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Magnitude and Patient Related Factors of Surgical Site Infections following Abdominal Surgery

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Abstract
Introduction*: Surgical site infection (SSI) is one of the most common health-care–associated infections, with 15%–25% incidence in abdominal surgery depending on the level of contamination. Advanced age, poor nutritional status, increased body mass index (BMI), smoking, remote infections, metabolic idease, malnutrition, and administration of immunosuppressive medication are amongst the most common patient-related risk factors for the occurrence of SSI.*
Materials and Methods*:This prospective study was conducted in Surgery department of tertiary care hospital of Gujarat among 140 patients underwent abdominal surgeries. All factors related to SSI were recorded in the data collection sheet. If SSI was present, the type of SSI, onset, and the micro-organism(s) cultured were reported. The treatment given, readmission and reoperation were documented.*
Results*: The incidence of SSI was 17.1%. Rate of SSI was not significantly different according age and gender. SSI rate was significantly higher in malnourished patients (45.0 %), diabetes mellitus patients (33.3%). and obese patients (22.2 %) and anaemic patients (21.2%). Most common organisms found from wound discharge were Escherischia Coli (45.8%) and Staphylococcus Aureus (37.5%).*
Conclusion*: Infection control guidelines should be strictly followed and extra measures should be taken in patients with comorbidity such as anaemia, diabetes mellitus, obesity and malnutiriton etc. The most commonly isolated pathogen was Escherischia Coli.*
Keywords*-Abdominal surgery, anaemia, diabetes mellitus, obesity, surgical site infection*

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I. Introduction

Surgical site infection (SSI) is defined by the Centers for Disease Control and Prevention as a wound infection that occurs within 30 days of an operative procedure or within a year if an implant is left in place and the infection is thought to be secondary to surgery.[1]SSI is the most surveyed and frequent type of Healthcare-Associated Infections (HAI) in low-and middle-income countries which affects one third of patients who have undergone a surgical procedure. SSI incidence is the second most frequent type of HAI.[2] SSI is one of the most common health-care–associated infections, occurring following 1%–3% of all surgical procedures.[3] The rates of SSI are much higher with abdominal surgery than with other types of surgery, with several prospective studies indicating an incidence of 15%–25% depending on the level of contamination.[3–6] Surgical site infection is preventable and is associated with high morbidity and mortality.

A plethora of patient and procedure-related factors have been strongly associated with the occurrence of SSI over the past decades (5). Advanced age, poor nutritional status, increased body mass index (BMI), smoking, remote infections, metabolic idease, malnutrition, and administration of immunosuppressive medication are amongst the most common patient-related risk factors for the occurrence of SSI. On the other hand, prolonged operative time, contaminated wound status, prophylactic administration of antibiotics, and emergency nature of surgery are among the most common procedure-related risk factors.[7,8] The most commonly isolated organisms from SSIs are Staphylococcus aureus, coagulase-negative staphylococci, Enterococcus spp. and Escherichia coli.[9,10]

It is one of the most common postoperative complications and causes significant postoperative morbidity, mortality, delayed wound healing, prolongs hospital stay, increased use of antibiotics and antibiotic resistance, revision surgery and excess healthcare costs.[11]

II. Aim And Objective:

a) To determine host factors responsible for surgical site infections. b) Isolate and culture pathogens in identified infected wounds and determine their sensitivity patterns to commonly used antibiotics

III. Material And Method:

This prospective study was conducted in Surgery department of tertiary care hospital of Gujarat for one year. Total 140 patients more than 15 years underwent non-traumatic abdominal surgeries were included through purposive sampling method. Exclusion criteria were a) patient with malignant condition b) hospital stay less than 5 days, c) associated with postoperative infection like UTI, RTI etc. Informed written consent was taken from the patients or their guardian willing to participate in the study. Data were collected by pre-tested structured questionnaire. All factors related to SSI were recorded in the data collection sheet. During the postoperative period all the patients were closely monitored everyday up to the discharge of the patient from the hospital. Examination of surgical incision during dressing changes, ward rounds, and review of patient records was done. If SSI was present, the type of SSI, onset, and the micro-organism(s) cultured were reported. The treatment given, readmission and reoperation were documented. Specimens were obtained by sterile swabs using aseptic technique to to detect growth identification of the organism and antibiotic sensitivity testing. Superficial incisional SSIs were managed with antibiotics with regular wound dressings; deep incisional SSIs were managed with incision and drainage with cleansing of wound with antimicrobial solutions along with injectable antibiotics; Organ/space SSIs were treated with incision and drainage of pus sometimes with debridement along with advance wound dressing and sensitive injectable antibiotics.

