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Risk Factors in Post Operative Wound Infections Following Elective Abdominal Operations

S.M. Akramuzzaman*[1], Md. Sherajul Islam[2], Asadullahil Galib[3], Chowdhury Sazzad Hyder[4], S.M Golam Azam[5]

Abstract

Introduction: *Surgical site infections are common post operative complication and cause significant post operative morbidity and mortality, and have serious consequences for outcomes and costs. Different risk factors are involved, including age, sex, smoking, nutrition, diabetes, pre existing illness, pre operative hospital stay time, pre operative shaving, level of surgeon, length of incision, duration of operation, per operative blood transfusion, wound drainage and nature of wound. The objective of this study was to determine the risk factors affecting abdominal surgical site infections and their rate at Dhaka Medical College & Hospital, a major referral teaching hospital in Bangladesh.* ***Objectives:*** *were to identify risk factors in post operative wound infections following elective abdominal surgery.* ***Materials and Methods:*** *A Cross sectional type of observation study was carried out among 153 patients in Department of Surgery, Dhaka Medical College Hospital, Dhaka from January 2008 to December 2009.* ***Results:*** *Patients (n = 153) who had undergone elective surgery were studied and the relationships among variables were analyzed by Student's t and Chi-square tests. To test the independence of the risk factors, the significant variables (p ≤.05) in the univariate analyses were entered into a stepwise logistic regression equation. Data were collected through pre and postoperative examinations. The subjects were followed till discharge. Of the 153 patients, 13 suffered from SSI (8.5%). Among the infections superficial SSI was in 8 cases (61.54%), deep SSI in 3 cases (23.08%), and organ/space SSI in 2 (15.38%) cases. There were 14 different variables in study to determine the risk factors. In univariate analysis ten risk factors were identified: age, underweight, diabetes, ASA score, pre operative hospital stay, per operative blood transfusion, length of incision, duration of operation, wound drain and contaminated wound. And in multivariate analysis duration of operation, diabetes mellitus and ASA score appeared to be independent risk factors for wound infection.* ***Conclusion:*** *The total elimination of wound infection is not possible, a reduction in the infection rate to a minimal level could have significant benefits in terms of both patient comfort and medical resources used. The SSI may be reduced to a more acceptable level by reducing the average operation time to less than 2 hours, pre operative hospital stay, and by reducing contamination during operation and wound drainage. Furthermore post operative study in large scale is recommended.*

Keywords: *Wound Infections, Abdominal Operations.*

Number of Tables: 08; Number of Figures: 02; Number of Bibliography: 25; Number of Correspondences; 05.

***1. Corresponding Author:**
Dr. S.M. Akramuzzaman
Assistant Professor
Department of Surgery
Sheikh Sayera Khatun Medical College, Gopalganj.
Email: drakzamankmc1@gmail.com
Mobile: 01712582888

2. Dr. Md. Sherajul Islam
Assistant Professor
Department of Surgery
Pubna Medical College, Pubna.

3. Dr. Asadullahil Galib
Assistant Professor
Department of Surgery
Khulna Medical College,
Khulna.

4. Dr. Chowdhury Sazzad Hyder
Assistant Professor
Department of Surgery
Shaheed Suhrawardy Medical College, Dhaka.

5. Dr. S.M Golam Azam
Assistant Professor
Department of Surgery
Satkhira Medical College, Satkhira.

Introduction:

Surgical site infections are the third most frequently reported nosocomial infection, accounting for 14%- 16% of all nosocomial infections among hospitalized patients. Among surgical patients, SSIs were the most common nosocomial infection, accounting for 38% of all such infections. (Alicia et al, 1999[1]) Infection rates in US National Nosocomial Infection Surveillance system hospitals

