A Comparative Study of the Incidence and Severity of Surgical Site Infection Following Emergency and Elective Abdominal Surgeries

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ABSTRACT

BACKGROUND

Surgical site infections (SSI) represent a significant hurdle in the recovery and return to normalcy of patients. When considering abdominal surgeries in particular, SSI and its complications have been identified as one of the most important causes for postoperative morbidity. Treatment of SSI's ideally begins with prevention and this can be done with the identification of risk factors. This allows for appropriate stratification and institution of steps to safeguard the patient against the development of SSI in the pre-surgical period. The objectives of the study were to compare the incidence, severity and microbiological profile of surgical site infections following emergency and elective abdominal surgeries.

METHODS

This study was a prospective observational study, conducted from December 2017 to May 2019 at Father Muller Medical College Hospital, Mangalore, among patients who underwent laparotomy (regardless of indication) in either an elective or emergency setting. Patients who had SSI were then stratified using the ASEPIS wound scoring system and the Southampton wound assessment scale. The type of SSI was further documented in each patient. Other parameters such as duration of stay in the hospital, microbiological profile, interventions performed etc. were also recorded in the study.

RESULTS

150 patients were enrolled in the study (84 female and 66 male), 23 patients (incidence of 15.33 %) developed an SSI (7 elective cases and 16 emergency cases), whereas 127 did not. Of the organisms cultured, the most common was found to be coagulase negative staphylococcus (CoNS, 7 cases) followed by *E. coli* (4 cases).

CONCLUSIONS

The following factors were found to significantly contribute to the development of SSI - nature of the surgery, i.e. elective vs. emergency (P-value 0.040), class of wound (P-value 0.001), underlying malignancy (P-value 0.030) and a concomitant urinary tract infection (UTI) (P-value 0.045). The following factors were not found to contribute to the development of a SSI - sex of the patient (P-value 0.108), age of the patient (P-value 0.699), presence of diabetes mellitus (DM) (P-value 0.816), chronic kidney disease (CKD) (P-value 0.904) and acute respiratory infection (ARI) (P-value 0.909).

KEY WORDS

Abdomen, Laparotomy, *Staphylococcus aureus*, Surgical Site Infections, Wound

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BACKGROUND

Surgical site infection (SSI) is defined by the Centre for Disease Control and Prevention as a wound infection that occurs within 30 days of an operative procedure or within a year if an implant is left in place and the infection is thought to be secondary to surgery.¹ Surgical site infections (SSI) represent a significant hurdle in the recovery and return to normalcy of patients. While once considered a necessary evil, as famously described by Osler: "Except on few occasions, the patient appears to die from the body's response to infection rather than from it",² there has been a slow yet powerful paradigm shift towards early identification and appropriate treatment of these infections.

When considering abdominal surgeries in particular, SSI and its complications have been identified as one of the most important causes for postoperative morbidity.³ In an era dominated by Enhanced Recovery Programs⁴ and day care surgery,⁵ with the ultimate emphasis being on early return to function and minimising hospital stay, SSI's have emerged as a potent hurdle to the successful execution of these principles. Consideration of SSI begins with classifying surgeries and the types of these infections.

Surgical wounds are also classified based on the presumed magnitude of the bacterial load at the time of surgery⁶:-

- Class I clean wounds.
- Class II clean / contaminated wounds.
- Class III contaminated wounds.
- Class IV dirty wounds.

Treatment of SSI's ideally begin with prevention, and prevention in itself begins with the identification of risk factors. This allows for appropriate stratification and institution of steps to safeguard the patient against the development of SSI in the presurgical period. This study was therefore conducted with the intention to better understand the spectrum of surgeries fostering SSI's and correlating that data with the type and severity of infections encountered, so as to allow for future stratification and appropriate treatment of patients. The objectives of the study were to compare the incidence, severity and microbiological profile of surgical site infections following emergency and elective abdominal surgeries.

