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A study of the rate of wound infection in contaminated and dirty emergency exploratory laparotomies.

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Abstract
Introduction: *Wound infections are amongst the most commonly occurring nosocomial infections, greatly increasing the mortality as well as morbidity of patients, in addition to prolonging the hospital stay thus increasing cost. Possible factors affecting the rate of wound infection may be age, sex, nutritional status, co-morbidities, type of antibiotic protocol, type of procedure, technique of wound closure and perioperative blood transfusion. Certain factors need to be further evaluated, like the interval between admission and surgery, the interval between onset of acute symptoms and surgery. This study was undertaken to determine the rate of wound infection in contaminated and dirty exploratory laparotomies using the performed on an emergency basis and the possible factors for the same.*
Materials and Methods: *It was a prospective study carried out a tertiary care hospital after obtaining institutional ethics committee clearance. 67 cases were included after written informed consent. Each wound was assessed for the presence of infection by the ASEPSIS scoring method. Data relevant to the patient (age, sex, co-morbidities); related to the surgery (indications, findings, lavage, wound closure, antibiotic protocol); and related to the post operative period (evaluation by the ASEPSIS Scoring system, culture reports of wound discharge if present) was collected.*
Results: *The overall rate of wound infection was 8.95 %. The individual significant risk factors for surgical wound infection were the interval between onset of acute symptoms and surgery > 2 days, interval >24 hours between admission and surgery, duration of surgery > 150 mins and type of procedure (resection anastomoses or stoma). Escherechia Coli and Klebsiella pneumoniae were the prevalent microorganisms. The median length of postoperative stay in infected patients was increased by 14.5 days, which was significant.*
Conclusion: *Early seeking of treatment by patients requiring abdominal surgeries, and timely diagnosis and management of his/her condition along with following of appropriate antibiotic and operative protocols may lead to a significant decrease in the incidence of post- operative wound infections.*
Keywords: *Classification of wounds, Surgical Site infections.*

I. Introduction

Hospital acquired infections also called nosocomial infections, are one of the leading causes of morbidities in patients. Surgical wound infections are amongst the most commonly occurring nosocomial infections [1], especially in developing countries [2]. The presence of a surgical wound infection increases the morbidity as well as mortality of a patient. It also increases the hospital stay and hence the cost [3, 4].
However, the surveillance of surgical wound infections is very low. Most of the surgical wound infections present after discharge from the hospital [5, 6], and have a chance of going unnoticed. There is an immense need to quantify this problem, with a view to define the policies for prevention. The overall rate of surgical wound infection, as shown by various studies, varies from 3.2% to 27.98% [7-11]. Such a difference in rate is mainly due to a difference in the definitions of surgical wound infection, as well as different wound evaluation methods. One review has shown the presence of 41 definitions in 82 such studies conducted, along with 13 grading scales for wound evaluation [12]. Therefore, a standardised definition as well as a standardized wound evaluation system such as the ASEPSIS score[13] needs to be used in such studies. The rates in contaminated surgeries vary from 11.4% to 66.66% and in dirty surgeries from 7.1% to 80% (2,14-19). The type of surgery represents the level of endogenous contamination, and is considered to be the most important indicator for the development of a surgical wound infection [16, 19-23]. These values are considerably higher than those in clean and clean contaminated surgeries. This is consistent with the fact that contaminated and dirty surgeries are high risk factors for surgical wound infection. It has been shown that the various risk factors, in addition to the level of endogenous contamination, are, increased duration of surgery; type of antibiotic prophylaxis; administration of antibiotics > 2 hours before surgery; and co-morbidities such as diabetes, high arterial blood pressure and malignancy [3, 14,17,24,25].

To aim of this study was to study the rate of wound infection in contaminated and dirty exploratory laparotomies performed on an emergency basis. This study aimed to determine the risk factors for wound infection, such as duration of surgery, the type of surgical procedure followed, age, sex, interval between onset of acute symptoms and surgery, interval between admission and surgery, blood loss during surgery and perioperative blood transfusion.

