International Journal of Health Sciences and Research
[Indexed, Peer-Reviewed Journal]
Volume 16; Issue: 3; March 2026
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Distribution of *Staphylococcus aureus* from Clinical Isolates Across Spectrum of Departments and Patient Profiles - A Clinico-Epidemiologic Study in Tertiary Care Medical College of Eastern India

Sourav Pal[1], Amritendu Mandal[2], Ayan Goswami[3], Neeladri Majumder[4], Agnik Pal[5]

[1]Assistant Professor, Department of Microbiology, Santiniketan Medical College, Bolpur, West Bengal 731204
[2]Assistant Professor, Department of General Medicine, East West Institute of Medical Sciences and Research, Talit, Purba Barddhaman, West Bengal 713141
[3]Associate Professor, Department of Physiology, Maharshi Devraha Baba Autonomous State Medical College, Deoria, Uttar Pradesh 274001
[4]Assistant Professor, Department of Pharmacology, Santiniketan Medical College, Bolpur, West Bengal 731204
[5]Professor and Head, Department of Pharmacology, Santiniketan Medical College, Bolpur, West Bengal 731204

Corresponding Author: Dr. Agnik Pal

DOI: https://doi.org/10.52403/ijhsr.20260325

ABSTRACT

Background: The study was undertaken to find out the distribution profile of *S. aureus* strains including methicillin-resistant Staphylococcus aureus (MRSA) and methicillin-sensitive *Staphylococcus aureus* (MSSA) in different age, sex as well as in clinical isolates from various departments of a tertiary care teaching hospital to understand the local epidemiologic pattern of the organism.
Materials and Methods: The present prospective study was carried out in a tertiary care teaching hospital where different clinical specimens (including blood, urine, pus, CSF, sputum, venous catheter tip, endotracheal tubing's, patient associated devices and sterile body fluids like pleural fluids, synovial fluids etc.) from different departments (OPDs and wards), were studied for staphylococci.
Results: The median age of the patients was 20 years with no difference in the occurrence of *S. aureus* infection, MSSA or MRSA, with gender. *S. aureus* infection was in higher occurrence in age group 21 to 45, followed by the infants, both for MRSA and MSSA. Also in both these groups, MRSA infections were significantly more common than MSSA. Of the total *S. aureus* isolates, 66.5% were from cutaneous and wound infections including surgical site infections; followed by bloodstream infections, 23.3%. 63.3% of the isolates from blood samples were MRSA. Highest number of *S aureus* isolates was from surgery department (34.2%). However highest percentage of MRSA isolates (39.8%) were from department of pediatrics.
Conclusion: MRSA infections were more common in infants and children <5 years of age; Most common infections were cutaneous and wound infections including surgical site infections and bloodstream infections; MRSA isolates were more commonly obtained from wards and ICUs. MSSA were more common in OPD isolates. High percentage of MRSA

isolated from medicine ICU and pediatric ICUs including neonatal ICUs indicates high rate of transmission of MRSA in these settings.

Keywords: Methicillin-resistant staphylococcus aureus, Methicillin-sensitive staphylococcus aureus, Surgical Site Infection, Bloodstream Infection, Respiratory Tract Infection, Urinary Tract Infection

INTRODUCTION

Staphylococcus aureus is one of the most important human pathogens that has been known to cause serious and invasive diseases. A wide range of virulence factors including various toxins and enzymes are responsible for immense diversity of staphylococcal disease.[1] It has now become one of the most important human pathogens responsible for hospital and community acquired infections.

Worldwide, *S aureus* is one of the most common bacterial pathogens in hospital and community acquired infections. Incidence rates of *S aureus* infections range from 28.4 and 35.4 per 100,000 inhabitants per year.[2] *S. aureus* causes an array of infections where it is either present on the infection site or acts at a distance by secreting toxins. The SENTRY antimicrobial surveillance program, data collected from the United States, Canada, Latin America, Europe, and the Western Pacific, reported the distributions of *S. aureus* infections as 39.2% of SSTI, 23.2% of lower respiratory tract infections, 22% of bloodstream infections, including infective endocarditis and 15.6% of other infections, including infections of the urinary tract, brain, and abdominal cavity.[3]

In the pre-antibiotic era, invasive disease due to *S. aureus* was associated with high mortality rate. With the introduction of the "wonder drug" penicillin in 1944, a huge number of deaths due the infections of this organism were eliminated. As early as in the 1950s, staphylococcal strains resistant to penicillin were isolated, and later on to semi-synthetic penicillin derivatives such as methicillin. Recently, methicillin-resistant *S. aureus* (MRSA) strains were isolated in the hospitals and even in community niches. *Staphylococcus aureus* produces a wide variety of exoproteins which contribute to its ability to colonize and cause disease in mammalian hosts. About 50 potential virulence determinants have been described and staphylococcal infections occur in a stepwise manner, each step involving one or several specific virulence factors.[4] S. aureus causes disease through the production of toxin or through the direct invasion and destruction of tissue. The clinical manifestations of some staphylococcal diseases such as impetigo, staphylococcal scalded skin syndrome (SSSS), staphylococcal food poisoning and toxic shock syndrome (TSS) are almost exclusively the result of toxin activity, whereas other diseases result from the proliferation of the organisms, leading to abscess formation and tissue destruction.[5]

MRSA contaminates a large number of hospital items such as pens, mattresses, chairs and bed frames as has been demonstrated in several studies.[6-7] MRSA are also carried with dust particles, could be aerosolized and was present in respirable range.[8] *S. aureus* is known to persist for weeks on items in the hospital such as patient care equipment, uniforms, computer key boards, cellular phones and identification badges.[9-10] In the health care settings transmission of *S. aureus* occurs through contact with contaminated surfaces in the environment.[11] Direct transmission of MRSA from environment to patients has not been demonstrated but plausible route maybe through gloves of health care workers.[12] Patients colonized or infected by MRSA shed the organism which results in contamination of their skin, clothing, bedding and environmental surfaces. Thus, environment plays a significant role in the spread of this antibiotic-resistant organism.

Our study was undertaken to find out the distribution profile of *S. aureus* strains including MRSA and MSSA in different age, sex as well as in clinical isolates from various departments of a tertiary care teaching hospital to understand the local epidemiologic pattern of the organism.

MATERIALS AND METHODS

The present prospective study was carried out in the department of Microbiology and Pharmacology in Santiniketan Medical College, Bolpur, West Bengal, a tertiary care teaching hospital which serves the population of eastern India, during the period of October 2023 to October 2025. During this period different clinical specimens (including blood, urine, pus, CSF, sputum, venous catheter tip, endotracheal tubing's, patient associated devices and sterile body fluids like pleural fluids, synovial fluids etc.) from different departments (OPDs and wards), were studied for staphylococci. *S. aureus* was identified by detection of coagulase enzyme and confirmed by detection of the same with latex agglutination test.

Hospital Acquired-MRSA (HA-MRSA) infection was defined as infection occurring in a patient: Whose isolate was cultured more than 48 h after admission, had a history of hospitalization/surgery/dialysis, residence in a long-term healthcare facility within 6 months prior to the culture date, had an indwelling intravenous line, catheter, or any other percutaneous medical device present at the time when the culture was taken. Patients in whom none of the above conditions were applicable were classified as having Community Acquired-MRSA infection (CA-MRSA).

Statistical calculations were done using Statistical Package for the Social Sciences (SPSS) Windows version 16.0 (SPSS Inc., Chicago, IL, USA). A p value of <0.05 was considered statistically significant.

