Original Article

Surgical Site Infection Prevalence and Associated Factors in Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia

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Abstract

Background: Surgical site infections (SSIs) continue the main problem in health care facilities, causing the prolonged length of stay, considerable morbidity, mortality, and the extra cost to patients after surgery. The aim of this study was to determine the prevalence of SSIs and explore its associated factors among surgical patients at Hawassa university comprehensive specialized hospital, southern Ethiopia.
Methods: A hospital-based cross-sectional study design was conducted among post-operative patients on a sample of 281 who were admitted and have had surgery from 1 March – 1 April 2019. Purposive sampling technique and the structured questioner were selected to gather data from the patient's medical record, interview, and observation. EPI Info 3.5.4 was a data entry software and SPSS version 20.0 was selected for analysis. Associations among variables were assessed by binary logistic regression.
Conclusion: The prevalence of SSIs was bigger than the worldwide range between (1.2%) and (5.2%) even higher compared to reports from several developing countries. This needs exceptional attention to reduce the odds of surgical site infection by standardizing patient care and controlling of comorbidities.

Keywords: Prevalence, surgical site infection, associated factors, Ethiopia.

Background

Surgical site infections circle as many as 30 days after surgery (or as late as one year after surgery in patients with implants) (Owens and Stoessel 2008, Anderson and Kaye 2009).Among hospital-acquired infections, surgical site infections (SSI) are the most frequently reported. The incidence of SSI could be nearly 4 times higher in low and middle-income countries (LMIC) than in high-income countries (Allegranzi, Bagheri Nejad et al. 2011). Surgical site infections were the primary infections in hospitals of Africa higher than magnitudes noted in developed countries (Allegranzi, Bagheri Nejad et al. 2011) with cumulative incidence extended from 2.5% to 30.9% (Nejad, Allegranzi et al. 2011). In Ethiopia, the incidence rate of SSIs ranges from 10.9% to 75% (Mulu, Kibru et al. 2013, Mengesha, Kasa et al. 2014, Gedefaw, Asires et al. 2018, Weldu, Berhane et al. 2018).

Although SSIs are preventable complications following surgery, they are associated with longer hospitalization; pain; discomfort; delayed wound healing; prolonged or permanent disability; and, in worst cases, death (Pittet, Allegranzi et al. 2008). Additionally, SSI places a significant economic burden on health system and patient finances and resources because of lengthier hospitalizations and increased cost of treatment (de Lissovoy, Fraeman et al. 2009). SSI comprise a multifaceted relationship among numerous factors: patient, microbial, surgical, and environmental (Cheadle 2006). Patient-related factors includes, age (Bagnall NM 2009, Hafez S 2012, Abdel-Aziz, El-Menyar et al. 2013, Mulu, Kibru et al. 2013), poor nutritional state (Bagnall NM 2009) obesity (De la Garza Ramos R 2017), (Olsen MA 2008) and presence of pre-morbid illness (Olsen MA 2008, Bagnall NM 2009, Mulu, Kibru et al. 2013, Mpogoro FJ 2014). Prolonged duration of the operation (Laloto TL 2017), (Mulu, Kibru et al. 2013), (Bagnall NM 2009), (Mpogoro FJ 2014), significant contamination of the incision (Bagnall NM 2009), (Hafez S 2012), long postoperative hospital stay (Laloto TL 2017), (Mulu, Kibru et al. 2013), (Hafez S 2012), inadequate prophylactic antibiotic therapy (Laloto TL 2017), (Bagnall NM 2009), (Olsen MA 2008), type of anesthesia (Waltz PK 2017), also associated with SSIs.

