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A Spatio-Temporal Analysis of MRSA Prevalence Across Diverse Hospital Departments

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ABSTRACT

Aims: To investigate the recent prevalence of MRSA S. aureus from clinical samples in a hospital and to evaluate their antibiotic resistance pattern.

Material and Methods: The study comprised 258 coagulase-positive staphylococci (COPS), isolated from a total of 25059 clinical specimens (like pus, blood, urine, sputum, vaginal swab, etc.) patients in the hospital for duration of 1 year. The bacteriological investigation was done according to the standard laboratory procedure and antimicrobial susceptibility testing was performed.

Statistical Analysis Used: Nil.

Results: During this time 258 samples of S. aureus were isolated. Out of which a total no. of 111 were cefoxitin resistant (MRSA) and remain the number of 147 isolates were cefoxitin sensitive (MSSA).

Conclusion: In many hospitals, one of the most common causes of therapeutic problems is MRSA. The MSSA isolates were more frequent than MRSA and also MRSA was multidrug-resistant compare to MSSA. Vancomycin and linezolid can be reserved drugs for life-threatening infections and also for treating multidrug-resistant MRSA infections.

Keywords: MRSA; MSSA; Multidrug Resistance

Introduction

In the 1960s, the introduction of methicillin and outbreaks of Methicillin-resistant Staphylococcus aureus (MRSA) were reported [1]. Later on, in 1961, MRSA was described. According to the CDC, MRSA is a cause of staphylococcus infection that is difficult to treat because of resistance to some antibiotics [2]. Methicillin resistance is mediated by PBP-2a, which is a penicillin-binding protein that helps to grow and divide the organisms in the presence of methicillin and other beta-lactam antibiotics [1]. S. aureus, which has a high resistance pattern against a good number of antibiotics but sensitive to methicillin, considered as methicillin-sensitive S. aureus (MSSA) as well as multidrug-resistant strains of S. aureus (MDRSA) [3]. One of the main responsible agent of infections like septicemia, pneumonia, skin and soft tissues infection is Staphylococcus aureus [4] and also may cause infection range from minor diseases to life-threatening infections [5]. The prevalence of MRSA in hospital environment infections as well as in community infections has become a great challenge [4]. Resistance to penicillin, ampicillin, amoxicillin, azlocillin, carbenicillin, mezlocillin, piperacillin, and ticacillin indicates positive β-lactamase test [6].

Methicillin resistance refers to which are resistance to the anti-staphylococcal, penicillinase-stable penicillins [6]. Resistant to drugs like cephalosporins and other beta-lactam makes the MRSA strain difficult to treat [6]. The knowledge of the prevalence of MRSA and their susceptibility pattern is a must for the appropriate treatment of these infections [5]. There are very few and expensive drugs like teicoplanin, vancomycin, and linezolid that are the current choice of drugs for the treatment of MRSA infections [6]. The preferred treatment for MRSA are glycopeptides and linezolid [6]. The main source of transmission of infection is hospital staff, infected and colonized patients which disseminate the MRSA strains [5]. The predisposing

factors which increase the emergence and spread of MRSA are prolonged and repeated hospitalization, indiscriminate use of antibiotics, lack of awareness, intravenous drug abuse, and presence of indwelling medical devices [5]. The present study was aimed to investigate the recent prevalence of MRSA S. aureus from clinical samples in a hospital and to evaluate their antibiotic resistance pattern.

Material and Methods

The study comprised of 258 coagulase-positive staphylococci (COPS), isolated from a total of 25059 clinical specimens (like pus, blood, urine, sputum, vaginal swab, etc.) of patients in the hospital.

Bacteriological Investigation

For initial screening, a loop of each sample was inoculated into blood agar, chocolate agar, and MacConkey agar and special media in some special situations. Culture plates were then incubated at 37^0C overnight. The organisms which are grown in the form of colonies were processed according to standard procedures for the identification of organisms.