II. Material And Methods

It was a prospective study, set up in a single tertiary care hospital, conducted for a period of two months. 77 consecutive patients who underwent emergency exploratory laparotomies and whose surgery was classified as contaminated or dirty (eg. Hollow viscus perforation with varying degrees contamination of the peritoneal cavity, intestinal obstruction), were included in the study. The wounds were classified as contaminated or dirty as per the National Research council wound classification. Patients who developed wound problems unrelated to superficial wound infection (eg. burst abdomen), who developed severe morbidity / mortality due to any other cause post operatively, cases where the wound was not available for inspection up to the opening of sutures, cases with severe co-morbidities such as diabetes mellitus, hypertension, organ failure, etc. were excluded so that their effect on wound infection can be nullified and the other factors can be studied. All the surgeries were conducted under general anesthesia. The surgical site was scrubbed with chlorhexidine, spirit and then finally by povidone iodine, in that order. All the patients had received a preoperative antibiotic combination of a 3rd generation cephalosporin (ceftriaxone, ceftazidime) or a fluoroqinolone (Ciprofloxacin) along with metronidazole to cover the aerobic as well as anaerobic microorganisms. The incision was midline or McBurney's and the wound was sutured in two steps; the rectus sheath using ethilon no. 1 and the skin using ethilon no. 3.

2.1 Evaluation of wound:

The wounds of patients were evaluated, using the ASEPSIS grading scale (26), on each postoperative day, until discharge. The informed consent of each patient was taken before evaluation. ASEPSIS is an acronym for 'Additional treatment; Serous discharge; Erythema; Purulent exudate; Separation of deep tissues; Isolation of bacteria; Stay as inpatient prolonged over 14 days.' Table 1 and 2 describe how ASEPSIS score is used to score wounds. The score was finally totaled, taking the highest value of the daily scores and the additional scores. (Table-2)

The wound was said to be infected if the score was greater than 20. (21-30: minor wound infection, 31-40: moderate wound infection and >40: severe wound infection.). A score of 11-20 was considered as a disturbance of healing and a score of 0-10 as satisfactory healing.

The Asepsis Wound Grading Scale (26)

	Points for daily wound inspection					
Wound characteristic	**Proportion of Wound Infected (%)**					
	0	**<20**	**20-39**	**40-59**	**60-79**	**>80**
Serous exudate	0	1	2	3	4	5
Erythema	0	1	2	3	4	5
Purulent exudate	0	2	4	6	8	10
Separation of deep tissues	0	2	4	6	8	10

Table – 1

Criterion For Grading Of Wound

	Criterion	**Points**
	Additional treatment	
A	Antibiotics	10
	Drainage of pus under local anesthetic	5
	Debridement of wound (general anesthesia)	10
S	Serous discharge	daily 0-5
E	Erythema	daily 0-5

P	Purulent exudate						daily 0-10
S	Separation of deep tissue						daily 0-10
I	Isolation of bacteria						10
S	Stay as inpatient prolonged over 14 days						5

Table – 2

2.2 Data Collection

Related to the patient: age, sex, personal history, major illnesses and duration of present illness, presence of shock or oliguria at the time of admission, any other evidence of septic shock (septicemias) at the time of admission, general parameters of the patient at the time of admission and personal history (alcohol, tobacco, smoking).

Related to the surgery: the indications for surgery, time lapsed between admission and surgery, time lapsed between onset of acute symptoms and surgery, degree of peritoneal contamination, operative findings, operative procedure (type of incision, technique of wound closure), blood loss during the surgery, perioperative blood transfusion and the antibiotic protocol followed.

Related to post-operative period: Daily ASEPSIS wound assessment score postoperatively (until discharge of patient), information on smear and culture reports of wound discharge (if any) and the additional treatments required.

2.3 Analysis of Data:

Based on the collected data the following was deduced:-

1) Overall rate of wound infection

2) Rate of wound infection related to type of surgery (contaminated/dirty), age, sex, diagnosis, duration between onset of acute symptoms and surgery, duration between admission and surgery, duration of surgery, type of procedure, blood loss during the surgery and peri operative blood transfusion was determined individually.

The significance of each of the above variables for determining surgical wound infection was deduced using the Chi-square test with the help of an online calculator (which used the Fisher exact test wherever necessary). A *p value* of less than 0.05 was considered to be significant.

3) The impact of the presence of wound infection on the length of postoperative hospital stay.

III. Results

Out of 77, 10 patients were excluded. The total number of patients included in the analysis was 67. There were 60 male and 7 female patients. The age of the patients ranged from 18 to 74 years. The median age was 35 years. Of the 67 surgeries, 15 were contaminated and 52 were categorized as dirty.

The detailed diagnosis of patients is given in Table 3

Diagnosis	N
Duodenal Ulcer Perforation	26
Ileal perforation	10
Appendicular Perforation	4
Stomach perforation	2
Caecal perforation	1
Sigmoid perforation	1
Unidentified perforation	3
Intestinal Obstruction	9
Trauma	3
Inflammatory conditions	3
Ischemic Bowel Disease	2
Bleeding Per Rectum	1
Sigmoid volvulus	1
Amebic liver abscess	1
Total	67

Table 3

Primary suturing of perforation was done in 34 patients, 16 patients underwent resection anastomosis and 8 patients had the formation of stoma. 5 patients underwent appendicectomy. There were other procedures also carried out like abscess drainage, adhesiolysis and splenectomy on the other patients. A midline incision was taken in 90% of the cases. There were 5.8% cases with a McBurney's incision and 3.9% with a para median incision taken. There was no significant correlation between the type of incision and the rate of surgical wound infection.

