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POSTOPERATIVE SURGICAL SITE INFECTION AND PROFILE OF MICROORGANISM IN ELECTIVE LAPAROTOMIES

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ABSTRACT

Laparotomy is one of the most common surgical procedures done by a surgeon. It is performed both as elective and an emergency procedure. Laparotomy procedures are prone to post-operative complications such as pain, fever, wound infection, wound dehiscence, incisional hernia, etc. The rate of these complications depends on preoperative antibiotic prophylaxis, skin antisepsis, control of contamination and surgical skills. SSI is the most common health-care-associated infection and is a cause of one-third of post-operative deaths. A prudent antibiotic prophylaxis and post-operative antibiotic management should be done. For successful management knowledge is necessary regarding the possible pathogens and their antibiotic resistance patterns. The aim of the study is to find out the incidence of SSI in elective laparotomies and to find out the type of pathogenic organism causing wound infection. This prospective observational study was conducted on 180 patients who had undergone elective laparotomy after taking an informed consent. A sterile swab for culture and sensitivity was taken Pre-operatively from incision site and sent to laboratory for assessment with normal culture technique. Repeat swabs for culture and sensitivity was done for patients with post-operative wound infection. Patients were followed up for 1 month. Out of 180 cases incidence of the SSI was seen in 17 cases of elective laparotomy (9.4%). Out of 17 SSI swab specimens 2 (11.8%) were Gram positive involving CONS pathogen, 13 (64.7%) were Gram negative involving *E. coli, K.pneumoniae and Pseudomonas (41.2%, 29.4%, 5.9%) while no growth was observed in 11.8% specimens.* SSIs were unaffected by demographic or operative variables. Surgical site infections were instrumental in prolonging the duration of hospital stay. Tigecycline and colistin were found to be 100 % sensitive for all the pathogens.

KEYWORDS: SSI (Surgical site infection), CONS (Coagulase negative Staphalococcus aureus).

INTRODUCTION

In surgical language, the word laparotomy is defined as exploration of the abdomen in order to proceed further according to the cause identified1. A number of approaches, viz. midline/median approach, paramedian approach, transverse approach, Pfannenstiel approach and subcostal approach are followed, however, midline or median approach is the most common approach. The median approach involves a cut in the midline along the linea alba2. Laparotomies are performed both as elective as well as emergency procedures. Emergency laparotomies have poor outcomes with variable postoperative critical care provision (1-2).

Despite being conducted in relatively controlled conditions, elective laparotomy procedures are prone to general post-operative complications such as pain, nausea and vomiting which are frequent but last only for a short duration. However, some patients develop short and long term complications like fever, wound infection, wound dehiscence, anastomosis disruption, adhesive bowel obstruction, incisional hernia, etc. that need more serious consideration. No doubt, these complications are more frequent in emergency surgeries, however, they are seen in elective procedures too, which is a cause of concern (1,3).

The rate of these complications is dependent on preoperative antibiotic prophylaxis, skin antisepsis, control of contamination and surgical skills. Variability in these conditions accounts for a phenomenal variation in their occurrence. It has been reported that rates of wound infection rates vary from 2.8% to 40% under varying operative conditions (1-2).

Surgical incision (wound) is a part of all the surgical procedures. Surgical procedures might be complex but significant risks for patients are associated despite the health-care setting1. Surgical site infection (SSI) is the most common health-care-associated infection among surgical patients. SSI is the cause of one-third of post-operative deaths and accounts for 8% of all deaths

caused by a nosocomial infection(1-3). Surgical site infections can be defined as an infection that "occurs when micro-organisms get into the part of the body that has been operated on and multiply in the tissues" . They are described as "infections occurring up to 30 days after surgery (or up to one year after surgery in patients receiving implants) and affecting either the incision or deep tissue at the operation site"4. The impact of SSIs on healthcare can be understood by the fact that patients who experience SSI are 60% more likely to spend time in intensive care unit and are 5 times more likely to be readmitted to hospital and twice as likely to die as patients without SSI1.