Antimicrobial Susceptibility Test to Various Drugs

Standard Kirbey-Bauer's Disc Diffusion method was carried out to identify the methicillin resistance and also to analyze the sensitivity pattern of MRSA isolates according to CLSI guidelines prevailing each year [7]. Antibiotics tested were Penicillin, Levofloxacin, Clindamycin, Amoxyclav, teicoplanin, cefoxitin, erythromycin, ciprofloxacin, gentamicin, linezolid, vancomycin, norfloxacin, nitrofurantoin (Hi-Media Mumbai). Nitrofurantoin and Norfloxacin were used only in urine samples. Isolates resistant to cefoxitin(30µg) were identified as MRSA and those susceptible to MSSA.

Results

This study was carried out from Feb 2019 to Feb 2020. A total number of 25059 clinical samples were collected from different wards (Tables 1-4) (Figures 1-4). During this time 258 samples of S. aureus were isolated. Out of which a total no. of 111 were cefoxitin resistant (MRSA) and remain the number of 147 isolates were cefoxitin sensitive (MSSA) (Tables 5-7) (Figures 5 & 6).

Table 1: Showing the growth of total sample from IPD & OPD.

Samples	OPD (n=15532)	IPD (n=9527)	Total Number (n=25059)
Total Growth	963	3195	4158
No Growth	14569	6332	20901
Bacterial Growth	651	2064	2715
Candia	6	60	66
Mix Growth	188	388	576
Non-Pathogenic	118	683	801

Table 2: Distribution of different types of isolates from different wards.

Types of Isolates	OPD (n= 652)	IPD (n= 2074)
Escherichia coli	283	583
Klebsiella spp.	62	215
Enterococcus spp.	35	148
CONS	85	375
Staphylococcus aureus	80	178
Proteus spp.	22	32
Enterobacter spp.	11	18
Citrobacter spp.	25	106
Acinetobacter spp.	10	146
Pseudomonas spp.	39	240
Stenotrophomonas maltophilia	0	3
Elizabethkingia meningoseptica	0	1
Sphingomonas paucimobilis	0	14
B-hemolytic streptococcus	0	1
Bulkholderia cepacian	0	1
Micrococcus	0	7
Salmonella typhi	0	3
Streptococcus pneumonia	0	1
Aeromonas salmonicida	0	2

Table 3: Number of *Staphylococcus aureus* (258) isolated from different Clinical samples.

Clinical Samples	OPD (n= 89)	IPD (n= 169)
Pus	62	119
Swab	13	17
Sputum	5	4
Urine	5	5
Tracheal secretion	4	2
BAL fluid	0	1
ETT	0	1
Catheter Tip	0	1
Pleural fluid	0	2
Semen	1	0
Blood	0	17

Table 4: Antibiogram Pattern of Percentage of *Staphylococcus aureus*.

ANTIBIOTIC	RESISTANCE(n=258)	SENSITIVITIY (n= 258)
Levofloxacin	104(40.4%)	154(59.6%)
Cefoxitin	111(43%)	147(56.9%)
Penicillin	205(79.4%)	53(20.5%)
Clindamycin	54(20.9%)	204(79%)
Vancomycin	0(0%)	258(100%)
Ciprofloxacin	185(71.7%)	73(28.2%)
Linezolid	6(2.3%)	252(97.6%)
Amoxclav	97(37.5%)	161(62.4%)
Erythromycin	134(51.9%)	124(48%)
Teicoplanin	9(3.4%)	249(96.5%)
Gentamicin	62(24%)	196(75.9%)
Nitrofurantoin	3(1.1%)	255(98.8%)
Norfloxacin	6(2.3%)	252(97.6%)

Table 5: Prevalence of MRSA and MSSA isolates from clinical samples.

Total Number of *S. aureus* Isolates	Methicillin-Resistant *S. aureus*	Methicillin Sensitive *S. aureus*
258	111	147

Table 6: Age groups distribution of MRSA and MSSA isolates.

Age	Total Number of MRSA Isolates	Total Number of MSSA Isolates
≤ 10 years old	15	23
11-40 years old	53	79
41-70 years old	36	40
≥ 71 years old	7	5
Total	111	147

Table 7: Distribution of MRSA and MSSA on Clinical samples.

