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ORIGINAL ARTICLE

Surgical Site Infection after Emergency and Elective Abdominal Surgery: Incidence and Risk Factors

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ABSTRACT

Background: A surgical site infection (SSI) is an infection occurring in an operative wound within 30 days of the procedure or 1 year if an implant was inserted.

Methods: Over a 2-year period from 2019-2021, patients were followed, the incidences of SSI were determined, and multivariate analyses were conducted. Data obtained included age (above or below 65 years), sex, operation class (elective or emergency), and wound type. The diagnosis and classification of SSI (superficial, deep, or site-specific), and the duration of follow-up (more or less than 15 days) were also recorded. The exclusion criteria were fecal fistula and re-operated patients.

Results: In a total of 384 patients undergoing abdominal surgery during the study period, patients diagnosed with SSIs were 34.9%, 54.2% of patients were males while 45.8% were females. There were no statistically significant differences in relation to age, duration of follow-up, duration of pre-operative hospitalization and associated comorbidities. Regarding the emergency state of surgery, the rate of SSIs in urgent operations showed a statistically significant higher incidence of SSIs compared with patients who did elective surgery.

Conclusions: Emergency state of the operation, type of operation, and ICU admission were the significant factors to develop SSIs, only the ICU admission and type of operations appeared to be independent prognostic factors that significantly develop SSIs.

Keywords: Surgical site infection; Abdominal incisions; Wound contamination

INTRODUCTION

Wound infection after abdominal surgeries is defined as an infection occurring within 30 days or within one year of an operation or implant [1]. It is the third most common cause of hospital-acquired infections [2]. It affects patient outcomes negatively [3] and causes more economic burdens [4, 5].

SSI can be categorized by depth into three types; superficial, deep, and organ-specific infections, where superficial infections are infections involving the skin and subcutaneous layer, and deep infections represent infections occurring in the fascia or muscle layer while organ-specific infections occur in organs or anatomical parts opened in the operation [1]. Abdominal or pelvic abscess after small bowel or colorectal surgery fits the definition of org SSI. A recent study that evaluated the incidence of SSI after major colorectal procedures reported an incidence of superficial, deep, and organ space SSI to be 7.5%, 3.2%, and 3.6%, respectively [6].

It is so important to determine the risk factors that cause post-operative infections [7]. These risk factors may be divided into exogenous factors such as staff members, devices, air or endogenous factors such as the patient's flora. More than 105 microorganisms per gram of tissue must be present to develop wound infection [5, 8].

The most important endogenous factor is the patients' flora [9]. An increasing number of patients have chronic illness or immunocompromised surgical patients, and the extensive use of broad-spectrum antibiotics are also factors which lead to increasing SSI [10]. The risk factors associated with SSIs have the potential to increase the incidence rate [11]. So the factors associated with SSI can be classified into the patient, hospital, and surgery-related factors [12, 13].

Which of these factors is more important, it was found that low serum albumin level is an important factor because it means that the patient has many co-morbidities associated [14]. Other important factors are age, diabetes mellitus, ischemia, also smoking, and obesity.[15]. Infections by pathogens such as MRSA (methicillin-resistant Staphylococcus aureus) frequently leads to infection, specifically in aged and immunocompromised patients [16].

Another factor that may affect the incidence of wound infection is the duration of the surgical procedure. Some factors such as body hair at the site of the incision are still needed to determine whether they significantly affect the incidence of wound infection or not [17]. Proper ventilation of the operational room, [18] proper use of surgical drains, gentle handling of tissues, closure of dead spaces, and controlling of hematomas should be considered in any surgical procedure [19].

Exogenous microorganisms can be classified into virulent enteric organisms are Staphylococcus aureus [20], or less virulent as Coagulase-negative Staphylococci and Bacteroides [7].

Many other factors can be considered risk factors to develop SSI such as hyperglycemia, hypothermia, blood transfusion, and shock [15].

Malnutrition leads to high morbidity and mortality rate [21, 22]. Before surgery, improvement of nutritional state could minimize the risk of SSIs [23].

METHODS

The current study was a prospective study on patients who underwent emergency and elective abdominal operations in the Department of Surgery; Minia university hospitals.

Over a 2-year period from 2019-2021, patients were followed up to identify risk factors to develop wound infections following abdominal incisions.

Inclusion criteria: any age, abdominal wound incisions.

***Exclusion criteria*:** patients who developed fecal fistula, patients with pancreatic fistula, and patients who cannot be reached in the follow-up visits.

The incidences of SSI were determined, and multivariate analysis was conducted to assess significant risk factors for the development of SSI. Routine postoperative care was provided to each patient. Infection was determined according to the Centre for Disease Control and Prevention's definitions of wound infection [21]. Data obtained included age (above or below 65 years), sex, operation class (elective or emergency), and wound type. The diagnosis and classification of SSI (superficial, deep, or site-specific), and the duration of follow-up (more or less than 15 days) were also recorded. The exclusion criteria were fecal fistula and re-operated patients.

