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A STUDY ON BACTERIOLOGICAL PROFILE AND ANTIBIOGRAM OF SURGICAL SITE INFECTIONS IN A TERTIARY CARE HOSPITAL IN KOLKATA

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ABSTRACT

INTRODUCTION- Surgical site infections (SSI) are the third most common healthcare associated infections which areassociated with high rates of morbidity and mortality and causeincreased economic burden to healthcare systems and patients. Even with improved prevention strategies, SSIs continue to be a major threat of nosocomial infection with increasing rates worldwide despite modern facilities and standard protocols for pre-operative preparations and antibiotic prophylaxis.

AIM-

1. To determine the spectrum of aerobic bacteria causing surgical site infection

2. To assess the antibiotic susceptibility pattern of the bacterial pathogens isolated from the clinical specimens.

MATERIALS AND METHODS- Relevant clinical samples from patients who underwent surgery in the General Surgery and Obstetrics &Gynaecology department were received for aerobic culture in the Department of Microbiology. Isolation and identification of the microorganisms were done by standard microbiological procedures and the results obtained were analysed and interpreted.

RESULTS- Rate of SSI was found to be 19.59% with rate in Surgery department being slightly higher than the rate in Gynaecology & Obstetric department. In surgical and gynaecolgical wards, the most common organism isolated was *Escherichia coli* but in obstetrical ward, the most common organism isolated was *Staphylococcus aureus*.

CONCLUSION- Management of SSIs remains a significant concern for surgeons and physicians in a health care facility and reduction in the rate of infection can have significant benefits by reducing wastage of healthcare resources and patient morbidity and mortality. This can be achieved by attention to multiple patients related and procedure related risk factors as well as proper infection control measures and a sound antibiotic policy.

KEYWORDS- SSI, healthcare associated infections, antibiotic policy

INTRODUCTION –

Surgical site infections (SSI) are defined as infections that develop at the surgical site within 30 days of surgery or within 90 days for some surgeries such as breast, cardiac, and joint surgeries including implants.[1]SSI is a serious problem with varying incidence in patients undergoing surgery[2]and is often under-estimated because of incomplete post-discharge data.[3]In certain high-risk patients having several co-morbidities the rate of SSI is even higher.[4]

The global estimates of SSI ranges between 0.5% to 15%. But several studies which are carried out in India have consistently shown higher rates ranging from 23% to 38%.[5,6,7]SSI is the most encountered form of nosocomial infection in surgical patients[8,9,10] andis the third most common healthcare associated infections.[11] They are associated with significantly higher rates of morbidity and mortality.[12]

World Health Organization (WHO) described hospital acquired infections as one of the important infectious diseases leading to huge monetary impact.[13]Thus SSIis also an important cause of increased economic burden to healthcare systems and patients resultingfrom the additional postoperative hospital stay and associated treatments.[14] On average SSI can increase length of hospital stay by 7-10 days.[15]

Mostly SSIs occurs during surgery due to microbial contamination of the wound from the patient's own commensal flora, surgeon's hands orfrom the surroundings.[16]Skin acts as a natural barrier against infection, so during surgery the breach in the skin can cause a postoperative infection. Any purulent discharge from a closed surgical incision, with signs of inflammation of the surrounding tissue should be considered as wound infection, irrespective of whether micro-organisms can be isolated or not.[17]

The risk of developing SSI depends upon various factors such as the patient's health status, age, gender, nutrition, smoking, alcoholism, co-morbidities, length of the surgical procedure, type of surgery, length of hospital stay, count and type of local skin flora, preoperative glucose levels, and improper antibiotic prophylaxis.[18] Even with improved operating room practices, instrument sterilization methods and prevention strategies, SSIs continue to be a major threat of nosocomial infection and the rates are increasing worldwide even in hospitals with modern facilities and standard protocols for the pre-operative preparations and antibiotic prophylaxis.[19]

To emphasize on total quality of hospital management, control of SSI remains an integral component. Determination of prevalence of surgical site infection provides a rationale to set infection control measures;hence, the present study had been undertaken.

AIM -

1. To determine the spectrum of aerobic bacteria causing surgical site infection.
2. To assess the antibiotic susceptibility pattern of the bacterial pathogens isolated from the clinical specimens.

