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A Study on Surgical Site Infections in Emergency Non-Traumatic Abdominal Operations

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Abstract :
Background: *Surgical site infection (SSI) has always been a major complication of surgery and trauma and has been documented for 4000-5000 years. Surgical site infections are the third most common hospital associated infection, accounting for 14-16 per cent of all infections in hospitalized patients. Among surgical patients, surgical site infections are the most frequent cause of such infections, accounting for 38 per cent of the total.*
Aims: *The purpose of this study is to determine the host factors responsible for surgical site infections, environmental factors contributing to surgical site infections following emergency non traumatic abdominal operations and to identify the microorganisms involved in surgical site infections.*
Methodology*: A descriptive study which includes all patients fulfilled the inclusion criteria in Rajiv Gandhi Government General Hospital during the time period of January 2014 to December 2015. Parameters included the host demographic details and the type of surgery and duration of surgery versus the onset of SSI.*
Results: *The infection rate increased with that of degree of wound contamination. 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 highly significant (P < 0.001)*
Conclusion: *Quality of surgical care including immediate assessment of patients, resuscitative measures, adequate preparation of patients and aseptic environment are important for control of SSI.*

Keywords: *Surgical site infections, Non traumatic abdominal surgery, Sepsis, Emergency Laparotomy, Mortality.*

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I. Introduction

The infection of a wound can be defined as the invasion of organisms through tissues following a breakdown of local and systemic host defences, leading to cellulitis, lymphangitis, abscess and bacteraemia. Surgical site infection (SSI) has always been a major complication of surgery and trauma and has been documented for 4000-5000 years. The understanding of the causes of infection came in the 19th century. Microbes had been seen under microscope, but Koch laid down the first definition of infective disease known as Koch's postulates. Louis Pasteur recognized that micro-organisms were responsible for spoiling wine, turning it into vinegar.

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. Among surgical patients, surgical site infections are the most frequent cause of such infections, accounting for 38 per cent of the total. The criteria used to define surgical site infections have been standardized and described three different anatomic levels of infection: superficial incisional surgical site infection, deep incisional surgical site infection and organ/space surgical site infection (Doherty and Way 2006).

According to the degree of contamination wounds may be classified as clean, potentially contaminated, contaminated, and dirty. 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 (Kirk and Ribbans2004). The risk of wound infection is influenced but not entirely determined by the degree of contamination.

Important host factors include – diabetes mellitus, hypoxemia, hypothermia, leucopenia, nicotine, long term use of steroids or immunosuppressive agents, malnutrition, nares contaminated with StaphylococcusAureus and poor skin hygiene. Perioperative / environmental factors are operative siteshaving, breaks in operative sterile technique, early or delayed initiation of antimicrobial prophylaxis, inadequate intraoperative 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 (Doherty and Way 2006). 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 requires 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.

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, delayed primary or secondary closure remains useful in contaminated wounds. When enteral 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 (Williams et al. 2008).

According to the sources, infection 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 (Williams et al. 2008).

There are various types of localized infections, such as abscess, cellulites, lymphangitis etc. Abscess may follow puncture wound as well as surgery, but can be metastatic in all tissues following bacteraemia. 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. Cellulites are nonsuppurative invasive infection of tissues. It is poorly localized in addition to cardinal signs of inflammation. It is usually caused by organisms such as ß-hemolyticstreptococci, staphylococci and C. perfringens. Tissue destruction, gangrene andulceration 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 by painful lymph node groups in the related drainage area (Williams et al. 2008).

Systemic inflammatory response syndrome (SIRS) can be defined as, presence of any two of: hyperthermia (>38◦C) or hypothermia (<36◦ C), tachycardia (>90 min-1, no ß-blockers) or tachypnoea (>20 min-1) and white cell count $>12\times 10^3$ l-1 or $<4 \times10^3$(Williams et al. 2008). Sepsis is defined as the systemic manifestation of SIRS, with a documented infection. Multiple organ dysfunction syndrome (MODS) is the effect that the infection produces systemically. Multiple system organ failure (MSOF) is the end-stage of uncontrolled MODS (Williams et al. 2008).

The use of antibiotic prophylaxis before surgery has evolved greatly in the last twenty years. It is generally recommended in elective clean surgical procedures using a foreign body and in clean-contaminated procedures that a single dose of cephalosporin, such as cefazolin, be administered intravenously by anesthesia personnel in the operative suit just before incision. Additional doses are generally recommended only when the operation lasts for longer than two to three hours (Nichols 2009).

