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Risk Factors Responsible to Surgical Site Infections Following Emergency non – Traumatic Exploratory Laparotomy

Amol Wagh[1], Gajjam Shrinivas[2]

[1]Assistant Professor, Department of General Surgery, Grant Govt. Medical College & Sir J J group of Hospitals, Mumbai, Maharashtra 400008, India, [2]Associate Professor, Department of General Surgery, Ashwini Rural Medical College, Hospital and Research Centre, Kumbhari, Solapur, Maharashtra 413006, India.

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Abstract

Background: Multiple risk factors and peri-operative characteristics can increase the likelihood of superficial surgical site infections. Research has shown that patient factors, surgical techniques, skin preparation, timing and method of wound closure are significant factors that can influence the incidence of subsequent infection. Keeping the facts in the mind, the present study was undertaken to determine the various risk factors to SSI. *Material and methods:* The present study is hospital based observational study conducted over period of two year. Patients admitted in surgical ward requiring Emergency non traumatic exploratory laparotomy were included in the study. After admission, short history and physical examination was conducted on each patient admitted in General surgery with acute abdomen. Patients requiring emergency laparotomy and fulfilling the inclusion criteria were offered to participate in the study. All the traumatic cases were excluded from the study. *Result:* Surgical Site Infections, though can be found at any age, high incidence was seen in the 4th, 5th, 6th decades of life. Most of the infections were noticed between 4th – 8th postoperative days. SSI was high in patients with co-morbidities. *Conclusion:* It can be concluded from the findings of the study that microorganisms that are normal inhabitants of our body are mainly responsible for surgical site infection (SSI). Proper care of the patients as a whole throughout the peri – operative period is very vital to reduce the rate of surgical site infection. Strict adherence to aseptic wound dressing techniques should be enforced during each procedure to reduce the SSIs.

Keywords: Risk factor; surgical site infection; Type of operation; Co-morbidity.

Corresponding Author: Gajjam Shrinivas, Associate Professor, Department of General Surgery, Ashwini Rural Medical College, Hospital and Research Centre, Kumbhari, Solapur, Maharashtra 413006, India.

E-mail: drgajjamshrinivas@rediffmail.com

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Introduction

Surgical site infections are one of the commonly encountered complications after surgery. They cause pain and inconvenience to patients resulting in prolonged hospital stay and may be potentially fatal at times. The infection of a wound can be defined as the invasion of organisms through tissues following a breakdown of local and systemic host defenses, leading to cellulitis, lymphangitis, abscess and bacteremia [1]. Surgical site infections and its management are cumbersome to both patient and health facilities.

Surgical Site Infections (SSIs), previously called post – operative wound infections, result from bacterial contamination during or after a surgical procedure. Surgical site infections are the third most common hospital associated infection, accounting for 14-16 per cent of all infections in hospitalized patients [2]. Despite every effort to maintain asepsis, most surgical wounds are contaminated to some extent. However infection rarely develops if contamination is minimal, if the wound has been made without undue injury, if the subcutaneous tissue is well perfused and well oxygenated and if there is no dead space. The criteria used to define surgical site infections have been standardized and described three different anatomic levels of infection: superficial surgical site infection restricted to skin and subcutaneous tissue, deep surgical site infection involving fascia and muscle layers and organ / space surgical site infection associated with the body organs and body spaces [2,3].

According to the degree of contamination wounds may be classified as clean, potentially contaminated, contaminated, and dirty [4]. The incidence of infection, morbidity and mortality increases from clean to dirty. The risk of infection is greater in all categories if surgery is performed as an emergency [5]. The risk of wound infection is influenced but not entirely determined by the degree of contamination.