Clinical Samples	Number of MRSA Isolates	Number of MSSA Isolates
Urine	9	21
Pus	75	52
Swab	16	43
Blood	11	31

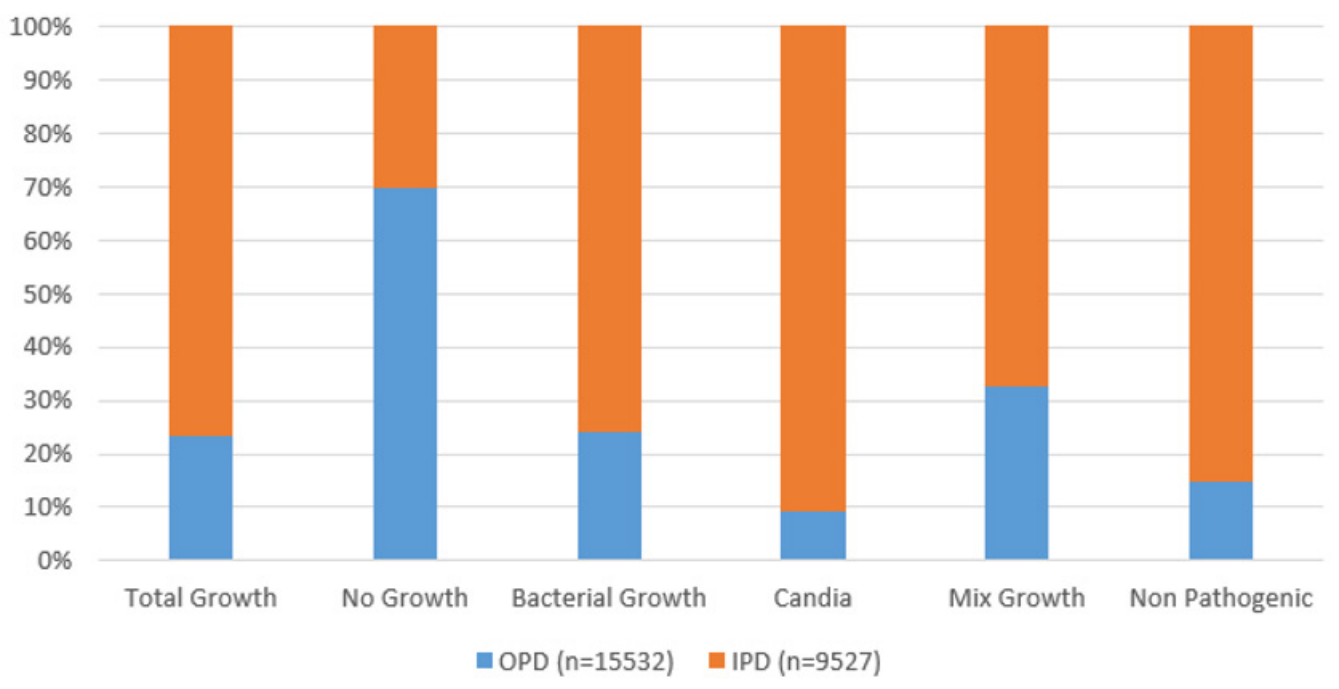

Figure 1: Distribution of total sample growth from IPD & OPD.