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 cases if proper assessment and appropriate measures are taken by the surgeons, nursing staffs, patients and others in the perioperative period.

II. AIMS & OBJECTIVES

A. General:

To determine the factors responsible for surgical site infections following emergency non-traumatic abdominal operations, which will be helpful in reducing the rate of surgical site infection.

B. Specific:

(1) To determine the host factors responsible for surgical site infections.

(2) To detect the environmental factors contributing to surgical site infections following emergency non traumatic abdominal operations.

(3)To identify the microorganisms involved in surgical site infections.

III. Materials and Methods

Study Design: Descriptive type
Sample Size: 140
Inclusion Criteria

- The patients having emergency nontraumatic abdominal operations.
- Operations carried out in surgery dept. of Madras Medical College and Rajiv Gandhi Government General Hospital

Exclusion criteria

- Patients with trauma were excluded from the study.

All patients who fit the inclusion criteria of peritonitis in Institute of General Surgery, Madras Medical College – Rajiv Gandhi Government General Hospital were selected. After getting ethics committee clearance, all patients were explained about the disease, benefits & possible side effects of treatment. Informed written consent was obtained from all patients before initiation of treatment. Detailed history were Studied and the following data collected Malignancy, Site of perforation, Pre operative duration, Type of exudates, Length of stay in hospital, Post op complication. Data analysis was done both manually and by using computer. Calculated data were arranged in systemic manner, presented in various table and figures and statistical analysis wasmade to evaluate the objectives of this study with the help of Statistical Package for Social Science (SPSS).

IV. Results

This descriptive, cross-sectional study was carried out to determine factors responsible for surgical site infections following emergency non-traumatic abdominal operations that will be helpful in reducing rate of surgical site infections. It was observed that age of 140 patients ranged from 13-65 years. Most of the patients (89.29 %) were in between 10-49 years. It was observed that rate of SSI in different age groups were as follows: 5 (16.13 %) in the 10-19 years, 2 (6.67 %) in the 20 - 29 years, 5 (16.67 %) in the 30 - 39 years, 9 (26.47 %) in the 40 - 49 years, 2 (22.23 %) in the 50 - 59 years and 1 (16.67 %) in the 60 - 69 years. It was highest 26.47 % (9 among 34) in the 40 - 49 years age group. However, these differences were not statistically significant. Regarding sex distribution, out of 140 patients, 89 (63.57 %) were male and 51 (36.43 %)were female. Male-female ratio was 1.74: 1. Regarding sex distribution rate of SSI was slightly higher in males. Sex difference in SSI was not statistically significant ($P > 0.05$).

Out of 140 patients with emergency non traumatic abdominal operations, rate of SSI indifferent operations were observed. It was found that out of 60 acute appendicitis cases 5(8.33 %) developed SSI, out of 30 small intestinal obstruction cases 3 (10.00%)developed SSI, out of 19 ileal perforation cases 8 (42.10 %) developed SSI, out of 15duodenal ulcer perforation 3(20.00 %) developed SSI, out of 12 burst appendix cases 4(33.33 %) developed SSI, out of 2 sigmoid volvulus cases 1 (50.00 %) developed SSI and it was nil between 2 obstructed inguinal hernia cases. The highest rate of SSI (50.00 %) was in volvulus cases and lowest in obstructed hernia operation.

Rate of SSI was highest, 1 in 2 (50.00 %) operations done through extended lower midline incision, whereas rate of SSI was 8 among 19 (42.11 %) in mid midline, 4 among 12 (33.33 %) in lower right para-median, 3 among 15 (20.00 %) in Rutherford Morison, 2 among 15 (13.33 %) in upper midline, 4 among 30 (13.33 %) in extended upper midline and 2 among 40 (5.00 %) in grid iron incisions. No infection occurred in 5 operations done through Lanz incision and 2 operations through inguinal incisions. With regard to association between delay to initiate operation and rate of SSI it was observed that the surgical site infection rates were 9.09%, 10.53%, 15.63%, 18.42%, 19.35% and 33.33% 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.