RESULTS

24,877 different clinical specimens like blood, urine, pus and swabs, CSF, sputum, venous catheter tip, endotracheal tubing's, patient associated devices and sterile body fluids like pleural fluids, synovial fluids etc. from different clinical departments, both OPDs and wards, were studied for staphylococci; of which 698(2.8%) specimens were positive for staphylococci. Out of the above number of staphylococcal isolates, 257 i.e. 36.8% samples were confirmed to be *Staphylococcus aureus*.

Age wise distribution of patients:

Age wise distribution, showed that maximum patients belonged to the age group of 21-45 yrs. (33.1%), and followed by infants (18.3%) and the age group 11-20 yrs. (17.9%). The age group of 45 yrs. and more constituted 14.8% while age groups of 1-5 yrs. and 6-10 yrs. comprised of 8.2% and 7.8% respectively. The median age of the patients was 20 years (interquartile range, 5 to 33 years).

Highest number of isolates belonging to both MRSA and MSSA category both came from patients from the age group 21-45 yrs. However, a considerable proportion of the MRSA isolates was also recovered from infants, 25.2%. The number of MRSA isolates obtained from this age group was significantly more when compared to the rest of the groups ($p<0.05$) The median age of the patients with MRSA infection was 17 years (interquartile range, 1.5 to 26.5 years), while that of patients with MSSA was 22 years (interquartile range, 9 to 36 years) (Table 1).

Table 1: Age wise distribution of patients.

Age Group	Number of Isolates (%)	Number of MRSA Isolates (%)	Number of MSSA Isolates (%)	*p* value
Infants	47 (18.3)	26 (25.2)	21 (13.6)	0.018
1-5 yrs.	21 (8.2)	12 (11.6)	9 (5.8)	0.09
6-10 yrs.	20 (7.8)	8 (7.7)	12 (7.8)	0.99
11-20 yrs.	46 (17.9)	13 (12.6)	33 (21.4)	0.07

21-45 yrs.	85 (33.1)	32 (31.1)	53 (34.4)	0.57
45 and more	38 (14.)	12 (11.6)	26 (16.8)	0.29
Total	257 (100)	103 (100)	154 (100)	-

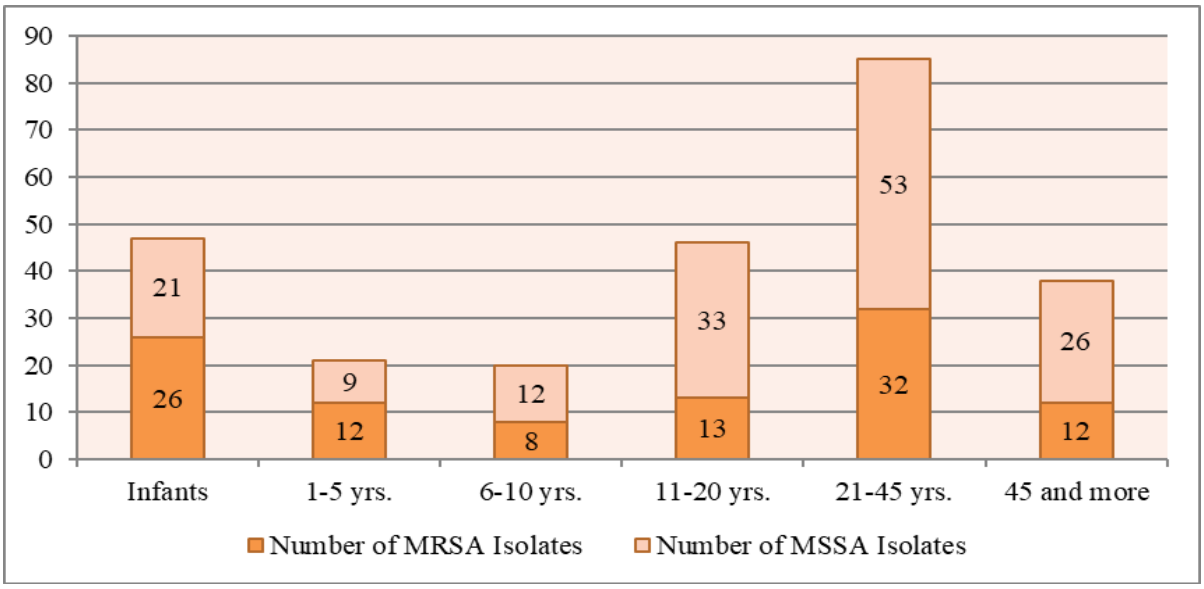

Fig 1: Chart showing the number of MRSA and MSSA isolates obtained from the clinical samples of patients of various age groups.

Sex wise distribution of the patients:

Sex wise distribution reveals 65.7% patients were males and the rest 34.2% were females. Among patients belonging to the age group 45 yrs. or more 86.8% were males. As with the previous, patients belonging to all age groups were more than the females i.e. infants 65.9%, 21-45 yrs. 63.5%, 11-20 yrs. 60.8% 1-5 yrs. 57.1% and 6-10 yrs. with 55% were males (Fig. 4.III).

In infants, male and females were infected almost equally. In all other age groups, the percentage of males infected with MRSA were higher than that of the females.

Tabulated data shows that the infections with MSSA are more common in all age groups in the male patients as compared with the female counterparts (Table 2). But the extent of the preponderance in the male sex in more pronounced in the extremes of age as exemplified by the higher percentage of male patients in the age group of 45 yrs. or more and in infants.

Table 2: Sex wise distribution of the patients according to age groups.

Age group	All isolates			MRSA isolates			MSSA isolates		
	No.	Male (%)	Female (%)	No.	Male (%)	Females (%)	No.	Males (%)	Females (%)
Infants	47	31 (65.9)	16 (34.1)	26	13 (50)	13 (50)	21	18 (85.7)	3 (14.2)
1-5 yrs.	21	12 (57.1)	9 (42.8)	12	7 (58.3)	5 (41.6)	9	5 (55.5)	5 (55.5)
6-10 yrs.	20	11 (55)	9 (45)	8	5 (62.5)	3 (37.5)	12	6 (50)	6 (50)
11-20 yrs.	46	28 (60.8)	18 (39.1)	13	7 (53.8)	6 (46.1)	33	21 (63.6)	12 (36.3)
21-45 yrs.	85	54 (63.5)	31 (36.4)	32	19 (59.3)	13 (40.6)	53	35 (66)	18 (33.9)
45 and more	38	33 (86.8)	5 (13.1)	12	11 (91.6)	1 (8.3)	26	22 (84.6)	3 (11.5)
Total	257	169 (65.7)	88 (34.2)	103	62 (60.1)	41 (39.8)	154	107 (69.4)	47 (30.5)

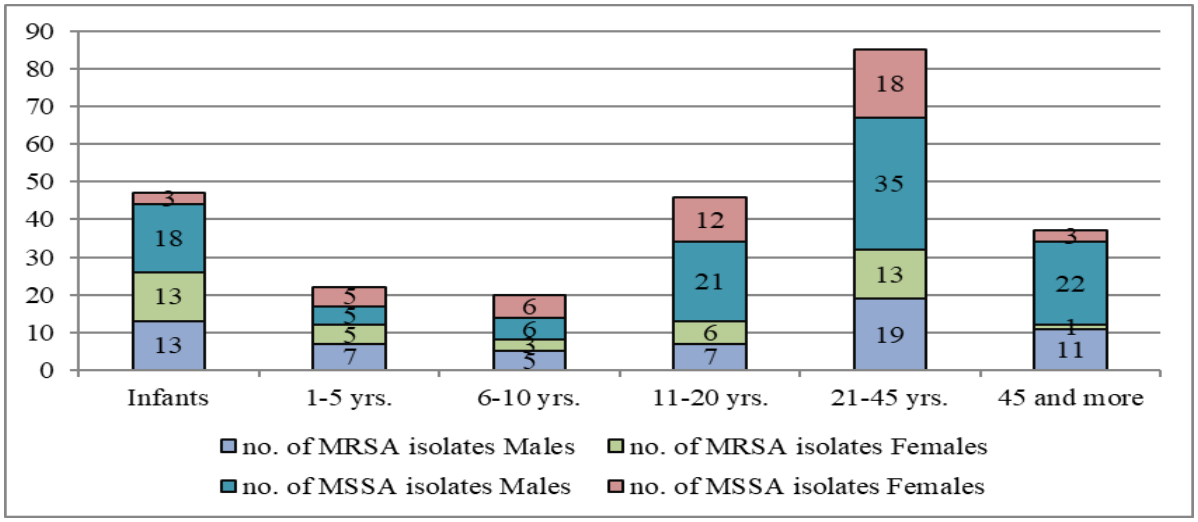

Fig 2: Chart showing the distribution of the MRSA and MSSA isolates based on sex and age groups.

