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A Prospective Study of Surgical Site Infection in Elective and Emergency General Surgery in a Tertiary Public Hospital in Malaysia - A Preliminary Report

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Abstract

Aim: To compare the incidence of surgical site infections (SSIs) in emergency versus elective surgeries and to determine if the difference can be accounted for by the seniority of surgeon operating.

Background: Surgical site infections (SSIs) remain, albeit unfortunately, a major contributor to increased morbidity, mortality and healthcare costs among surgical patients worldwide. However, few studies assessed the role of surgeons in contributing to SSIs.

Methods: A prospective cohort study was carried out on 248 patients who underwent general surgical operations in a tertiary public hospital in Malaysia. Patients prospectively allotted into two cohorts;

Group A (emergency): patients underwent emergency surgery after office hours (5pm-8am)

Group B (elective): patients who are admitted for elective surgery and underwent operation as per elective surgery list.

Patient demographics and factors, seniority of surgeon and other operation-related details were collected as well as the presence of SSIs up to 30 days post-op.

Results: 248 patients were included in the present study, with 67 being elective surgical cases and 181 emergency surgical cases. Elective surgery reported a higher rate of SSIs, 19.40%, as compared with 15.47% in emergency surgery.10 out of 72 cases with clean wound got SSI, with a rate of 13.9%, while it's 22.0% (11/50) for clean-contaminated cases, 6.3% (3/48) for contaminated cases, and 23.0% (17/74) for surgery with dirty wound.

Conclusions: This paper highlights the incidence of SSI in the Malaysian setting, as well as the factors that may contribute to the high incidence of infection. Further research must be undertaken in the local setting to better understand the degree of contribution of each individual risks factor onto SSI incidence.

Keywords: Surgical site infection; Emergency; Elective; General surgery; Surgeon seniorit.

Introduction

Surgical site infection (SSI), as with many medicinal subjects, has more than a simple one-line definition. The reason being that the clinical manifestation of SSIs is varied and SSIs penetrating to differing depths of tissues may cause diverse effects ranging from simple superficial skin infection to severe life-threatening sepsis [1]. However, the

Centres for Disease Control and Prevention (CDC) in the US have tried to standardise its definition, classifying SSIs into three categories: superficial incisional, deep incisional and organ/space based on the depth of tissues involved [2]. Typically, the presence of signs of inflammation or pus discharge arising (within 30 days) from a surgical incision that was primarily closed constitutes a SSI [3-5].

Regardless, SSIs remain an old enemy despite major advancements in the fields of infection control, sterilization and antibiotics [6]; continuing to be a formidable cause for mortality and morbidity among surgical patients, resulting in a two-fold increase in mortality and a 7-10 days increase in hospital stay [3,7]. In regards to healthcare costs, SSIs remain a major contributor in expenses throughout the world with one study citing a €814 to €6,626 increase in cost per patient in the UK while in the US, the figure stood at $25,546 per infection [8] amounting to an estimated $1.8 billion a year [9]. Such costs are caused by longer hospital stays, re-admission and re-operations where necessary, and an increase in drug use [8]. Interestingly, there have been talks of utilising incidence of SSIs to compare each hospital's or surgery units' performance and even possibly rank hospitals [10-12].

Although the incidence of SSIs has seen a steady decline over the decades with improved guidelines, developed nations still report an incidence of 1-3% in the US, Germany, and France while it has been reported to be as high as 20% in Ethiopia [8]. A small study in Sarawak, Malaysia reports an incidence of 13.8% [4]. Low to middle income countries often report a higher rate of SSIs compared to first world nations, mainly reflecting limited resources leading to irregular guidelines and a poor implementation of any such guidelines in areas of antibiotic use and infection control [13]. An effective infection control program has been shown to decrease the incidence of SSI by up to 20% [14]. Such hospitals also face overcrowding and a lack of medical supplies, trained healthcare personnel and an effective surveillance programme contributing to hospital-acquired infections on a whole [13].

The development of SSIs in general depends on the interplay of four factors; (1) inoculum of bacteria, (2) virulence of bacteria, (3) microenvironment of surgical site and (4) host defences [3]. From these four factors, many of the risk factors known to cause SSIs can be linked to its pathogenesis. As an example, a longer operation time and procedures involving access into body cavities naturally colonised with bacteria increases the chances of inoculation. In this aspect, the bowels; especially going distally have the highest concentration of bacteria which when in balance are not pathogenic but when changes to host factors and its microflora occur, infections are likely to occur. This may be the reason why abdominal surgeries in particular involving the colon often report a higher rate of SSI [8,15,16]. Haridas et al reports that 74% of patients who developed complicated SSIs (deep and organ/space) were those who had a gastrointestinal surgery and 71% of these involved the colon. This may also explain a lower incidence of SSIs in orthopaedics surgery [8]. This is also where the classification of wound into clean, clean-contaminated, contaminated and dirty can be used to predict SSI risk and hence initiate preventive measures [3].