The rate of SSI increased with prolongation of duration of operation. The difference in percentage of SSI with duration of operation was statistically significant ($P < 0.001$). In relation to appearance of infection on postoperative days it was observed that most of the infections (91.66 %) were started between 4th and 8th post operative days (POD) and it was highest 8 (33.33 %) on 5th POD. In relation to different types of wounds, by the degree of contamination, it was observed that among 140 cases 23 were clean wounds; SSI developed only in 1 (4.35 %) of these clean cases. There were 60 clean contaminated cases, among them SSI occurred in 5 (8.33 %); whereas SSI developed in 3 among 11 (27.27 %) contaminated wounds. The rate of SSI was as high as 15 among 46 (32.61 %) dirty cases. The difference had high statistical significance ($P < 0.01$). It can be assumed that the infection rate increased with that of degree of wound contamination. 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 highly significant ($P < 0.001$). In 24 patients with malnutrition 11(45.12 %) developed SSI, whereas among 7 patients with COPD 2 (28.57 %) developed SSI. 6 persons were diabetic, among them 2 (33.33 %) suffered from SSI. 3 persons were obese, 1 of them (33.33 %) developed SSI, whereas, 1of 2 (50.00 %) persons suffering from medical jaundice developed SSI. E.Coli were found as the commonest organism (11 among 24 cases) causing 45.83 % ofthe surgical site infections. Staph. aureus were the second most common organism (9 among 24 cases) causing 37.50 % of the infections. Each of klebsiella and pseudomonas were causing 8.33 % of the surgical site infections (found in 2 cases among 24 SSI). Fifty (50) per cent cases of Pseudomonus aeruginosa were sensitive to Ciprofloxacin and Nitrofurantoin, and all the cases of P. aeruginosa (100%) sensitive to Ceftriaxone and Imipenem. All of them (100%) were resistant to Cephradin, Cotrimoxazole and Flucloxacillin.

V. Discussion

This descriptive, cross-sectional study was conducted among 140 purposively selected patients with emergency non-traumatic abdominal operations conducted in surgery department. Male-female ratio was 1.74: 1.So, it can be assumed that males are more commonly affected by acute abdominal conditions requiring surgery. It was observed that host factors like type of disease, presence/absence of co-morbidity and types of co-morbidity and other factors like seniority of surgeon, delay to initiate operation and duration of surgery were associated with the rate of surgical site infection.

The highest rate of infection (50.00%) was in volvulus cases and lowest in obstructed hernia operations. These findings were consistant with the result of Surgical Site Infection Survillance (SSIS) for general surgery which was 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 done 132 appendicectomy, among them SSI occurred in 7 (5.3%) cases. SSI occurred in 10 (19.2 %) cases among 52 Colonic surgeries, 4 (23.5%) cases among 17 Small bowel surgery and 5(26.3%) cases among 19 Laparotomies. No SSI was reported among 82 herniorrhaphy cases (Surgical Site Infection Survillance for general surgery 2009).

In present study infection rate was higher in midline incisions that may be attributed to less vascularity of the linea alba and most contaminated and dirty cases were operated through these incisions. The findings were consistent with the findings of study carried out by Paul in 2004, where the infection rate was 50.00 per cent for Rutherford Morison, 25 per cent for each of right para median and extended midline, 18.18 per cent for upper midline, 9.38 per cent for grid iron incision and nil for inguinal incision (Paul 2004).

With respect to duration of operation and percentage of SSI it was observed that the infection rate varies with duration of operation. It was only 4.6 % when the duration of operation was less then one hour. The rate rises with the prolongation of operation. Infection rate was 32.55% when the duration of operation was between one and two hours. The rate of SSI increased statistically very significantly with that of duration of operation ($P < 0.001$). It may be due to the prolonged exposure of the wound to the environment leading to more chance to inoculation of micro-organisms.

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 (Cruse and Frood 1980).

The difference of rate of infection between these two groups was very obvious. 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 ($P < 0.001$). It was observed that infection rate was 45.12 per cent in clinically malnourished patients, whereas it was 28.57 per cent in COPD cases and 33.33 per cent in obese patients. Moreover, two patients underwent laparotomy with medical jaundice. Of them one (50 %) developed SSI. In addition six patients with diabetes mellitus underwent emergency abdominal surgery. Of them two patients (33.33%) developed SSI. Israelsson and Jonsson identified increased rate of SSI among overweight patients (Israelsson and Jonsson 1997). Another study by Cruse and Frood showed that clean wound infection rate rises to 10.7% in patients with diabetes, 13.5% in obesity and 16.6% in malnourished patients (Cruse and Frood 1980).