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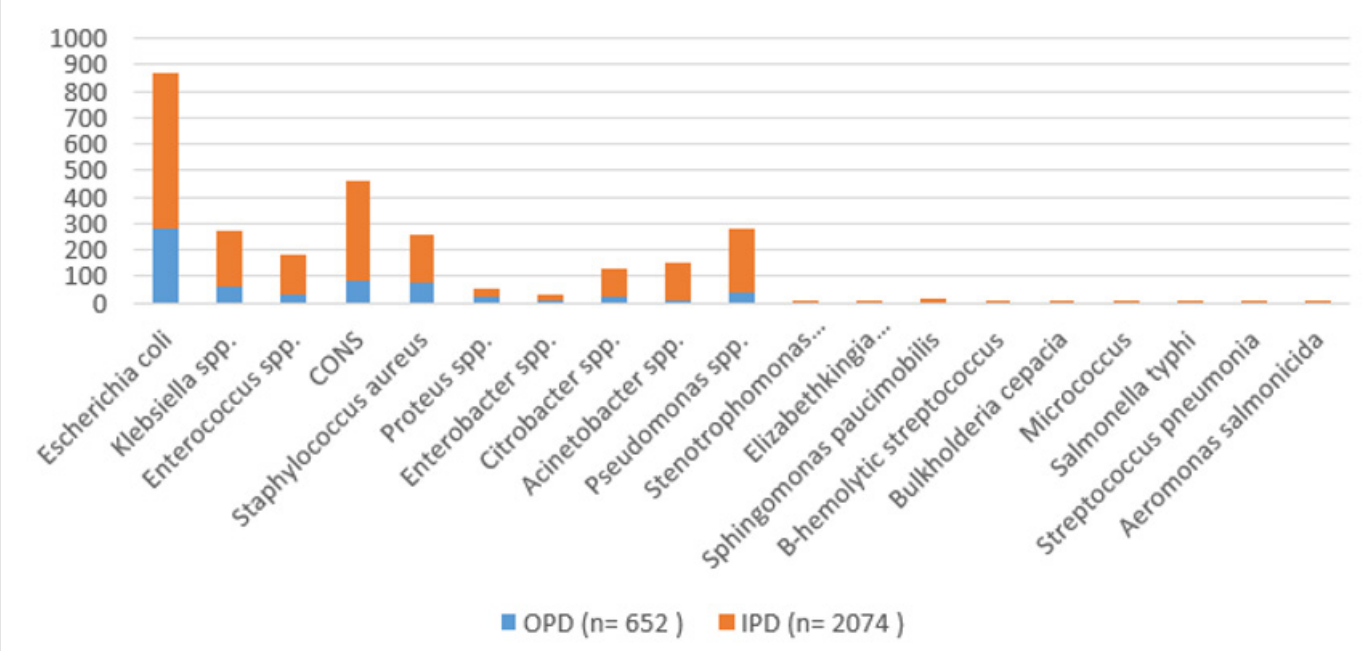

Figure 2: Graphical distribution of different isolates from different wards.

