Surgical Site Infections in Abdominal Surgeries - A Clinicopathological Prospective Study

Biswaranjan Mohapatra[1], Dipesh Kumar Padhihari[2], Mrutynjay Das[3], Sai Barath Sunkara [4] Saikh Kasif Sahajada[5]

[1, 2, 4, 5] Department of General Surgery, Hi-Tech Medical College, Bhubaneswar, Odisha, India.
[3]Department of Plastic Surgery, Hi-Tech Medical College, Bhubaneswar, Odisha, India.

ABSTRACT

BACKGROUND

Surgical site infection still remains a nightmare for most surgeons even in these times despite many advances in medical science, surgical techniques & better operating room environment. Surgical site infection (SSI) is defined as 'an infection occurring within 30 days of a surgery (or within 1 year if an implant is left in place after procedure) and affecting either incision or deep tissues at the operation site.

METHODS

A single observer, cross sectional, prospective study was carried out in the Dept. of General Surgery, in collaboration with Microbiology & Pathology Departments of Hi-tech Medical College and Hospital, Bhubaneswar, Odisha. The study included all patients who underwent laparotomy during the period of study, patients of all age groups except neonates and patients with post-operative surgical site infections.

RESULTS

The prospective study involved culture and sensitivity of 114 patients undergoing clean-contaminated surgeries (group A), contaminated-surgeries (group B) in the Department of Surgery at our institute. The study shows that the maximum number of cases were between 21 to 60 yrs. of age. (78 %) and the mean age in the group A was 39.2 years while in group B, it was 39.8 years. There was a total of 90 patients between 21 - 60 yrs. of age. Mean hospital stay in group A was 5.7 days and group B was 8.9 days. The sex ratio is quite evenly matched, 63 male patients and 51 female patients out of 114 cases. Amongst the 114 subjects, group A comprised of 58.77 % (67) while group B consisted of 41.22 % (47.13) patients. Out of 67, 13 from group A came back as sterile, in group B sterile samples were 10.

CONCLUSIONS

This study concludes that age, sex, class of wound, peri-operative management, operating time and co-morbidities of the patient, all have a significant effect on the incidence of surgical site infections.

KEYWORDS

Surgical Site Infection, Laparotomy, Purulent Discharge, Drain

Corresponding Author:
Dr. Sai Barath Sunkara,
Assistant Professor,
Department of General Surgery,
Hi-Tech Medical College,
Bhubaneswar, Odisha, India.
E-mail: saibharatsunkara@gmail.com

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BACKGROUND

Surgical site infection still remains a nightmare to all surgeons even in this era of advanced medical science. In spite of advances in surgical techniques, better operating room environment, antibiotic prophylaxis, it still occurs in a significant number of patients.[1] In 1992, Centre for Disease Control (CDC, US) revised its definition of 'wound infection' by creating the definition 'surgical site infection' (SSI).[2]

Surgical site infection (SSI) is defined as 'an infection occurring within 30 days after a surgical operation (or within 1 year if an implant is left in place after procedure) and affecting either incision or deep tissues at the operation site.[3] These infections may be superficial or deep incisional infections or infections involving organ or body space. These infections are usually caused by the exogenous or endogenous microorganisms that enter the operative wound during the course of surgery.[4]

Based on National Nosocomial Infection Surveillance (NNIS) of United States of America system reports, SSIs are the third most frequently reported nosocomial infections. They account for 14 to 16 % of all nosocomial infections among hospitalized patients. Incidence of SSIs in India reported to vary from 3.6 % to 22.5 %.[5]

Each hospital has its own unique bacterial flora to which patients are at risk for acquiring infection during hospitalisation. In such situations, microorganisms exhibit unique antibiotic susceptibility pattern during a certain period of time. Only when such epidemiological data are available can the surgeon employ a logical approach towards surgical site infection control. Also, resistance to antimicrobials has become a serious problem necessitating in depth study of SSI to prevent the future complications in operated cases.[6]

The risk of developing a surgical site infection, depends on the balance between factors determining the number of bacteria contaminating the site and the factors determining the resistance of the site against infection.[7] Postoperative wound infection results from bacterial contamination during or after a surgical procedure.[8] It can occur from first day onwards to many years after an operation but commonly occurs between the fifth and tenth days after surgery and can cause life threatening postoperative complication. Most SSIs are caused by contamination of an incision with microorganisms from the patient's own body during surgery. Infection caused by microorganisms from an outside source following surgery is less common. Majority of SSIs are preventable. Measures can be taken in the pre, intra and post-operative phases of care to reduce risk of infection.[9]

