

# Clinico-Surgical Factors Affecting Surgical Site Infection in Colorectal Surgical Procedures

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## Abstract

**Introduction:** Surgical site infections (SSIs) are the third most common nosocomial infections, accounting for 38% of nosocomial infections among surgical patients. SSIs after colorectal surgical procedures are associated with increased morbidity, mortality, hospital stay and cost of treatment. The various risk factors for the development of SSI depend upon the patient characteristics as well as the surgical procedure.

**Aims and objectives:** To study the incidence of SSI and various clinico-surgical factors affecting the occurrence of SSI in patients undergoing colorectal surgery.

**Material and methods:** This 2 year prospective study included total of 350 patients who underwent different types of colorectal surgical procedures depending on the underlying pathology. Parameters studied were age, sex, BMI, nutritional status, smoking history, ASA grade, associated co-morbidities, type of surgical approach (open or laparoscopic) and mean operating time. Postoperatively patients were followed for development of any SSI and data as such collected was subjected to various statistical analysis tests and pre-operative risk factors were correlated with postoperative SSI taking into consideration the statistically significant results only where p-value was <0.05.

**Results:** Total of 350 patients were included in this hospital based prospective study from June 2013 to May 2015. The overall incidence of SSI in our study was 17.4%. Rate of SSI in patients with some associated co-morbidity was 21.5% while as it is about 14.1% in the patients without any comorbidity. However we did not find any statistically significant correlation of SSI with smoking status, surgical settings (elective vs emergency) and surgical approach (open vs laparoscopic). SSI rate in patients with BMI>25 was 29.2% while it was 11.3% in patients with BMI<25 (p-value of 0.01). SSI developed in 14.1% patients with ASA grade-I and 21.9% patients with ASA grade-II and none in ASA grade-III. With respect to age group the incidence of SSI in our study was highest in age group 75-95 (66.7%) and lowest in youngest age group 15-35 (10.6%); (p-value of 0.001). Also mean operating time was higher in patients that developed SSI (179.54±37.21) as compared to those that didn't develop SSI (156.33±49.58); (p value=0.012). Incidence of SSI in our study was 5.9% in well built patients and 33.3% in under-nourished patients (p-value 0.0001).

**Conclusion:** Overall incidence of SSI in our study (17.4%) is comparable to that reported in literature. The incidence of SSI is significantly higher in patients with higher BMI (obese patients), with higher mean operating time, higher age-group patients and in under-nourished patients.

## Keywords

Colorectal, incidence, surgical site infection, clinic-surgical factors.

## Introduction

Surgical site infection (SSI) is the infection of the skin and subcutaneous tissues, organs or spaces exposed by surgeons during performance of an invasive procedure. The Centre of Disease Control (CDC), USA definition of SSI states that “an infection would be regarded as surgical site infection if it occurs within 30 days of procedure and has at least one of these characteristics like purulent drainage from the wound, pain or tenderness, localized swelling, redness, malodor and fever”. In 1992, the Centers for Disease Control (CDC) and National Nosocomial Infections Surveillance (NNIS) system modified the definition of surgical wound infection slightly and changed the name to surgical site infection. SSIs are categorized as incisional (superficial or deep) infections or organ/space infections.(1) Superficial incisional infections involve only skin and subcutaneous tissue and excluding stitch abscesses. Deep incisional infections involve deeper soft tissues at the site of incision. Organ-space infections are defined as infections in any organ or space other than the incised layer of body wall that are opened or manipulated during the initial surgical procedure.

Surgical site infections (SSIs) are the third most common nosocomial infections, accounting for 38% of nosocomial infections among surgical patients and 14% to 16% of overall nosocomial infections.(2) Surgical Site Infections (SSIs) after any surgery especially after colorectal surgical procedures are associated with increased morbidity and mortality; increased hospital stay and cost of treatment, increased re-admission rates and excess utilization of health care resources. SSIs increase hospital stay on average by 7 to 13 days and average cost by 2.6 to 3 times per case.(3-5) Even after discharge, patients with SSI experience impaired physical as well as mental well-being.(6) Among various surgical specialties, colorectal surgery has one of the highest rates of SSI. This rate as measured by several independent investigators is highly variable, ranging from 15 to 30%. (7-10) Recently in a joint study by the Joint Commission Center for Transforming Healthcare and the American College of Surgeons (ACS), baseline SSI rate of 15.8% was found among 7 US institutions participating in this multi-disciplinary effort to reduce the risk of infections after colorectal surgery.(11) The various risk factors for the development of SSI depend upon the patient characteristics as well as the surgical procedure. Risk factors related to surgical procedure like type of surgery, duration of operation and operative blood loss have greater influence on SSI occurrence than do the patient characteristics like age, diabetes, and use of nicotine or steroids.(2,12-13) The risk factors for incisional and organ/space SSIs may also be different. National Nosocomial Infections Surveillance (NNIS) of CDC in 1991, proposed a risk scoring index for each operation by counting the number of risk factors present among the following: ASA score of patient, operation classification (contaminated or dirty-infected); and prolonged length of surgical procedure.(14) The NNIS risk index may provide a valid comparison of SSI rates among surgeons or among hospitals. Additional risk factors, including patient and surgical factors, need to be identified.

