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Bacteriological Profile of Post-Operative Wound Infections and their Antimicrobial Susceptibility Pattern in a Tertiary Care Hospital

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ABSTRACT

Postoperative wound infections or surgical site infection is one of the most commonly Hospital associated infections of patients undergoing surgery. This study was proposed to evaluate the aerobic bacterial isolates and their drug susceptibility patterns in patients with clinically suspected postoperative infection. Samples that were sent to the microbiology laboratory from clinically suspected cases of post-operative wound infections were grown on aerobic culture and their species were identified by standard biochemical tests. Antibiotic sensitivity testing and phenotypic identification of MRSA and ESBL producers were done as per CLSI guidelines 2020. The rate of postoperative wound infection in Rajah Muthiah Medical hospital was 5.59%. Out of 300 infected cases, 145 samples showed culture positivity. The most common organism isolated was Staphylococcus aureus followed by E.coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Coagulase negative staphylococcus aureus (CONS), and Proteus mirabilis. About 84 % of S.aureus were MRSA and 16 % were MSSA. 96% S.aureus were sensitive to Linezolid. ESBL producers were about 41.8 % of which 21.6 % were Enterobacteriaceae and 13.2% were P.aeruginosa. In this study, a higher number of MDR strains was found as the causative agent of wound infection. Thus, to achieve effective therapy for wound infections and to reduce/stop the appearance of multidrug-resistant (MDR) pathogens, continuous monitoring is essential with the appropriate use of antimicrobial agents. So, routine microbiological analysis of the wound specimen and their antibiotic susceptibility testing are recommended that will guide medical practitioners in the empirical treatment of wound infection, to reduce the spread of resistant bacteria.

Keywords: *Staphylococcus aureus*, Prevalence, Antibiotic resistance, Postoperative infection, Multidrug resistance.

INTRODUCTION

Post-operative wound infections, also known as Surgical Site Infections (SSI), are infections that occur within 30 days of surgery for skin or subcutaneous tissue through a superficial incision or without an implant in place, as well as infections that occur within 90 days of surgery for deep soft tissues or organs space through a deep incision or with an implant in place. Post-operative wound infections (23.94%) are the most common healthcare-associated infections (Nair et al., 2017)[1]. According to Vatavati et al., (2020), - the global estimates of SSI have varied from 0.5% to 15%. In India, the SSI incidence varies from 4.04% to 30% (Bangal et al., 2014)[3]. Three major factors contribute to post-operative wound infection: (a) degree of microbial contamination of the wound during surgery, (b) duration of the operative procedure, (c) host factors (age, obesity, malnutrition, diabetes, carrier state i.e., chronic Staphylococcal carriage, immunosuppression, anaemia, renal failure, radiation etc. (Beilman et al., 2015)[4]. Microbiology of SSI depends on the nature of the surgery, incision location and body cavity/hollow viscous entry during the procedure. In most of these wound infections, the causative agents arise from the endogenous flora of the patient's skin, mucous membranes or hollow viscera. (Shamanna et al., 2017)[5].

MATERIALS AND METHODS

This study was conducted in the department of Microbiology at Rajah Muthiah Medical College Hospital, Chidambaram from September 2021 to August 2022 after ethical clearance. The material for the study was obtained from the samples of patients with signs and symptoms of post-operative wound infections that were sent to the department of Microbiology from various surgical units.

Inclusion criteria

1. Exudate and swab samples of patients received with suspected Surgical Site Infection.
2. All Surgical procedures performed within any of the following designated surgical services: General surgery, Orthopaedics, Obstetrics and Gynaecology (OBG)

Exclusion criteria

1. Surgical procedures performed in departments other than General surgery, Orthopaedics, Obstetrics and Gynaecology (OBG) and
2. Infected Burns

Methods of processing

All the pus samples or wound swabs of clinically suspected SSI cases were received in the Department of Microbiology, Rajah Muthiah Medical College and Hospital, Chidambaram. These samples were subjected to direct microscopic examination by Gram stain and inoculated onto nutrient agar, 5% sheep blood agar and MacConkey agar using a sterile bacteriological loop. Plates were incubated aerobically at 37°C for 24 hours and if there was no growth, they were incubated for another 48 hours. Standard bacteriological procedures were used to analyse and identify the isolated organisms with appropriate Biochemical reactions. Antibiotic susceptibility was determined in Mueller Hinton Agar using the Kirby-Bauer disk diffusion technique according to CLSI 2020 guidelines.All drugs required for sensitivity testing were purachased from High Media.

