Original Article

Surgical site infection; effect of contamination and duration of surgical procedure

Muhammad Iqbal[1], Muhammad Naeem Zia[2], Sadaf Ijaz[3], Naveed Akhtar Malik[4]

[1] Assistant Professor Surgery, Rawalpindi Medical University, Rawalpindi.
[2,4] Professor Surgery, Rawalpindi Medical University, Rawalpindi.
[3] Senior Registrar Paediatrics, Benazir Bhutto Hospital, Rawalpindi.

Author's Contribution

[1] Conception of study
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[1,3] Manuscript Writing
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[1] Facilitation and Material analysis

Corresponding Author

Dr. Eruj Shuja,
Assistant Professor Surgery,
Rawalpindi Medical University,
Rawalpindi
Email: iqbalnazir1976@gmail.com

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Abstract

Introduction: Surgical site infections are responsible for increased treatment cost, prolonged hospital stay, and increased morbidity on the surgical floor. Increased level of per-operative contamination and prolonged surgery increases the incidence of surgical site infections.

Objective: To know the effect of contamination and duration of surgery on the incidence of surgical site infections in emergency surgical patients so that specific strategies can be developed to decrease the morbidity and mortality caused by these infections.

Materials and Methods: All the patients who underwent general surgical operations on an emergency basis at the surgical unit-1 of the Benazir Bhutto Hospital Rawalpindi from 01-01-2019 to 31-12-2020 were evaluated for surgical site infections. The level of contamination per operatively and duration of surgery were documented. Surgical site infections suspected clinically were confirmed by culture and sensitivity.

Results: Among 2202 emergency-operated patients, two hundred and thirty-seven patients (10.76%) had surgical site infection confirmed on culture and sensitivity (C/S) report. About sixty-five percent of patients were male. Of two hundred and thirty-seven positive patients, seventy (29.09%) patients underwent laparotomy for penetrating and blunt abdominal trauma. About fifty-eight percent of SSI patients had contaminated wounds per operatively. Operative time was one to three hours in about sixty-seven percent of SSI-positive patients. Staph aureus was present in one hundred and forty-five (79.67%) patients. E.coli was the most commonest Gram-ve micro-organism (70.95%).

Conclusion: Surgical site infection causes a significant rise in morbidity on the surgical floor. Increased levels of contamination per operatively and prolonged operative time increase the incidence of SSI in emergency surgical operations.

Keywords: Emergency surgical operations, surgical site infection, contamination, duration of surgery, Staph aureus.

Introduction

Surgical site infections (SSIs) are defined as infections occurring up to 30 days after surgery (or up to one year after surgery in patients receiving implants) and affecting either the incision or deep tissue at the operation site.[1] SSI may present clinically as redness, delayed healing, fever, pain, tenderness, warmth, swelling, or discharge of pus.[2]
Surgical site infections (SSI) are a major cause of morbidity in surgical patients and they increase health care costs considerably due to prolonged stay in the hospital and extra usage of the hospital facilities like costly antibiotics and use of ventilatory support etc.[3]
SSI accounts for 14-17% of overall hospital-acquired infections and nearly 38% of hospital-acquired infections in surgical patients postoperatively.[4]
Patients with an SSI have a 2–11 times higher risk of death, compared with operative patients without an SSI.[5,9]
Patient factors like old age, co-morbidities i.e. diabetes, cardiovascular diseases, hypertension, immune-compromised state, smoking, alcohol, obesity, stress, and malnutrition enhance the risk of SSI. It also depends on operative intervention, emergency/ elective setting, duration of operation, perioperative infusion, type of wound, and length of hospital stay.[5]
The incidence of SSI is much higher in patients undergoing emergency surgery than in elective surgery.[5,6] Emergency procedures are defined as unplanned operations and include reoperations after previous procedures.[5,6,24] Contaminated and dirty wounds, prolonged duration of the operation, patient comorbidities, and high American Society of Anesthesiologists (ASA) score are commonly present in this type of surgery.[5,6] Gastrointestinal tract procedures especially large bowel surgery carry a high chance of SSI due to high levels of contamination.[5,6,7,8,9]
Wounds are classified by their level of contamination as clean, clean-contaminated, contaminated, and dirty.[10]
Operative duration is an independent and potentially modifiable risk factor for SSI. The likelihood of SSI increases with the increasing time of surgery.[11,22]
Causative pathogens are acquired endogenously from the patient's flora or exogenously from contact with operative room personnel or the environment.[12] Most SSIs are caused by Staphylococcus aureus, E.coli, and Enterococci.[12,13]
We must adhere to guidelines for the prevention of SSIs in form of good patient preparation, aseptic practice, minimizing operative time, attention to surgical technique, minimizing operative contamination, and broad-spectrum antimicrobial prophylaxis.[14]
The purpose of this study was to know the effect of wound contamination and length of operative time on the causation of SSI in emergency surgical procedures. Depending on the results, specific strategies can be developed to decrease the morbidity and mortality caused by SSIs.