In an environment like ours, where SSIs are an inevitable part of surgical milieu, it is important that prudent antibiotic prophylaxis and post-operative antibiotic management should be done. A successful antibiotic intervention depends upon proper understanding of the possible pathogens and their antibiotic resistance pattern. Although, nosocomial infections, predominantly caused by Gram positive pathogens like Staphylococcus aureus are most common surgical site infections in different studies(1-6). Moreover the antibiotic susceptibility pattern in different studies have shown a considerable difference depending upon the emergence of new resistant varieties of underlying pathogens. Coupled with these differences, there is lack of studies specifically discussing the surgical site infection rates in elective laparotomy and their microbial picture and antibiotic susceptibility pattern.

AIMS AND OBJECTIVES

Hence, the present study was planned with the aim to study the incidence of post-operative surgical site infection and their microbial profile among cases undergoing elective laparotomy at a tertiary care centre in North India.

MATERIALS AND METHOD

The study was carried out at Department of Surgery in Era's Lucknow Medical College & Hospital, Lucknow.

DURATION OF STUDY

Two years. Starting from January 2017 to December 2019.

SAMPLING FRAME

Patients scheduled for elective laparotomy at the Department of Surgery, Era's Lucknow Medical College & Hospital, Lucknow.

Inclusion Criteria :

- Age>18 years
- All the patients undergoing elective laparotomy at Department of Surgery, ELMC&H, Lucknow.

Exclusion Criteria

- Patients with pre-existing conditions and with immunocompromised states such as HIV, malignancy, diabetes mellitus, malignancy.
- Not giving consent for inclusion in the study.

After obtaining an informed consent, all the patients were clinically examined and demographic information was collected, which was noted on a separate case sheet for every individual. All the patients were subjected to necessary laboratory/radiographic investigations, thereafter these patients were subjected to laparotomy. Usual pre-operative part preparation (shaving and bathing) was done for all the patients. Third generation cephalosporin (Ceftriaxone) IV (1 gm) used as the pre-operative antimicrobial prophylaxis administered one hour before surgery.

Betadine 10% (Povidone iodine) used for all the patients as anti-microbial paint. A sterile swab for culture and sensitivity was taken pre-operatively from incision site and sent to laboratory for assessment with normal culture technique. Repeat swabs for culture and sensitivity was done patients with post-operative wound infection. Patients were followed up for 1 month.

RESULTS

S.N.	Age Group	No. of cases	Percentages(%)
1.	≤20 Years	2	1.1
2.	21-30 Years	38	21.1
3.	31-40 Years	45	25.0
4.	41-50 Years	44	24.4
5.	51-60 Years	34	18.9
6.	61-70 Years	13	7.2
7.	71-80 Years	4	2.2
Mean±SD (Range) in years		43.58±13.56 (20-75)	

Table 1: Age Wise Distribution of Cases

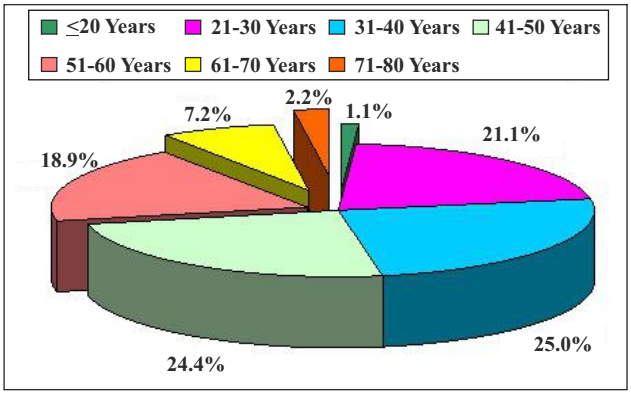
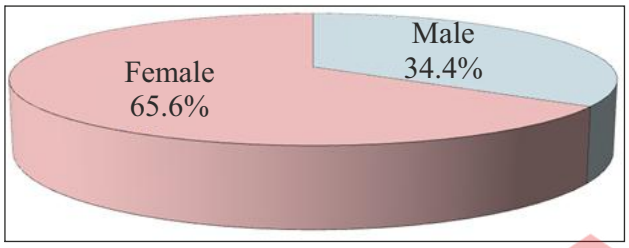


Table 1: Age Wise Distribution of Cases

Range of patients enrolled in the study was 20 to 75 years, mean age was 43.58±13.56 years. Most common age group of patients was 31-40 years (25.0%) followed by 41-50 years (24.4%), 21-30 years (21.1%) and 51-60 years (18.9%) while the least common age group was ≤20 years (1.1%) followed by 71-80 years (2.2%), 61-70 years (7.2%).