Statistical analysis: The collected data were coded, tabulated, and analyzed by Statistical Package for Social Sciences program (SPSS) software version 22. Descriptive statistics were done for numerical variables by mean and standard deviation, while they were done for qualitative variables by number and percentage. The Chi-square test was used to determine the statistical difference between the two groups for qualitative variables. Binary logistic regression was done to determine the impact of multiple independent variables. The level of significance was taken at p-value less than 0.05 is significant.

RESULTS

In a total of 384 patients undergoing abdominal surgery during the study period, patients diagnosed with SSIs were 34.9%, the percentage of SSIs was 22.1% for superficial infections and for the deep infection, it was 6.5% of patients while the incidence of site-specific infection was 6.3% (Table 1). 54.2% of patients were males while 45.8% were females, 90.6% of patients aged below 65 years, and only 9.4% of patients were above 65 years. Table (2) shows the patients, operative characteristics, and comorbidities of patients involved in the current study. Table (3) shows that there were no statistically significant differences in the incidence of SSI in relation to age, duration of follow up, duration of pre-operative hospitalization, and associated comorbidities.

Regarding the emergency state of surgery, the rate of SSIs in urgent operations showed a statistically significant higher incidence of SSIs compared with patients who did elective surgery (p=0.009) (Table 4). According to the wound classification, 100 patients (26%) had clean wounds, 164 patients (42.7%) had clean contaminated wounds while 72 patients had contaminated wounds (18.8%), and 48 (12.5%) patients had an infected wound demonstrated a significantly increased risk of SSIs (P <0.0001) (table 5). Furthermore, patients who were admitted

to the ICU developed SSIs more statistically often than patients who were not admitted to the ICU (table 6).

Factors that showed statistically significant differences were examined together in a multivariate analysis. Only ICU admission & wound type appeared to be independent prognostic factors for surgical site infections. Table (7) shows the order of different factors for the development of SSIs according to the multivariable analysis.

Table 1. Prevalence of SSIs in 384 patients.

SSI	N (%)
Superficial	85 (22.1%)
deep	25 (6.5%)
site specific	24 (6.3%)
No	250 (65.1%)

Table 2. Characteristics of patients.

	N (%)
Age	
<65 years	348 (90.6%)
>65 years	36 (9.4%)
Sex	
Male	208 (54.2%)
Female	176 (45.8%)
Operative time (hr.)	
Mean ± SD	1.5±0.8
Range	0.5-5
Follow up duration	
<15 days	169 (44%)
>15 days	215 (56%)
Duration of hospital stay	
>48 hours	67 (17.4%)
<48 hours	317 (82.6%)
Emergency	
Elective	165 (43%)
Emergent	219 (57%)
Type of operation	
Clean	100 (26%)
Clean contaminant	164 (42.7%)
Contaminant	72 (18.8%)
Infected	48 (12.5%)
ICU admission	
Yes	64 (16.7%)
No	320 (83.3%)
Comorbidity	
Obesity	4 (1%)
DM	14 (3.6%)
HTN	20 (5.2%)
Cirrhosis	15 (3.9%)
Covid-19	4 (1%)
Malignancy	4 (1%)
CKD	4 (1%)
No	319 (83.1%)

Table 3. Factors associated with SSIs.

	Male	Female	P value
SSI			
Superficial	36 (17.3%)	49(27.8%)	
deep	11(5.3%)	14(8%)	0.002*

site specific	20(9.6%)	4(2.3%)	
No	141(67.8%)	109(61.9%)	
	Comorbidity	**No comorbidity**	**P value**
SSI			
Superficial	15(23.1%)	70(21.9%)	
deep	3(4.6%)	22(6.9%)	0.924
site specific	4(6.2%)	20(6.3%)	
No	43(66.2%)	207(64.9%)	
	<65 years	**>65 years**	**P value**
SSI			
Superficial	77(22.1%)	8(22.2%)	
deep	22(6.3%)	3(8.3%)	0.970
site specific	22(6.3%)	2(5.6%)	
No	227(65.2%)	23(63.9%)	
	<15 days	**>15 days**	**P value**
SSI			
Superficial	32(18.9%)	53(24.7%)	
deep	14(8.3%)	11(5.1%)	0.384
site specific	10(5.9%)	14(6.5%)	
No	113(66.9%)	137(63.7%)	

Table 4. Relation between SSIs & emergency state of the operation

	Elective	**Emergent**	**P value**
SSI			
Superficial	33 (20%)	52(23.7%)	
deep	5(3%)	20(9.1%)	0.009*
site specific	16(9.7%)	8(3.7%)	
No	111(67.3%)	139(63.5%)	

Table 5. Relation between type of operation& SSI

	Infected	**Not infected**	**P value**
SSI			
Superficial	14(29.2%)	71(21.1%)	
deep	8(16.7%)	17(5.1%)	0.0001*
site specific	12(25%)	12(3.6%)	
No	14(29.2%)	236(70.2%)	

Table 6. Relation between ICU admission& SSI.