Distribution of the patients based on the treatment settings.

Out of the 257 patients, about half were treated as outpatients (49.4%). Among the patients who were admitted, some were treated in the intensive care units (19.8%), while rest of them was treated in the wards (30.7%); (Fig. 4.V). Most of the patients from whom MRSA was isolated were treated indoor/ward (40.7%). About 1/3rd of the all patients with MRSA infection were treated in OPD (29.1%) and in ICU (30%). MSSA isolates were mostly obtained from OPD, 62.9%, while 24% patients treated in indoor/ward and 12.9% in ICU. When compared to the rest of the data, MSSA was found significantly more in number in outpatients (p<0.05), while inpatients and patients treated in ICU had a significant higher number of MRSA isolates. (p<0.05)

Table 3: Distribution of the patients based on the treatment settings.

Treatment Setting	No. of patients (%)	No. of patients with MRSA infection (%)	No. of patients with MSSA infection (%)	*p* value
OPD	127 (49.4)	30 (29.1)	97 (62.9)	<0.05
Indoor/Ward	79 (30.7)	42 (40.7)	37 (24)	<0.05
ICU	51 (19.8)	31 (30)	20 (12.9)	<0.05
Total	257 (100)	103 (100)	154 (100)	-

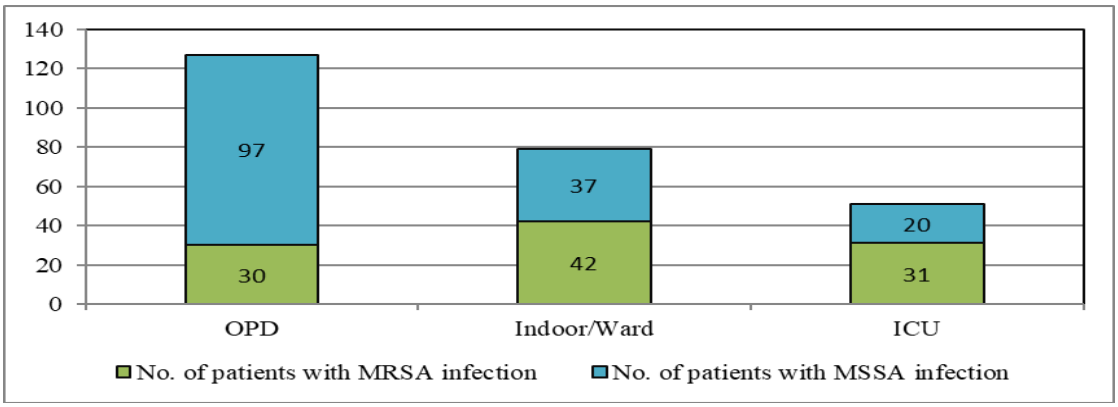

Fig 3: A chart showing the distribution of the patients based on the treatment settings.

Department wise distribution of the patients:

Most of the patients were from department of Surgery (34.2%) followed by the department of Pediatrics (27.6%). Other patients were from department of Medicine (12%), Orthopedics (8.9%) and Dermatology (8.2%). Very few patients

were from department of Obstetrics and Gynecology (1.9%), Otorhinolaryngology (4.6%), Ophthalmology (0.8%) and pulmonary medicine (1.6%); (Table 4.VII). Most of the MRSA isolates were from patients who were from department of Pediatrics (39.8%) followed by the department of Surgery (36.8%). Other patients were from department of Medicine (8.7%), Orthopedics (4.8%) and Dermatology (3.8%). Very few patients were from department of Obstetrics and Gynecology (3.8%), Otorhinolaryngology (0.9%), and Pulmonary medicine (0.9%). The MSSA isolates showed similar trends.

Table 4: Department wise distribution of the patients.

Department	No. of patients (%)	No. of patients with MRSA infections (%)	No. of patients with MSSA infections (%)
Surgery	88 (34.2)	38 (36.8)	50 (32.4)
Paediatrics	71 (27.6)	41 (39.8)	30 (19.4)
Medicine	31 (12)	9 (8.7)	22 (14.2)
Orthopaedics	23 (8.9)	5 (4.8)	18 (11.6)
Dermatology	21 (8.2)	4 (3.8)	17 (11)
Otorhinolaryngology	12 (4.6)	1 (0.9)	11 (7.1)
Obstetrics and Gynaecology	5 (1.9)	4 (3.8)	1 (0.6)
Pulmonary medicine	4 (1.6)	1 (0.9)	3 (1.9)
Ophthalmology	2 (0.8)	0	2 (1.2)
Total	257 (100)	103 (100)	154 (100)

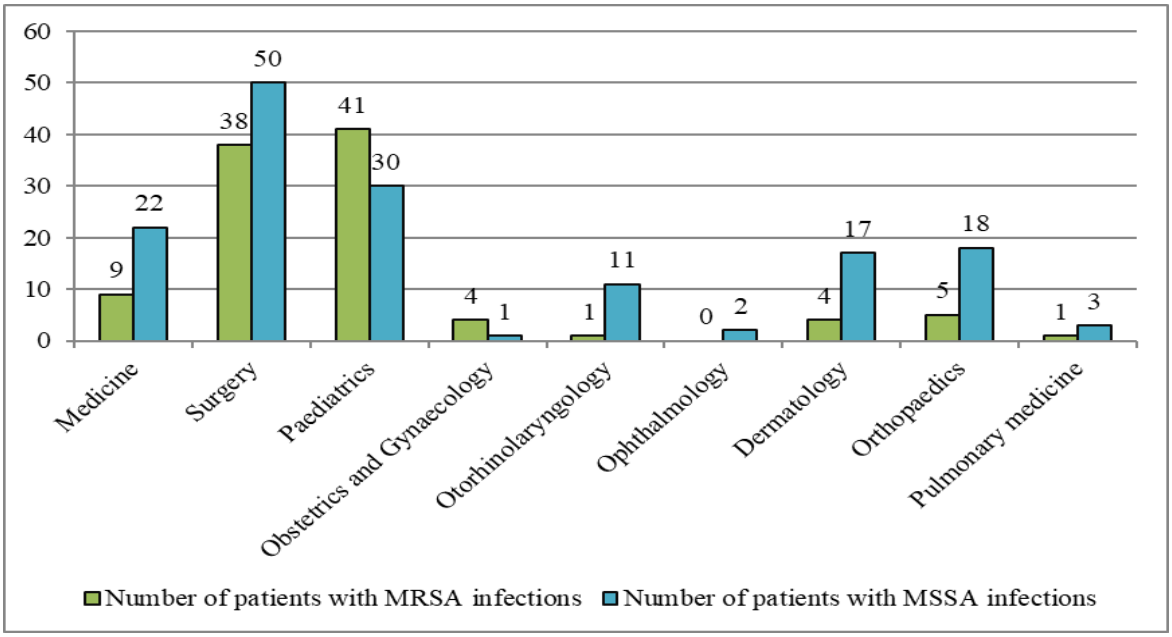

Fig 4: Chart showing the distribution of the patients who were infected with MRSA and MSSA.