S.N.	Gender	No. of cases	Percentages(%)
1.	Male	62	34.4
2.	Female	118	65.6

Table 2: Sex wise Distribution

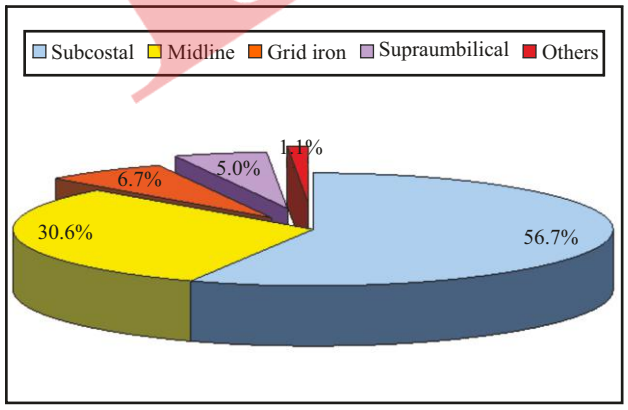


Graph 2: Sex wise Distribution of cases

Out of 180 cases enrolled in the study, around two-thirds (65.6%) were female and rest were male (34.4%). Male:Female ratio was0.53.

SN	Site	No. of cases	Percentages(%)
1.	Subcostal	102	56.7
2.	Midline	55	30.6
3.	Grid iron	12	6.7
4.	Supraumbilical	9	5.0
5.	Others	2	1.2

Table 3: Distribution of cases according to site of Incision

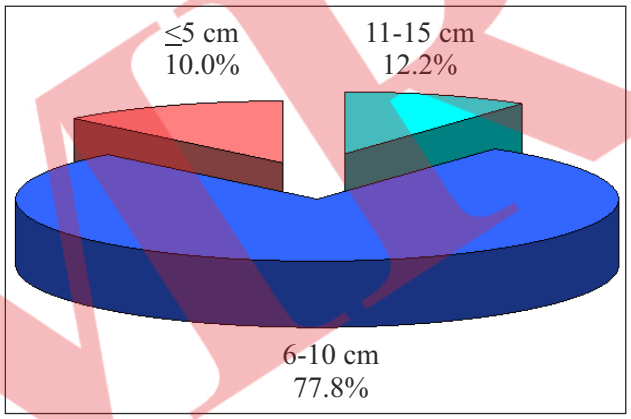


Graph 3: Distribution of cases according to Site of Incision

Subcostal approach (56.7%) was used in majority of the laparotomy cases followed by Midline incision (30.6%) while Grid iron incision, Supraumbilical incisions were less common (6.7% & 5.0%), other approaches were used in 2 (1.2%) cases of laparotomy.

SN	Size	No. of cases	Percentages (%)
1.	≤5 cm	18	10.0
2.	6-10 cm	140	77.8
3.	11-15 cm	22	12.2

Table 4: Distribution of cases according to size of Incision

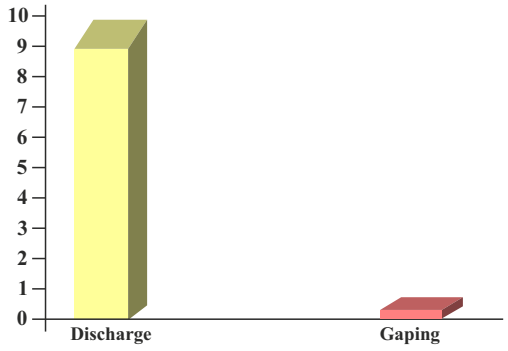


Graph 4: Distribution of cases according to Size of Incision

Size of incision was 6-10 cm in majority of the cases (77.8%), size of incision was ≤5 cm in 10.0% and 11-15 cm in 12.2% cases only.

