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Surgical Site Infection (SSI) Rate After Colorectal Surgery at the Philippine General Hospital

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Objective: Surgical site infection (SSI) is one of the most common healthcare-associated infections. This study aimed to determine SSI rate and the associated factors among colorectal surgery patients.
Methods: This included adult patients who underwent surgery under the Division of Colorectal Surgery from January to May 2018. Clinico-demographic, operative, and SSI outcome data were reviewed. Occurrence of SSI during admission until discharge, and up to 30 days after the surgery was analyzed.
Results: A total of 172 surgeries were performed. Majority were elective procedures (68.0%), and performed via open approach (67.4%). Most were malignant cases (62.6%). Sixty-three colorectal resections were done (41 colon and 22 rectal). SSI rate prior to discharge was 6.4%, and15.7% at 30 days. Among colorectal resections, 18 (28.6%) patients had SSI at 30 days. SSI rates were significantly higher among patients who were ASA 2 or 3; received chemotherapy 12 weeks prior to surgery; had malignant pathology; underwent emergency surgery; received perioperative transfusion; had stapled skin closure; had low anterior resection for rectal cancer; and had multivisceral resection.
Conclusion: The Division of Colorectal Surgery at the Philippine General Hospital had a higher SSI rate as compared to literature. Although this could be partly explained by the differences in patient and surgeon population, improving on SSI rates will be the unit's goal. Continued SSI surveillance with more patient accrual may provide better insight to the associated risk factors.

Key words: Surgical site infection, colorectal surgery, risk factors

Surgical site infection (SSI) is one of the most commonly occurring health care-associated infections. The morbidity and mortality associated with SSI significantly impact on patient outcomes and contribute to increased healthcare costs. Thus, minimizing the occurrence of SSI must be considered a priority in the delivery of surgical care. An active SSI surveillance program is recognized to be vital in establishing accurate estimates, and in obtaining relevant knowledge on the epidemiology of such infections. Surveillance is a recommended strategy in SSI prevention.

SSI is the third most frequent type of nosocomial infection, accounting for 15 to 18 percent of all hospital-related infections.[1] A systematic review and meta-analysis of 60 datasets across 57 studies estimated the overall SSI incidence at 3.7 percent, ranging from 0.1 to 50.4 percent.[2] Philippine data on the incidence of SSI is scarce due to the absence of a standard surveillance program.[3] The cause of SSI is multifactorial. The most frequently cited risk factors are increasing age, malnutrition, poor tissue perfusion, obesity, diabetes, immunosuppressant drugs, timing of surgery, prolonged operative time, hypothermia, and inappropriate prophylactic antibiotic use.[4]

Colorectal surgery is associated with an incidence of SSIs four times higher compared to other abdominal surgeries. The reported incidence of SSI in colorectal surgery ranges from 15 to 30 percent.[4] In studies involving prospectively collected data, however, these rates are almost always higher. In some series, the SSI rate after elective colorectal resection was as high as 45 percent.[5] The higher rates of SSI in these patients was mainly attributed to the following factors: 1) colorectal surgery is often classified as clean-contaminated or contaminated; 2) patients undergoing colorectal surgery are of older age (median over 65 years) and are associated with decreased immune function and more comorbidities[6]; and 3) morbidity associated with colorectal surgery (anastomotic leak and hemorrhage) will directly cause a surgical site infection.[1]

Since July 15, 2016, the Department of Surgery of the Philippine General Hospital (PGH) has implemented its Surgical Site Infection Surveillance Program requiring the systematic monitoring for the development of SSI among its patients who have undergone surgery and the structured, complete recording of a pre-defined set of relevant data for SSI surveillance and benchmarking. This is a key quality improvement activity of the Department aimed to determine the SSI rate within the Department and the factors associated with the development of SSI, and to feedback this information to its staff and other stakeholders.

The primary aim of this study was to determine the frequency of SSI in colorectal surgery cases at the Department after the implementation of the SSI Surveillance Program. It also aimed to describe the demographic and clinical characteristics of patients who underwent colorectal surgery and those who developed SSI and determine factors associated with SSI.