Multiple risk factors and peri-operative characteristics can increase the likelihood of superficial surgical site infections. Important host factors include diabetic mellitus, hypoxemia, hypothermia, leucopenia, nicotine, long term use of steroids or immunosuppressive agents, malnutrition, nares contaminated with Staphylococcus aureus and poor skin hygiene. Peri-operative / environmental factors are operative site shaving, breaks in operative sterile technique, early or delayed initiation of antimicrobial prophylaxis, inadequate intra-operative dosing of antimicrobial prophylaxis, infected or colonized surgical personnel, prolonged hypotension, poor operative room air quality, contaminated operating room instruments or environment and poor wound care postoperatively [3].

Wound infections usually appear between fifth and tenth post – operative day, but they may appear as early as first post – operative day or even years later. The first sign is usually fever, and post – operative fever required inspection of the wound. The patient may complain of pain at the surgical site. The wound rarely appear severely inflamed, but edema may be obvious because the skin sutures appear tight [3].

Advances in the control of infection in surgery have occurred in many ways, such as, aseptic operating theatre techniques have replaced toxic antiseptic techniques, antibiotics have reduced post – operative infection rates, and delayed primary or secondary closure remains useful in contaminated wounds. When eneral feeding is suspended during the peri – operative period, and particularly with underlying disease such as immunosuppression, cancer, shock or sepsis bacteria tend to colonize the normally sterile upper gastrointestinal tract. They may then translocate to the mesenteric lymph nodes and cause the release of endotoxin, which further increases the susceptibility to infection and sepsis, through activation of macrophages and pro-inflammatory cytokine release. The use of selective decontamination of the digestive tract (SDD) is based on the prevention of this colonization [6].

According to the sources, Surgical Site Infections may be classified into two types, primary and secondary or exogenous. Primary infections are those acquired from community or endogenous source. Secondary or exogenous infections are acquired from operating theatre or the ward or from contamination at or after surgery. According to severity, surgical site infections can be divided into two types, major and minor. Criteria of major SSI are significant quantity of pus, delayed return home and Patients are systemically ill. Minor SSI may discharge pus or infected serous fluid but should not be associated with excessive discomfort, systemic signs or delay in return home [6].

There are various types of localized infections, such as abscess, cellulitis, lymphangitis etc. Abscess may follow puncture wound as well as surgery, but can be metastatic in all tissues following bacteremia. Abscess needs drainage with curettage. Modern imaging techniques may allow guided aspiration. Antibiotics are indicated if the abscess is not localized. Healing by secondary intention is encouraged. Cellulitis is non-supportive invasive infection of tissues. It is poorly localized in addition to cardinal signs of inflammation. It is usually caused by organisms such as –hemolytic streptococci, staphylococci and Clostridium perfringens. Tissue destruction, gangrene and ulceration may follow, which are caused by release of proteases. Systemic signs are common, such as SIRS, chills, fever and rigors. These follow the release of organisms, exotoxins and cytokines into the circulation. However, blood cultures are often negative. Lymphangitis presents as painful red streaks in affected lymphatic, often accompanied lymph node groups in the related drainage area [6].

Systemic inflammatory response syndrome (SIRS) can be defined as, presence of any two of hyperthermia ($>38^0$C) or hypothermia ($<36^0$C), tachycardia (>90 beats / min) or tachypnea (>20 cycles / min) and white cell cound >12,000 or <4,000 [6].

Sepsis is defined as the systemic manifestation of SIRS, with a documented infection. Multiple organ dysfunction syndromes (MODS) is the effect that the infection produces systemically. Multiple system organ failure (MSOF) is the end stage of uncontrolled MODS [6].

The use of antibiotic prophylaxis before surgery has evolved greatly in the last twenty years. It is generally recommended in elective clean surgical procedures and in clean- contaminated procedures that a single dose of cephalosporin, be administered intravenously by anesthesia personnel in the operative room just before incision. Additional doses are generally recommended only when the operation lasts for longer than two to three hours [7].

Surgical site infection is the most important cause of morbidity and mortality in the post – operative patients, but it is preventable in most of the case if proper assessment and appropriate measures are taken by the surgeons, nursing staff, patients and others in the preoperative period.

