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Surgery Section

A Prospective Study of Post-operative Surgical Site Infection

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ABSTRACT

Introduction: Organ specific surgical site infections are those that involve any part of the anatomy other than the incised body wall layer opened or manipulated during an operation. The proper understanding of bacteriology and mode of infections has surely reduced the incidence of wound infection, but it is not totally controlled. Hence the efforts are still concentrated upon various factors which play important role in wound infection.

Materials and Methods: A total of 582 consecutive patient undergoing major and minor surgeries between March 2010 and October 2011 were included in the study. Detail history, physical examination, laboratory and radiological investigation according to Performa with special reference to any factor that could lead to postoperative infection – Age, sex, socioeconomic status, nutrition was recorded. Initial assessment of intra operative findings divided these cases into clean, clean contaminated, contaminated and dirty SSI.

Result: A total of 582 patients out of these, 100 have SSI, SSI rate in our hospital was found to be 17.18% including all classes of wounds. Coagulase positive staphylococci were responsible for a majority of SSIs and mixed infections were quite common. The other microorganism responsible for SSIs were E.coli, Coagulase negative staphylococci, Pseudomonas and Proteus etc.

Conclusion: The data from our study suggests a need to control modifiable risk factor responsible for development of SSI. Though we may not have a full control on the patient related factors, it is essential that the associated health conditions like Diabetes. The anemia should be controlled as far as possible before surgical procedures.

Keywords: Anemia, DM, Malignancy, Pus culture and sensitivity, Surgical site infection

INTRODUCTION

Surgery has made great advances in last few decades, and post operative wound infection is the commonest complication faced by surgeons since the advent of surgery [1]. Galen (Roman Gladiatorial surgeon, pathologist and philosopher) recognized that location of infection (suppuration) in wounds, inflicted in gladiatorial arena, often heralded recovery, particularly after drainage of pus. Theodoric of cervia, Ambroise pare and Guy de chauliac all pointed out that clean wounds, closed primarily, could heal without infection or suppuration.

During the second half of the 19th century many operations were developed after anesthesia was introduced by Morton in 1846, but advances were few for many years because of the high rate of infection and the high mortality that followed infections. By the beginning of 20th century, following the work of Ignaz Philipp Semmelweis and later with the introduction of antisepsis into the practice of medicine by Joseph Lister, reduced infection rates and mortality in surgical patients were seen [2]. The work of Holmes, Pasteur, and Kocher in infectious diseases, as well as the operating room environment and discipline established by Halsted, continued to prove the aseptic and antiseptic theory to be the first effective measures for preventing infections in surgical patients.

Antimicrobial agents were once failed as 'Magic bullets' that promised to eradicate infection. Unfortunately this promise has not been fulfilled; the use of antimicrobial agents to prevent surgical infection has become a subject of controversy and disappointment in clinical practice. These initial principles helped change surgical therapy from a dreaded event, with infection and death being Common place, to one that alleviates suffering and prolongs life with predictable success when carefully performed. With the introduction of antibiotic therapy in middle of the 20th century, a new adjunctive method to treat and prevent surgical infections was discovered , and hope for final elimination of infections continued, but widespread antibiotic therapy has also often made prevention and control of surgical infections more difficult. The present generation of surgeons has seen increasing no. Of serious infections related to a complex combination of factors, including the performance of more complicated and longer operations, an increasing in the number of geriatric patients with accompanying chronic or debilitating diseases, many few surgical procedures with implants made up of foreign materials, a rapidly expanding number of organ transplants requiring the use of immunosuppressive agents, and increased use of diagnostic and treatment modalities that cause greater bacterial exposure or suppression of normal host resistance.

The modern surgeon cannot escape the responsibility of dealing with infections and, aseptic technique, proper use of prophylactic and therapeutic antibiotics, and adequate monitoring and support with novel surgical and pharmacological modalities, as well as non-pharmacological aids [3]. Basic understanding of how the body defends itself against infection is essential to rational application of surgical and other therapeutical principles to the control of infection. Operative wound infection is examined through classification based on estimation of frequency, severity and source of infection.

Wound infection is defined as serous or purulent discharge from wound within 30 days postoperatively and one year if prosthetic material is used like mesh repair in hernia surgery or prosthetic valve in cardiac surgery etc [4].