S.N.	Features	No. of cases	Percentages (%)
1.	Discharge	17	9.4
2.	Gaping	1	0.6

Table 5: Post-operative features suggestive of SSI



Graph 5: Incidence of post-operative features suggestive of SSI

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Hb	180	10	15	12.21	1.59
TLC	180	4500	11500	7530.89	1752.52
DLC					
P	180	54	86	68.27	6.04
L	180	12	44	24.93	5.16
E	180	1	12	4.65	2.34
M	180	0	5	2.51	1.69
Platelet count (lakhs/cumm)	180	1.0	4.5	1.68	0.55
Duration of hospital stay (days	180	4	16	7.64	2.59

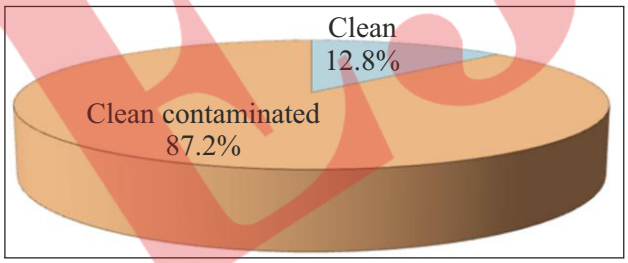
Table 6: Hematological profile and Duration of Hospital Stay

Mean Hemoglobin, TLC, Neutrophil count, Lymphocyte counts, Eosinophil counts, monocytes, were 12.21±1.59 g/dl, 68.27±6.04%, 24.93±5.16%, 4.65±2.34%, 2.51±1.69%. Mean platelet counts were 1.68±0.55 lakhs/cumm.

Duration of hospital stay of cases ranged from 4 to 16 days, mean duration being 7.64±2.59 days.

S.N.	Wound Type	No. of cases	Percentages (%)
1.	Clean	23	9.4
2.	Clean contaminated	157	87.2

Table 7: Distribution of cases according to wound type (physical examination)

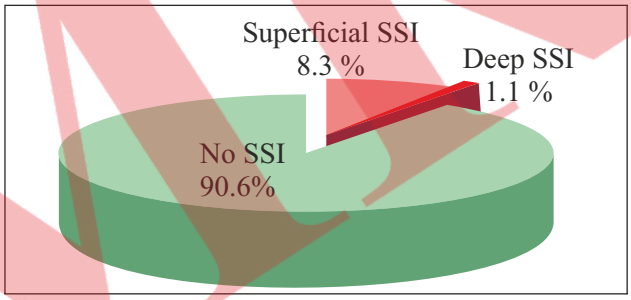


Graph 6: Distribution of cases according to Wound Type

Majority of the wounds of (87.2%) were found to be clean contaminated.

S.N.	SSI	No. of cases	Percentages (%)
1.	Yes Superficial Deep	17 15 2	9.4 8.3 1.1
2.	No	163	90.6

Table 8: Distribution of cases according to incidence of SSI and its type

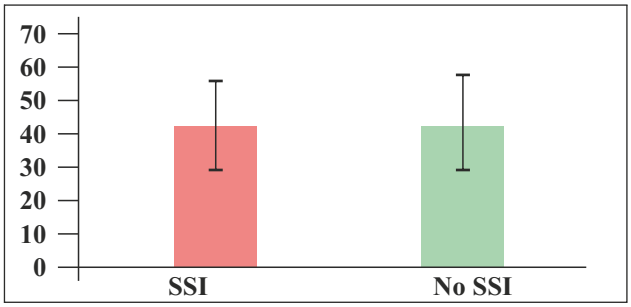


Graph 7: Incidence of SSI in laparotomy Cases

Out of 180 cases enrolled in the study, SSI was observed in 17 (9.4%), of these15 (8.3%) had superficial SSI and 2 cases (1.1%) had deep SSI. In 163 cases (90.6%) SSI was not observed.

