Original Article

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Clinical Study of Postoperative Surgical Site Infection in a Tertiary Care Centre

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Abstract

Introduction: Surgical site infection is one of the most common postoperative complications that causes significant postoperative morbidity and mortality leading to prolonged hospital stay and increases cost. About 25-30 percent infections are preventable to the adherence to strict guidelines by health care workers. There are many factors that affect susceptibility of any wound to infection. *Aim and Objectives*: To study the frequency, common risk factors, different organisms and complications of surgical site wound infections. *Materials and Methods*: This prospective study was conducted in the General surgery department amongst 527 patients for surgery, both emergency as well as elective. *Results and Analysis*: The infection rate in clean cases was 9.04%, contaminated 16.20%, clean contaminated 20% and in dirty 32.87%. Overall infection rate was 16.12%. In dirty cases out of 73 cases 6(25%) were mild, 7(29.16%) moderate, 11(45.83%) severe infections including two burst abdomen. The SSI rate in elective surgeries was 12.08% and in emergency surgeries it was 21.39%. The infection rate in patients with hospital stay 0-4 days was 13.06%. The infection rate in preoperative hospital stay of 5-8 days is 24.32%. The wound infection rate in anaemic patient was 25.71%. The postoperative wound infection was 21.34% when drains were used. Coagulase positive Staphylococcus aureus was a single major organism obtained. Conclusion :The overall infection rate was 16.12% which was mainly due to the higher infection rate in the contaminated (20%) and dirty procedures (32.87%).

Keywords: Wound Infection; Contaminated; Emergency; Nosocomial; Infected.

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Introduction

Surgical site infection is one of the most common postoperative complications that causes significant postoperative morbidity and mortality leading to prolonged hospital stay and increases cost. Surgical site infections categorized under a broad term nosocomial infection refers to infection acquired during hospital stay [1]. WHO described hospital acquired infection as one of the major disease having huge economic impact [2]. This develops where medical and paramedical staff is in close contact with patient in various stages of treatment. About 25-30 percent infections are preventable to the adherence to strict guidelines by health care workers. These factors include pre-existing illness, length of operation, wound class and wound contamination, and other factors are extremes of ages, malignancy, metabolic diseases, malnutrition, immune suppression, cigarette smoking, remote site infection, emergency procedures and long duration of pre-operative hospitalization. There are many factors that affect susceptibility of any wound to infection [3].

A wide variety of aerobic and anaerobic species of bacteria may be present either single or in combination. Infection of wound is generally associated with the production of pus. A wound infection is commonest and most troublesome disorder of wound healing. The discovery of

antimicrobial agent also enables us to perform surgeries in many conditions that were previously thought to be impossible in the pre antibiotic era due to risk of infection. Far reaching advances in the field of medicine, techniques in surgery, anaesthetic techniques, innumerable antibiotics, advances in the operating room maintenance after the introduction of lamellar air flow systems and the body exhaust systems have enriched the surgeon's armamentarium. As a result, the post- operative infection rate has come down from about 70% in the pre-listerian era to less than 1% in the developed countries. U.S. National research council group in 1964 developed a system of classification for operative wound which was based on the degree of microbial contamination four wound class with an increasing risk of surgical site infection were described clean, clean contaminated, contaminated, dirty [4].

Hence a constant awareness of the ever present infection would guide the surgical fraternity towards a better patient care. With this preview this study was undertaken.

Aim and Objectives

To study the frequency, common risk factors, different organisms and complications of surgical site wound infections.

- To determine incidence of infection in different category of surgeries.
- To determine host and environmental factors responsible for the surgical site infections.
- To identify the micro-organisms involved in surgical site infections.

Materials and Methods

This prospective study was conducted in the General surgery department. A total of 527 surgical operations, both emergency as well as elective surgeries done during December 2013 to November 2015.