MATERIALS AND METHODS–

This is a hospital-based cross sectionalstudy conducted in the Department of Microbiology in collaboration with Department of Surgery and Department of Obstetrics &Gynaecology at Medical College and Hospital, Kolkata over a period of one year from April 2021 to March 2022.

Relevant clinical samples (pus, aspirate from abscess, tissue biopsies) collected under aseptic conditions before antimicrobial therapy and/or before application of antiseptic dressingfrom847 patients who underwent emergency and elective surgery in the Department of General Surgery and the Department of Obstetrics &Gynaecology were received for aerobic culture in the Department of Microbiology. A predesigned and structured proforma was used to collect relevant information regarding the patients with SSI.

All the clinical samples were processed for aerobic culture; isolation of the microorganism were done by standard microbiological procedures such asculturing the samples on blood agar and MacConkey agar and identification of any growth observed was done by gram stain, followed by other relevant standard biochemical tests.Antibiotic susceptibility testing was done by Kirby-Bauers

disc diffusion methodon Muller-Hinton agar taking 0.1 McFarland standard inoculum and results were interpreted according to CLSI guidelines 2021.Non fermenters were identified and their antibiotic susceptibility performed using automated method of VITEK 2 compact system (bioMerieux).
Results were tabulated in Microsoft office excel worksheet. Descriptive statistics were used and results expressed with suitable charts, bar diagram and tables. SPSS has been used for analysis and the level of statistical significance is set as p value < 0.05.

RESULTS-
Out of 847 total surgeries performed in the department of Surgery and the department of Gynaecology and Obstetrics, 166 cases of surgical site infections were detected, thus the overall rate of SSI in this hospital was found to be 19.59%(fig. 1).
It was evident that in patients admitted in surgical wards, SSI peaked in the age group between 40-49 years (32.08%); however, in patients admitted in Gynaecology& Obstetrics wards it was between 20-29 years (51.67%). (Table 1)

Table 1: age wise distribution of patients admitted in surgical and Gynaecology& Obstetrics ward

AGE GROUP (YEARS)	PERSON WITH SSI IN SURGICAL WARDS	%	PERSON WITH SSI IN G&O WARDS	%
10-19	5	4.72	1	1.67
20-29	15	14.15	31	51.67
30-39	17	16.03	14	23.33
40-49	34	32.08	9	15.0
50-59	21	19.81	2	3.34
60-69	11	10.37	3	5.0
70-79	3	2.83	0	0
TOTAL	106	100	60	100

While considering patients admitted in surgical wards only, the male:female ratio came out to be 1.4**:**1. (Table 2)

Table 2 : gender wise distribution of patients in surgery departement

GENDER	TOTAL NO. OF SURGERIES PERFORMED	PERSON with SSI
MALE	290	74
FEMALE	195	32
Ratio= 1.4:1		

SSI rate in Surgery department was slightly higher (21.85%) than SSI rate in Gynaecolgy& Obstetric department (16.57%). (Table 3)

Table 3: Incidence of SSI in surgical and gynaecology& obstetric patients

WARDS	TOTAL NO. OF SURGERIES PERFORMED	TOTAL NO OF SSI	PERCENTAGE (%)
SURGICAL	485	106	21.85
GYNAECOLOGY & OBSTETRICS	362	60	16.57

The association between different risk and SSI cases were studied and following are the findings: (Figure 1)
- Diabetes is strongly associated with SSI. Other risk factors include hypertension, smoking and carcinoma.
- Clean-contaminated, contaminated and dirty wound are major risk factors for SSI.
- Another significant risk factor was use of surgical drains.

