Post-Operative Surgical Site Infection and Associated Factors at Hiwot Fana Specialized Comprehensive University Hospital, Eastern Ethiopia

Girma Wami[1], Moa Chali[1], Sisay Habte[2]*, Indeshaw Ketema[2], and Fitsum Weldegebreal[3]

[1]School of Medicine, College of Health and Medical Science, Haramaya University, Harar, Ethiopia
[2]School of Nursing and Midwifery, College of Health and Medical Science, Haramaya University, Harar, Ethiopia
[3]School of Medical Laboratory Sciences, College of Health and Medical Science, Haramaya University, Harar, Ethiopia

Abstract

Background: Surgical site infection is the most common nosocomial infection that can cause serious morbidity and mortality. It can lead to prolonged hospital stays, frequent readmissions, antimicrobial resistance, and increased healthcare costs. However, there is limited evidence regarding post-operative surgical site infection and associated factors in Ethiopia, particularly in the study area. Therefore, this study aimed to assess the magnitude of surgical site infection and associated factors among patients who underwent a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia.

Methods: An institutional-based cross-sectional study was conducted among 213 patients who underwent major surgeries from May to July 30, 2021. Data were collected using pretested structured questionnaires. Patients were followed at outpatient surgical clinics and through phone calls for 30 days after a surgical procedure. Surgical site infection was diagnosed based on the Centers for Disease Control and Prevention's surgical site infection surveillance criteria. Data were analyzed using Statistical Package for Social Sciences version 20.0. A P-value less than 0.05 was considered statistically significant.

Results: The magnitude of post-operative surgical site infection was 21.6% (95% CI: 20.9, 22.3). Age greater than or equal to 40 years (AOR= 2.57; 95% CI: 1.76, 5.74), emergency surgery (AOR= 1.21; 95% CI: 1.09, 3.23), and history of previous surgery (AOR= 3.24; 95% CI: 2.16, 6.15) were found predictors of surgical site infections.

Conclusion: In this study, one out of five patients developed post-operative surgical site infections. Age, types of surgery, and history of previous surgery were significantly associated with postoperative surgical site infections. Hence, proper post-operative surgical wound management should be strictly implemented for patients of advanced age, who have undergone emergency surgery, and who have a history of previous surgery to minimize the burden of surgical site infections.

Keywords: Magnitude, Surgical site infection, Hiwot Fana Hospital, eastern Ethiopia

How to cite: Wami, W., Chali M., Habte, S., Ketema, I., and Weldegebreal, F.2022. Post-Operative Surgical Site Infection and Associated Factors at Hiwot Fana Fana Hiwot Fana Specialized comprehensive University Hospital, Eastern Ethiopia. *East African Journal of Health and Biomedical Sciences, Volume* 6 (2): 11-20

Introduction

Surgical Site Infection (SSI) is defined by the Centers for Disease Control and Prevention (CDC) as a wound infection occurring within 30 days of an invasive procedure or 90 days after the implementation of prosthetic material (Alkaaki *et al*., 2019; Azeze *et al*., 2019; Horan *et al*., 2008). It is the most common public health problem among all types of healthcare associated infections (HAIs) (Eriksen *et al*., 2003; Shiferaw et al., 2020; Milne *et al*., 2012). It accounts for about 31% of HAIs (Eriksen *et al*., 2003). It is associated with considerable morbidity and occasional lethality (Afenigus *et al*., 2019; Leaper *et al*., 2013; CDC, 2021). The risk of death among patients with SSI is 2 to 11 times higher than those without infections (Andersen *et al*., 2018). Globally, the prevalence of SSIs ranges from 2.5 to 41.9% (Singh *et al*., 2014), with a higher rate in low-income countries (Todd *et al*., 2017). In Africa, the incidence of SSIs ranges from 2.5 to 30.9% (Legesse Laloto *et al*., 2017). In Ethiopia, it ranges from 10 to 25%, with an estimated pooled prevalence of 12.3% (Shiferaw et al., 2020) (Awoke *et al*., 2019; Walelign *et al.,* 2020).

Surgical site infection significantly increases healthcare costs and is considered the third most costly HAI (Azeze *et al*., 2019, Iskandar *et al*., 2019). The healthcare cost of SSIs was attributed to prolonged hospital stays,

Corresponding Author; Email: sisayhabtem@yahoo.com
Haramaya University, 2022
ISSN 2519-917X

frequent readmissions, multiple investigation tests, additional surgical costs, and even extra surgical procedures and other treatment costs (Isik *et al*., 2015; Badia *et al*., 2017; Smyth *et al*., 2000; Jenks *et al*., 2014). . Patients who develop SSIs are up to 60% more likely to spend their time in the intensive care unit, readmitted to the hospital and more likely to die compared with patients without surgical site infections (Gedefaw *et al*., 2018; WHO, 2016).

