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ABSTRACT:

Introduction: Surgical site infections (SSI's) are amongst the most common hospital acquired infections within surgical patients. It increases morbidity and healthcare costs. The aim of this project was to look at risk factors for surgical site infections.

Methods: Odds ratio analysis was done on the infected and non infected groups comparing variables that potentially contribute to surgical site infections. Multivariate analysis was then performed on each of the significant findings to ascertain if the results were still significant after adjusting for age, operative time and ASA scores. A p value of <0.05 was considered statistically significant.

Results: Forty-eight out of the 620 patients that underwent colorectal surgery during 2013 and 2014 had wound infections (7.7%). A statistically significant SSI association is seen for open surgery (OR 6.13, P= 0.003), emergency operations (OR 2.15, P=0.01), peritoneal contamination (OR 3, P=0.001), stoma formation (2.18, p= 0.01), closure with staples (OR 2.82, p=0.009) and closure with absorbable sutures (OR 0.18, p=0.001). Even though both staples and absorbable sutures were significantly associated with SSI's, the odds ratio was greater with staples. On multivariate analysis all of the above variables were independently associated with wound infection after adjusting for age, operative time and ASA.

Conclusion: The study shows that commonly accepted factors such as open surgery, contaminated abdominal cavities, emergency operation and stoma formation increase the likelihood of SSI’s. Using staples may also increase the likelihood of SSI’s compared to sutures.

1.0 Introduction

Surgical site infections (SSI's) are a common problem in surgery and especially so in the discipline of colorectal surgery [1]. The higher incidence of SSI's documented in colorectal surgical units is most likely due to handling bowel and its contents. SSI's are an important complication of colorectal surgery as it adds to morbidity, mortality and increased health expenditure[2,3,4].

The Victorian Healthcare Associated Surveillance System, or VICNISS, modelled on the US Centres for Disease Control and Prevention (CDC) defines an SSI as “infection related to an operation within 30 days after Surgery, or within 90 days if prosthetic material is implanted”[5,6]. The reported incidence of SSI's in colorectal surgery in the literature varies between 12-25%[7,8,9].

Although some studies have tried to establish risk factors that contribute to an increased rate of SSI's, these have not been universally reported. Some of the reported risk factors include, high BMI and ASA scores, open operations, pre-existing diabetes and kidney disease, wound closure methods and emergency operations[10,11,12,13,14,15].

Due to the high morbidity and mortality it places on patients and healthcare institutions, SSI's along with prevention strategies have become a hot topic of discussion. This paper attempts to identify, through a retrospective audit, potential risk factors that specifically contribute to increased SSI rates in colorectal surgery patients.

2.0 Methods

All patients who underwent 'colorectal surgery' as defined by VICNISS as 'Incision, resection, or anastomosis of the large intestine; includes large-to-small and small-to-large bowel anastomosis, including operations on rectum' between years 2013 and 2014 at our institution were included in the study[6]. The patients with an SSI were those that also met the SSI definition as per VICNISS (defined above). Although VICNISS classifies SSI's into superficial, deep and organ categories we have decided to cluster all the SSI's under one category.

Variables looked at as possible contributors to SSI's were age, sex, ASA score, length of surgery, antibiotic prophylaxis (both an initial dose and a second dose if surgical time was greater than 3 hours), open and laparoscopic surgery, emergency and elective surgery, peritoneal contamination, presence of a stoma, type of skin prep used (iodine in alcohol, plain iodine, chlorhexidine), bowel prep prior to surgery, pre-existing diabetes and kidney disease, perioperative systolic blood pressure, temperature and oxygen saturations and method of skin closure (staples, absorbable or non-absorbable sutures).

Two groups were identified: Infected group and the non-infected control group. Using wound infection as the outcome variable, we calculated odds ratios (ORs) and 95% confidence intervals (95% CIs) for the above mentioned risk factors. A multivariate analysis of those factors that showed a statistically significant odds ratio($P<0.005$) was then undertaken. Factors such as age, operative time and ASA scores were used in the multivariate analysis to see the independent effect of these risk factors on wound infection.

