E-ISSN: 2616-3470
P-ISSN: 2616-3462

www.surgeryscience.com
2021; 4(4): 314-320
Received: 2-12-2020
Accepted: 20-12-2020

Dr. Sandeep Kumar V
Assistant Professor, Department of General Surgery, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda, Telangana, India

Dr. KVR Rammohan Rao
Associate Professor, Department of General Surgery, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda, Telangana, India

Corresponding Author:
Dr. KVR Rammohan Rao
Associate Professor, Department of General Surgery, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda, Telangana, India

A study on clinical and bacteriological profile of abdominal surgical site infections (SSI): An observational study

Sandeep Kumar V and KVR Rammohan Rao

DOI: https://doi.org/10.33545/surgery.2020.v4.i4e.1125

Abstract
Background & Objectives: A surgical site infection is an infection that occurs after surgery in the part of the body where the surgery took place. SSIs previously called Post-operative wound infection result from bacterial contamination during or after a surgical procedure. Surgical Site Infection (SSI) by definition refers to an infection which occurs within 30 days after the surgery or within 1 year when an implant is left in place after the surgery and involving the incision or deep tissues at the operated site or infections involving organ or body space other than the incision, which was opened or manipulated during an operation. Surgical site infections (SSI) constitute a major public health problem worldwide and are the second most frequently reported nosocomial infections. They are responsible for increasing the treatment cost, length of hospital stay and significant morbidity and mortality. A surgical site infection is an infection that occurs after surgery in the part of the body where the surgery took place.
This study is an attempt to know the pre-operative, Operative and post-operative factors predisposing to Surgical site infections and the bacteriological profile of those infection so as to establish Antibiotic guidelines in our tertiary care centre.
Materials & Methods: All adult male and female patients of age more than 18 yrs undergoing abdominal surgeries for various reasons were included in the study. This prospective study was conducted in the department of general surgery in Kamineni Institute of Medical Sciences between November 2019 to October 2020.
Results: This study included 100 patients who underwent abdominal surgery, out of which 30 patients developed surgical site infections. So the incidence is 30%. Incidence of SSI among males was 29.3 % whereas incidence of infection among females was 33.3 %. Clean wounds had least SSI (6.7%) and the Dirty wounds had the highest SSI (50%)
Using drain was associated with increased incidence of SSI (44%) and mesh usage was not associated with SSI. SSI was most commonly detected on Post op day (POD) 4 (20 out of 45 cases). The SSI rate increased with increasing age and it also increased significantly with the increasing duration of pre-operative hospitalization. The SSI rate was significantly higher in emergency surgeries as compared to the elective surgeries. The infection rate was significantly higher as the duration of the surgery increased. The most commonly isolated organism from surgical site infections were *Enterococci* (22.2%) and staphylococcus aureus (22.2%) and other bacteria. 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 more rational use of antibiotics.
Conclusion: The rate of SSI observed in this study was comparable to other similar studies, however we observed a higher degree of antimicrobial resistance. Adherence to strict infection control measures, maintenance of proper hand hygiene and optimal preoperative, intraoperative and postoperative patient care will surely reduce the incidence of SSIs.

Keywords: Antimicrobial resistance, infection control, MRSA, nosocomial infection, post-operative wound

Introduction

Surgical site infections (SSI), one of the most common causes of nosocomial infections and complication associated with surgery and with a reported incidence rates of 2-20% [1]. Surgical Site Infection (SSI) by definition refers to an infection which occurs within 30 days after the surgery or within 1 year when an implant is left in place after the surgery and involving the incision or deep tissues at the operated site or infections involving organ or body space other than the incision, which was opened or manipulated during an operation [2].

