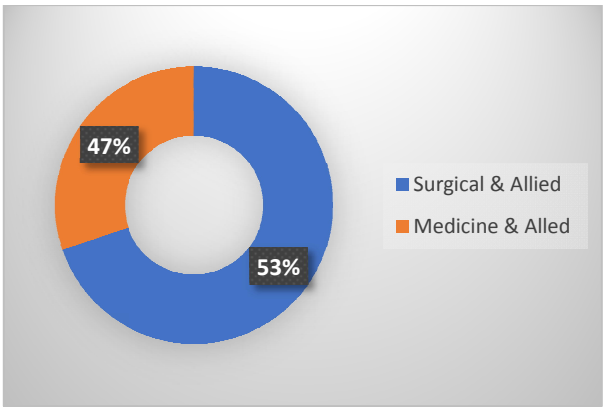

Fig. 1. Distribution of Resistant isolates (MRSA) from Surgical & Medicine Allied clinical wards (n=125)

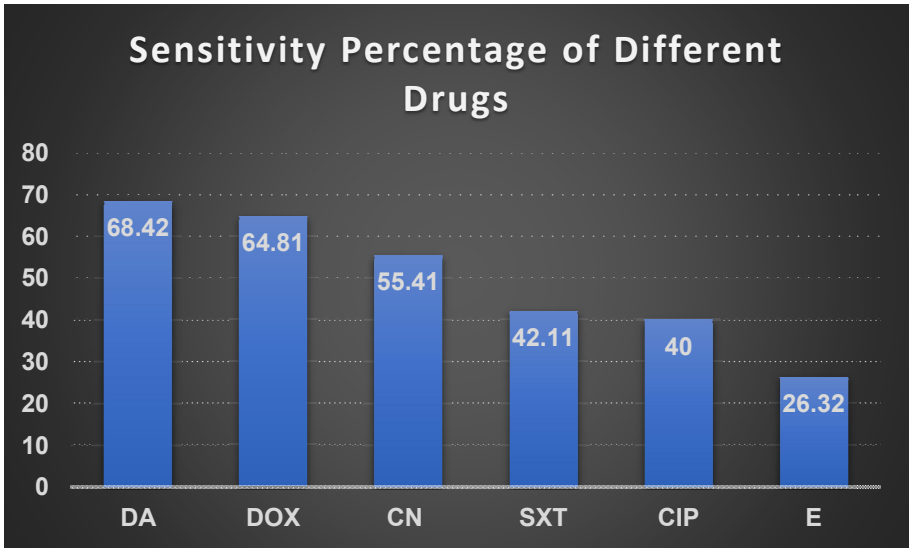

Fig. 2. Sensitivity Pattern of MRSA isolates (n=125) to different drugs.

4. DISCUSSION

The problematic task of antimicrobial resistance has to be undertaken effectually; otherwise in coming decades, one person every three seconds will be facing downfall. The grave stimulus of resistance to antibiotics can be decreased by reducing the stress pressure of antimicrobials in humans and by lessening their excessive usage for live-stock and farming. The progressive key solutions in fighting resistant diseases include: global awareness at large; effective sanitation and hygiene; infection control and prevention, health-care surveillance; advancement of latest, swift and affordable methods for absolute diagnosis; and/or promote benefitting vaccines as substitutes to antimicrobials [11].

In coming days, resistance to accessible antibiotics can endanger our lives by deadly infections, adding to this is the non-development of new classes of antibiotics. Addition of new antibiotics is a prerequisite to combat with the continuous threat of resistant strains that cause untreatable infections in public and hospital setting [12].

Frequency of MRSA was found to be 14.91% (n=493) out of total 3305 *Staphylococcus aureus* isolates (Table 1), while Sader has reported an overall 18.5% (15.8-21.4% in Europe & Asia-Pacific region)[12]. The difference in male (51.49%) to female ratio (48.50%) is not significant. Higher proportion of MRSA infections in male patients has been documented by other researchers [13,14,15].

Our study shows higher percentage of MRSA isolates from blood followed by pus and wound swabs. Studies have documented that higher frequency of MRSA isolates belong to pus and wound swab (40-75%) followed by blood samples [14,15].

The distribution of MRSA being isolated from surgical and allied clinical wards is measured to be two times more (70%) than the resistant isolates from medical and allied wards (Fig 1), although the difference is non-significant. Researchers have found MRSA to be the predominant cause of surgical site infections, as compared to the isolated pathogens from medical and allied departments [16]. Khan et al has documented that mostly MRSA was isolated from emergency department followed by medical and allied wards [17].

During the 5-year study period, sensitivity pattern of all the 493 MRSA isolates (Fig. 2) shows that all the isolates were 100% resistant to penicillin, cefoxitin and oxacillin, followed by erythromycin (75.25%), trimethoprim/sulfamethoxazole (73.83%), ciprofloxacin (63.69%), gentamicin (49.49%), clindamycin (39.14%) and doxycycline (35.49%). Sensitivity to vancomycin and linezolid of all the 493 MRSA isolates was 100%. Researchers have provided variable resistance profile i.e., quinolones (75-90%), erythromycin (57-90%), clindamycin (50%) and trimethoprim/sulfamethoxazole (32%) [4]. This combined pattern of resistance with MRSA signals towards presence of *gyr* A, B mutations and *erm* genes along with *mec*A gene. Maximum sensitivity has been shown to glycopeptides and linezolid by some researchers [13,15,18].

WHO has devised GLASS (Global Antimicrobial Resistance and Use Surveillance System) to provide guidelines to minimize AMR challenges? This target can be efficiently achieved by following local antibiogram and national surveillance reports, thus greatly reducing both the cost and resistance burdens [19].

5. CONCLUSION

Sensitivity to vancomycin and linezolid was 100%. The unrestrained use of antibiotics can lead to the increasing frequency of difficult to treat MRSA infections. The judicious use of antibiotics has to be assured to avoid unnecessary and over-exposure of antimicrobials. Infection control strategies, antibiotic stewardship program and strict hospital surveillance policies have to be formulated and implemented to bring this MRSA “superbug” under control.

ETHICAL APPROVAL AND CONSENT

As per international standard or university standard guideline patients consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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