Bacteriological studies have shown that SSIs are universal and etiological agents involved may vary with geographical location, between various procedures, between surgeons, from hospital to hospital or even in different wards of the same hospital. The problem gets complicated by irrational use of broad-spectrum antibiotics and resulting antimicrobial resistance. Poor infection control practices and overcrowded hospitals further add to the woes.[10]

Staphylococcus aureus is frequently isolated from surgical site infections which may serve as nidus for the development of systemic infections. Strains of methicillin resistant *Staphylococcus aureus* (MRSA) have become established as the prevalent strains in hospitals. MRSA has become the 'bugbear' of modern surgical practice. Increased frequency of MRSA in hospitalized patients and possibility of vancomycin resistance requires permanent control of MRSA spread in the hospital.[11]

Hence, this study was conducted with an objective to identify the organisms causing SSIs and evaluate the antibiotic resistance pattern among the most common bacteria which are associated with SSIs and identification of risk factors causing SSIs.

Objectives

1. To determine the incidence of surgical site infections in surgical department.
2. Isolate and identify the causative bacterial pathogens.
3. Assess their antibiotic susceptibility pattern.
4. To evaluate different risk factors causing SSIs.

METHODS

This is a single observer, cross sectional, prospective study carried out in the Dept. of General Surgery, in collaboration with microbiology & pathology departments of Hi-tech Medical College and Hospital, Bhubaneswar, Odisha. The study included all patients who underwent laparotomy during the period of study.

One hundred and fourteen patients were operated from three surgical departments in the study period of 2 years from November 2016 to October 2018.

Inclusion Criteria

a. Patients of all age groups except neonates.
b. Presence of post-operative surgical site infections.

Exclusion Criteria

a. Infection occurring 30 days after operation if no implant is in place.
b. Procedures in which healthy skin was not incised.
c. Patients not willing to take part.

Parameters Studied

a. Detailed clinical history of the patient was taken with special reference to existing chronic disease (such as diabetes mellitus), past medical history, current drug use such as steroid, smoking, length of preoperative hospital stays, duration of operation and antimicrobial prophylaxis.
b. Isolation and identification of pathogens causing infections in the patients suspected with postoperative wound infection.
c. Antibiotic sensitivity pattern of the isolates.

Study Techniques

Two wound swabs (one for Gram stain and another for culture) or pus from wounds were processed. Gram staining was done from one swab and findings were recorded. Another swab was used for culture on 5 % sheep blood agar and MacConkey agar. Inoculated plates were incubated at 37°C. After overnight incubation, growth was identified by standard bacteriological techniques including colony morphology, Gram staining from colony and biochemical properties including antibiogram.

Wound infection was clinically diagnosed if any one of the following criteria were fulfilled:

1. Serous or non-purulent discharge from the wound.
2. Pus discharge from the wound.
3. Serous or non-purulent discharge from the wound with signs of inflammation (oedema, redness, warmth, tenderness, increased local temperature and fever >38ºC).

Methodology

1. Study was carried out amongst the patients admitted in surgery ward.
2. Informed valid written consent was obtained after the patient is explained about the study in her/his language.
3. Preoperative, intraoperative, postoperative variables like antibiotics, time of shave and preparing parts were standardised.
4. Sample was taken from two sites, operative field and subcutaneous planes. The area was then washed and closed.
5. Fever was noted if present.
6. If drain was placed, drain fluid culture and sensitivity was done if there were signs of infection.
7. Sterile swabs were used to collect samples from suture site at three different places, the ends and middle portion.
8. Culture was done according to standard procedure protocol as followed in HMCH, Micro-Biology Department.
9. Routine sensitivity for standard drugs was done.
10. Different data was collected in correlated tabular forms and analysed.
11. Postoperative swabs were collected from.

    A. Serous or non-purulent discharge from the wound.
    B. Pus discharge from wound.
    C. Serous or non-purulent discharge from wound with signs of inflammation.
    D. Wound deliberately opened by surgeon to drain collection (serous / purulent).

