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Original Research Article

A Study on Surgical Site Infections (SSI) and associated factors in a Tertiary care Hospital in Tumkur, Karnataka

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Abstract

Background: Nosocomial infection or hospital acquired infection refers to the infection occurring in patients after admission at the hospital that was neither present nor incubating at the time of admission. It is one of the public health problems throughout the world. Surgical Site Infections (SSI) are commonest nosocomial infections after urinary tract infection. Surgical site infections have been responsible for the increasing cost, morbidity and mortality related to surgical operations and continue to be a major problem even in hospitals with most modern facilities and standard protocols of pre-operative preparation and antibiotic prophylaxis. **Methodology:** A descriptive type of cross sectional study was conducted. All 1000 patients who got admitted in surgical wards and underwent various abdominal surgeries in District Hospital, Tumkur were included. Surgical sites were examined and graded as clean, clean contaminated, contaminated and dirty based on the extent of intraoperative contamination. The data collected includes details of surgical wound infection, the wound classes, preoperative stay, duration of operation, types of intervention (emergency and elective surgeries), co-morbidity status apart from demographic profile of the patient. Culture and sensitivity testing was done on infected wounds. Data was entered in Microsoft Excel 2013 and Pearson's Chi square test was used for analysis. P value of <0.05 was considered statistically significant. **Results:** Surgical site infections rate was 12.40%. SSIs were common among the aged, females, emergency surgeries, increase in surgical wound class, increase in pre-operative hospital stay, longer duration of surgery and in anaemics, diabetics, hypertensives and obese. Most of the SSIs yielded multiple organisms and the most common organism isolated was Staphylococcus Aureus 53(42%).
Conclusion: The incidence of SSI is high. A pre-existing medical illness, prolonged operating time, the wound class, emergency surgeries and wound contamination strongly predispose to wound infection. Antimicrobial prophylaxis is effective in reducing the incidence of post-operative wound infections for a number of different operative procedures but, timing of administration is critical.
Keywords: Surgical Site Infection, Risk factors, Antibiotic Resistance.

INTRODUCTION

Nosocomial infection or hospital acquired infection refers to the infection occurring in patients after admission at the hospital that was neither present nor incubating at the time of admission. It is one of the public health problems throughout the world.[1]Infections acquired in the hospital account for major causes of death, morbidity, functional disability, emotional suffering and economic burden among the hospitalized patients. The Nosocomial Infections (NI) occur among 7-12% of the hospitalized patients globally.[2] The World Health organization estimates that 10-30% of all hospital admissions result in healthcare acquired infections.

Despite the advances made in asepsis, antimicrobial drugs, sterilization and operative techniques, surgical site infections continue to be a major problem in all surgical branches.[3] Surgical site infections are the commonest nosocomial infections after urinary tract infection.[4] SSI rate has varied from a low of 2.5% to a high of 41.9%.[5] The Centre for Disease Control (CDC's), Healthcare-Associated Infection (HAI)

prevalence survey found that there were an estimated more than one lakh surgical site infections associated with inpatient surgeries in 2011.[6]

Emergency procedures, wound class, wound contamination, extremes of age, metabolic disease, immunosuppressant, malnutrition, remote site infection, duration of pre-operative and post-operative hospital stay, pre-existing illness, length of surgical operation are some important factors which influence the incidence of surgical site infections.[7] The problem of SSI continues to be a problem even after maintaining the standard protocol of pre-operative preparations and antibiotic prophylaxis. A reduction in the infection rate to a minimal level due to antimicrobial prophylaxis prescription could have significant benefits in terms of reducing postoperative morbidity and mortality and wastage of health care resources.[8]

Surgical site infection is the most important cause of morbidity and mortality in the post-operative patients, but it is preventable in most of the cases if proper assessment and appropriate measures are taken by the surgeons, nursing staffs, patients and others in the perioperative period.

This study was undertaken to know the incidence of surgical site infections, factors influencing surgical site infections& antibiotic sensitivity pattern.

MATERIAL AND METHODS

Study Design:

Descriptive type of cross sectional study.

Source of Data:

One thousand patients who underwent various surgeries in District hospital, Tumakuru were taken as study participants.