They are responsible for increasing the treatment cost, length of hospital stay and significant morbidity and mortality. Despite the technical advances in infection control and surgical practices, SSI still continue to be a major problem, even in hospitals with most modern facilities. These infections are usually caused by exogenous and/or endogenous micro organisms that enter the operative wound either during the surgery (Primary infection) or after the surgery (Secondary infection) [3, 4]. Primary infections are usually more serious, appearing within five to seven days of surgery. Majority of SSIs are uncomplicated involving only skin and subcutaneous tissue but sometimes can progress to necrotizing infections. The usual presentation of infected surgical wound can be characterized by pain, tenderness, warmth, erythema, swelling and pus formation [5, 6]. A number of patient related factors (Old age, nutritional status, pre-existing infection, co-morbid illness) and procedure related factors (poor surgical technique, prolonged duration of surgery, pre-operative part preparation, inadequate sterilization of surgical instruments) can influence the risk of SSIs significantly. In addition to these risk factors, the virulence and the invasiveness of the organism involved, physiological state of the wound tissue and the immunological integrity of the host are also the important factors that determine whether infection occurs or not [7, 8].

Bacteriological studies have shown that SSIs are universal and the 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. In the recent years there has been a growing prevalence of gram negative organisms as a cause of serious infections in many hospitals. In addition irrational use of broad spectrum antibiotics and resulting anti-microbial resistance (AMR) has further deteriorated the condition in this regard. The problem gets more complicated in developing countries due to poor infection control practices, overcrowded hospitals and inappropriate use of antimicrobials [9, 10].

Inappropriate choice of antibiotics increases favoring emergence of pathogenic drug resistant bacteria. Numerous bacteriological studies reveal that gram-positive and gram negative bacteria both play a role in the infection of surgical wounds. For proper management of the patients it is very essential to know which pathogen has caused the infection and also its antibiotic susceptibility.

Objectives

1. To assess the prevalence of modifiable (Smoking, Obesity, Anemia) and non- modifiable (Age, DM, HTN) risk factors in those who have SSI.
2. To evaluate the influence of pre-operative, operative and post-operative factors in SSI
3. To know the susceptibility pattern of microbes so as to plan empirical antimicrobial therapy in our setting.
4. To evaluate nasal Staphylococci carriers and the occurrence of SSIs.

Materials & Methods

Patients undergoing abdominal surgeries in the department of general surgery in Kamineni Institute of Medical Sciences, Narketpally from November 219 to October 2020.

Surgical site were considered to be infected according to the definition by NNIS. The wounds were classified according to the wound contamination class system.

Inclusion criteria

Patients undergoing abdominal surgeries in the Surgery Department. Both male and female patients of age more than 18 yrs and ready to give consent.

Exclusion criteria

Past history of abdominal surgeries Presence of Infections elsewhere in the body

Sample Size: 100 patients will be included in the study who fulfils the inclusion criteria. An elaborate study of the cases with regard to date of admission, history, clinical features of wound infection, type of surgery, emergency or elective, preoperative preparation and postoperative management is done till patient is discharged from hospital, and then followed up the patient on OPD basis for any signs of wound infection.

In history, presenting complaints, duration, associated diseases, coexistent infections at a remote body site, personal history including smoking, and alcoholism were noted. Preoperative findings which include preoperative bath, skin preparation, type and time of preparation, nasal swab for culture for commensals, preoperative antibiotics use and O2 saturation. Operative findings which include, type of incision, wound contamination, drain used and its type, and duration of operation.

Postoperative 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 colour 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. Appropriate management of surgical site infection was done as per the guideline.

Procedure in laboratory

In the microbiology department, the swabs were inoculated onto blood agar plate, McConkey's agar plates and nutrient broth. Inoculated media were incubated aerobically at 370 C for 24-48 hrs. Nutrient broth was sub cultured if the original plates did not yield organisms. The bacteria isolated were identified by their morphological and cultural characteristics.

The samples collected were processed as follows:

a) Direct microscopic examination of gram stained smear.
b) Inoculation of the samples onto different culture media for aerobic and anaerobicorganisms.
c) Preliminary identification
d) Bio-chemical tests
e) Antibiotic sensitivity.