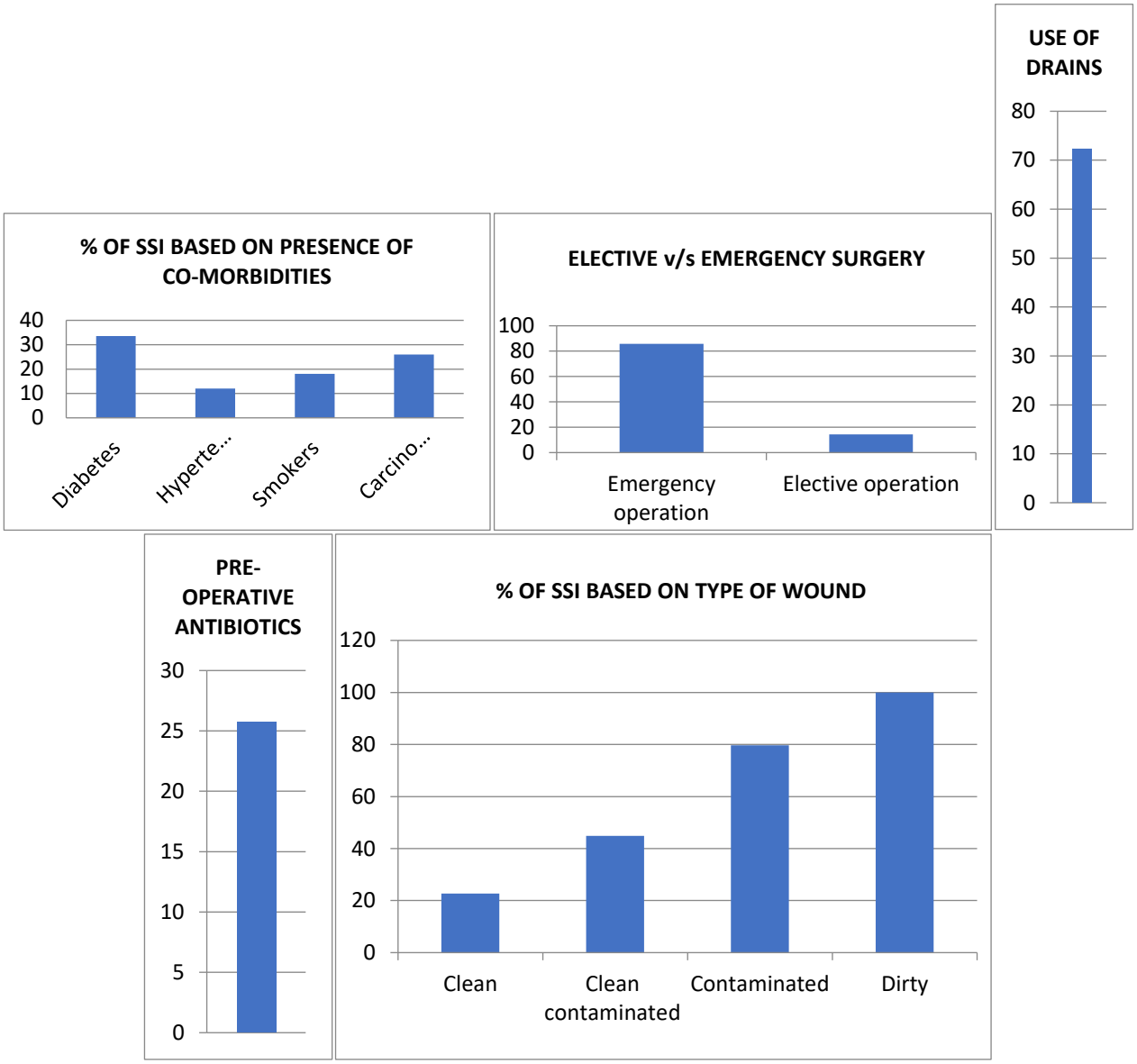

Figure 1: Association between different risk and SSI cases

In surgical and gynaecolgical wards, the most common organism isolated was *Escherichia coli*, 24.81% and 45.45% respectively.But in obstetrical ward, the most common organism isolated was *Staphylococcus aureus*(24.07%).(Table 4)

Table 4 :frequency of organisms isolated from clinical specimen in SSI

WARD ORGANISMS	SURGERY	GYNAE	OBSTETRICS
ESCHIRICHIA COLI	32 (24.81%)	5 (45.45%)	10 (18.52%)
KLEBSIELLA SPP.	30 (23.26%)	1(9.09%)	8 (14.81%)
CITROBACTER SPP.	1(0.78%)	0	0
PROTEUS SPP.	7 (5.43%)	0	0
PESUDOMONAS SPP.	13 (10.08%)	0	3 (5.56%)
ACINETOBACTER SPP.	12 (9.30%)	1 (9.09%)	10 (18.52%)
STAPHYLOCOCCUS AUREUS	19 (14.73%)	3 (27.27%)	13 (24.07%)
COAGULASE NEGATIVE STAPHYLOCOCCUS	5 (3.38%)	0	4 (7.41%)
ENTEROCOCCUS SPP.	10 (7.75%)	1 (9.09%)	6 (11.11%)