This audit research was a retrospective review of data collected under the SSI surveillance program from the Division of Colorectal Surgery from January to May 2018. The object of this study was to determine the SSI rate of colorectal surgery procedures and its associated risk factors at the department.

Methods

Consecutive adult patients (age > 18 years old) male and female, admitted to the surgical wards who underwent elective and emergency surgery under the Division of Colorectal Surgery were included in the study.

Surgical site infection was defined using the 2008 Center for Disease Control definitions of SSI. The diagnosis of SSI requires the patient to have at least one of the following:

- Purulent drainage from the superficial or deep (fascia or muscle) incision but not from within the organ/ space component of the surgical site.
- At least one of pain or tenderness, localized swelling, redness, heat, fever, AND the incision is opened deliberately or spontaneously dehisces.
- Abscess within the wound (clinically or radiologically detected)

Clinical records of eligible patients were reviewed. Baseline demographic data (age, sex, ASA score, diabetes mellitus, smoking status, chemotherapy status) and operative data (length of operation, urgency, laparoscopic/ open, wound contamination status, method of skin closure, and antibiotic use) and SSI outcome data during admission were based on the patient's in-hospital, emergency room (as applicable), and operative records; and the SSI In-hospital Surveillance Form as filled out by members of the patient's attending surgical team. Prior to discharge, patients who had not developed SSI were instructed in the proper detection and reporting of signs and symptoms of SSI by a member of the attending surgical team, using a visual aid. In complying with the Department's SSI Surveillance Program, the patients were followed up for 30 days, either through outpatient clinic visits or through a telephone call by the attending surgeons. Follow-up data collected for the study was based on the information recorded on the patients' outpatient clinic chart, or on the SSI Follow-up Surveillance Form.

Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Frequency and proportion were used for categorical variables, and mean and SD for normally distributed continuous variables. Independent Sample T-test, Mann-Whitney U test and Fisher's Exact/Chi-square test was used to determine the difference of mean, rank and frequency, respectively, between patients with and without surgical site infection at 30 days post-operatively. Odds ratio and corresponding 95% confidence intervals from binary logistic regression was computed to determine significant predictors of surgical site infection prior to discharge and on its 30th day. All statistical tests were two tailed test. Shapiro-Wilk was used to test the normality of the continuous variables. Missing variables were neither replaced nor estimated. Null hypotheses were rejected at 0.05 α-level of significance. STATA 13.1 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.) was used for data analysis.

Results

Between January to May 2018, 172 patients underwent surgery under the Division of Colorectal Surgery. Mean age was 47 years, with 60.47 percent of patients being men. Fifty-eight percent were ASA 2 and 30.99 percent were ASA 1. Twelve percent had diabetes mellitus and 11.11 percent of patients received chemotherapy within 12 weeks of surgery. Only 23.98 percent of patients had no nutritional risk, 33.33 percent of patients had moderate nutritional risk and 12.87 percent were of high nutritional risk. Mean albumin was 37.87 g/dL ± 5.31. Majority (68.02%) of surgeries were elective in nature, most of which were clean-contaminated (73.10 percent). Of all cases, 62.57 percent were done for a malignant pathology. Laparoscopic procedures were done in 32.56 percent of cases, whereas the rest were done via the open approach. Sixty-three colorectal resections were done (41 colon and 22 rectal). Table 1 summarizes the demographic and clinical profile of the patient population, comparing those with versus those without SSI.

SSIs (Table 2) developed in 27 patients during the study period. Eleven were detected during their hospital admission while the rest were diagnosed within 30 days of follow-up. Overall SSI rate prior to discharge was 6.4 percent. 30-day SSI rate was 15.70 percent. Looking at the colorectal resections alone (63 patients), 18 patients had SSIs at 30 days (28.57%).

Table 1. Demographic and clinical profile of the patients undergoing colorectal surgery, PGH, January-May 2018.