Materials and Methods

Study design: Cross-sectional observational study.
Setting: surgical unit 1, Benazir Bhutto Hospital, Rawalpindi.
Duration of study: Two years from 01-01-2019 to 31-12-2020.
Sample size: According to the WHO sample size calculator 363 patients kept a confidence interval of 95%, a margin of error of 5%, and a population proportion of 38%.[4]
Sampling technique: Non-probability consecutive sampling.
Inclusion criteria: All adult patients admitted to surgical wards after undergoing emergency surgeries.
Exclusion criteria:

1. Emergency patients who died after admission to the hospital and before undergoing surgical procedures.
2. Elective surgeries.
3. Pediatric population.

Data collection procedure:
All the patients eligible for inclusion in the study were enrolled consecutively and followed from the time of admission until the time of discharge. Informed consent was taken from all the patients or their attendants. Before the start of the study, the pathological department of the same hospital was taken into liaison regarding culture and sensitivity testing of the wound swab. All the patients were operated on with full anti-septic protocol by senior registrars and registrars having good surgical experience. The level of contamination and time duration of each surgery was recorded. Post-operatively all the patients were managed in the surgical ward on merit. Patients were discharged when they were hemodynamically stable and regularly followed in the out-patients department till the end of the first month. Clinical specimen of apparent pus and wound discharge from clinically suspected SSI patients was taken under full aseptic measures in a sterile container. They were sent to the

pathological department with a patient profile under sterile conditions for culture and sensitivity examination using a standard machine. Data like name, age, gender, date of admission, name of surgery, level of wound contamination, duration of surgery, report of culture, and sensitivity to antibiotics were recorded using a performed proforma.

Statistical analysis of data:

It was done using Statistical Package for Social Sciences version 21 (SPSS 21). Frequencies and percentages were calculated for qualitative data like the number of positive SS patients, level of contamination, operation time, pathogens, and their sensitivity to antibiotics.

Results

Out of the total 2202 operated patients, 237(10.76%) developed surgical site infection (SSI).

One hundred and fifty-five (65.40%) SSI patients were male and eighty-two (35.59%) were female. The most involved age groups were 11-20 and 21-30 years (30.80% and 27.00%) respectively. Of the total 237 patients with SSI, fifty (21.09%) had laparotomy for acute abdomen, seventy (29.09%) had laparotomy for penetrating and blunt abdominal trauma and thirty-five (14.76%) had appendectomy (Table 1).

One hundred and thirty-nine (58.64%) patients' wounds were contaminated at the time of surgery while forty-nine (20.67%) were dirty (Table 2 & table 3).

Duration of surgery was 01-02 hours in ninety-five patients, 02-03 hours in sixty-five patients, and 1/2 – 01 hours in sixty-one patients (Table 4).

Gram-positive organisms were identified in seventy-three percent of SSI patients and Gram-negative organisms were reported in twenty-six percent. Staph aureus was the commonest organism detected (Table 5).

Most of the organisms were resistant to the commonly used antibiotics like Ceftriaxone and Ciprofloxacin. Twelve out of one hundred and eighty-two (06.59%) Staph aureus cultures were Methicillin-resistant Staph aureus (MRSA) while two patients (01.09%) had Vancomycin-resistant Staph aureus (VRSA). Six (50%) MRSA patients were sensitive to Linezolid and six (50%) MRSA patients were sensitive to Vancomycin. Two (0.84%) patients were sensitive to Tigecycline.