Several risk factors have been identified as being associated with SSI, including the presence of co-morbidity, advanced age, history of previous surgery, prolonged preoperative hospital stay, type of surgery, history of previous hospitalizations, frequent readmissions, inadequate wound care, and substance use (Azeze *et al*., 2019; Legesse Laloto *et al*., 2017; Shiferaw *et al*., 2020).

Periodic surveillance of SSIs and design action can reduce the incidence of SSIs (Lives *et al.,* 2009). However, in developing countries, including Ethiopia, surveillance of SSIs is not fully implemented as it requires enormous resources (Allegranzi *et al*., 2008). There are few studies conducted on the magnitude of SSI, and little is known regarding factors associated with SSI in Ethiopia, particularly in the study area. Therefore, this study aimed to assess the magnitude of SSI and its associated factors among patients who underwent a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia.

Materials and Methods

Study Area and Period

The study was conducted at Hiwot Fana Specialized Comprehensive University Hospital (HFSCUH), Harar, eastern Ethiopia from May to July 30, 2021. Harar town is located 526 km to the east of Addis Ababa, the capital of Ethiopia, is the administrative city of Harari Regional State and the East Hararghe Zone of Oromia Regional State. The town has two public hospitals (Jugal General Hospital and HFSUH), one Federal Police Hospital, one private general hospital, four health centers, and one Family Guidance Association (CSA, 2016).Hiwot Fana Specialized University Hospital is the largest referral hospital which serves as a teaching institution of Haramaya University and other health science colleges in the town. It provides 24-hour comprehensive services for more than 5.8 million populations from the entire eastern part of the city. The hospital has a bed capacity of 502 and an average annual admission of more than 20,000 patients. The hospital provides emergency medicine, internal medicine, general surgery, orthopedics, neurosurgery, obstetrics and gynecology, pediatrics, radiology, dermatology, pathology, oncology, anesthesiology, and neonatal care specialty services (Nigussie *et al*., 2022).

Study Design and Population

An institutional-based cross-sectional study was conducted among selected patients who had undergone a surgical procedure and were willing to follow up for 30 days after the surgical procedure. Patients with any disability that jeopardized their ability to consent or impeded post-discharge phone contact, as well as those who had a surgical procedure at another institution and came to HFSCUH for follow-up were excluded.

Sample Size and Sampling Technique

The sample size for the study was calculated by using a single population proportion formula considering 19.1% proportion of SSI taken from a previous study (Legesse L. *et al*., 2017), a 1.96 value of standard score at 95% confidence level, a 5% margin of error, and a 5% non-response rate. Hence, the final sample size for the study was 247. All surgical patients who had undergone a surgical procedure during the study period were included in the study.

Methods of Data Collection

Data were collected by the following method;

Face-to-face interview: was conducted using a pretested structured questionnaire which was adapted by reviewing relevant literature (Legesse Laloto *et al.,* 2017; Awoke *et al.,* 2019; Walelign *et al*., 2020).

Observation: was conducted by trained data collectors at a surgical clinic to assess for the presence of any signs of infection after a surgical procedure.

Medical record review: was conducted to obtain necessary information on the types of surgery, hospital stay, previous surgery, perioperative antibiotic, comorbidity, presence of implants at the surgical site, and anesthesia-related characteristics.

Post-discharge follow-up: was conducted by trained nurses with MSc qualifications using phone calls and at a surgical follow-up clinic. The first contact was made

15 days after discharge from the hospital, followed by a second contact 30 days later. The diagnosis of SSI was made based on the for Centers Disease Control and Prevention/National Health care Safety Network (CDC/NHSN) surveillance definition of healthcare-associated infection (Horan *et al*., 2008).

Definition of Terms

Surgical site infection: is defined as a surgical wound infection with purulent drainage, redness, swelling, pain/tenderness, tachycardia, and temperature above 38°C, in the first 30 days following a surgical procedure (CDC, 2021; Todd *et al*., 2017).

Superficial SSI: is a surgical infection involving only the skin and subcutaneous tissue (Birhanu *et al*., 2022).

Deep SSI: is a surgical infection involving fascia and muscles (Birhanu *et al*., 2022).

Organ/Space SSI: is a surgical infection with the presence of an abscess or other evidence of infection involving the organ or space (Afenigus *et al*., 2019).