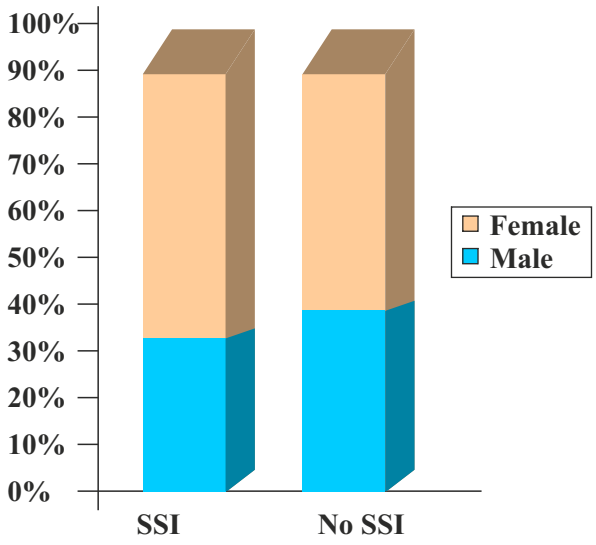
S.N.	Characteristic	SSI (n=17)		No SSI (n=163)		Statistical significance	
		No.	%	No.	%	X^2	'P'
1.	Mean Age±SD	42.94±11.92		43.65±13.75		't'=0.205; p=0.838	
2.	Sex						
	Male	5	29.4	57	35.0	0.211	0.646
	Female	12	70.6	106	65.0		

Table 9: Association of SSI with demographic profile of patients



Graph 8: Association of SSI with Age

Mean age of cases of SSI (42.94±11.92 years) as compared to No SSI (43.65±13.75 years).



Graph 9: Association of SSI with Gender

Proportion of female cases of SSI was higher as compared to no SSI (12 vs 106) cases (70.6% vs. 65.0%) while proportion of males was higher in no SSI as compared to SSI (57 vs 5 cases) (35.0% vs. 29.4%).

S.N.	Characteristic	SSI (n=17)		No SSI (n=163)		Statistical significance	
		Mean	SD	Mean	SD	't'	'p'
1.	Hb	12.13	1.73	12.21	1.58	-0.207	0.836
2.	TLC	8000.00	1833.03	7481.96	1742.49	1.161	0.247
3.	DLC						
	P	70.35	5.94	68.05	6.02	1.503	0.135
	L	24.24	4.82	25.01	5.20	-0.585	0.559
	E	3.61	1.87	4.75	2.36	-1.950	0.052
	M	1.88	1.80	2.57	1.67	-1.608	0.110
4.	Platelet count	1.69	0.42	1.68	0.56	0.086	0.931

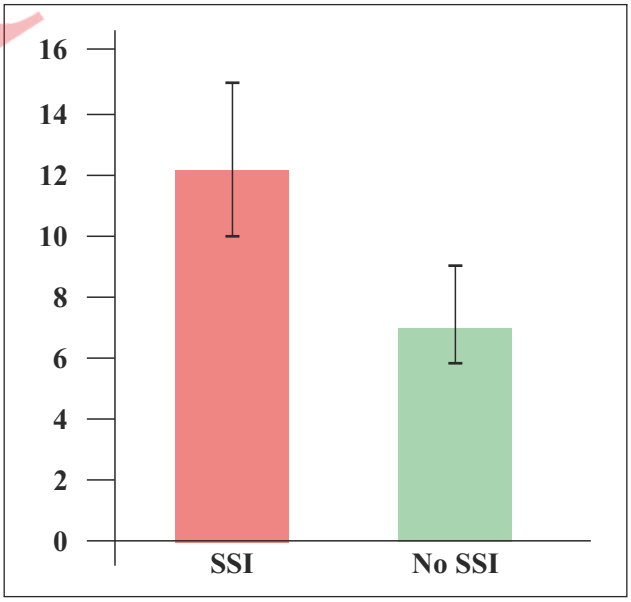
Table 10: Association of SSI with Hematological/Biochemical profile of patients

No significant association of SSI with pre-operative Hematological/ Biochemical parameters given above was found.