Methicillin Resistant Staphylococcus aureus using oxacillin disc for mecA-mediated resistance and Extended Spectrum Beta Lactamase (ESBL) based on CLSI guidelines 2020 were identified.

RESULTS AND DISCUSSION

A total of 2,595surgeries were performed during the study period in the department of Surgery (941), Orthopaedics (439), and Obstetrics and Gynaecology (1,215). Out of these 300, clinically suspected samples were sent to the Microbiology lab for Bacterial identification and Antibiotic susceptibility testing.

In the present study operative wound infection rate was 5.59%.Our finding is similar to the studies by Bangal et al., (2014)[3] and Golia et al., (2014)[7], who have reported SSI incidence of around 5%. In contrary Kokate et al., (2017)[6] reported an overall incidence of 2.69%. The incidence of SSI was 6.38% among patients undergoing orthopaedic surgeries whereas Jain et al., (2013)[8] reported a high rate of 22.58% infection in their study in Bhopal.

Table 1. Incidence of SSI

Departments	Total surgeries performed	Total isolates
SURGERY	941	100 (10.63%)
ORTHO	439	28 (6.68%)
OBG	1215	17 (1.40%)
Total	2595	145 (5.59%)

In our study, the rate of post-operative wound infection was 10.63% in General Surgeries whereas it was 11.7% and 39% reported by Maheshwari et al., (2013)[9] from Meerut and Apanga et al., (2014)[10] from Ghana. In our study incidence of post-operative wound infection was 1.40% in Obstetrics and Gynaecological surgeries whereas Valecha SM et al., (2017)[11] from Mumbai have reported a higher incidence of SSI (7.3%). It may be due to patients seeking treatment at primary and secondary care health centres.

Table 2. Gender distribution

Gender	Male	Female
SURGERY (N=100)	56 (56%)	44 (44%)
ORTHO (N=28)	22 (79%)	06 (21%)
OBG (N=17)	0	17 (100%)
Total (n=145)	78 (54%)	67 (46%)

In our study, the ratio of male (78) and female (67) patients who developed post operative wound infection was 1.16:1. Among patients with post-operative wound infection, the incidence was higher in the age group of >50 years (31%) which is similar to that of Saxena et al., (2013)[12]. We have noticed that number of post-operative wound infections increased as the age increased.

A higher incidence of post-operative wound infection in the elderly age group may be attributed to underlying chronic metabolic disorders like diabetes. However, there was a rise in infection rates among those aged 21 to 30 yrs. This was caused by more LSCS surgeries done in our Hospital.

