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Original Research Article

A Hospital Based, Prospective Investigation on the Many Risk Factors Linked to Surgical Site Infection

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Abstract

Aim: A clinical investigation on the many risk factors linked to surgical site infection in a tertiary hospital.

Material and Methods: A hospital based, retrospective, observational study was conducted at Department of Microbiology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India for February 2021 to November 2021. Patients with surgical site infections following non-traumatic exploratory laparotomy during study period were considered for this study. Patients 18-70 years age, of either gender, underwent non-traumatic exploratory laparotomy, had surgical site infections following laparotomy, willing to participate in present study.

Results: During study period, among 1332 laparotomies, 81 patients had surgical site infections, thus incidence of SSI was 6.08 %. Majority cases were from 41-50 years age group (28.4%), followed by 51-60 years age group (20.99%). Mean age of study patients was 50.4 ± 8.24. Male (64.2%) outnumbered female (35.8%) cases. Common co-morbidities noted were diabetes (43.21%) followed by BMI 25-30 kg/m2 (41.98%), dyslipidaemia (33.33%), smoking (28.4%) and hypertension (25.03%). Most patients had ASA score 2 (50.62%) and duration of surgery > 2 hours (53.09%). In present study, SSI was most common in Exploratory laparotomy with appendicectomy and peritoneal lavage (28.4%) followed by open appendicectomy (14.81%), adhesiolysis/resection anastomosis and peritoneal lavage (11.11% each). In SSI patients, surgical wounds were labelled as clean, clean contaminated and contaminated, majority of wounds were Clean (45.68%) followed by Clean contaminated (29.63%), Contaminated (16.0%) and Dirty or infected (8.64%).

Conclusion: Surgical site infection is a preventable morbidity. BMI > 25, co-morbidities such as diabetes, smoking, dyslipidaemia, surgery > 2 hours, appendicectomy were few high-risk factors noted for surgical site infections following elective/emergency abdominal surgeries. Pre-operative assessment, evaluation of high-risk factors, intraoperative care and postoperative monitoring is important to prevent SSI.

Keywords: Surgical Site Infection, Diabetes, Smoking, Dyslipidaemia, Abdominal Surgeries.

Introduction

Surgical site infections (SSIs) are one of the most common complications following surgical procedures, significantly impacting patient morbidity, mortality, and healthcare costs. SSIs are infections that occur at or near the surgical incision within 30 days of the procedure or within one year if an implant is placed . The incidence of SSIs varies depending on the type of surgery, patient characteristics, and healthcare settings, with rates ranging from 2% to 5% in most surgical procedures . This introduction explores the various risk factors associated with SSIs, emphasizing the importance of identifying and mitigating these factors to improve surgical outcomes. [1,2] Several patient-related factors have been identified as significant contributors to the development of SSIs. These include age, obesity, diabetes, smoking, and immunosuppression. Advanced age is a well-documented risk factor for SSIs. Older patients often have comorbidities and diminished immune responses, which increase their susceptibility to infections. Studies have shown that patients over 65 years of age are at a higher risk of developing SSIs compared to younger patients. Obesity is another critical risk factor, with several studies indicating that obese patients have a higher risk of SSIs. Increased adipose tissue can impair wound healing and provide a favourable environment for bacterial

growth. Obese patients undergoing bariatric or general surgeries are particularly at risk . [3-7]

Diabetes mellitus is associated with poor wound healing and increased risk of infections. Hyperglycaemias impairs immune function and collagen synthesis, crucial for effective wound repair . Tight glycaemic control has been shown to reduce SSI rates in diabetic patients. Smoking negatively affects wound healing by reducing tissue oxygenation and impairing immune function. Smokers have been found to have higher rates of SSIs compared to non-smokers . Smoking cessation prior to surgery has been recommended to decrease SSI risk. Patients with compromised immune systems, whether due to disease or medication, are at higher risk for SSIs. Conditions such as HIV/AIDS, cancer, and use of immunosuppressive drugs increase susceptibility to infections. [8,9] The type of surgical procedure, duration, and complexity are significant determinants of SSI risk. Certain types of surgeries, such as gastrointestinal, cardiovascular, and orthopaedic procedures, have higher SSI rates due to the nature of the tissues involved and the potential for contamination. Prolonged surgical procedures are associated with increased SSI risk. Extended operative time increases exposure to potential contaminants and causes greater tissue damage and immune suppression. The surgical technique and operating room environment also play a critical role. Factors such as improper sterilization of instruments, inadequate surgical site preparation, and failure to adhere to aseptic techniques can increase SSI risk. Use of prophylactic antibiotics has been shown to significantly reduce SSI rates when administered appropriately. [10]

Material and Methods

A hospital based, retrospective, observational study was conducted at Department of Microbiology, Darbhanga Medical College and Hospital, Laheriasarai ,Darbhanga, Bihar, India for February 2021 to November 2021. Patients with surgical site infections following non-traumatic exploratory laparotomy during study period were considered for this study.

Inclusion criteria: Patients 18-70 years age, of either gender, underwent non-traumatic exploratory laparotomy, had surgical site infections following laparotomy, willing to participate in present study.