**Aim and objective:** To study the incidence of SSI and various clinico-surgical factors affecting the occurrence of SSI in patients undergoing colorectal surgery at Colorectal Division of Department of General and Minimal Invasive Surgery, at a tertiary care referral institute.

## Material and Methods

This 2 year prospective study was conducted from June 2013 to May 2015 in Colorectal Division of Department of General and Minimal Invasive Surgery at our institute. Total of 350 patients who underwent different types of colorectal surgical procedures depending on the underlying pathology were included in this study. All patients were evaluated with respect to detailed history and physical examination and were investigated to confirm the diagnosis. Parameters studied were age, sex, BMI, nutritional status, smoking history, ASA grade, associated co-morbidities, nature of disease i.e. whether the patient was operated for colorectal cancer (malignant) or any other benign disease like IBD,rectal prolapse,

fistula in ano etc, type of surgical approach (open or laparoscopic) and mean operating time.

In nutritional status parameter, patients were divided into well nourished and poorly nourished groups according to ABCD assessment i.e. anthropometric, biochemical, clinical and dietary assessment.

Patients above 15 years of age of both sexes of any ASA grade undergoing open, laparoscopic as well as transanal colorectal procedures in elective as well as emergency settings were included in the study. However patients under 15 years of age and patients undergoing non-colorectal surgical procedures were excluded from study.

Postoperatively patients were followed for development of any SSI and data as such collected was subjected to various statistical analysis tests and preoperative risk factors were correlated with postoperative SSI taking into consideration the statistically significant results only where p-value was <0.05.

## STATISTICAL ANALYSIS

Our study was approved by the Institutional Ethical Committee and consent forms were signed by the patients. Statistical analysis was performed using the SPSS statistical software package (SPSS Inc.; Chicago, IL). The univariate relation between each independent variable and postoperative SSI was evaluated using a logistic model for continuous variables and Pearson chi-square test for categorical variables. *P* values <0.05 were considered to be statistically significant.

## Results

Total of 350 patients were included in this prospective hospital based study from June 2013 to May 2015. Table (1) describes the patient characteristics in our study. Out 350 patients, 271 were operated for colorectal malignancies, 13 for benign rectal polyps, 20 for FIA, 5 for rectal prolapse, 12 for FAP, 14 for IBD and 15 patients were operated for bowel obstruction. And various surgical procedures performed included right hemicolectomy (n=46; 13.1%), transverse colectomy (n=7; 2%), left hemicolectomy (n=15; 4.3%), sigmoidectomy (n=15; 4.3%), low anterior resection (n=100; 28.6%), abdominoperineal resection (n=39; 11.1%), anterior resection (n=12; 3.4%), transanal surgeries for benign rectal polyps (TAE, TAMIS) (n=13; 3.7%), total proctocolectomy with ileal pouch anal anastomosis (n=12; 3.4%), fistulectomy (n=20; 5.7%), ileostomy (n=31; 8.8%), Hartmann's procedure (n=15; 4.3%), laparoscopic rectopexy (n=5; 1.4%) and stoma closure (n=20; 5.7%). And out of 350 procedures only 42 (12%) were performed laparoscopically.

**Table 1.** Demographic and Clinical Characteristics of Patients (n=350)

Clinical Characteristics	No. of patients	%age
Gender	Male	56.0
	Female	44.0
BMI	< 25	65.71
	> 25	34.28
ASA Class	I	54.57
	II	44.28
	≥ III	1.14
Co-morbidity	Present	45.14
	Absent	54.85
Smoking history	Yes	48.8
	No	51.1
Nutritional Status	Well nourished	34.28
	Under nourished	65.71
Disease	Malignant	77.4
	Benign	22.5
Approach	Open	88.0
	Laparoscopic	12.0
Setting	Emergency	88.8
	Elective	11.1