Surgical site infection are classified as being either incisional or involve organ/space accessed during operation. Incisional surgical site infection are further divided into those involving only skin and subcutaneous tissue and those involving deeper soft tissue of the incision. Organ/space surgical site infections are those that involve any part of the anatomy other than the incised body wall layers opened or manipulated during an operation. Since ages wound infection has been a major complication following any surgical procedure [5]. The proper understanding of bacteriology and mode of infections has surely reduced the incidence of wound infection, but it is not totally controlled. Hence the efforts are still concentrated upon various factors which play important role in wound infection. So the aim of the study is to analyze the incidence of surgical site infection in post-operative patient and different factors affecting it and different preventive measures to reduce it.

Aims and objectives

- To analyze the incidence of surgical site infection in postoperative patients.
- To study the pre-operative, and postoperative factors responsible for post-operative wound infection.
- To study the source of infection and various ways and means to prevent and rectify it pre and postoperatively.
- To detect the common microorganisms causing post operative wound infection in relation to the type of surgery.
- To correlate the antimicrobial sensitivity of related organism with the use of antibiotics in surgical patients.
- To emphasize on factor involved in prophylaxis of and adequately surgical control of surgical site infection.
- To analyze the role of antibiotic prophylaxis in surgical site infection.
- To study its impact in terms of hospital stay, money and time.

MATERIALS AND METHODS

This is the prospective study on SSI carried out in the Department of Surgery, Dhiraj Hospital, SBKS Medical institute and Research centre, Sumandeep Vidyapeeth, Piparia. During period March 2010 to Oct 2011. A total of 582 consecutive patients undergoing various surgical procedures between March 2010 and October 2011 were included in the study.

Inclusion criteria

- All patients undergoing surgical procedures in the department of Surgery other than peripheral soft tissue abscesses and necrotizing fasciitis, irrespective of the age group were included in the study.
- All patients with presence /absence of risk factors were included.
- To study the bacteriological aspect of this project, an analysis of pus culture sent from infected wounds was carried out.

Exclusion criteria

- Cases operated for minor procedures like sebaceous cyst, lipoma, fibroadenoma, etc. were excluded from this study.

The Evaluation of the Patients Included

Pre-operative Phase: Detail history, physical examination, laboratory and radiological investigation according to Performa with special reference to any factor that could lead to postoperative infection – Age, Sex, Socioeconomic status, nutrition are recorded.

Intra-operative phase: Initial assessment of intra-operative findings divided these cases into clean, clean contaminated, contaminated and dirty SSI.

Classification	Description	Infective risk (%)
Clean (class 1)	Uninfected operative wound No acute inflammation closed primarily Respiratory, Gastrointestinal, biliary, and urinary tracts not entered. No break in aseptic technique closed drainage used if necessary.	< 2 %
Clean–Contaminated (class 2)	Effective entry into respiratory, biliary, gastrointestinal, urinary Tracts and with minimal spillage. No evidence of infection or major break in aseptic technique.	< 10 %
Contaminated (Class 3)	Non-purulent inflammation present Gross spillage from gastrointestinal tract penetrating traumatic wounds < 4 hours Major break in aseptic technique.	About 20 %
Dirty – infected (class 4)	Pre-existing clinical infection (purulent inflammation) present pre-operative perforation of viscera. Penetrating traumatic wounds >4 hours.	About 40 %
(CDC, 1996; Cruse, 1980)		

(Pre-existing clinical infection category of patients included patients with Acute Appendicular Abscess, Pneumoperitoneum, Ruptured Liver abscess, etc.)

Post-operative phase: In the post-operative period, the frequency of opening dressing, wound haematoma, seroma, the quantity and duration of drainage from drains, gaping of wounds, pain, fever and subsequently the detailed assessment of the wound was recorded such as cellulites, indurations, minor stitch abscesses, localized pus collection, minor wound gaping, wound draining pus and soaked dressing, septicaemia and toxaemia. For assessment of etiological factors leading to post-operative wound infection. The swabs were sending from patients wound infection. The swabs were sending from patients wound, operation theatre and from wards.

Methods of sending culture swab: From bacteriology department: The sterile test tubes with sterile swab stick were obtained. After wetting the cotton on the swab sticks with sterile normal saline they were rubbed against the material to be tested and put in the sterile test tube and taken for culture study immediately. In the laboratory, they were placed on culture media and incubated for 24 hours for bacterial colonization. After the growth was noticed, the organisms were identified by Gram stain and other biochemical tests and colony characteristics. The colonies were placed on antibiotic sensitivity media for testing sensitivity pattern of specific organisms.