The presence of devitalised tissue, dead space (for example poor technique [15]) and necrotic tissue as well as poor tissue perfusion and oxygenation (for example COPD) results in a conducive microenvironment for the seedling of infection [3,17]. Host factors that may decrease immunity – such as poor nutrition, reflected by hypoalbuminemia, diabetes mellitus, smoking, cancer, extremes of ages and other comorbidities, which is reflected by a higher ASA (American Society of Anaesthesiologists) – score at a much higher risk of developing SSIs. Korol et al also reports that patients who are admitted from long term care facilities or require assistance in activities of daily living have an odds ratio of 4.35 (CI 1.64-11.11) and 2.75 (CI 1.16-6.46) respectively for developing SSI. In this respect, antibiotic prophylaxis can be seen as an augmentation of host defences.

Other factors of note; minimally invasive approaches or laparoscopy has been shown to decrease the risk of superficial and deep SSI (odds ratio 0.62, CI 0.46-0.84) but organ/space SSI remains unchanged [18-20]. The authors suggest other parameters are at play that contribute to organ/space SSI [17]. Intriguingly, there was also a significant increase in the incidence of SSIs in patients who were last on the operating list compared to those who were first on the list (10.6% vs 5.8% and 15.8% vs 8.6%) [15].

In an interesting study by Hübner et al, it was found that surgeons themselves are risk factors for the development of SSIs in their patients; individual surgeons had odds ratio for SSIs that varied from 2.37 (CI 1.63-3.95) to being protective, with odds ratio of 0.16 (CI 0.07-0.37). This difference in SSI risk could not be explained by the surgeons' adherence to guidelines (self-reported), their years of experience, difference in surgical procedure, patient distribution or hospital facilities and staffing [7]. The authors propose other areas not assessed in their study as possible explanations for the discrepancy, for example the surgeons' level of skill and other practices in controlling risk factors (for example, glycaemic control and theatre discipline) and a possibility of underreporting of SSIs [7].

However, we did not come across any studies whose main focus was to compare the incidence of SSI between elective and emergency surgeriesthough the general consensus is that the incidence of SSIs is higher in emergency versus elective surgeries [21,22], the literature to support or disprove it has been rather poor. Hence, we would like to establish the incidence of SSI in emergency versus elective surgeries done in our large public hospital, Hospital SultanahAminah (one thousand bed capacity) and the factors responsible for it. Second, we wish to establish if the difference, if any can be accounted for by the seniority of surgeon operating. We aim to establish any possible contribution of lower surgeon seniority to SSIs and hope to evoke change in areas of surgeon supervision or training especially in emergency surgeries so as to reduce the incidence of SSI for the benefit of patients.

Review of Literature

As it is somewhat intuitive to think that emergency surgeries carry a higher risk of SSIs than elective surgeries because of a dirtier wound, we often take for granted what about emergency surgeries cause an increase incidence of SSIs. Is it truly just the dirtier wounds? In fact, Nguyen et al in his paper of 697 patients involving all surgical procedures performed in two large hospitals titled 'Incidence and Predictors of Surgical Site Infection in Vietnam' reports a lower incidence of SSIs in emergency versus elective cases (8.7% vs 13.1%) even though 7.5% of emergency surgeries had dirty wounds versus 4.5% in elective cases. The reason put forth by the authors is a longer pre-operative stay in elective cases at 4.5 days compared to a mere 0.6 days in emergency cases [14]. A longer pre-operative stay has been documented to be an independent risk factor [16].

Although a total of 13 articles were found to report on the increased incidence or odds ratio (OR) of SSIs in emergency versus elective surgeries, almost no explanation for this difference is given. Fan et al. [8] in his systematic review 'The incidence and distribution of surgical site infection in mainland China-a meta-analysis of 84 prospective observational studies' which included studies of general surgery, abdominal surgery, gynaecology and obstetrics, neurosurgery, thoracic and orthopaedic surgery reports an incidence of 5.9% versus 4.1% in emergency versus elective cases. Rioux et al. [10] with a crude incidence of 3.84% versus 2.20% in his article titled 'Impact of a six-year control programme on surgical site infections in France, results of the INCISO surveillance' which included procedures involving the urinary tract, gastrointestinal and cardiovascular systems, gynaecologic and orthopaedic operations. In Petrosillo et al. [16] one-month prospective national multicentre surveillance study of 48 Italian hospitals' general and gynaecological units, an OR of 1.73 (CI 1.22-2.44) was reported.