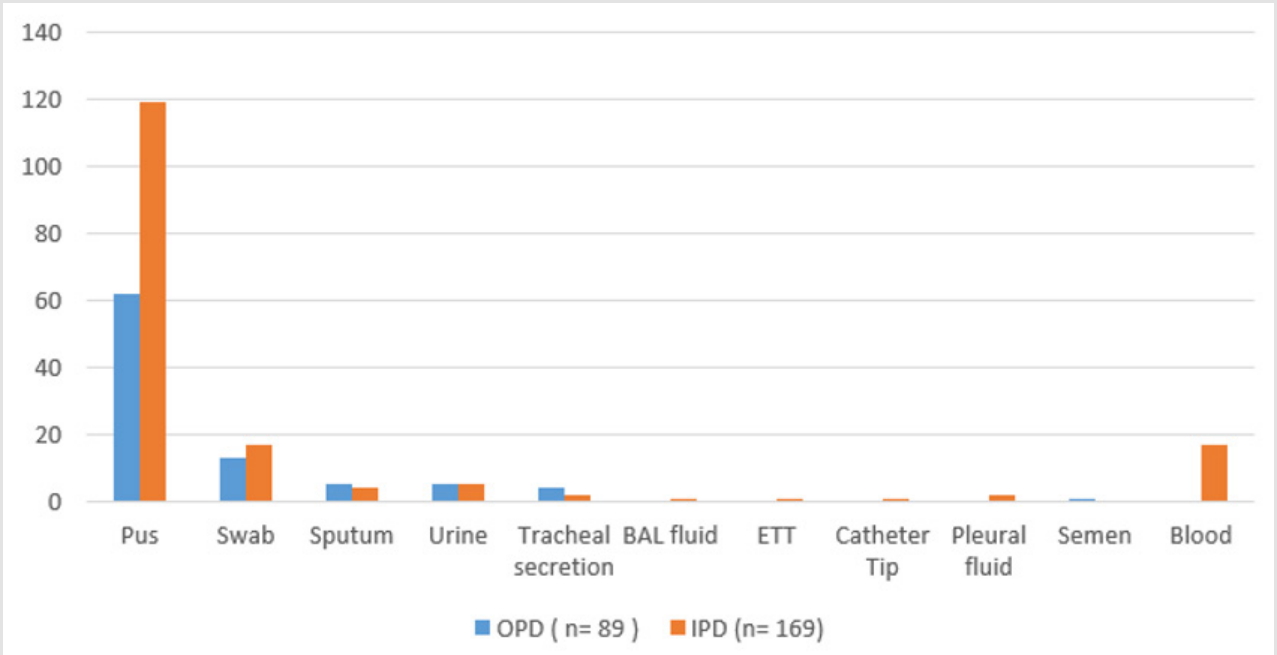

Figure 3: Isolation of S.aureus from various clinical samples.

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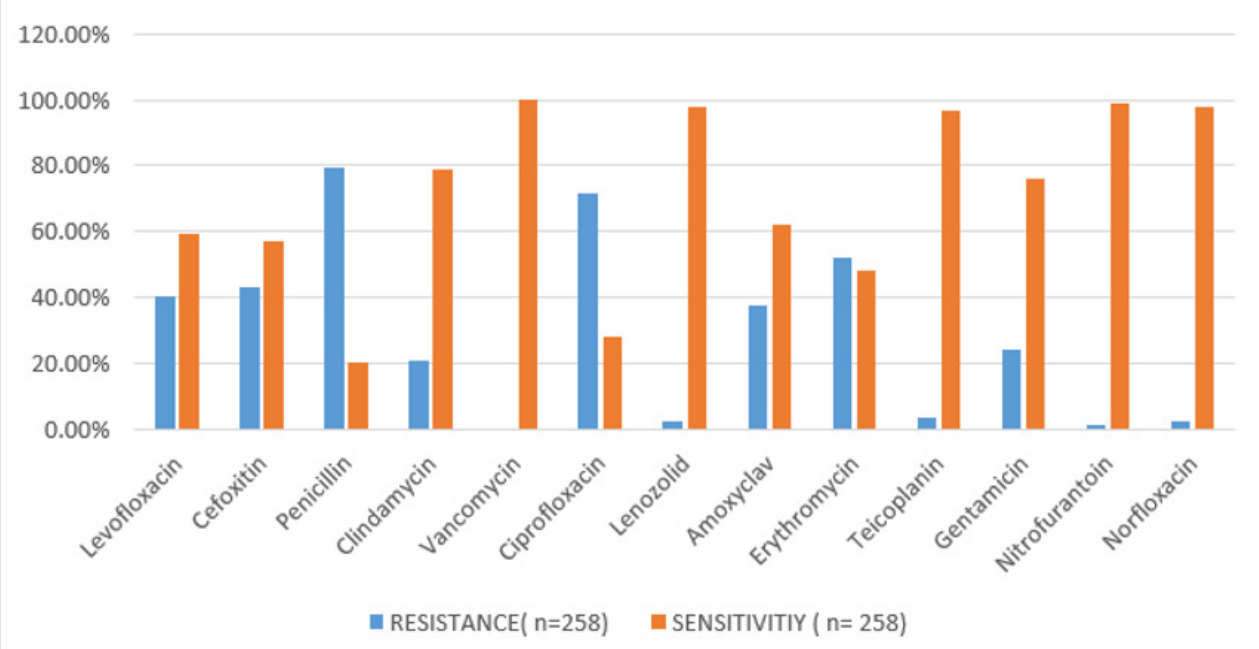

Figure 4: Antibiogram of Staphylococcus aureus.