Sample size calculation:

According to a study done by Amrutham R et al.,[24] the surgical site infection rate was 18.14% using this data, the following formula has been applied to determine the required sample size for the study.

$n = (1.96)^2pq/d^2$ where n = sample size

So the sample size calculated was 903. Due to sample loss because of non-response of the participants extra 10% was added to the sample i.e., 90. Hence, the estimated sample size was 993. So the total participants included in the study was rounded of to1000 subjects.

Period of Study:

The study was conducted during 1st January to 30th April 2017

Inclusion criteria:

1. Abdominal Surgeries done in this hospital.
2. Occurs within 30 days after the operation.

Exclusion criteria:

1. Patient refusal.
2. Patient coming with wound infection after getting discharge from the hospital.

Methodology:

Non-random purposive sampling was used. Approval from Institutional Ethical Committee was taken. After admission short history was taken and physical examination was conducted on each patient admitted in surgical wards. Only the necessary investigations such as complete blood count, urine routine, viral serology were considered. Informed written consent was taken from the patients. A detailed history regarding age, sex, type of illness, diagnosis, preoperative stay, type and duration of surgery performed and the associated co-morbid diseases was obtained from the patients. Data collection sheets were filled in by the investigator himself. All of the preoperative factors such as age, co-morbidity status and nutritional status related to SSI present in the patient were noted down in the data sheet. During the postoperative period, all the patients were closely monitored everyday up to the discharge of the patient from the hospital. Surgical sites were examined and graded as clean, clean contaminated, contaminated and dirty based on the extent of intraoperative contamination.[9] If any collection of pus identified it was drained out and sent for culture and sensitivity test. Specific antibiotic was given to every patient both preoperative and post-operative periods. Using sterile cotton swabs, two pus swabs/ wound swabs were collected aseptically from each patient suspected of having SSI. Gram stained preparations were made from one swab for provisional diagnosis. The other swab was inoculated on 5% sheep Blood Agar (BA) and Mac Conkey agar (MA) plates and incubated at 37°C for 48 hours before being reported as sterile. Growth on culture plates was identified by its colony characters and the battery of standard biochemical tests.[10] Antimicrobial Sensitivity Testing (AST) was carried out by modified Kirby Bauer disc diffusion method on Muller Hinton agar and results were interpreted in accordance with Clinical Laboratory Standards Institute guidelines.[11] Appropriate care was given to each of the patients of surgical site infection. Antibiotics were changed wherever necessary after getting the report of culture and sensitivity test. Postoperative events were recorded in the data sheet during every day follow up. Data was entered in Microsoft Excel 2013 and analyzed using SPSS version 20 (trial version). Categorical data were presented as frequencies and analyzed using Pearson's Chi-square test. P value of <0.05 was considered statistically significant.

RESULTS

The present study included one thousand various types of abdominal surgical procedures performed [Table.1]. A total of 10 types of abdominal procedures were performed out of which appendicectomy, caesarean section, abdominal hysterectomy, exploratory laparotomy,

Table 1: Distribution of subjects on the basis of Factors associated with SSI.