Distribution of the patients from various departments based on the treatment settings.

About half of the patients (53.5%) from all outpatients were surgery department. Most of the cases from the wards (44.3 %) and ICU (62.7 %) were from department of Paediatrics (Table 4.VIII). Overall department of Medicine, Surgery and Paediatrics were the biggest contributors.

Distribution of the patients with respect to the department and treatment settings showed that most of the patients treated as outpatients were from the Surgery department (83.3%). In case of Intensive Care Units most of the patients (64.5%) were from department of Paediatrics.

Significant portion was also contributed by the department of Medicine (29%).

Table 5: Distribution of the patients from various departments based on clinical settings.

Department	No. of pts from OPD		No. of Pts from IPD/Ward		No. of pts from ICU	
	With *S. aureus* isolates (%).	With MRSA isolates (%).	With *S. aureus* isolates (%).	With MRSA isolates (%).	With *S. aureus* isolates (%).	With MRSA isolates (%).
Surgery	68 (53.5)	25 (83.3)	19 (24)	12 (28.5)	1 (1.9)	1 (3.2)
Paediatrics	4 (3.1)	0	35 (44.3)	21 (50)	32 (62.7)	20 (64.5)
Medicine	13 (10.2)	0	4 (5)	0	14 (27.4)	9 (29)
Orthopaedics	7 (5.5)	0	12 (15.1)	4 (9.5)	4 (7.8)	1 (3.2)
Dermato-logy	21 (16.5)	4 (13.3)	0	0	0	0
Otorhino-laryngology	11 (8.6)	1 (3.3)	1 (1.2)	0	0	0
Obstetrics and Gynecology	1 (0.7)	0	4 (5)	4 (9.5)	0	0
Pulmonary medicine	0	0	4 (5)	1 (2.3)	0	0
Ophthalmology	2 (1.5)	0	0	0	0	0
Total	127 (100)	30 (100)	79 (100)	42 (100)	51 (100)	31 (100)

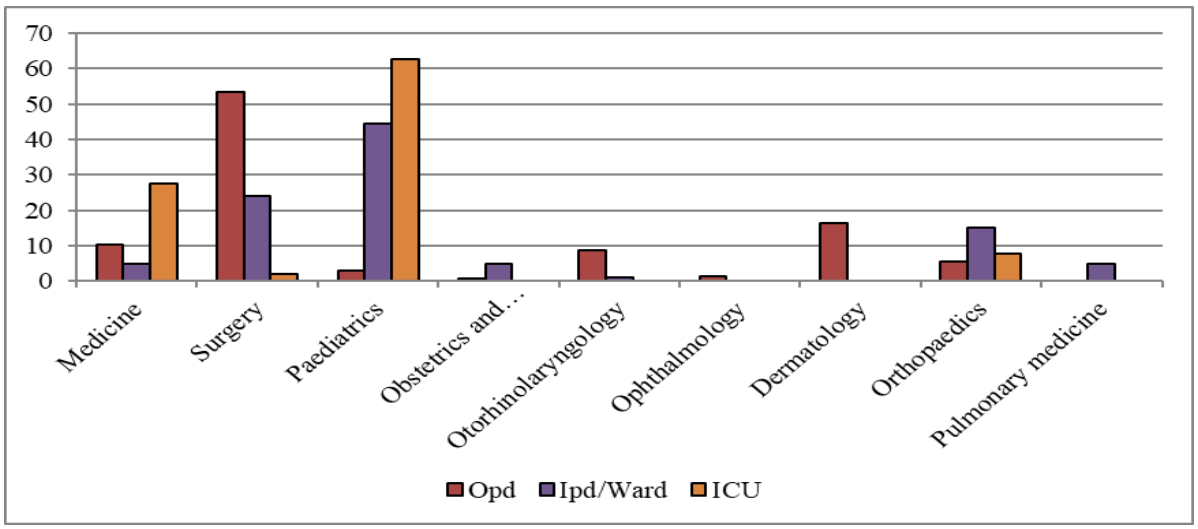

Fig 5: Distribution of the patients from various departments based on clinical settings.

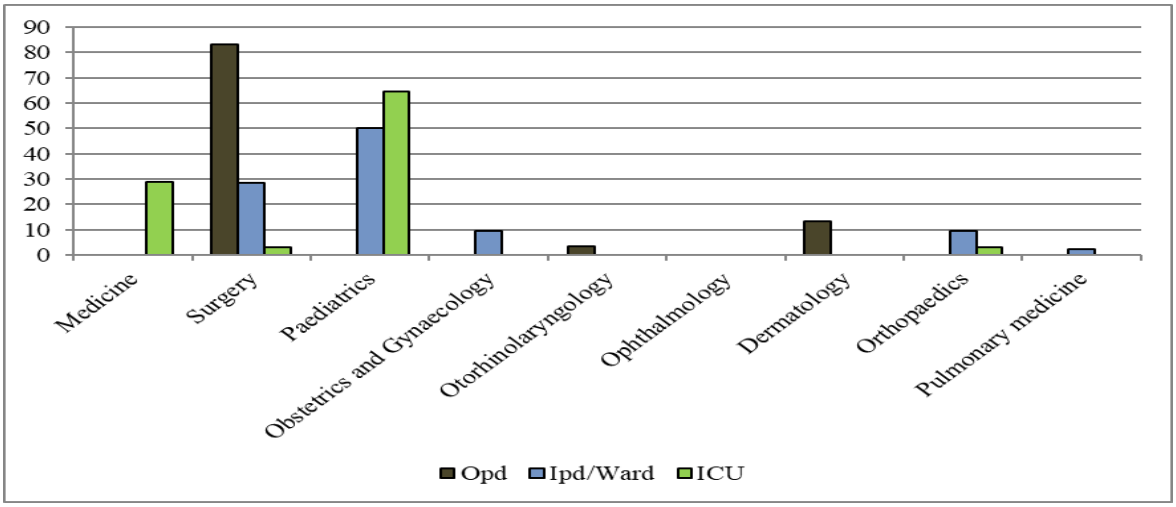

Fig 6: Distribution of the patients with MRSA infections from various departments based on clinical settings.

Table 6: Distribution of different infections caused by *S. aureus* and MRSA.

Type of infection	Number of *S. aureus* Isolates (%)	Number of MRSA Isolates (%)
Cutaneous and wound infections	171 (66.5)	61 (59.2)
Bacteremia	60 (23.3)	38 (36.8)
Urinary tract infections	9 (3.5)	2 (1.9)
Respiratory infections	12 (4.6)	1 (0.9)
Others	5 (1.9)	1 (0.9)
Total	257 (100)	103 (100)

