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Study of Surgical Site Infection in Emergency and Elective Laparotomies

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Original Research Article

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Abstract: Surgical site infection has always been a major complication of surgery and trauma. The present study was aimed to assess various risk factors associated with SSI. It consisted of 100 cases of laparotomies operated at G.R.M.C, Gwalior from July' 2006 to Sept.' 2008. It is observed that incidence of wound infection, peritoneal infection or both is 24% and there is a considerably higher incidence of wound and peritoneal infection in Emergency surgery (44%) than those operated electively (4%). Commonest infecting organisms are Esch. Coli followed by Klebsiella, Staph aureus, Coagulase negative Staph. Pseudomonas, Proteus and Streptococci in decreasing order of frequency.
Keywords: Surgical site, wound infection, Staph. Pseudomonas, Proteus.

INTRODUCTION

Healthcare associated infections are frequent causes of morbidity and mortality in hospitalized patients. In contrast to more developed countries, where device-associated infections are predominant, resource limited countries often report surgical site infections (SSIs) as the most common healthcare settings.

Advances in infection control practices include improved operating room ventilation, sterilization methods, barriers, surgical technique, and availability of antimicrobial prophylaxis.

Despite these activities, SSIs remain a substantial cause of morbidity and mortality among hospitalized patients. This may be partially explained by the emergence of antimicrobial resistant pathogens and the increased number of surgical patients who are elderly and/or have a wide variety of chronic, debilitating, or immuno-compromising underlying diseases. There also are increased numbers of prosthetic implant and organ transplant operations performed.

Thus to reduce the risk of SSI, a systematic but realistic approach must be applied with the awareness that this risk is influenced by characteristics of the patients, operation, personnel, and hospital.

AIM AND OBJECTIVES

- To study the relative incidence of incisional wound infection and peritoneal infection in case of clean, clean contaminated, contaminated and dirty laparotomies.
- To study the bacteriological aspect of the ensuing infection in clean, clean contaminated, contaminated and dirty cases.
- To study the factors affecting wound infection in the study group.
- To study the efficacy of NNIS risk index as a predictor of wound infection in an Indian hospital.

Review of literature

The Hippocratic teachings described the use of anti-microbials, such as wine and vinegar, which were widely used to irrigate open, infected wounds before delayed primary or secondary wound closure. A belief common to all these civilizations, and indeed even later to the Romans, was that, whenever pus localised in an infected wound, it needed to be drained[1].

Galen recognised that this localisation of infection (suppuration) in wounds, inflicted in the glandiatorial arena, often heralded recovery, particularly after drainage (pus bonum et laundabile). Theodoric of Cervia, Ambroise Pare and Guy de

Chauliac observed that clean wounds, closed primarily, could heal without infection or suppuration [2].

The understanding of the causes of infection came in the nineteenth century. Microbes had been seen under the microscope, but Koch laid down the first definition of infective disease [3]. The Austrian obstetrician Ignac Semmelweis showed that puerperal sepsis could be reduced from over 10% to fewer than 2% by the simple act of hand-washing between cases, particularly between post-mortem examinations and the delivery suite. Though he was ignored by his contemporaries [4].

Louis Pasteur recognised that micro-organisms were responsible for spoiling wine, turning it into vinegar. Joseph Lister applied this knowledge to the reduction of colonising organisms in compound fractures by using antiseptics. This allowed surgery without infection. His principles of antiseptic surgery soon gave way to aseptic surgery at the turn of the century, some of which are still employed in modern operating theatres [5].

The concept of a 'magic bullet' (Zauberkugel) that could kill microbes but not their host became a reality with the discovery of sulphonamide chemotherapy in the mid-twentieth century. The discovery of the antibiotic penicillin is attributed to Alexander Fleming, but it was isolated by Florey and Chain. Since then, there has been a proliferation of antibiotics with broad-spectrum activity [2].

However, most staphylococci are not resistant to penicillin, whereas streptococci remain sensitive, although they are now resistanct through the acquisition of β-lactamases, which break up the β-lactam ring in many antibiotics. The acquisition of extended spectrum β-lactamases (ESBLs) is an increasing concern in some Gram-negative organisms that cause urinary tract infections. In addition, there is increasing concern about the rising resistance of many other bacteria to antibiotics, in particular the emergence of methicillin-resistant Staphylococcus aureus (MRSA) and glycopeptide-resistant enterococci (GRE), which are also relevant in general surgical practice [6].