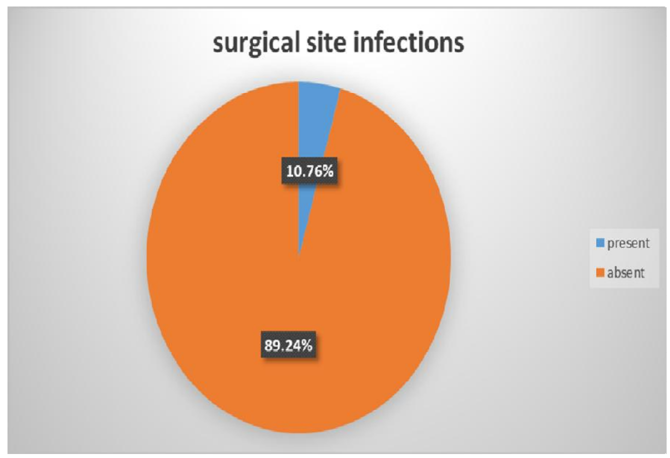

Figure 1:

Table 1: Demographic and pathological characteristics of SSI cases

Serial.no.	*Characteristics*	*No. of patients (n)*	*Percentage (%)*
Age groups (years)	11-20	73	30.80
	21-30	64	27.00
	31-40	40	16.87
	41-50	37	15.61
	51-60	23	09.70
Gender	Male	155	65.40
	Female	82	35.50
Surgery	Laparotomy (acute abdomen)	50	21.09
	Laparotomy (penetrating and blunt trauma)	70	29.09
	appendectomy	35	14.76
	Vascular injury repair	09	3.79
	Open fractures	20	8.43
	Debridement of infected and gangrenous wounds	27	11.39
	Below knee amputations	9	14.76
	Above knee amputations	4	01.68
	Repair of obstructed hernia repair	7	02.94
	Fasciotomy	2	0.84
	Miscellaneous	4	01.68

Growth	Mono growth	152	64.13
	Poly growth	85	35.86

Table 2: Distribution of SSI according to the presence of contamination

Serial number	*Type of contamination*	*No. of patients*	*Percentage %*
1	Clean contaminated	49	20.67
2	contaminated	139	58.64
3	Dirty	49	20.64
4	total	237	100

Table 3: Distribution of SSI cases according to the presence of contamination

Serial number	*Procedure*	*Clean contaminated*	*Contaminated*	*Dirty*	*Total*
1	Laparotomy for blunt and penetrating abdominal trauma	15	50	5	70
2	Laparotomy for acute abdomen	2	35	13	50
3	Appendicectomy	14	16	5	35
4	Debridement of Gangrenous wounds	2	12	13	27
5	Management of type 3 & 4 open fractures	9	8	3	20
6	Below knee amputation	0	5	4	09
7	Above knee amputation	0	2	2	04
8	Surgeries for complicated hernias	2	3	2	07
9	Fasciotomies	1	1	0	02
10	Miscellaneous	0	2	2	04
11	Total	49 (20.67%)	139 (58.64%)	49 (20.67%)	237 (100.00%)

Table 4: **Duration of emergency operations**

Serial number	*Duration of surgery (Hours)*	*No. of patients (n)*	*Percentage (%)*
1	Half an hour--one hour	61	25.73
2	1-2	95	40.08
3	2-3	65	27.42
4	3-4	14	05.90
5	>4	02	00.84
6	Total	237	100

Table 5: Micro-organisms distribution

Serial no.	*Micro-organism*	*No of patients*	*Percentage (%)*
Gram positive n= 182(76.79%)	Staph aureus	145	79.67
	Enterococcus	18	9.80
	Streptococcus	11	6.04
	Clostridium	06	3.29
	Acinobacter	2	0.84
Gram negative n= 55(23.20%)	E.coli	39	70.90
	Klebsiella	10	18.18
	Pseudomonas	06	10.90