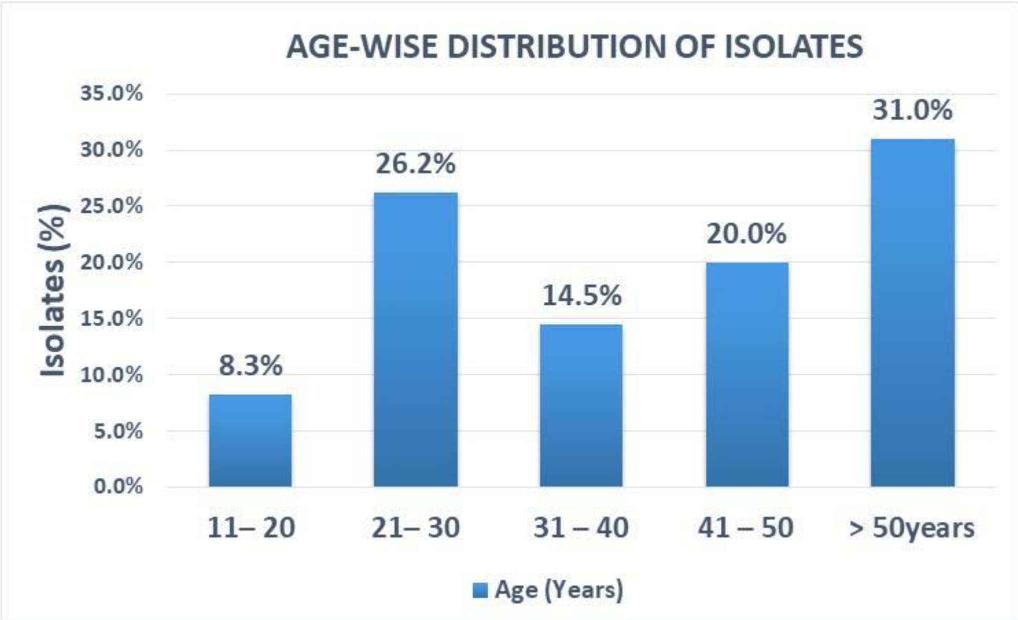

Fig.1 Age Distribution

Table 3. Presenting symptoms

Symptoms	SURGERY (n=100)		ORTHO (n=28)		OBG (n=17)		TOTAL (n=145)
	n	%	n	%	n	%	n, %
Fever	21	21	7	25	4	24	32 (22)
Purulent discharge	65	65	24	86	12	71	101 (70)
Wound Gaping	14	14	4	14	4	24	22 (15)
Pain tenderness	38	38	18	64	7	41	63 (43)

Table 4. Risk factors

Department / Risk factors	SURGERY (n=100)	ORTHO (n=28)	OBG (n=17)	TOTAL (n=145)
Diabetes Mellitus	18	6	2	26 (17.9)
Hypertension	18	4	1	23 (15.9)
Advanced age	25	7	3	35 (24.1)

Table 5. Type of surgeries conducted

Department	Type of surgery	Number (%)
Surgery n=100	Appendicectomy	20 (14.5)
	Hernia surgery	21 (15.2)
	Laparotomy	20 (13.8)
	Mastectomy	07 (4.8)
	Debridement	10 (6.9.)
	Amputation	06 (4.1)
	Skin Grafting	14 (9.7)
Orthopaedics n=28	Fracture repair	24 (16.6)
	Below knee amputation	02 (1.4)
	knee Hemiarthroplasty	02 (1.4)
Obstetric and Gynaecology n=17	Elective LSCS	04 (2.8)
	Emergency LSCS	09 (6.2)
	Abdominal hysterectomy	02 (1.4)
	Post-partum sterilization	02 (1.4)
	TOTAL	300

The most common presenting symptom in this study was purulent discharge (69.9%) followed by pain and tenderness (43.4%), fever (22.1%) and wound gaping (15.2%).

In our study Diabetes Mellitus and advancing age were the common risk factors among patients which is similar to the study reported by Apanga et al., (2014)[10]. Hyperglycaemia has deleterious effects on host immune function, especially on the function of neutrophils. Poor control of glucose during surgery and in the peri-operative period increases the risk of infection and worsens the outcome of sepsis.

We also observed multiparity as the risk factor in 12 out of 17 (70%) obstetrics and gynaecological surgeries which were similar to Bhadauria et al., (2013)[13] study. This may be due to malnutrition and anaemia in repeated childbirth.

Fracture repair was associated with the highest number of post-operative wound infections (24 out of 145) followed by Hernia repair (15.2%), Laparoscopic Appendicectomy (14.5%), Laparotomy procedures (13.8%) skin grafting constituted 9.7% and debridement surgery 6.9%. The rest of the operative procedures constituted 39% of post-operative wound infections. In our study, elective surgeries were associated with a higher number of post-operative wound infections (60.1%) when compared to emergency surgeries (39.9%) which was similar to the study reported by Shahane et al., (2012)[14].

In this study rate of infection was found to be more in emergency surgeries among Orthopaedic and Obstetrics surgeries which were in accordance with the report by Patel et al., (2012)[15].