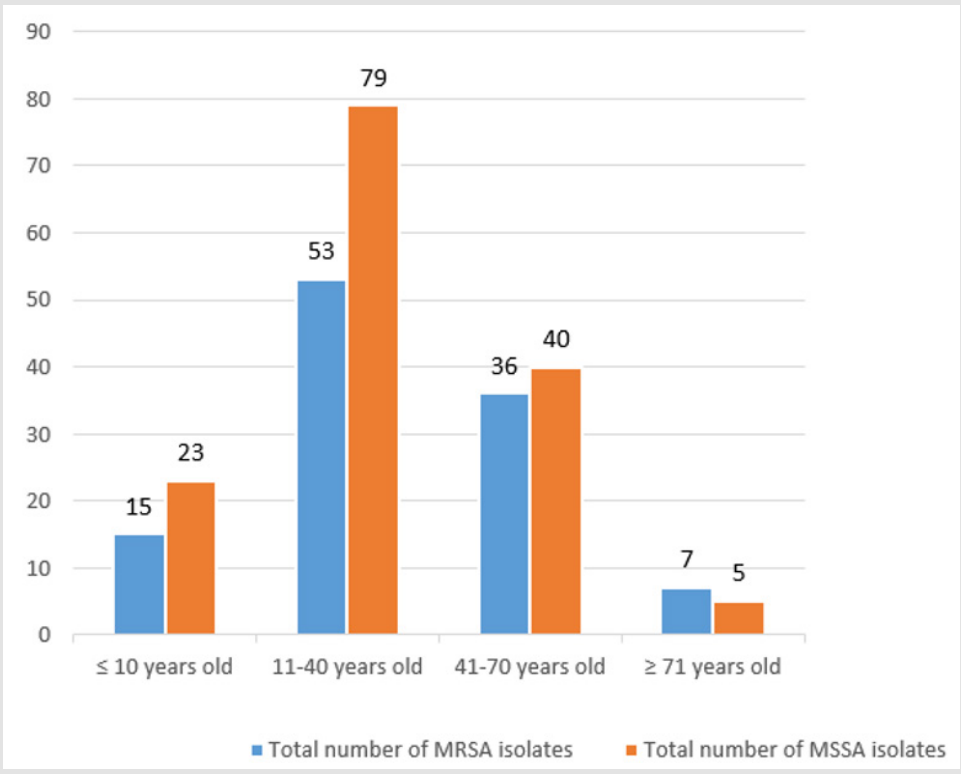

Figure 5: GRAPHICAL REPRESENATION OF AGE GROUPS DISTRIBUTION OF MRSA AND MSSA ISOLATION.