Causes of risk factors

Multiple risk factors for SSI have been identified over time and can all be compiled within one or more of the three major determinants of SSI: bacterial factors, local wound factors, and patient factors. Bacterial factors include virulence and bacterial load in the surgical site. Length of preoperative stay, remote site infection at the time of surgery, and duration of the procedure have also been associated with an increased bacterial load and SSI rate.

Local wound factors are related to the invasiveness of an operation and to specific surgeon's practices and surgical technique. Good surgical technique while managing tissues (local wound) in the most appropriate manner and using sutures, drains, and foreign bodies only with adequate indication is the best way to avoid SSIs [7].

Patient-related factor includes age, immunosuppression, steroids, malignancy, obesity, perioperative transfusions, cigarette smoking, diabetes, other preexisting illness and malnutrition.

Surgical wound classification

Class I/Clean

An uninfected operative wound in which no inflammation is encountered

Class II/Clean-Contaminated

An operative wound in which the respiratory, alimentary, genital, or urinary tract are entered under controlled conditions and without unusual contamination.

Class III/Contaminated

Open, fresh, accidental wounds. In addition, operations with major break in sterile technique or gross spillage from the gastrointestinal tract.

Class IV/Dirty-infected

Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera.

SSI risk has traditionally been correlated to wound class. The accepted range of infection rates has been 1% to 5% for clean, 3% to 11% for clean contaminated, 10% to 17% for contaminated, and greater than 27% for dirty wounds. Wound class, as discussed earlier, is a significant risk factor for SSI; however it assesses only the bacterial factor related to wound infection and is thus an imprecise method of including different types of procedures and different kinds of patients in one category [8].

More recently, the NNIS score, published by Culver and associates in 1991 and recently validated, includes additional factors that have an independent relationship with SSI. NNIS uses a combination of factors differentiates the risk for SSI more accurately than the previous wound classification system does when used alone [9].

Nnis score and risk for ssi

Risk factors:

- Procedure time > 75th percentile
- Contaminated or dirty wound
- ASA III, IV, V

Number of positive risk factors	Risk for SSI
0	1.5%
1	2.9%
2	6.8%
3	13.0%

Prevention

Two milestones in preventing SSI have been defined by specific preventive measures: first, the aseptic and antiseptic technique introduced by Lister and second, the proper use of prophylactic antibiotics. A third milestone is currently being defined by practices that optimize and maximize the patient's own ability to prevent infection.

In recent years research has focussed on manipulating host (patient) factors to assist the body in dealing with fixed bacterial factors. Finally, as we practice in the era of health care management and management and quality assurance, an additional and recently emphasized key component in preventing SSI had become the ability to implement and translate known preventive measures into everyday practice[10].

MATERIAL AND METHOD

Study design

Randomized Double Blinded Prospective study

Sample size

n = 100

This study was carried out on 100 patients admitted to the surgical wards of G.R. Medical College, Gwalior and J.A. Group of Hospitals, Gwalior between July 2006 to Sept. 2008, who underwent laparotomy either on an elective basis or an emergency one.

Methodology

A detailed pre-operative clinical examination of all the patients was carried out to assess the nature and degree of the disease condition and to determine the course of treatment required. Those patients who required laparotomy operation were divided into two groups, namely, 'Elective' or 'Emergency', depending upon whether the laparotomy was done on an Elective or Emergency basis. The elective group consisted of those patients on whom surgery was pre-planned and these patients were prepared pre-operatively taking all antiseptic and aseptic measures. The emergency group composed of those patients who needed laparotomy because of some acute abdominal condition. In these patients, it was impossible to have routine pre-operative preparations e.g.: bowel preparation etc. Of the 100 patients studied, 50 were operated on elective basis and 50 on emergency basis.

Constants employed in all patients

- Skin preparation was done by removing the hairs by shaving immediately before the operation in emergency cases. In elective cases skin preparation was done a night before by shaving.
- All patients were given preoperative intravenous Antimicrobial Prophylaxis roughly ½ an hour before the skin incision. A third generation Cephalosporin was usually employed.
- Painting was done with Povidone-iodine, savlon and alcohol, in accordance with the accepted methods of painting and draping.
- Special care was taken to achieve hemostasis at the site of operation with electrocautery.
- In all emergency cases, the skin and the subcutaneous tissue at the site were washed thoroughly with Betadine before applying skin sutures.
- In obese patients the subcutaneous fat was approximated with interrupted vicryl sutures.
- Silk 2-0 reverse cutting used for closure of skin.
- Post-operative antibiotics were given to all patients for longer than one day. Third generation cephalosporins being the first choice, in combination with Aminoglycosides.
- Closed drains were used whenever needed.