Surgical procedures are associated with high infection rates and mortality in developing countries because necessary resources are inadequate (Mawalla, Mshana et al. 2011), (Abdel-Aziz, El-Menyar et al. 2013). According to the World health organization (WHO) and other studies, episodic investigation on SSIs prevalence and its related issues can reduce SSIs by up to 50% (Safety 2006), (Ercole, Starling et al. 2007). There are inadequate studies concerning the prevalence of SSIs and its linked factors in Ethiopia particularly in Hawassa. Hence, this study required to determine the prevalence of SSI and explore its associated factors at Hawassa University comprehensive specialized hospital in southern Ethiopia.The result of this study will provide baseline information to develop evidence-based strategies to diminish preventable SSIs and their adverse effects by the Federal Ministry of the health of Ethiopia and concerned non-governmental organizations.

Methods

Study design and setting: A hospital-based cross-sectional study was done from 1 March – 1 April 2019. Hawassa is situated at the eastern shore of Lake Hawassa and is located 275 km to the south of Addis Ababa, the capital city of the country. Hawassa University comprehensive specialized hospital is located in the south part of Hawassa town in the SNNPR regional state. The University Hospital is the only biggest comprehensive specialized referral and teaching hospital in the region. It is giving inpatient and as an outpatient service for more than 25 million people from the surrounding zones and nearby regions. This teaching hospital consists of an operating room, intensive care unit (ICU), 16 wards with 400 beds, and 11 outpatient departments. The study was carried out at surgical ward.

Sample size and sampling procedure: The sample size was determined by using a single population proportion formula with a 95% confidence interval, a 5% margin of error and adding 5% contingency for illegible handwriting and incomplete medical records. By using the proportion of prevalence of Surgical site infection 35 % as published data was acquired from the Addis Ababa study (Endalafer, Gebre-Selassie et al. 2011) the sample size was calculated as follows.

$n = \frac{(z)^2 P(1-P)}{d^2}$ $n = \frac{(1.96)^2 0.5(1-0.5)}{(0.05)^2} = \boldsymbol{350}$

Therefore, by adding 10 % for possible non-response rate, the final sample size was =**385.**

Then since the study population is < 10,000 correction formula was used as follows: $\frac{1+ni}{n+N}$

Sample size= ni=Ni x N=385*1049/385+1049 (N= total surgical patients admitted to surgical ward to 1 March to 1 April 2019) = 281 total sample size

The sampling technique was purposive because the patients visiting the health care for disease conditions are random by their nature until the required sample sizes are filled.

Data collection tools and procedures: A structured data collection tool was used to capture data from medical records, patient charts and study participants who developed surgical site infections. The selected patients were assessed by physical examination using the observational checklist adopted from the US Center for Disease Control and Prevention (CDC) criteria (Ducel G 2002). SSIs was diagnosed in the presence of as a minimum one of the next signs or symptoms of infection after surgery within 30 days : (a) pain, tenderness, localized swelling, redness, heat or purulent discharge with or without laboratory confirmation in cases of superficial incisional infections; (b) evidence of abscess or fever of >38°C in infections of the deep incision; (c) localized pain or tenderness with an organism isolated from an organ/space infection; and (d) positive culture from wound drainage or percutaneous aspiration. Data on site-specific SSI, patient data including demographics, clinical and surgical procedures, and possible risk factors were collected by 4 trained BSc nurses with data collection experience. The data collectors were trained for one day on data collection methodology and related issues prior to the start of data collection and were closely supervised by 2 MSc nurses during the data collection. Filled checklists were checked on a daily bases for completeness, clarity, and accuracy. Data cleaning was undertaken before entry and analysis.

Statistical analysis: Data entry was done by using EPI Info 3.5.1 and exported to SPSS version 20.0 software package for analysis. The descriptive analysis including frequency and cross tabs were used to assess the frequency of variables with independent variables. Binary logistic regression was carried out to assess the association of dependent variable with independent variables and to determine predictors of SSI using odds ratios with 95% confidence interval (CIs). Finally, forward stepwise logistic regression model with all independent variables having p-value <0.25 were fitted and adjusted odds ratio (AORs) were calculated to identify independent predictors of SSI among patients undergone surgery. A value of p< 0.05 was considered statistically significant.