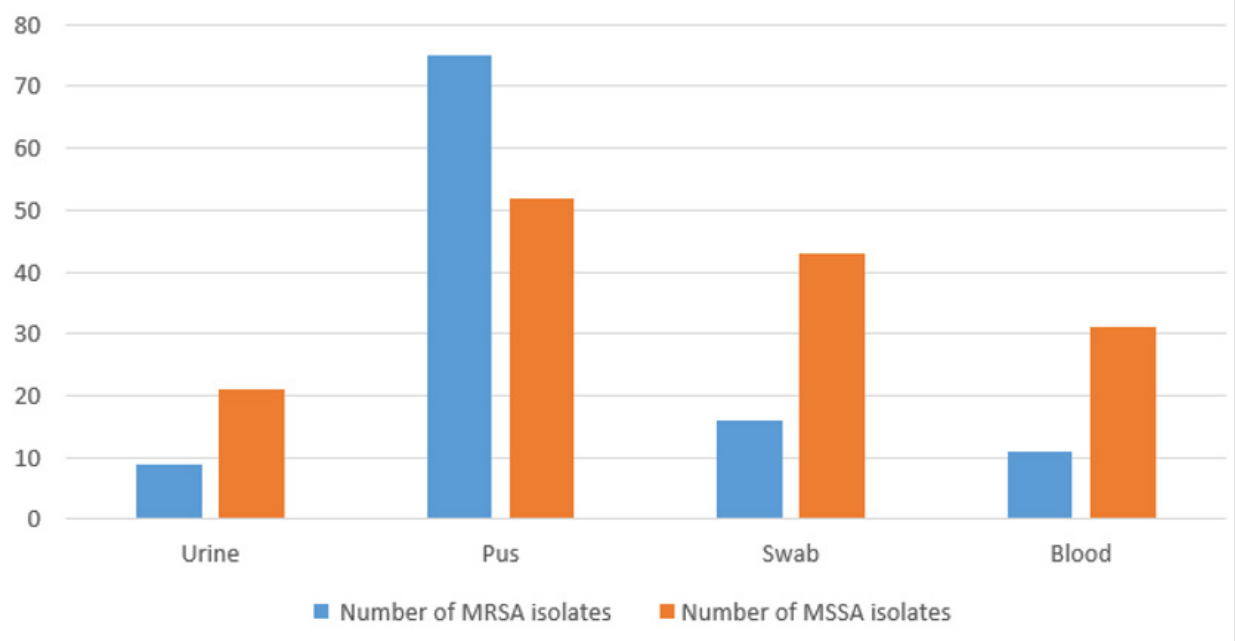

Figure 6: Graphical presentation of MRSA & MSSA in clinical samples.

Discussion

MRSA is the main responsible and most prominent pathogens, which causes HA and CA acquired infections. The incidence of MRSA varies from 25% in the western part of India and 50% in South India [8]. In this study, the prevalence rate was found to be 43%% in a total of 258 isolated *S.aureus* organisms. In this study, 65% (169 of 258) of MRSA strains were HA-MRSA and 34.4% (89 of 258) were of CA-MRSA. This result is similar to the study of Sit S P et al, 59% of MRSA were HA -MRSA and 31% MRSA were of CA-MRSA [4]. The majority of the MRSA infections cases were isolated from 41 to 70-year-old adults followed by the age group of 11-40 years old patients. Because of the more frequent exposure to excessive manipulation, the highest number of infections occurs in adults and elderly peoples. This is the result was correlated with the study of Rodrigues A M, et al. [4] in which the highest number of MRSA was isolated from 11-40 and 41-70-year-old age group [6]. The percentage of total MSSA isolates was (56.97%) compared to MRSA (43.02%). This result was similar to the study done by Pirko Y E, et al [9] in which the percentage of MSSA was 57.5% and MRSA was 42.5% [9].

MRSA isolates were higher than MSSA in pus (67% vs. 35.37%), whereas MSSA isolates were higher than MRSA in urine (14.2% vs 8.10%), blood (21.1% vs 9.09%) and swab (29.25% vs 14.41%). This result was comparable with the study done by Pirko Y E, et al. [9] in which also MSSA isolates were higher than MRSA in urine (38% vs 17%), blood (29% vs 22%), and ear specimens (1% vs 0%) [9]. In this study, the antibiotic susceptibility test reveals that all MRSA isolated were sensitive to Vancomycin(100%) followed by Nitrofurantoin (98.8%), Linezolid (97.6%), and Teicoplanin(96.5%). This result was similar to the study done by Arunkumar V, et al. [6] in which all MRSA isolated were found to be sensitive to Vancomycin and teicoplanin [6]. About 79.4% of MRSA isolates were resistant to penicillin, 71.7% to ciprofloxacin, 51.9% to erythromycin, and 43% to cefoxitin. This result was comparable with the study done by Ameer Abbas which concluded that MRSA isolated were resistant to erythromycin about 61.19%, 52.73% to ciprofloxacin [10].

Conclusion

In this study, the prevalence of MRSA is considered as a high warrant urgent infection awareness. In many hospitals, one of the most common causes of therapeutic problems is MRSA. The MSSA isolates were more frequent than MRSA and also MRSA was multidrug-resistant compare to MSSA. Vancomycin and linezolid can be reserved drugs for life-threatening infections and also for treating multi-drug-resistant MRSA infections. To prevent the spread of MRSA infections, all clinical and paramedical staff must be trained and educated regarding the control measures, and to reduce MRSA prevalence, regular surveillance of hospital infection and monitoring of antibiotic sensitivity pattern is required.

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