Continuous variables were summarised using mean ± standard deviation (SD) or median (inter-quartile range (IQR)) wherever appropriate. Categorical variables were reported as percentages. A two-sided P value <0.05 was considered statistically significant. Statistical analyses were performed with SAS software version 9.4 (SAS Institute, Cary, NC, USA).

3.0 Results

There were 620 patients that underwent 'colorectal surgery' as per the definition of VICNISS during the study period between 2013 and 2014. Of these, 48 reported wound infections, giving an overall wound infection rate of 7.7%.

Odds ratio analysis showed a statistically significant SSI association for open surgery, emergency operations, peritoneal contamination, stoma formation, closure with staples and closure with absorbable sutures (Table 1). It is important to note that even though both closing with staple and absorbable sutures were significantly associated with SSI, the odds were higher for closing with staples. The other variables did not show any statistically significant association.

On multivariate analysis, closure by staples, absorbable sutures, contamination, open surgery, stoma and emergency surgery were independently associated with wound infection after adjusting for age, operative time and ASA (Table 2).

4.0 Discussion:

Surgical site infections are amongst the most common hospital acquired infections within surgical patients[1]. It increases morbidity, mortality and healthcare costs[2]. Although many studies have attempted to identify risk factors that increase the likelihood of SSI's, not all of these have been mentioned universally. Therefore, it should be noted that a complex interaction of surgeon, patient, procedural and postoperative environmental factors contribute to SSI's.

Our study shows that emergency surgery, contaminated peritoneal cavities and, indeed, open operations increase the likelihood of SSI's. This is understandable as emergency operations are frequently associated with perforated bowel and, thus, are likely to be contaminated. Furthermore, it is also likely that the surgeon will approach such cases with an open operation as opposed to laparoscopy. Therefore, it is not surprising that that emergency surgery with an already contaminated surgical field increases the risk of SSI's. However, there is emerging evidence that Hinchey III diverticulitis may be amenable to laparoscopic washouts than a Hartmann's procedure but the impact of this on potential SSI's is unknown[16].

The presence of a stoma also increased the likelihood of getting an SSI. The most obvious reason for this may be due to soiling of the wound in the immediate postoperative period. It is also interesting to note that in elective surgery, a stoma is sited prior to the operation and is, therefore, measured and marked, leaving adequate space between the stoma bag and the wound. In emergency cases there is often no time to properly site the stoma and therefore it is more likely that wounds get contaminated due to inadequate space between the wound and the stoma. There is no literature looking at this particular aspect of colorectal surgery.

A retrospective study with propensity matching has shown that using staples to close skin wounds may in fact increase the risk of SSI's, arguing against the traditional practice of stapling wounds that are at high risk of infection [14]. Our study tends to agree with this observation. Even though both absorbable sutures and staples showed an increased likelihood of SSI's, the odds ratio is much higher for staples. It is possible that the staple ends up crushing the wound edges, compromising the blood supply to the local area and thus increases the risk of SSI's[14]. A more recent randomised control trial, however, has shown that staples do not in fact increase the risk of SSI's [17]. We believe that more studies are necessary in order to bring clarity into this matter.

This study did not find factors like age, ASA score, antibiotic prophylaxis, surgical time greater than 3 hours, pre-existing diabetes or kidney injury as risk factors but there have been other studies that have shown a correlation [10, 11, 12, 13, 18].