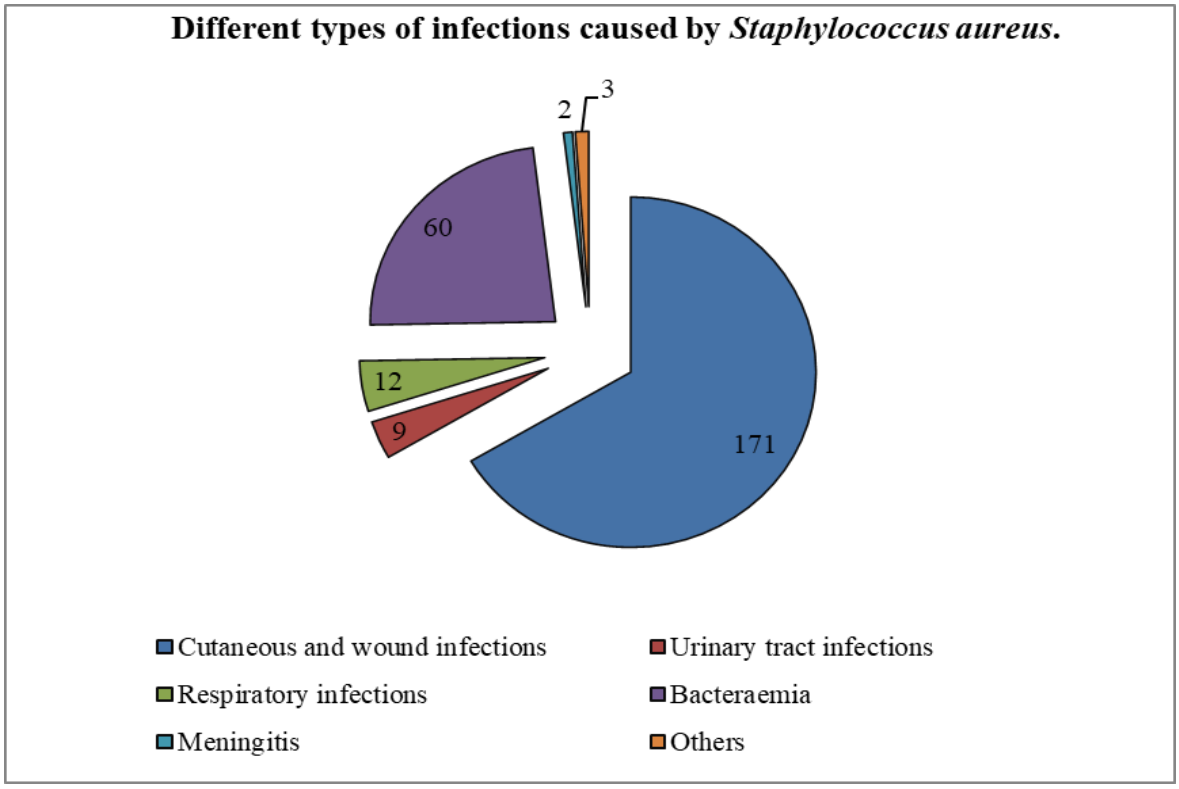

Fig 7: A pie chart showing the frequency of different infections caused by *Staphylococcus aureus*.

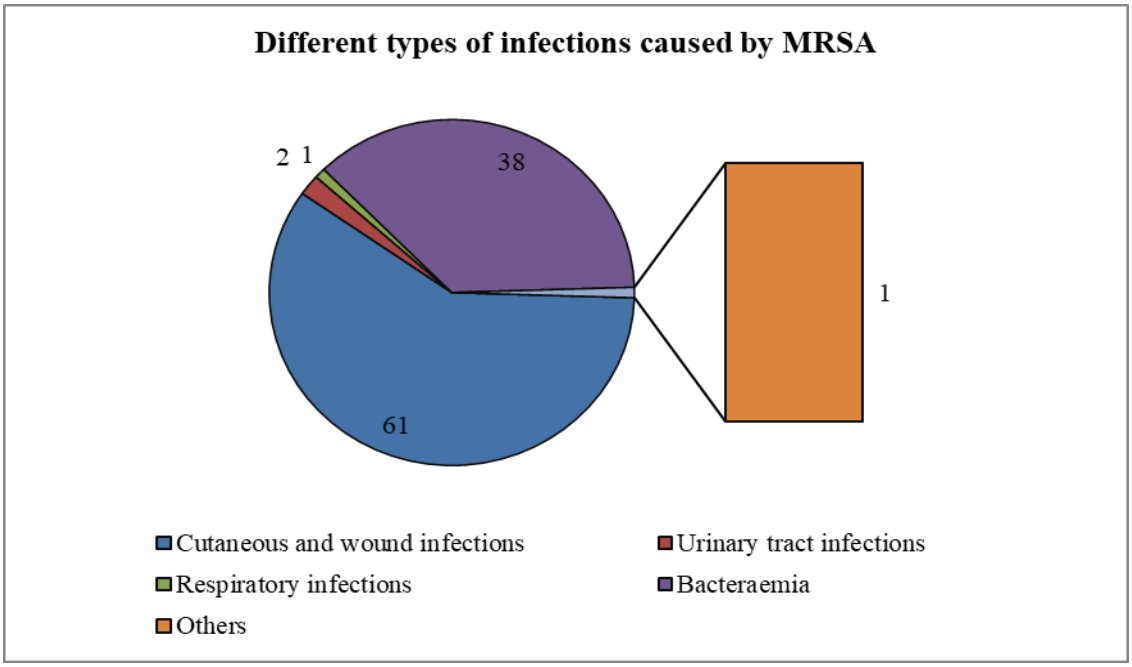

Fig 8: A pie chart showing the frequency of different infections caused by Methicillin Resistant *Staphylococcus aureus* (MRSA).

DISCUSSION

Staphylococci are ubiquitous; with almost all people having coagulase-negative staphylococci on their skin. Transient colonization of moist skin folds, and in neonates, colonization of umbilical stump, skin, and perineal area with *S. aureus* are very common. *S. aureus* and coagulase-negative staphylococci are also found in the oropharynx, gastrointestinal tract, and urogenital tract in healthy adults. About 15% of normal healthy adults are persistent nasopharyngeal carriers with *S. aureus*, with a slightly higher incidence reported for hospitalized patients, medical personnel, persons with eczematous skin diseases, and those who regularly use needles either illicitly or for medical reasons.[13] *S. aureus* rarely causes problems in otherwise healthy people, but is commonly associated with infections of prosthetic devices and surgical wounds, bacteraemia, endocarditis, urinary tract infections and pneumonia in hospitalized patients. Most of these infections start locally (e.g., skin or catheter infections) then spread to the bloodstream, thus putting patients at risk of developing endocarditis and other complications. Shedding of the organism is also very common and is responsible for many hospital-acquired infections.[2]

In hospitals, chief source of *S. aureus* are the colonized patients, in whom they act as endogenous reservoir for overt clinical infections or may spread to other patients. Young children, patient with diabetes or suffering from HIV have a higher frequency of colonization.[14] The fact that nasal *S. aureus* strain and the infecting strain share the same phage type of genotype supports the causal relationship between *S. aureus* nasal carriage and infection.[15] In another study of clinical isolates, total 36.8% of all staphylococcal infections were found to be caused by *S. aureus*, of which 40% were MRSA, which were susceptible to linezolid, netilmicin moxifloxacin, rifampicin and ciprofloxacin (in MSSA) strains; had variable susceptibility to tetracycline, clindamycin, and low susceptibility to erythromycin, gentamicin and cotrimoxazole and were highly resistant to penicillin.[16]

Indian Network for Surveillance of Antimicrobial Resistance (INSAR) group did a multicentric study during 2008 and 2009 at 15 tertiary care centers, which revealed an incidence of 42% MRSA in 2008 and 40% in 2009.[17] A study in Bangalore showed an incidence of 52.2% MRSA isolates.[18] Another study in north India showed a prevalence of MRSA to be 54.85%[19], while a different study in the same institute showed an overall prevalence of MRSA to be 38.44%.[20] In Southeast Asia, a multinational study in 2011 revealed that the proportion of MRSA among clinical *S. aureus* isolates ranged from 28% in Indonesia to 59% in the Philippines.[21]In south Asia the proportion of MRSA among *S. aureus* clinical isolates was reported to be very high, up to a rate of 80.8% as reported in a 1999 study from an Indian hospital.[22]In our study we found an overall 40% prevalence of MRSA isolates during the period of study.