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were reported to be: clean 2.1%, clean-contaminated 3.3%, contaminated 6.4% and dirty 7.1% (Culver et al, 1991)[2]. Estimating the cost of SSIs has proved to be difficult but many studies agree that additional bed occupancy is the most significant factor. In 1980, Cruse estimated that an SSI increases a patient's hospital stay by approximately 10 days and cost an additional $2000. Many factors influence surgical wound healing and determine the potential for, and the incidence of, infection. There are some patient related factors such as age, sex, diabetes, smoking, poor nutrition, obesity etc. Surgical considerations like, skin preparation, length of incision, intraoperative aseptic measures, surgical techniques, duration of surgery, per operative blood transfusion, wound class and level of surgeon also influences SSIs(Razavi et al, 2005)[3]. Usually postoperative wound infection appears between 3rd to 5th post operative days. But presentation may be delayed for 2 to 3 weeks. Clinical features of post operative wound infection include wound pain and swelling, pyrexia, wound tenderness, erythema, purulent or serosanguinous discharge, and wound dehiscence(Alicia et al, 1999)[1].

Surgical site infection can be classified as-

a) Superficial incisional SSI

b) Deep incisional SSI

c) Organ/ space SSI.

Of these SSIs, two thirds are confined to the incision, and one third involve organs or spaces accessed during operation (Alicia et al, 1999)1. Organ/space SSIs as compared to incisional SSIs are associated with greater increase in morbidity and mortality.Wound infection is a clinical outcome indicator of fundamental importance in elective surgery, surgical practice depends upon healing by primary intension and without serious complication. Post operative sepsis can have serious and significant effect on ultimate result of the operation as well as the patient is general wellbeing. To achieve a good surgical outcome, it is important to identify the risk factors that increase the incidence of SSI. This issue has been addressed in many centers in the world with differing results and recommendations. But in our hospital no such study has been conducted to measure the rate and risk factors for SSI. So SSI surveillance should be conducted and maintained in all hospitals to promote better surgical out come.

Materials and Methods:

A Cross sectional type of observation study was carried out among 153 patients in Department of Surgery, Dhaka Medical College Hospital, Dhaka from January 2008 to December 2009. Inclusion criteria were only elective abdominal surgery, Non- pregnant patients and Patients who agreed to participate in the study. Exclusion criteria were the patient who had emergency operation, Other than abdominal surgery, pregnant patient, moribund patient who were treated in I.C.U. and Laparoscopy surgery.

Result:

In the study period 153 patients from surgery unit were included for investigation and studied. Among them 13(8.50%) patients developed post operative wound infection.

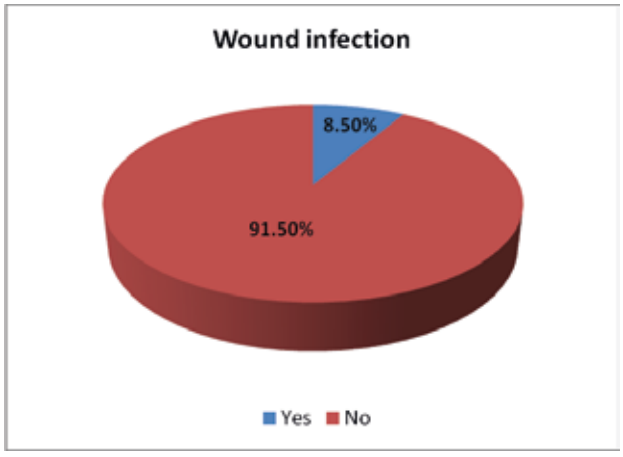

Figure 1: Wound infection rate in the study

In this study, 8 cases (61.54%) of wound infection involved only skin or subcutaneous tissue of the incision. In 3 cases (23.08%) of infection involved deep fascia/ muscle of the incision. In 2 cases (15.38%) of infection involved organ/space manipulated during operation.