Inclusion Criteria

Patient of age group 14 to 60 years

Exclusion Criteria

1. Minor surgical procedures.
2. Wounds which were laid open and operations on ulcers like skin grafting.
3. Perianal surgeries

Factors Studied

Individual cases were analysed with regard to the following particulars: Age , sex, preoperative and post operative hospitalization, presence of any septic focus, diabetes, smoking habits, weight and height, hemoglobin, surgery done, type of anaesthesia, duration of surgery, nature of surgery (clean ,clean-contaminated, contaminated and dirty), urgency of surgery, preoperative preparation, drains used or not. Standard surgical protocol was followed in all the cases. A single dose perioperative antibiotic prophylaxis using Inj .Amoxicillin-clavulinic acid 1.2 gm was given to all the patients at the time of induction of anaesthesia. Postoperatively amoxicillin-clavulinic acid or cefotaxime or ceftriaxone (depends on availability in hospital) were given for most of the cases. In abdominal cases metronidazole was added. All the 527 wounds were inspected for evidence of wound infection such as erythema, wound discharge on the 3rd postoperative day, at the time of suture removal and at follow up. Vital charting was done during the patients stay in the hospital, post operative fever was correlated with the wound findings as it could be due to reasons other than wound infection. Any discharge from the wound was sent for bacteriological evaluation, culture and sensitivity.

Wound infection was graded as follows.

Grade I- (Stitch Abscess) Redness or pustules near one or more stitches

Grade II - (Mild Infection) Minor infection of wound without separations of wound edges. Slight seropurulent discharge. No systemic reaction.

Grade III- (Moderate Infection) Frank infection in relatively a small portion of the wound with purulent discharge and possibly some systemic reactions present.

Grade IV- (Severe Infection) Frank infection of large portion of the wound with abscess formation usually with systemic reaction and wound dehiscence.

In cases of wound infection additional procedures were done to deal with the infection.

Classification of Surgery

Surgeries were classified into 4 groups

1. Clean - when the operative procedure does not enter into a normally colonized viscous or lumen of the body.

2. Clean contaminated - surgical site was seen when the operative procedure enters into a colonized viscus or cavity of the body, but under elective and controlled circumstances.
3. Contaminated - procedures occur when gross contamination was present at the surgical site in the absence of obvious infection.
4. Dirty - when surgical procedures performed where active infection was already present.

Statistical Analysis

Microsoft Excel was used for analysis of data. Chi square test was used to test the statistical significance of the results. Odds ratio was calculated to measure the strength of association of various factors to wound infection.

Results and Analysis

Total 527 (n) patients were studied, out of which 85 got infected. Out of 527 cases 210 were clean, 179 clean contaminated, 65 contaminated and 73 dirty cases.

The infection rate in clean cases was 9.04%, contaminated 16.20%, clean contaminated 20% and in dirty 32.87%. Infection was higher in contaminated and dirty operations as compared to clean cases. Overall infection rate was 16.12%. Odds ratio suggestive that the incidence of infection in clean contaminated cases was 1.94 times that in clean cases, it was statistically significant as shown by 95% confidence intervals, also odds ratio for contaminated cases was 2.51 and dirty cases 4.92 which were more likely to get infection. The results were statistically significant($p<0.05$) .

Table 1: Distribution of the cases according to the infection rate according to the nature of surgery

Nature of Surgery	No. of infected	No. of uninfected	Total	Odds ratio
Clean	19(9.04%)	191 (90.95%)	210 (39.84%)	1
Clean Contaminated	29 (16.20%)	150 (83.79%)	179 (33.96%)	1.94 (1.049 to 3.602)
Contaminated	13 (20%)	52 (80%)	65 (12.33%)	2.51 (1.164 to 5.425)
Dirty	24 (32.87%)	49 (67.12%)	73 (13.85%)	4.92 (2.497 to 9.709)
Total	85 (16.12%)	442 (83.87%)	527	

Chi square $\chi 2 = 23.64$, Degree of freedom = 3, P=0.00029 (significant),

Table 2: Distribution of the cases according to the type of infection in each surgery group.

Nature of Surgery	Mild	Moderate	Severe	Total
Clean	**12**(5.71%)	5(2.38%)	2(0.95%)	19
Clean Contaminated	11(6.14%)	11(6.14%)	7(3.91%)	29
Contaminated	4(30.76%)	5(38.46%)	4(30.76%)	13
Dirty	6(25%)	7(29.16%)	**11**(45.83%)	24
Total	**33**	**28**	**24**	**85**

It was observed that majority of wound infection in the clean category were mild infections and most of severe infections were seen in dirty category.

