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Predictors of Surgical Site Infections in Rural Kanpur, India

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Surgical site infections (SSIs) remain a significant problem following an operation and the third most frequently reported nosocomial infection. The current study was carried out on 4500 surgeries. SSI was detected in 950 patients, giving the infection rate of 23.75%. *Staphylococcus aureus* was the predominant organism 250/820 (30.49 %); of which 49/250 (19.6 %) were MRSA.This was followed by *E.coli* 170/820 (20.73 %),CONS 115/820 (14.02 %) and *Pseudomonas aeruginosa* 111/820 (13.53 %). Among the *E.coli* and *Klebsiella pneumoniae* 112/170 (65.88 %) and 66/82 (80.49 %) isolates were ESBL producer respectively, giving an overall 70.64 % of ESBL producer. Most of the organisms were multi drug resistant. The high rate of resistance to many antibiotics underscored the need for a policy that could promote a more rationale use of antibiotics. Preoperative hair removal, smoking, order of operation, people in operation theatre, type of anaesthesia, pre-existing illness and preoperative skin preparation significantly predicted SSI. Rationale use of antibiotics and prevention strategies focusing on factors associated with SSI is necessary in order to reduce SSI rate in our setting.

Key words: Surgical site infection (SSI), Antibiotic resistance pattern, Predictors, MRSA, ESBL.

Despite improvement in operating room practices, instrument sterilization methods, better surgical techniques and the best efforts of infection prevention strategies ,surgical site infections remain a major cause of hospital–acquired infections and rates are increasing globally even in hospitals with modern facilities and standard protocols of preoperative preparation and antibiotic prophylaxis. Moreover, in developing countries where resources are limited , even basic life-saving operations, such as appendicectomies and caesarean sections, are associated with high infection rates and mortality[1]. Although total elimination is not possible, a reduction in the infection rate to a minimal level could have significant benefits in terms of both the patient comfort and the medical resources which are used[2]. The organisms which cause surgical infections vary from time to time and from place to place[3].The most frequent co-resistances found in ESBL producing organisms are aminoglycosides, fluoroquinolones, tetracycline, chloramphenicol and sulfamethoxazole-trimethoprim[4]. The present study was aimed at obtaining surgical site infection rate, determining the antibiotic resistance pattern of isolated aerobic bacteria and determining the factors which are influencing the infection rate.

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MATERIALS AND METHODS

A total of 4500 samples from postoperative wounds in General surgery, Obstetric-Gynaecology, Orthopaedic, ENT and Ophthalmology Departments which were clean, clean-contaminated and suspected of SSIs submitted to the Microbiology Laboratory of Rama Medical College, Hospital and Research Centre, Kanpur for a period of 2 years from august

2010 to July 2012 included in the study. Each patient was followed up from the time of admission till discharge from the hospital and also for 30 days postoperatively.

Inclusion criteria

1. Wound with serous or sero-purulent discharge.
2. Wound with pus discharge.
3. Wound with serous or non-purulent discharge with sign of inflammation (oedema, redness, raised local temperature, fever >38°C,tenderness and induration).
4. Wound deliberately opened up by the surgeon due to localized collection (serous/purulent).

Exclusion criteria

Wounds with cellulites and suture abscess were excluded in the study.

Relevant history

Regarding age, sex, diagnosis, type of operation, pre-existing illness like diabetes, hypertension and antibiotic given was obtained.

Specimen collection

Pus samples were collected from each patient with the help of two sterile swabs under aseptic precautions after taking an informed written consent, of which one was used for smear preparation and other for culture.

Specimen transport

The swabs were brought to the Microbiology Laboratory of RMCHRC Kanpur, immediately and processed within 30 minutes of collection.

Culture Methods

The Pus samples were inoculated onto blood agar and mac conkey agar and incubated at 37°C for 24 hours in 7-10 % Co_2 concentration. The isolated organisms were identified by standard microbiological techniques[5]. All the isolates were tested for antimicrobial susceptibility (Hi-Media Mumbai) by Kirby-Bauer disk diffusion method on Mueller- Hinton agar. MRSA and ESBL were detected by CLSI guidelines[6].