Class I (Clean wound): a surgical wound without a break in an aseptic operating procedure, in which no inflammation is encountered and the respiratory, alimentary, or genitourinary tracts are not entered (Afenigus *et al*., 2019).

Class II (Clean-contaminated wound): a wound in which the respiratory, alimentary, or genitourinary tracts are entered under controlled conditions i.e., without significant spillage or visible contamination (Adugna *et al*., 2020).

Cass III (Contaminated wound): a wound in which acute inflammation without pus is encountered, or visible contamination of the wound. For example; gross spillage from a hollow viscous during the operation or compound/open injuries operated within 4 hours (Birhanu *et al.,* 2022).

Class IV (Dirty/infected wound): in the presence of pus, round a previously perforated hollow viscoscous, or compound/open injury more than 4 hours old (Todd *et al.,* 2017).

Data Quality Assurance

The questionnaire was initially developed in English, translated to the local languages (Afan Oromo and Amharic), and then back-translated into English by lan guage experts to check for consistency. One day training was given to data collectors on the objectives of the study, the contents of data collection tools, and how to collect and record data appropriately. A pre-test on the data collection tool was conducted on 5% (a total of 12 patients) of the sample size at Jugal General Hospital. The collected data were carefully checked for completeness and consistency by supervisors and the principal investigator daily. Two individuals did double data entry.

Data Processing and Analysis

The collected data were manually cleaned, coded, and entered into Epi-data version 3.1 and exported for analysis to Statistical Package for Social Sciences (SPSS) version 20.0 software. Descriptive statistics and summary statistics were presented using texts and tables. Bi-variable and multivariable logistic regression analyses were conducted to identify factors associated with SSI. All variables with a p-value less than 0.25 in the bi-variable analysis were fitted into the multivariable logistic regression analysis. Statistical significance was determined at a p-value less than 0.05 with a 95% confidence interval (CI).

Ethical Consideration

Ethical clearance was obtained from the Institutional Health Research and Ethics Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University with Ref. No. IHRERC/40/2020. Informed voluntary written and signed consent was obtained from the study participants after they were informed of the aim, purpose, and benefits of the study. For the participants under the age of 18, consent was obtained from their parents or legal guardians. The confidentiality of the information was ensured throughout the data collection and dissemination process.

Results

Socio-Demographic Characteristics

A total of 336 patients underwent surgical procedures and about 213 of them participated in the study. The mean (standard division (SD)) age of study participants was 28.0 (±16.02) years. The majority of the study participants were males (74.2%), in the age group of 19-40 years (60.7%), literate (62.9%), and married (54.5%) (Table 1).

Table 1: Socio-demographic characteristics of patients who had undergone a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia, 2021 (n=213)

Variables	Frequency	Percent
Gender		
Female	55	25.8
Male	158	74.2
Age (in years)		
≤ 18	40	18.8
19-40	129	60.7
> 40	44	20.8
Educational status		
Not read and write	79	37.1
Literate	134	62.9
Place of residency		
Rural	152	71.4
Urban	61	28.6
Religion		
Muslim	25	11.7
Orthodox	183	85.9
Protestant	5 2	2.3
Formal education		
Yes	134	62.9
No	79	37.1

Clinical Characteristics

The pre-operative average hospital stay was 1 ± 2.08 days. About 21 (9.9%) of the study participants had a history of previous surgery. The majority, 166 (77.9%) of the study participants, received pre-operative antibiotic prophylaxis. In the present study, 18 (8.4%) of the respondents had at least one co-morbidity (Table 2).

Table 2: Clinical characteristics of patients who underwent a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia, 2021 (n=213)

Variables	Frequency	Percent
Pre-operative hospital stays (in days)		
≤ 5	193	90.6
> 5	20	9.4
History of previous surgery		
Yes	21	9.9
No	192	90.1
Pre-operative antibiotic prophylaxis		
Received	166	77.9
Not received	47	22.1
Presence of co-morbidity		
Yes	18	8.4
No	195	91.6
Cancer Diagnosis		
Yes	10	4.7
No	203	95.3

Surgery Related Characteristics

The majority of patients had an American Society of Anesthesiologists (ASA) physical status classification score of class I (62.9%) and received general anesthesia (72.7%). More than half (54.5%) of patients had undergone emergency surgical procedures. Abdominal surgery (64.3%) was the leading surgical procedure performed in this study (Table 3).

Magnitude of Surgical Site Infection

The overall magnitude of surgical site infection was 21.6% (95% CI: 20.9, 22.3). Among patients with surgical site infections, 40 (18.8%) were diagnosed after they were discharged from the hospital. In nine (19.6%) of patients, SSI was diagnosed within the first 15 days following a surgical procedure. Superficial incisional infection was seen in 34 (84.8%) patients. In addition, 19 (41.3%) of patients with SSIs required hospital readmissions for treatment (Table 4).