SSIs are one of the most important causes of healthcare – associated infections. Surgical site infections (SSI) are still a real risk of surgery and represent a substantial burden of disease for both patients and healthcare services in terms of morbidity, mortality and economic cost. Infections increase the discomfort and disability experienced by patients following surgical procedures.

Research has shown that patient factors, surgical techniques, skin preparation, timing and method of wound closure are significant factors that can influence the incidence of subsequent infection. Previous literature has shown Escherichia Coli was the commonest microorganism responsible for surgical site infections following emergency non traumatic abdominal operations, further research is necessary to identify the important factors responsible for high infection rate following emergency non traumatic exploratory laparotomy. In this study it has been tried to find out the common organisms responsible for surgical site infections following emergency non traumatic exploratory lapaotomy. In addition, the sensitivity patterns of the microorganisms were ascertained. Further, factors responsible for infections were determined, that will be helpful to prevent infection in future following similar types of operation. So these study findings will play an important role to reduce the infection rate and thereby reduce the morbidity and mortality. Furthermore, application of the recommendations of this study in the practical field will reduce the rate of surgical site infections and thereby will improve cosmesis and make the results of operations better as a whole.

Keeping above facts in the mind, the present study was undertaken to determine the incidence of various risk factors such as clinical, socioeconomic, nutritional and other co-morbid conditions contributing to surgical site infections following emergency non – traumatic exploratory laparotomy.

Materials and methods

The present study is hospital based observational study conducted at Dept. of General Surgery, J J hospital, Mumbai over period of two years. Patients admitted in surgical ward requiring Emergency non traumatic exploratory laparotomy were included in the study.

Before start of our study an informed consent is obtained in local vermacular language for each patient. The study did not involve any additional investigation or any significant risk.

Selection criteria

Inclusion Criteria:

1. The patients required emergency non traumatic exploratory laparotomy
2. Patients more than 12 years of age.
3. All superficial and deep SSI developing within a 30 day period Post – surgery, as per the traditional definition.

Exclusion Criteria

1. Patients with trauma were excluded from the study
2. Patients less than 12 years of age.
3. Organ space SSI & Wound infections occurring beyond the 30 day time period post – surgery.

Data collection procedure

After admission, short history and physical examination was conducted on each patient admitted in General surgery with acute abdomen. Patients requiring emergency laparotomy and fulfilling the inclusion criteria were offered to participate in the study. All the traumatic cases were excluded from the study. All the necessary information regarding the study was explained to the patients or their guardian willing to participate in the study. Detailed history was taken to establish proper diagnosis and to know about the presence of the risk factors regarding surgical site infection. All the surgical procedures, medical management and investigations were conducted under direct guidance and supervision of senior. Only essential investigations were done for proper diagnosis and reduction of risk. Data collection sheets were filled in by the investigator himself. All of the preoperative factors related to SSI present in the patient were noted down in the data sheet. After proper resuscitation (where applicable) and preparation, patients were sent to operation theatre for operation. Strict aseptic precautions were followed during the operation. Meticulous techniques were practiced as far as possible.

The operation procedure and related perioperative factors were observed directly and recorded in the data collection sheet instantly. During the postoperative period all the patients were closely monitored. If any symptom or sign of infection appear during this period then proper investigation was instituted for the the diagnosis of infection and to assess the type and severity of the infection. If any collection of pus identified it was drained out and sent for culture and sensitivity test. Proper antibiotic was given to every patient both preoperative and post – operative periods. Postoperative events were recorded in the data sheet during every day follow up.

After completing the collection of data was compiled in a systematic way. Patients were followed up 30 days postoperative period with weekly OPD visits and telephone conversations as and when required.

Data analysis

Descriptive statistics such as mean, SD and percentage was used to present the data. To assess, the association factors with SSI, chi-square test was used. A p-value less than 0.05 were considered as significant. Data analysis was performed by using software SPSS v16.0.