Quality control

1. *Staphylococcus aureus* ATCC 25923-Oxacillin susceptible.
2. *Staphylococcus aureus* ATCC 43300-Oxacillin resistant.
3. *Klebsiella pneumoniae* ATCC 700603- ESBL positive
4. *Escherichia coli* ATCC J53RI(TEM ESBL)-ESBL positive

RESULTS

A total number of 15000 patients underwent major surgery at RMCHRC Kanpur included in the study from august 2010 to July 2012.4500 patients fulfilled the inclusion criteria, of these 500 patients were excluded from the analysis due to loss of follow up. SSI was detected in 950 patients, giving an overall infection rate of 23.75 %.Failure to perform anaerobic culture might have contributed to the low prevalence of SSI.

DISCUSSION

SSI has been found to pose a major problem in the field of surgery for a long time. In our study ,the overall SSI rate was 23.75 %. Many studies from India at different places have shown

Table 1. Aerobic bacteria isolated from SSI

Name of Bacteria	N. of isolates	Percentage
Gram Positive cocci		
S. aureus	250	30.49
CONS	115	14.02
Enterococcus	30	3.66
Gram Negative bacilli		
E.coli	170	20.73
K.pneumoniae	82	10.00
P.aeruginosa	111	13.53
P.mirabilis	30	3.66
C.freundii	16	1.95
Enterobacter	8	0.98
Acinetobacter	8	0.98
Total	820	100.00

Table 2. ESBL rate in GNB of SSI

Bacteria	N. of isolates	N. of isolates producing ESBL	Percentage of ESBL
K.pneumoniae	82	66	80.49
E.coli	170	112	65.88
Total	252	178	70.64

Table 3. Antibiotic resistance pattern (percentage) of Gram positive cocci

Antimicrobials	*S.aureus* N=250	CONS N=115	Enterococcus N=30
Ampicillin	100.00	100.00	93.33
Cotrimoxazole	80.00	100.00	NT
Ciprofloxacin	61.20	85.22	63.33
Chloramphenicol	64.80	30.44	80.00
Tetracycline	70.00	51.30	76.67
Gentamicin	66.00	82.61	NT
Amikacin	24.00	21.74	NT
Azithromycin	28.80	56.52	NT
Clindamycin	28.80	52.17	NT
Cefoxitin	19.60	21.74	NT
Vancomycin	0.00	0.00	0.00
Linezolid	0.00	0.00	0.00
Teicoplanin	0.00	0.00	0.00

Abbreviation: NT - Not Tested

the SSI rate to vary from 6.09 % to 38.7%.The infection rate in Indian hospitals is much higher than that in developed countries; for instances in the USA, it is 2.8% and it is 2-5% in European countries. The higher infection rate in Indian hospitals may be due to the poor set up of our hospitals and also due to lack of attention towards the basic infection control measures[7].

Staphylococcus aureus (30.49 %) was the commonest bacteria, followed by *E.coli* (20.73 %), CONS (14.02 %), *Pseudomonas aeruginosa* (13.53 %) and *Klebsiella pneumoniae* (10%) {Table 1/ Fig.1}. Similar findings were recorded by Srivastava *et al.,*[8] and Bhatia *et al.*[9]. *S. aureus* was the most common organism isolated from SSIs by Sampson[10] and Prabhakar *et al.,*[11]. *E.coli* was reported as most common isolate from SSIs by Agarwal *et al.*[3], *Pseudomonas* by Umesh *et al.*[12] and Lateef *et al.*[13] and *Klebsiella pneumoniae*