The median age of the patients in our study was 20 years (interquartile range, 5 to 33 years). In a study in Andhra Pradesh, the median age of patients was 29 years (interquartile range, 8.5 to 39.3), and 60.2% were males, from whom the MRSA isolates were obtained.[23] In another study in Bangalore, the authors reported a median age was 43 years (range, 7 days to 91 years) with a male to female sex ratio of 2.29.[18] The results in our study were on similar lines to the results of the aforementioned studies, although the median age was much less. This could be attributed to the fact that a proportionately high number of MRSA isolates were isolated from pediatric patients, especially from Neonatal ICU. This is most probably responsible for the skewed median age towards a younger age group.

The present study finding shows that there is no difference in the occurrence of *S. aureus* infection, MSSA or MRSA, with gender. In the present study, *S. aureus*

infection was in higher occurrence in age group 21 to 45, followed by the infants, both for MRSA and MSSA. Further, occurrence of MRSA and MSSA was almost similar in all age groups. A study in USA, reported highest incidence of invasive MRSA infection among people 65 years and older, blacks and males.[24] In another study in France, MRSA infection was found to be associated with older age group, patients required long hospital stay and were infected later compared to MSSA.[25] MRSA is reported to be a problem of older patients, with 82 % of the patients being 60 years and over in another study.[26] However, in our study no predisposition was seen with advanced age group but in the children less than 1 year of age and the children of age group 1-5 years, the occurrence of MRSA infections were more than that of the MSSA ($p<0.05$).

S. aureus is a leading cause of nosocomial infections, especially in surgical site infections (19.5% to 30%), catheter-related bacteraemia, and ventilator-associated pneumonia (20.5% to 28%). In the community, it is one of the causes of native (31.6%) and prosthetic valve endocarditis (23%) and osteomyelitis (50-70%) and the second most common cause of community-onset bacteremia after *Escherichia coli* (15-23.5%).[27] In USA, *S. aureus* is reported to cause 20%, 19%, 16%, 2% and 17% of pneumonia, SSI, BSI, UTI and others respectively in nosocomial infections.[28] There are medical conditions that increase the risk of invasive *S. aureus* infections, examples include diabetes (RR, 7), cancer (RR, 7.1 to 12.9), rheumatoid arthritis (RR, 2.2 to 9.2), HIV infection (RR, 23.7), intravenous drug use (RR, 10.1), or alcohol abuse (RR, 8.2).[27]

In the present study, of total *S. aureus* isolates, more than half, 66.5%, were isolated from cutaneous and wound infections including surgical site infections (SSI). The other significant proportion was contributed by the patients with sepsis i.e. bloodstream infections (BSI), 23.3%. Other infections like urinary tract infections (UTI), respiratory tract infections (RTI), meningitis were 3.5%, 4.6% and 0.7%. Other types of infections were only 1.2%. Similar to the data of the SENTRY study, cutaneous and wound infections including SSIs were the most common samples from which *S aureus* was isolated and BSI were also similar to the SENTRY study but the number samples for RTI were very small in our study when compared.[3] Indian Network for Surveillance of Antimicrobial Resistance (INSAR) group did a multicentric study during 2008 and 2009 at 15 tertiary care centres and found that skin and soft tissue infections contributed a very significant part of the disease spectrum with 64% in 2008 and 61% in 2009, followed by blood and respiratory samples with 13.6% in 2008, 14.3% in 2009 and 8.4% in 2008, 9.1% in 2009 respectively while UTI and sterile body fluids contributed 2% and 1.1% in 2008 and 1.8% and 1.9% in 2009 respectively.[17] In a study in Bangalore, the author reported an incidence of skin and soft tissue infection of about 68.5%, followed by bone and joint infection of 12%. Respiratory infection was reported to be 14.1% and sepsis with bacteremia and urinary tract infection was reported at 4% and 1% respectively.[18]

In the present study, out of the 257 patients, about half were treated as an outpatient (49.4%). Among the patients who were admitted, some were treated in the Intensive care units (19.8%) while rests of them were treated in the wards (30.7%). MRSA isolates were observed in 29.1% of outpatients, 40.7% of non-ICU inpatients and 30% in ICU patients. In the outpatients MSSA infections were more common than MRSA infections ($p<0.05$). On the contrary, MRSA infections were significantly more common in inpatients and patients of ICU ($p<0.05$). The INSAR study reveals 25.1% & 28.4% isolates of *S aureus* from outpatients in the year 2008 and 2009 respectively. While that of non-ICU in patients and ICU patients were 68.4%, 6.4% and 63.6%, 4.1% for 2008, 2009 respectively; on the other hand, the MRSA

rates among outpatients, non-ICU inpatients and ICU patients were 28%, 42% and 43%, respectively in 2008 and 27%, 49% and 47%, respectively in 2009.[17] Studies in the United States shows, a continuing increase of MRSA infections in hospitals, as high as 3.1% per year in ICUs. During the period from 2006 to 2007, the proportion of hospital-onset *S. aureus* infections that were methicillin resistant reached 56.2% in U.S. hospitals, a proportion that is even higher (64.4%) in US ICUs.[27]

In the present study highest number of *S aureus* isolates were from surgery department (34.2%) including MRSA (36.8%). Department of pediatrics and department of medicine were next contributors with 27.6% and 12% for *S aureus* isolates. However highest percentage of MRSA isolates (39.8%) were from department of pediatrics. Highest number of MRSA isolates from outpatients were from department of surgery (83.3%) while that of inpatients were from department of pediatrics (50%) followed by department of surgery (28.5%). Among the MRSA isolates from ICUs highest number of isolates were obtained from patients from department of pediatrics (64.5%) followed by department of medicine (29%). In our study many isolates were obtained from outpatients. The plausible explanation would be inclusion of a large number of the patients treated as outpatients by the department of medicine, pediatric and dermatology. A significant proportion was also contributed by the department of surgery. As the institute caters a huge population, a significant part of treatment is done on outpatient basis. This could be the reason of this bias. Similarly, a high number of isolates were also isolated from the ICU. Huge number of patients particularly from pediatric ICU and shifting of patients from wards to ICU have resulted in the rise of cases of both MRSA and MSSA from ICU. However high percentage of MRSA isolated from particular settings like pediatric ICUs including neonatal ICUs probably indicates high rate of transmission of MRSA in these settings highlighting the need for stringent infection control practices.

The high occurrence of *S. aureus* in cutaneous and wound infection produced by a study in Spain; which show that *S. aureus* is the most common cause the SSI, attributed to about 20 %.[29] According to Manian & Meyer, *S. aureus* caused 15-20% of the SSIs when only 33-67% of the infected wounds were cultured.[30] In the present study, highest number (59.2%) of the MRSA strains was isolated from cutaneous and wound infections. Although the prevalence of the cutaneous and wound infections in the present study (66.5%) was similar to the findings of the INSAR study (64% in 2008 and 61% in 2009), the latter reported a higher percentage of MRSA isolates from these infections (71% for 2008 and 75% for 2009).[17] These infections cause a huge economic burden as postoperative wound infections increase the length of hospital stay and the cost of the procedure. This is further complicated with association of significant morbidity especially in immunocompromised patients. The high rate of the cutaneous and wound infections, which includes surgical site infections (SSI), occurs also because of the associated risk factors like extremes of age, morbid obesity, diabetes mellitus, prolonged peri-operative hospital stay and concurrent infections.[31]Besides, extended surgical procedure, the wound classification, the use of razor for hair removal before surgery, surgeon's less technical skill, surgeries last 2 or more hours, dirty contaminated surgeries and inadequacy of pre-operative preparation like scrubbing are associated with higher rates of infection peri-operatively.[31] Clipping of hair instead of shaving and warming of the patient during surgery significantly reduces the infection rates as warming improves blood circulation and hence the immune function in the operative.[32]*S aureus* is also the most common cause of cutaneous and deep infections in the community. The above discussed various risk factors and along with the fact that *S aureus* is the most

common organism infecting surgical sites probably have led to the high occurrence of these infections in our study. The hospital environment serves as a reservoir for *S. aureus*, as they survive over relatively long periods on inanimate surfaces and are stable in dry environment with a median survival time of 12 days (1 to >60 days) on inanimate surfaces in ICU.[33] Many hospital surfaces contain viable MRSA and they can remain viable for several weeks to several months on dry surfaces.[11] Inadequate surface cleaning and nurse under-staffing in ICU have been reported to be associated with MRSA infection.[34] Hence, the prevalence of infection in one place cannot be compared with another place.