Results

Table 1: Surgical site infection (SSI) distribution by different age groups

Age in Years	SSI Status		Total
	Yes	No	
15–19	4 (33.3)	8 (66.7)	12
20–29	6 (15.4)	33 (84.6)	39
30–39	12 (24.0)	38 (76.0)	50
40–49	15 (29.4)	36 (70.6)	51
50–59	9 (29.0)	22 (71.0)	31
60–69	7 (41.2)	10 (58.8)	17
Total	53 (26.5)	147 (73.5)	200

Mean ± SD = (40.2±13.3) years

It was observed that, majority of the patients were belongs to age group 40-49 (25.5%) followed 30-39 (25%), 20-29 (19.5%), 50-59 (15.5%), 60-69 (8.5%) and 15-19 (6%). However, these differences were not statistically significant (p = 0.4) (Table 1).

Table 2: Surgical site infection (SSI) distribution by sex

Sex	SSI Status		Total
	Yes	No	
Male	28 (22.2)	98 (77.8)	126
Female	25 (33.8)	49 (66.2)	74
Total	53 (26.5)	147 (73.5)	200

It was observed that among 126 male patients 28 (22.2%) developed SSI, whereas among 74 female patients 25 (33.8%) developed SSI. Rate of SSI was slightly higher in females. Sex difference in SSI was not statistically significant (p =0.1) (Table 2).

Table 3: SSI distribution based on types of operations

Types of Operations	SSI Status		Total
	Yes	No	
1. Appendectomy in case of appendiculat with Peritoneal toileting	15 (25.00)	45 (75.00)	60
2. Adhesiolysis or resection and anastomosis in small intestinal obstruction	06 (10.00)	54 (90.00)	60
3. Repair of ileal perforation / ileostomy and thorough Peritoneal toileting	13 (41.9)	18 (58.1)	31
4. Repair of Peptic ulcer Perforation	13 (56.5)	10 (43.5)	23
5. Resection of Volvulus of sigmoid colon and primary anastomosis / Hartman's procedure 1	06 (30.00)	14 (70.00)	20
6. Herniotomy and Herniorhaphy in case of Obstructed inguinal hernia	0 (0.00)	6 (100.00)	6 (100.00)
Total	53 (26.5)	147 (73.5)	200

It was found that out of 60 Appendicular Perforation cases 15 (25.0%) developed SSI, out of 60 small intestinal obstruction cases 6 (10.00%) developed SSI, out of 31 ileal perforation cases 13 (41.9%) developed SSI, out of 23 Peptic ulcer perforation 13 (56.5%) developed SSI, out of 20 sigmoid volvulus cases 6 (30.00%) developed SSI and it was nil for 6 obstructed inguinal hernia cases. The highest rate of SSI (56.5%) was in Repair of Peptic ulcer cases and lowest in obstructed hernia operations. The associated between the type of operation and rate of SSI was statistically significant (p = 0.001) (Table 3).

Table 4: SSI distribution based on timing of surgery after appearance of symptoms

Timing of Surgery after Appearance of Symptoms (in Hours)	SSI Status		Total
	Yes	No	
< 6	02 (11.1)	16 (88.9)	18
6–12	05 (17.20)	24 (82.8)	29
12–24	09 (23.1)	30 (76.9)	39
24–48	11 (26.2)	31 (73.8)	42
48–72	13 (32.5)	27 (67.5)	40
>72	13 (40.6)	19 (59.4)	32
Total	53 (26.5)	147 (73.5)	200

With regard to association between timing of surgery and appearance of symptoms and rate of SSI, it was observed that the surgical site infection rates were 11.1%, 17.2%, 23.1%, 26.2%, 32.5%, 40.6% when operations were initiated <6, 6 -12, 12-24, 24-48, 48-72 and >72 hours later respectively. The rate of infection increased as the time lapse between appearance of first symptom and initiation of operation were increased. However association between the timing of the surgery after appearance of symptoms with the rate of SSI was not statistically significant (p =0.17) (Table 4).