Results

This study included 100 patients who underwent abdominal surgery, out of which 30 patients developed surgical site infections. So the incidence is 30%.

Table 1: Incidence in relation to sex

Gender	Total No. of cases	Infected	Percentage
Male	82	24	29.3
Female	18	6	33.3
Total	100	30	-

Incidence of SSI among males was 29.3 % whereas incidence of infection among females was 33.3 %. Among 100 patients who underwent abdominal surgeries, 28 of them had SSI. Youngest patient being 18yrs and oldest 81 yrs. With lowest incidence in the age group 18-30 (12 %) and highest incidence in the age group >50 years (58 %). Incidence of SSI among elective cases was 18 % whereas it was 41 % in Emergency cases. Diabetic patients had Infection rate of 82 %, Hypertensives 48 % and patients with COPD/Asthma had infection rate of 63 %. SSI in obese patients was 77 %, Out of 16 anemic patients 10 had SSI and 68.5 % SSI was observed in patients with Hypoproteinemia.

Table 2: Incidence in relation to pre-op hospital stay (In Elective cases)

Pre op stay	No. of Cases	SSI	Percentage
0-2 days	32	4	12.5%
3-5 days	27	6	22.2 %
>5 days	4	1	25.0 %

In elective surgeries, with pre-op hospital stay 0-2 days SSIs were found in 4, 3-5 days stay 6 out of 27 cases and > 5 days stay it was 1 SSI reported, as the pre-op hospital stay increased, the rate of SSI increased with 12.5% for 0-2 days and 25% for >5 days of hospital stay.

Incidence of SSI in nasal staph aureus carriers

No. of nasal carriers cases were 40 (40%), and with 30 cases (37.5%) presenting SSIs. Amongst the non-nasal carriers, 60 (60%), 18 (30%) presented with SSIs. Infection rate was higher (35.13) in nasal carriers of *S. aureus* than Non-carriers.

Incidence of SSI in relation to sPO2: No. of cases with >95% sPO2 were 80 (80%), and with 30 cases (37.5%) presenting SSIs. Amongst the cases with < 95% sPO2, 20 (20%), 12 (60%) presented with SSIs. Pre-operative sPO2 of <95% increased the incidence of SSI (60 %).

Incidence in relation to smoking and alcoholism

No. of cases with smoking history were 30 (30%), and with 12 cases (40%) presenting SSIs. Amongst the cases with no smoking history, 70 (70%), 8 (11.4 %) presented with SSIs. Smoking increased the incidence of SSI (40 %). No. of cases with alcoholism history were 28 (28%), and with 10 cases (35.7%) presenting SSIs. Amongst the cases with no alcoholism history, 72 (72%), 7 (9.7%) presented with SSIs. alcoholism history increased the incidence of SSI (35.7 %).

Table 3: Incidence in relation to diagnosis

Diagnosis	No. of Cases	SSI	Percentage (%)
Appendicular abscess	4	1	25
Acute Appendicitis	34	9	26.5
Appendicular perforation	10	3	30.0
Ca Ascending Colon	1	1	100
Ca Cecum	1	0	0
Ca Rectum	2	2	100
Ca Stomach	2	1	50
Cholelithiasis	14	4	28.6
Duodenal Ulcer Perforation	21	15	72.0
Epigastric Hernia	3	0	
Inguinal Hernia	23	1	4.3
Ileal Perforation	11	5	45.45
Jejunal perforation	3	1	33.3
Meckel’s diverticulitis	1	0	0
Mesenteric Ischemia	1	0	0
Recurrent Appendicitis	14	1	7.2
Sigmoid perforation	1	0	0
Umbilical Hernia	4	1	25

Appendicectomy (48) was the most common procedure followed by hernioplast/herniorrhaphy (23). SSI was common in perforated viscus and colorectal surgeries. Preparation of the patient: Patient’s parts were prepared 12 hrs prior to surgery in 86 patients and the incidence of SSI in those patients was 18 % and in those prepared <12 hr before surgery SSI was 42%.