In this study the next common infection observed was Bloodstream infections (BSI). Although coagulase negative staphylococci (CoNS) are reported as the most common agent of BSI, *S. aureus* is attributed to about 16% it.[35] Occurrence of BSI depends on many factors like size of hospital, type of hospital, type of population admitted to the hospital, the length of hospital stay and the location within the hospital as well as population size, extremes of age in admitted patients, patients with severe underlying illnesses, poor nutritional status, limited mobility, poor host defense, even the use of venous catheter playing an important role of increasing the risk of BSI.[3,35] Multiple interventions at the same time known as "bundling" may be the best strategy to reduce the central venous catheter related infection.[36] In our study of all isolates coming from patients admitted in the hospital, 63.3% of the isolates from blood samples were MRSA and 80% of the isolates came from the department of pediatrics and 41.6% from neonatal ICU and pediatric ICU. It contributed to about 36.8% of all the MRSA isolates recovered. The INSAR study had reported 15.3% and 17.9% of the MRSA isolates from blood for the year 2008 and 2009.[17] Poor infection control in the above two treatment setups could be the reason for high incidence of BSI. Also, the data could be slightly skewed as not many adult patients were reported with staphylococcal BSI. Rampant and un-scrutinized use of antimicrobials results in poor diagnosis of BSI by culture. This is also accentuated by the fact that many times blood is sent for culture after the administration of antimicrobials.

RTI in the present study was the third highest in prevalence (4.6%). However, only one MRSA strain was isolated from specimens for the above infection. *S. aureus* is the most commonly isolated organism (19%) from the lower respiratory tract infection in NNIS study.[35] So, in the present study the number isolates from respiratory sample were much less when compared to the NNIS data. But INSAR study had also reported much smaller number of RTIs, (8.4-9.1% for 2008 and 2009) besides contributing only 9.5-9.8% of all MRSA isolates.[17] The risk factors predisposing RTI include the severe underlying disease, extremes of age, chronic lung diseases, use of immunosuppressant drugs, large volume of aspiration, intubation, mechanically assisted ventilation, and various surgeries. Intubations breach the first line of defense and due to placement of endotracheal tube patients aspirate the organisms. Most of the RTIs in the hospital setup are caused by the gram-negative bacteria. This could be probably due to uninhibited use of antimicrobials empirically, most of which is directed towards gram positive organisms. This could probably be the most important reason due to which the numbers of isolates, recovered from culture of respiratory samples, are minimal. Reduction in ventilator associated pneumonia can be achieved by avoiding tracheal intubation whenever possible, placing the patient in semi-erect position ($30\text{-}45^0$) and using enteral feeding rather than parenteral feeding whenever possible.[37]

UTI was the next most common infection (4.6%) which was higher when compared with the INSAR study (2-1.8%).[17] In our study 2% of MRSA isolates were obtained from urine, this is similar to the previously

mentioned study, where they reported 2-2.4%. Majority of the cases of UTI precipitate due to the use of catheters, which breaches the normal defense of the mucosa, introduce the hospital strains into bladder, function as a conduit from environment to inside, blunt the immune response, provide a surface for the growth of biofilm and do not allow complete voiding of urine.[38, 39] Use of silver tipped urinary catheter has been reported to be associated with 41 % reduction of UTI.[39] *S. aureus* is not commonly isolated from UTI, but is a common isolate from other sites.[28] Thus, *S. aureus* being not a common organism causing UTI, the incidence of infection could have been observed fourth in order in the present study.

CONCLUSION

The median age of the patients was 20 years (interquartile range, 5 to 33 years). There was no difference in the occurrence of *S. aureus* infection, MSSA or MRSA, with gender. *S. aureus* infection was in higher occurrence in age group 21 to 45, followed by the infants, both for MRSA and MSSA. Also in both these groups, MRSA infections were significantly more common than MSSA. Of the total *S. aureus* isolates, 66.5% were from cutaneous and wound infections including SSI; followed by BSI, 23.3%. 63.3% of the isolates from blood samples were MRSA. Highest number of *S aureus* isolates was from surgery department (34.2%). SSIs can be reduced by 35-50% by regular surveillance programs.[40] A successful SSI surveillance program includes standardized definitions of infection, efficient surveillance methods and stratification of the SSI rates according to risk factors associated with the development of SSI. Feedback of information to surgeons and other relevant staff has been an important element in the overall strategy to reduce the numbers of SSIs.[41] Data from the present studies showed a high rate of cutaneous infections including the SSIs.

However highest percentage of MRSA isolates (39.8%) were from department of paediatrics. MRSA infections were more common in infants and children <5 years of age; most common infections were cutaneous and wound infections including SSI (66.5%) and BSI (23.3%); MRSA isolates were more commonly obtained from wards and ICUs. MSSA were more common in OPD isolates. High percentage of MRSA isolated from medicine ICU and pediatric ICUs including neonatal ICUs indicates high rate of transmission of MRSA in these settings.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Bal AM, Gould IM. Antibiotic resistance in Staphylococcus aureus and its relevance in therapy. Expert opinion on pharmacotherapy. 2005 Oct 1;6(13):2257-69.
2. Moreillon P, Que YA, Glauser MP. Staphylococcus aureus (including staphylococcal toxic shock). Mandell, Douglas and Bennett's principles and practice of infectious diseases. 2005; 2:2321-51.
3. Diekema DJ, Hsueh PR, Mendes RE, Pfaller MA, Rolston KV, Sader HS, Jones RN. The microbiology of bloodstream infection: 20-year trends from the SENTRY antimicrobial surveillance program. Antimicrobial agents and chemotherapy. 2019 Jul;63(7):10-128.4.
4. Baron E, Peterson L, Finegold SB. Scott's diagnostic microbiology. The CV, Toronto. 1994;362.
5. Blythe D, Keenlyside D, Dawson SJ, Galloway A. Environmental contamination due to methicillin resistant Staphylococcus aureus (MRSA). J. Hosp. Infect. 1998; 38:67-70.
6. Bures S, Fishbain JT, Uyehara CF, Parker JM, Berg BW. Computer keyboards and faucet handle as reservoirs of nosocomial pathogens in the intensive care unit. American journal of infection control. 2000 Dec 1;28(6):465-71.