Table 3: Surgery-related characteristics of patients who underwent a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia, 2021 (n= 213).

Variables	Frequency	Percent
ASA score		
Class I	134	62.9
Class II	75	35.2
Class III	3	1.4
Class IV	1	0.5
Types of anesthesia		
General	155	72.7
Regional	9	4.3
Spinal	49	23.0
Types of Surgery		
Elective	97	45.5
Emergency	116	54.5
Sites of Surgery		
Abdominal	137	64.3
Thoracic	17	8
Head and neck	21	9.8
Extremities	33	15.5
Others	5	2.4
Duration of surgery (in hours)		
< 2	140	65.7
2-4	55	25.8
> 4	18	8.5
Implants inserted at the surgical site		
Yes	0	0.0
No	213	100.0

Others: pelvic, perineum and breast

Table 4: Diagnosis of surgical site infection and related characteristics of patients at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia, 2021 (n= 46).

Variables	Category	Frequency	Percent
Diagnosis of surgical site infection	In the hospital	6	2.8
	After discharge from the hospital	40	18.8
Types of surgical site infection	Superficial	39	84.8
	Deep	5	10.9
	Organ spaced	2	4.3
Diagnostic window after a surgical procedure	Within the first 15 days	9	19.6
	After 15 days	37	80.4
Readmission	No	27	58.7
	Yes	19	41.3

Factors Associated with Surgical Site Infection

In the bivariate analysis, gender, age, educational status, place of residency, pre-operative hospital stays, pre-operative antibiotics, and history of previous surgery were identified as candidates for the multivariate logistic regression analysis.

In the multivariate analysis, age, presence of comorbidity, types of surgery, and history of previous surgery were significantly associated with SSI. The odds of SSI among patients aged greater than or equal to 40 years were 2.57 times (AOR= 2.57; 95% CI: 1.76, 5.74) higher than patients with age less than or equal to 18 years. Similarly, patients who underwent emergency surgery were more than 1.21 times (AOR= 1.21; 95% CI: 1.09, 3.23) more likely to develop SSI compared to those who underwent elective surgery. In addition, patients having a history of previous surgery were more than 3.24 times (AOR= 3.24; 95% CI: 2.16, 6.15) more likely to develop SSI compared to patients without a history of previous surgery (Table 5).

Table 5: Factors associated with surgical site infection among patients who underwent a surgical procedure at Hiwot Fana Specialized Comprehensive University Hospital, eastern Ethiopia, 2021 (n= 213).

Variables	Surgical Site Infection		COR (95% CI)	AOR (95% CI)
	Yes	No		
	N (%)	N (%)		
Gender				
Female	7 (12.73)	48 (87.27)	1	1
Male	39 (24.68)	119 (75.32)	2.25 (0.94, 5.37)	1.67 (0.23, 3.98)
Age (in years)				
≤ 18	8 (20.0)	32 (80.0)	1	1
19-40	15 (11.63)	114 (88.37)	0.52 (0.15, 0.91)	0.49 (0.20, 3.30)
> 40	23 (52.27)	21 (47.73)	4.38 (1.65, 81.22)	2.57 (1.76, 5.74) *
Educational Status				
Not read and write	25 (31.65)	54 (68.35)	1	1
Literate	21 (15.67)	113 (84.33)	0.40 (0.28, 0.84)	0.34 (0.16, 2.18)
Place of residency				
Urban	18 (29.51)	43 (70.49)	1	1
Rural	28 (18.42)	124 (81.58)	0.07 (0.03, 0.61)	0.62 (0.29, 2.19)
Pre-operative hospital stays (in days)				
≤ 5	37 (19.17)	156 (80.83)	1	1
> 5	9 (45.0)	11 (55.0)	3.45 (1.11, 7.52)	2.31 (1.10, 5.43)
Pre-operative antibiotics				
Received	37 (22.29)	129 (77.71)	1	1
Not received	9 (19.15)	38 (80.85)	0.83 (0.54, 0.93)	0.57 (0.40, 2.90)
Type of surgery				
Elective	20 (20.62)	77 (79.38)	1	1
Emergency	26 (22.41)	90 (77.59)	1.11 (1.01, 5.28)	1.21 (1.09, 3.23) *
History of previous surgery				
No	32 (17.02)	156 (82.98)	1	1
Yes	14 (56.0)	11 (44.0)	6.20 (2.21, 9.42)	3.24 (2.16, 6.15) *

* Statistically significant

Discussion

The overall magnitude of SSI among patients who underwent a surgical procedure at HFSUH was 21.6%. Age greater than or equal to 40 years, emergency surgery, and history of previous surgery were significantly associated with SSI.