The data was entered in Microsoft Excel 2010 and analyzed with Epi info version 7.1.4.0 Continuous data was presented with mean and standard deviation while categorial data was presented with frequency and percentage. Comparison of categorial data were analysed with Chi square and p value less than 0.05 was considered as significant.

IV. Results

This prospective study was conducted among 140 cases having non-traumatic abdominal surgeries. Overall surgical site infection rate was 17.1%. Majority of the patients (89.3 %) were in between 11-50 years. Male to female ratio was 1.74:1. About 17.9% (25) were illiterate. Highest SSI rate was observed in 41 to 50 year age group (26.5%) followed by 51 to 60 years (22.2%). However, rate of SSI was not significantly different according age (p- 0.46). SSI rate in male was 18.0% which was not significantly different from female (15.7%, p – 0.72). SSI rate among illiterate patients and patients educated up to primary was 24.0% and 22.2% respectively. However, SSI rate among patients with education up to secondary, higher secondary and graduation was 17.7%, 11.1% and 11.5% respectively. This difference was not statistically significant (p – 0.72).

Table 1: Surgical site infection according to socio demographic variables

Variables	SSI status		Total	χ^2, p value
Age group	**Yes (n-24)**	**No (n-116)**		
11 to 20	5 (16.1)	26 (83.9)	31 (100)	χ^2 - 4.59, p - 0.46
21 to 30	2 (6.7)	28 (93.3)	30 (100)	
31 to 40	5 (16.7)	25 (83.3)	30 (100)	
41 to 50	9 (26.5)	25 (73.5)	34 (100)	
51 to 60	2 (22.2)	7 (77.8)	9 (100)	
61 to 70	1 (16.7)	5 (83.3)	9 (100)	
Gender				
Male	16 (18.0)	73 (82.0)	89 (100)	χ^2 - 0.11, p - 0.72
Female	8 (15.7)	43 (84.3)	51 (100)	
Education				
Illiterate	6 (24.0)	19 (76.0)	25 (100)	χ^2 - 2.04, p -0.72
Primary	2 (22.2)	7 (77.8)	9 (100)	
Secondary	11 (17.7)	51 (82.3)	62 (100)	
Higher secondary	2 (11.1)	16 (88.9)	18 (100)	
Graduation or above	3 (11.5)	23 (88.5)	26 (100)	

Out of 140 patients, 62 patients (44.2%) had co-morbid disorders associated with the main surgical disease. Among these 62 patients with co-morbid disorders, 20 (32.26 %) developed SSI, whereas, in the 78 patients without any co-morbidity only 4 (5.1 %) developed SSI. The difference was statistically highly significant (p< 0.001). It was clear that associated co-morbid disorders played a vital role as a host related risk factor for SSI.

Table 2: SSI rate according to comorbidties

Comorbidities	SSI status		Total	χ^2, p value
	Yes (n-24)	No (n-116)		
Present	20 (32.3)	42 (67.7)	62 (100)	χ^2 - 17.89, p < 0.001
Absent	4 (5.1)	74 (94.9)	78 (100)	

SSI rate was 21.2% in anaemic as compared to 6.8% in non anaemic patients (p < 0.001). SSI rate was 50%, 23.2%, 6.9% and 6.3% in patients ith Hb level <7gm%, 7-10 gm%, 10-15 gm% and >15 gm% respectively. The rate of SSI was increased with law level of Hb (50% with Hb <7gm% and 23.2% with Hb level 7 to 10gm %).