S.N.	Characteristic	SSI (n=17)		No SSI (n=163)		Statistical significance	
		No.	%	No.	%	X^2	'p'
1.	Site						
	Subcostal	7	41.2	95	58.3	5.647	0.342
	Midline	8	47.1	47	28.8		
	Grid iron	0	0	12	7.4		
	Supraumbilical	2	11.8	7	4.3		
	Others	0	0	2	1.2		
2.	Size						
	≤5 cm	0	0	18	11.0	3.845	0.146
	6-10 cm	13	76.5	127	77.9		
	11-15 cm	4	23.5	18	11.0		
3.	Wound type						
	Clean	3	17.6	20	23.3	0.399	0.527
	Clean-contaminated	14	82.4	147	87.7		
		Mean	SD	Mean	SD	't'	'p'
4.	Duration of hospital stay	12.29	2.49	7.15	2.06	9.589	<0.001

Table 11: Association of SSI with clinical profile of patients

No significant association of SSI with Site of incision, Size of incision and wound type was observed.



Graph 10: Association of SSI with Duration of hospital stay

Duration of hospital stay of patients with SSI (12.29±2.49 days) was found to be significantly higher as compared to No SSI cases (7.15±2.06 days).

S.N.	Pathogen	Gram Stain	No. of cases	Percentages (%)
1.	No growth	-	2	11.8
2.	E. coli	Negative	7	41.2
3.	Klebsiella pneumoniae	Negative	5	29.4
4.	CONS	Positive	2	11.8
5.	Pseudomonas	Negative	1	5.9

Table 12: Culture Sensitivity (n=17)

Out of 17 swab specimens, no growth was observed in 2 (11.8%) and 2 (11.8%) cases were Gram positive involving CONS pathogen, rest of the cases were Gram negative wherein E. coli (n=7; 41.2%) was most common pathogen, followed by K. pneumoniae (n=5; 29.4%) and Pseudomonas (n=1; 5.9%)

S.N.	Antibiotic	E. coli (n=7)	K. pneumoniae (n=5)	CONS (n=2)	Pseudomonas (n=1)
1.	Doxycycline	5 (71.4%)	2 (40%)	1 (50%)	0
2.	Gentamicin	3 (42.9%)	1 (20%)	2 (100%)	0
3.	Ciprofloxacin	4 (57.1%)	0	1 (50%)	0
4.	Levofloxacin	4 (57.1%)	1 (20%)	1 (50%)	0
5.	Amikacin	2 (28.6%)	2(40%)	2 (100%)	0
6.	Netimicin	3 (42.9%)	3 (60%)	1/1 (100%)	0
7.	Cefepime	1 (14.3%)	1 (20%)	1/1 (100%)	0
8.	Meropenem	4 (57.1%)	2 (40%)	1/1 (100%)	0
9.	Doripenem	4 (57.1%)	1/4 (25%)	-	0
10.	Piperacillin and Tazobactum	4 (57.1%)	1 (20%)	-	0
11.	Ceftriaxone	1 (14.3%)	0	-	0
12.	Amoxicillin/ Calvunic acid	3 (42.9%)	1 (20%)	1/1 (100%)	0
13.	Tigecyclin	7 (100%)	5 (100%)	1/1 (100%)	1 (100%)
14.	Colistin	7 (100%)	5 (100%)	1/1 (100%)	1 (100%)
15.	Cefoperazone and Salbactum	2 (28.6%)	0/4 (0%)	-	0
16.	Cefoxitin	-	-	1/1 (100%)	-
17.	Vancomycin	-	-	1/1 (100%)	-
18.	Tiecoplanin	-	-	1/1 (100%)	-

Table 13: Antibiotic Sensitivity

Tigecyclin and Colistin were found to be 100% sensitive for all the pathogens.

DISCUSSION

The present study was performed with an aim to study the incidence of post-operative surgical site infection in elective laparotomies at Department of General Surgery, Era's Lucknow Medical College and Hospital, Lucknow. For this purpose, a total of 180 patients scheduled to undergo elective laparotomy were enrolled in the study. Age of patients ranged from 20 to 75 years with a mean age of 43.58±13.56 years with majority being males (65.6%). The most common site of incision was subcostal (102 cases or 56.7%) followed by midline (55 cases or 30.6%), while the most common incision size was 6-10 cm in 140 cases (77.8%.) A total of 157 (87.2%) had clean-contaminated wound. The surgical site infection rate was seen in 17 cases (9.4%).