Out of 300 suspected samples, 145 (48.3%) were culture positive and 114 (38.0%) were culture Negative. The remaining 41 samples showed organisms in Gram stain but no growth in an aerobic culture which might be Anaerobes. Our finding on culture positivity is similar to the study reported by Kokate et al., (2017)[6].

Table 6. Post-operative wound infections in emergency and elective surgeries

Type of Surgery	Emergency (%) (n=60)	Elective (%) (n=85)
Surgery(n=100)	32	68
Ortho (n=28)	64.3	35.7
Obg (n=17)	58.8	41.2
Total (n=145)	41.6	58.6

·A total of 145 samples showed growth on aerobic culture. Among these *Staphylococcus aureus* was the predominant isolate 50 (34.5%). which was similar to the study reported by Mahat et al., (2017)[17], and Preethishree et al., (2017)[18]. About 84% (42) of *S.aureus* were Methicillin-resistant which is similar to Golia et al., (2014)[7]. The majority of *S.aureus* were isolated from General and orthopaedic surgeries in our study. 96% of *Staphylococcus aureus* isolates showed susceptibility to Linezolid which was similar to the study reported by Rao et al., (2013)[19], and Ranjan et al., (2013)[20]. More than 60% of the isolates were sensitive to Gentamicin, clindamycin, and tetracycline.

