

Prospective Study of Laparotomy Wound Infections and Associated Risk Factors and Profile of Causative Microorganisms

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Abstract: ***Introduction:** Post operative surgical infections arouses big interest among surgeons and are considered unfortunate but inevitable. Despite the tremendous sophistication in surgical techniques and advances in microbial studies, postoperative infections continue to present major challenge in the day to day practice, It also causes discomfort to the patient, delay in resuming in work due to disability, decreases the quality of life index and increases the financial burden especially in a resource limited country like ours. This study briefly discusses the history and the relevant definition necessary for the discussion of surgical site wound infection, The known postulated risk factors and the profile of causative microorganism. **Methods:** 75 cases of laparotomies (elective and emergencies) carried out from 28/5/2005 and studied prospectively. Study is based on clinical observation of the patient. All the patients irrespective of age included in the study. For the convenience, laparotomy wound infections are graded as GRADE 0 – No infection, GRADE 1 – Surgical site erythema, GRADE 2 – Subcutaneous collection, GRADE 3 – Partial Burst, GRADE 4 – Complete Burst. **Result:** The incidence of post operative laparotomies was 26.66%, The percentage of post operative wound infection increases with the Poor nutrition, Rising age, Anemia, Hypoproteinaemia, Contaminated peritoneum of abdomen , With poor chest compliance. The rate of post operative wound infection is directly proportional to the duration of surgery, hospital stay. Deranged Liver Function and Renal function leads to increase incidence of post operative wound infection. The rate of post operative wound infection is less in cases where the gastrointestinal tract was not open. The most common organism found in infected cases was Escheria Coli.*

Keywords: laprotomy wound, surgery,organism, infection

1. Introduction

Post operative surgical infections arouses big interest among surgeons and are considered unfortunate but inevitable. Despite the tremendous sophistication in surgical techniques and advances in microbial studies, postoperative infections continue to present major challenge in the day today practice.

Surgical site infections results in inconvenience to the patient and may land up in disastrous outcome. The postoperative wound infections may manifest as a stitch abscess leading to massive tissue destruction, terminating in septicemia and death of the patient. It also causes discomfort to the patient, delay in resuming in work due to disability, decreases the quality of life index and increases the financial burden especially in a resource limited country like ours.

Surgical site wound infection continues to consume a considerable proportion of health care finances. Even though complete elimination of wound infection is not possible, reduction in the observed wound infection rate to a minimum level could have marked benefits in terms of both patient's comfort and resources used. The problem of post operative wound infection is complex.

With the advent of newer antibiotics, the problem of post operative wound infection remains far from being totally solved because of the nosocomial organisms which are resistant to routine antibiotics. Bacterial contamination of the wound does not necessarily mean wound sepsis, as body

defenses are quite capable of looking after these bacterias, for instance- A case of frank peritonitis may heal without even a stitch abscess.

This study briefly discusses the history and the relevant definition necessary for the discussion of surgical site wound infection, the known postulated risk factors and the profile of causative microorganism.

This study includes 75 cases of Laparotomy (elective as well as emergency) which were performed during the period of June 2005-June 2006.

2. Aims and Objectives

- To find out the approximate incidence of post operative wound infections following emergency and elective laparotomies.
- To find out the type of pathogenic organisms causing laparotomy wound infection.
- To determine the relationship of post operative wound infection with certain possible pre disposing factors.

3. Materials and Methods

- 75 cases of laparotomies (elective and emergencies) carried out from 28/5/2005 and studied prospectively.
- Study is based on clinical observation of the patient.
- All the patients irrespective of age included in the study.

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Cancer, TB, DM, HIV, patient on steroid therapy and chemotherapy EXCLUDED from the study.

Cases studied under following headings:-

- 1) Personal details
- 2) Preoperative assessment
- 3) Pre operative investigations
- 4) Pre operative skin preparation
- 5) Peri and post operative antibiotics
- 6) Operative details.
- 7) Outcome.)

For the convenience, laparotomy wound infections are graded as

- GRADE 0 – No infection
- GRADE 1 – Surgical site erythema
- GRADE 2 – Subcutaneous collection
- GRADE 3 – Partial Burst
- GRADE 4 – Complete Burst
- Pre operative skin preparations done for all patients.
- Peri and post operative antibiotics given to all patients.
- Nutritional assessment of all the patients has been done with the help of mid arm circumference
- Broca's index
- Serum proteins
- Skin fold thickness

For all peritoneal contaminated cases ascitic fluid sent for routine, microscopic examination and cultured for isolation of causative microorganism. Surgical site pus culture done by appropriate methods.

