Research Article (Open access)

Clinical Study of Causative Factors, Precautionary Measures and the Treatment of Surgical Site Infections (SSIs) in Elective General Surgery Cases at Dr B.R.AMCH

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ABSTRACT- Background: Surgical Site Infections (SSI) still remains a significant problem following an operation and the third most frequently reported nosocomial infections. SSI contributes significantly to increased health care costs in terms of prolonged hospital stay and lost work days. The current study was undertaken to identify the incidence of SSI and the risk factors associated with it, and the common organism isolated and its antibiotic sensitivity and resistance.

Methods: A total number of 3211 patients admitted in general surgical wards for elective surgery in the study period, out of which 1225 were clean and clean contaminated cases, fulfilling our study criteria. Totally 56 cases had surgical site infections, which had been taken up for this study. Wound discharges were sent for culture and sensitivity.

Results and Conclusions: The overall infection rate was 4.57%. The SSI rate was almost equal in clean surgeries and clean contaminated ones. Superficial surgical site infections in the most common type and accounted for about 66.07% of all the SSI's and deep surgical site infection accounted for about 25% with 8.92% was organ space. The most commonly isolated organisms from surgical site infections were *Staphylococcus aureus* followed by *Pseudomonas* and then *E. coli*. Drains, prosthesis usage and other risk factors of SSI have been identified. Most of the organisms which were isolated were multidrug resistant. The high rate of resistance to many antibiotics underscored the need for a policy that could promote a more rational use of antibiotics.

Key-words- Surgical site infections, National Nosocomial Infections Surveillance (NNIS) risk index, Antibiotic koprophylaxis

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INTRODUCTION

Surgical site infections are the commonest nosocomial infections, which significantly prolong the duration of hospitalization, thus adding the economic burden. Surgical infections are those that occur as a result of a surgical procedure or those that require surgical intervention as part of their treatment.

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They are characterized by a breach of mechanical/anatomic defense mechanisms (barriers) and are associated with greater morbidity, significant mortality, and increased cost of care.[1]

Despite the advances in surgical sciences post-operative wound infection remains one of the commonest complication which surgeons encounter. This problem if not evaluated and treated in a timely manner can have significant sequel. Infection is encountered by all surgeons by nature of their crafts; they invariably impaired the first line of host defense. The cutaneous or mucosal barrier, the entrance of microbes into the host tissue is the initial requirement for infection.[2] The discovery and confirmation of the link between microbes and diseases led ultimately to the use of arsenic, mercury and of sulphonamides and following the discovery of penicillin to the steady development of antibiotics.[3] SSI can double the length of time a patient stays in hospital and thereby increase the costs of health care. The main additional costs are related to re-operation,

extra nursing care and interventions, and drug treatment costs. The indirect costs, due to loss of productivity, patient dissatisfaction and litigation, and reduced quality of life, have been studied less extensively.[4] Surgical site infection is most challenging to every surgeon and each and everybody is trying their methods to reduce the problem.

MATERIALS AND METHODS

Source of data

This study was conducted in Dr B R Ambedkar Medical College, Department of General Surgery, Bangalore, India from October 2011 to November 2013.

Inclusion criteria

1. Only elective general surgical cases involving clean and clean contaminated surgeries were taken up for study
2. Both sexes were included
3. Younger and older age groups were included
4. Patients who were willing to be part of this study were taken

Exclusion criteria

1. Emergency surgeries
2. Contaminated surgeries
3. Surgeries for malignancies
4. Surgeries on severely immune compromised patients
5. Re-look surgeries
6. Incomplete primary closure
7. Excision biopsy
8. Stitch abscess involving minimal inflammation
9. Patients willing to be the part of this study

Methodology

A total number of 3211 patients admitted in general surgical wards for elective surgery in the study period, out of which 1225 were clean and clean contaminated cases, fulfilling our study criteria. Totally 56 cases had surgical site infections, which had been taken up for this study.

Collection of data

An elaborate study of these cases was done till the patient was discharged from hospital, and then followed up the patient on OPD basis for any signs of wound infection. The wounds were examined for suggestive Signs/Symptoms of infection in the post-operative period, during wound dressing or when the dressings were soaked. In history, presenting complaints, duration, associated diseases, coexistent infections at a remote body site, personal history, including diet, smoking, and alcoholism were noted.

Operative findings, which include, type of incision, wound contamination, drain used and its type and duration of operation were studied. Post-operative findings which included day of wound infection, day of 1st dressing and frequency of change of dressing. Findings on the day of diagnosis of wound infection were noted which included fever, erythema, discharge, type and color and the exudates was collected from the depth of the wound using sterile cotton swab and was sent to microbiology department for culture and sensitivity.