Factors		SSI Status		Total	Chi Square (χ^2)	p Value
		Yes	No			
Age (Yrs)	< 30	47(12.08%)	342(87.92%)	389	13.71	0.0033
	31 – 40	21(8.37%)	230(91.63%)	251		
	41 – 50	22(11.40%)	171(88.60%)	193		
	>50	34(20.36%)	133(79.64%)	167		
Gender	Male	58(11.13%)	463(88.87%)	521	1.609	0.205
	Female	66(13.78%)	413(86.22%)	479		
Preoperative Stay	<2 days	26(7.95%)	301(92.05%)	327	14.78	0.0006
	2-7 days	60(12.58%)	417(87.42%)	477		
	>7 days	38(19.39%)	158(80.61%)	196		
Wound Class	Clean	08(2.65%)	294(97.35%)	302	103.3	<0.0000001
	Clean contaminated	47(10.61%)	396(89.39%)	443		
	Contaminated	45(21.95%)	160(78.05%)	205		
	Dirty/Infected	24(48.00%)	26(52.00%)	50		
Duration of Operation	<1hr	24(4.94%)	462(95.06%)	486	128.3	<0.0000001
	1-2hrs	36(10.40%)	310(89.60%)	346		
	>2hrs	64(38.10%)	104(61.90%)	168		
Type of Intervention	Elective	49(7.56%)	599(92.44%)	648	39.67	<0.0000001
	Emergency	75(21.31%)	277(78.69%)	352		
Co-Morbidity status	Present	78(20.05%)	311(79.95%)	389	34.31	<0.0000001
	Absent	46(7.53%)	565(92.47%)	611		
Types of Co-Morbidity	Anemia	14(14.89%)	80(85.11%)	94	12.53	0.0058
	Diabetes Mellitus	34(30.63%)	77(69.37%)	111		
	Hypertension	21(19.44%)	87(80.56%)	108		
	Obesity	09(11.84%)	67(88.16%)	76		
Operative Procedures	Appendisectomy	19(11.51%)	146(88.49%)	165	34.05	0.000006572
	LSCS	39(15.98%)	205(84.02%)	244		
	Herniopalsty	06(4.48%)	128(95.52%)	134		
	Exploratory Laparotomy	24(20.87%)	91(79.13%)	115		
	Abdominal hysterectomy	20(19.42%)	83(80.58%)	103		
	Cholecystectomy	08(14.29%)	48(85.71%)	56		
	Splenectomy	0	05(100.00%)	5		
	Abdominal Tubectomy	02(1.45%)	136(98.55%)	138		
	Bladder & Prostate surgeries	04(14.29%)	24(85.71%)	28		
	Colorectal surgeries	02(16.67%)	10(83.33%)	12		

Figure 1: Distribution of subjects on the basis of Organisms Isolated

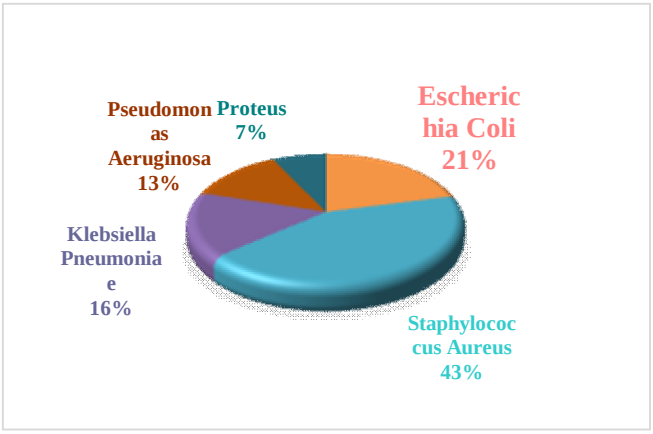

Table 2: Distribution of subjects on the basis of Antibiotic Sensitivity.

Name of Micro organism (No. of cases)	Antibiotics and their sensitivity								
	Ampicillin	Amikacin	Ciprofloxacin	Cotrimoxazole	Norfloxacin	Nitrofurantoin	Ceftriaxone	Imipenam	Vancomycin
Escherichia Coli (26)	5 19.23%	7 26.92%	12 46.15%	13 50%	-	6 23.10%	20 76.92%	26 100%	26 100%
Staphylococcus Aureus (53)	8 15.09%	11 20.75%	23 43.40%	-	18 ######	-	47 88.68%	53 100%	50 94.34%
Klebsiella Pneumoniae (20)	7 35%	12 60%	-	11 55%	-	-	20 100%	20 100%	20 100%
Pseudomonas Aeruginosa (16)	-	9 56.25%	8 50%	-	-	8 50%	16 100%	16 100%	16 100%
Proteus (9)	2 22.22%	-	3 33.33%	-	-	-	8 88.89%	9 100%	9 100%

abdominal tubectomy and hernioplasty accounted for 89.9% of the total surgical procedures.

During the study period 124 patients developed surgical site infections out of 1000 subjects. The Surgical site infections rate was 12.40%.