Table 3: Assocaition between SSI rate and anaemia

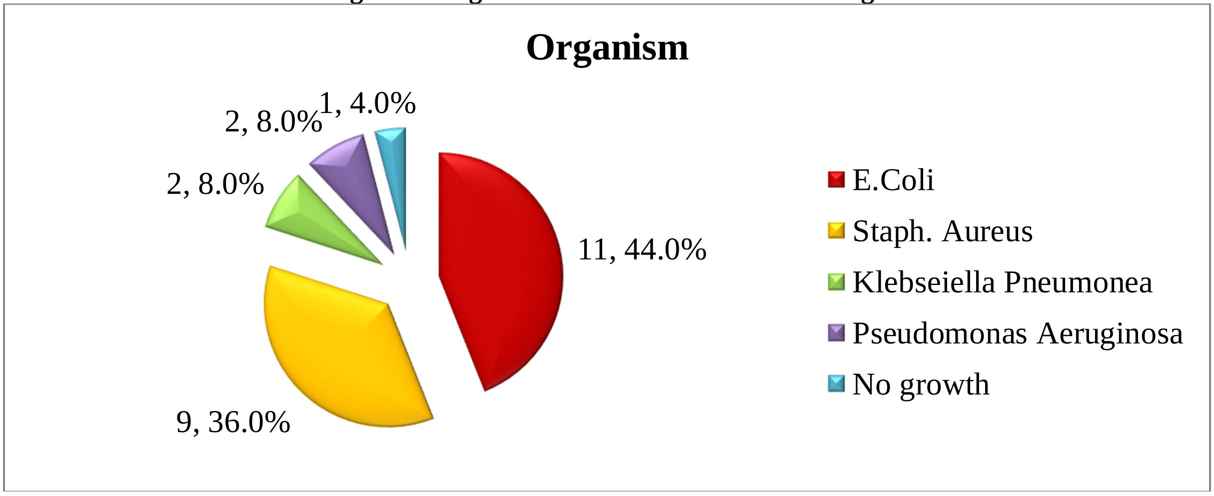
Anaemia	SSI status		Total	χ^2, p value
	Yes (n-24)	No (n-116)		
– Present	18 (21.2)	34 (79.8)	52 (100)	χ^2 –17.78, p <0.001
– Absent	6 (6.8)	82 (93.2)	88 (100)	
Hb level (gm %)				
– < 7	11 (50.0)	11 (50.0)	22 (100)	χ^2 - 24.13, p < 0.0001
– 7 to 10	7 (23.2)	23 (76.7)	30 (100)	
– 10 to 15	5 (6.9)	67 (93.1)	72 (100)	
– > 15	1 (6.3)	15 (93.8)	16 (100)	

SSI rate was 45 % in malnourished, 22.2 % in obese and 9.7 % in well-nourished or averagely nourished patients. SSI rate was 28.6% in COPD and 33.3% in DM.

Table 4: SSI rate based on nutritional status

Comorbidities	SSI status		Total	χ^2, p value
Nutritional status	Yes (n-24)	No (n-116)		
– Malnutrition	9 (45.0)	11 (55.0)	20 (100)	χ^2 - 15.06, < 0.001
– Obesity	6 (22.2)	21 (77.8)	27 (100)	
– Well nourished	9 (9.7)	84 (90.3)	92 (100)	
Other comorbidities				
– COPD	2 (28.6)	5 (71.4)	7 (100)	χ^2 - 0.67, p - 0.41
– DM	2 (33.3)	4 (66.7)	6 (100)	χ^2 - 1.15, p - 0.28
– Medical jaundice	1 (50)	1 (50)	2 (100)	χ^2 - 1.54, p - 0.21

Figure 1: Organism found from wound discharge



Twenty five samples of discharge from the wounds were sent for culture and sensitivity test. Among them causative pathogens were detected in twenty four cases. Most common organisms found from wound discharge were Escherischia Coli with thin muddy odourless pus (11, 45.8%) and Staphylococcus Aureus with thick creamy pus (9, 37.5%). Others were Klebsiella Pneumonae with yellow fishy odour pus and Pseudomonas Aeruginosa with bluish green pus in 2 cases (8.3%) each.