Discussion

This study was conducted on 2202 patients who underwent emergency surgeries. The incidence of surgical site infection varies worldwide from 2.5% to 41.9% as per different studies.[6] The incidence of SSI in our study was 10.76%, while Alkaaki A et al[15] reported an incidence of 16.03%. Akter B et al[16] reported an incidence of 26.70% after emergency laparotomy for perforated viscus. About sixty-five percent of patients in our study were male. Such high male preponderance is also reported by many other studies like Aghdassi, S.J.S et al and Mukagendaneza, M.J et al [17,18]. The incidence of SSI was higher in younger age groups. Ntundu SH, Herman AM, Kishe A et al also recorded higher younger age incidence.[19] In our study, 21.09% of SSI cases underwent laparotomies for acute abdomen. The most common causes of the acute abdomen were perforated peptic ulcer, perforated appendix, enteric perforation, and intestinal perforation proximal to obstructed gut due to ileocecal tuberculosis and recto-sigmoid tumors. Such patients were mostly in sepsis due to contamination and shock due to multisystem injury at the time of presentation. This fact jeopardizes the immune system of the patients. Such an observation was also noticed by Patterson JW et al.[20]

In our study, 29.53% of SSI patients underwent laparotomy for penetrating and blunt abdominal trauma. Most of these patients had multiple gut injuries and solid viscera injuries like liver or splenic lacerations causing feculent and chemical peritonitis. These contaminating factors increase the chance of the development of SSI. Such finding was also observed by Ntundu, S.H., Herman, A.M., Kishe, A et al.[19] Level of wound contamination is an important factor for the development of SSI. In our study, 58.64% of SSI patients had contaminated wounds, and each 20.64% of patients had clean contaminated, and dirty wounds. Mukagendaneza, M.J et al[18] noticed that SSI incidence was 8.5 times high in contaminated and dirty wounds compared to clean surgical wounds. Berríos-Torres, SI et al also observed such findings.[21]

Operative time contributes a lot to the development of SSI and it depends on many factors like the complexity of the surgical procedure, hypovolemia, expertise of the operating surgeon, level of contamination, and findings of the operative field. In our study operative time was one to two hours in 40.08%. Cheng H et al found that on average, across various procedures, the mean operative time was approximately 30 min longer in patients with SSI compared with those patients without SSI.[22] Zejnullahu VA et al observed that the duration of the operation of less than 1 hour decreases the incidence of SSI.[23]

Improper triage, poor pre-operative preparations, delayed shifting of patients to operation theatre and induction and reversal of anesthesia also increase the exposure of the operative field to the external environment.[24]

In our study, Gram-positive microorganisms were present in 181(76.79%) SSI patients and Gram-negative microorganisms were present in 55(23.20%) patients (Table 5). Baker, A et al also observed such epidemiology.[25]

Culture and sensitivity results showed that bacteria are becoming resistant to the commonly used empirical antibiotics like Co-amoxiclav, Ceftriaxone, and Ciprofloxacin and becoming more sensitive to new broad-spectrum antibiotics like Linezolid and Piperacillin. In two (0.84%) SSI patients in our study who were managed in the intensive care unit after surgery, Acinetobacter was found which was sensitive to Tigecycline.[26,27] Such drug resistance pattern was also observed by Mouiche, M.M.M. et al[28] and Hemmati, H et al.[29] Methicillin-resistant Staph aureus (MRSA) was present in about seven percent of patients in our study. Many other studies have reported such increased incidences of MRSA and VRSA.[28,29,30,31] Most of the newer antibiotics are much more costly and generally not available in the hospital pharmacy of our hospital. They have to be purchased from private pharmacies at high cost putting an extra financial burden on the hospital resources and prolonging hospital stays.[30,31,32]

Conclusion

Increased levels of wound contamination per operatively and increased length of operative procedures increase the incidence of surgical site infection in emergency-operated patients.

Recommendations

1. Every possible effort should be made to decrease the incidence of road traffic accidents by better traffic regulations to decrease the incidence of blunt abdominal trauma.
2. Pre-operative resuscitation time can be decreased if adequate pre-transfer teams like 1122 services are more vigilant.

3. Thorough per operative wound wash decreases the spread of contamination which can lead to decreased incidence of SSI.
4. Operative time can be managed by better trauma management training of the trauma surgical team.
5. Operative time can also be managed if major surgeries are performed by experienced senior surgeons.

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