The age of study subjects ranged between 18 years to 67 years. Majority (38.9%) of them belonged to <30 years age group. Out of 389 patients in this group 47(12.08%) got infected. 167 patients were more than 50 years and among them 34(20.36%) developed surgical site infection. It was found that the frequency of SSI increased with age and this was statistically very highly significant (P < 0.001) [Table 1].

Regarding sex distribution of SSI it was observed that among 521 male patients 58(11.13%) developed SSI, whereas among 479 female patients 66(13.78%) developed SSI. Rate of SSI was slightly higher in females. Sex difference in SSI was not statistically significant (P > 0.05) [Table 1].

With regard to association between preoperative stay and rate of SSI it was observed that the surgical site infection rates were 7.95%, 12.58% and 19.39% for a preoperative stay of <2 days, 2-7 days and >7 days respectively. The difference had very high statistical significance (P < 0.001) [Table 1].

The patients were divided into different groups having different preoperative hospital stay. Highest rate of infection (19.39%) was found in patients having preoperative hospital stay of >7 days. The rate of infection increased as the time lapse between preoperative stay and initiation of operation were increased. However, these differences were statistically very highly significant (P < 0.001) [Table 1].

The surgical wounds were divided into various classes according to the degree of contamination.[9] It was observed that among 302 were clean wounds; SSI developed only in 8(2.65%) of these clean cases. There were 443 clean contaminated cases, among them SSI occurred in 47(10.61%); whereas SSI developed in 45(21.95%) among 205 contaminated wounds. The rate of SSI was as high as 24(48.00%) among 50 dirty cases. The difference had very high statistical significance (P < 0.001) [Table 1]. It can be assumed that the infection rate increased with that of degree of wound contamination.

Table 1 shows that the surgeries were divided into 3 groups according to the time taken during the surgery. Highest rate of infection was found with duration of surgery > 2 hrs (38.10%). The rate of infection increased as the duration of operation was increased. The difference in percentage of SSI with duration of operation was statistically very highly significant (P < 0.001)

Based on type of intervention it was observed that the surgical site infection rates were higher in emergency cases 75(21.31%) than elective cases 49(7.56%). The difference in percentage of SSI with type of intervention was statistically very highly significant (P < 0.001) [Table 1].

In relation to co-morbidity, it was observed that among 389 patients with co-morbid disorders 78(20.05%) developed surgical site infection (SSI). It was clear that associated co-morbid disorders played a vital role as a host related risk factor for SSI. Moreover, the difference was statistically very highly significant (P < 0.001). In 94 patients with anemia 14(14.89%) developed SSI, 111 patients were diabetic among them 34(30.63%) developed SSI, 108 persons were hypertensive among them 21(19.44%) suffered from SSI and 76 persons were obese of which 9(11.84%) developed SSI [Table 1].

Staphylococcus Aureus were found as the commonest organism being isolated causing 42% of the surgical site infections followed by E.Coli 21%, Klebsiella pneumoniae 16%, Pseudomonas Aeruginosa 13% and Proteus 8% [Figure 1].

All the cases of E. coli were resistant to Norfloxacin, Staphylococcus aureus were resistant to Cotrimoxazole and Nitrofurantoin. Similarly Klebsiella Pneumoniae were resistant to Ciprofloxacin, Norfloxacin and Nitrofurantoin, Pseudomonas Aeruginosa were resistant to Ampicillin, Cotrimoxazole and Norfloxacin and Proteus were resistant to Amikacin, Norfloxacin, Cotrimoxazole and Nitrofurantoin. All (100%) the organisms isolated were sensitive to Imipenem [Table 2].

DISCUSSION

This descriptive, cross-sectional study was conducted among 1000 purposively selected patients admitted in surgical wards and getting operated in District Hospital Tumakuru. The study was carried out with a view to determine the incidence of Surgical Site Infections, factors influencing surgical site infections and Antibiotic resistance pattern.

