Overview of Rate and Risk Factors of Surgical Site Infection in a Tertiary Hospital in Liberia: A Prospective Cohort Study

Abstract

Background: Surgical site infection (SSI) is accountable for a third of postoperative deaths and for 8% of all deaths due to hospital-acquired infections. There is a wide disparity in the incidence and burden of SSI in low and high-income countries. **Objectives:** To assess the rates and risk factors of SSI in a tertiary hospital in a resource-limited sub-Saharan African country and generate institutional baseline data for future monitoring and interventions. **Materials and Methods:** This was a descriptive prospective cohort study done at John F Kennedy Memorial Hospital, a tertiary hospital in Monrovia, Liberia, from October 18 to December 18, 2021. Consecutive participants, including children and adults that had surgical operations within the study period, were recruited. Criteria for diagnosis of SSI were as defined by the Centre for Disease Control (1999). Data were collected on the demography of the participants, type of surgery done, presence of SSI, comorbidities, and risk factors for SSI. **Results:** Of the 111 patients analyzed, thirty-two patients had SSI giving a hospital incident rate of 28.8%. This comprises superficial SSI (22/31; 71.0%), deep SSI (6/31; 19.4%), and organ/space SSI (3/31; 9.7%). Twelve out of 42 females (28.6%) and 20 of 69 males (29.0%) had SSI. There is no statistically significant difference in gender SSI rate ($P = 0.963$). SSI occurred more in dirty wounds (13/23; 56.5%), compared to contaminated wounds (6/11, 54.6%), clean contaminated (7/22; 31.8%), and clean wounds (6/55, 10.9%). There is a statistical difference in the rate of SSI among the wound classes ($P = 0.001$). The infection rate is also more in emergency surgeries (18/39, 46.2%) compared to elective surgeries (14/72, 19.4%), and it is significant ($P = 0.003$). Statistically, there was no significant difference between the two skin preparation agents used ($P = 0.351$). The abdomen was the most common site of surgical incision and had the highest rate of SSI (24/79; 30.4%) ($P = 0.045$). There was no statistical difference in SSI rate between those whose hairs were removed in the ward or in the theatre ($P = 0.114$); length of incision ($P = 0.297$), or duration of surgery ($P = 0.715$) (see table for classification and rates). **Conclusion:** The SSI rate in our study is high at 28.8%. Abdominal surgeries, emergencies, and wound class accounted for the majority of the SSIs. The baseline data will be useful in developing infection control strategies.

Keywords: *Hospital acquired infection, surgical wound infection, post-operative wound infection, infection surveillance, post-operative complications*

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Introduction

Deaths from surgery are the third most common cause of mortality globally, after ischaemic heart disease and stroke.[1] Annually, more people die within 30 days following surgery than from HIV, malaria, and tuberculosis combined.[2,3] In a high-income country, surgical site infection (SSI) is accountable for a third of postoperative deaths in those with SSI and for 8% of all deaths due to hospital-acquired infections.[4] SSI constitutes a major global burden with a worse impact in low Human Development Index (HDI) countries. More than half of the global postoperative mortality burden occurs in low and middle-income countries (LMICs).[1] It is also the most common hospital-acquired infection. The childhood mortality rate from SSI, especially neonates, is profound (29.2%), with an associated high mortality odd ratio of 3.4 attributable to SSI.[5]

The recent publication by the Global Surgery Collaborative put into perspective the wide disparity in SSI burden between the high and low HDI's SSI rates. At 23.2%, the SSI rate in the low HDI countries contrasts sharply with 14% and 9.4% in the middle and high HDIs, respectively.[6] The study

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documented an unacceptable four-fold risk of children in low HDI countries getting SSI compared to High HDI countries.[6]

The impact of a high burden of SSI in resource-strained low-income countries manifests in high catastrophic health expenditures with affected families thrown into poverty, increased antibiotic abuse and resistance, and high mortality rate.[3]

The landmark study and documentation of SSI globally by the Global Surgery Collaborative is a crucial initial step in solving the high SSI burden in low-income nations. However, at the local institutions, it is important to understand the responsible risk factors, prevailing institutional peculiarities, and the degree of adherence to standard precautions. Studies in this area could improve knowledge, prevention, and control of these multiple risk factors.[7]

The aim of this study thus is to generate institutional baseline indices of SSI in a tertiary hospital in a resource-limited sub-Saharan African country with a view of documenting the rates and risk factors. This will subsequently help in developing a quality improvement solution to reduce and monitor the incidence and burden of SSI in the institution.[8]

Materials and Methods

This was a descriptive prospective cohort study done at John F Kennedy Memorial Hospital, a tertiary hospital in Monrovia, Liberia, from October 18 to December 18, 2021. The surgery department has eight consultants, four specialist surgeons, and five resident doctors; and receives patients from Monrovia and all parts of the country. As of the time of the study, the total surgical bed capacity is 60, but the hospital is undergoing structural expansion as well as upgrading of infrastructures and personnel. Patients were managed in the male, female, and children surgical wards as well as the special care baby unit for neonates.

Consecutive participants, including children and adults that had surgical operations within the study period, were recruited. Excluded were patients with burn wounds, patients received with infected wounds, orthopedic implant surgeries, and obstetric and gynecological surgeries.

Criteria for diagnosis of SSI were as defined by the CDC (1999), as stated below.

As stipulated in the CDC (1999), guideline for the prevention of SSI, a patient in which at least one of the following was observed was considered positive for SSI.[9]

Purulent drainage, with or without laboratory confirmation from the incision site.

Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision.