Exclusion criteria: Patients undergoing exploratory laparotomy for traumatic causes. Patients receiving steroids, Chemotherapy/radiotherapy, immunosuppressant drugs. Patients presenting with pre-existing skin infections. Patients operated outside the hospital.

Study was explained to patients in local language and written consent was taken for participation and study. Socio-demographic details, associated co morbidities like diabetes/hypertension/ bronchial asthma/ thyroid disorders/renal disease or any immunosuppressive disorders, clinical details, prophylactic antibiotic use, blood transfusion, preoperative hospital stay, ASA score, nature of surgery, type of anaesthesia, duration of surgery, intraoperative findings, post-operative course, present examination findings, routine investigations (CBC, blood sugar, wound swab culture and sensitivity, LFT, RFT) were noted.

Wound infection was diagnosed if any one of these criteria was fulfilled: Serous or no purulent discharge from the wound, pus discharge from the wound, serious or nonprurient discharge from the wound with the sign of inflammation and when wound was deliberately opened by the surgeon due to the localized collection.

Wound swab was sent to microbiology department for culture + sensitivity and after the swab culture and sensitivity report was available, the antibiotic was changed, if required. Follow up was kept till clearance of SSI. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

Results

During study period, among 1332 laparotomies, 81 patients had surgical site infections, thus incidence of SSI was 6.08 %. Majority cases were from 41-50 years age group (28.4 %), followed by 51-60 years age group (20.99 %). Mean age of study patients was 50.4 ± 8.24. Male (64.2 %) outnumbered female (35.8 %) cases. Common co-morbidities noted were diabetes (43.21 %) followed by BMI 25-30 kg/m2 (41.98 %), dyslipidaemia (33.33 %), smoking (28.4 %) and hypertension (25.03 %). Most patients had ASA score 2 (50.62 %) and duration of surgery > 2 hours (53.09 %). In present study, SSI was most common in Exploratory laparotomy with appendicectomy and peritoneal lavage (28.4 %) followed by open appendicectomy (14.81 %), adhesiolysis/resection anastomosis and peritoneal lavage (11.11 % each). In SSI patients, surgical wounds were labelled as clean, clean contaminated and contaminated, majority of wounds were Clean (45.68 %) followed by Clean contaminated (29.63 %), Contaminated (16.05 %) and Dirty or infected (8.64 %). In present study, Superficial SSI (65.43 %) was most common followed by Deep SSI (28.4 %) and Organ space SSI (6.17%). In present study, most common organism isolated was E. coli (19.75 %) followed by Pseudomonas (16.05 %), Streptococcus (13.58 %), Klebsiella (9.88 %), MRSA (7.41 %), Acinetobacter (4.94 %), Helicobacter (2.47 %) and Providentia (1.23 %). No growth was noted in 33 cases (40.74 %).

Table 1: General Characteristic

Characteristic	No. of patients (n=81)	Percentage
Age group (years)		
≤30	12	14.81%
31-40	14	17.28%
41-50	23	28.40%
51-60	17	20.99%
61-70	15	18.52%
Gender		
Male	52	64.20%
Female	29	35.80%
Co-morbidities		
Diabetes	35	43.21%
BMI >25 kg/m2	34	41.98%
Dyslipidaemia	27	33.33%
Smoking	23	28.40%
Hypertension	21	25.93%
Chronic obstructive pulmonary disease	17	20.99%
Coronary artery disease	6	7.41%
ASA grade		0.00%
I	11	13.58%
II	41	50.62%
III or more	29	35.80%
Duration of operation (Hours)		
<1 hr	15	18.52%
1-2 hr	23	28.40%
>2 hr	43	53.09%

Table 2: Type of Surgery

Surgery	No. of patients (n=81)	Percentage
Appendicectomy and peritoneal lavage	23	28.40%
Open appendicectomy	12	14.81%
Adhesiolysis/Resection Anastomosis	9	11.11%
Peritoneal lavage	9	11.11%
Hernia repair	8	9.88%
Ileal repair/ileostomy	6	7.41%
Exploratory laparotomy with omental patch repair	5	6.17%
RA repair of sigmoid volvulus	4	4.94%
Duodenal ulcer perforation repair	2	2.47%
Liver abscess drainage and peritoneal lavage	2	2.47%
Repair of intussusception	1	1.23%

Table 3: SSI related characteristics

Characteristic	No. of patients (n=81)	%
Type of wound		
Clean	37	45.68%
Clean contaminated	24	29.63%
Contaminated	13	16.05%
Dirty or infected	7	8.64%
Type of SSI7	81	
Superficial SSI	53	65.43%
Deep SSI	23	28.40%
Organ space SSI	5	6.17%

Table 4: Organism isolated

Organism isolated*	No. of patients (n=81)	Percentage
No growth	33	40.74%
E. coli	16	19.75%
Pseudomonas	13	16.05%
Streptococcus	11	13.58%
Klebsiella	8	9.88%
MRSA	6	7.41%
Acinetobacter	4	4.94%
Helicobacter	2	2.47%
Providentia	1	1.23%