Antibiotics: In our hospital we routinely give preoperative and postoperative antibiotics to our patients. The commonly used combination pre and post operative period was inj gentamycine, inj metronidazole, inj cefotaxime in therapeutic doses. The secondary antibiotics were used when infection resolution did not occur. They were selected according to the sensitivity pattern.

Hospital stay and expenditure: Impact of post-operative wound infection of hospital in terms of increased expenditure and occupancy of hospital beds was studied by calculating;

- Increase in hospital stay.
- Extra expenditure on medicine and hospital stay during the recovery period.

Measures to control postoperative SSI: Measures to control post-operative wound infections were applied by following principles of asepsis and antisepsis during and after surgery.

This includes:=

- a) Preoperative treatment of any infection or any other associated disease in that particular patient.
- b) Preoperative preparation of patient.
- c) Throughout surgical scrubbing of hands by doctors and nurses etc.
- d) Maintaining operation theatre environment clean, wearing gown, gloves and masks.
- e) Gentle and minimum handling of tissues.
- f) Intra-operative antibiotic for major surgery.
- g) Ward care:- proper dressing technique.
- h) Careful observation of wound for earlier detection of post operative wound infection.

Follow-up patients

The end point of the study was considered as the total time taken for complete healing of the wounds and discharge of the patients. Hospital stay of the patients depended upon the total time taken for healing and coincided with the end point of healing and discharge in all the patient.

RESULTS AND ANALYSIS

A total 582 patients were selected for the study, out of them 100 patient developed SSI [Table/Fig-1]. This table shows post-operative infection rate in our hospital is 17.18 %. Fever with chills was the most common presentation and was seen in 65/100 patients. The other clinical presentations were pain, erythema, raised temperature, discharge and septicaemia (unexplained tachycardia and tachypnoea with or without hypotension) [Table/Fig-2]. The most common local presentation of SSI was collection in the wound. Collection was seen in 56 patients [Table/Fig-3].

In our study maximum infected cases (24 %) were found from age group 31 – 40 yrs, followed by 22 % from age group 41 – 50 yrs. The youngest patient was newborn while the oldest was 80 years old female, operated for intestinal obstruction [Table/Fig-4].

The number of SSI were slightly higher in the males (17.64%) as compared to females (16.23%) [Table/Fig-5] 54 % of the

No. Of patients	SSI(+)	SSI(-)	RATE
582	100	100	17.18 %

[Table/Fig-1]: Showing infection rate in our hospital

Sr. No.	Signs and Symptoms	No. of infected patients
1	Fever with chills	65
2	Pain at incision site	20
3	Erythema and local rise in temperature	25
4	Purulent discharge	16
5	Septicemia	5

[Table/Fig-2]: Showing various signs and symptoms of SSI

Sr. No.	Presentation of wound infection	SSI
1	Slough	13
2	Superficial wound gape	12
3	Serosangunious collection	56
4	Frank pus	16
5	Burst abdomen, anastomotic leak with gape and faecal fistula	9

[Table/Fig-3]: Showing various local presentation of SSI

Age group	No. of infected cases	Percentage
0 – 10	13	13 %
11 – 20	11	11 %
21 – 30	12	12 %
31 – 40	24	24 %
41 – 50	22	22 %
51 – 60	12	12 %
61 – 70	4	4 %
71 – 80	2	2 %
Total	100	100 %

[Table/Fig-4]: Showing age group distribution of infected cases

Sex	No. Of cases with SSI	No. Of cases without SSI	Percentage of SSI
Male	69	322	17.64%
Female	31	160	16.23%
Total	100	482	

[Table/Fig-5]: Showing sex distribution of cases

patients with SSI had haemoglobin level less than 10 gm % [Table/Fig-6]. 46% of the patients with SSI had haemoglobin level more than 10 gm %. 47 % patients with SSI associated to morbid disease such as malignancy, diabetes mellitus, hypertension, ischemic heart disease and tuberculosis. Malignancy was the common associated condition which was seen in 22 % patients [Table/Fig-7].