The duration of surgery ranged from 30 mins to 240 mins. The median duration of surgery was 85 minutes. The blood loss during surgery ranged from less than 100 ml up to 1800 ml. The median blood loss was 200 ml.

6 out of 67(8.95%) patients had an ASEPSIS score of greater than 20, thus classified as having a wound infection. Three patients (4.47%) had a score of 11-20, classified to have impaired wound healing. 58 patients had normal wound healing with a score of less than 10.

Wound infection developed in 3 out of 15(20%) contaminated wounds, and in 3 out 52 (5.76%) dirty wounds. Out of the 6 infected patients, 1 was female and 5 were male. The wound infection rate in females was 14.2 % and in males was 8.33%.

Age group (years)	Total no. of patients	No. infected	Wound infection rate (%)
<20	3	0	0
20-39	33	2	6.06
40-59	23	2	8.69
60-79	8	2	25

Table - 4

A higher rate of wound infection was seen with increasing age group (Table - 4). Out of the 6 infected patients, 2 had been diagnosed with ileal perforation, 2 with intestinal obstruction, 1 with an appendicular perforation and 1 with ischemic bowel disease. The wound infection rate in patients with perforative peritonitis was 6.38%, in those with intestinal obstruction was 22.22% and in those with other conditions was 9.1% There was no significance of the age, sex, type of surgery, type of wound or the diagnosis of the patient with the rate of infection. Interval between onset of acute symptoms and surgery ranged from 3 hours to 15 days. The patients were divided into 3 categories, those with an interval of less than 1 day, those with an interval of 1-2 days and those with an interval of greater than two days. All the patients who developed wound infection had an interval of >2 days between onset of acute symptoms and surgery. (25%) This was found to be statistically significant ($p < 0.025$).Interval between admission and surgery ranged from 45 minutes to 12 days. The median interval was 5 hours. Out of the 6 infected patients, 2 had in interval of greater than 24 hours. 3 had an interval of less than 12 hours, and one between 12 and 24 hours (Table – 5). Rate of wound infection with an interval of > 24 hours was 66.66%.

Interval	Total no. of patients	No. infected	Wound infection rate (%)
<12 hrs	58	3	5.15%
12-24 hrs	6	1	16.66%
>24 hrs	3	2	66.66%

Table -5

This distribution was statistically significant ($p < 0.01$). Amongst the infected patients, the duration of surgery ranged from 85 to 165 minutes. The median duration of surgery in infected patients was 140 minutes. There were 33 patients with duration of surgery lasting between 30 and 90 minutes; however none of them developed wound infection. Patients who had a longer duration of surgery (>150 minutes) had a significantly higher rate of wound infection ($p<0.01$).

Wound infection rate according to the type of procedure performed is shown in table 6

Procedure	Total no. of patients	No. infected	Wound infection rate (%)
Suturing of Perforation	34	0	0
Resection anastomoses	16	2	12.5
Stoma	8	2	25
Others	11	2	18.18

Table - 6

This difference in rates of wound infection was statistically significant ($p < 0.05$). Amount of blood loss intraoperatively had no impact on wound infection. There was no significant difference in the wound infection rates in patients with blood loss less than 300 ml versus those with loss more than 300 ml.The duration of stay of the patients ranged from 5 days to 104 days. The median duration of stay was 8 days. 17 patients had length of hospital stay greater than 14 days For the patients who developed infection, the stay ranged from 14 to 104 days, and the median duration of stay was 22.5 days. The difference in the postoperative stay was statistically significant ($p<0.001$) in patients with and without wound infection. Microorganisms were isolated from 9 wounds. Out of these, Escherichia coli was isolated from 6 wounds. Klebsiella Pneumoniae was isolated from 2 wounds. Proteus mirabilis and Providentia spp. were the other microorganisms isolated.