4. Observation and Results

1) Infection Rate

Non Infected	55	73.33%
Infected	20	26.67%
Total	75	100%

Out of 75 total cases 20 cases showed postoperative wound infection and the percentage of post operative wound infection was 26.67% .

2) Sex Ratio

Sex	No.	Infected Cases	%
Male	64	17	26.56
Female	11	03	27.27

Post operative wound infection in male and females 26.56% of male cases and 27.27% of female cases were infected with wound infection.

3) Age Distribution

Age (Yrs.)	No.	Infected	%
0-10	02	00	00
11-20	12	04	33.33
21-30	21	04	19.04
31-40	21	07	33.33
41-50	15	03	20
51-60	02	01	50

post operative wound infections are more common in old ages. Infection percentage is 50% in age group more than 50 years and it is 20-30% in younger age groups.

4) Post Operative Wound Infection in Different Nutritional Status

Nutritional Status	Total Cases	No. of Infected Cases	%
Well	23	03	13.04
Moderate	28	08	28.50
Poor	24	09	37.50

The incidence of post operative wound infection is highest in cases from poor nutritional cases status and it is least in well nourished groups. In nutritionally well group it is 13.04% in moderate group, it is 28.05% and in nutritionally poor group ,it is 37.50%.The nutritional status of the patient was assessed with Brocas index, Mid arm circumference ,skin fold thickness, serum proteins and Hb concentration.

5) Respiratory Complications Status

Status	No.	Infected	%
Clear	51	13	25.49
Pleural Effusion	10	04	40
Consolidation	07	02	28.50
Atelectasis	03	01	33.33
Copd	04	00	00
Total	75	20	100

Table no 5 denotes incidence of postoperative wound infections in the cases having compromised pulmonary functions and in the cases with normal chest compliance. In cases having clear chest, The wound infection rate 25.49%.It rises with the reduced compliance of the lung. It is 40%.

6) Postoperative Wound Infection in Different Hemoglobin Concentration

Hb (Gm%)	No. Of Cases	Infected Cases	%
5.1 – 10	12	06	50
10 – 15	54	12	22.22
15.1 – 20	09	02	22.22

Basically study of Hb concentration denotes nutritional status of the patient. Hb concentration below 10gm % is considered as anaemia. Table no 6 with bar diagram compares incidence of post operative wound infections with varying levels of Hb. The incidence of postoperative wound infections is 50% in the cases having Hb below 10 gm% whereas it is 22.22% in cases having Hb above 10 gm%. So as the Hb concentration increases rate of post operative wound infection decreases. Thats why anemia and hypoproteinaemia are associated with high incidence of laparotomy wound infection.

7) Postoperative Infection in Different Serum Bilirubin Concentration

S. Bilirubin (mg %)	No. of Cases	Infected Cases	%
0.5-1.0	35	08	22.85
1.1-1.5	26	06	23.07
1.6-2.0	07	03	42.80
2.1-2.5	07	03	42.80

8) Post Operative Wound Infection in Different Serum Creatinine Concentration

S. Creatinine (mg%)	No. of Cases	Infected Cases	%
0.5-1.0	36	05	13.88
1.1-1.5	26	09	34.61
1.6-2.0	08	04	50
2.1-2.5	02	00	00
2.6-3.0	02	01	50
3.1-3.5	01	01	100

Rising titres of serum creatinine are associated with increase in incidence of the postoperative wound infections. Normal level of serum creatinine is 1 mg%. So from the study, the rate of infection is 34.61% in the cases having serum creatinine above 1mg% whereas it is 13.88mg% in creatinine level below 1 mg%. The rate of infection increases with increase in serum creatinine value. So poor renal function is associated with raised incidence of post operative wound infections

9) Post Operative Wound Infection in Different Serum Proteins Concentration

S. Protein (gm%)	No. Of Cases	Infected Cases	%
5-6	10	05	50
6.1-7	33	10	30.30
7.1-8	32	05	15.60

Hypoproteinemia is associated with increases incidence of post operative wound infection, as already stated in Table no 4. Serum protein level denotes nutritional status of the patient. Low level of serum proteins are associated with incidence of laparotomy infections. In Table no 9, Proteins below 6 gm% having rate of infection 50% whereas above 7 gm% has rate 15.6%.