There are some limitations to this study. Firstly, it has the inherent issues associated with a retrospective study, especially information bias. For example, perioperative temperature was not always accurately recorded. Variables such as diabetes and kidney disease were looked as a whole group and not subdivided into stages of severity as documentation of this was poor. This study looked at antibiotic prophylaxis both prior to the operation and at the 3 hour mark, if the duration was beyond that. What this paper did not look at was the appropriateness of the antibiotic given and how long post-operative antibiotics were prescribed for, if at all. The ASA score was used to assess disease severity but other studies have also used albumin as a marker [15]. Although albumin is used frequently to assess nutritional status, it may not be reliable in the overtly septic patient[19]. Often surgical wounds are closed by junior members of the surgical team and it is hard to objectively measure the technique used. How much these factors contribute to SSI's is again unknown. It is also hard to comment on the results for the use of chlorhexidine as skin prep and non-absorbable sutures to close skin as the numbers were so small. Finally, the effect of the type of wound dressing used has not been looked at in this study.

5.0 Conclusion

The aim of this project was to look at possible contributors to SSI's. The results show that commonly accepted factors such as open surgery, contaminated abdominal cavities, emergency operations and stoma formation increases the likelihood of SSI's.

Furthermore, using staples to close skin wounds may also increase the likelihood of SSI's, a trend that has only recently been cited in the literature[14].

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Table 1. Univariate analysis of risk factors for wound infection.

Risk factor	Wound Infection		Odds Ratio (95% CI)	P value
	yes (n=48)	no (n=572)		
ASA score, Median (IQR)	2.5(2-3)	2 (2-3)	1.35 (0.92-1.98)	0.13
Male gender	39.5%	48.6%	0.69 (0.38-1.26)	0.23
Age (year), Mean ± SD	61.7±17.1	63.5±16.8	0.99 (0.98-1.01)	0.47
BMI, Mean ± SD	26.3±6.2	26.2±5.1	1.004 (0.95-1.06)	0.89
Diabetes	14.5%	17.3%	0.82 (0.36-1.87)	0.63
Kidney Disease	12.5%	8.5%	1.52 (0.62-3.77)	0.36
Skin prep (iodine in alcohol)	77%	70.3%	1.42 (0.71-2.85)	0.33
Skin prep (povidone iodine)	22.9%	26.7%	0.81 (0.40-1.64)	0.56
skin prep (chlorhexidine)	0%	2.90%	--	0.98
Bowel Prep	42.5%	42%	1.02 (0.56-1.87)	0.94
Closure with staples	82.6%	62.7%	2.82 (1.29-6.17)	0.009
Closure with absorbable	8.6%	35%	0.18 (0.06-0.5)	0.001
Closure with non-absorbable	6.5%	1.9%	3.46 (0.93-12.85)	0.064
Contamination	31.2%	13.1%	3 (1.56-5.79)	0.001
Stoma	56.2%	37%	2.18 (1.20- 3.96)	0.01
Time (mins)	202 (158-250)	213(161-272)	1.001 (1.00-1.004)	0.34

Systolic > 90mmHg	97.9%	86.8%	7.09 (0.96-52.08)	0.054
Temperature >36C	70% (n=40)	76.4% (n=492)	0.72(0.36-1.46)	0.36
Emergency	*52.10%*	*33.6%*	*2.15 (1.19-3.89)*	*0.01*
Open Surgery	93.7%	70.9%	6.13 (1.88-20.01)	0.003
Time >3hrs	68.7%	64.1%	1.23 (0.65-2.32)	0.52
First dose of Antibiotics	91.4%	94%	0.68 (0.23-2.0)	0.48
If time >3hr, second antibiotic dose	29% (n=31)	39.9% (n=366)	0.62 (0.28-1.38)	0.24

Table 2. Effect of closure by staples, closure by absorbable, contamination, open surgery, stoma and emergency surgery on wound infection after adjusting for age, operative time and ASA on multivariate logistic regression analysis

Variable	Adjusted Odds ratio (95% CI)	P value
Closure by absorbable	0.19 (0.07-0.55)	0.002
Closure by staples	2.62 (1.19-5.76)	0.02
Contamination	2.72 (1.39-5.35)	0.004
Open surgery	5.55 (1.69-18.27)	0.005
Stoma	2.08 (1.12-3.86)	0.02
Emergency surgery	2.15 (1.15-4.02)	0.02