METHODS

This study was a prospective observational study, conducted from December 2017 to May 2019 in Father Muller Medical College Hospital, Mangalore. The study was done on those patients who consented for the study and signed a written informed consent. The study was initiated after obtaining ethical clearance from the institution's ethical clearance committee. The patients admitted to Father Muller Medical College Hospital from December 2017 to May 2019, who underwent laparotomy (regardless of indication) in either an elective or emergency setting, aged above 12 years were included in the study.

Exclusion Criteria

- Patients diagnosed to be immunocompromised and on steroid treatment.

- Patients below the age of 12.
- Patients with prosthesis.
- Patients undergoing relaparotomy for any reason other than surgical site infections.
- Patients not willing to participate in the study.

Method of Collection of Data

Routine, daily postoperative assessment of the patient's general condition and local examination of the patient's laparotomy wound was done to assess for presence or absence of surgical site infection. Patients who had SSIs were then stratified using the ASEPSIS wound scoring system.⁷ and the Southampton wound assessment scale.⁸ The type of SSI was further documented in each patient. Other parameters such as duration of stay in the hospital, microbiological profile, interventions performed etc. were also recorded. Patients with SSI's were investigated with wound culture and sensitivity, complete haemogram, ultrasound abdomen and / or computed tomography (CT) abdomen, if required (depending on the severity of the infection). Renal and liver function tests were also done.

Sample Size Estimation

The sample size was determined using the formula:

$$N = (Z\alpha + Z\beta)^2 \times pq \times 2 / d^2$$

Where,

N = sample size, p = average of prevalence according to study, q = 100 - p

Zα = Z score of α error (i.e. 1.96 with an α error of 5 %)

Zβ = Z score of β error (i.e. 0.842 with β error of 20 %)

D = p1 - p2

A retrospective observational study done in tertiary care centre, conducted in the Department of General Surgery and in the Department of Obstetrics and Gynaecology in Bangalore over a period of 18 months stated that the overall surgical wound infection rate was 13.7 % and the infection rate was more with emergency surgery (25.2 %) when compared to elective surgery (7.6 %).⁹ So, substituting values, sample size would be 78. 150 patients fulfilling the eligibility criteria, from Father Mullers Medical College Hospital, Mangalore during the proposed study period were included.

Statistical Analysis

Collected data was summarised by frequency and percentages. Comparison between the two groups with respect to various parameters was done using chi-square test. Level of significance was 5 % and analysis was done using Statistical Package for the Social Sciences (SPSS)-23 software.

RESULTS

Age

Of the 150 subjects enrolled in the study, the age of the patients ranged from 12 years (minimum included age) to above 80 years of age) (mean age of 46.36 and standard deviation of

17.10466), with the majority of patients clustering in the age group of 21 to 70 years, with an absolute majority being in the age group between 21 and 30 years of age. Only 3 patients were found to be above 80 years of age. This is depicted in Table 1.

Age (in years)	No. of Patients	Valid Percent
< 20	2	1.3
21 – 30	33	22
31 – 40	27	18
41 – 50	26	17.3
51 – 60	28	18.7
61 – 70	21	14
71 – 80	10	6.7
> 80	3	2
Total	150	100

Table 1. Age Distribution of Patients Enrolled in the Study

Type of Operative Procedure

As all laparotomies were considered, a wide distribution of cases was observed. The distribution of cases is highlighted in Table 2.

Type of Surgery	No. of Patients	Valid Percent
Adhesiolysis	1	0.7
Anterior resection	7	4.7
Appendectomy	34	22.7
Appendicular abscess	3	2
APR	2	1.3
CBD exploration	1	0.7
Colostomy closure	3	2
Cytoreduction	4	2.7
Exploratory laparotomy	21	14
Feeding Jejunostomy	3	2
Gastrojejunostomy	2	1.3
Hemicolectomy	3	2
Ileostomy	4	2.7
Incisional hernia	1	0.7
Intestinal obstruction	2	1.3
Left hemicolectomy	3	2
LSCS	13	8.7
Lumbar sympathectomy	1	0.7
Myomectomy	3	2
Obstructed femoral hernia	1	0.7
Open cholecystectomy	1	0.7
Ovarian cystectomy	3	2
Hollow viscus perforation	7	4.7
Radical cholecystectomy	1	0.7
Radical cystectomy	1	0.7
Resection and anastomosis	6	4
Subtotal gastrectomy+ FJ	1	0.7
TAH+ BSO	10	6.7
TAH+BSO+PLND	1	0.7
Trans hiatal esophagectomy	2	2
Whipple procedure	3	2
Total	150	100