Out of 350 patients, surgical site infection (SSI) was seen in 61 patients after colorectal surgical procedures i.e. the overall incidence of SSI in our study was 17.4%. Out of 61 patients who developed SSI, 35 were males (17.9% incidence) and 26 were females (16.9% incidence). However the correlation of SSI with sex was statistically insignificant (p-value of 0.887). Out of 350 patients in our study, 158 had some associated co-morbidity (like hypertension, diabetes, CAD, COPD etc.) while as 192 had no comorbidity. Out of 61 patients with SSI in our study, 34 patients had an associated comorbidity while as 27 patients had no known comorbidity. Thus the calculated incidence of SSI in patients with some associated co-morbidity was 21.5% while as it is about 14.1% in the patients without any comorbidity. However this difference is statistically insignificant with p-value of 0.089. Out of 350 patients in our study, 171 were smokers and 179 were non-smokers. Among smokers 29 (17%) developed SSI while as 32 (17.9%) patients from nonsmoker group developed SSI (p-value 0.88).

Depending upon the patient BMI, we divided patients into two groups i.e. BMI<25 and BMI>25. Out of 350 patients in our study, 230 had BMI<25 and 120 had BMI>25. And 35(29.2%) patients with BMI>25 developed SSI and 26 (11.3%) patients with BMI<25 developed SSI. It was statistically significant with p-value of 0.01. Hence there is increased incidence of SSI after colorectal surgical procedures in obese patients. SSI developed in 27 (14.1%) patients with ASA grade I (n=191); 34 (21.9%) patients with ASA grade II (n=154) and in no patient with ASA grade III (n=4). So there is no statistically significant (p-value=0.107) difference in incidence of SSI after colorectal surgical procedures with respect to the ASA score of the patient.

Among 350 patients in our study, 311 were operated electively while as 39 patients were operated on emergency basis. SSI was reported in 53 (17%) patients operated on elective basis (n=311) and in 8 (20.5%) patients operated in emergency (n=39). Result was statistically insignificant (p-value 0.654).

The age of patients in this study ranged between 15 to 95 years with an average of 47.52±14.2 years. With respect to age group the incidence of SSI in our study was highest in age group 75-95 (6 out of 9; 66.7%), followed by 55-75 age group (27 out of 118; 22.9%) and age group 35-55 (21 out of 157; 13.4%). And the incidence of SSI was lowest in youngest age group 15-35 (7 out of 66; 10.6%). The results were statistically significant with p-value of 0.001. Thus the incidence of SSI increases with the age of the patients as shown in table (2).

**Table 2.** Rate of SSI with respect to Age group.

Age group (Yrs)	No of patients	No of patients with SSI	Rate of SSI
15-35	66	7	10.6%
35-55	157	21	13.4%
55-75	118	27	22.9%
75-95	9	6	66.7%
TOTAL	350	61	17.4%

Mean operating time was higher in patients that developed SSI (179.54±37.21) as compared to those that didn't develop SSI (156.33±49.58). And this difference was statistically significant (p value=0.012). So the incidence of SSI is

significantly increased in procedures where duration of surgery was prolonged. Incidence of SSI in our study was 14% (6 out of 42) in patients who got operated laparoscopy and 17.9% (55 out of 308) in open procedures.(p-value 0.669). Incidence of SSI in our study was 5.9% (12 out of 230) in patients who were well built and well nourished and 33.3% (49 out of 120) in under-nourished patients. And the result is statistically significant (p-value 0.0001).

## Discussion

The National Nosocomial Infections Surveillance (NNIS) risk index may provide a valid comparison of SSI rates among surgeons or among hospitals. There are limitations in predicting SSI risk after elective colectomy, as most of the patients undergoing such a procedure have an ASA grade of 1 or 2 and are classified as clean-contaminated procedure. Additional risk factors, including patient and surgical factors, need to be identified. The primary goal of this prospective study was to identify the risk factors for SSI in patients undergoing colorectal surgeries.

The overall incidence of SSI in our study was 17.4% (61 patients out of 350 patients). Our incidence of SSI is comparable to that of Mao Hagihara et al. Mao Hagihara et al(15) in their study of 304 patients who underwent elective colorectal resection from June 2006 to May 2009 reported that 46(15.1%) patients were diagnosed with SSI. Daniel Brock Hewitt et al reported in their 2 years study of 489 colorectal surgery cases that SSIs occurred in 68 patients (13.9% SSI rate).(16)

Jennifer Blumetti et al(17) in their retrospective review of 428 colorectal operations performed between January 2002 and December 2005 reported an overall SSI rate of 25%. However Debra L. Malone et al.(18) prospectively reviewed the data of 5031 noncardiac surgical patients at the Veteran's Administration Maryland Healthcare System from 1995 to 2000. They reported that SSI occurred in 162 patients, comprising only 3.2% of the study cohort. Rate of SSI in our study was more than their study because they have taken all non-cardiac patients and because of high risk of bacterial contamination in colorectal surgery patient and hence associated with a particularly higher risk of SSI.