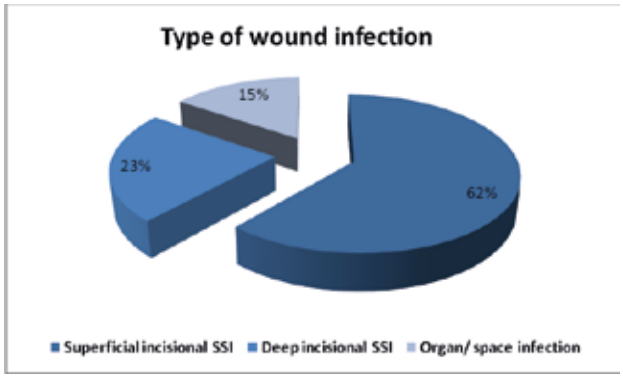

Figure 2: Types of wound infection

Tablel I shows that, common indications for operation in descending order include chronic calculus cholecystitis followed by, inguinal hernia, recurrent appendicitis, incisional hernia, colostomy and Illiostomy, and colo-rectal carcinoma.

Table I: Clinical condition for operation

Clinical Diagnosis	No(%) of patients
Chronic Calculus Cholecystitis	45(29.41)
Inguinal Hernia	38(24.84)
Recurrent Appendicitis	14 (9.15)
Incisinal hernia	9 (5.88)
Colostomy Closer	7 (4.58)
Illiostomy Closer	6 (3.92)

Clinical Diagnosis	No(%) of patients
Carcinoma Stomach	5 (3.26)
Rectal carcinoma	4 (2.61)
Epigastric Hernia	4 (2.61)
Choledocholithiasis	3 (1.96)
Colonic Cancer	2 (1.30)
Pyloric Stenosis (D.U.)	2 (1.30)
Gastric Outlet Obstruction (antral growth)	2 (1.30)
Empyema G.B.	2 (1.30)
Umblical Hernia	2 (1.30)
Hepatolithiasis	1 (0.65)
Nephrolithiasis	1 (0.65)
Others	6 (3.92)
Total	**153** (100.0)

Table II shows, common operation categories with rate of SSI. The table shows that the most common intervention was hernia repair followed by biliary surgery, colonic surgery, gastric surgery and rectal surgery. Wound infection was more common colonic surgery, gastric surgery and hernia repair.

Table II: Type of interventions with frequency and SSI rate(n=153)

Interventions	No(%) of patients	No(%) of wound infection
Hernia repair	53 (34.64)	3 (23.07)
Biliary surgery	51 (33.33)	1 (7.69)
Colonic Surgery	15 (9.80)	4 (30.76)
Appendices surgery	14 (9.15)	0 (0)
Gastric surgery	9 (5.88)	3 (23.07)
Rectal Surgery	4 (2.61)	1 (7.69)
Others	7 (4.58)	1 (7.69)

In this study, thirteen patients (8.50%) were diabetic. Among them 4 (30.77%) patients developed post operative wound infection. This is statistically highly significant with a p value of <0.013.

Table III: Diabetes mellitus versus Wound Infection.

Diabetes mellitus	Wound infection		Total (%)	The Chi-square value	P value
	Yes (%)	No (%)			
Present	4(30.77)	9(69.23)	13(8.50)	6.20	<0.013
Absent	9(6.43)	131(93.57)	140(91.50)		
Total	**13**	**140**	**153**		

In the study, 141(92.16%) patients had ASA score of 1 or 2 and 12 (7.84%) patients had ASA score of ≥3. Among the 12 patients with ASA score of ≥3, 4(33.3%) patients developed post operative wound infection. This result indicates that post operative wound infection rate is significantly higher in patients with ASA score of ≥3 with a p value of <0.007.

Table IV: ASA score versus Wound Infection

ASA score	Wound infection		Total (%)	The Chi-square value	P value
	Yes (%)	No (%)			
1 or 2	9 (6.38)	132(93.62)	141(92.16)	7.16	<0.007
≥3	4 (33.33)	8 (66.67)	12 (7.84)		
Total	13	140	153		

Majority of operations (85) took less than or equal to 60 minutes from skin incision to skin closure: 12 (7.84%) operations required more than 2 hours to be completed. The duration of surgical operation also proved to be a significant factor: only 3.53% of operations lasting 60 minutes or less led to infection, while for operations lasting more than 2 hours this rate leapt to 33.33%.