Assessment of wound sepsis

The operated wounds and exudates from drains (if left in situ) were examined 24-72 hours after primary dressing or even earlier if there was lot of soakage or patient had high temperature or pain at the site of wound. If there was any evidence of infection or frank pus, swab was taken from wound and subjected to bacteriological examination.

In contaminated and dirty cases, an assessment was made of degree of any preexisting peritonitis or any gross contamination of peritoneum as evidenced by turbid, fibrinous or frank purulent fluid. A sample of the peritoneal fluid was taken in addition to the swabs already mentioned in case of potentially clean laparotomies.

A detailed clinical assessment was carried out with an emphasis on any clinical evidence of post-operative incisional wound infection or peritoneal infection. All the patients were followed up and observed closely during their stay in the hospital and for one month following the operation.

Observations

The overall incidence of infection in the wound or infection in the peritoneal cavity or both was 24%. Wound and peritoneal infection rate was lowest in clean followed in ascending order by clean contaminated, contaminated and dirty and infected cases.

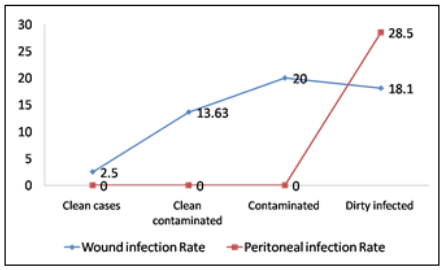

Fig-01: Infection rate in different classes of wound

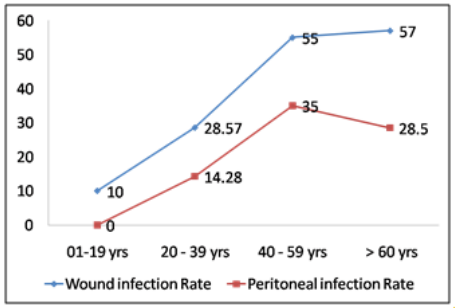

Fig-02: Infection rate in different age groups

The peritoneal infection rate in emergency cases was much higher than in the elective case; 26% in emergency against 2% in elective cases.

Low infection rates were found in the youngest group, with the lowest rates of wound and peritoneal infection (10% & 0%) respectively in 1-19 year group. The infection rate steadily rises with age and in the >60 year group it was as high as 57% for wound infection & 28.5% for peritoneal infection.

Urgency of operation

Operative procedures were recorded as 1 elective & 2 emergency. For the purpose of this study, procedures were considered elective if they were electively scheduled, and emergency procedures were those in which operation could not by delayed for more than 12 hours.

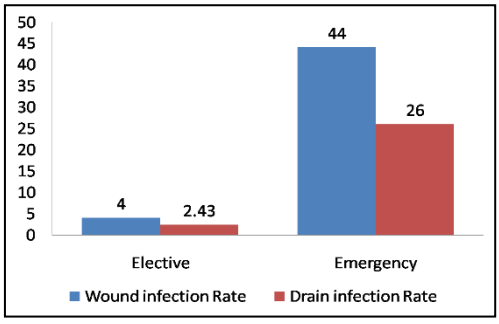

Fig-03: Infection rate in elective vs emergency cases.

The high infection rates for emergency operations may result not from the common factor of urgency alone, but from the contaminated nature of many of the non-elective procedures or from the susceptibility of the patients undergoing non elective surgery to infection by virtue of age or other conditions.

Duration of operation

SSI rate increased with increase in operating time. It is only 10% in surgeries of duration less than 2 hours, whereas it peaks to 100% if duration is greater than 4 hours. Hence, the risk of infection increased with the duration.