Pre-operative preparation

In our series, all cases were prepared by shaving method of depilation 1-2 hours pre-operatively and washed with routine soaps. Patients were admitted one or two days prior to surgery on appointment basis since all the cases were electively posted for surgery except for few cases, which required bowel preparations. Prophylactic antibiotics were given in all the cases 1–2 hours pre-operatively after test dose, most commonly cephalosporins (cefotaxime/ cefazolin). Povidine iodine and surgical spirits was the only antiseptic solutions used for painting the operative field and cleaning the wound before and during surgery in all cases. Conventional suturing by various combinations of absorbable & non absorbable suture materials for various layers was used appropriately. Skin staplers or bowel staplers were not used in any of the cases. Dressings were done using povidine iodine solution or ointment with sterile gauze and pads, post-operative wound review was done around 48-72 hrs following surgery.

SSI was diagnosed post operatively on an average from 3rd–5th day and the discharge from the wound were sent laboratory for culture & antibiotic sensitivity in most of the cases. Antibiotics were changed and administered according to the sensitivity profile based on the report. Symptomatic treatment was given depending upon the combination and severity of various symptoms due to SSI.

RESULTS

In the present study the overall post-operative SSI rate in elective clean and clean contaminated cases is 4.57% (Table 1a). Here low incidence would be due to exclusion criteria limiting our sample. Superficial surgical site infections in the most common type and accounted for about 66.07% (Table 1b). Most of the cases were in the middle age group. Extremes of age are one of the factors in SSI as shown in few studies. Our series did not have significant statistical difference with respect to the relation between sex and SSI. Although the incidence was slightly more in case of men accounting for 52% of the overall cases.

Table 1: Incidence of SSI in our series

Total elective cases	2894
Clean & clean contaminated cases	1225
Total SSI cases	56

Table 1: Type of SSI

Type	No. of cases	Percentage (%)
Superficial SSI	37	66.07
Deep	14	25
Organ space	5	8.92

Fig. 1: Surgical site infection in Open appendectomy

Fig. 2: Mazhar Husain[1], Devendra Sonkar[2], Vipul Kumar Srivastava[3], Areena Hoda Siddiqui[3]*

Infections are more in drained wounds and in the procedure involving implanting prosthesis like mesh. This increased incidence may be due to the effect of the drain itself by acting as a microbial pathway. Implants carry higher risk of infections acting as a foreign body if in case there is breach in the strict aseptic protocols.

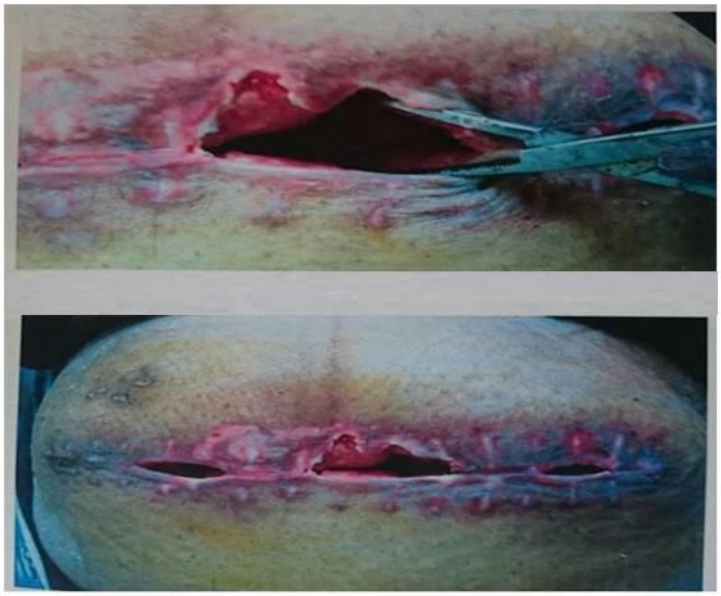

Fig. 3: Surgical site infection following huge incisional hernia mesh repair

Patients detected with surgical site infections were found to have co-morbities like diabetes, obesity etc. accounting for about 66.07% of all the cases. Poor glycemic control and reduced immunity in diabetic patients might be responsible for the development of SSI. Fat necrosis, fat stripping, tissue insult and long hours of surgery in case of obese patients might be the cause for SSI. The homeostasis in such cases also might have been imperfect activating infection.

Our series had no difference in the incidence of SSI between the clean and clean contaminated surgeries. Many other studies have proved that there is increase in incidence of SSI as there is increase in contamination. Sample size being small and the similar surgical techniques for both clean and clean contaminated surgeries would have been responsible for the failure in drawing any conclusion.