	ICU	**No ICU**	**P value**
SSI			
Superficial	8(12.5%)	77(24.1%)	
deep	14(21.9%)	11(3.4%)	0.0001*
site specific	14(21.9%)	10(3.1%)	
No	28(43.8%)	222(69.4%)	

Table 7. Multiple logistic regression analysis for factors affecting SSI.

Independent variables	**Odds ratio (95% CI)**	**P-value**
Sex		
Male	Ref.	0.187
Female	1.361(0.861-2.150)	
Age group		
<65 years	Ref.	0.781
>65 years	1.068(0.465-2.455)	
ICU admission		
Yes	2.920(1.627-5.242)	0.0001*
No	Ref.	

Operation type		
Infected	5.439(2.747-10.770)	0.0001*
Not infected	Ref.	
Follow up duration		
<15 days	Ref.	0.601
>15 days	1.131(0.712-1.796)	
Emergency		
Elective	Ref.	0.475
Emergent	1.186(0.743-1.892)	

DISCUSSION

In the current study, the incidence of patients diagnosed with SSIs was 31.9%, Anwar, Medhat Mohamed, et al. showed that (30.7%) had surgical site infection in their assessment of 150 patients [24], Khaleid, M., A. Haleim, and K. Zein. found an incidence of 25.8% of SSIs in their study done in 2010 [25]. Our incidence is higher than the incidence in some other studies [26, 27]. We can explain this relatively high incidence by the fact that more than half of our patients (57%) had emergency procedures; also we count the superficial infections; not only the deep or site-specific infections, the incidence of deep infections in our study was 8% while the incidence of site-specific infection was 2.3%, this was consistent with the literature [28]. The incidence of postoperative infections in developing countries is more than in industrial countries [29, 30], this was explained by the lack of control of infection measures [31]. Alexiou, K., et al. studied the prevalence of SSI among postoperative patients in Ethiopia and revealed a prevalence of 12.3% in 24 extracted studies [27]. Watanabe, Akihiro, et al. revealed that the overall incidence of SSI in developing countries; including post-emergency procedures, was 15.5% [32]. Alp, Emine, et al. studied the incidence of SSIs in developing countries, and found an incidence of 10.8 % of patients but in this study, 80% of patients had elective operations [31].

One of the main objectives of our study was to determine the independent factors to develop SSIs after abdominal surgery. There were no statistically significant differences in relation to age, and associated comorbidities. The study done by Alexiou, K., et al. showed age and concomitant diseases demonstrated a significantly increased risk of SSIs [27], however, other studies have no statistically significant differences in SSI related to the age and concomitant diseases [24].

Duration of follow-up, and duration of pre-operative hospitalization have no statistically significant effect on SSIs, while other studies showed there were statistically significant differences according to preoperative length of hospital stay [24, 25, 33].

Regarding the emergency state of surgery in this work, the rate of SSIs in urgent operations was statistically significantly higher compared to patients undergoing elective surgery.

According to the wound classification, 100 patients (26%) had clean wounds, 164 patients (42.7%) had clean contaminated wound, while 72 patients had contaminated wounds (18.8%), and 48 (12.5%) patients had infected wounds demonstrated a significantly increased risk of SSIs (P <0.0001). Furthermore, patients admitted to the ICU developed SSIs more statistically often than patients who were not admitted to the ICU. Kasatpibal et al. [34], and Chattopadhyay et al. [35] indicated a significant association between the surgical wound classification, duration of surgery, and SSI.

By multivariate analysis, only ICU admission & wound type appeared to be independent prognostic factors for surgical site infections. Other studies determine multiple independent factors for the development of SSIs: The type of operation, blood loss, wound classification, emergency procedures, frequency of changing gloves, subcutaneous sutures, combined resection procedures, and the type of seromuscular suture material were independent factors [30, 31, 36, 37].

CONCLUSIONS

We concluded that the incidence of SSIs in one of the developing countries is about 34.9%, most of them are superficial infections, and this is relatively high, so we recommend more strict application of infection control measures, and more appropriate use of antibiotics. Emergency state of the operation, type of operation, and ICU admission were the significant factors to develop SSIs in our current study. Only the ICU admission, and type of operations (infected operations) appeared to be independent prognostic factors that significantly develop SSIs.

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