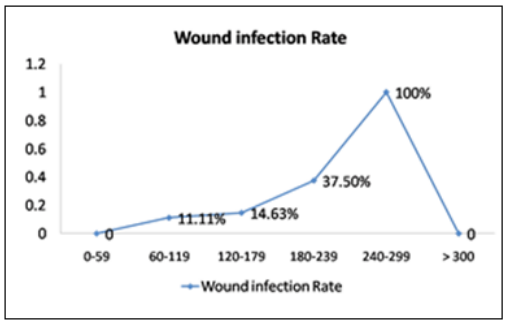

Fig-04: Infection rate againt duration of surgery

Other co factors

1. Haemoglobin estimation was done in all cases, elective and emergency. There were 7 cases with Hb<10 gm% in the elective group, and 34 cases in the emergency group. Infection rate was higher in patients with <10gm of Hb.

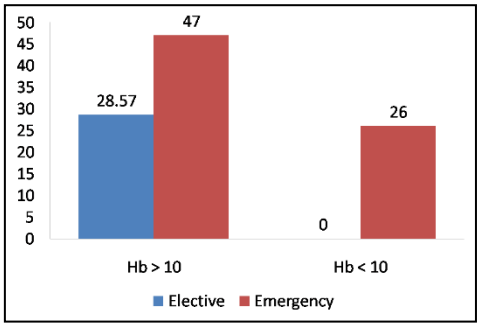

Fig-05: Infection rate in anaemic and non-anemic patients

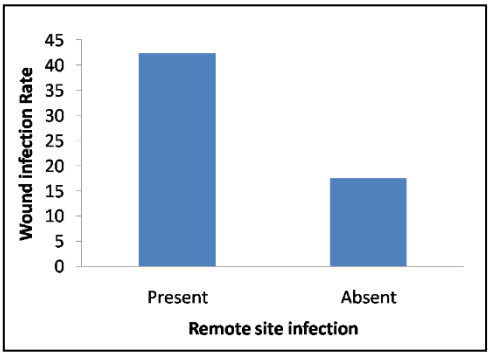

Fig-06: Infection rate in cases with distant infective foci

2. A higher incidence of wound infection is observed in cases that had remote infection. Remote infections occurred in respiratory and genitourinary tracts most commonly.
3. The wound infection rates were highest amongst underweight patients (BMI <20). Obesity (BMI > 25) was also associated with a higher than expected wound infection rate of 31.4% as compared to 12.72% in patients with normal weight.

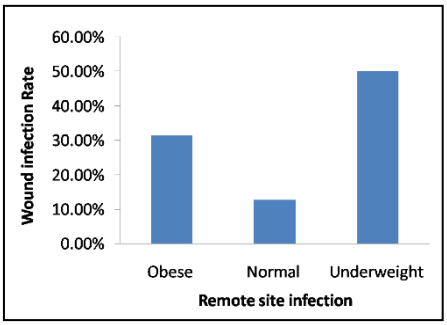

Fig-07: Infection rate in obese and underweight patients.

Relationship of wound infection to NNIS risk Index Score

The risk index category is established by the added total of the risk factors present at the time of surgery. For each risk factor present, a point is allocated; risk index values range from 0-3.

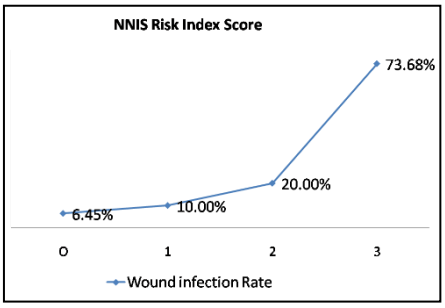

Fig-08: Infection rate plotted against NNIS Risk Index Score

Bacteriological observations

Certain wound and peritoneal infections were caused by only one organism while in other cases mixed infection i.e. more than one organism was recovered. Single infection rate was found to be 70.8% & 35.6% for wound and peritoneal infections respectively, while mixed infections were higher in peritoneal infection i.e. about 64.3%. The total infection rate was maximum with E.coli 32% followed in descending order by Klebsiella and Coagulase negative staphylococci.

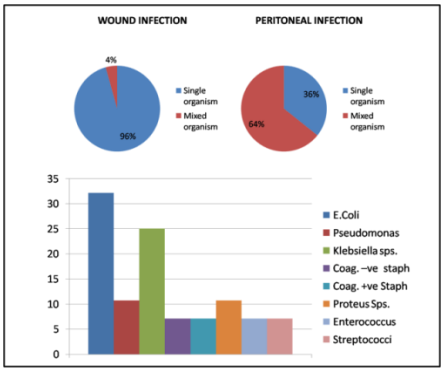

Fig-09: Bacteriological analysis of wound infection

DISCUSSION

The overall incidence of surgical site infections in our study was 24%, which is in sharp contrast to other western studies. Our study gives comparable results with other Indian studies done in the past in which a SSI incidence between 23% and 32% was identified [11]. 23.4%, Basu *et al*. [12] 23.4%, Chawal *et al*. [13] 32%, Subramaniam *et al*. [14] 24.8%, Jindal SP (1978) 54%. A host of factors determine the incidence of wound infection and it is not surprising that figures of incidence by various authors show a wide range.