Table 3: Distribution of the cases according to the infection rate with reference to the urgency of operations.

Urgency of surgery	No. of infected	No. of uninfected	Total	Odds ratio
Elective	36 (12.08%)	262 (87.91%)	298 (56.54%)	**1**
Emergency	49 (21.39%)	180 (78.60%)	229 (43.45)	1.981 (1.238 to 1.171)
Total	85 (16.12%)	442 (83.87%)	**527**	

Chi square $\chi 2 = 8.31$, degree of freedom = 1, p = 0.0039 (significant).

Table 4: Distribution of the cases according to the incidence of infection in relation to experience of surgeon.

Experience of Surgeon	No. of infected	No. of uninfected	Total	Odds ratio
Category A	07 (6.93%)	94 (93.06%)	101 (19.16%)	1
Category B	13 (12.26%)	93 (87.73%)	106 (20.11%)	1.87 (0.6785 to 4.615)
Category C	65 (20.31%)	255 (79.68%)	320 (60.72%)	3.42 (1.302 to 6.597)
Total	85 (16.12%)	442 (83.87%)	**527**	

Category A= senior consultant (Professor, associate professor), Category B= junior consultant (assistant professor/lecturer/senior registrar), Category C = Residents (Jr1, Jr2, Jr3)

Table 5: Distribution of the cases according to the incidence of postoperative wound infection in relation to the preoperative hospital stay

Preoperative Hospitalization in days	No. of infected	No. of uninfected	Total	Odds ratio
0- 4 days	52 (61.17%)	346 (78.28%)	398 (75.52%)	**1**
5 to 8 days	27 (31.76%)	84 (19.00%)	111 (21.06%)	2.139 (1.26 to 3.60)
9 to 12 days	03 (3.52%)	07 (1.58%)	10 (1.89%)	2.852 (0.71 to 11.38)
13 to 16 days	03 (3.52%)	05 (1.13%)	08 (1.51%)	3.992 (0.92 to 17.21)
Total	85 **(16.12%)**	442 (83.87%)	**527**	

Chi square for linear trend =12.40, degree of freedom=3, P<0.05(significant)

Table 6: Distribution of the cases according to the incidence of postoperative wound infection in relation to anaemia

Anaemia	No. of infected	No. of uninfected	Total	Odds ratio
Non-anaemic	67 (78.82%)	390 (88.23%)	457 (86.71%)	**1**
Anaemic	18 (21.17%)	52(11.76%)	70 (13.28%)	2.015(1.111 to 3.655)
Total	85 (16.12%)	442 (83.87%)	527	

Chi square $\chi 2 = 5.483$, degree of freedom = 1, p = 0.0192 (significant)

Table 7: Distribution of the cases according to the incidence of wound infection in relation to drains used

Drains	No. if infected	No. of uninfected	Total	Odds ratio
Without Drains	31 (36.74%)	243 (54.97%)	274 (51.99%)	**1**
With Drains	54 (63.52%)	199 (45.02%)	253 (48.00%)	2.127(1.316 to 3.487)
Total	85 (16.12%)	442 (83.87%)	527	

Chi square $\chi 2 = 9.782$, degree of freedom = 1, p = 0.0018 (significant)

Table 8: Distribution of the cases according to the bacteria found

Organisms Cultured	Number
Coagulase positive Staphylococcus aureus	21
E.Coli	15
Klebsiella sp	10
Pseudomonas sp	10
Coagulase negative Staphylococcus aureus	3
Coagulase positive Staphylococcus aureus + E.Coli	
E.Coli +Klebsiella sp	4
Klebsiella sp+ Coagulase positive Staphylococcus aureus	1
E.Coli +Pseudomonas sp	1
pseudomonas sp+ Coagulase positive Staphylococcus aureus	2
Proteus mirabilis	2
Enterococcus sp	2
No organism cultured (sterile)	11

Out of the 210 clean cases there were 12 (5.71%) minor infections, 5 (2.38%) moderate infections and 2(0.95%) severe infections. Out of 179 clean contaminated cases 11(6.14%) were mild, 11 (6.14%) moderate, 7(3.91%) severe infections. In the contaminated group, out of 65 cases 4 (30.76%) were mild, 5 (38.46%) moderate, 4(30.76%) were severe infections. In dirty cases out of 73 cases 6(25%) were mild, 7(29.16%) moderate, 11(45.83%) severe infections including two burst abdomen.