Table 4: Incidence in relation to class of wound

Wound Class	No. of cases	SSI	Percentage
Clean	30	2	6.7%
Clean Contaminated	30	6	20%
Contaminated	40	12	30%
Dirty	50	25	50%

Clean wounds had least SSI (6.7%) and the Dirty wounds had the highest SSI (50%)

Using drain was associated with increased incidence of SSI (44%) and mesh usage was not associated with SSI. SSI was most commonly detected on Post op day (POD) 4 (20 out of 45 cases).

Table 5: Incidence of organism isolated

Organism	No. of cases	Percentage
Acinetobacter	2	6.7%
CONS	2	6.7%
E. Coli	5	16.7%
Enterococci	10	33.3%
Klebsiella	2	6.7%
MRSA	6	20%
Pseudomonas	3	10%
S. aureus	10	33.3%
Streptococci	5	16.7%

aureus & *Enterococci* were the most common organisms isolated followed by MRSA.

Table 6: Organisms isolated in wound types

Organism/Type	Clean	%	Clean Contaminate d	%	Contaminated	%	Dirty	%
Acinetobacter	0	0	0	0	1	8.3	1	4
CONS	0	0	0	0	2	16.6	0	0
E. Coli	0	0	0	0	0	0	5	20
Enterococci	0	0	1	16.6	3	25	6	24
Klebsiella	0	0	0	0	1	8.3	1	4
MRSA	1	50	1	16.6	1	8.3	3	12
Pseudomonas	0	0	0	0	0	0	3	12
S. aureus	1	50	2	33.3	3	25	4	16
Streptococci	0	0	2	33.3	1	8.3	2	8

E. coli, *Enterococci* and *Pseudomonas* is commonly isolated from Dirty wound, CONS from contaminated wound. *S. aureus* and MRSA from clean wound.

Table 7: Antibiotic sensitivity spectrum

Organism	AMP		CD		E		CX		CO		LZ		TE		VA	CP		G		HLG		AK		AZ		I		PT		CI		CA	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
ACI	-	2	0	0	0	0	0	0	1	1	0	-	0	2	0	0	2	0	2	0	0	1	1	1	1	1	1	2	0	1	1	1	1
%		100	0	0	0	0	0	0	50	50	0	-	-	100	0	0	100	0	100	0	0	50	50	50	50	50	50	100	0	50	50	50	50
CONS	-	2	2	0	2	0	2	0	1	1	2	-	1	1	2	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
%		100	100	0	100	0	100	0	50	50	100	-	50	50	100	100	0	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC	-	5	0	0	0	0	0	0	0	5	0	-	0	5	0	2	3	0	5	0	0	2	3	0	5	3	2	4	1	0	5	0	5
%		100	0	0	0	0	0	0	0	100	0	-	0	100	0	40	60	0	100	0	0	40	60	0	100	60	40	80	20	0	100	0	100
EN	-	10	0	9	0	8	0	0	0	10	10	-	4	6	10	1	9	0	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0
%		100	0	90	0	80	0	0	0	100	100	-	40	60	100	10	90	0	0	20	80	0	0	0	0	0	0	0	0	0	0	0	0
KLE	-	2	0	0	0	0	0	0	0	2	0	-	1	1	0	1	1	0	2	0	0	0	2	0	2	2	0	1	1	0	2	0	2
%		100	0	0	0	0	0	0	0	100	0	-	50	50	0	50	50	0	100	0	0	0	100	0	100	100	0	50	50	0	100	0	100
MRSA	-	6	4	2	2	4	0	6	1	5	6	-	4	2	6	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
%		100	66.6	33.3	33.3	66.6	.0	100	16.6	83.3	100	-	66.6	33.3	100	50	50	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS	-	3	0	0	0	0	0	0	0	3	0	-	0	3	0	3	0	2	1	0	0	2	1	0	3	1	2	0	3	0	3	0	3
%		100	0	0	0	0	0	0	0	100	0	-	0	100	0	100	0	66.6	33.3	0	0	66.6	33.3	.	100	33.3	66.6	0	100	0	100	0	100
SA	-	10	10	0	10	0	10	0	10	0	10	-	10	0	10	8	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
%		100	100	0	100	0	100	0	100	0	100	-	100	0	100	80	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ST	-	5	3	2	4	1	0	0	4	1	5	-	4	1	5	4	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
%		100	60	40	80	20	0	0	80	20	100	-	80	20	100	80	20	80	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Enterococci was most sensitive to LZ followed by VA and TE. *S. aureus* was most sensitive to CD, E, CX, CO, LZ, TE, VA and G Followed by CP.