Sr. No.	Hb gm%	No. Of SSIs (+)	No. Of SSI s(-)	Percentage of SSI
1	< 10	54	119	9.27 %
2	> 10	46	363	7.90 %
3	Total	100	482	17.18 %

[Table/Fig-6]: Showing distribution of infected cases according to Haemoglobin level

Sr. No.	Co morbid diseases	No. Of infected cases	Percentage
1	Malignancy	22	22 %
2	Diabetes Mellitus	8	8 %
3	Other diseases*	17	17 %
4	Total	47	47 %

[Table/Fig-7]: Showing association of co morbid diseases with surgical site infections

Sr. No.	Preoperative stay (days)	No. Of infected cases	Percentage
1	Immediate surgery	34	34 %
2	< 2 days	10	10 %
3	2 – 4 days	26	26 %
4	4 – 7 days	10	10 %
5	>7	20	20 %
	Total	100	100 %

[Table/Fig-8]: Showing association of preoperative hospital stay and surgical site infection

In present study about 30 % infected case 4s had preoperative stay more than 4 days. Emergency (no preoperative stay) had maximum infection rate (34 %). It was observed that shorter the duration of preoperative stay in planned surgeries, lesser the incidence of SSI [Table/Fig-8].

In present study data shows that the surgeries between 0-2 Hrs duration of operation are having higher chance of wound site infection. In our study maximum no. Of isolated micro-organism (64.00%) were found of Coagulase + Staph. Aureus, followed by *E. Coli* (34.00%). Table shows that 173 micro-organism were isolated from 100 patients suggestive of mixed infection were more common [Table/Fig-9,10].

Sr. No.	Duration of operation	No. of infected patients	No. Of Non-infected patients	Total	Percentage of infected cases
1	0-2	56	334	390	9.62%
2	2-4	30	116	146	5.15%
3	>4	14	32	46	2.40%
4	Total	100	482	582	17.18%

[Table/Fig-9]: Showing duration of operation v/s postoperative wound infections

Sr. No.	Organisms	No. Of Isolated	Percentage
1	Coagulase + Staph. aureus	64	64.00%
2	Coagulase - Staph. aureus	26	26.00%
3	Klebsiella sp.	26	26.00%
4	Pseudomonas sp.	6	6.00%
5	E.Coli	34	34.00%
6	Proteus	15	15.00%
7	Other	2	2.00%

[Table/Fig-10]: Showing distribution of microorganism isolated from SSI

The dirty class of surgeries was associated with highest incidence of SSI 52.23%. While clean class of surgeries was associated with least incidence that is 4.43% [Table/Fig-11]. The clean contaminated class of surgeries was associated with incidence of SSI 43.68% and contaminated class of surgeries was associated with incidence of SSI 36.58%.

In present study, it shows number of infected patients is more in laparotomy (63.00%) followed by appendisectomy (10.00%) [Table/Fig-12]. In our hospital expenditure for medicine was Rs. 72.50 per day per patient. Expenditure for diet was Rs. 25.25 per day per patient. Total for one day would be (72.50+25.25=97.75). Considering the average hospital stay for a uninfected patient to be ten days the expenditure for 10 days stay of 100 patients without infection would be 97.75x100x10=97750. Expenditure for 28 days stay of 100 infected patients was 97.75x100x28=273700. This table shows extra expenditure of Rs. 175950/- was spent on infected patients in six months period [Table/Fig-13].

Sr. No.	Type of surgery	Infected	Non-infected	Rate of infection
1	Clean	13	293	4.43%
2	Clean contaminated	45	103	43.68%
3	Contaminated	7	19	36.58%
4	Dirty	35	67	52.23%

[Table/Fig-11]: Showing relationship between type of surgery and SSI

Sr. No.	Operation name	No.of infected patients	Percentage
1	Herniorrhaphy	6	6.00%
2	Genitourinary surgery	8	8.00%
3	Mastectomy	4	4.00%
4	Appendisectomy	10	10.00%
5	Cholecystectomy	4	4.00%
6	Laparotomy	63	63.00%
7	Other operations	5	5.00%

[Table/Fig-12]: Showing distribution of infected patients in various operations

Cost	Expenses for cases without infection	Expenses for cases with infection
Medicine	72476	202934
Diet	25274	70766
Total	97750	273700
Avarage stay	10 days	28 days

[Table/Fig-13]: Showing estimates of hospital expenses

DISCUSSION [Table/Fig-14-19]

The introduction of antiseptic principles in surgical practice revolutionized the scope of surgery. Since then many advances that have been made in asepsis and antisepsis have considerably reduced the hazards of infection in surgical operations. Despite all these advances wound infection still remains one of the important causes of postoperative morbidity and mortality in the hospital. [Table/Fig-18] shows superficial Incisional surgical site infection, The present study aims at finding the post-operative infection rate in our hospital, the type of bacteriamost commonly involved and other factors contributing to postoperative wound infection, so also the measures which can be used to control it, and its cost effectiveness. In the present study, we have included 582 cases of various age and sex who underwent various surgical procedures and of whom 100 subsequently developed postoperative SSI. Out of 582 cases, 306 cases were from clean class, 148 were from clean contaminated class & 26 were from contaminated class while 102 were from dirty class of wounds. The post-operative wound infection rate reported by various workers varies from 2.8% to a high as 55.6 % [16]. [Table/Fig-19] shows organ surgical site infection. The post-operative wound infection rate depends upon the quantity of work load and the hospital environment. It has been suggested that any breach in asepsis in operation theatre is responsible for high infection rate.