The rate of SSI varies greatly worldwide and from hospital to hospital. The prevalence rate of surgical site wound infection, though preventable, is high (National nosocomial infections surveillance, 1999). The rate of SSI varies from 2.5% to 41.9% as per different studies.[4, 5, 12, 13] The incidence of SSI in the present study is 12.4% which is in concurrence with the study conducted by Suchitra Joyce B. and Lakshmidevi N.[14]

In the present study it was observed that rate of SSI was highest (20.36%) in >50 years age group. It is consistent with the studies done by Patel DA et al, [15] Bandaru NR et al,[16] Jain BK et al,[17] Shah KH et al,[18] Setty NH et al,[19] where the rate of SSI was highest in > 60 yr age group i.e 41.66%, 14.29%, 42.5%, 4.61%, 63.15% whereas according to Gurav PD et al,[20] it is highest among < 30 yr age group 39.0%.

Regarding sex distribution it was observed that Rate of SSI was slightly higher in females (13.78%). It is contradictory with the studies done by Patel DA et al,[15] Bandaru NR et al,[16] Jain BK et al,[17] Setty NH et al,[19] Gurav PD et al,[20] Amrutham R et al,[21] Varsha S et al,[22] rate of SSI was highest in Males i.e 14.29%, 11.63%, 58.27%, 29.1%, 64.4%, 19.68%, 7.4% respectively.

In the present study with regard to association between Pre-operative stay and rate of SSI it was observed that the surgical site infection rates were higher for patients with pre-operative stay of >7 days (19.39%). Similarly according to a study done by Patel DA et al,[15] Shah KH et al,[18] Setty NH et al,[19] and Patel SM et al,[23] rate of SSI was highest in pre-operative stay of >7 days i.e 66.67%, 44.4%, 42.86% and 33.3% respectively.

In relation to different types of wounds, by the degree of contamination, it was observed that rate of SSI was as high as 48.00% among dirty wounds. It goes hand in hand with the study done by Patel DA et al,[15] Shah KH et al, [18] Patel SM et al,[23] Satyanarayana V et al,[24] More SR et al,[25] and Singh AK et al,[26] rate of SSI was highest in

dirty wounds i.e 23.81%, 37.5%, 40.9%, 56.7%, 54.55% and 79.2% respectively.

In the present study with regard to association between duration of operation and rate of SSI it was observed that highest rate of infection was found with duration of surgery > 2 hrs (38.10%). Similarly according to a study done by Mahesh CB et al,[3] Patel DA et al,[15] Shah KH et al,[18] Varsha S et al,[22] Patil BS et al,[27] and Ganguly PS et al,[28] i.e 26.66%, 23.81%, 22.3%, 13.1%, 8% and 61.2% respectively.

Based on type of intervention it was observed that the surgical site infection rates were higher in emergency cases 75(21.31%) than elective cases 49(7.56%). It is consistent with the studies done by Mahesh CB et al,[3] Patel DA et al,[15] Jain BK et al,[17] Patel SM et al,[23] Singh AK et al,[26] Sharan H et al,[29] and Mundhada AS et al,[30] i.e 21.05%, 18.75%, 25.98%, 24.14%, 28%, 19.44% and 45%respectively.

In relation to co-morbidity, it was observed that among 389 patients with co-morbid disorders 78(20.05%) developed surgical site infection (SSI). In 94 patients with anemia 14(14.89%) developed SSI, 111 patients were diabetic among them 34(30.63%) developed SSI, 108 persons were hypertensive among them 21(19.44%) suffered from SSI and 76 persons were obese of which 9(11.84%) developed SSI. According to a study done by Bhadauria AR et al,[31] Surgical site infection was more in patients with pre-existing illness such as anemia 21.13%, obesity 13.62%, hypertension 4.69% and Diabetes Mellitus 8.45%. Similarly in another study done by Setty NH et al,[19] Surgical site infection was more in patients with pre-existing illness such as anemia (62.16%), hypertension (73.91%) and Diabetes Mellitus (83.33%). A similar study done by Jain BK et al,[17] Surgical site infection was more in patients with pre-existing illness such as Diabetes Mellitus (9.35%) and anemia (7.41%).