Ethical consideration: A written ethical clearance was obtained from the Institutional Review Board of Hawassa University, Hawassa, Ethiopia. A formal letter of cooperation was written to the Hawassa University comprehensive specialized hospital and permission were obtained prior to the beginning of data collection. After the provision of sufficient information about the purpose of the study, verbal and written consent was obtained from all study participants.

Results

Socio-demographic characteristics of the study participants: A total of 281 patients have participated and the age ranged from 1 to 80 years with the mean age of 30.3 (±18.9) years. Female accounts (54.1%) and more than half of them were from rural in residency (51.6%). Concerning the educational status of the participants, the majority (38.1%) accomplished grades 1-8. (Table1).The Surgical condition and clinical characteristics of patients: Local anesthesia was given for (59.8%) of patients and the majority (82.9%) stayed one hour or less in a surgical procedure. Antibiotic prophylaxis was given to (51.6%) patients before surgery and (61.9%) were operated in emergency surgery. Preoperative surgical site shaving was given to (29.2 %) of patients and abdominal surgery was the largest (57.3%). The majority of patients (69.9%) had a clean wound and (86.8%) of the surgical site was closed. Sign and symptoms of malnutrition were identified on (10.0 %) of patients while nine of the respondent were identified with comorbid diseases which indicates immunosuppression like Tuberculosis, HIV/AIDS and diabetes. (Table 2).

Prevalence of Surgical Site Infection: A total of 69 out of 281 patients developed surgical site infections giving an overall prevalence (24.6%) with (95% CI [19.6 – 29.69). (Figure 1). According to this study, the prevalence of SSIs among clean and clean-contaminated wounds was (5.1%) and (69.4%) respectively. Patients with clean wounds were (99.4%) less likely to develop surgical site infection as compared to those patients with the clean-contaminated wounds (AOR=0.006, 95% CI 0.002, 0.024). This study also identified in open kept surgical sites, the odds of developing surgical site infection was 5.2 times as compared to close kept surgical site (AOR= 5.189, 95% CI 1.511, 17.821). The prevalence of SSI in those patients with Malnutrition was more than three folds (64.3%) and malnourished patients were 29.3 times more likely to develop SSIs than well-nourished patients (AOR= 29.351 95% CI 5.711, 150.851). Details of factors associated with surgical site infection were presented in (Table 3).

Table 1: Socio-demographic characteristics of surgical patients at Surgical ward of Hawassa University comprehensive specialized hospital, Hawassa, SNNPR, Ethiopia, from 1/3 – 1/4 2019 (n=281).

Socio-demographic characteristics		Frequency	Percent
Age	< 15 year	69	24.6
	15 - 65 year	195	69.4
	>65 year	17	6.0
Sex	Male	129	45.9
	Female	152	54.1
Residency	Urban	136	48.4
	Rural	145	51.6
Educational status	Unable to read and write	84	29.9
	Read and write only	25	8.9
	Grade 1-8	107	38.1
	Grade 9-12	26	9.3
	Certificate and above	39	13.9

Table 2: Surgical condition and clinical characteristics of patients at Surgical ward of Hawassa University comprehensive specialized hospital, Hawassa, SNNPR, Ethiopia, from 1 March – 1 April 2019 (n=281).