Table 2. Operative Procedures Performed, with the Number of Patients Who Underwent Each Procedure

Crosstab						
			No	Yes	Total	P-Value (< 0.05 sig)
Emergency / Elective	Elective	Count	68	7	75	0.040
		% within SSI	54 %	30.4 %	50 %	
	Emergency	Count	59	16	75	
		% within SSI	46 %	69.6 %	50 %	
Total	Count	126	23	150		
	% within SSI	100 %	100 %	100 %		

Table 3. Comparison of Prevalence of SSI's in Elective vs. Emergency Cases

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The patients under emergency setting had a greater number of SSI when compared to elective surgery.

Crosstab			Emergency / Elective		Total
			Emergency	Elective	
Organism	<i>Citrobacter Koseri</i>	Count	0	1	1
		% within emergency / elective	0 %	6.2 %	4.3 %
	CONS	Count	2	5	7
		% within emergency / elective	28.6 %	31.2 %	30.4 %
	<i>E. coli</i>	Count	1	3	4
		% within emergency / elective	14.3 %	18.8 %	17.4 %
	<i>Enterococcus faecalis</i>	Count	1	1	2
		% within emergency / elective	14.3 %	6.2 %	8.7 %
	<i>Enterococcus faecium</i>	Count	0	1	1
		% Within emergency / elective	0 %	6.2 %	4.3 %
	Klebsiella	Count	0	3	3
		% within emergency / elective	0 %	18.8 %	13.0 %
	MRSA	Count	1	0	1
		% within emergency / elective	14.3 %	0 %	4.3 %
Pseudomonas	Count	2	0	2	
	% within emergency / elective	28.6 %	0 %	8.7 %	
<i>Staphylococcus aureus</i>	Count	0	2	2	
	% within emergency / elective	0 %	12.5 %	8.7 %	
Total	Count	7	16	23	
	% within elective / emergency	100 %	100 %	100 %	

Table 4. Microbiological Profile of SSI's

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On doing culture and sensitivity study coagulase negative staphylococcus (CONS) is found to be predominant organism as shown in table 4.

Crosstab					P-Value (< 0.05 is Sig)	
		No	Yes	Total		
Diabetes	No	Count	92	17	109	0.816
		% within SSI	72.2 %	73.9 %	72.7 %	
	Yes	Count	35	6	41	
		% within SSI	27.8 %	26.1 %	27.3 %	
Total	Count	127	23	150		
	% within SSI	100 %	100 %	100 %		

Table 5. Association between Diabetes Mellitus and SSI

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Out of the 41 diabetic patients only 6 patients developed SSI as shown in table 5.

DISCUSSION

A total of 150 patients were enrolled and followed up in the course of this study. The parameters that were considered have been detailed earlier in the article. While considering the age of the patients involved in the study, the vast majority clustered in the 20 – 60 age group (114 of 150 patients) as shown in Table 1. Most series describing SSIs show a similar clustering of patients, owing to numerous factors such as age-related attrition (due to death or due to deference of surgery) and the relative incidence of surgical diseases requiring

laparotomy in this age group.¹⁰ Age has been established as an independent risk factor in numerous studies.^{11,12} This can probably be explained by the clustering of patients in age groups that do not significantly alter the post-operative course of the patient, relative absence of patients of extremes of age and probably due to the better access and understanding of health care among the aged population.