Implications

1. If the rate of infection and organisms cultured are in accordance with national and international studies.
2. If the organisms cultured remain the same irrespective of which organ system was operated on.
3. If the organisms cultured from the drain fluid and suture site overlap for a given patient.
4. If the sensitivity and resistance profile matched the accepted standards for the given set up.

RESULTS

This prospective study involved culture and sensitivity of 114 patients undergoing clean-contaminated surgeries (group A), contaminated-surgeries (group B) in the Department of Surgery at our institute. Patients were from three general surgical units who were operated as the first procedure of the day in the three allotted operating rooms. Swabs were collected by the investigator.

The study shows the maximum number of cases are between 21 to 60 yr. (78 %) of age and the mean age in group A was 39.2 years while in group B was 39.8 years. There was a total of 90 patients in the age of 21 - 60 yrs. The study shows the mean age of both the groups and mean hospital stay in group A was 5.7 days and group B was 8.9 days. The sex ratio is quite evenly matched, 63 male patients and 51 female patients out of 114 cases.

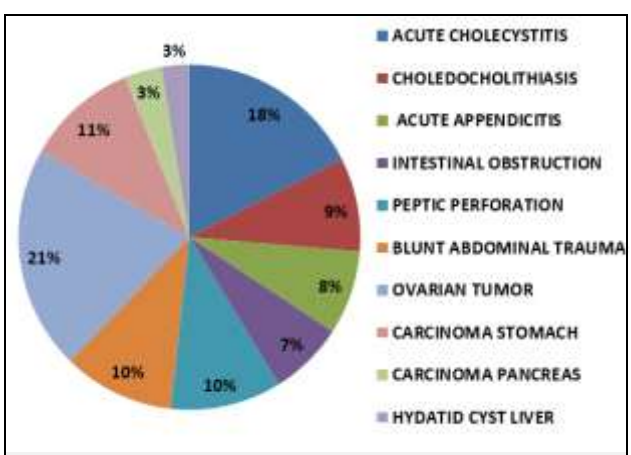

Chart 1. Distribution of Patients According to Diagnosis

It is observed from the study that out of 114 cases, 51 cases (44.2 %) are emergency while the remaining 63 cases (56.78 %) are elective. The distribution of patients according to the operative procedure; Amongst the 114 cases 75 cases, 65.7 % underwent explorative laparotomy, 20 cases, 17.5 % underwent open cholecystectomy, 10 cases 8.7 % underwent CBD exploration and remaining 7.8 % cases underwent open appendectomy.

Time Period	Group A (N= 67)	Group B (N=47)
< 60 Mins	43	39
60 – 120 Mins	24	4
> 120 Mins	0	4

Table 1. Distribution of Patients According to Operative Time Period

In this study over 76 % were operated with midline incision, the remaining 24 % with paramedian and transverse incision. The number of cases with haemoglobin below and above 10 gm % and its significance to surgical site infections.

Total Protein	No. of Cases
< 2.9 gm / dL	10
> 3.0 gm / dL	104

Table 2. Percentage of Patients with Hypo-Proteinemia at Time of Surgery

Table 2 denotes total number of patients with total protein below and above 3.0 gm / dL. Amongst the 114 subjects group A comprised of 58.77 % (67) while group B consisted of 41.22 %. 13 out of 67 in group A came back as sterile, in group B sterile samples were 10. Amongst all the culture positive examples, 10 in group A and 11 in group B grew two types of micro-organisms on a single culture. In gist total organisms cultured in group A are 64 and group B are 48. So, for all statistical analysis the total will be 64 and 48 for group A and group B respectively. As one of the two organisms is bound to give rise to the infections.