In our study the calculated incidence of SSI in patients with some associated co-morbidity (like hypertension, diabetes, CAD, COPD etc.) was 21.5% while as it is about 14.1% in the patients without any comorbidity. However this difference is statistically insignificant with p-value of 0.089. We also did not find any statistically significant difference in the rate of SSI between smokers and nonsmokers. Debra L. Malone et al.(18) in their study after multiple logistic regression analysis documented that diabetes, low postoperative hematocrit, weight loss (within 6 months), and ascitis were significantly associated with increased SSI. However Tobacco use, steroid use, and chronic obstructive pulmonary disease (COPD) were not predictors for SSI.

Rate of SSI in our study with BMI>25 was 29.2% and only 11.3% in patients with BMI<25 (p-value of 0.01). Jennifer Blumetti et al(17) in their retrospective review of 428 colorectal operations also reported that the multivariate analysis of their data suggested that incisional infection was independently associated with body mass index (odds ratio [OR], 1.07; 95% confidence interval [CI], 1.02-1.11) and creation/revision/reversal of an ostomy(OR, 2.2; 95% CI, 1.3-3.9).

In our study the mean operating time was higher in patients that developed SSI ( $179.54 \pm 37.21$ ) as compared to those that didn't develop SSI ( $156.33 \pm 49.58$ ), with statistically significant p value ( $=0.012$ ). Mao Hagihara et al(15) also in their study of 304 patients of elective colorectal resection showed that the patients who developed SSI had more intraoperative blood loss ( $308.1 \pm 29.8$  vs.  $153.9 \pm 12.2$ ;  $p < 0.05$ ), longer postoperative antimicrobial administration ( $5.3 \pm 2.2$  vs.  $4.5 \pm 1.5$ ;  $p < 0.05$ ), and longer operative time ( $3.3 \pm 1.6$  vs.  $2.7 \pm 1.2$ ;  $p < 0.05$ ). Guido Beldi et al(19) in their prospective cohort study trial of 1,032 patients performed between July 2005 and January 2007 showed that univariate analysis revealed that among investigated patient characteristics, only a high body mass index 30 kg/m<sup>2</sup> had a significant influence

on the rate of SSI. Among surgical risk factors, realization of an intestinal anastomosis, operations lasting longer than 3 hours and lapses in adherence to principles of asepsis were independently associated with an increased incidence of SSI. In our study SSI developed in 27 (14.1%) patients with ASA grade I (n=191); 34 (21.9%) patients with ASA grade II (n=154) and in no patient with ASA grade III (n=4). Though there was a difference in rate of SSI in grade I and grade II ASA patients but our overall results were statistically insignificant because most of our patients were from grade I and II and only few were from ASA grade III patients. Reiping Tang et al(20) performed a prospective study of 2,809 consecutive patients undergoing elective colorectal resection via laparotomy between February 1995 and December 1998 at a single institution. They concluded that the risk factors for overall SSI were American Society of Anesthesiology (ASA) score 2 or 3 (odd ratio [OR] 5 1.7), male gender (OR 5 1.5), surgeons (OR 5 1.3–3.3), types of operation (OR 5 0.3–2.1), creation of ostomy (OR 5 2.1), contaminated wound (OR 5 2.9), use of drainage (OR 5 1.6), and intra- or post-operative blood transfusion (1–3 units, OR 5 5.3;  $\geq$ 4 units, OR 5 6.2).

Jensen T. Poon et al(21) in their prospective study of ‘Impact of Laparoscopic Colorectal Resection on Surgical Site Infection’ on 1011 patients showed that the laparoscopic surgery was associated with reduction of rate of SSI by more than 50% when compared with open surgery and would have a strong impact on the prevention of surgical infection. However the incidence of SSI in our study was 14% (6 out of 42) in patients who got operated laparoscopy and 17.9% (55 out of 308) in open procedures and the results were statistically insignificant (p- value 0.669). This discard of our results with that of Jensen T. Poon et al is probably due to the fact that a small number of patients in our study were operated laproscopically.

Incidence of SSI in our study was 5.9% in well nourished patients and 33.3% under-nourished patients (p-value 0.0001). Debra L. Malone et al.(18) in their study also showed that malnutrition was significantly associated with increased SSI.

## Conclusions

Overall incidence of SSI in our study (17.4%) is comparable to that reported in literature. However we did not find any statistically significant correlation of SSI with sex, smoking status, associated co-morbidities and ASA grade. The incidence of SSI is significantly higher in patients with higher BMI (obese patients), with higher mean operating time and in under-nourished patients.

## Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

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