Discussion

There are various factors contributing to the risk of SSI occurrence and preventative measures require an integrative approach that focuses through the pre-, intra and postoperative care involving all the stakeholders. Numerous multimodal preventive intervention programs based on guidelines, surgical site care bundles, and surgical safety checklists have been established. Despite several advancements in procedures, the optimal reduction of SSIs remains a challenge. [8,9] The development of SSI is multifactorial, and it may be related to patient's risk factors such as age, comorbidities, smoking habit, obesity, malnutrition, immunosuppression, malignancies, and the class of contamination of the wound. [10] 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. [11]

The incidence of SSI in study by Prakash V et al.,12 was 25.34% with 81.58% superficial SSI and 18.42% deep SSI. Laparotomy was the common procedure and 63.2% of cases were females and 41-60 years was the most common age group. Staphylococcus aureus, Klebsiella pneumoniae and Escherichia coli were the common pathogens and were sensitive to carbapenems, vancomycin and linezolid. Significant association was observed with presence of pre-morbid analysis, presence of drain, use of povidone iodine alone and development of SSI. Patel S M et al., [13] noted that, SSI rate was 16% (32/200).The most common organism isolated was Escherichia coli (35.7%, 10/28). Increase in pre-operative hospital stay, ASA (American Society of Anesthesiology) score > 2, increase in surgical wound class, emergency surgeries, longer duration of surgery were associated with increased SSI rates. Amrutham R et al., [14] noted that surgical site infections (SSIs) were most commonly found among males, aged, diabetics, anaemic, underweight and overweight, hypertensive, blood transfusion and patients with longer hospital stay. Surgical Site Infections were higher in emergency cases than elective surgeries. Staphylococcus aureus was the most common organism isolated from surgical site infections. Multidrug resistance organisms were predominant in surgical site infections. In study by Amit Agrawal [15], SSI incidence was 15.7 % (59/375). In elective surgeries, the SSI rate was 5.7% and in emergency surgeries, it was 28.6%. It was found that SSI increased with increasing age linearly. Other significant factors involved were increasing class of wound (dirty > clean wound class), increased preoperative stay, presence of remote site infection, increased duration of surgery and use of drains. E. coli was found to be the most common organism causing SSI in abdominal operations. In a systematic review, Salahuddin M et al., [16] studied 18 articles, occurrence rate of SSI ranges from 2% to 17.8%. 3 microorganisms commonly reported were Staphylococcus aureus, Klebsiella pneumonia, and E.Coli. High SSI incidence noted among emergency surgical procedures and lower among obstetrics and gynaecology procedures. Longer preoperative duration of stays in hospital, decreased Hb and serum albumin level, comorbid conditions such as diabetes, hypertension are potential risk factors for the development of SSI. The occurrence rate of SSI among post-operative patients is very high, especially in developing countries. Korol E et al., [17] conducted a systemic review and noted that median SSI incidence was 3.7%, ranging from 0.1% to 50.4%. Incidence of overall SSI and S. aureus SSI were both highest in tumor-related and transplant surgeries. Median time until SSI onset was 17.0 days, with longer time-to-onset for orthopaedic and transplant surgeries. Risk factors consistently identified as associated with SSI included co-morbidities, advanced age, risk indices, patient frailty, and surgery complexity. Thirteen studies considered diabetes as a risk factor in multivariable analysis; 85% found a significant association with SSI, with odds ratios ranging from 1.5-24.3. Longer surgeries were associated with increased SSI risk, with a median odds ratio of 2.3 across 11 studies reporting significant results. Multiple risk factors and peri-operative characteristics can increase the likelihood of superficial surgical site infections. Important host factors include diabetic mellitus, hypoxemia, hypothermia, leucopenia, nicotine, long

term use of steroids or immunosuppressive agents, malnutrition, nares contaminated with Staphylococcus aureus and poor skin hygiene.[18] Peri-operative / environmental factors are operative site shaving, breaks in operative sterile technique, early or delayed initiation of antimicrobial prophylaxis, inadequate intra-operative dosing of antimicrobial prophylaxis, infected or colonized surgical personnel, prolonged hypotension, poor operative room air quality, contaminated operating room instruments or environment and poor wound care postoperatively. [18,19] Correctly performed hand hygiene among health care workers (HCWs) is the most important action to interrupt the chain of transmission of pathogenic microorganisms between patients and therefore reducing HAI, including SSI. [20] With rising incidence rate of SSI, its end results will have a greater impact on patients as well as on healthcare systems. Prevention of SSI requires multipronged approach targeting both patient related and procedure related risk factors in pre- operative, intra-operative, and post-operative period.

Conclusion

Surgical site infection is a preventable morbidity. BMI > 25, co-morbidities such as diabetes, smoking, dyslipidaemia, surgery > 2 hours, appendicectomy were few high-risk factors noted for surgical site infections following elective/emergency abdominal surgeries. Pre-operative assessment, evaluation of high-risk factors, intraoperative care and postoperative monitoring is important to prevent SSI.

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