	Total n=172 (%)	With SSI 30 days n=27 (%)	Without SSI 30 days n=145 (%)	p-value*
Age	47.47 ± 16.7	49.67 ± 16.70	47.06 ± 16.98	0.458
Sex				0.154
Male	104 (60.47)	13 (48.15)	54 (37.24)	
Female	68 (39.53)	14 (51.85)	91 (62.76)	
ASA				**0.003**
No organic pathology	53 (30.99)	2 (7.41)	51 (35.42)	
Moderate but definite Systemic disturbance	99 (57.89)	19 (70.37)	80 (55.56)	
Severe systemic disturbance	15 (8.77)	5 (18.52)	10 (6.94)	
Extreme systemic disorders				
Moribund	3 (1.75)	0	3 (2.08)	
	1 (0.58)	1 (3.70)	0	
Diabetes Mellitus	21 (12.28)	5 (18.52)	16 (11.11)	0.282
Chemotherapy	19 (11.11)	8 (29.63)	11 (7.64)	**0.001**
Smoking Status				0.884
Non-smoker	87 (50.88)	14 (51.85)	73 (50.69)	
Current smoker	40 (23.39)	7 (25.93)	33 (22.92)	
Previous smoker	44 (25.73)	6 (22.22)	38 (26.39)	
Nutritional Risk				0.347
No risk	41 (23.98)	4 (14.81)	37 (25.69)	
Low risk	51 (29.82)	8 (29.63)	43 (29.86)	
Moderate risk	57 (33.33)	9 (33.33)	48 (33.33)	
High risk	22 (12.87)	6 (22.22)	16 (11.11)	
Preop Albumin	37.87 ± 5.31	37.13 ± 4.45	38.07 ± 5.57	0.662
Urgency of Operation				**0.016**
Elective	117 (68.02)	13 (48.15)	104 (71.72)	
Emergency	55 (31.98)	14 (51.85)	41 (28.28)	

Intraoperative Contamination				0.816
Clean				
Clean-contaminated	1 (0.58)	0	1 (0.69)	
Contaminated	125 (73.10)	21 (77.78)	104 (72.22)	
Dirty	41 (23.98)	5 (18.52)	36 (25)	
	4 (2.34)	1 (3.70)	3 (2.08)	
Pathology				**0.027**
Benign	63 (37.43)	5 (18.52)	59 (40.97)	
Malignant	107 (62.57)	22 (81.48)	85 (59.03)	
Perioperative Transfusion				**0.001**
Yes				
No	67 (39.18)	18 (66.67)	49 (34.03)	
	104 (60.82)	9 (33.33)	95 (65.97)	
Skin Closure				**<0.001**
Suture	78 (45.61)	3 (11.11)	75 (52.08)	
Stapler	93 (54.39)	24 (88.89)	69 (47.92)	
Readmission				0.028
Yes	5 (2.91)	3 (11.11)	2 (1.38)	
No	167 (97.09)	24 (88.89)	143 (98.62)	
Laparoscopy	56 (32.56)	2 (7.41)	54 (37.24)	**0.002**
Open	116 (67.44)	25 (92.59)	91 (37.24)	**0.002**
Colon				**0.016**
Not applicable	131 (76.16)	16 (59.26)	115 (79.31)	
Right	19 (11.05)	4 (14.81)	15 (10.34)	
Left	18 (10.47)	5 (18.52)	13 (8.97)	
Transverse	2 (1.16)	0	2 (1.38)	
Total	2 (1.16)	2 (7.41)	0	
Rectal				**0.025**
Not applicable	150 (87.21)	20 (74.07)	130 (89.66)	
LAR	18 (10.47)	7 (25.93)	11 (7.59)	
APR	4 (2.33)	0	4 (2.76)	
Multivisceral	17 (9.88)	6 (22.22)	11 (7.59)	**0.031**
Diversion				**0.047**
Not applicable	124 (72.09)	23 (85.19)	101 (69.66)	
Lap	26 (15.12)	0	26 (17.93)	
Open EL	14 (8.14)	3 (11.11)	11 (7.59)	
Open minilap	8 (4.65)	1 (3.70)	7 (4.83)	
Appendectomy				0.429
Not applicable	123 (71.51)	24 (88.89)	99 (68.28)	
Lap	19 (11.05)	1 (3.70)	18 (12.41)	
Open RLQ	11 (6.40)	1 (3.70)	10 (6.90)	
Lap converted to open	3 (1.74)	0	3 (2.07)	
Opel EL				
	16 (9.30)	1 (3.70)	15 (10.34)	

*p-values in bold are statistically significant.