Discussion

This study was conducted in Department of General surgery. This is prospective study of 100 cases that have undergoing abdominal surgery and were followed up from the day of operation to 30 days after discharge and in those cases where mesh was used they were followed up to 1 year.

Incidence of SSI: The overall SSI rate wa 30%. The incidence rate in this study is more compared to other studies. Different studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7% [8]. 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 [1]. The higher 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. The following table shows incidence in various other studies.

Author	Year	Country	No. Of cases	SSI
Cruse and Foord [9]	1980	Canada	62939	4.7%
Edwards [10]	1984	U.S	20,193	2.8%
Cameron et al. [11]	1999	India	3280	6.09%
Hoer J et al. [12]	2008	India	114	30.7%
Mahesh c b et al. [13]	2010	India	418	20.9%
Present study	2014	India	100	30%

Age & Gender

Incidence of SSI among males was 29.3 % whereas incidence of infection among females was 33.3 %. Among 100 patients who underwent abdominal surgeries, 28 of them had SSI. Youngest patient being 18yrs and oldest 81yrs. With lowest incidence in the age group 18-30 (12%) and highest incidence in the age group >50 years (58 %).

Likewise Cruse and Foord [9] observed in their study that older patients are more likely to develop infection in clean wounds than younger patient.

Similar findings were demonstrated by Mahesh et al. [13], who observed an increased wound infection in patients less than 1 year old (2.7%) or greater than 50 years old (2.8%) versus those 1 to 50 years old (0.7%).

Type of Surgeries & Comorbidities

Incidence of SSI among elective cases was 18 % whereas it was 41 % in Emergency cases.

In our study is perhaps due to decreased immunocompetence and increased chances of co-morbid factors like Diabetes Mellitus, Hypertension, Chronic ailments like Asthma and personal habits like Smoking and Alcoholism. Age, obviously is an immutable patient characteristic and even, if it is a risk factor for wound infection, it appears to be at most a modest one. Diabetic patients had Infection rate of 82 %, Hypertensives 48 % and patients with COPD/Asthma had infection rate of 63 %. SSI in obese patients was 77 %, Out of 16 Anaemic patients 10 had SSI and 68.5 %SSI was observed in patients with Hypoproteinemia.

Incidence of SSI among elective cases was 18 % whereas it was 41 % in Emergency cases. The incidence of SSI in elective cases was higher compared with the results obtained by other workers. Similar like Mahesh C B et al. [13], 2010 for elective 7.61% and for emergency 21.05% The high rates of infection in emergency surgeries can be attributed to inadequate pre-operative preparation, the underlying conditions which predisposed to the emergency surgery and the more frequency of contaminated or dirty wounds in emergency surgeries.

Diabetic patients had Infection rate of 82 %, Hypertensives 48 % and patients with COPD/Asthma had infection rate of 63 %. SSI in obese patients was 77 %, Out of 16 Anaemic patients 10 had SSI and 68.5 % SSI was observed in patients with Hypoproteinemia. Similar results were also obtained in other studies. Cause being the reduced immunocompetence, wound healing factors, hyperglycemia, and preexisting infections. In this study both obese patients had high incidence of SSI (75%). Similar results were obtained in Hoer J et al study [12]. One reason being a decrease in blood circulation in fat tissues is associated with the increase in infection rate.

