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Journal of Infectious Diseases & Preventive Medicine

Research Article

Surgical Anti-Microbial Prophylaxis and Incidence of Surgical Site Infections: A Hospital Based Prospective Study

Raju Niraula[1*], Ramesh M. Tambat[2], Sunita Devkota[3], Ramu Gupta[1]

[1]Department of Pharmacy, Nargund College of Pharmacy, Banglore, Karnataka, India; [2]Department of General Surgery, Bangalore Medical College and Research Institute, Banglore, Karnataka, India; [3]Department of Paediatrics, Patan Academy of Health Sciences, Patan, Nepal

ABSTRACT

Introduction: Health Care-Associated Infections (HAI) remain as an important public health concern. Amongst the prominent HAIs, Surgical Site Infections (SSL) contributing to substantial rate. of mortality, significant morbidity. Considerable prolongation in length of hospitalization and added treatment expenses. Wound infections are the commonest hospital-acquired infections in surgical patients. They result in increased antibiotic usage, increased costs and prolonged hospitalization. Appropriate antibiotic prophylaxis can reduce the risk of postoperative wound infections, but additional antibiotic use also increases the selective pressure favoring the emergence of antimicrobial resistance. Approximately 30%-50% of antibiotic use in hospital practice is now for surgical prophylaxis. However, between 30% and 70% of this prophylaxis is inappropriate. Most commonly, the antibiotic is either given at the wrong time or continued for too long.

Aim: To evaluate the pattern of antimicrobial prophylaxis in general surgery. To assess the frequency of post-operative infection. To assess the prevalence of surgical site infection. Finding and comparing frequency of risk factors, incidence of SSI, type of antibiotics used.

Methodology: A hospital based prospective observational study was carried out for a period of 6 months in Jayanagar General Hospital, by enrolling In-patients considering study criteria. During the study. 180 prescriptions were studied and patient's record were collected and analyzed using spss and Microsoft excel.

Results: 180 patients were enrolled in the study. Majority of the prescription were of females (51.11%) compared to males (48.89%). The incidence of SSI was similar to both male (5.45%) and female (5%) in general surgery *Staphylococcus aureus* (52%) and *Pseudomonas aeruginosa* (15.79%) are found to be the most common microorganism causes SSI. Increased chances of infection were due to associated risk factor like DM, HTN, Anaemia eye. Patients with advanced age >50 years) were most susceptible to SS rather than younger age. Infected patient was treated with more than two numbers of antibiotics where non infected with single or double antibiotics. Hospital stays increases with incidences of SSI.

Conclusion: The study clearly concluded about the overuse and inappropriate choices of antibiotics. Hence, our study also suggests following the guidelines for rational use of antibiotics and minimizing the inappropriate antibiotic use is the best way to minimize the chances of SSI. Hospital should establish prophylactic antibiotics guideline which should be open and accessible by every member of the surgical team. Medical checklist should be practiced effectively. Frequent audit of prophylactic antibiotic use is needed to improve proper practices (prophylactic antibiotics uses). Surgeons should adhere to prophylactic antibiotics guidelines.

Keywords: Health care-associated infections; Surgical site infections; Antibiotic

Correspondence to: Dr. Raju Niraula, Department of Pharmacy, Nargund College of Pharmacy, Bangalore, Karnataka, India, Tel: 9862228526; E-mail: Niraularaju4@gmail.com

Received: November 03, 2020; **Accepted**: November 17, 2020; **Published**: November 24, 2020

Citation: Niraula R, Tambat RM, Devkota S, Gupta R (2020) Surgical Antimicrobial Prophylaxis and Incidence of Surgical Site Infections: A Hospital Based Prospective Study. J Infect Dis Prev Med. 8:207.

INTRODUCTION

Health Care-Associated Infections (HAIs) remain as an important public health concern. Amongst the prominent HAIs, Surgical Site Infections (SSIs) contributing to substantial rate of mortality, significant morbidity, considerable prolongation in length of hospitalization and added treatment expenses [1].