Among 140 patients, 25 developed some type of discharge from the wounds/ collection of pus anywhere in the abdominal area. In 11cases there were muddy thin odourless pus, in 9 cases there were thick creamy pus, in 2 cases there were bluish green pus, in another 2 cases there were yellow fishy odoured pus and in 1 case there was serosanguinous discharge (Fig. 18). Sample of pus or discharge from wound were sent for culture and sensitivity test in these 25 cases. One of them with serosanguinous discharge showed no growth, but the remaining 24 showed growth of various micro-organisms. E.Coli were found in 11 (45.83%) cases, the commonest organism causing surgical site infections (SSI). Staph. Aureus were the second most common organism found in 9 (37.50%) cases. Each of klebsiella and pseudomonas were causing 2 (8.33%) cases of SSI.

For the prevention of surgical site infection antibiotics such as Ceftriaxone,Cefuroxim axetil, Ciprofloxacin, Metronidazole were used in pre-operative and post-operative period in all of the cases. Regarding sensitivity of the micro-organisms it was observed that, Escherischiacoli were sensitive to Ciprofloxacin (45.45% cases), Cephradin (54.54% cases),Cotrimoxazole (45.45 % cases), Nitrofurantoin (9.09 % cases), Ceftriaxone (72.72% cases) and Imipenem (100% cases). All the cases of E. coli were resistant to flucloxacillin.

Staphylococcus aureus were sensitive to Ciprofloxacin (44.45% cases), Cephradin(44.45% cases), Flucloxacin (55.55% cases), Ceftriaxone (88.90 % cases) and Imipenem(100.00% cases). But, in all the cases Staph. aureus were resistant to Cotrimoxazole and Nitrofurantoin. These findings can be compared with the findings of a national survey in Ireland done in 1993. The overall percentage of S.aureus sensitivity to the testedantibiotics were as follows: Methicillin 85%, penicillin 8%, gentamycin 89%,ciprofloxacin 85%, erythromycin 80%, fusidic acid 96 % and mupirocin 98%(Moorhouse et al. 1996). Here, sensitivity of the organisms to ciprofloxacin is much higher than the present study. Results are inconsistent with that of present study; it may be due to limited number of isolates in the present study and variation in the methodology.

Klebsiella pneumoniae were sensitive to Cephradin and Cotrimoxazole in 50 percent cases each. All of the cases (100.00%) were sensitive to Ceftriaxone and Imipenem. But, all the cases of Kl. Pneumoniae were resistant to Ciprofloxacin, Flucloxacillin and Nitrofurantoin.

All the organisms isolated (100.00%) were sensitive to Imipenem because this is an excellent newer drug with broad spectrum of activity and another fact is that it is not a commonly used drug. so, development of resistance is uncommon. Use of newer drugs should be reserved for specific cases and must not be used empirically or prophylactically.

VI. CONCLUSION

- Micro-organisms that are normal inhabitants of our body are mainly responsible for surgical site infection (SSI).
- Various host factors like malnutrition, obesity, patients knowledge about hygiene, presence of co-morbidity etc. coupled with environmental factors such as condition of the wounds, delay to initiate operation, 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 and experience of operating surgeon greatly contribute to occurrences of SSI.
- 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 use prophylactic antibiotics to encounter the various types of micro-organisms.

Figures and Tables

SSI distribution based on types of wounds by the degree of contamination.

Types of wounds	**SSI status**			**Total**
		Yes	**No**	
Clean	1	(4.35)	22 (95.65)	23 (100.00)
Clean contaminated	5 (8.33)		55 (91.67)	60 (100.00)
Contaminated	3 (27.27)		8 (72.73)	11 (100.00)
Dirty	15	(32.61)	31 (67.39)	46 (100.00)
Total	**24**	(17.14)	**116** (82.86)	**140** (100.00)

SSI distribution based on duration of operations

Duration of Operation	**SSI status**			**Total**
		Yes	**No**	
Less than 1 hour	4	(4.60)	83 (95.40)	87(100.00)
1 to 2 hours	14 (32.55)		29 (67.45)	43(100.00)
More than 2 hours	6 (60.00)		04 (40.00)	10(100.00)
Total	**24**	**(17.14)**	**116 (82.86)**	**140(100.00)**

SSI distribution based on Co-morbidity status**.**

Co-morbidity status	SSI status		Total
	Yes	No	
With co-morbidity	17 (40.48)	25 (59.52)	42 (100.00)
Without Co-morbidity	7 (7.14)	91 (92.86)	98 (100.00)
Total	**24** (17.14)	**116** (82.86)	**140** (100.00)

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