A plethora of surgical procedures were performed on the patients enrolled in the study with the most common procedure being an appendicectomy (34 of 150 patients). This is advantageous, as it indicates the ability to apply the findings of this study over a broader category of surgical patients. A detailed list of the various procedures performed is tabulated in table 2. As described earlier, the nature of surgery performed plays a role in the development of SSI, however due to the smaller number of cases that developed an SSI and the wide range of procedures performed, a definitive correlation could not be ascertained.

All the patients enrolled in the study received prophylactic antibiotics. In most cases (44 of 150 cases) the antibiotic used was ceftriaxone with cefuroxime being the second most commonly used antibiotic (30 of 150 cases). This is in accordance with the hospital antibiotic protocol, which in turn is based on available literature that advocates the utilisation of cephalosporins as a prophylactic agent.¹³ Additionally, available recommendations also indicate switch over to other focussed antibiotics in conditions where there is high clinical suspicion of the offending organism.¹⁴ Subgroup analysis showed that a majority of patients (9 of 23) who subsequently went on to develop an SSI were administered ceftriaxone in the pre-operative period, likely indicating antibiotic resistance among organisms in the region under study due to local factors. This underscores the importance of regional factors in establishing protocols in the prevention and subsequent treatment of SSIs. Of the 150 patients studied, 23 patients developed an SSI, accounting for 15.3 % of patients. The quoted incidence of SSI varies widely in available literature, with authors describing rates as low as 5 %¹⁵ to 20 %¹⁶ and 55.56 %, indicating that this study was within acceptable parameters. Of the various factors considered, the first factor was the nature of the surgery, i.e., elective or emergent. Of the 23 patients who went on to develop an SSI, 16 patients underwent surgery on an emergency basis, whereas, 7 patients had routinely scheduled elective procedures. A significant statistical difference was also observed (Table 3), thereby establishing that the nature of surgery (i.e. elective or emergency) also serves as a risk factor for the development of SSI. However, this study and comparative studies described earlier,¹⁸ clearly establish that the nature of surgery poses an inherent risk to the development of SSI's indicating that these patients warrant heightened vigilance and awareness.

The microbiological profiling of the SSIs showed that the most common organism cultured was coagulase negative staphylococcus (CONS) (7 of 23 cases), with *E. coli* being the second most common organism (4 of 23 cases). Most studies have shown that the most common organism cultured in SSIs are *Staphylococcus aureus* followed by coagulase-negative staphylococci CoNS, owing to the ubiquity of *S. aureus* as skin flora.^{19,20} However, as demonstrated in Table 3, only two cases of *S. aureus* were isolated in this study. The remainder of the organism spectrum was stable and comparable to available literature.

Diabetes mellitus as a risk factor for the development of SSI is well documented in the literature.²¹ The mechanisms involve immune dysfunction, poor circulation and atherosclerosis. Patients are also inherently more susceptible to antibiotic resistant strains such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant enterococci. Of the patients enrolled in this study, it was found that 41 of the 150 had pre-existing DM, only 6 of these patients developed an SSI. Correlation statistics did not show a significant difference. Therefore, DM was not a significant risk factor towards developing SSI.

CONCLUSIONS

While surgical site infections continue to be a major thorn in a surgeon's paw, analysis of risk factors, optimal management in the perioperative period and targeted therapy of established infections can significantly ease the burden. Elucidation of risk factors such as the nature of surgery performed (i.e., emergent vs. elective), underlying comorbidities, presence or absence of remote infections and the type of wound, allow for appropriate patient stratification and treatment of risk factors.

This study also demonstrates the changing nature of the microbiological flora implicated in SSI and the resultant antibiotic resistances, highlighting the regional and demographic distributions of SSIs. This allows for alteration of antibiotic protocols and emphasises the need for more regional and hospital-based surveillance programs.

In conclusion, the effective management of SSIs relies on a two pronged approach, consisting of risk factor management for prevention and appropriate therapy for established infection.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

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