Wound infections are the commonest hospital-acquired infections in surgical patients. They result in increased antibiotic usage, increased costs and prolonged hospitalization [2]. Appropriate antibiotic prophylaxis can reduce the risk of postoperative wound infections, but additional antibiotic use also increases the selective pressure favoring the emergence of antimicrobial resistance [3].

Surgical antibiotic prophylaxis is defined as the use of antibiotics to prevent infections at the surgical site. It must be clearly distinguished from pre-emptive use of antibiotics to treat early infection, for example perforated appendix, hernia etc. even though infection may not be clinically apparent.

The original surgical antibiotic prophylaxis experiments were performed 40 years ago in pigs. The results concluded that 'the most effective period for prophylaxis begins the moment bacteria gain access to the tissues and is over in three hours. Since then there have been many studies in animal models and in humans undergoing surgery. This has resulted in the principles of antibiotic prophylaxis becoming an accepted part of surgical practice [4].

Approximately 30%-50% of antibiotic use in hospital practice is now for surgical prophylaxis. However, between 30% and 70% of this prophylaxis is inappropriate. Most commonly, the antibiotic is either given at the wrong time or continued for too long. Controversy remains as to duration of prophylaxis and also as to which specific surgical procedures should receive prophylaxis [5].

SSI classification

According to the Centers for Disease Control and Prevention (CDC)'s guideline, SSIs are separated into three types, depending on the depth of infection penetration into the wound [6-8].

By these criteria, SSIs are classified as being. Either incisional or organ/space. Incisional SSIs are further divided into those involving only skin and subcutaneous tissue (superficial incisional SSI) and those involving deeper soft tissues of the incision (deep incisional SSI). Organ/space SSIs involve any part of the anatomy (e.g., organ or space) other than incised body wall layers that was opened or manipulated during an operation (Figures 1 and 2).

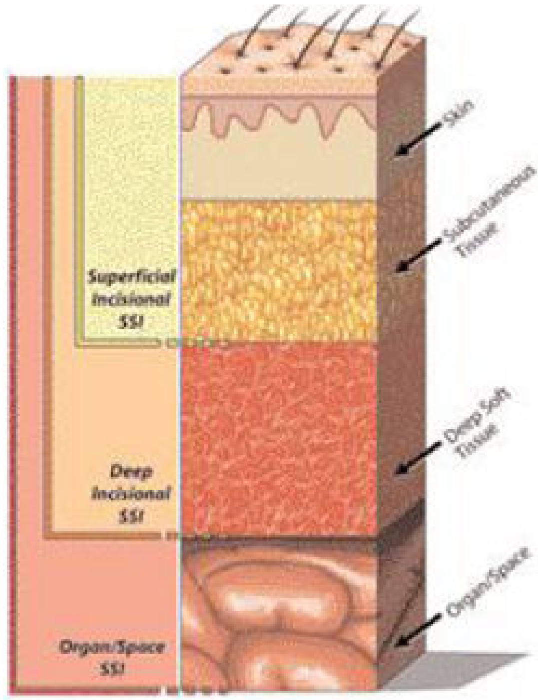

Figure 1: Types of SSI relating to infection penetration depth [9].

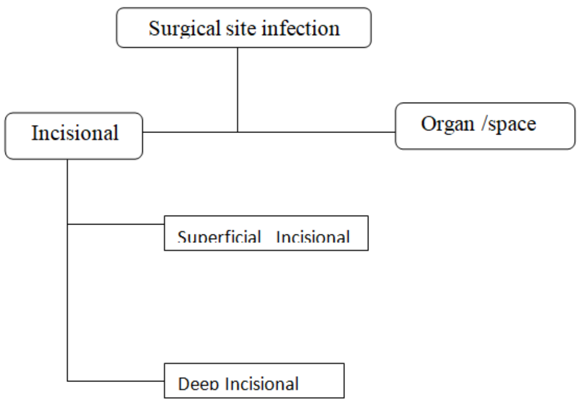

Figure 2: Classification of SSI [9,10].