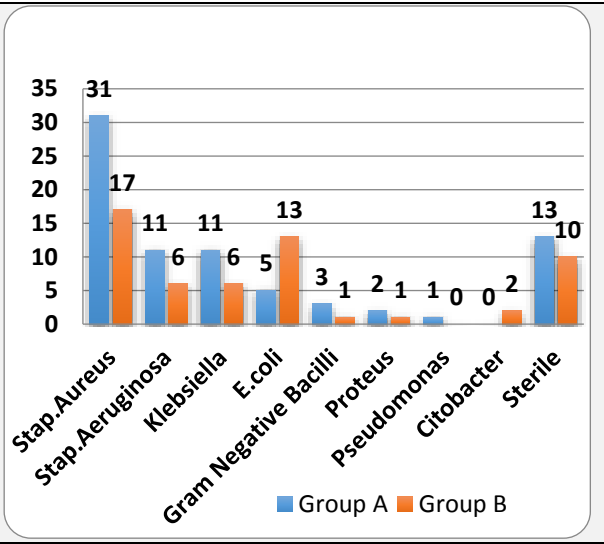

Chart 2. Analysis of the Organisms Grown in Culture

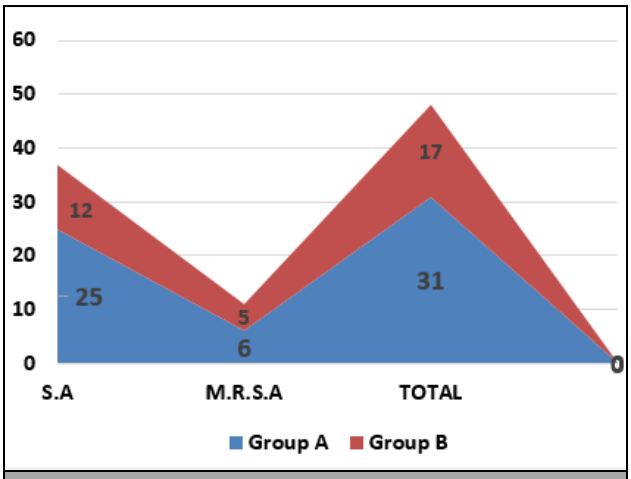

Chart 3. Proportion of M.R.S.A. among Staph. aureus

Chart 2 shows the detailed analysis of the different types of organism cultured in the two groups, most common being *Staph. Aureus, Staph. Aeruginosa, Klebsiella and E. coli* in descending order in group A. Group B has *Staph Aureus, E. coli* being the most common followed by *Staph. aeruginosa, Klebsiella*. While Gram negative bacilli, *Proteus, Pseudomonas, Citrobacter* were cultured in different frequencies.

Chart-3 states the MRSA proportion among *Staph. Aureus*, 6 out of 25 cases in group A and 5 out of 12 cases in group B were positive for MRSA.

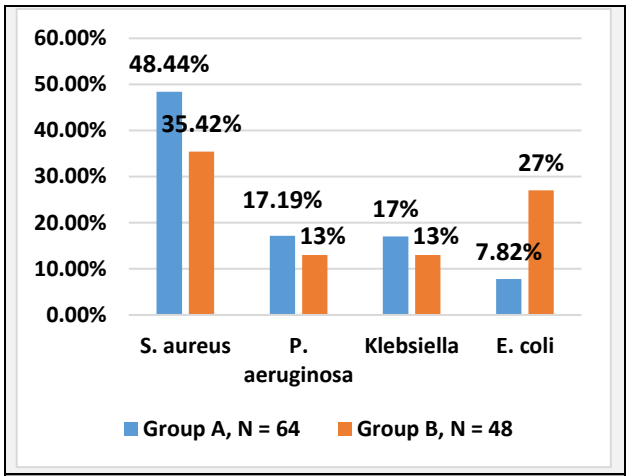

Chart 4. Percentage of Most Frequently Cultured Organisms

Group A		Group B	
Staph. Aureus			
Sensitive	**Resistant**	**Sensitive**	**Resistant**
Linezolid – 26	Co-trimoxazole – 20	Doxycycline – 14	Clindamycin – 9
Amikacin – 25	Ciprofloxacin – 17	Amikacin- 12	Pencillin – 15
Doxycycline – 25	Penicillin – 15	Linezolid – 12	Ciprofloxacin – 9
Clindamycin –17	Levofloxacin – 14	Clindamycin – 9	Erythromycin – 7

Table 3. Sensitivity & Resistance Profile of Most Frequently Encountered Organisms

DISCUSSION

Despite the advances in surgical techniques and better understanding of the pathogenesis of wound infection, management of SSIs remains a significant concern for surgeons and physicians in a health care facility. Patients with SSIs face additional exposure to microbial populations circulating in a hospital setup which is always charged with microbial pathogens. The unrestrained and rapidly spreading resistance to the available array of antimicrobials further contributes to the existing problem.[10]

This prospective study "Abdominal Surgical Site Infections-A Prospective Clinico-pathological Study" at Hi-Tech Medical College and Hospital was conducted in the Department of General Surgery in collaboration with various other (Microbiology, Pathology, Statistical medicine) departments for a period of 24 months (November 2016 to October 2018). In the present study, a total of 114 swab samples were collected from surgical site infections, out of all operated cases in 2 years from Department of Surgery. From a total of 114 operated cases, 75 cases, 65.7 % underwent explorative laparotomy, 20 cases, 17.5 % underwent open cholecystectomy, 10 cases 8.7 % underwent common bile duct (CBD) exploration and remaining 7.8 % cases underwent open appendectomy.