In the present study, Staphylococcus Aureus were found as the commonest organism being isolated causing 42% of the surgical site infections followed by E.Coli 21%, Klebsiella pneumoniae 16%, Pseudomonas Aeruginosa 13% and Proteus 8%. It goes hand in hand with the studies done by Mahesh CB et al,[3] More SR et al,[25] and Mundhada AS et al,[30] the commonest organism being isolated is Staph Aureus i.e 34.44%, 35.48% and 29.16% respectively. It is contradictory according to a study done by Gurav PD et al,[20] Bhadauria AR et al,[31] and Rajput V et al,[32] the commonest organism being isolated is E Coli i.e 33.9%, 36.62% and 26% respectively.

For the prevention of surgical site infection the antibiotics used during pre-surgical prophylaxis were Ampicillin, Amikacin, Ciprofloxacin, Cotrimoxazole, Ceftriaxone and Norfloxacin. The antibiotics used during post-operative period were Ampicillin, Amikacin, Ciprofloxacin, Ceftriaxone, Metronidazole,Norfloxacin, Nitrofurantoin, Vancomycin and Imipenam in all of the cases. This has contrasting evidence as showed by Rasul and Ashraf in their study conducted in 1979 who did not use antibiotics in any of 65 selected cases and there was not a single incidence of wound infection.

According to a study done by Patil BS et al,[27] Ciprofloxacin, Cefuroxime and Cefotaxime proved to be some effective antibiotics against gram negative bacilli, Polymyxin-B and Ceftazidime showed the highest efficacy of 100% against pseudomonas aeruginosa. Methicillin (cefoxitin) resistance was noted in 6% of staphylococcus aureus. Similarly in a study done by Gurav PD et al,[20] the common sensitive antibiotics were Amikacin, carbenicillin, ceftriaxone, Polymyxin-B. The common resistant antibiotics were cephalexin, ciprofloxacin, Erythromycin, Gentamicin. Rajput V et al,[32] in his study the most effective antibiotics were Imipenem, Amikacin, Neticillin, Piperacillin, Tetracycline and Gentamicin. The least effective antibiotics were Penicillin, Cefotaxime, Cefuroxime and Cefoxitin. Similarly in a study done by Setty NH et al,[19] Organisms isolated from the SSIs showed resistance to all groups of antibiotics. Tetracycline encountered majority of the resistance followed by erythromycin. The commonly used antibiotics like Amikacin, Cephalexin and Cefotaxime also encountered resistance. Similarly Negi V et al,[33] in his study Antibiotic susceptibility results revealed that a high degree of resistance was seen for majority of the bacterial isolates. For gram positive bacteria vancomycin, teicoplanin, linezolid and amikacin were found to be the most effective antibiotics. Meropenem, piperacillin-tazobactam, and amikacin were found to be the most effective antimicrobial agents whereas ampicillin, amoxicillin-clavulanate and cefotaxime were among the most resistant drugs.

CONCLUSION:

The incidence of SSI was high. Age, gender, pre-operative stay, duration of surgery, Co-morbid conditions like anemia, hypertension, diabetes mellitus, obesity and prophylactic antibiotic usage were risk factors for SSI. A pre-existing medical illness, prolonged operating time, the wound class, emergency surgeries and wound contamination strongly predispose to wound infection. Staphylococcus aureus was the most common organism associated with SSI. Majority of the SSIs were resistant to multiple antibiotics.

RECOMMENDATIONS:

On the basis of the findings of the study, the following recommendations can be made:

1. Prompt diagnosis, proper assessment, quick resuscitation and appropriate preoperative preparation are keys to better outcome in emergency operations, but undue delay should be avoided in treating any emergency condition.

2. Duration of operation should be optimum to minimize the level of wound contamination and prevention of SSI.
3. Efforts are needed to strengthen infection control programs, appropriate national strategies for prevention of Hospital Acquired Infections, antibiotic stewardship in our institution in order to decrease the prevalence of Hospital Acquired Infections.
4. Appropriate antibiotic prophylaxis should be practiced.
5. Training of Nursing staff, technicians in postoperative wards regarding maintenance of strict aseptic environment needs emphasis. Concepts of barrier nursing and task nursing can go a long way in tackling SSI.
6. Periodic surveillance of SSI will guide the Infection Control Committee in laying down strict guidelines to further decrease the SSI incidence in our setup, which is an indicator of health care in a given system.

DECLARATIONS

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