Superficial incisional infection: Superficial incision infection defined as a surgical site infection that occurs within 30 days of surgery and involves only the skin or subcutaneous tissue of the incision, and meets at least one of the following criteria:

Purulent drainage from the incision.

Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision.

At least one of the following signs or symptoms of infection-pain or tenderness, localised swelling, redness or heat.

Deep incisional surgical site infections: Deep incisional surgical site infections must meet the following three criteria: it occurs within 30 days of procedure (or one year in the case of implants); it is related to the procedure and this involves deep soft tissues, such as the fascia and muscles. Besides deep incisional surgical site infections may involve any of the following criteria:

Purulent drainage from the incision but not from the organ/space of the surgical site.

A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms-fever (>38°C), localized pain or tenderness-unless the culture is negative.

An abscess or other evidence of infection involving the incision is found on direct examination or by histopathologic or radiological examination.

Diagnosis of a deep incisional SSI by a surgeon or attending physician.

Organ/Space SSI: In Organ/Space SSI occurs within 30 days after the operation if no implant is left in place or within 1.

Sources of infection

Sources of infection are widely varied. Infections may be primarily acquired from a community or endogenous source. Sources of infection may be hospital acquired or community acquired [11].

Endogenous factors or sources of bacteria:

Co-existing infection in other site of body

Skin

Bowel

Nature and site of operation (Clean, clean-contaminated, contaminated and dirty)

Exogenous factors or sources of bacteria:

Operating team-related-Comportment; Use of impermeable drapes and gowns;

Surgical scrub.

Operating room related-Traffic control; Cleaning; Air

Surgical wound infections are also strongly influenced by the risk factors related to patients-extremities of age, obesity, diabetes mellitus, smoking habit, Coexisting infection at other site etc.

Etiological agents

Many different bacteria, viruses, fungi and parasites may cause wound infections. Infections may be caused by a microorganism acquired from another person in the hospital (cross-infection) or may be caused by the patient's own flora (endogenous infection). Some organisms may be acquired from an inanimate object or substances recently contaminated from another human source (environmental infection.

According to data from the national nosocomial infection surveillance system, the distribution of pathogens isolated from SSIs has not changed markedly during the last decade where *Staphylococcus aureus*, Coagulase-negative Staphylococci (CoNS), *Enterococcus spp*. And *Escherichia coli* remain the most frequently isolated pathogens [12].

Furthermore, nosocomial blood stream infections are usually caused by Gram-positive organisms including Coagulase negative *Staphylococcus*, *S. aureus*, *Enterococci* [13,14] and these microorganisms nearly always represent true bacteremia such as *E. coli* and other members of the *Enterobacteriaceae*, *Pseudomonas aeruginosa*, and *Streptococcus pyogenes* (Table 1) [14].

Age	Antimicrobial prophylaxis	Skin antisepsis
Nutritional status	Colonization with microorganisms	Preoperative shaving
Diabetes	Altered immune response	Duration of operation
Smoking	Length of preoperative stay	Coexistent infections at a remote body site
Obesity Inadequate sterilization of instruments	Duration of surgical scrub Foreign material in the surgical site	Operating room ventilation Poor haemostasis
Surgical technique	Tissue trauma	Preoperative skin prep

Table 1: Risk factors.

Prophylactic antibiotics: Prophylactic antibiotics decrease the risk of infection and represents important components of most favourable management of the surgical patient [15-21]. So errors in antimicrobial prophylaxis for surgical patients remain one of the most frequent types of medication errors in hospitals. The antibiotics selected for prophylaxis must cover the expected pathogens responsible for infection, should achieve adequate tissue levels during operation, cause minimal side effects and be relatively inexpensive [22].