Preoperative hospitalization of more than 5 days had an incidence of 25%. The rates of SSIs increased with the increasing duration of pre-operative hospitalization in elective surgeries. The higher incidence of infections due to a longer stay in the hospital could be attributed to the increased colonization of patients with nosocomial strains in the hospital, a longer pre-operative stay in the hospital reflected the severity of the illness and the co- morbid conditions which required patient work- up and or therapy before the operation. Similar results were obtained in other studies like in the study by Valentine et al. [14] which showed 1- 15 days of pre op admission had SSI of 18 whereas more than 15 days had infection rate of 25.9%. Edwards et al. [15] 2006 also had increased risk of SSI with increasing duration pre-operative hospital stay.

All the patients in our study were given pre op antibiotics. Antibiotic prophylaxis reduced the microbial burden of the intra operative contamination to a level that could not overwhelm the host defenses. The pre-operative antibiotic prophylaxis could decrease post-operative morbidity, shorten the hospital stay and it could also reduce the overall costs which were attributable to the infection.

Valentine et al. [14] in 2005, showed that administration of prophylactic antibiotic half an hour before the operation would bring about the best results and the lowest SSI. In 2010 Cheadle WG et al. [16] showed that antibiotic prophylaxis in preventing postoperative complications in colorectal surgery is well established through many studies. However, 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. In 2001. Dohmen et al. [17] in contrast to other reports, there was three times more predominant in surgical procedures preceded by antibiotic prophylaxis in colonic surgeries. This might be explained by the fact that these were contaminated wounds with increased risk of infection.

Pre-operative preparation

Pre-operative preparation was done with shaving in all the cases. In elective surgeries, with pre-op hospital stay 0-2 days SSIs were found in 4, 3-5 days stay 6 out of 27 cases and > 5 days stay it was 1 SSI reported, as the pre-op hospital stay increased, the rate of SSI increased with 12.5% for 0-2 days and 25% for >5 days of hospital stay.

But most of the studies compared the shaving and non-shaving or other types of hair removal. Alexander et al. [18] and Hamilton et al. [19] compared shaving with no hair removal. Both trials were conducted in abdominal surgery and used observations and swabs to determine infection. 9.6 % (17/177) of people who were shaved developed an SSI compared with 6% (11/181) who were not shaved (Pooling these two trials using a random effects model gave an RR 1.59. sPO2 (Oxygen Saturation)

No. of cases with >95% sPO2 were 80 (80%), and with 30 cases (37.5%) presenting SSIs. Amongst the cases with < 95% sPO2, 20 (20%), 12 (60%) presented with SSIs. Pre-operative sPO2 of <95% increased the incidence of SSI (60 %).

Type of wound

In this study incidence in relation to the type of surgery, clean wounds had least SSI (6.7%) and the Dirty wounds had the highest SSI (50%).

Using drain was associated with increased incidence of SSI (44%) and mesh usage was not associated with SSI. Hoer et al. [12] in 2002 at Kosovo Teaching Hospital had the incidence rate of SSI differed by wound classification: 3.1% for clean (n=64), 9.8% for clean- contaminated (n=143), 46.1% for Contaminated (n=13), and 100% for dirty infected wounds (n=5). The relative risk of development SSI for contaminated wounds was 5.4-fold higher than for clean wounds.

Valentine et al. [14] at an Iranian teaching hospital found clean wounds in 109 cases (13.6%); clean-contaminated wounds in 214 cases (26.7%); contaminated wounds in 307 cases (45.8%); and dirty infected wounds in 112 cases (14%).

Mahesh C B et al. [13] in 2010 at Bagalkote had SSI rate of 11.53% in clean surgeries, 23.33% in clean contaminated ones, 38.10% in contaminated ones and 57.14% in dirty surgeries. Our study correlates with the Mahesh C B et al. [13] series incidence among dirty cases are more due to most of the cases were bowel perforation cases. Clean cases had few infection.