Most studies report similar odds ratios; Fiorio et al. [23] 1.44 (CI 0.95-2.21), Neumayer et al. [24] in his study titled 'Multivariable predictors of postoperative surgical site infection after general and vascular surgery, results from the patient safety in surgery study' with a patient database of 7035 patients over a 3-year period reports an OR of 1.502 (CI 1.352-1.668). Hubner et al. [7] 'Surgical site infections in colon surgery: the patient, the procedure, the hospital, and the surgeon', a prospective study of 2,393 patients undergoing colon surgery in 9 public Swiss hospitals also presents an OR of1.56 (CI 1.14-2.13), Biscione et al. [18] in his comparative study of open versus laparoscopic cholecystectomy in five private hospitals over 13 years involving 5,848 patients with an overall OR of 1.75 (CI 1.17-2.63), Di Leo et al. [25] 'Surgical site infections in an Italian surgical ward- a prospective study' with a cohort size of 1,281 general surgery patients reported an OR of 2.44 (CI 1.41-4.22), Blumetti et al. [9] in her article 'Surgical site infections after colorectal surgery- do risk factors vary depending on the type of infection considered' reports an OR of 2.3 (CI 1.2-4.4) from 428 patients undergoing colorectal-related surgeries and Watanabe et al. [26] similarly looking at risk factors for SSIs in upper versus lower gastrointestinal surgery reports an OR of 3.38 (CI 1.3900-8.1800), gathered from data of a SSI surveillance programme of 27 hospitals in Japan.

However, Petrosillo et al. [16] went one step further to determine if this risk factor held out for both the development of SSI in-hospital and post-discharge. She found that an odds ratio of 1.97 (CI 1.37-2.82) was significant only in the in-hospital period. In fact, many of the risk factors for developing SSIs did not hold up in the post-discharge period (age, National Nosocomial Infection Surveillance (NNIS) score less than 1, presence of prosthesis and presence of drain for less than 3 days) [16].

'Thirteen years of surgical site infection surveillance in Swiss hospitals' by Staszewicz et al. [19] involving 23 public Swiss hospitals demonstrated that the timing of operation (emergency or elective) was only significant for several surgical procedures, namely colectomy and herniorrhaphy but not appendectomy, cholecystectomy and knee or hip arthroplasty. The odds ratio for emergency colectomy is 1.27 (CI 1.08-1.48) while for herniorrhaphy 1.94 (CI 1.12-3.38) [19]. Why this may be so was not given.

In Li et al. [27] study of case matched patients requiring primary ventral hernia repair acutely versus as elective cases, although patients undergoing emergency surgery had a higher rate of SSIs at 33% vs 13% (in addition to increased rates of mortality and recurrence), it was not found to an independent risk factor. Rather than the acuteness of surgery, the presence of an incarcerated hernia which correlated to a need for acute surgery and other patient factors were more important independent contributors to SSIs.

Alternatively, several studies report no significant difference between the incidence of SSIs in emergency versus elective surgeries as demonstrated by Giri et al. [28] in his prospective study of 230 abdominal surgery patients in a teaching university hospital in Nepal as also supported by Mawalla et al. [29] in his article 'Predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania', a prospective study of 250 patients undergoing mainly general surgery but includes others such as thoracotomy, skull elevation and spinal bifida repair. Arabshahi et al. [30] with a prospective study of 910 patients of general surgery, gynaecology and obstetrics, neurosurgery, orthopaedic surgery and ear, nose and throat surgery in five hospitals in Tehran also reports no significant difference.

Method

All patients above the age of 18 undergoing general surgery in a tertiary public hospital were included in this study. Written informed consent was obtained in all cases. Patient data was gathered on a standardised fact sheet which includes;

- Patient parameters (gender, age, dates of admission, surgery and discharge, comorbidities, cigarette and alcohol use)

- Operation details (wound class, surgical diagnosis and procedure, position in surgical list, elective or emergency surgery, seniority of surgeon, duration of surgery)
- Antibiotic prophylaxis

In our study, an emergency operation is defined as operations performed after 'office' hours (5pm-8am) while patients admitted for surgery and underwent operation as per elective surgery list are classified as elective.