A prophylactic antibiotic should be used where evidence of benefit exists. Choice of antibiotic depend on type of surgery, area of surgery, etiological agents mostly responsible for wound infections, patient's physical status and wound class. According to the Antibiotic prophylaxis in surgery (A national clinical guideline) Scottish Intercollegiate Guidelines Network, Prophylaxis antibiotics are highly recommended for Appendicectomy, Colorectal surgery, Caesarean section, Transurethral resection of the prostate, and Arthroplasty surgery to reduces major morbidity, hospital costs [21]. In gynaecology. For prophylaxis, first generation cephalosporins are suitable choices to prevent postoperative sepsis, by *E. coli*, *S. aureus* and *B. fragilis* [23-25]. Many systematic studies were carried out to measure the relative efficacy of antimicrobial prophylaxis for the prevention of postoperative wound infection in different surgery.

Study criteria

Inclusion criteria:

Patient undergone surgery.

Patient of age above 18 years.

Patient who are willing to participate in the study.

Exclusion criteria:

Surgery where there is no need for prophylactic antibiotics.

The post-operative follow up was missed.

Pregnant and nursing mother.

Psychiatric patient.

MATERIALS AND METHODS

A descriptive, prospective and hospital-based study was conducted in Jayanagar General Hospital, Bangalore in department of general surgery over a period of 6 months, after obtaining the clearance and approval from the Institutional Ethics Committee.

Statistical analysis

Descriptive statistics is done by measuring different proportions. Statistical measurement was done in SPSS trial version 24.0. Graphical representation was done in using Microsoft Excel.

RESULTS

Patient demographics

A total of 180 patients were enrolled in the study,who satisfies inclusion and exclusion criteria, 88 (48.89%) were males and 92 (51.11%) were females. majority of patient were found under the age group of 41-50 years 59(32.78%) followed by 52(28.89%) patients under 31-40 years; 35(19.44%) patient under 21-30 years, 22(12.22%) patients under 0-20(18-20) years, 6(3.33%) patient age under 51-60 years and patient over 60 years, 6(3.33%).among them 56% of patient having no formal education, 16.11% have primary education followed by 13.88% secondary, 11.11% PUC education and 2.77 having degrees and 56.12% patient enroll any of occupation was 88.34% (Table 2).

Patients characteristics	No. of patients	Percentage
Gender distribution		
Male	88	48.89%
Female	92	51.11%
Age distribution		
0-20	22	12.22%
21-30	35	19.44%
31-40	52	28.89%
41-50	59	32.78%
51-60	6	3.33%
Education distribution		
Primary	29	16.11%
Secondary	25	13.88%
PUC	20	11.11%
No formal education	101	56.12%
Occupation		
Agriculturist	28	15.55%
Self employed	67	37.22%
In service	23	12.78%
House wife	41	22.77%
None	21	11.66%

Table 2: Patient characteristics.

Age distribution and SSI

Increasing age increases the insidance of surgical site infections. Out of these, age(51-60) is 3 out of 6 is 50%, >60 age is 2 out of 6 is 33.33% and age (41-50) is 8% followed by 4 out of 59 patient, 5 out of 52 patient,2 out of 22, 3 out of 35 (Figure 3).

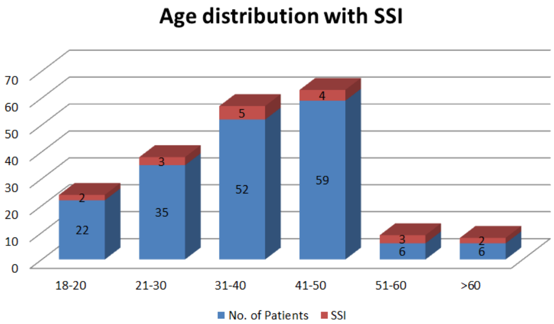

Figure 3: Age distribution with SSI.

Presence of risk factor associated with infection

Among 180 patients in this study, 93 patient (51.66%) is having previous risk factor, Among them 40.86% were smokers,27.96% are anemic, followed by patient associated with DM,DM/HTN, obesity, blood loss and other infection. Coexisting infected patient is 2 among 3 which is 66.67% (Table 3 and Figure 4).