Table 5: Sensitivity pattern of the cultured micro organism to various antibiotics

Micro organism	Antibiotic							
	Ciprofloxacin	Amoxicillin/ Sulbactum	Cotrimoxazole	Linezolid	Nitroflurantoin	Ceftriaxone	Amikacin	Imipenam
E coli (11)	5 (45.4)	6 (54.5)	5 (45.5)	NA	1 (9.1)	8 (72.7)	5 (45.5)	11 (100)
Staph. Aureus (9)	4 (44.4)	4 (44.4)	NA	5 (55.6)	NA	8 (88.9)	4 (54.5)	9 (100)
Klebsiella Pneumoniae (2)	NA	1 (50)	1(50)	NA	NA	2 (100)	NA	2 (100)
Pseudomonus aeruginosa (2)	1 (50)	NA	NA	1 (50)	1 (50)	2 (100)	NA	2 (100)

Escherischia coli were sensitive to Ciprofloxacin (45.5% cases), Amoxicillin/ Sulbactam (54.5 % cases), Cotrimoxazole (45.5 % cases), Nitrofurantoin (9.1 % cases), Ceftriaxone (72.7 % cases), Amikacin (45.5 % cases) and Imipenem (100 % cases). All the cases of E. coli were resistant to Linezolid.Staphylococcus aureus were sensitive to Ciprofloxacin (44.5% cases), Amoxicillin/ Sulbactam (44.5% cases), Linezolid (55.6% cases), Ceftriaxone (88.9% cases), Amikacin (54.5% cases) and Imipenem (100% cases). But, all the cases of Staph. Aureus were resistant to Cotrimoxazole and Nitrofurantoin. Klebsiella pneumoniae were sensitive to Amoxicillin/ Sulbactam and Cotrimoxazole in 50.0% cases each and to Ceftriaxone and Imipenem in all (100 %) cases. But, all the cases of Klebsiella Pneumoniae were resistant to Ciprofloxacin, Linezolid and Nitrofurantoin. About 50.0% cases of Pseudomonas aeruginosa were sensitive to Ciprofloxacin and Nitrofurantoin, and all the cases of P. aeruginosa (100%) sensitive to Ceftriaxone and Imipenem. All of them (100%) were resistant to Amoxicillin/ Sulbactam, Cotrimoxazole and Linezolid. All (100%) the organisms isolated were sensitive to Imipenem. As this study was done in our institute with limited resources, it was not possible to do culture and sensitivity for all antibiotics.

Table 6: SSIs wound scoring with different type of management

SSI (Southampton wound scoring)	No of cases	Management
Grade 1	4	Antibiotic, Traditional wound dressing
Grade 2	3	Antibiotic, Traditional wound dressing
Grade 3	9	I & D, Cleansing of wound, sensitive injectable antibiotic
Grade 4	7	I & D, Cleansing of wound, sensitive injectable antibiotic
Grade 5	2	Debridement, Advanced wound dressing, Resuturing, Sensitive higher antibiotics

As per Southampton wound scoring system, Out of 25 patients who developed discharge from the wound, 04 cases were in grade 1, 03 cases in grade 2, 09 cases in grade 3, 07 cases in grade 4 and 02 cases in grade 5. Grade 1 and 2 cases with serous discharge, erythema and other signs of inflammation were managed by injectable antibiotics and traditional wound dressing with antiseptic solution, Grade 3 and 4 cases with serosenguinous to pustulous discharge from wound with inflammation required removal of sutures and drainage with proper cleansing of wound with povidone iodine and hydrogen peroxide (H2O2) with sensitive injectable antibiotics and advanced wound dressing. 2 cases in Grade 5 were presented with wound dehiscence with necrotizing margins, pus discharge, required wound debridement with sensitive injectable antibiotics for longer duration followed by advanced wound dressing and resuturing after some time.