S. aureus is the commonest organism isolated from the surgical wounds from 42.85% of cases, including MRSA (methicillin resistant *staphylococcus aureus)*, MSSA (methicillin sensitive *staphylococcus aureus*) and coagulase negative *S. aureus*. *S. aureus* was encountered to be the organisms prevalent in SSI in both the clean and clean contaminated types (Fig. 4), whereas pseudomonas is the organism predominant in the clean contaminated wounds accounting for 28.57%. *E. coli* isolated from both the kind of surgeries but predominantly about 14.28% of the clean contaminated cases. Klebsiella was isolated only from the clean contaminated wounds 10.17% of the cases and not from any clean cases (Table 2).

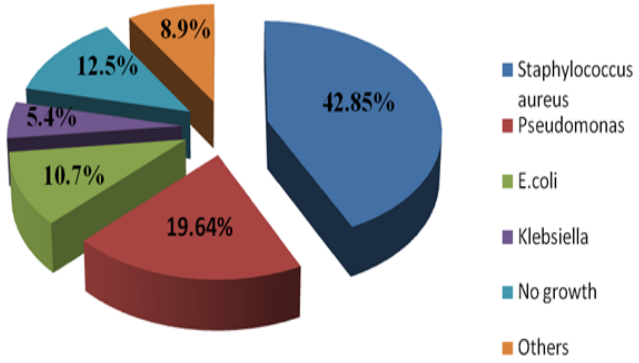

Fig. 4: Organisms isolated from SSI wounds

Table 2: Relation of organisms with the type of surgery

Type	*S. aureus*	*P. aeruginosa*	*E. coli*	*Klebsiella*
Clean	13	4	2	0
Percentage	46	14.28	7.1	0
Clean contaminated	7	8	4	3
Percentage	25	28.57	14.28	10.71

Antibiotic sensitivity

Staphylococci the most common organism in general is most sensitive for linezolid, followed by cefotaxim and ciprofloxacin. Pseudomonas is most sensitive for piperacillin and tazobactum, followed by amikacin, cefotaxim and meropenem. MRSA is most sensitive to vancomycin followed by linezolid. MSSA is most sensitive to linezolid followed by vancomycin, gentamycin and ciprofloxacin. *E. coli* is sensitive to amikacin, ceftriaxone and imipenem most commonly. *Klebsiella* is sensitive to co-trimaxazole, gentamycin and amikacin. Overall linezolid, amikacin and cefotaxim are the sensitive drugs for SSI's developed in clean and clean contaminated surgeries in our hospital.

Secondary suturing was done in 71.42% of cases and the remaining 28.57% of cases healed by secondary intension. The method used for wound healing was preferred based on the site, size and intensity of the infection. Smaller wounds with less and superficial infections were allowed to heal by secondary intension. Whereas antibiotic administration, according to sensitivity report, regular wound debridement and dressings with secondary closure has found to reduce the duration of hospital stay, faster wound healing and less scar compared to secondary intension.

Surgical site infections have a significant morbidity in our series accounting for about 10.56 days on an average as extra number of days of hospitalization. SSI not only burdens the patients with increased duration of hospitalization but also in increasing the cost of daily expenditures. Prolonged hospital stays not only gives way for cross infections, but also in the development of multi drug resistant strains of micro-organisms. Overall patient will be affected socially, psychologically, economically and hampering the ability to perform routine work.

DISCUSSION

Incidence of infection

In the present study the overall post-operative SSI rate in elective clean and clean contaminated cases was 4.57%. Reports of SSI from different workers gave different infection rates. Number of studies carried out in India indicate overall infection rate of 4.04 to 30% of clean surgical cases. The infection rate in Indian hospitals was much higher than that in other countries; for instance in the USA, it is 2.8% and it was 2–5% in European countries. The highest infection rate in Indian hospitals may be due to the poor set up of our hospitals and also due to the lack of attention towards the basic infection control measures (Table 3).

Table 3: Comparison with similar other studies

Authors	Year	Country	No. of Surgeries	Infections
Cruse *et al.* [5]	1980	Foord Canada	62939	4.7%
Anvikar *et al.* [6]	1999	India	3280	6.09%
Mahesh *et al.* [7]	2010	India	418	20.9%
Present study	2013	India	1225	4.57%

Age and Sex distribution

The incidence was slightly more in case of men accounting for 52% of the overall cases. The various factors attributed to the significant difference in men and women as observed by different authors were-

1. Nicotine use and alcohol consumption more commonly associated with men than in women.
2. A difference in the intensity of immune response between men and women.
3. Gender linked differences in cytokine release plasma levels of the pro-inflammatory mediators like procalcitonin, inteleukin-6 and tumor necrosis factor ά exhibited elevated levels in males.
4. In females an elevated level of the anti inflammatory cytokines interleukin-10.
5. Women are immunologically better equipped to handle septic challenge.
6. Young women have best prognosis and survival rate in surgical ICU.