7. Shiomori T, Miyamoto H, Makishima K, Yoshida M, Fujiyoshi T, Udaka T, Inaba T, Hiraki N. Evaluation of bedmaking-related airborne and surface methicillin-resistant Staphylococcus aureus contamination. Journal of Hospital Infection. 2002 Jan 1;50(1):30-5.
8. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC infectious diseases. 2006 Aug 16;6(1):130.
9. Landers TF, Hoet A, Wittum TE. Swab type, moistening, and preenrichment for Staphylococcus aureus on environmental surfaces. Journal of clinical microbiology. 2010 Jun;48(6):2235-6.
10. Boyce JM. Environmental contamination makes an important contribution to hospital infection. Journal of hospital infection. 2007 Jun 1; 65:50-4.
11. Boyce JM, Potter-Bynoe G, Chenevert C, King T. Environmental contamination due to methicillin-resistant Staphylococcus aureus: possible infection control implications. Infect Control Hosp Epidemiol. 1997 Sep;18(9):622-7.
12. Zanger P, Nurjadi D, Vath B, Kremsner PG. Persistent nasal carriage of Staphylococcus aureus is associated with deficient induction of human beta-defensin 3 after sterile wounding of healthy skin in vivo. Infect Immun. 2011 Jul;79(7):2658-62.
13. Liu GY. Molecular pathogenesis of Staphylococcus aureus infection. Pediatric research. 2009 May;65(7):71-7.
14. Valentine FC, Hall-Smith SP. Superficial staphylococcal infection. Lancet. 1952 Aug 23;2(6730):351-4.
15. Pal S, Majumder N, Mandal A, Goswami A, Pal A. Characterization of Method of Detection and Antibiotic Susceptibility Profile of Staphylococcus aureus from Clinical Isolates - A Laboratory Study from Eastern Indian Tertiary Care Medical College. International Journal of Current Pharmaceutical Review and Research 2025 Nov;17(11); 333-343.
16. Joshi S, Ray P, Manchanda V, Bajaj J, Chitnis DS, Gautam V, Goswami P, Gupta V, Harish BN, Kagal A, Kapil A. Methicillin resistant Staphylococcus aureus (MRSA) in India: prevalence & susceptibility pattern. Indian Journal of Medical Research. 2013 Feb 1;137(2):363-9.
17. Bouchiat C, El-Zeenni N, Chakrakodi B, Nagaraj S, Arakere G, Etienne J. Epidemiology of Staphylococcus aureus in Bangalore, India: emergence of the ST217 clone and high rate of resistance to erythromycin and ciprofloxacin in the community. New microbes and new infections. 2015 Sep 1; 7:15-20.
18. Anupurba S, Sen MR, Nath G, Sharma BM, Gulati AK, Mohapatra TM. Prevalence of methicillin resistant Staphylococcus aureus in a tertiary referral hospital in eastern Uttar Pradesh. Indian journal of medical microbiology. 2003 Jan 1;21(1):49-51.
19. Tiwari HK, Sapkota D, Sen MR. High prevalence of multidrug-resistant MRSA in a tertiary care hospital of northern India. Infection and drug resistance. 2008 Nov 30:57-61.
20. Mendes RE, Mendoza M, Banga Singh KK, Castanheira M, Bell JM, Turnidge JD, Lin SS, Jones RN. Regional resistance surveillance program results for 12 Asia-Pacific nations (2011). Antimicrobial agents and chemotherapy. 2013 Nov;57(11):5721-6.
21. Verma S, Joshi S, Chitnis V, Hemwani N, Chitnis D. Growing problem of methicillin resistant staphylococci--Indian scenario. Indian journal of medical sciences. 2000 Dec 1;54(12):535-40.
22. Alvarez-Uria G, Reddy R. Prevalence and Antibiotic Susceptibility of Community-Associated Methicillin-Resistant Staphylococcus aureus in a Rural Area of India: Is MRSA Replacing Methicillin-Susceptible Staphylococcus aureus in the Community? International Scholarly Research Notices. 2012;2012(1):248951.
23. Klevens RM, Morrison MA, Nadle J, Petit S, Gershman K, Ray S, Harrison LH, Lynfield R, Dumyati G, Townes JM, Craig AS. Invasive methicillin-resistant Staphylococcus aureus infections in the United States. Jama. 2007 Oct 17;298(15):1763-71.
24. Lepelletier D, Ferréol S, Villers D, Richet H. Infections nosocomiales à Staphylococcus aureus résistant à la méthicillineenréanimationmédicalepolyvalente: facteurs de risque, morbidité et impact

économique. Pathologie Biologie. 2004 Oct 1;52(8):474-9.
25. Gemmell CG, Edwards DI, Fraise AP, Gould FK, Ridgway GL, Warren RE. Guidelines for the prophylaxis and treatment of methicillin-resistant Staphylococcus aureus (MRSA) infections in the UK. Journal of antimicrobial chemotherapy. 2006 Apr 1;57(4):589-608.
26. Moreillon P, Que YA, Glauser MP, "Staphylococcus aureus (including staphylococcal toxic shock), "In: G.L. Mandell, J.E. Bennett, R. Dolin, Ed., Principles and Practice of Infectious Diseases. 6th edition. Philadelphia, Churchill Livingstone, 2005, pp.2321.
27. Emori TG, Gaynes RP. An overview of nosocomial infections, including the role of the microbiology laboratory. Clinical microbiology reviews. 1993 Oct;6(4):428-42.
28. Lizan-Garcia M, Peyro R, Cortina M, Crespo MD, Tobias A. Nosocomial infection surveillance in a surgical intensive care unit in Spain, 1996-2000: a time-trend analysis. Infection Control & Hospital Epidemiology. 2006 Jan;27(1):54-9.
29. Manian FA, Meyer L. Comprehensive surveillance of surgical wound infections in outpatient and inpatient surgery. Infection Control & Hospital Epidemiology. 1990 Oct;11(10):515-20.
30. Cheadle WG. Risk factors for surgical site infection. Surgical infections. 2006 Jan 1;7(1_suppl):s7-11.
31. Melling AC, Ali B, Scott EM, Leaper DJ. Effects of preoperative warming on the incidence of wound infection after clean surgery: a randomised controlled trial. The Lancet. 2001 Sep 15;358(9285):876-80.
32. Neely AN, Maley MP. Survival of enterococci and staphylococci on hospital fabrics and plastic. Journal of clinical microbiology. 2000 Feb 1;38(2):724-6.
33. Dancer SJ, Coyne M, Speekenbrink A, Samavedam S, Kennedy J, Wallace PG. MRSA acquisition in an intensive care unit. American journal of infection control. 2006 Feb 1;34(1):10-7.
34. Weinstein RA, Gaynes R, Edwards JR, National Nosocomial Infections Surveillance System. Overview of nosocomial infections caused by gram-negative bacilli. Clinical infectious diseases. 2005 Sep 15;41(6):848-54.
35. Mermel LA. Prevention of central venous catheter-related infections: what works other than impregnated or coated catheters? Journal of Hospital Infection. 2007 Jun 1; 65:30-3.
36. Isakow W, Kollef MH. Preventing ventilator-associated pneumonia: an evidence-based approach of modifiable risk factors. InSeminars in Respiratory and Critical Care Medicine 2006 Feb (Vol. 27, No. 01, pp. 005-017).
37. Mitiku A, Aklilu A, Biresaw G, Gize A. Prevalence and associated factors of methicillin resistance Staphylococcus aureus (MRSA) among urinary tract infection suspected patients attending at Arba Minch General Hospital, Southern Ethiopia. Infection and drug resistance. 2021 Jun 9:2133-42.
38. Saint S, Savel RH, Matthay MA. Enhancing the safety of critically ill patients by reducing urinary and central venous catheter-related infections. American journal of respiratory and critical care medicine. 2002 Jun 1;165(11):1475-9.
39. Roy MC, Perl TM. Basics of surgical-site infection surveillance. Infection Control & Hospital Epidemiology. 1997 Sep;18(9):659-68.
40. Smyth ET, Emmerson AM. Surgical site infection surveillance. Journal of Hospital Infection. 2000 Jul 1;45(3):173-84.

How to cite this article: Sourav Pal, Amritendu Mandal, Ayan Goswami, Neeladri Majumder, Agnik Pal. Distribution of *Staphylococcus aureus* from clinical isolates across spectrum of departments and patient profiles - a clinico-epidemiologic study in tertiary care medical college of Eastern India. *Int J Health Sci Res.* 2026; 16(3):201-215. DOI: *https://doi.org/10.52403/ijhsr.20260325*

******