The difference in the rates of SSIs between the clean and the clean contaminated wounds showed the effect of endogenous contamination and the difference in the rates of SSIs between the clean contaminated and the dirty wounds showed the effect of exogenous contamination. The endogenous or the exogenous contamination of the wounds by the organisms had a profound influence on the SSIs. 125 cases had operation in less than 2hrs with incidence of infection of 21.6%, 25 cases had operation in 2 to 4 hrs with an incidence of infection of 72%. Incidence was more in longer duration of surgery. Similar results were present in many studies, Valentine et al. [14]; Hoer et al. [12] in 2002, Mahesh C B et al. [13] in 2010 all had similar results.

Drain

Use of drain had infection rate of 44% in our study. Hamilton et al. [19] 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. While the proportion of those with postoperative drain acquiring SSI was 62.5% (15/24), it was 22.2% (20/90) among those without the drain. Further, the infection rate increases with the increasing duration of the drain. Similar observations were made in other studies on SSI, and could be attributed to the nature of operation necessitating the drainage, the drain acting as the portal of entry, or the effect of the drain itself.

Day of SSI

Abdominal surgical site infection was noted most commonly on day 4 (44.4%) in our study. Similar results were obtained in other studies at Irani hospital 2005 by Valentine et al. [14].

Organism isolated in SSI

Most common organisms isolated in our study were *Enterococci* and *S. aureus* (22.2%), followed by MRSA (6%), *E. coli* (11.1%), *Streptococci* (11.1%).

These is increased incidence of *S. aureus*, MRSA and *E. coli* compared to Hamilton et al. [19] Seventy-nine per cent (79.33%) of the isolates were gram-negative bacteria; *Pseudomonas* being the commonest one, followed by Staphylococcus pyogenes in the prospective study of surgical site infections in a teaching hospital in Goa.

Pseudomonas was most common isolate in other studies like Hamilton et al. [19] Bacterial Agents of Abdominal Surgical Site Infections in Lagos Nigeria in 2009. 25 (17.4%) of the 144 patients studied developed surgical site infections. *Pseudomonas* was the most frequently cultured aerobic organism in 28% (n=7) of the cultures, while *Bacteroides* species was the most common anaerobe isolated. Our findings of a predominance of *S. aureus* and *Enterococci* are different from that of other workers. In most cases of SSI the organism is usually patient's endogenous flora. In abdominal surgeries the opening of the gastrointestinal tract increases the likelihood of coliforms, gram negative bacilli which was our finding in this study. This group of organisms tends to be endemic in hospital environment by being easily transferred from object to object, they also tend to be resistant to common antiseptics and are difficult to eradicate in the long term. This group of organisms is increasingly playing a greater role in the many hospital acquired infections. Nasal carriers of Staph. Aureus had higher *S. aureus* SSI compared to others.

Antibiotic sensitivity and resistance

Enterococci was most sensitive to Linezolid, Vancomycin followed by tetracycline. *S. aureus* was most sensitive to Clindamycin, Erythromycin, Cefoxitin, Cotrimoxazole, Linezolid, Tetracycline, Vancomycin and Gentamicin Followed by Ciprofloxacin. All the organisms were resistant to Ampicillin.

Alexander et al. [18] had *Pseudomonas* species 37.5% sensitive for ceftaxidine followed by 12.5% ceftriaxone. And it was most resistant for cefotaxime.

Hamilton et al. [19] 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. This 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 since 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.

Conclusion

To establish the most suitable empirical treatment for each patient, it is very important to know the microbial epidemiology of each institution. The information obtained from this study allows a better understanding of the microbial etiology of SSIs in our hospital which may have epidemiological and therapeutic implications. Using the results of this study, an initiative for establishing improved hospital antimicrobial policy and antimicrobial prescribing guidelines should be undertaken. Also the inappropriate and prolonged use of antibiotics should be avoided as this can lead to the development of resistant micro organisms which are even more difficult to get rid of.