Table V: SSI rate in relation to duration of operation

Duration of operation	Wound infection		Total (%)	The Chi-square value	P value
	Yes (%)	No (%)			
≤60 minutes	3(3.53)	82(96.47)	85(55.56)	12.57	<0.002
61 -120 minutes	6(10.71)	50(89.29)	56(36.60)		
>120 minutes	4(33.33)	8(66.67)	12(7.84)		
Total	13	140	153		

So far as wound type is concerned, it was found clean wounds in 59 cases (38.56%); clean-contaminated wounds in 75 cases (49.02%) and contaminated wounds in 19 cases (12.42%). SSI rate was significantly higher in contaminated wound with a 'p' value of <0.011.

Table VI: Wound class versus wound infection

Wound class	Wound infection		Total (%)	The Chi-square value	P value
	Yes (%)	No (%)			
Clean	4 (6.78)	55 (93.22)	59 (38.56)	8.95	<0.011
Clean contaminated	4 (5.33)	71(94.67)	75(49.02)		
Contaminated	5 (26.32)	14 (73.68)	19 (12.42)		
Total	13	140	153		

In the study the culture sensitivity report showed 2 negative and 11 positive growths. The most frequent organism was Escherichia coli (E. coli).

Table VII : Most frequent isolated organism (n=13)

Organism Isolated	No. of wound	
Escherichia coli	7	53.84
Pseudomonas spp	2	15.38
Kleb siella spp	0	0
Proteus spp	1	7.69
Staphylococcus aureus	1	7.69
Acinetobacter spp	0	0
Peptostreptococcus	0	0
βhaemolytic streptococci	0	0

All the risk factors for SSI with p value ≤ 0.05 in univariate analysis were entered into a stepwise logistic regression model for multivariate analysis. Duration of operation (p<.001), Diabetes mellitus (p<.003) and ASA score (p<.026) were found to be independent risk factors for wound infection.

Model Summary[d]

Table VIII: Multivariate analysis: stepwise logistic regression model summary (taken from SPSS output)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.269(a)	.072	.066	.270	.072	11.800	1	151	.001
2	.355(b)	.126	.114	.263	.054	9.202	1	150	.003
3	.394(c)	.155	.138	.260	.029	5.073	1	149	.026

a Predictors: (Constant), duration of operation

b Predictors: (Constant), duration of operation, diabetes mellitus

c Predictors: (Constant), duration of operation, diabetes mellitus, ASA score

d. Dependent Variable: wound infection

Discussion:

This study was carried out in the department of Surgery, Dhaka Medical College & Hospital. From December 2008 to November 2009 with an aim to estimate rate of SSI in elective surgical procedure and to determine risk factor associated with infection. There were 153 patients, of them 13 developed wound infections. The overall infection rate was 8.5%. The overall incidence of surgical wound infection varied in different studies from 4.7 to 17 percent. SSI rate was found between 4-30% (Suchitra et al, 2009)[4]. So our result was in agreement in findings with them. Of the 13 cases of SSI, in 8 cases (62%) infections were limited within skin and superficial tissue, in 3 cases (23%) deeper incisional tissue was involved and organ/ space infections occurred in the rest 2 (15%) cases, of these SSIs, two thirds were confined to the incision and one third involved organ/ space, (Alicia et al, 1999)[1]. The rate of wound infection varies according to wound class as follows 6.78% for clean operation, 5.33% for clean and contaminated operation and 26.32% for contaminated operation, Similar observation was reported in some other literature but Culver et al[2], described much lower infection rate in all three wound classes (Razavi et al, 2005)[3]. It should be made clear that our hospital was a tertiary level hospital and a reference centre within Bangladesh National Health Service and that the patients sent to our hospital were those selected from other hospitals all over the country who were more likely to be severely ill. This relative high rate of post operative wound infection in this series was most probably because of high underlying severity of illness in our patients. In this series, common indications for operation in descending order include chronic calculus cholecystitis, recurrent appendicitis, gastric carcinoma, rectal carcinoma, inguinal hernia. Common operation category includes hernia repair, colonic surgery, appendices surgery, gastric surgery, rectal surgery. SSI rate was higher in colonic surgery (30.76%), gastric surgery (23.07%), hernia repair (23.07%), rectal surgery (7.69%), billiary surgery (7.69%) respectively. Among the 14 studied independent variables, in univariate analysis the following 10 risk factors for post operative infectious complications were identified: age>50 years, underweight, diabetes mellitus, ASA score≥3, preoperative hospital stay, prolonged operative time, peroperative blood transfusion, length of incision, wound class 3 and wound drainage. Age was a risk factor for postoperative infection complications, commonly reported in the medical literature. Age above 45 years was associated with SSIs (Nicolle et al, 1992)[5]. Increasing age is related with chronic conditions, malnutrition and fall in the body immunological efficiency, causing more extensive SSI. The present findings supported this argument. SSI was not related with sex, this was in agreement with previous findings (Razavi et al, 2005[3]; Pessauux et al,[6] 2003; Watanabe et al, 2008[7]; Petrosillo et al, 2008[8]; Heal et al, 2006)[9]. In the study, mean BMI of patients was 22.83kg/m2 (SD±2.9), in a range of 17.29-32.05. Nutritional state is regarded as an important factor in wound healing (Clark et al, 2000)[10]. Underweight indicates poor nutritional status of patients. Some other investigators also mentioned association of malnutrition with SSI rate, our result is in agreement with finding of (Leite et al, 1987[11]; Katelaris et al, 1986)[12]. In this study although differences in SSI rates were not significantly related to shaving pattern, a trend was apparent: SSI rate was higher when shaving done day before surgery than prior to surgery