The magnitude of SSI in the current study is slightly lower than the finding from Hawassa University Referral Hospital (19.1%) (Legese Laloto *et al*., 2017). However, it is higher than the studies conducted in Ethiopia: Wolaita Sodo University Teaching and Referral Hospital (13%) (Awoke *et al*., 2019), Felege Hiwot Referral Hospital (10.9%) (Mulu *et al*., 2013), and Debre Tabor General Hospital (11.5%) (Walelign *et al*., 2020). This finding is much lower than the study conducted in Ayder Teaching and Referral Hospital, Mekelle, Ethiopia (75%) (Mengesha *et al*., 2014). The reason for the difference might be due to the difference in the quality of surgical care provision, the method of data collection, postoperative care, sterility during surgical procedures, and infection control practice.

In the current study, patients in the age group greater than or equal to 40 years were less likely to develop SSI compared to their counterparts. This finding is consistent with other studies in Ethiopia and elsewhere (Legese Laloto *et al*., 2017; Gagliardi *et al*., 2009; Miliani *et al*., 2009). This might be because as age increases immune system becomes lower which can a risk of developing infections. The findings of the present study also showed that the presence of comorbidity was significantly associated with surgical site infections. This finding is in line with the studies conducted in Ethiopia (Afenigus *et al.,* 2019; Shiferaw *et al*., 2020). This might be due to the presence of comorbidity, which leads to impaired immunity, thus increasing patients' susceptibility to acquiring infections (Castle *et al*., 2005).

Surgical site infection might result from microorganisms within a patient's body that gain access during surgery (Darouiche et al., 2021). In the study patients who had undergone emergency surgery were more likely to develop SSI compared with patients who underwent elective surgery. This is in line with the studies conducted in Saudi Arabia (Alkaaki *et al.,* 2019), Turkey (Isik *et al*., 2015), Brazil (Ercole *et al*., 2011), and Japan (Watanabe *et al*., 2008). This could be explained by the fact that, during emergency surgery, there might be insufficient time for surgical scrubbing, the provision of prophylactic antibiotics, and antiseptic skin preparation, which in turn leads to the development of infection (Darouiche *et al*., 2021; Cheadle *et al.,* 2006).

Moreover, the findings of the current study showed that a history of previous surgery was significantly associated with the development of surgical site infections. This finding is supported by a study conducted in India (Setty *et al*., 2014). The possible reason might be that multiple surgeries could stress the body and suppress immune responses, thus exposing the patient to infection (Salo *et al*., 1992).

In general, this study provided some important information on the magnitude of surgical site infections and associated factors, which will help us to generate a hypothesis and guide policymakers and other concerned bodies in designing preventive measures and combating the problems. However, in this study the outcome and exposure status were evaluated at the same time, thus the temporal relationship between the outcome and the exposure could not be established.

Conclusions and Recommendations

In this study one in five patients developed surgical site infections. Age, type of surgery, and history of previous surgery were factors significantly associated with the occurrence of surgical site infections. Hence, strengthening continuous follow-ups on the implementation of infection prevention practices in the hospital which is highly recommended to reduce the risk and burden of surgical site infections. In addition, proper management of patients with history of previous surgery is crucial to minimize the burden of surgical site infections. Moreover, a further study that used a large sample size is recommended to fill the gap in the study.

Acknowledgments

First and foremost, we would like to thank Haramaya University's postgraduate directorate for funding this study and the College's Institutional Health Research and Ethics Review Committee for critically reviewing and approving the study's ethical protocol. Second, we would like to extend our gratitude to the study participants. Furthermore, we would like to thank HFCSUH for providing the necessary information. Finally, we would like to thank the data collectors and supervisors.

Conflict of Interests

The authors declare that there is no conflict of interest.

Funding Statement

Haramaya University has provided financial support for this study. The authors declared that the funding body had no role in study selection, study design, data collection, analysis, conclusion, or interpretation

List of Abbreviations

AOR: Adjusted Odd Ratio; CI: Confidence Interval COR: Crude Odd Ratio; HFSUH: Hiwot Fana Specialized Comprehensive University Hospital; IHRERC: Institutional Health Research and Ethics Review Committee; SPSS: Statistical Package for Social Science.

Authors' Contribution

All authors made a significant contribution to the work reported, whether that is in the conception, study design, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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