Table 5: SSI distribution based on types of wounds by the degree of contamination

Types of Wounds	SSI Status		Total
	Yes	No	
Clean	02 (5.4)	35 (94.6)	37
Clean Contaminated	05 (7.7)	60 (92.3)	65
Contaminated	13 (52.0)	12 (48.0)	25
Dirty	33 (45.2)	40 (54.8)	73
Total	53 (26.5)	147 (73.5)	200

In relation to different types of wounds, by the degree of contamination, it was observed that 37 were clean wounds; SSI developed only in 2 (5.4%) of these clean cases. There were 65 clean contaminated cases, among them SSI occurred in 5 (7.7%); whereas SSI developed in 13 cases among 25 (52%) contaminated wounds, which was high rate. The rate of SSI is 33 among 73 (45.2%) dirty cases. The difference had high statistical significance (P < 0.001). It can be understood that the infection rate increased with that of degree of wound contamination (Table 5).

Table 6: SSI distribution based on co-morbidity status.

Co-Morbidity Status	SSI Status		Total
	Yes	No	
With Co – morbidity	38 (43.7)	49 (56.3)	87
Without Co – morbidity	15 (13.3)	98 (86.7)	113
Total	53 (26.5)	147 (73.5)	200

In relation to co-morbidity, it was observed that 87 (43.5%) patients had co –morbid disorders associated with the main surgical disease and 113 (56.5%) patients had no co-morbid disorder. Among the patients with co- morbid disorders 38 (43.7%) developed surgical site infection. Whereas, in the patients without any co-morbidity only 15 (13.3%) developed SSI. It was clear that associated co – morbid disorders played a vital role as a host related risk factor for SSI. Moreover the difference was statistically significant (p < 0.001) (Table 6).

Discussion

The present study however revealed an alarming rate of 26.5% overall prevalence rate after abdominal surgery. It is above the infection rate in so many places. The incidence in America is reported as 5% [8], 4.65% in England [9] and 20% in India [10].

Such a high prevalence revealed by the study requires urgent attention by all, bearing in mind the financial implication to both patients and hospital management. It is important to suggest that steps are taken to reduce the rate of infections to an acceptable level. The surgical procedure with the highest SSI percentage was small bowel surgery (70%) because the small bowel as well as the large, is colonized by lots of bacteria increasing the risk of infection in that category.

Age of 200 patients ranged from 15-65 years. Most of the patients (171, 85.5%) were in between 20-60 years with average age 40 years. In a similar study conducted in an Iranian teaching hospital average age of the patients was 46.70 years [11]. Average age of the patients in the Iranian study was much higher than the present study.

It was revealed that among 200 patients, 53 (26.5%) developed surgical site infection (SSI). This findings is consistent with the finding of Razavi et al. where they found 189 patients among 802 (26.40) suffered from SSI [11]. The overall SSI rate of present study as consistent with findings of study carried out by Renvall et al. in which SSI rate in acute surgery was 22.4 percent [12].

Regarding sex distribution of the patients, 126 (63%) were male and 74 (37%) were female. Rate of SSI in males were 22.2%, whereas among females it was 33.8%. Rate of SSI was slightly higher in females, which was not statistically significant. This finding is consistent with that of Razavi et al. where they could not find any significant correlation between sex and SI. Moreover, rate of SSI in males were 19.6% whereas in females it was 15.1% ($p < 0.093$). So, SSI is not correlated with sex [11].