(10.53%). This is one area where we can lower the risk by approximating the time of shaving as much as possible to that of operation i.e. prior to surgery or none (5.17%). An infection rate was 17.4% when pre operative stay was 0-7 days. An infection rate was 71.4% with a pre operative stay of more than 21 days. Pre operative hospital stay predisposed an individual to 1.76% risk of acquiring an infection. A pre operative stay of one week increased the risk rate to 5%. (Suchitra et al, 2009)[4]. This was marginally supported by this study ($P<0.05$). This is one of the factors to be taken in to account by reducing pre-operative hospital stay we may decrease SSI. The individual surgeon performing the procedure can have an impact on outcome for the patient. There is evidence to suggest that grade of surgeon can have an impact on SSI rate (Mishriki et al, 1990)[13]. Guidance from the Specialist Advisory Committee of the Joint Committee on Higher Surgical Training of Scotland suggests that where a consultant does not perform the procedure, one should be present in the operating theatre in order to minimize this risk. But in this study, SSI rate was unusually higher when done by consultants. The probable explanation is that: most of the elective procedures done by residents in our hospital are minor clean operation (e.g. inguinoscrotal surgery), take short duration, and usually done under supervision of consultants, discharged in earlier and thus infection rate is low; infection rate is high in emergency operation, done by residents without supervision which was not included in this study. Blood transfusion was a predictor of SSI in this study. The adverse effects of blood transfusion have been well documented in patients having colorectal, gastrointestinal and cancer surgery (Reiping et al, 2001[14]; Morris et al, 2003; Vamvakas et al, 1996[15]; Walz et al, 2006)[16]. In this study, blood recipient are also of similar category. In the present study, drain usage or type of drain have shown impact on SSI rate, but presence of drain for longer than 3 days increased wound infection rate significantly. Similar observation was reported in medical literature (Simchen et al, 1981[17]; Claesson et al, 1988[18]; Watanabe et al, 2008[7]; Moro et al, 1996)[19]. In some studies, use of drain was found to be independent risk factor for SSI (Pessauux et al, 2003[6]; Petrosillo et al, 2008[8]; Reiping et al, 2001[14]; Velasco et al, 1996)[20]. The main aim of drainage is to evacuate residual effusions to avoid infection. Thus, every drainage has its own limitation because of obstruction and mobility. It can be at the origin of retrograde bacterial colonization, especially when the drainage is no longer an aspirate. In this study, contaminated wound is significantly associated with post operative wound infection. The finding is comparable with other studies (Razavi et al, 2005[3]; Pessauux et al, 2003[6]; Watanabe et al, 2008[7]; Mishkiri et al, 1990[13]; Garibaldi et al, 1991[21]; Velasco et al, 1996[20]; Nguyen et al, 2001[22]; Barber et al, 1995)[23]. The multivariate logistic analysis found three independent risk factors. These in descending order are as follows: Duration of operation > 2 hours, diabetes mellitus and ASA score≥ 3. These factors were also significant in univariate analysis. Diabetes mellitus was a predictor of postoperative wound infection in this study. ASA score 3 indicates presence of a severe systemic disease. Patients with ASA score >2 may be compared with elderly people. Thus SSI rate is likely to be higher in them. In this study ASA score ≥3 was most significant predictor of SSI in both univariate and multivariate analysis. Similar finding was reported by (Culver et al, 1991[2]; Garibaldi et al, 1991[21]; and Velasco et al, 1996)[20]. Morris et al,[24] Nichole et a[15], Garibaldi et al[21],Velasco et al[20], Razavi et a[13] and Moro et al[19], showed the existence of a direct relationship between operative time and postoperative infectious risk. Pessauux et al[6] showed that risk doubled with each additional operative hour. Our results agree with this finding, as our rates of postoperative infection were 3.53% for 1 hour, 10.71% for 1 to 2 hours, and 33.33% for longer than 2 hours. Certainly, longer procedures are associated with greater blood loss and perhaps an associated washout of prophylactic antibiotics. Unlike blood products, which are administered on need basis, antibiotics are usually dispensed once during operation. Hence, as blood is lost and replaced, the concentrations of circulating antibiotics diminish disproportionately. Thus, for prolonged operations, periodic reinjection of antibiotic agents (according to half-life) during the intervention should be favored (Cheadle et al, 2006)[25]. Regarding culture sensitivity report majority of the organism causing wound infection were gram negative, of which Escherichia-coli was found to be the commonest (53.84%), followed by pseudomonas (15.78%), Proteus spp & staphylococcus aureus (7.69%). E. coli was isolated from the wound following operation on the gastro intestina tract.

- E. coli is sensitive to ciprofloxacin, ceftriaxone, azithromycin, pivmecillin, nalidixic acid, and resistant to amoxycillin, cotrimoxazole.
- Proteus spp is sensitive to gentamicin, meropenem and resistant to ceftazidime, ceftriaxone, ciprofloxacin, cotrimoxazole, flucloxacillin.
- Pseudomonas is sensitive to gentamicin and ciprofloxacin and resistant to doxycycline, ceftazidime, ceftriaxone, cefixime, meropenem.
- Staphylococcus Aureus is sensitive to gentamicin, ceftazidime, flucloxacillin, cefuroxime and resistant to ceftriaxome, ciprofloxacin, cotrimoxazole, cefixime.

All the gram negative organisms were sensitive to newly introduced chemotherapeutic agent imipenem.

Conclusion:

This study provided information on rate and risk factors for SSI occurrence in elective abdominal operations in Department of General Surgery of Dhaka Medical College & Hospital. In this study three independent risk factors were identified in both univariate and multivariate analyses. Another seven risk factors were identified in univariate analysis but not in multivariate analysis. By modifying the factors before or during surgery, the SSI can be reduced as well as post operative morbidity and mortality rate. In conclusion, further study in large scale is needed.

Conflict of Interest: None.

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