S. No.	Risk factors	No. of patient	Percentage	No. of SSI	Percentage
1	Anaemia	26	14.44%	4	2.22%

2	Blood loss	5	2.77%	-	-
3	DM	6	3.33%	3	1.66%
4	DM +HTN	5	2.77%	2	1.11%
5	HTN	4	2.22%	2	1.11%
6	Infection	3	1.66%	2	1.11%
7	Obesity	6	3.33%	-	-
8	Smoking	38	21.11%	2	1.11%
9	None	87	48.33%	4	2.22%
Total		180	100%	19	10.50%

Table 3: Presence of risk factor.

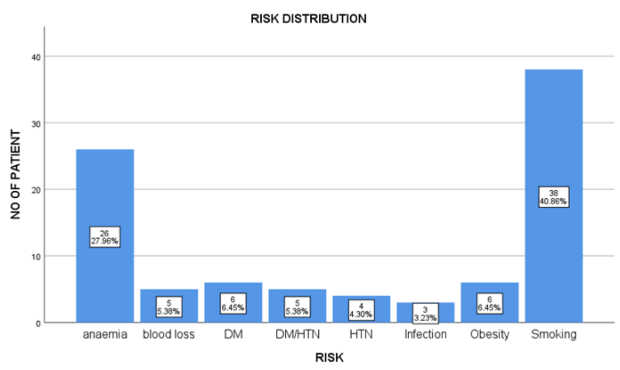

Figure 4: Risk distribution.

Duration of operation to discharge depending upon present of SSI

The length of hospital stay after surgery had increased more than 3 times for the patient with SSI than patient who did not have SSI. It imposes increased cost burden to the patient (Table 4 and Figure 5).

	No. of hospital stay		
	Average	**Minimum**	**Maximum**
Patient having SSI	11.85	9	18
Patient not having SSI	4.45	4	8

Table 4: Duration of operation.

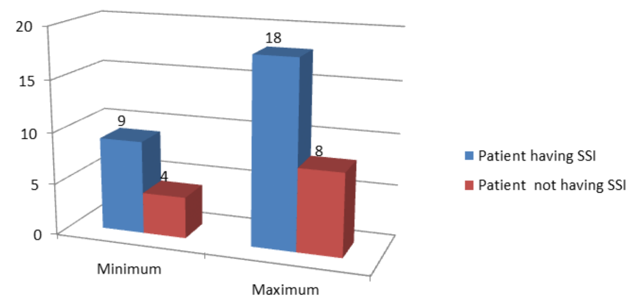

Figure 5: Patients with and without SSI.

Incidence of SSI and gender

Among 180 patient enrolled in the study, out of 88 male patient 10 developed infection.i.e., 5.55% of total patient. Whereas among 92 female patient 9 developed infection i.e., 5% of total patient enrolled in the study. This suggested that both sex have equal chances of developing infection (Table 5 and Figure 6).

S.no	Gender	Total no. of patient	SSI	Percentage
1	Male	88	10	5.55%
2	Female	92	9	5.00%
3	Total	180	19	10.55%

Table 5: Total number of patients.

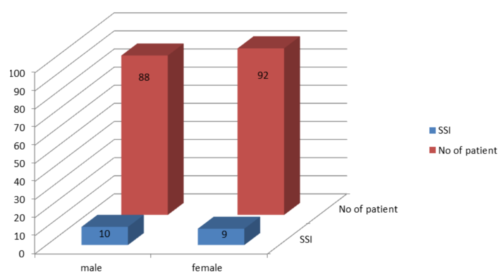

Figure 6: Patients statistics.

Distribution of bacteria associated with infection

Out of 19 patient with SSI patient undergone for culture tests. 10 patient (52.63%) infected patient have staphylococcus infection, 3(15.79%) are having *Pseudomonous aerogenosa* followed by 2(10.53%) with *E. coli*, 2(10.53%) *Enterococcus*, 2(10.53%) *Klebsellia pneumonia* from culture and the incidence of isolated organism after SSI in different population. Staphylococcus was more in female rather than male and the *Pseudomonous*, *E.coli*, *Klebesilla*, *Enterococcus* is having similar incidences in male and female that pathogens showed differences for sensitive *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which were more frequent in women than male (Table 6 and Figure 7).