With regards to types of operations, the highest rate of infection (56.5%) was in repair of Peptic perforation cases and lowest in obstructed hernia operations. Theses findings were consistent with the result of Surgical Site Infection Surveillance (SSIS) for general surgery which was the published as Wexford General Hospital Surgical Site Infection (SSI) data report in 2009 showing number of SSI and rate of SSI (%) by category of operations. They had done 132 appendicular perforation, among them SSI occurred in 7 (5.3%) cases. SSI occurred in 10 (19.2%) cases among 52 Colonic surgeries, 4 (23.5%) case among 17 small bowel surgery and 5 (26.3%) cases among 19 Laparotomies. No SSI was reported among 82 herniorrhaphy case [13].

With regard to Timing of surgery after appearance of symptoms and rate of SSI, it was observed that the site infection rate was 11.1%, 17.2%, 23.1%, 26.2%, 32.5%, 40.6% when operations were initiated <6, 6 -12, 12-24, 24-48, 48-72 and >72 hours later respectively. The rate of SSI increased as the time lapse between first manifestation of symptoms and initiation of operation prolonged. This is similar to the findings was observed by Huda M.N., SSI rate was 15.25%, 21.73%, 27.27%, 40% and 50% respectively when operations were done 6, 12, 24, 48 and 72 hours later [14]. This finding is also consistent with the study conducted in a Peruvian hospital; in which patients with SSI had a longer hospital stay than did not-infected patients (14.0 Vs 6.1 days; $p < 0.001$); it is because prolonged preoperative hospital stay increases SSI rate and occurrence of SSI causes prolonged postoperative stay [15].

In relation to different types wounds, by the degree of contamination, it was observed that 37 were clean wounds, SSI developed only in 2 (5.4%) of these clean cases. There were 65 clean contaminated cases, among them SSI occurred in 5 (7.7%); whereas SSI developed in 13 (52%) among 17 contaminated wounds. The rate of SSI was 33 among 73 (45.2%) dirty cases. Among SSI, rate of SSI was high in dirty cases (36.5%). The difference was statistical significant ($p < 0.01$). It was revealed that the infection rate increased with that of degree of wound contamination. These findings were consistent with the findings of 10 years prospective study of 62,963 wounds by Cruse and Frood in 1980, where infection rate was 1.5%, 7.7%, 15.2% and 40% in clean, clean contaminated, contaminated and dirty wounds respectively [16]. Moreover survey conducted by Ali and Khan observed SSI 25.00%, 28.60% and 54.80% respectively in clean, clean contaminated and contaminated wounds [17]. In addition, Renvall et al. in a prospective study carried out on 696 patients estimated SSI rates were 4.2%, 9.1% and 14.4% in clean, clean contaminated and dirty wounds respectively [12].

In all the studies mentioned above rate of SSI rose with increase in the degree of wound contamination. In relation to co – morbidity, it was observed that 87 patients had co – morbid disorders associated with the main surgical disease and 113 patients had no co – morbid disorder. Among the patients with co – morbid disorders, 38 (43.7%) developed surgical site infection (SSI), whereas in the patients without any co – morbidity only 15 (13.3%) developed SSI. It was clear that associated co – morbid disorders played a vital role as a host related risk factor for SSI. Moreover, the difference was statistically significant ($p < 0.001$).

Conclusion

The study revealed that there was around 25% Surgical Site infection rate after abdominal surgery which was quite high, Pragmatic steps are thus needed to reduce the infection rate to acceptable levels. It can be concluded from the findings of the study that microorganisms that are normal inhabitants of our body are mainly responsible for SSI. Various factors like condition of the wounds, timing of surgery after appearance of symptoms, duration of operation, prolonged exposure of peritoneal cavity to environment, prophylactic use of antibiotics and factors associated with surgery like type of incision, type of operation, presence of co – morbidity etc greatly contribute to occurrences of SSI. So, quality of surgical care including immediate assessment of patients, resuscitative measures, adequate preparation of patients and aseptic environment are important for control of SSI. Moreover in absence of highly advanced surgical amenities, preoperative resuscitative units, modern operation theatre facilities and sophisticated sterilization procedure, it is necessary to sue prophylactic antibiotics to encounter the various types of micro – organisms responsible for surgical site infection.

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