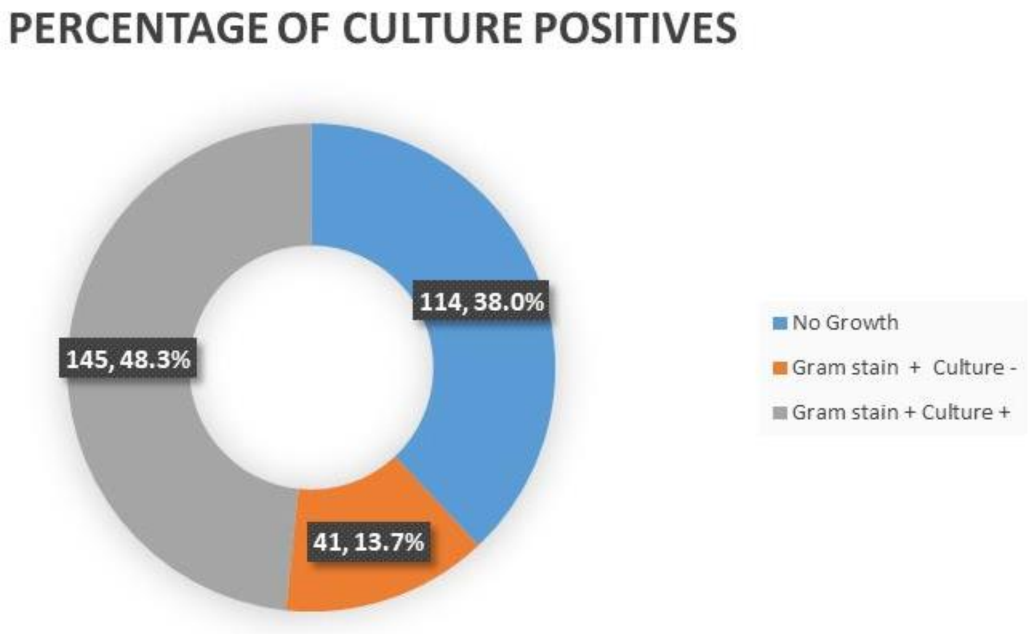

Fig. 2 Correlation of Gram stain and Culture

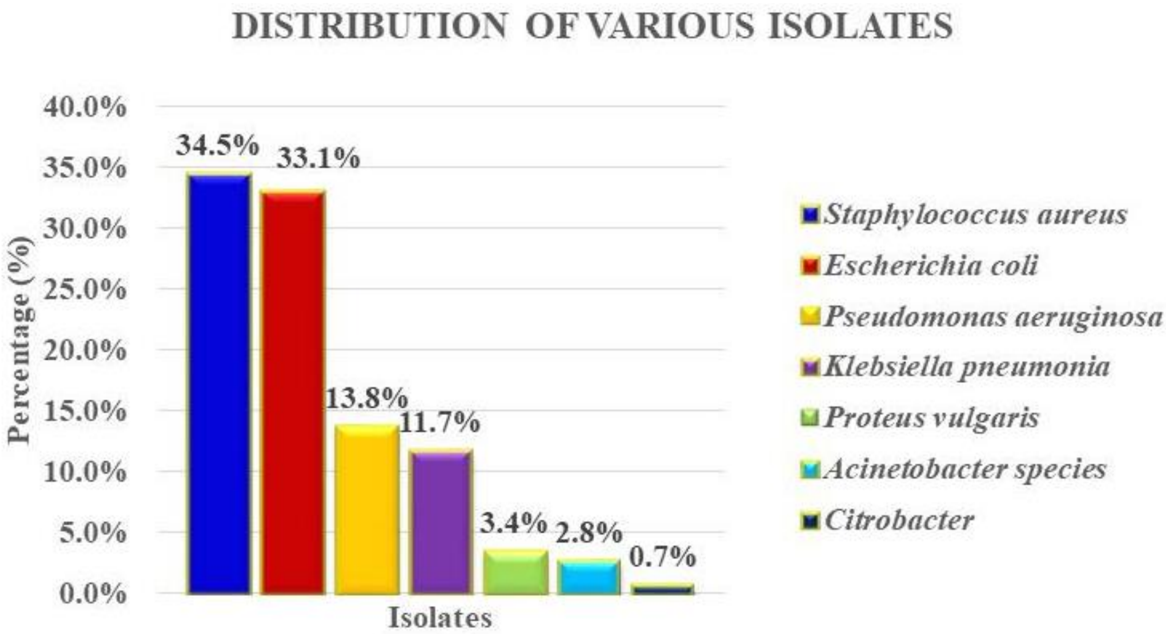

Fig. 3 Bacterial profile of post-operative wound infection

The common organism isolated was S.aereus (34.5%), followed by E.coli (33.1%), P.aeruginosa (13.8%), Klebsiella (11.7%), Protues, Acinetobacter and Citrobacter. Gram positive organisms isolated were S.aureus(29%) and Coagulase-Negative S.aereu(5.5%).

Table 7. Bacterial profile of post-operative wound infection

Organisms isolated	SURGERY	ORTHO	OBG	TOTAL n , %
Staphylococcus aureus	28	10	4	42 (29.0)
CONS	4	3	1	08 (5.5)
E coli	33	8	7	48 (33.1)
Pseudomonas	14	5	1	20 (13.8)
Klebsiella	13	1	3	17 (11.7)
Proteus	3	1	1	05 (3.4)
Acinetobacter	4	0	0	04 (2.8)
Citrobacter	1	0	0	01 (0.7)
Total (n)	68	15	12	145

Table 8. Antibiotic susceptibility pattern of *Staphylococcus aureus*

SENSITIVITY	SURGERY (n=32) %	ORTHO (n=13) %	OBG (n=05) %	TOTAL (n=50) %
Ampicillin	25	54	40	34
Oxacillin	13	23	20	16
Ceftriaxone	22	15	20	20
Amoxicillin -clavulanic acid	9	8	20	20
Erythromycin	22	54	0	30
Tetracycline	69	69	40	66
Clindamycin	66	69	60	66
Gentamicin	69	77	80	72
Chloramphenicol	63	77	60	66
Ciprofloxacin	56	31	40	48
Cotrimoxazole	28	23	20	26
Linezolid	100	85	100	96

Table 9. Antibiotic susceptibility pattern of Enterobacteriaceae (%)