Gender	Population	SSI rate	Isolated organism	No. of organism

Male	88	10	*Staphylococcus aureus*	3
			E. coli	1
			Pseudomonas aeruginosa	2
			Klebsella	1
			Enterococcus	1
Female	92	9	*Staphylococcus aureus*	7
			E. coli	1
			Pseudomonas aeruginosa	1
			Klebsella	1
			Enterococcus	1
Total	180	19		19

Table 6: Organisms isolated.

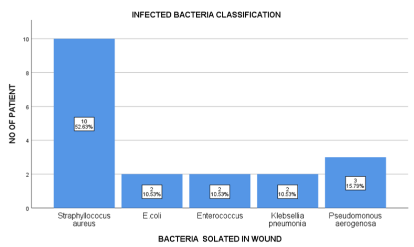

Figure 7: Classification of bacteria.

Wound classification

102(56.67%) were having clean-contaminated wound, 56(31.11%) were having clean wound followed by 20(11.11%) were having contaminated and 1.11% having dirty wound (Tables 7 and 8) (Figure 8).

S.no	Wound	No. of surgery	Percentage
1	Clean	56	31.11%
2	Clean-contaminated	102	56.67%
3	Contaminated	20	11.11%
4	Dirty	2	1.11%
Total		180	100%

Table 7: Wound surgery.

Timing of pre-operative administration of antibiotic			
Timing of administration	No. of surgery/ percentage	SSI	Percentage
Before 1 hours	89(49.44%)	12	13.48%
Before 1.5 hours	45(25%)	3	6.66%
Before 2 hours	33(18.33%)	2	6.06%
>2.5 hours	13(7.22%)	2	15.38%
No. of antibiotics used and associated with SSI			
No. of antibiotics used	No. of patients	SSI	Percentage
Single antibiotics	37	6	16.66%
Double antibiotics	120	10	8.33%
three antibiotics and more	23	3	13.04%
No. of hospital stay			
0-4	59		32.77%
05-Aug	94		52.22%
09-Dec	22		12.22%
13-16	4		2.22%
>16	1		0.56%

Table 8: Surgery performed.

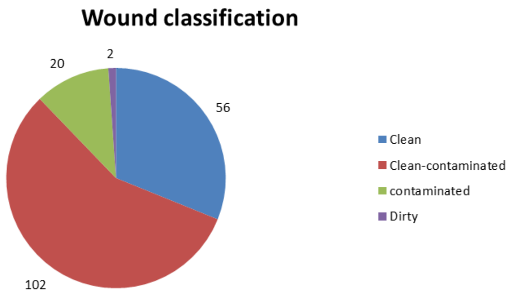

Figure 8: Wound classification.

DISCUSSION

A hospital based, prospective study was carried out for a period of six months. A total of 180 patients from the general Surgery department of general hospital (only in-patients) who satisfied the study criteria and consented to participate were included. Jayanagar general hospital is 300 bedded governmental hospitals with advanced practices of ICU, NICU, dialysis etc.

Among all cases 88(48.89%) were male patient and 92(51.11%) were female patient. The finding is similar to the case carried out by reported No gender-specific differences were found in general surgery. Isolated pathogens showed differences for sensitive *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which were more frequent in women than male [1]. The age-wise distribution of patient, In our study we found that majority of patients belong to the age group of 41-50 years, 31-40 years and 21-30 years (32.78%, 29.89%,19.44%) respectively showing that adult patient are more chances for surgical problems like appendicitis, hernia, hydrocele, fissure in ano rather than old one. Similar study was conducted by Gandage et al. showing similar distribution of patient undergoes the surgery [2].