10) Postoperative Wound Infection in Different type of Laparotomy

Type of Laprotomy	No of Cases	Infected Cases	%
Emergency	55	16	73.37
Elective	20	04	26.66

In emergency laparotomy, rate of infection is 73.37% with 16 infected cases out of 20. In laparotomies done electively, rate of infection decreases to the rate of 26.66. So incidence of laparotomy wound infection increases with emergency.

11) Postoperative Wound Infection in Relation to Blood Loss

Amount of Blood Loss (ML)	No of Cases	Infected Cases	%
<100	24	05	20.80
101-200	30	08	26.60
201-300	07	01	14.20
301-400	04	01	25.60
401-500	02	01	50
>501	08	04	50

The incidence of post operative laparotomy infection increases with increases in Intra-operative blood loss. In our

study laparotomy wound infection rate rises to 50% if the blood loss is more than 400ml. Infection rate is 20.8% when the blood loss is below 100ml. So post operative laparotomy wound infection increases with intra-operative blood loss.

12) Postoperative Wound Infection in Relation to Status of Peritoneum

Status of Peritoneum	No of Cases	Infected Cases	%
Healthy	21	02	9.50
Contaminated	54	18	33.33

Healthy peritoneum during laparotomy is associated with less infected cases whereas contaminated peritoneum during laparotomy is having more infected cases. In our study out of 21 patients having healthy peritoneum during laparotomy only two cases got infected eventually with the rate of infection 9.5%. Out of 54 contaminated patients 18 cases got infected with the rate of 33.33%. So contaminated peritoneum is more prone to develop post operative laparotomy infection than its healthy counterpart.

13) Postoperative Wound Infection In Relation To Peritoneal Drains

Drains	No Of Cases	Infected Cases	%
Kept	68	19	27.94
Not Kept	07	01	14.28

In our study 68 laparotomy patients had drains in situ. Out of these 19 cases developed postoperative laparotomy wound infection with the rate of 27.94%, whereas 7 patients in whom drains had not been kept only one got infected with the rate of 14.28%.

14) Postoperative Wound Infection in Relation to Time Taken For Surgery

Surgery Time(Hrs)	No of Cases	Infected Cases	%
<1	12	02	16.66
1-2	41	07	17.07
2-3	20	10	50
>3	02	01	50

Any laparotomy taking more than two hours is more prone to develop wound infection. In our study 20 cases has taken more than 2 hours. Out of these 10 cases suffered laparotomy wound infection with the rate of 50%. This rate reduced to 16.66% in cases of surgery in which time taken is less than one hour.

15) Postoperative Wound Infection in Relation to Duration of Stay in Wards

Duration (Days)	No of Cases	Infected Cases	%
<15	54	09	16.66
16-20	18	08	44.44
21-25	02	02	100
>25	01	01	100

Rate of laparotomy wound infection increases with the increases in hospital stay of the patient after laparotomy. In our study 54 laparotomy cases were hospitalized for less than 15 days. Out of these 9 cases were infected with the rate of 16.66% whereas this rate increased to 100% if the patient stay was increased to more than 25 days.

16) Postoperative Wound Infection in Relation To Suturing Technique

Technique	No Of Cases	Infected Cases	%
Interrupted	37	09	24.30
Continuous	38	11	28.90

the rate of laparotomy wound infection is 24.30% if the abdomen is sutured interruptedly whereas this rate increased to 28.9% in cases of patients whose wounds were closed continuously.

17) Post Operative Wound Infection with Profile of Micro Organisms

Organisms Isolated	No of Organisms
Pseudomonas Aeruginosa	02
Staphylococcus Auerus	05
E. Coli	09
Klebsiella Pneumoniae	02
Proteus Mirabilis	02
Anaerobes	03

Out of 20 infected cases we isolated causative organisms from 16 patients. Some patient has infection with only one organism and some of them have mixed infections. So E. coli is main micro organisms which has been isolated from 9 cultures, followed by stap. Auerus (5), anaerobes (3), k. pneumonia (2), proteus m (2), pseudomonas (2).