The SSI rate in elective surgeries was 12.08% and in emergency surgeries it was 21.39%. The incidence of SSI in emergency was 1.98 times that of in elective operations and the findings was significant p<0.05 as shown by 95 %confidence intervals.

Chi square $\chi 2 = 11.63$, degree of freedom = 2, p = 0.0030 (significant). Infection rate in surgeries done by less experience or junior doctor (Resident) was 20.31%, which was 3.42 times higher as compared to experienced surgeons (6.93%). This result was statistically significant as shown by 95 % confidence intervals (p<0.05).

The infection rate in patients with hospital stay 0-4 days was 13.06%. The infection rate in preoperative

hospital stay of 5-8 days is 24.32%. This was 2.13 times more than previous group. The postoperative wound infection rate in group with pre op stay of 9-12 days and 13-16 days were 30% and 37.5% respectively .which is 2.85 and 3.99 times higher than 0-4 days group respectively. This result was statistically significant as shown by 95% confidence intervals ($p<0.05$).

The wound infection rate in anaemic patient was 25.71% and in nonanaemic patient was 14.66%. It was 2.015 times higher for anaemic in terms of odds ratio, and also significant ($p<0.05$) for 95 % confidence intervals.

The postoperative wound infection when drains not used was 11.31%, whereas the same was 21.34% when drains were used. The wound infection rate was 2.12 times higher when drains were used than drains not used. This was statistically significant ($p<0.05$) as shown by 95% confidence intervals.

Various organisms cultured from the 85 wounds are shown in the Table 8. Whenever there was a discharge from the wound, a swab was taken and sent for microbiological examination. Coagulase positive Staphylococcus aureus was a single major organism obtained. E.coli was 2nd most common organism and most common gram negative organism for SSI in our study.

Discussion

The present study was carried out on 527 patients in a tertiary care hospital in Aurangabad those underwent various surgeries. Incidence of infection in this study was 16.12% which appears to be high. Many studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7% [5]. Like Anand Saxena et al [6] reported 14.33%, Satyanarayana et al [7] 13.7%. The etiology of surgical site infections was dependent on the location of the surgery, the bacterial load in the tissue or blood peri-operatively and the integrity of host defenses. In our study, infection rate as per class of procedure was clean (9.04%), clean contaminated (16.20%), contaminated (20%) and dirty (32.87%).

The increased incidence of SSI in clean surgeries can be due to cross infection in wards and in operation theatre. In our study most cases of SSI occurred in dirty surgeries, which is consistent with the literature [8].

Higher infection rate in our study was particularly due to higher infection rate in the contaminated (20%) and dirty operative procedures category (32.87%) as the national medical council (1960) [9] has rightly pointed out, certain operative procedures have a higher propensity for infection. The infection rates in the contaminated and dirty procedures category were comparable with those of Satyanarayana et al [7] and Narsinga Rao et al [10]. The infection rate in clean procedure were comparable with those of Mahesh et al [5], Anand Saxena et al [6].

The infection rate in our hospital remains high over the years that are explained considering the fact that the most of the patients were anemic with higher susceptibility to infection. This being a teaching hospital, Operation Theater was often crowded with medical and nursing students providing higher chance of contamination. This along with improper ventilation increases chances of wound infection. Hot and humid condition and poor nutritional status of Indian population makes them more vulnerable for wound sepsis than well-nourished western population. The infection rate in Indian hospitals is much higher than that in other countries, for instance in the USA, it is 2.8% and it is 2-5% in European countries.

Elective vs Emergency Procedure

In our study wound infection rate in emergency surgeries was 21.39%, which was 1.98 (odds ratio) times higher than elective surgeries (12.08%). Same was reported by Razavi et al [11] (18.1%), Mahesh et al [5] (21.05%). In our study more cases that had SSI were operated on emergency basis. The higher rate of infection in emergencies may be because of insufficient pre-operative preparation, the underlying condition which predisposed to emergency procedure.