A comparative assessment of surgical site infection rate in different studies along with patient profile in comparison to present study is shown in Table D1 below:

In different studies reporting a detailed profile of patients undergoing elective laparotomy, the surgical site infection rate ranges from as low as 4.7%(Murtaza et al) to as high as 25.4% (Adejumo et al). Athough in other studies not providing extensive details of patient as well as surgical profile, the post-operative surgical site infection rates in elective laparotomies have been reported to range from 6% to 25%[13,14,15,16,17,18,19]

Among studies giving a detailed patient/surgical profile, the findings of present study are close to that reported by Shahzad*et al.*[10] who showed surgical site infection rate to be 9.2% which is close to 9.4% (17 cases) in our study. As far as age and gender profile is concerned, we had a similar age and gender profile as in their study. Similar to their study, we also have low proportion of clean wounds(12.8%). There are two other close studies[9,11] close to findings of present study with surgical site infection rate of 12.5%. In one of these studies, all the wounds were clean[9], though mean age of patients was much higher (56

S.N.	Author (Year)	n	Age Profile	Gender profile (M:F)	Surgery profile	Wound Profile	Incision site/ Size	SSI
1.	Murtaza*et al.* (2010) (6)	21	Mean age 37.1 years	0.11	66.6% Ovarian masses	-	-	4.7%
2.	Ishikawa *et al.* (2014) (7)	224	Mean age 67 years	1.22	Colorectal cancer	14.2% Clean contaminated 17.1% Contaminated	>20 cm in 20.3%	14.7%
3.	Adejumo*et al.* (2015) (8)	65	Maximum aged 21-40 Yrs	2.38	GI pathologies (46.2%) and HPB pathologies (44.6%)	Majority Clean-contaminated and contaminated	-	25.4%
4.	Kumarand Rai (2017) (9)	3321	Mean age 56 years	0.7	-	All clean	-	12.5%
5.	Shahzad*et al.* (2017) (10)	76	Mean age 48.8 years	1.81	-	Only 17.1% clean	-	9.2%
6.	Vinay *et al.* (2019) (11)	180	-	2.46	Pancreatico-biliary (63.9%)	Clean-contaminated	-	12.5%
7.	Present study (2019)	180	Mean age 43.8 years	0.53	Laparotomy	12.85 %clean	77.8% 6-10 cm	9.4%

Table D1: Patient profile and Surgical Site Infection rate in different studies as compared to present study

years) as compared to present study (43.8 years). The gender profile of their study also showed a dominance of females as compared to males in present study.

As such an overview of Table D1 above showed that younger age seems to have lower surgical site infection rates. It could be seen that Murtaza *et al.*[6] who reported minimum SSI rate (4.7%) had youngest age profile (Mean age 37.1%). In present study too, we had SSI rate of 9.4% (17 cases in total) only among patients with mean age 43.8 years which is lower in comparison to the studies by Ishikawa *et al.*, Kumar *et al.* and Shahzad*et al.* who reported mean age of patients in age range 48.8 to 67 years. However, younger age alone does not guarantee lower SSI rates, as could be seen in the studies of Kumar and Rai[9] who reported SSI rate of 12.5% despite having patients with mean age 56 years and Ishikawa *et al.*[7] who found SSI rate of 14.7% in a study population with mean age 67 years. Among factors governing the SSI incidence, the wound profile seems to hold high relevance. In the study by Adejumo*et al.*[17] who reported the maximum SSI rate (25.4%) majority of wounds were clean contaminated whereas studies reporting low incidence of SSI[11] there was a dominance of clean or clean-contaminated wounds. In studies reporting a higher SSI rate, such as that by Serra-Aracil*et al.*[14] who reported a SSI rate of 23.2% only 55% of the SSIs were superficial and as many as 36% were organ/space infections. Chavan*et al.*[16] who reported a SSI rate of 13.9% in elective laparotomies also reported majority to be superficial (60%) and remaining (40%) deep but did not report any organ/space infection.