Table 5 :antibiotic sensitivity pattern of gram-negative isolates in surgical wards

	IC (%)	MRP (%)	AMC (%)	PTZ (%)	CEP 2ND GEN (%)	CEP 3RD GEN (%)	CFS (%)	CEP 4TH GEN (%)	FQ (%)	AG (%)	TGC (%)	COT (%)	CAZ (%)
Escherichia coli (n=32)	18 (56.25%)	16 (50%)	1 (3.12%)	16 (50%)	5 (15.62%)	6 (18.75%)	19 (59.37%)	9 (28.12%)	9 (28.12%)	13 (40.62%)	22 (68.75%)	15 (46.87%)	X
Klebsiella spp. (n=30)	9 (30%)	8 (26.66%)	2 (6.66%)	13 (43.33%)	3 (10%)	4 (13.33%)	10 (33.33%)	11 (36.66%)	6 (20%)	10 (33.33%)	25 (83.33%)	13 (43.33%)	X
Citrobacter spp. (n=1)	1 (100%)	1 (100%)	0	0	IR	0	1 (100%)	1 (100%)	0	0	1 (100%)	1 (100%)	X
Proteus spp. (n=7)	2 (28.57%)	2 (28.57%)	0	3 (42.85%)	0	4 (57.14%)	4 (57.14%)	4 (57.14%)	1 (14.28%)	1 (14.28%)	IR	3 (42.85%)	X
Pseudomonas spp. (n=13)	7 (53.84%)	8 (61.53%)	IR	9 (69.23%)	0	IR	5 (38.46%)	4 (30.76%)	8 (61.53%)	7 (53.84%)	IR	IR	2 (15.38%)
Acinetobacter spp. (n=12)	4 (33.33%)	4 (33.33%)	IR	7 (58.33%)	0	1 (8.33%)	6 (50%)	4 (33.33%)	3 (25%)	5 (41.66%)	5 (41.66%)	9 (75%)	X

Table 6 :antibiotic sensitivity pattern of gram-positive isolates in surgical wards

	AMP (%)	AMC (%)	CX (%)	VA (%)	LZ (%)	DOX (%)	FQ (%)	AG (%)	E (%)	CD (%)	COT (%)
***Staphylococcus aureus* (n=19)**	X	8 (42.11%)	8 (42.11%)	19 (100%)	19 (100%)	7 (36.84%)	8 (42.11%)	12 (63.16%)	7 (36.84%)	8 (42.11%)	11 (57.89%)
CONS (n=5)	X	0	0	5 (100%)	5 (100%)	3 (60%)	2 (40%)	2 (40%)	3 (60%)	4 (80%)	4 (80%)
***Enterococcus spp.* (n=10)**	3 (30%)	X	IR	7 (70%)	10 (100%)	3 (30%)	6 (60%)	IR	4 (40%)	IR	IR

Table 7 :antibiotic sensitivity pattern of gram-negative isolates in gynae-obs ward

	IC (%)	MRP (%)	AMC (%)	PTZ (%)	CEP 2ND GEN (%)	CEP 3RD GEN (%)	CFS (%)	CEP 4TH GEN (%)	FQ (%)	AG (%)	TGC (%)	COT (%)	CAZ (%)
Escherichia coli (n=15)	6 (40%)	7 (46.67%)	2 (13.33%)	8 (53.33%)	4 (26.67%)	6 (40%)	4 (26.67%)	7 (46.67%)	5 (33.33%)	7 (46.667%)	11 (73.33%)	8 (53.33%)	X
Klebsiella spp. (n=9)	5 (56.56%)	5 (56.56%)	1 (11.11%)	4 (44.44%)	4 (44.44%)	6 (66.67%)	2 (22.22%)	5 (55.56%)	3 (33.33%)	4 (44.44%)	6 (66.67%)	3 (33.33%)	X
Pseudomonas spp. (n=3)	3 (100%)	2 (66.67%)	IR	3 (100%)	0	IR	2 (66.67%)	2 (66.67%)	3 (100%)	2 (66.67%)	IR	IR	0
Acinetobacter spp. (n=11)	5 (45.45%)	5 (45.45%)	IR	6 (54.55%)	1 (9.09%)	7 (63.64%)	2 (18.18%)	5 (45.45%)	4 (36.36%)	3 (27.27%)	8 (72.73%)	7 (63.64%)	X