IV. Discussion

The overall rate of wound infection was 8.95 %. This was found to be consistent with other studies [7-11]. The rates of wound infection in contaminated and dirty surgeries was 20% and 5.76 % respectively, which was again found to be consistent with other studies [2,14-19]. However, unlike other studies, the rate in contaminated surgeries was greater than in dirty surgeries, which does not agree with the fact that the rate of wound infection is determined by the amount of endogenous contamination. However, this difference in rates was not statistically significant. Also, the rate in dirty surgeries was on the lower side when compared to those found in other studies [16, 18,27]. The reason for this might be that each and every patient received preoperative antibiotics (combination of a 3rd generation cephalosporin /fluoroquinolone with metronidazole to cover the aerobes as well as anaerobes). The pre- operative protocol for scrubbing, using chlorhexidine, spirit and povidone iodine may also be responsible for the rate to be on the lower side. The sex of the patient was not significantly associated with the development of wound infection, which was in agreement with other studies [28,29]. The rate of wound infection was higher with increasing age, but this increase in wound infection rate was not significant. Contradictory results are shown by other studies where age is found by some to be a risk factor [2,14,23] and not so by some [7,29]. An interval between the onset of acute symptoms and surgery greater than 2 days was found to be significantly associated with postoperative wound infection. This factor has not been studied before. A longer interval [greater than 24 hrs] between admission and surgery was also a significant risk factor for surgical wound infection. This was also shown by another study [2], which had considered only clean and clean-contaminated wounds.

It was found that duration of surgery >150 minutes was significantly associated with an increase in wound infection rate which was consistent with other studies[2,3,14,17,21,30]. Certain studies have shown that the length of surgical procedure longer than 120 minutes is a significant risk factor [3,6].

The wound infection rate with creation of stomas was 25 %, with resection anastomosis was 12.5 %, with primary suturing of perforation was 0% and with various other procedures was 18.18 %. This difference in the rates of wound infection was significant. The type of procedure performed depends on the local condition of the bowel and peritoneal cavity. A stoma is performed when there is a distal obstruction, poor vascularity of the bowel, severe contamination of the cavity or edema of the bowel. Resection anastomoses are performed when there is a large perforation or stricture, but with less contamination, and suturing when the perforation is small. This indicates that the level of endogenous contamination was different in these cases, being higher in those cases where a stoma was performed. This is also reflected in the wound infection rates, the highest rate occurring in cases with stoma. Therefore the type of procedure may not be a true indicator, since the rate in these cases is a reflection of the endogenous risk for wound infection.

There was no significant correlation between the amount of blood loss during the surgery and the development of a surgical wound infection. There was also no significant correlation between the perioperative blood transfusion and the rate of wound infection. This was also shown by another study [31]. This is in contrast to studies which have shown an increased risk with the presence of a perioperative blood transfusion [32]. The type of incision was not significantly associated with the rate of wound infection.

The prevalent microorganisms isolated were Escherechia Coli (E. Coli) and Klebsiella pneumoniae (Kleb. Pneumoniae). Prevalence of E. coli has been shown by many other studies [18, 33, 34]. However, Kleb. pneumonia was prevalent only in one study [35]. This maybe suggestive of Kleb. pneumoniae being an important hospital acquired pathogen in this set up. E.coli is an indicator of increased endogenous contamination. However, many of these studies also showed Staphylococcus aureus as the prevalent microorganism, which was not prevalent in this study [2,3,18,36,37]. Since S.aureus is an exogenous contaminant, its absence indicates a good management protocol.

The length of postoperative hospital stay was significantly greater in patients with a surgical wound infection. The median stay in infected patients was increased by 14.5 days. The increase in length of postoperative stay is an important consequence of developing post- operative wound infection, as the cost of hospital stay also increases. [3, 4]

There are other factors which may also contribute to the occurrence of a surgical wound infection, such as alcohol abuse, smoking and tobacco chewing; however, these factors were not taken into consideration in this study.

V. Conclusions

The overall rate of wound infection in contaminated and dirty surgeries was 8.95 %, which was low as compared to other studies. The significant risk factors for wound infection are: an interval between onset of acute symptoms and surgery of greater than 2 days, an interval between time of admission and surgery of greater than 24 hours, and duration of surgery greater than 150 minutes. There is a significant association between the kind of procedure performed and the rate of wound infection. Factors like age, sex, blood loss during the surgery, peri-operative blood transfusion, type of incision and the diagnosis have no significant correlation with wound infection. There is no significant correlation of the type of surgery (contaminated/dirty) with the rate of wound infection. The prevalent microorganisms were Escherichia coli and Klebsiella Pneumoniae. Postoperative stay increases significantly in patients with wound infection thus increasing the economic burden on the patient and the hospital.

Accessibility of medical help to the population which will help patients to seek treatment early and a rapid diagnosis with timely surgical management will help reducing the rate of postoperative wound infection. Preoperative broad spectrum antibiotic administration, availability of round the clock operating theatres and a short procedure to keep the duration of surgery low are important for reducing the rate of wound infection

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