Surgical condition and clinical characteristics		Frequency	Percent
Type of anesthesia	Local	168	59.8
	General	113	40.2
Duration of surgery in hour	≤ 1 hour	233	82.9
	≥ 2 hours	48	17.1
Antibiotic prophylaxis before surgery	Yes	160	51.6
	No	121	48.4
Type of surgery	Elective	107	38.1
	Emergency	174	61.9

Preoperative surgical site shaving	Yes	82	29.2
	No	199	70.8
Site of surgery	Head	13	4.6
	Upper extremities	28	10.0
	Lower extremities	68	24.2
	Abdomen	161	57.3
	Genital areas	11	3.9
Types of wound	Clean	196	69.9
	Clean contaminated	52	18.5
	Contaminated	30	10.7
	Dirty	3	1.1
The condition of the surgical site	Opened	37	13.2
	Closed	244	86.8
Sign and symptom of Malnutrition	Yes	28	10.0
	No	253	90.0
Comorbid diseases indicating Immunosuppression	Tuberculosis	6	2.1
	HIV/ AIDS	2	0.7
	Diabetic mellitus	1	0.4

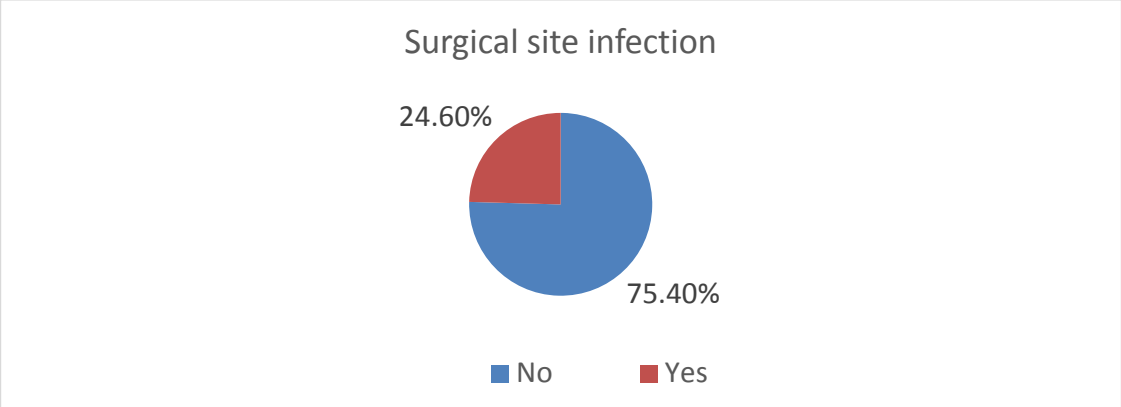

Figure 1: Prevalence of surgical site infection at Surgical ward of Hawassa University comprehensive specialized hospital, Hawassa, SNNPR, Ethiopia, from 1 March – 1 April 2019 (n=281).

Factors associated with surgical site infection: Different studies indicate the age of patients has effect on the development of surgical site infection. This study identified that SSIs was higher in older patients whose ages> 65 years (41.2%) and patients <15 years were (86.9%) less likely to develop surgical site infection as compared to those above 65 years old (AOR= 0.131, 95% CI 0.020, 0.087). Those patients who received local anesthesia developed SSI almost twice (30.4%) than general anesthesia receivers (15.9%) and they were 2.3 times more likely to develop surgical site infection if all other factors were kept constant (COR= 2.301, 95% CI 1.260, 4.199) but not statistically significant in multivariate analysis.

Table 3: Factors associated with SSIs at Surgical ward of Hawassa University comprehensive specialized hospital, Hawassa, SNNPR, Ethiopia, from 1 March – 1 April 2019 (n=281)