Table 8 : antibiotic sensitivity pattern of gram-positive isolates in gynaecological& obstetrics wards

	AMP	AMC	CX	VA	LZ	DOX	FQ	AG	E	CD	COT
Staphylococcus aureus (n=16)	X	5 (31.25%)	5 (31.25%)	16 (100%)	16 (100%)	7 (43.75%)	6 (37.5%)	9 (56.25%)	2 (12.5%)	7 (43.75%)	10 (62.5%)
CONS (n=4)	X	0	0	4 (100%)	4 (100%)	2 (50%)	2 (50%)	4 (100%)	2 (50%)	2 (50%)	3 (75%)
Enterococcus spp. (n=7)	2 (28.57%)	X	IR	6 (86.71%)	7 (100%)	2 (28.57%)	3 (42.86%)	IR	5 (71.43%)	IR	IR

DISCUSSION-

In the present study the overall rate of SSI was 19.59% which was in concordance with the study conducted by Satyanarayana et al., who reported the overall rate of SSI as 13.7% in their study. [20] Various other studies from India have shown the rate of SSI to vary from 6.1% to 38.7%. [21-24]

As to the effect of age, the incidence of SSI in the present study was highest in the age group 40-49 years (32.08%). A previous study showed a predominance of SSI in the age group >65 years compared to <65 years. [25] However in this study less number of patients were >60 years of age which can be explained by the difference in the type of operations performed in each study population.

The predominance of male patients was seen in the surgery department in this study with male: female ratio of 1.4:1 and this finding co-relates with other studies. [26,27]

A study of Mejia et. al. has found the patients with comorbidities acts as risk factors favouring SSI and our results echo with similar results where we found that SSI having comorbidities acts as a one of the important risk factors. [28] In this study, we found risk factors like diabetes, higher class of wound type, and use of drain post-operatively is strongly associated with SSI (p- value <0.05). However, there is no positive association with hypertension, malignancy, smoking etc. This finding is similar to a study done by Naveen Kikkeriet. Al. [29]

From this study we found that *Escherichia coli* (24.81%) followed by *Klebsiella pneumonia* (23.26%) were the predominantly isolated organisms from the surgical site in surgical ward. In contrast, literature review revealed *Staphylococcus aureus* (37.83%) as the most commonly isolated

pathogen from wound site. [30]Raza MS et al., also found that *S. aureus* (37.5%) was the single predominant bacterial isolate followed by *E. coli* (25%) and *Klebsiella pneumonia* (10.41%). [31] However, Shah KH et al., states that *Escherichia coli (*34.8%) followed by Klebsiella pneumonia (15.2%), *Staphylococcus aureus* (10.9%) were the most common causative pathogen isolated from SSI, which is similar finding as that of this study. [32] Study conducted by Lilani et al. also found occurrence of more gram-negative bacteria isolated from clean-contaminated wounds. [33]Presence of enteric organisms could be attributed to thepatient's normal endogenous microbial faecal flora. [34]

Similar to a study by Kaplan et. al. which exposed *Staphylococcus aureus* in 42% of positive samples after Caesarean delivery, [35] the bacteriological profile in patients with SSI in this study, showed predominance of the skin flora mostly *Staphylococcus aureus* (24.07%) and *Coagulase Negative Staphylococcus spp*. (CONS) to a lesser extent (7.41%) from obstetrical ward. However, E. coli (45.45%) was again the most common organism isolated from gynaecological wards.

A high degree of resistance was found for majority of the bacterial isolates from theantibiotic susceptibility results. For gram-positive bacteria vancomycin, linezolid and aminoglycosides were found to be the most effective antibiotics. The degree of resistance was even higher among the gram-negative bacteria and the commonly used drugs were found to be more resistant with an average resistance range from 50% to 100%. Tigecycline and carbapenems, were found to be the most effective antimicrobial agents whereas amoxicillin-clavulanate and cephalosporins were among the most resistant drugs.