5. Discussion

Surgical site infection is probably the most common post operative complication. Postoperative wound infections can have deleterious effects on ultimate results of operation and patient's wellbeing. Apart from inconvenience to the patient, the expenses of the hospital also rises considerably as these patient's wound require prolonged stay in hospital, repeated dressing and repeated surgical intervention in the form of debridement and secondary suturing.

This study of laparotomy wound infection has been done in M.G.M Hospital ,Navi Mumbai in the year 2005-06. Total 75 cases has been taken from surgical wards and studied prospectively. This study includes both elective & emergency laparotomies.

This study is undertaken to find out the incidence of postoperative infection in cases of laparotomy & to find out association between certain possible predisposing risk factors & wound infection with profile of causative microorganisms.

Boyd has mentioned that the time required for complete repair of the wound will depend on number of factors of which amount of tissue destruction & degree of asepsis are the important. Howes said that wound infection is the septic breakdown of the devitalized tissue, blood clot or serum. However direct bacterial inoculum is necessary. Out of 75 cases 20 cases showed postoperative wound infection. So the incidence is 26.6%

Out of these 20% infected cases 17 are male and 3 females. Greater number of non clean infections among men than women.

Increasing age has definite effect on wound healing. In our series, the percentage of postoperative wound infection was highest in older age group (51-70 years) is 50%. Malnutrition is associated with high risk of postoperative wound infection. Diabetes Mellitus has been thought to decrease host resistance to infection but in our studies we have excluded diabetes mellitus.

In post operative wound infection, condition of the chest of the patient is also a prime deciding factor. The reduced compliance of the chest associated with pleural effusion, consolidation of lung atelectasis of lung and COPD is associated with high incidence of post operative wound infection.

Anemia is the most important factor responsible for post operative wound infection. In our study 12 cases are having hb below 10. out of 12, 6 patients developed post operative wound infection with percentage of 50%. This rate of infection decreases with increase in hb%.

The type of laparotomy is very important determinant of wound infection. The more the contamination, more have been found the chances of wound infection. In this study the wound infection rate went on increasing from 9.5% for clean laparotomies to 33.33% for contaminated.

Wound healing is critically dependent upon an intact inflammatory response for initial formation of wound matrix and subsequent maintenance of sterile environment. Raised level of serum creatinine is associated with impaired immune function leading to laparotomy wound infection and increase risk of wound dehiscence. Jaundice, raised level of serum bilirubin, is also associated with post operative laparotomy wound infection. Acute blood loss during surgery leads to poor oxygenation of the tissue which eventually leads to good media for bacterial growth.

Longer the patient stay in the hospital is the wound infection rate it is due to the fact that a spectrum of organisms which resides in the ward come to colonize the site of surgery.

Closure of abdomen is carried out in two ways i.e. monolayer (continuous) and multilayer (interrupted). In study continuous suturing constitutes 28.9% of wound infection whereas interrupted closure has infection rate of 24.3%.

6. Pathophysiology of Wound Infection

- It is essential to study in detail the events that follow the healing of the wound following wound incisions.
- Within 24 hours: **FORMATION OF EXUDATE**
 After abdominal incision, there is a typical acute inflammatory response to trauma. Within 24 hours neutrophils, some lymphocytes and monocytes, as cellular response, present at margin of the wound incision with the fluid exudate. At the same time, the fibroblasts and fibrocytes appear in the clot and migrate at rate of 0.2mm/day. The fibroblast proliferates by mitotic activity and spread along the fibrin mesh. The fibrin strand provides the solid foundation for the growth of the fibroblast into wound defect.

• 3rd -4th: STAGE OF RESOLUTION AND ORGANIZATION

The wound defect is colonised by the newly formed repetitive cells and the inflammatory exudate gets absorbed. The phagocytes like polymorphs, lymphocytes and monocytes digest fibrin and white cells with the help of proteolytic enzymes and resultant fluid get absorbed in the blood, called as resolution. At the same time the injured blood vessels show some changes like the endothelial cells of the blood vessels swell and show mitotic activity. Small solid vascular buds of growing endothelial cells follow the fine capillaries.