V. Discussion

In the present study, the overall surgical wound infection rate was 17.1%. Many studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7%.[12–15] Majority of the patients (89.3 %) were in between 11-50 years. Male to female ratio was 1.74:1. About 17.9% (25) were illiterate. Similar age distribution was observed in the study by Karim et al.[16] In the present study, rate of SSI was not significantly different according age and gender. Rate of SSI decreased with rise in level of education, which is associated with lack of health awareness and poor hygiene in patients with less education.[17,18]

Ansari S et al.[19] observed greater SSI rate among more than 50 years age group (11.4%) as compared to less than 50years age group patients (6.4%, $p < 0.001$). SSI rate among male and female was not significantly different (8.5% v/s 9.3% respectively, p -0.71).Sattar F et al.[20] reported higher SSI rate in patients whose age was above 60 years (44.4%) and lower in patients whose age was less than 15 years (9.1%). A study conducted at Andhra Pradesh, India showed similar results.[21] Increasing age is associated with a greater likelihood of certain chronic conditions and delayed healing which is most probably the cause of the increased incidence in higher age groups. Gener and educational status were not significantly associated with development of SSIs.[20]

In the present study, SSI rate was significantly higher in patient with co morbid disorder (32.3 %) as compared to patients without any co-morbidity (5.1 %, $p < 0.001$). SSI rate was significantly higher in malnourished patients (45.0 %), DM patients (33.3%). and obese patients (22.2 %). In the malnourished patients the general resistance is reduced so the incidence of wound infection is more. Obesity is also another important patient-related risk factor. Sattar F et al.[20] also concluded that the incidence of SSIs in patients with obesity (36.8%) was higher than non-obese patients (26.3%). Morbid obesity has been correlated with prolonged wound healing which is a known risk factor for deep SSIs.[22] Patients with diabetes had a greater percentage of SSIs (66.7%) as compared to other co-morbidities such as renal failure and hypertension. A study conducted at a teaching hospital in Saudi Arabia also showed diabetes to be an important risk factor in the incidence of SSIs (25.0%).[23] SSI rate was also higher in anaemic patients (21.2%). Anemia was also found to be a risk factor. About 40.9% anemic developed an infection after surgery. A study conducted at Nawab Shah also showed anemia to be a risk factor in the incidence of SSIs.[24]In the present study, SSI rate was significantly increased with decreasing level of Hb. As the haemoglobin percentage is reduced, the amount of oxygenation of the tissue is reduced and the vitality of the tissue is affected so there are more chances of infection, when the haemoglobin is low. This shows importance of oxygenation in wound healing.[17,18]

In the present study, causative pathogens were detected in 24 samples out of 25 samples. Most common organisms found from wound discharge were Escherischia Coli (11, 45.8%) and Staphylococcus Aureus (9, 37.5%), Klebsiella Pneumonae (2, 8.3%) and Pseudomonas Aeruginosa (2, 8.3%). Similar findings was observed in other study by Karim et al.[16], (E.coli - 45.7% and Staph. Aureus - 22.1 %). As E.coli and Staph. Aureus were most commonly present in normal skin flora, SSIs rate were higher with these two pathogens. Majority if the organisms were sensitive to Imipenam and Ceftriaxone. In the study of Lakoh S et al.[25] Of 338 patients, 39 (11.5%) developed an SSI. Wound swabs were collected in 29 (74.4%) patients, of which 18 (62.1%) had bacterial growth. In total, 49 isolates of 14 different bacteria including gram-negative 41 (83.7%) and gram-positive 8 (16.3%) isolates were identified. Of these, 32 (65.3%) were Enterobacteriaceae, 9 (18.4%) were Non-fermenting gram-negative bacilli and 10 (12.2%) were Enterococci. The most common isolates were Escherichia coli (12, 24.5%), Klebsiella pneumonia (10, 20.4%), Acinetobacter baumannii (5, 10.2%), Klebsiella oxytoca (4, 8.2%) and Enterococcus faecalis (4, 8.2%). The Enterobacteriaceae were either resistance to carbapenems (4, 8.2%) or were extended-spectrum beta-lactamase (ESBL)

VI. Conclusion

Surgical site infection is one of the important complications of Surgeries. SSI is more likely to develop in the patients with comorbidity such as anemia, diabetes, obesity and malnutiriton etc. The most commonly isolated pathogens were Escherischia Coli and Staphylococcus Aureus. Infection control guidelines should be strictly followed and extra measures should be taken in high-risk patients to prevent infections.

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