The present study revealed that *E. coli* was highly resistant to drugs like, amoxicillin-clavulanate, cephalosporins 2^{nd}, 3^{rd}, 4^{th}, generations, fluoroquinolones and aminoglycosides and was highly sensitive to drugs like tigecycline, imipenem, meropenem and cefoperazone-sulbactam.

Klebsiella spp. was highly resistant to drugs such as amoxicillin-clavulanate, piperacillin-tazobactam, cephalosporins 2^{nd}, 3^{rd}, 4^{th}, generations, fluoroquinolones and aminoglycosides and was highly sensitive to drug tigecycline. A study by Dessie W et al., found that E. coli were resistant to tetracycline, cefotaxime, ampicillin, cefuroxime, ceftriaxone, amoxicillin/clavulanic acid, cephazolin, ciprofloxacin and was sensitive to Chloramphenicol.Klebsiella pneumonia showed higher resistance to ampicillin, amoxicillin, cephazolin, ceftriaxone, ceftazidime, cefotaxime cefuroxime sodium and higher sensitivity to ciprofloxacin, tetracycline, chloramphenicol, gentamicin. [36] *P. aeruginosa*strains isolated in the present study were found highly resistant in comparison to the previous studies. [37,38]

*Staphylococcus aureus*in this research showed high sensitivities to vancomycin, linezolid and aminoglycosides but was resistant to erythromycin, clindamycin and fluoroquinolones. These findings were consistent to those found in Jinja RRH. [39] 68.75% strains of the *Staphylococcus* isolates were methicillin resistant. Similar findings with 45% and 58.2% of MRSA have been documented by Eagye et al. [40] and Kaye et al. [41] respectively. *Enterococcus spp.* was highly resistant to drugs such as ampicillin and doxycycline, and was highly sensitive to vancomycin and linezolid. Similarly, Paul M et al., states that Enterococcus shows 100% susceptibility to vancomycin, linezolid and resistance to drugs such as ciprofloxacin, ampicillin. [42]

Emergence of resistant bacterial strains havebecome a global problem. The appearance of multi drug resistant (MDR) strains over the past decades has been regarded as an inevitable genetic response to the strong selective pressure imposed by antimicrobial chemotherapy which is vital for evolution of antibiotic resistant bacteria.

All cases in our study received prophylactic antimicrobials prior to the surgery with beta lactam beta lactamase combinations in surgical wards and with 3^{rd} generation cephalosporins for gynaecological and obstetrical patients. Current recommendations for antimicrobial prophylaxis to prevent SSI advise that an antimicrobial agent be administered within 60 minutes prior to surgery and discontinued soon afterward. [43] However, more than 50% of our patients received preoperative antimicrobials more than six hours before surgery andalmost all patients were treated with antimicrobials after surgery. Most of them were treated till the dayof discharge to prevent infection

while they were hospitalized. The most widely used combination was a 3rd generation cephalosporin and an aminoglycoside, howevermost of the isolates were resistant to these agents.
The frequent empirical prescription of these antimicrobials as a treatment and prophylaxis in our hospital might have contributed for observed high degree of resistance. This is a concerning situation requiring immediate revision of antibiotic policy and antibiotic prescribing guidelines.

CONCLUSION-

Despite the advances in surgical techniques and better understanding of the pathogenesis of wound infection, management of SSIs remains a significant concern for surgeons and physicians in a health care facility and even though SSIs cannot be completely eliminated, reduction of the rate of infection can have significant benefits in reducing the wastage of healthcare resources and patient morbidity and mortality. This can be achieved by attention to multiple patients and procedure related risk factors and proper infection control measures with a sound antibiotic policy.The knowledge of microbial epidemiology of each institution is important for establishment ofa suitable empirical treatment for each patient. The information obtained from this study allows a thorough understanding ofthe above,resulting in better therapeutic implications and the results of this study can be usedto establish an improved hospital antimicrobial policy. Also, the inappropriate and prolonged use of antibiotics should be avoided as this can lead to the development of resistant micro-organisms which are even more difficult to treat.

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