Table 2. Prevalence of surgical site infection in patients undergoing colorectal surgery, PGH, January-May 2018.

	Frequency (%)
SSI prior to discharge	11 (6.40)
SSI 30 days	27 (15.70)
SSI Colorectal resections (n=63)	18 (28.57)

Odds ratio and corresponding 95% confidence intervals from binary logistic regression was computed to determine significant predictors of surgical site infection within 30 days of follow-up. A higher risk of SSI was noted in patients who were ASA 2 (OR 6.06, p = 0.019) and ASA 3 (OR 12.75, p = 0.005), received chemotherapy 12 weeks prior to surgery (OR 3.42, p = 0.007), and had a malignant pathology (OR 3.05 p = 0.033). Patients also had higher risk of SSI after emergency surgery (OR 2.73, p = 0.019), received perioperative transfusion (OR 3.99, p = 0.002) or received stapled skin closure (OR 8.70, p = 0.004). Patients who underwent a low anterior resection (OR 4.14, p = 0.009) for rectal cancer or a multivisceral resection (OR 3.48, p = 0.026) were also of higher risk. A reduced risk for SSI was noted for patients who underwent a laparoscopic procedure (OR 0.13, p = 0.008). Table 3 summarizes the above findings.

Table 3. Factors associated with development of surgical site infection at 30 days in patients undergoing colorectal surgery, PGH, January-May 2018.

Parameters	**Odds ratio**	**95% CI**	**p-value***
ASA			
No organic pathology	(reference)	-	-
Moderate but definite systemic disturbance	6.06	1.35 to 27.11	**0.019**
Severe systemic disturbance			
Extreme systemic disorders	12.75	2.16 to 75.18	**0.005**
Moribund	-	-	-
	-	-	-
Chemotherapy	5.09	1.82 to 14.26	**0.002**
Urgency of Operation			
Elective	(reference)	-	-
Emergency	2.73	1.18 to 6.31	**0.019**
Pathology			
Benign	(reference)	-	-
Malignant	3.05	1.09 to 8.52	**0.033**
Perioperative Transfusion	3.88	1.62 to 9.27	**0.002**
Skin Closure			
Suture	(reference)	-	-
Stapler	8.70	2.51 to 30.17	**0.001**
Laparoscopy	0.13	0.03 to 0.59	**0.008**
Rectal			
LAR	4.14	1.44 to 11.92	**0.019**
APR	-	-	-
Multivisceral	3.48	1.16 to 10.41	**0.026**

*p-values in bold are statistically significant.

Discussion

Surgical site infection is one of the most commonly occurring health care-associated infections. Complications associated with SSI significantly impact patient outcomes and increase healthcare costs. Monitoring and minimizing the occurrence of SSI are paramount in the delivery of optimal surgical care. Colorectal surgery is associated with a higher incidence compared to other abdominal surgeries with a reported incidence SSI ranging from 15 to 30 percent.[4] Kwaan identified 112,282 patients who underwent elective colorectal surgery using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. The overall SSI rate for this cohort was 9.2 percent.[5]

The authors reported the findings of a retrospective review of data collected during their institution's SSI surveillance program covering the period of five months (January-May 2018) for the Division of Colorectal Surgery. During the study period, the overall SSI rate prior to discharge was 6.4 percent. Thirty-day SSI rate was 15.7 percent. A majority of SSIs were detected on outpatient follow-up highlighting the importance of active surveillance for SSI even after discharge. Relying on in-hospital SSI detection may grossly underestimate actual infection rates. Their unit also employs an enhanced-recovery after surgery (ERAS) protocol leading to shorter lengths of stay. Surgical infections may yet to manifest due to the earlier time to discharge, therefore many are detected on follow-up.