Table 4. Antibiotic resistance pattern (percentage) of Gram negative bacilli

Antimicrobial	*E.coli* N.170	*K.pneumoniae* N.82	*P.mirabilis* N.30	*C.freundii* N.16	*Enterobacter* N.8	*P.aeruginosa* N.111	*Acinet-obacter* N.8
Ampicillin	94.12	100	100	100	100	100	100
Cotrimoxazole	92.35	100	100	100	75	NT	50
Ciprofloxacin	70.59	84.15	73.33	75	25	81.08	50
Chloramphenicol	47.06	50	63.33	56.25	50	NT	NT
Tetracycline	70.59	42.68	76.67	50	75	NT	62.50
Gentamicin	44.12	85.37	83.33	75	75	85.59	62.50
Amikacin	32.35	29.27	40	31.25	50	50.45	100
Cefazolin	82.35	58.54	73.33	68.75	100	NT	NT
Ticarcillin	67.65	65.85	80	68.75	75	67.57	50
Cefoperazone	47.06	79.27	66.67	62.50	75	NT	NT
PB	NT	NT	NT	NT	NT	36.04	37.50
PT	50	54.88	46.67	37.50	37.50	46.85	50
I	20	26.83	23.33	18.75	25	21.62	25

NT - Not Tested

Table 5. Preoperative hair removal

Method	Total n. of cases	N. of infected cases	Per. %
Depilatory cream	1850	142	7.68
Razor Saving	2150	808	37.58
Total	4000	950	23.75

Table 6. Smoking

Smoking	Total n. of cases	N. of infected cases	Per. %
Yes	490	398	81.22
NO	3510	552	15.73
Total	4000	950	23.75

Table 7. Order of operation

Order of operation	Total n. of cases	No. of infected cases	Per. %
1	1300	215	16.54
2	1110	245	22.07
3	1000	285	28.50
4	590	205	34.75
Total	4000	950	23.75

Table 8. People in OT

No of people	Total n. of cases	No. of infected cases	Per. %
≤6	2475	175	7.07
≥7	1525	775	50.82
Total	4000	950	23.75

Table 9. Type of anaesthesia

Type of anaesthesia	Total n. of cases	N. of cases	Per. infected cases	%
GA	2750	770	28.00	SAB
1250	180	14.40		
Total	4000	950	23.75	

Table 10. Pre-Existing Illness

Pre-Existing Illness	Total No. of cases	No. of infected cases	Per. %
Other illness	2500	553	22.12
Diabetes mellitus	800	282	35.25
Malignancy	700	115	16.43
Total	4000	950	23.75

Table 11. Preoperative skin preparation

Agent	Total No. of cases	N. of infected cases	Per. %
Chlorhexidine	880	470	53.41
Betadine	3120	480	15.39
Total	4000	950	23.75

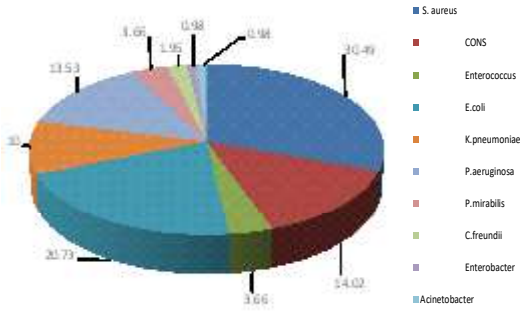

Fig. 1. Aerobic bacteria isolated from SSI

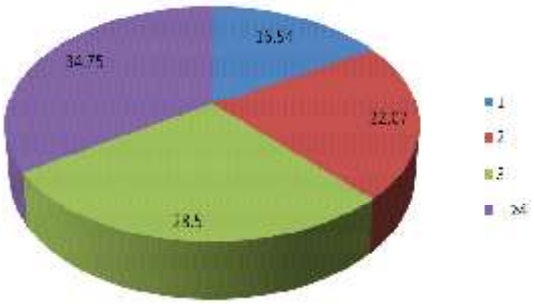

Fig. 2. Order of operation

The incidence of MRSA was 19.6 % which is in agreement with the incidence (20.6%) of Weigelt *et al.*,[15] study in SSIs. All the strains of MRSA were sensitive to vancomycin, teicoplanin and linezolid. This finding could have relevant clinical use in the antibiotic policy guidelines for hospitals. ESBL production was detected in 65.88 % strains of *E.coli* and 80.49 % of *Klebsiella pneumoniae*. With the spread of ESBL positive strains in hospital, co-resistance found to aminoglycosides, fluoroquinolones, chloramphenicol, tetracycline and cotrimoxazole indicating multi drug resistance pattern. Mechanism of co-resistance are not clear, but one possible mechanism is the co-