• 7th day: STAGE OF SCAR FORMATION AND GAINING OF TENSILE STRENGTH

Proliferation of fibroblast and collagen deposition continues till it forms a scar. This produces mechanical pressure on the walls of capillaries and compress them. The deposition of intracellular reticulin and collagen fibers strengthens the wound, gaining the tensile strength. The tensile strength is the basic requirement to hold the tissue together till the wound heals by fibrosis. So the tensile strength of the tissues is defined as maximum strength of the tissue which offers resistance against the maximum tension and below this maximum strength tissue gives away. The increase in tensile strength is due to increase in the collagen deposition. The collagen gets fibrosed and results in the cellular, avascular collagenous connective tissue known as scar.

7. Pathogenesis of Wound Infection

The pathogenesis of wound infection begins with the wounding process. Tissue disruption activates the coagulation cascade, platelets, mast cells, complement proteins and the contact activating system. Activation of the five initiators of the inflammatory response results in local tissue vasodilatation and increased vascular permeability. Vasodilatation increases the total perfusion to the area of injury, but slows flow velocity to allow neutrophil delivery and efficient margination of neutrophils. Increased vascular permeability allows suffusion of plasma proteins and plasma volume into the injured area and results in tissue edema. Tissue edema delivers opsonic proteins into the area of injury and contamination and provides aqueous channels for phagocytic cell migration.

Activation of initiators of inflammation produces chemo attractant factors, which serve as chemical 'beacon' to attract phagocytic cells to the area of injury and contamination. These chemo attractant include activated Hageman factor from the coagulation cascade, inflammatory from mast cells and platelets, complement cleavage products and bradykinine from contact activating system. Chemokines are specific chemo attractant cytokines that are also produced by populations. Diffusion of the chemo attractant factors from the epicentre of the injury up regulates adhesion molecules on endothelial cells, which initially slow neutrophils by causing 'rolling' across the epithelial surface. The rolling then allows complete margination of the neutrophils to the endothelial cell by the interaction of neutrophil integrins with intercellular adhesion molecule (ICAM) on epithelial surface. Neutrophils

diapedesis towards the chemo tactic gradient of the area of injury and contamination then initiates phagocytosis.

Neutrophil mobilization occurs within 24 hours of injury and contamination. At 24-48 hours, monocyte cell is similarly mobilized into the area of injury. If injury and contamination is minimal as sensed by the intensity of the chemo attractant signal, the monocyte may be a minimal participant in the process as normal phagocytic function of the neutrophil eradicates pathogens from the wound. In the absence of strong chemo tactic signals, the monocyte becomes instrumental in the elaboration of important cytokine signals, which initiates the process of healing. If large concentrations of chemo attractant signals are present as a reflection of severe injury and microbial proliferation, the monocyte elaborates proinflammatory cytokines, which includes tumor necrosis factor (TNF), interleukin-(IL)-1, IL-6 and IL-8- TNF and these proinflammatory signals mediate an intense up regulation of neutrophil phagocytic activity. Extracellular release of acid hydrolases and reactive oxygen intermediates from the neutrophil considerably enhance local inflammation. The end result of digested tissue, dead neutrophils, microbial cells and thick proteinaceous exudate is generally known as pus. Clinical sign in the wound of advancing cellulitis, erythema, induration, wound tenderness and pus define the state of active clinical infection.

8. Factors Influencing Surgical Site Infection

Many factors influence surgical wound healing and determine the potential for, and the incidence of, infection. The level of bacterial burden is the most significant risk factor, but modern surgical techniques and the use of prophylactic antibiotics have reduced this risk.

A system of classification for operative wounds that is based on the degree of microbial contamination was developed by the US National Research Council group in 1964. Four wound classes with an increasing risk of SSIs were described: clean, clean-contaminated and dirty. The simplicity of this system of classification has resulted in it being widely used to predict the rate of infection after surgery.

9. Conclusion

- 1) The incidence of post operative laparotomies was 26.66%
- 2) The percentage of post operative wound infection increases with the
 - Poor nutrition
 - Rising age
 - Anemia
 - Hypoproteinaemia
 - Contaminated peritoneum of abdomen
 - With poor chest compliance
- 3) The rate of post operative wound infection is directly proportional to the duration of surgery, hospital stay.
- 4) Deranged Liver Function and Renal function leads to increase incidence of post operative wound infection.
- 5) The rate of post operative wound infection is less in cases where the gastrointestinal tract was not open.

- 6) The most common organism found in infected cases was Escheria Coli .

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