The present study shows that the incidence of SSI is more among 41–60 yrs age group. This confirmed that there was a gradual rise in incidence of wound infection as age advances although in this study the >60 yrs age group had lesser incidence owing to lesser number of elective surgeries in this group. Likewise Cruse and Foord[5] observed in their study that older patients are more likely to develop infection in clean wounds than younger patients.

The literature shows that SSI increases with obesity, one reason being a decrease in blood circulation in fat tissues.[8-9] Recent preliminary findings from a study of patients who underwent coronary artery bypass graft showed a significant relationship between increasing levels of HbA1c and SSI rates. Also, increased glucose levels (>200 mg/dL) in the immediate postoperative period (<48 hours) were associated with increased SSI risk.[10]

There is still a debate about the duration of the antibiotic treatment and the kind of antibiotic which should be used. In summary, most studies favour one to three intravenous doses of a second generation cephalosporin with or without metronidazole with the first dose being administered before skin incision.[11]

Drain and prosthesis

Infections are more in drained wounds and in the procedure involving implanting prosthesis like mesh. This increased incidence may be due to the effect of the drain itself by acting as a microbial pathway. Implants carry higher risk of infections acting as a foreign body if in case there is breach in the strict aseptic protocols.

Umesh *et al*.[12] in 2007 studied that patients with post-operative drain were 5.8 (2.33–14.66) times more likely to develop SSI compared to those without the drain. Further, the infection rate increases with the increasing duration of the drain. The predominant organisms isolated were *S. aureus* followed by *E. coli.*

Pseudomonas was most common isolate in other studies like Mofikoya *et al*. Bacterial Agents of Abdominal Surgical Site Infections in Lagos Nigeria in 2009. Mofikoya B et al had Pseudomonas species 37.5% sensitive for Ceftaxidine followed by 12.5% Ceftriaxone, and it was most resistant for Cefotaxime. Umesh *et al*. [12] had *Pseudomonas* species 21.4% sensitive for Cephoperazone-sulbactum combination. The proportion of bacteria resistant to all antibiotics for which tested was as high as 63.93% (39/61).

Most of the study showed that virtually all of the pathogens were resistant to the commonly prescribed antibiotics such as Ampicillin and Doxycyclin. The cultured aerobes also demonstrated less than 50% sensitivity to the cephalosporin's tested (Ceftaxidine, Cefuroxime and Ceftriaxone) in over 80% of the infected patients. The finding further supports the well known high prevalence of multiple antibiotic resistant nosocomial pathogens in our environment and may reflect the widespread abuse of antibiotics in the general population. The relative frequency of different isolates also varied between different studies. Thus, it can be concluded that the organisms that cause SSIs change from place to place and from time to time in the same place. The antibiotic sensitivity testing of different isolates showed multidrug resistance by most of the isolates. The review of literature indicates that there is gradual increase in drug resistance to many antibiotics in most of the organisms which are isolated from surgical patients.

Our study reveals that though SSIs have been widely studied for a long time, they still remain as one of the most important causes of morbidity and mortality in surgically treated patients. The steps taken to reduce SSIs are still not adequate. Proper infection control measures and a sound antibiotic policy should reduce SSIs in the future.

CONCLUSIONS

Incidence of surgical site infection in this study was 4.57%. The majority of patients in the study belong to age group of 41–60 yrs age group, followed by 21–40 yrs age group because the extremes of age are less involved in case of elective surgeries in our hospital. The incidence was slightly more in case of men. Superficial surgical site infections in the most common type. DM and obesity was found to be the main risk factors with more number of SSI's. Use of drain and prosthesis was associated with increased rate of SSI. Hence strict aseptic precautions to be maintained, while using prosthesis and drains. *S. aureus* is the commonest organism isolated from the surgical wounds. Most of the organisms were isolated from the clean and clean contaminated cases. Overall linezolid, amikacin and cefotaxim are the sensitive drugs for SSI's developed in clean and clean contaminated surgeries in our hospital. Surgical site infections were identified in 3rd to 5th post operative day. Early detection of surgical site infections, Antibiotic administration, according to sensitivity report, regular wound debridement and dressings with secondary suturing once the local infection is reduced has found to reduce the duration of hospital stay, faster wound healing and less scar compared to secondary intension. SSI will be a burden to the patients in every way. Prevention will be better than cure.

RECOMMENDATION

Following methods are recommended for further reducing infection.

Setting up of hospital infection control committee with its members. Antibiotic policy and strict adherence to it. Regular surveillance and feedback of results to surgeons and following strict surgical auditing. Reducing the pre-operative stay to minimum. Ensuring that the patient is as fit medically as possible especially in elective cases. Using a good surgical technique. Avoiding wound drains. If this is not possible, using a closed drainage system and removal of drains as soon as possible. Proper collection and transport of samples from the surgical site, immediately on suspicion of infection. Awaiting antibiotic sensitivity test results for appropriate antibiotic therapy.

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