(26.80%) by Anvikar *et al.*[14]. It is our postulation that there may be more Staphylococcus aureus carriers, as the hospital staff could be silent carriers and this finding may be relevant to rural Kanpur also. The relative frequency of different isolates also varied between different studies. Thus, it can be concluded that the organisms which causes SSIs change from place to place and from time to time even in the same place.

transmission of ESBL and resistance to other antimicrobials within the same conjugative plasmids[16]. A therapeutic alternative has been recommended to prevent drug resistance among other organisms and hence , there is a need to formulate an antibiotic policy.

It is seen from the study that most of the bacteria were resistant to commonly used antibiotics due to overuse resulting in selection of resistant strains. It is necessary to know the antibiogram for two reasons; Firstly , to select the appropriate antibiotics to avoid the emergence or overgrowth of resistant bacteria and Secondly, these resistant bacteria can cause cross infection to other patients. Updating the antibiogram periodically will further reduce the SSIs to a considerable extent[17,18,19].

Preoperative hair removal with razor shaving predisposes to skin injuries (microscopic cuts act as foci for bacterial contamination and multiplication) which increase SSI rate. Such injuries and resultant SSI are less when depilatory cream is used for hair removal[20].

In this study, 490 (12.25 %) patients had history of cigarette smoking. Of these 490, 398 patients (81.22%) developed SSI (Table-6). Smoking delay wound healing as tobacco and its smoke, particularly nicotine, cotinine, carbon monoxide and hydrogen cyanide are cytotoxic to wound healing cells. Nicotine increases platelet adhesiveness, raising the risk of microvascular occlusion, tissue ischemia. Smoking release catecholamine resulting in vasoconstriction, decrease tissue perfusion ,suppress the innate and host immune response, affecting the function of neutrophils the prime line of defence against infection[21].

SSI rate increased as order of operation increased (Table.7/Fig.2) due to onset of fatigue, resulting in a decline of aseptic measures and an increase in pollution in operation theatre with the lapse of time[22], as more contaminated operations were performed towards the end of the operation session for the fear of contaminating the operation theatre early during the day[13].

In the present study, the number of people more than 7 in theatre was associated with increased risk of SSI by 7.19 times (Table 8) which may be due to greater amount of airborne contamination with increased movement[23].

SSI rate more (2 times) in general anaesthesia than spinal/epidural (Table.9) as general anaesthesia not block afferent inputs and autonomic responses resulting in stress, vasoconstriction, impair tissue perfusion and decrease tissue O_2 tension .Volatile anaesthetics and opioids per se impair neutrophil, macrophage, dendritic cell, T-cell, natural killer cell immune functions and diminishing host defence mechanisms but epidural/spinal anaesthesia provide a sympathetic blockage, greater vasodilatation, improve tissue oxygenation and increased polymorphonuclear cells at surgical sites[24].

SSI rate was highest in diabetes mellitus (35.25%) followed by other illness (22.12 %) and malignancy (16.43%) {Table.10}.Diabetes predispose to SSI by two mechanisms, Firstly by decreasing vascular circulation, tissue perfusion and cellular functions and secondly by reducing cellular immunity, phagocytosis, killing of polymorphonuclear cells, monocytes and macrophages[25].The pre-existing illness increase the SSI rate due to increase in preoperative hospital stay which favour the bacterial colonization and increase the infection rate.

Iodophore (betadine) based compounds are superior to chlorhexidine for preoperative skin preparation as iodophore (betadine) active against spores but chlorhexidine does not[26,27].

CONCLUSION

Multi drug resistant Staphylococcus aureus followed by E.coli, CONS, Pseudomonas aeruginosa and Klebsiella pneumoniae are common bacteria causing SSIs. Due to the increased morbidity and mortality which are associated with these drug resistant organisms ,an early detection and intervention is a prerequisite in surgical patients. Proper infection control measures and a sound antibiotic policy should reduce SSIs in the future. A little modification in these predictors can reduce the SSIs rate in a hospital to a cost-effective way.

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