Following their surgery, patients were monitored for signs of SSIs daily as per standard hospital protocol by the patients' primary physician. A positive SSI is considered if any one of the following is positive at the surgical site;

- Signs of inflammation (pain or tenderness, erythema, swelling, warmth)
- Pus discharge
- Positive culture of swab or fluid

Upon discharge, patients were required to return for a follow-up visit at 30 days for re-examination of surgical site. Diagnosis of SSI was left to the discretion of the treating surgeon. Patients failing to return for follow up were telephoned to determine the status of their surgical site. Based on the presence or absence of surgical site infection by the 30 day post-operation end point, two cohorts of participants were formed and analysis of data performed comparatively.

A total of 248 cases were included in the present study. There were 124 Malays patients, 60 Chinese patients, 29 Indian patients and 33 from other minority groups such as the Indigenous Malaysian people (Orang Asli), Ibans, and other foreign workers from Myanmar, Indonesia, Philippines and Bangladesh.

Statistical Analysis

Cases was collected throughout months of May, June and July 2017. Data were then entered into computer and analysed using IBM SPSS version 22. Simple logistic regression and Chi-square test were used to determine the strength of association of each factors with the outcome (surgical sites infection). Significance is defined as p-value less than 0.05.

Results

248 patients were included in the present study, with 67 being elective surgical cases and 181 emergency surgical cases. Elective surgery reported a higher rate of SSIs, 19.40%, as compared with 15.47% in emergency surgery. Odds Ratio (OR) obtained with simple logistic regression is 1.315 with 95% Confidence Interval (CI) 0.636 to 2.722 and p-value of 0.460. The average time for elective surgery is 117 minutes, and 78 minutes for emergency surgery. The longer surgery duration may contribute to the increase rate of SSI amongst elective surgery.

Out of 95 cases operated by medical officers, only 9 cases reported with SSIs while 26 out of 129 cases done by specialists and 6 out of 22 cases done by consultants reported SSIs. Surgery operated by a consultant has a 3.5 times higher chance of getting an SSI, as compared to medical officers (p-value 0.031). While it's 2.4 times more likely, when surgery is done by specialist (p-value 0.033).

Pearson Chi-square test show a p-value of 0.040. Even though the results is statistically significant, we would like to point out that, there are multiple possibly confounding factors which may contribute to this higher SSI rate among surgery done by senior surgeons. First and foremost, it is commonly understood that medical officers, when compared to specialists and consultants, are less experienced thus will only be given the chance to operate on simple, uncomplicated surgeries, namely appendectomy. Specialists and consultants will be responsible for surgery with higher complexity, which require longer operating hour, and may come in with a more contaminated wound. Both these factors were well-established independent risk factors for SSI.

When compared to Malays, Chinese patients are 2.6 times likely to develop an SSI (95% CI: 1.203, 5.803, p-value=0.015) while Indian patients have a lesser chance, OR 0.838 (95% CI: 0.226, 3.112, p-value=0.792).

Majority (N=148) of the patients included in the present study are non-smokers and the SSI rate is 15.5% (N=23), while it is 18.5% (5/27) for past smokers and 22.6% (12/53) for current smokers. Current smokers have a higher risk of SSI (OR 1.591, 95% CI: 0.728, 3.477, p-value =0.245) when compared to non-smokers.

Each cases is classified according to the wound condition into "Clean", "Clean-contaminated", "Contaminated" and "Dirty". 10 out of 72 cases with clean wound got SSI, with a rate of 13.9%, while it's 22.0% (11/50) for clean-contaminated cases, 6.3% (3/48) for contaminated cases, and 23.0% (17/74) for surgery with dirty wound. Cases with wound classification "Dirty" (OR:1.849, 95%CI: 0.783, 4.369, p-value=0.161) and "Clean-contaminated" (OR:1.749, 95%CI: 0.679,4.501, p-value=0.247) are twice likely to get SSI as compared to cases with "clean" wound class. Pearson Chi-square test showed a p-value of 0.065.

Patient's height and weight were obtained and BMI calculated. With each unit (kg/m^2) increase in BMI, there is 0.027 times increase in SSI risk, p-value=0.370.

Duration of surgery was recorded in minutes, range from 17 minutes to 948 minutes, with a mean of 88.1 minutes, median 70 minutes and standard deviation 81.4 minutes. With every extra minute spent in the operation theatre, there is a 0.004 time increase in SSI risk (OR 1.004, 95%CI: 1.000-1.008, p-value=0.058).

Usage of drain is associated with 2.2 times higher SSI rate (OR 2.210, 95%CI 1.120-4.363) with a significant p-value of 0.022.

In present study, we also looked into other factors, like, age, gender, presence of comorbidities, immunosuppression, usage of pre-op and post-op antibiotics, but with the high p-value, we cannot prove that these are associated with SSI.