Age and Sex of Patient

In our study infection rate were increasing as age increases with peak at age group 46-60 years (19.45%). Though the infection rate in 46-60 years groups was 1.74 times (odds ratio) than in younger age groups this was statistically non significant. Same trend were noted by Anand Saxena et al [6] and Patel Sachin et al [12]. The other factors like the general conditions of the patient, metabolic diseases, reduced compliance were common in older age groups.

Diabetes

Infection rate in diabetics were significantly higher (44.68%) than nondiabetics (13.33%) which was significant (OR=5.25) though sugar levels were

controlled before operation by giving insulin. Post-operative blood glucose levels were maintained below 200mg/dl in our study. Diabetic patient were more prone for infection than non-diabetic patient. The increased susceptibility to infection in diabetics was an established risk factor [13]. Other studies by Syed Mansour Razvi, et al [14], William G. Cheadl [8], have also found that diabetes increases the risk of postoperative wound infection.

Obesity

Obesity was present in 65 patients in our study, BMI more than 30 considered as obesity .Out of which 24 (36.92%) got infection. Obesity was known to be a well-established risk factor for postoperative wound infection. It contributes as strongly as surgical procedure category for likelihood of acquiring surgical site infection. Narsinga Rao et al [10], Barber G. R et al [15], Habte gabr et al [16] showed that obesity was an independent risk factor for development of SSI. One study conducted by Zeynep et al [9] has shown that obesity delays wound healing and increases the risk of wound dehiscence in patients with postoperative wound infection. These findings were consistent with the patients in our study.

Anaemia

Infection rate in patient with anemia (hemoglobin <9 gm %) was 25.71% with odds ratio 2.015, these values were statistically significant showing association between anemia and postoperative wound infection. Narsinga Rao et al [10] reported SSI rate of 24%, Anand Saxena et al [6] reported 21.73% while Satyanarayana V et al [7] reported 21.08% in anemic patients.

Experience of Surgeon

The rates of postoperative wound infections were higher (20.31%) amongst the patients who were operated by the junior surgeons with lesser experience than amongst those who were operated by senior surgeons (6.93%) with longer experiences. Narsinga Rao et al [10] had reported 17.54% infection rate with junior surgeons compared to 6.2% with senior surgeons. Patel Sachin et al [12] reported 19.6% with junior surgeons and 12.9% with seniors.

Use of Drains

This study also confirmed that there was an increase incidence of wound infection in operations where drains were used (21.34%) when compared to operations where drains were not used (11.31%). This finding was statistically significant (odds ratio 2.12), drains were used mainly in dirty and emergency operations, which were by itself associated with higher infection rate. Cruse and Ford [17] found that use of drains was associated with higher infection rate.

Pre-Operative Hospitalization

In our study the infection rate was higher when the preoperative hospitalization was more 9-12 days (30%) compared to 0-4 days (13.06%). Anand Saxena et al [6] had reported infection rate of 21.88% with pre op stay of 6-10 days. Patel Sachin et al [12] reported 33.3% with pre op stay of 6-10 days.

Bacteriology

In our study the commonest etiologic agent among gram-positive organisms was Staphylococcus aureus and gram negative organism was E.coli. We found the staphylococcus aureus as most commonly identified organism from wounds similar to Shittu et al [18]. But Patel Sachin et al [12] found E.coli most offending pathogen.

Conclusion

The overall infection rate was 16.12% which was mainly due to the higher infection rate in the contaminated (20%) and dirty procedures (32.87%). The infection rate was higher in the emergency operative procedures (21.39%) when compared to the elective procedures (12.08%). Infection rate was higher among patient age group 46-60 years, and in patients with preoperative hospitalization more than 0-4 day. SSI decreases as experience of surgeon increases. SSI was more in diabetics. Delayed wound healing was more in patients with SSI with diabetes. Obesity was risk factor for SSI. Delayed wound healing and surgical wound dehiscence was more in patients with SSI with obesity. SSI was most common in dirty surgeries and least common in clean surgeries. Staphylococcus aureus was the most common organism responsible for SSI. E.Coli was the 2nd most common organism and most common gram negative organism responsible for SSI. Amikacin was the most sensitive antibiotic in the study.

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