Variables		Surgical site infection		COR (95% CI)	AOR (95% CI)
		NO SSI	SSI		
Age group in Years	<15	57 (82.6%)	12 (17.4%)	0.301 (0.095, 0.949)*	0.131 (0.020, 0.087)*
	15-65	145 (74.4%)	50 (25.6%)	0.493 (0.178, 1.363)	0.363 (0.042, 3.112)
	>65	10 (58.8%)	7 (41.2%)	1	1
Sex	Male	91 (70.5%)	38 (29.5%)	1	1
	Female	121 (79.6%)	31 (20.4%)	1.630 (0.943, 2.816)	1.540 (0.627, 3.782)
Residence	Rural	109 (81.1%)	27 (19.9%)	1	1
	Urban	103 (71.0%)	42 (29.0%)	0.607 (0.349, 1.057)	1.534 (0.630, 3.737)
Type of anesthesia	Local	117 (69.6%)	51 (30.4%)	2.301 (1.260, 4.199)*	1.733 (0.616, 4.878)
	General	95 (84.1%)	18 (15.9%)	1	1
Duration of surgery in hour	≤ 1 hour	176 (75.5%)	57 (24.5%)	1	1
	≥ 2 hours	36 (75.0%)	12 (25.0%)	0.972 (0.474, 1.993)	1.272 (0.445, 3.639)
Antibiotic prophylaxis before surgery	Yes	110 (71.4%)	44 (28.6%)	1.632 (0.932, 2.857)	1.631 (0.618, 4.303)
	No	102 (80.3%)	25 (19.7%)	1	1
Types of Surgery	Elective	81 (75.7%)	26 (24.3%)	0.978 (0.558,1.712)	1.617 (0.473,5.523)
	Emergency	131 (75.3%)	43 (24.7%)	1	1
Preoperative surgical site shaving	Yes	60 (73.2%)	22 (26.8%)	1	1
	No	152 (76.4%)	47 (23.6%)	1.186 (0.659, 2.135)	2.626 (0.722, 9.552)
Type of surgical wound	Clean	186 (94.9%)	10 (5.1%)	0.24 (0.011, 0.052)*	0.006 (0.002, 0.024)*
	Clean contaminated	26 (30.6%)	59 (69.4%)	1	1
The condition of surgical site	Open	20 (51.4%)	17 (45.9%)	3.138 (1.535, 6.419)*	5.189 (1.511, 17.821)*
	Closed	192 (78.7%)	52 (21.3%)	1	1
Sign and symptom of Malnutrition	Yes	10 (35.7%)	18 (64.3%)	7.129 (3.103, 16.380)*	29.351 (5.711, 150.851)*
	No	202 (79.8%)	51 (20.2%)	1	1
Comorbid diseases indicating Immunosuppression	Yes	4 (44.4%)	5 (55.6%)	4.062 (1.059, 15.582)*	0.159 (0.015, 1.705)
	No	208 (76.5%)	64 (23.5%)	1	1

Discussion

Surgical site infections persist the worrying threat to the patient undergoing surgery. Decreasing the prevalence of modifiable risk factors by up-to-date strategies and intervention prior to surgery may decrease the threat of infection. The prevalence of SSIs was (24.6 %) (95% CI 19.6 – 29.69). The finding is higher to those of studies conducted in Mekelle Ethiopia (11.1%) (Weldu, Berhane et al. 2018), Jimma Ethiopia (11.4%) (Amenu, Belachew et al. 2011), Hawassa Ethiopia (19.1%) (Guta, Aragaw et al. 2014), Uganda (16.4%) (Lubega, Joel et al. 2017), Pakistan (8.6%) (Zafar Iqbal Malik 2013), Vietnam (10.9%) (Sohn, Parvez et al. 2002), India (5%) (Pathak, Saliba et al. 2014) and Bolivia (12%) (Soleto, Pirard et al. 2003). This higher SSIs prevalence could be due to various issues like high flow patients as the hospital served more than 25 million people which cause overcrowding, lack of adequate postoperative care, shortage of trained manpower, failure to preserve sterility during surgical procedures, insufficient infection control due to deprived hygiene and water shortage, resource and structural constraints, and lack of awareness regarding SSIs among the overall population.This study identified that SSIs were higher in older patients aged above 65 years and patients less than 15 years were (86.9%) less likely to develop surgical site infection as compared to those above 65 years (AOR= 0.131, 95% CI 0.020, 0.087). The result was similar to other studies (Guta, Aragaw et al. 2014), (Zafar Iqbal Malik 2013) approving that when age advances the risk of SSIs increases.