In present study, we did not find a significant association of age, gender and hematological profile of patients with SSI incidence. Similar to present study, Adejumo*et al.*[8] also found no significant difference. In present study, among surgical profile factors, we did not find a significant association of site of incision and size of incision on surgical site infection rate, but found the SSI rate to be significantly higher in clean-contaminated wounds 87.2% (157 of total cases) as compared to clean wounds 12.8% (23 of total cases). Similar to findings of present study, Adejumo*et al.*[8] also observed the risk of SSI to be higher in contaminated and dirty wound as compared to clean wounds. However, given a high variability in SSI incidence in different studies, these factors seem to have a role in determining the SSI incidence. It is an important factor that we would like to recommend to be included in future studies. In another study, Aga *et al.*[19] also found that surgical procedure lasting >2 hrs and contaminated and dirty wound to be associated with increased risk of SSI. Role of wound type other than clean wound in increasing the incidence of SSI was also revealed by other workers([13,17] ,[10,20,18]). In present study, we found that duration of hospital stay was longer by almost 5 days in patients experiencing SSI. SSI is one of the leading causes of extended post-operative hospital stay[21,20]. In present study it extended the hospital stay by 1.4 times. However, Kumar and Rai[9] in their study did not find a significant association between SSI and duration of hospital stay, which might be owing to a possible difference in profile of surgeries.

In present study, in the 17 SSI cases, the culture positivity rate was 88.2% . The pathogen profile showed a dominance of Gram negative (86.7%) isolates. Only 2 (13.3%) isolates were Gram positive that were identified as Coagulase negative *Staphlyococcus aureus*. Among Gram negative isolates were *E. coli* (n=7; 41.2%) was most common pathogen, followed by K. pneumoniae (n=5; 29.4%) and Pseudomonas (n=1; 5.9%). Compared to present study, Adejumo*et al.43* found *Klebsiella spp.* (34%) as the most common isolate followed by *Staph. aureus* (30.4%), *Proteus spp.* (19.6%), *Providencia spp.* (12.5%) and *Escherichia coli* (3.6%) respectively in cases where single pathogen could be isolated and combination of *S. aureus+Klebsiellaspp.+Proteus spp.* (33.3%), *S. aureus+Proteus spp.* (28.6%), *S. aureus+Klebsiellaspp.+E.coli* (19.0%) and *Klebsiellaspp.+Providencia spp.*(19.0%) respectively in cases where multiple isolates were seen. Compared to their study, in present study, none of the cases had multiple pathogens. Moreover, a dominance of Gram negative isolates and an absence of Gram positive isolates, particularly that of *Staphylococcus aureus* showed a conducive role of better environmental conditions with good control on nosocomial infection.

On antibiotic susceptibility evaluation, in present study Tigycyclin and Colistin were found to be 100% sensitive for all the pathogens. Tigecycline is the first in the glycylcycline class of antibiotics and is used against response to the growing rate of antibiotic resistant bacteria such as *Staphylococcus aureus, Acinetobacter baumannii*, and *E. coli*. Colistin is a polymixin class of antibiotic and has been proposed as a drug of choice in cases of multidrug-resistant Gram-negative bacteria, however, in present study, against 2 Gram positive CONS too, it was absolutely sensitive.

The findings of present study showed that in a well-controlled environment, promising a good post-operative care and high standards of nosocomial infection control, the incidence of SSI in elective procedures could be controlled considerably. Apart from the sample size, the present study also had a limitation of non-inclusion of some other variables like duration of

surgery and skill level of surgeon which perhaps could also have provided some more information regarding the possible factors actuating the SSI rate.

CONCLUSION

Incidence of SSI among cases of elective laparatomy cases was 9.4% (17 cases of total cases) .Association of SSI was not found to be significant with Age, Gender, Biochemical parameters, Site of incision or Size of incision. Duration of hospital stay was significantly higher in SSI cases as compared to no SSI cases . Out of 17 SSI swab specimens 2 (11.8%)were Gram positive involving CONS pathogen, 13 (64.7%)were Gram negative involving *E. coli, K. pneumonia* and *Pseudomonas* while no growth was observed in 2(11.8%) specimens. Tigecyclin and Colistin were found to be 100% sensitive for all the pathogens. The findings of present study show that surgical site infections in elective laparotomies cases in our study were in accordance with the secular trends of surgical site infections and were unaffected by demographic or operative variables excepting type of wound. Surgical site infections were instrumental in prolonging the duration of hospital stay.

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