The gender distribution of the study population shows 51 (44.1 %) of females being operated in comparison to 63 (55.9 %) male patients. In this present study, Overall incidence of SSI was 8.5 % which is in concordance with study carried out by Jain A et al.[12] (2014, Western India) 6.97 % SSI rates in other studies were 17.8 % (Vikrant Negi et al.)[10] and 14 % (Shreeram A et al.)[13] Rate of SSIs have been reported to be 2.5 % to 41.9 %.[14] However, in comparison to the Indian hospitals, the rate of infection reported from other countries is quite low; for instance, in USA it is 2.8 % and in European countries, it is reported at 2-5 %.[10]

The lack of attention towards the infection control measures, inappropriate hand hygiene practices and overcrowded hospitals can be the major contributory factors for high infection rates in Indian hospitals. The changing pattern of SSIs could be due to the reported indiscriminate use of new / many broad-spectrum antibiotics, the increasing use of instrumentation, the long preoperative stay and coexisting infections at a remote body site.[15] The current study showed 63 (55.1 %) of male patients and 51(44.9 %) of female patients developed SSI in contrast to study carried out by B Ananthi et al. (2017, Chennai)[16] which had male patients (57.38 %) and female patients (42.62 %).

As far as association of SSIs with age of patients is concerned, maximum number of patients in our study belonged to the age above 40 years in Surgery Department. Vikrant Negi et al. (2015)[10] had similar findings in their study from Uttarakhand which had 51.8 % of patients with SSI above 50 years of age. Advancing age is an important factor for the development of SSIs, as in old age patients there is low healing rate, low immunity, increased catabolic processes and presence of comorbid illness like diabetes, hypertension etc.[10]

Type of surgery had a significant impact on development of SSIs in different departments. The current study had 44.7 (51 out of 114) of SSIs developing from emergency surgeries alone. This observation was in concordance with study done by Amrutham R et al. (2017, Telangana).[17] Surgeries with highest incidence of SSIs were exploratory laparotomies, compound fractures and high-risk pregnancies.

The present study indicates the presence of SSI in both clean and contaminated cases. This observation is in accordance with study done by Dhaigude BD et al. (2016, Pune)[18] In the study, there were more cases of SSI in Open Cholecystectomy procedure for both the groups (83.3 % and 57.1 % respectively). SSI was also observed in interval appendectomy procedure (16.7 % and 42.9 % respectively). The association of SSI with Operative procedure was statistically not significant as per Chi-Square test ($p > 0.05$).

Staphylococcus aureus is a major human pathogen and a predominant cause of SSIs worldwide with prevalence rate ranging from 4.6 % to 54.4 %. *Staphylococcus aureus* was the single predominant gram-positive isolate obtained in this study. Infection with *Staphylococcus aureus* is most likely associated with endogenous source as it is a member of skin and nasal flora and also with contamination from environment, surgical instruments or from hands of health care workers.[10]

Methicillin resistant *Staphylococcus aureus* (MRSA) have become increasingly prevalent worldwide. Due to an increasing number of infections caused by MRSA strains, which are now most often multi resistant, therapy has become problematic. MRSA spreads by direct physical contact or transmitted indirectly by contact with towels, clothes etc. Surgical patients are at risk of infection if they are colonized with MRSA or if MRSA is inoculated into their surgical wound by contaminated hands or instruments including dressing scissors.[11] The knowledge of the causative agents of wound infection has proved to be helpful in selection of antimicrobial therapy and on infection control measures in the hospital.[19]

CONCLUSIONS

Overall, SSI rate is high in elderly population, in contaminated wounds, and in surgeries of long duration (>60 mins). The most common gram-positive organism causing SSI is *Staphylococcus aureus* and the most common gram-negative organism is *E. coli*. Presence of comorbidities (diabetes, hypertension, low protein, etc.) and low haemoglobin concentration influence postoperative infections. Midline incision has more significance for wound dehiscence and mean wound dehiscence day is 8.9 days.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
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