According to this study, the prevalence of SSIs among clean and clean-contaminated wounds was (5.1%) and (69.4%) respectively. Patients with clean wounds were (99.4%) less likely to develop surgical site infection as compared to those patients with clean-contaminated wounds (AOR=0.006, 95% CI 0.002, 0.024). The finding was coherent with other researches done in Addis Ababa Ethiopia as the SSIs prevalence was higher in clean-contaminated wounds (50.0 %) than clean wound (15.7 %) (Endalafer, Gebre-Selassie et al. 2011), in Mekelle Ethiopia (29.5%) against (8.3%) (Weldu, Berhane et al. 2018), in Sudan (9.5%) versus (8%) (Miliani, L'Hériteau et al. 2009) also in Bolivia (13.9%) compared to , (6.9%) (Soleto, Pirard et al. 2003). The low prevalence of SSIs on clean wounds in this study could be due to more precaution including antibiotic use for most clean wounds in the study setting. This study also identified, in open kept surgical sites, the odds of developing surgical site infection was 5.2 times as compared to close kept surgical site (AOR= 5.189, 95% CI 1.511, 17.821). The result was consistent with Indian study as the open wound is exposed to potential contamination from time of incision and closure (Pathak, Saliba et al. 2014).The prevalence of SSI in those patients with Malnutrition was more than three folds and malnourished patients were 29.3 times more likely to develop SSIs than well-nourished patients (AOR= 29.351 95% CI 5.711, 150.851). The finding is similar to other studies as Malnutrition is a well-documented risk factor for SSI (Lubega, Joel et al. 2017), (Zafar Iqbal Malik 2013), (Pruzansky, Bronson et al. 2014).

Limitation of the study: Since the study design was cross-sectional, it is difficult to establish a sequential relationship between surgical site infections and descriptive variables. Further, a short study period limited us to take large sample size. Also due to resource shortage, variables related to health professional's infection prevention practice, equipment sterilization methods and types of antiseptics used for patient preparation were not studied.

Conclusion: The prevalence of SSIs was bigger than the worldwide range (1.2%) to (5.2%), even higher compared to reports from many developing countries and it is a significant problem in the study hospital. Age greater than 65 years old, presence of clean-contaminated wounds, keeping surgical sites open and Malnutrition were independently associated factors for SSIs. Moreover, Antibiotic prophylaxis and surgical site shaving before surgery were not identified as a protective associated factor for SSIs. Presence of Immunosuppression indicating comorbid diseases like Tuberculosis, HIV/AIDS and Diabetes and taking local anesthesia were identified as predictors of SSIs but the association was not solid enough. Therefore, to challenge the burden of SSI in the hospitals, special consideration is needed to reduce the odds of surgical site infection by standardizing patient care, implementing WHO surgical safety protocol and controlling of comorbidities. Also, extraordinary devotion should

be given to infection prevention strategies, establishing strict sterile environment and aseptic surgical techniques.Furthermore, a periodic study on prevalence and associated factors with long study period and large sample size may further decrease the burden of SSIs.

List of abbreviations: SSIs: surgical site infections; BSc: Bachelor of Science; MSc: Masters of Science; CDC: Center for Disease Control and Prevention; WHO: World Health Organization; LMIC: Low- to Middle-Income Countries; IRB: Institutional review board of Hawassa University; SNNPRS: Southern Nations Nationalities and Peoples Region; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval; SPSS: Statistical Package for Social Sciences.

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References

Abdel-Aziz, A. E.-M., Ayman Al-Thani, Hassan Zarour, Ahmad Parchani, Ashok Asim, Mohammad El-Enany, Rasha Al-Tamimi, Haleema Latifi, Rifat (2013). "Adherence of surgeons to antimicrobial prophylaxis guidelines in a tertiary general hospital in a rapidly developing country." J Advances in Pharmacological Sciences Published online 2013 Dec 23. doi: 10.1155/2013/842593.