Sensitivity	*E. Coli* N=48	*Klebsiella* N=17	*Proteus* N=05	*Citrobacter* N=01	*Pseudomonas* N=20	*Acinetobacter* N=04
Ampicillin	10	53	0	0	-	-
Cefuroxime	25	18	40	100	0	0
Ceftazidime	25	0	40	0	10	50
Cefoperazone	25	18	40	0	10	25
Amoxicillin - clavulanic acid	0	0	60	0	-	-
Gentamicin	52	71	80	0	45	100
Amikacin	79	53	60	0	60	50
Tobramycin	58	82	80	100	55	75
Ciprofloxacin	63	47	40	0	40	75
Cotrimoxazole	38	24	20	0	-	-
Pipercillin tazobactam	67	47	60	100	60	25
Meropenem	85	100	100	100	70	100
Polymyxin B	96	82	100	100	80	100

Escherichia coli (33.1%) was the second most common organism isolated in our study. Maximum susceptibility was **se**en against Polymyxin B (96%), Meropenem (85%), and Amikacin (79%). Least susceptibility was observed against ciprofloxacin, cephalosporins, and Cotrimoxazole (Table 9) which was well correlated with antibiotic sensitivity pattern by Shah et al., (2015)[20] and Golia et al., (2014)[7].
Pseudomonas (13.8%) was the third most common organism which showed maximum susceptibility to polymyxin B Meropenem, Piperacillin-tazobactam, and Amikacin (Table 9).
Klebsiella pneumoniae (11.7%) was the next common organism among the isolates that showed maximum sensitivity to Meropenem (70%), polymyxin B (82%) followed by Tobramycin (82%), and Gentamicin (71%) Only about a half of the isolates were sensitive to Amikacin (53%) and Piperacillin-tazobactam (47%). Like *E.coli*, *K. pneumoniae* also showed the least susceptibility against ciprofloxacin (42%, each) and cephalosporins, (18% each). However, Verma et al., (2012)[21] reported varied susceptibility towards ceftriaxone (66.67%) in their study.
P. aeruginosa (20 of 145) in the present study showed maximum susceptibility to Polymyxin B, (80%) Meropenem (70%)., Amikacin (60%) and Piperacillin-Tazobactam (60%). *Pseudomonas was* almost resistant to the Cephalosporin class of drugs. Over 80% susceptibility was showed against Piperacillin-tazobactam and Imipenem which is similar to the study by Shahane et al., (2012)[14].
Out of 42 S.aureus, 35 (84%) were MRSA. and 7 were MSSA. ESBL production was seen in 26 of the 71 *Enterobacteriaceae* isolated accounting for 36.6%. Among these, 22 were *E.coli*, 2 were *K.pneumoniae* and 2 were *Proteus mirabilis* (45.8%, 20% and 11.8% respectively). In contrary Over 60 % of high ESBL production has been noted by Shanthi et al., (2012)[22], and Wassef et al., (2012)[23]. Among *Pseudomonas* isolates 12 out of 20 (60%) showed ESBL production.

Table.10 ESBL producers

Organisms	ESBL producers (n, %)	Enterobacteriaceae (n=71) n ,%	Overall ESBL (n=91) n ,%
Escherichia coli (n=48)	22 (45.8)		
Klebsiella pneumonia (n=17)	02 (11.8)	26 (36.62)	21.6
Proteus mirabilis (n=05)	02 (40)		
Citrobacter (n=01)	0		
Pseudomonas aeruginosa (n=20)	12 (60)		13.2
TOTAL ESBL	38		41.8

The overall incidence of post-operative wound infections in the present study was 5.59%. The risk factors associated were Diabetes mellitus, hypertension, advanced age and multiparty. *S. aureus* was the predominant isolate followed by *E.coli*, *P. aeruginosa K. pneumoniae,* and *P.mirabilis.* 84% of *S. aureus* were Methicillin-resistant and also showed co-resistance to many of the commonly used antibiotics. Among the *Enterobacteriaceae* isolated, 36.6**%** of them were ESBL producers.

CONCLUSION

Reduced rates of post-operative wound infection are required to reduce morbidity and mortality, as well as the waste of healthcare resources, treatment costs, and the patient's economic burden. The most effective ways to minimise post-operative wound infections and the establishment of multidrug resistance strains include adequate glycemic control in diabetic patients, good antimicrobial prophylaxis, infection control measures, appropriate antibiotic policy creation, and surveillance.

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