The authors acknowledge that their SSI rate may also be diluted due to the inclusion of non-major colorectal resections such as stoma creation and appendectomies. If by look at colorectal resections alone, their SSI rate was 28.57 percent, much higher than that reported in the NSQIP database of 9.2 percent. There are a number of possible explanations for this difference. First, their population may be different from those reported in surgical literature. Their institution is a tertiary referral center catering to more complex colorectal cases, majority of which belong to the underprivileged class. This group of patients generally have worse nutritional status and have poor health-seeking behavior leading to advance stage at diagnosis. These patients also come with comorbidities that are only diagnosed for the first time, or may be uncontrolled. The peri-operative optimization of these patients becomes challenging because of these factors. Secondly, a third of their surgeries were emergent in nature, whereas most reported data are based on elective surgery cohorts. Emergency cases usually have suboptimal preoperative preparation and have higher rates of being contaminated/dirty operations. Finally, their institution is a training hospital and most of these cases were performed by trainees (general surgery residents and colorectal surgery fellows). Less experience and longer operative times may lead to an increased infection rate.

The authors also analyzed potential risk factors for developing SSI. SSI rates were significantly higher for patients who were ASA 2 and 3; received chemotherapy 12 weeks prior to surgery; had a malignant pathology; underwent emergency surgery; received perioperative transfusion; or had stapled skin closure. A low anterior resection for rectal cancer and a multivisceral resection were also of higher risk. ASA 2 or 3 patients have comorbidities that may be controlled or uncontrolled. A study by Khan et al showed that SSI rate was directly related to increasing ASA scores.[6] Patients who received chemotherapy 12 weeks prior to surgery were mostly in the form of neoadjuvant long course chemoradiotherapy, wherein chemotherapy is given at a non-systemic dose. More than the immunosuppressant effect of chemotherapeutic drugs, the advanced stage in itself may have caused the higher infection rate.

Peri-operative transfusion is also a recognized risk factor for developing SSIs. Allogenic blood transfusion has been shown to induce immunosuppression and impede microvascular circulation leading to poor wound healing.[7] Avoiding unnecessary blood transfusions and minimizing intraoperative blood loss may lower our infection rates. Stapled skin closure had higher rates of SSI due to the status of wound contamination. In their institution, subcuticular wound closure with sutures was reserved for clean surgeries, where as staples were used for clean-contaminated, contaminated, and dirty surgeries.

Literature has often cited left-sided colon resections and rectal resections as having higher rates of SSI. This can be highest in those undergoing an abdominoperineal resection with and infection rate as high as 40 percent.[8] In their study, low anterior resections had higher rates of

SSI as compared to abdominoperineal resections. APRs performed were only four and this sample size may be too low to detect the reported incidence of infection. The presence of low rectal anastomosis performed by trainees could lead to a higher leak rate and consequently more SSIs.

Multivisceral resections also had higher rates of SSI. The complexity of these procedures would often lead to more blood loss and longer operative times. A study by Hennessey showed that procedures over three hours in duration were also an independent risk factor for the development of SSI. Prolonged surgical duration is associated with more tissue trauma, longer wound exposure to pathogenic microorganisms and diminished tissue levels of prophylactic antibiotics.[8] Ensuring that antibiotics are re-administered within the recommended time for these long cases may be beneficial.

Among all the risk factors, only the laparoscopic approach conveyed a protective effect. Minimal incisions provide less surface area for infection, the use of incision protectors may also decrease wound contamination in these cases.[9] Selection bias may also come in to play because less advanced tumors and simpler cases are chosen for the laparoscopic approach whereas more complex cases are done via the open approach.

Other commonly cited risk factors such as nutritional risk, hypoalbuminemia, age, gender, and smoking status did not have a statistically significant effect in this study.

This study is not without limitations. Additional risk factors such as operative time, bowel preparation, evidence of septic shock, and glucose control were not examined. The sample size is also small compared with many of the studies relying on administrative databases. This limits the power of this study to identify factors associated with SSI. The cases reviewed were all surgeries performed by their unit and were not limited to colorectal resections alone. This may have diluted the SSI rate and the significance of each risk factor analyzed.

Conclusion

Surgical site infection is a common complication of surgery, especially colorectal surgery, that influences outcomes and increases healthcare cost. The Division of Colorectal Surgery at the Philippine General Hospital has a higher rate of SSIs as compared to that of reported literature. Although this can be partly explained by the differences in patient and surgeon population, improving on their SSI rates will be a key quality improvement activity of our unit. The identified risk factors can help them in formulating an SSI prevention bundle to mitigate the contributors to infection. Continued SSI surveillance for a longer period of time with more patient accrual may provide better insight into the infection rates and the associated risk factors.

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