High incidence of SSI is associated with DM, DM/HTN, infection are 2.22%, 1.11%, 1.11% of total population. Moderate incidence associated with smoking and anemia whereas less associated with obesity. Similar study conducted by shows patient with associated infection, DM, DM/HTN are highly associated with SSI [2].The incidence of SSI with or without infection shows that patient having 66.01% more chances of having SSI rather than patient not having associated infection. Study conducted by how's that patient with infection is 69.22% more associated with co-existing infection [4]. Shows the hospital stay of patient who developed infection or not developed infection. Tamer et al. conduct study on antimicrobial study on SSI results shows that the length of hospital stay after surgery had increased incidence more than 3 times for the patient with SSI than patient without SSI. In our study shows that mean day of stay from operation to discharge is 11.85 days (with SSI), 4.45 (Without SSI). Hospital stay ranges in (9-18 days in patient develop SSI), (4-8 days in patient without develop SSI) shows the incidence of SSI over gender distribution of patient. Almost male and female have similar incidence of developing SSIs, out of 88 male patient 10 person develop, out of 92 patient 9 person develop infection that is 5.55% for male and 5% for female respectively. Langelotz et al. reported No gender-specific differences were found in general surgery [1] shows 5 types of microorganism identified in the culture test. *Staphylococcus aureus* was the most common organism identified in 10(52.63%) patients followed by *Pseudomonas species* (15.79%), *Klebsiella* (10.53%), *Enterococcus* (10.53%) and *E. coli* (10.53%). Sheikh et al. shows the similar result in their study where *Staphylococcus* is the major organism develops SSI.

According to ASHP guidelines for antimicrobial prophylaxis in clean surgery only no or one dose antibiotics is enough, while clean contaminated and other require two or more antibiotics to prevent infection [7] shows the incidence of SSI in population age distribution showed that, incidence of getting infection is more in age above 40 years. Our study showed that patient with >40 years chances of infection after surgery is increased, age (51-60) is 3 out of 6 is 50%, >60 age is 2 out of 6 is 33.33% and age (41-50) is 8%. Saied et al., explain the study resulted that patient with higher age is more likely to chances of SSI.

SSI increases the length of hospital stay and increases the cost of the therapy.in our study patient without infection spent shorter time compare with patient develop SSI. Our study shows 89.52% patient stay in hospital for less than 8 days does not develop infection where those develop infection stays >9 days. 52.22% stays hospital for 5-8 days, 32.77% stay <4 days, 12.22% stays for 9-12 days and remaining for >12 days.

This study helps to find the correlation between plasma drug concentrations and the infection. Classen et al. where the relation between the timing of antibiotic prophylaxis in clinical practice and the occurrence of surgical wound infection has been well studied. They found that use of antibiotics with in the 2 hour period before incision associated with lowest rate of wound infection and those receive surgery more than 2 hour before have more likely to have chances for infection. In our study 49.44% patient received antibiotics before 1 hour of incision, 25% patient received before 1.5 hours, and 18% patient received before 2 hours and 7.22% of patient receive after 2 hours. Among our results about 92.78% patient received antibiotics before 2 hours. This is rational use of antibiotics pattern and 7.22% received after 2 hours [26-30].

CONCLUSION

Postoperative surgical patients are at risk of developing multiple types of hospital-acquired infections. Most common is surgical site infection which leads to prolonged hospital stay, increase cost of therapy, cause morbidity, disability; increase the cost of healthcare and even mortality. All surgical wounds are likely to become contaminated, by various sources endogenous, articles used during surgery or any environmental factors. Despite of various research and best practice in surgery operating room, use of prophylactic antibiotics, infection still remains the second most common adverse event occurring in hospitalized patient and a major source of mortality and morbidity following surgical procedures. Surgical site infection depends upon the use of prophylactic antibiotics practices in hospital.

The study revealed that most of the antibiotics prescribed is 3rd generation cephalosporin. cefotaxime, ceftriaxone and amikacin is the most commonest antibiotics used in hospital. The study has indicated that some prophylactic antibiotics practices are inappropriate. Two or three antibiotics combination received by patient which is not recommended by any guidelines. Prolonged use of Post-surgery prophylaxis is not recommended which increases the cost of therapy. Patient with diabetes, old age and associated infection is the most common cause developed infection.

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