Allegranzi Benedetta, B. N., S Chraiti, MN Castillejos, GG Kilpatrick, C Kelley (2011). Report on the burden of endemic healthcare-associated infection worldwide. Geneva, Switzerland:, World Health Organization.

Amenu Demisew, B. T., Araya Fitsum (2011). "Surgical site infection rate and risk factors among obstetric cases of Jimma University Specialized Hospital, Southwest Ethiopia." Ethiopian Journal of health sciences 21(2): 91-100.

Anderson Deverick J, K. K. S. (2009). "Staphylococcal surgical site infections." Infectious Disease Clinics of North America 23(1): 53-72.

Bagnall NM, V. S., Trivedi P. (2009). "Surgical-site infection." Surgery Research and Practice 27: 426-430.

Cheadle, G. W. (2006). "Risk factors for surgical site infection." Surgical Infections 7(S1): s7-s11.

de Lissovoy, G. F., Kathy Hutchins, Valerie Murphy, Denise Song, David Vaughn (2009). "Surgical site infection: incidence and impact on hospital utilization and treatment costs." American Journal of Infection Control 37(5): 387-397.

Ducel G, F. J., Nicolle L (2002). Prevention of Hospital-acquired Infections, 2nd ed. A Practical Guide. Geneva, WHO/CDS/CSR/EPH

Endalafer Nigatu, G.-S. S., Kotiso Berhanu (2011). "Nosocomial bacterial infections in a tertiary hospital in Ethiopia." Journal of Infection Prevention 12(1): 38-43.

Ercole, F. F. S., Carlos Ernesto Ferreira Chianca, Tânia Couto Machado Carneiro, Mariângela (2007). "Applicability of the national nosocomial infections surveillance system risk index for the prediction of surgical site infections: a review." Brazilian Journal of Infectious Diseases 11(1): 134-141.

Garza De la, R. R., J Nakhla, R Nasser (2017). "Case-control study of risk factors for surgical site infection after three-column osteotomy for spine deformity." Turk Neurosurg 1.

Gedefaw Getnet, A. A., Shiferaw Shumiye, Addisu Dagne (2018). "Factors associated with surgical site infection among women undergoing obstetrics surgery at Felegehiwot Referral Hospital, Bahir Dar, Northwest Ethiopia: a retrospective cross-sectional study." Safety in Health 4(1): 14.

Guta Meseret, A. K., Merid Yared (2014). "Bacteria from infected surgical wounds and their antimicrobial resistance in Hawassa University Referral Teaching Hospital, Southern Ethiopia." African Journal of Microbiology Research 8(11): 1118-1124.

Hafez S, S. T., Hasan E (2012). "Incidence and modifiable risk factors of surveillance of surgical site infections in Egypt: A prospective study." Am J Infect Control 40: 426-430.

Laloto TL, G. D., Abdella SH. (2017). "Incidence and predictors of surgical site infection in Ethiopia: Prospective cohort." BMC Infect Dis 17: 119.

Lubega Abubaker, J. B., Justina Lucy Najjuka (2017). "Incidence and etiology of surgical site infections among emergency postoperative patients in Mbarara regional referral hospital, South Western Uganda." Surgery Research and Practice 2017:6365172.
doi: 10.1155/2017/6365172. Epub 2017 Jan 12.

Mawalla Brian Mshana, S. E. C., Phillipo L Imirzalioglu, Can Mahalu William (2011). "Predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania." BMC surgery 11(1): 21.

Mengesha, R. E. K., Berhe Gebre-Selassie Saravanan, Muthupandian Berhe, Derbew Fikadu Wasihun, Araya Gebreyesus (2014). "Aerobic bacteria in post-surgical wound infections and pattern of their antimicrobial susceptibility in Ayder Teaching and Referral Hospital, Mekelle, Ethiopia." BMC research notes 7(1): 575.