Acknowledgment

The author is thankful to Department of General Surgery for providing all the facilities to carry out this work.

Conflict of Interest

None

Funding Support

Nil

References

1. Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. J Hosp Infect. 2008;70(2):3-10.
2. Pradhan GB, Agrawal J. Comparative study of post-operative wound infection following emergency lower segment caesarean section with and without the topical use of fusidic acid. Nepal Med Coll J. 2009;11(3):189-191.
3. Ahmed MI. Prevalence of nosocomial wound infection among postoperative patients and antibiotics patterns at teaching hospital in Sudan. N Am J Med Sci. 2012;4(1):29-34.
4. Mulu W, Kibru G, Beyene G, Datie M. Postoperative nosocomial infections and antimicrobial resistance patterns of bacterial isolates among patients admitted at FelegeHiwot Referral Hospital, Bahirdar, Ethiopia. Ethiop J Health Sci. 2012;22(1):7-18.
5. Masaadeh HA, Jaran AS. Incident of Pseudomonas aeruginosa in post-operative wound infection. Am J Infect Dis. 2009;5:1-6.
6. Hope D, Ampaire L, Oyet C, Muwanguzi E, Twizerimana H, Apecu RO. Antimicrobial resistance in pathogenic aerobic bacteria causing surgical site infections in Mbarara regional referral hospital, Southwestern Uganda. Sci Rep. 2019;9(1):1-1.
7. Sattar F, Sattar Z, Zaman M, Akbar S. Frequency of post-operative surgical site infections in a tertiary care hospital in Abbottabad, Pakistan. Cureus. 2019, 12(3).
8. Aerobic bacteriological profile and antimicrobial susceptibility pattern of pus isolates from tertiary care hospital in India. J Infect Dev Ctries. 2018;12(10):842-848.
9. Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. Arch Surg. 1973;107:206-210.

10. Ziv Y, Church JM, Fazio VW, King TM, Lavery IC. Effect of systemic steroids on ileal pouch-anal anastomosis in patients with ulcerative colitis. Dis Colon Rectum. 1996;39(5):504-508.
11. Edwards LD. The epidemiology of 2056 remote site infections and 1966 surgical wound infections occurring in 1865 patients: a four year study of 40,923 operations at Rush-Presbyterian-St. Luke's Hospital, Chicago. Ann Surg. 1976;184(6):758-766.
12. Cameron AE, Parker CJ, Field ES, et al. A randomised comparison of polydioxanone (PDS) and polypropylene (Prolene) for abdominal wound closure. Ann R Coll Surg Engl. 1987;69:113.
13. Hoer J, Lawong G, Klinge U, Schumpelick V. Factors influencing the development of incisional hernia. A retrospective study of 2,983 laparotomy patients over a period of 10 years. Chirurg. 2002;73:474-480.
14. Mahesh CB, Shivakumar S, Suresh BS, Chidanand SP, Vishwanath Y. A prospective study of surgical site infections in a teaching hospital. J Clin Diagn Res. 2010 Oct;4:3114-3119.
15. Valentine RJ, Weigelt JA, Dryer D, Rodgers C. Effect of remote infections on clean wound infection rates. Am J Infect Control. 1986;14(2):64-67.
16. Hunt TK, Hopf HW. Wound healing and wound infection: what surgeons and anesthesiologists can do. Surg Clin North Am. 1997;77(3):587-606.
17. Cheadle WG. Risk factors for surgical site infection. Surg Infect (Larchmt). 2006;7(1):S7-S11.
18. Dohmen PM. Influence of skin flora and preventive measures on surgical site infection during cardiac surgery. Surg Infect (Larchmt). 2006;7(1):S13-S17.
19. Alexander JW, Fischer JE, Boyajian M, Palmquist J, Morris MJ. The influence of hair-removal methods on wound infections. Arch Surg. 1983;118(3):347-352.
20. Hamilton HW, Hamilton KR, Lone FJ. Preoperative hair removal. Can J Surg. 1977;20:269-71, 274-5.