Table 1. Factors associated with surgical site infection.

	OR (95% CI)	p-value
Emergency vs Elective		
Emergency	1	0.460
Elective	1.315 (0.636, 2.722)	
Operating Surgeon		
Medical officer	1	
Specialist	2.412 (1.073, 5.424)	0.033
Consultant	3.583 (1.120, 11.461)	0.031
Race		
Malays	1	
Chinese	2.642 (1.203, 5.803)	0.015
Indians	0.838 (0.226, 3.112)	0.792
Others	1.956 (0.724, 5.286)	0.186
Smoker Status		
Non-smoker	1	
Past-smoker	1.235 (0.425, 3.594)	0.698
Current smoker	1.591 (0.728, 3.477)	0.245
Wound Classification		
Clean	1	
Clean-contaminated	1.749 (0.679, 4.501)	0.247
Contaminated	0.413 (0.108, 1.588)	0.198
Dirty	1.849 (0.783, 4.369)	0.161
Age	1.004 (0.985, 1.023)	0.707
Gender		
Male	1	
Female	1.063 (0.535, 2.112)	0.862
BMI	1.027 (0.969, 1.089)	0.370
Comorbidities	1.021 (0.495, 2.109)	0.954
Immunosuppression	0	0.999
Duration of surgery	1.004 (1.000, 1.008)	0.058
Usage of drain	2.210 (1.120, 4.363)	0.022
Pre-op Antibiotics	1.194 (0.485, 2.940)	0.770
Post-op Antibiotics	1.193 (0.603, 2.362)	0.613

OR = Odd Ratios; CI = Confidence Interval.

Discussion

The results show that the incidence of surgical site infections in elective surgery is higher at 19.4% while its incidence in emergency surgery is 15.47%. However, this finding is not statistically significant (OR 1.315, 95% CI: 0.636-2.722). The higher statistic in elective cases can be attributed to the longer operative duration associated with major surgeries. This finding is in contrast to the conclusions drawn from the majority of research comparing Elective and Emergency general surgeries, where they conclude that incidence is higher in emergency surgery [31-38]. Only a handful demonstrated a higher incidence in elective surgeries [39,40].

Our study found a statistically significant positive association between surgeon seniority and SSI incidence, with specialists at OR 2.4 (95% CI: 1.073 – 5.424) and Consultants at OR 3.583 (95% CI: 1.120 – 11.461). In literature, correlation between surgeon seniority and SSI outcome in general surgery is an infrequently explored field. However, studies available, such as those carried out by Bandaru and Ahmed link a correlation between junior surgeons and SSI incidence [41,42].

Additionally, an association was found between SSI and ethnically Chinese patients (OR 2.642, 95% CI: 1.203-5.803). However, other studies revealed no difference in incidence between ethnic groups [43,44].

The results of our study found a weak association amongst past and current smokers. While our study's results were not statistically significant, Sorenson's systematic review ruled a strong association between smoking and surgical site infections, while a separate systematic review revealed a reduction in incidence of infections upon cessation of smoking pre-operatively [45,46].

Weak associations were also found with increasing contamination in wound classification. However, recent reports argue against the effectiveness of the wound classification system in stratifying risk of postoperative infection due to inter-observer variability [47, 48].

There was no difference in the incidence of SSI between genders. Literature is currently mixed, with no general consensus [49-51].

Comorbidities in this study were not found to contribute to SSI risk. However, studies such as those by Everhart et al. [48] and Khan et al. [49] show a close association between incidence of infection and presence of comorbidities [52,53]. Khan further illustrated the potential use of American Society of Anesthesiologists (ASA) score and the Charlson Comorbidity Index (CCI) to quantify comorbidity severity and identify SSI risk [53].

Post-operative drain usage was significantly associated with an increase in SSI incidence. This is in agreement to multiple studies describing the relationship between prolonged drain use (>24 hours) and increased SSI risk. Tang et al. [51] attributed it to how drain use was more prevalent in more complicated surgeries and its effect as a foreign body.

While our study found no association between antibiotic prophylaxis and SSI prevention, a Cochrane review studying the role of prophylactic antibiotics to prevent SSI found overwhelming evidence pointing to its benefit. However, Young et al. [50] commented how continuation of use post-surgery provides no additional protection. A recent systematic review by de Jonge at al. [53] concluded that timing of administration made significant difference to SSI incidence, with the ideal time being less than 120 minutes before incision.

Conclusion

This paper highlights the incidence of SSI in the Malaysian setting, as well as the factors that may contribute to the high incidence of infection. Further research must be undertaken to better understand how individual risk factors are responsible for surgical site infection in Malaysia.

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