Miliani Katiuska, L. H. F., Astagneau Pascal, INCISO Network Study Group (2009). "Non-compliance with recommendations for the practice of antibiotic prophylaxis and risk of surgical site infection: results of a multilevel analysis from the INCISO Surveillance Network." Journal of antimicrobial chemotherapy 64(6): 1307-1315.

Mpogoro FJ, M. S., Mirambo MM (2014). "Incidence and predictors of surgical site infections following cesarean sections at Bugando Medical Centre, Mwanza, Tanzania." Antimicrob Resist Infect Control 2: 25.

Mulu Wondemagegn, K. G., Beyene Getenet, Damtie H (2013). "Associated risk factors for postoperative nosocomial infections among patients admitted at Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia." Clin Med Res 2(6): 140-147.

Nejad Sepideh Bagheri, A. B. S., Shamsuzzoha B Ellis, Benjamin Pittet Didier (2011). "Health-care-associated infection in Africa: a systematic review." Bulletin of the World Health Organization 89: 757-765.

Olsen MA, N. J., Riew KD (2008). "Risk factors for surgical site infection following orthopedic spinal operations." J Bone Joint Surg 90: 62-69.

Owens CD, S. K. (2008). "Surgical site infections: epidemiology, microbiology, and prevention." Journal of Hospital Infection 70: 3-10.

Pathak Ashish, S. E. A., Sharma Shailendra, Mahadik Vijay Kumar, Shah Harshada, Lundborg Cecilia Stålsby (2014). "Incidence and factors associated with surgical site infections in a teaching hospital in Ujjain, India." American journal of infection control 42(1): e11-e15.

Pittet Didier Allegranzi, B. S., J Nejad, S Bagheri Dziekan, G Leotsakos, A Donaldson (2008). "Infection control as a major World Health Organization priority for developing countries." Journal of Hospital Infection 68(4): 285-292.

Pruzansky Jason S, B. M. J., Grelsamer Ronald P, Strauss Elton, Moucha Calin S (2014). "Prevalence of modifiable surgical site infection risk factors in hip and knee joint arthroplasty patients at an urban academic hospital." The Journal of arthroplasty 29(2): 272-276.

Safety, W. P. (2006). Forward programme, 2006-2007, Geneva: World Health Organization.

Sohn Annette H, P. F. M., Vu Tien Hai, Hoang H, Bich Nguyen N, Le Thi A, Thu Le, Thi T Hoa, Thanh Nguyen H, Viet Truong V, Archibald Lennox K (2002). "Prevalence of surgical-site infections and patterns of antimicrobial use in a large tertiary-care hospital in Ho Chi Minh City, Vietnam." Infection Control & Hospital Epidemiology 23(7): 382-387.

Soleto Lorena, P. M. B. M., Peredo Remberto, Vargas Reinerio, Gianella Alberto, Van der Stuyft Patrick (2003). "Incidence of surgical-site infections and the validity of the National Nosocomial Infections Surveillance System risk index in a general surgical ward in Santa Cruz, Bolivia." Infection Control & Hospital Epidemiology 24(1): 26-30.

Waltz PK, Z. B. (2017). "Surgical site infections and associated operative characteristics." Surg Infect 18: 447–450.

Weldu Meresa Gebremedhin, B., Haileselasie, Berhe Negassie, Haile Kebede, Sibhatu Yosef, Gidey Tsehaynesh, Amare Kahsay, Zelalem Hiwot, Mezemir Rahel, Hadgu Tsegay, Kesete Birhane (2018). "Magnitude and Determinant Factors of Surgical Site Infection in Suhul Hospital Tigrai, Northern Ethiopia: A Cross-Sectional Study." Surgical infections 19(7): 684-690.

Zafar Iqbal Malik, T. N., M Tariq Abdullah, S H Waqar, M A Zahid (2013). "Surgical Site Infections in General Surgical Wards at a Tertiary Care Hospital." Pak J Med Res 52.