The mean age of patients in our study is 38.3 years (range 13-72 years). The wound infection rate increased with increase in age of the patients. Being 21.59% for patients <60 years of age to 41.66% in >60 years group. The Public Health Laboratory Services (P.H.L.S) from U.K. also shows an increased incidence of wound infection in older patients. In the original study of Rruse & Foord, they found that patients >65 years old are six times more likely to develop infection than patients between 1-14 years.

The male to female ratio in our study was 1.04:1. There is slightly higher incidence of wound infection in males than in females, which is statistically insignificant. In our study we recorded a wound infection rate of 44% for emergency surgeries and a rate of 4% for elective surgeries. In our study the, the incidence of wound infection in emergency cases is almost 11 times the incidence in elective cases. Debra L Malone *et al.* demonstrated that emergency procedures were associated with increased risk for SSIs.

In our study SSI rate increased with increase in operating time. Peritoneal infection rate also increase similarly. Possible reasons can be increased bacterial contamination with increase in time, increased amount of suture and electro coagulation that may reduce the local resistance of the wound or longer procedures are more liable to be associated with blood loss and shock, thereby reducing overall resistance of the patients. Malone DL *et al*. also found the duration of operation to

be a significant, independent risk factor regardless of wound class. The incidence of SSI increased 3-fold (2.1-6.4%) as operations went from <20 to >4 hr duration.

In our study wound infection was higher in patients operated in emergency with Hb<10gm%. It was also noted that in a specific group viz. Elective or Emergency wound infection was higher in patients with Hb<10gm%. It goes without saying that, the ability to fight infections is compromised in patients with low haemoglobin. Malone Dl *et al*. in 2001 showed in her study that both preoperative and postoperative anemia was associated with risk of wound infection. Post-operative anemia was present in 91% of the patients with SSI and was found to be a independent predictor of SSI by Logistic Regression analysis. Thus our observation is in accordance with the other studies on the subject.

In our study a wound infection rate of 31.4% was found in obese patients was compared to 12.7% in normal for weight patients. The wound infection rate in underweight patients was even higher i.e. 60%. In our study obesity and malnutrition both were associated with a higher wound infection rate. Debra L. Malone *et al*, in Feb. 2001 in her study reported association of preoperative weight loss to increased risk of SSI.

In our study we found that Escherichia Coli was the most frequently isolated organism, followed by Klebsiella, Proteus, Pseudomonas, Coagulase Negative Staphylococci, and others. It only seems logical to conclude that the organisms were from the resident flora of the skin or the intestines. E Coli was frequently positive in cases in which hollow viscus had perforated.

CONCLUSION

The study consists of 100 cases that were operated at G.R. Medical College, Gwalior (M.P.) from July 2006 to Sept. 2008. The following conclusions are drawn:

- The overall incidence of wound infection, peritoneal infection or both is 24%.
- Infection rate increases with increasing age of patients with higher infection rate in patients >60 years of age.
- The sex of the patient does not have any significant effect on the incidence of wound and peritoneal infection.
- There is a considerably higher incidence of wound and peritoneal infection in cases requiring emergency surgery (44%) than in cases that are electively operated (4%).
- Incidence of wound and peritoneal infection increases with the increasing duration of operation, doubling with every extra hour.
- Most of the infections associated with Emergency Surgery were mixed infections. In contrast, Elective operations were associated with single infections only.
- A low haemoglobin (<10gm %) causes a higher incidence of post-operative infection.
- A focus of infection elsewhere in the body (respiratory or genitourinary infections) leads to a higher post-operative infection rate.
- Commonest infection organisms are Esch. Coli followed by Klebsiella, Staph aureus, Coagulase negative Staph, Pseudomonas, Proteus and streptococci in decreasing order of frequency.
- Wound infection in our study was higher as compared to those predicted by the NNIS RISK INDEX.

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