Study	Infection rate
Mary Olson et al., (1984)[6]	4 – 7 %
Khan MA et al., (1985)[7]	20.0 %
Kowli SS et al., (1985)[8]	41.9 %
National Research Council[9]	7.5 %
Linani SP et al., (2005)[10]	8.95 %
Razvai et al., (2005)[11]	17.4 %
Kamran et al., (2006)[12]	8.14 %
Present study	17.18 %

[Table/Fig-14]: Showing rate of postoperative wound infection by various workers

Study	Years of age	Infection rate
Kowli SS et al., (1985)[8]	>50	75 %
Khan MA et al., (1985)[7]	60 – 69	29.0 %
Razvai et al., (2005)[11]	>65	25.2 %
Kamran et al., (2006)[12]	<60	22.72 %
Present study	>50	18.00 %

[Table/Fig-15]: Showing analysis of age and infection rate

Study	Duration	SSI rate
Raos & Harsha M (1975)[13]	>2 hours	50%
Schwartz (1980)[14]	>6 hours	13%
Razvai et al., (2005)[11]	>4 hours	64.28%
Linani SP et al., (2005)[10]	>2 hours	38.46%
Present study	>4 hours	2.40%

[Table/Fig-16]: Showing analysis of age and infection rate

Sex	Peter Cruze et al., 1980 [15]	Syed Razavi et al., 2005 [11]	Present study
Clean	1.5	4.5	4.43
Clean contaminated	7.7	4.2	43.68
Contaminated	15.2	31.3	36.58
Dirty	40.0	8.9	52,23

[Table/Fig-17]: Showing infection rate in various classes of wound [14,7,13,8,9,6,11,12]

The proportion of SSI in our hospital is 17.18% including patients of all categories (clean, clean contaminated, contaminated and dirty class of wounds) [16]. The results of our study are consistent with others measuring the incidences of SSI, though on higher side. The rate appears to be comparable to previous studies although comparisons may be difficult as the patient population and method of data collection may vary. The incidence of SSI has varied in different countries. In a study from United State of America the rate of SSI was estimated to be 2.8%. While in African countries it has ranged from 16.4 to 38.7%. In the European countries the average rate of SSI has been found to be between 2 to 5 %. The rate of SSI in Asian countries has varied between

[Table/Fig-18]: Superficial incisional surgical site infection

[Table/Fig-19]: Organ/space surgical site infection

7.6 to 17.4%. However more realistic range of rate of SSI lies between 15 and 20%, depending mainly on type of surgical procedure and the wound classification. Though the rate of SSI 17.18% which was found in present study is high when compared with developed countries it is comparable to other studies from developing countries. There are various factors influencing SSI.

- Age: Post-operative SSI appears to be more common in elderly patients and age is well established risk factor for postoperative wound infection mainly because of decreased immunity and association with certain chronic conditions such as atherosclerosis, malnutrition and geriatric disease [5,18]
- Sex: In present study the incidence of SSI in males was 17.64% while females were infected in 16.23%. Our finding is consistent with finding of Razavi et al., [11].
- Anaemia: Severe anaemia is always associated with tissue hypoxia thereby decreasing tissue resistance to infection. The associated catabolic state can explain decreased immunity to infection in these patients [18].
- Diabetes: Considered as an important risk factor for post-operative wound infection. Cruse and Foord [18] reported higher rate of surgical wound infection in patients with diabetes. Cahil [19] has pointed out that the diabetics are more prone for infection. In present study incidence of SSI in diabetes mellitus was 26.66% as compared to 16.66% in non diabetic patients. This is comparable with Kamran et al., [12] in which it is 20% compared to 7.09 in non diabetic.
- Steroid treatment and immune suppressive therapy is often associated with an increased risk of infection. National research council (164) [9], Cruse PJE and Foord observed that immunosuppression occurs after major and minor surgery.
- Use of drains produce some necrosis of tissues with which is comes in contact but drains are almost indispensible in presence of necrotic tissue and infection (Wangesteen et al.,[3].

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