At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, and the incision site is deliberately opened by the surgeon unless the incision is culture-negative.

Fascial dehiscence or fascia deliberately opened by the surgeon because of signs of inflammation, purulent discharge from a drain placed via stab wound into an organ/space, or abscess cavity seen during reoperation or radiologically.

Diagnosis of SSI by the surgeon or attending physician.

The principal investigator kept a log of recruited participants and ensured the integrity of data collected was as set in the research protocol.

The research team had several training sessions on the study protocol as well as wound assessment guidelines. A team member was trained on the use of phone call interviews to assess the wounds of those that defaulted from follow-up appointments. Data were collected during patient management in the operation theatre, adult and children's wards, and in the outpatient clinics during postoperative visits. Wounds were carefully inspected at the initial time of opening of the dressings and subsequently at each dressing change and at the follow-up visits. Categorization into superficial, deep, or organ space infection was as stipulated by the CDC guidelines.[9] Patients were followed up till 30 days postoperation for the development of SSI. Clavien–Dindo classification was used to grade the SSI complications.[10]

Data were collected on the demography of the participants, comorbidities, type of surgery done, surgical wound characteristics, cadre of operating surgeons, prophylactic antibiotic use, presence and type of SSI, duration of hospital stay, and risk factors for SSI. Data were analyzed with STATA® version 16.0 (statistics/data analysis, StataCorp, Texas). Frequencies, percentages, and means were computed, and categorical variables were compared using Pearson Chi-square analysis. Linear regression analysis was done to predict the odds of developing SSI from the risk factors. P value less than 0.05 was accepted as being significant.

Ethical approval was obtained from the institutional ethics committee. Being an observational study with little or no influence on the patients' management course, only verbal consent was obtained from the patients or caregivers. Those that refused consent were in no way discriminated against in the course of care.

Treatment of patients with SSI followed standard guidelines, which were modified as institutional resources permit.

Telephone interview was used to assess wound outcome in a few patients who did not or could not meet up with the 30-day follow-up visit.

Results

In total, 124 qualified participants were enrolled, 13 were excluded (three died within 48 h of surgery, and 10 could not be reached for follow-up). Out of the remaining 111 patients analyzed, 32 patients had SSI giving a hospital incident rate of 28.8%. This comprises superficial SSI (23/32; 71.9%), deep SSI (6/32; 18.8%), and organ/space SSI (3/31; 9.4%).

Twelve out of 42 females (28.6%) and 20 of 69 males (29.0%) had SSI. There is no statistically significant difference in gender SSI rate ($P = 0.963$).

SSI occurred more in dirty wounds (13/23; 56.5%), compared to contaminated wounds (6/11; 54.5%), clean contaminated (7/22; 31.8%), and clean wounds (6/55; 10.9%) [Table 1]. There is a statistical difference in the rate of SSI among the wound classes ($P = 0.001$). Respectively, the risk (odds ratio [OR]) of developing SSI from clean, clean-contaminated, contaminated, and dirty wounds are 0.12, 3.81, 9.80, and 10.62 [Table 2].

The infection rate is also more in emergency surgeries (18/39; 46.2%) compared to elective surgeries (14/72; 19.4%), and it is significant (OR = 3.55; $P = 0.003$).

The bulk of the SSIs were from the specialties of general surgery (15/28; 53.6%) and pediatric surgery (12/28; 42.9%). The rest is shown in Table 1.

A majority, 86 (77.5%) of the surgeries were done by the consultants. There was no statistical difference in SSI rate between those done by the consultants and the specialists or residents under training ($P = 0.084$).

Ninety-nine (90.0%) of the surgeries were for benign conditions,4 (3.6%) were for malignant conditions, and 7 (6.4%) were for trauma. Table 1 shows the major procedures that were done.

Factors influencing surgical site infection

Two major skin preparation antiseptics were used; the choice was at the discretion of the surgeon or the availability of the agent. Alcohol and chlorhexidine were used in 26 cases, with SSI occurring in 5 (19.2 %), while povidone–iodine preparations were used in 85, with SSI occurring in 28 cases (32.9%). Statistically, there was no significant difference between the two skin preparation agents used ($P = 0.351$).

The abdomen was the most common site of surgical incision and had the highest rate of SSI (24/79; 30.4%) ($P = 0.045$).

There was no statistical difference in SSI rate between those whose hairs were removed in the ward or in the theatre ($P = 0.114$), length of incision ($P = 0.297$), or duration of surgery ($P = 0.715$) (see Table 1 for classification and rates).

Drains were used in 15 cases, with SSI occurring in 9 (60%) ($P = 0.004$).

Few comorbidities were encountered: nine (8.1%) participants had high blood pressure, and one (0.01%) each had diabetes mellitus, HIV, or malignancy.

Other factors are shown in Table 1.

Clavien–Dindo classification

A majority of the SSI complications were of Clavien–Dindo class I (no.= 11; 35.9%) and class II (no.= 10; 32.3%). Class 2b was 1 (3.2%) and 3b (no. =9; 29.6%).

Mortality

Seven patients (6.3%) died within the study period. The seven deaths occurred in the emergency surgery group. However, only three (3/32, 9.4%) of the deaths were associated with SSI.

Discussion

Studying and documenting infection rates and associated factors is important in monitoring progress made in providing quality and safe surgical care. It is also very useful in providing an overview, baseline data, and trends for future interventions to improve outcomes.

The high SS1 rate of 28.8% in this study is similar to the 23.2% rate observed in low HDI countries.[11] Subregional challenges like insufficient manpower and facilities, lack of infection surveillance and control mechanisms, nonimplementation of prevention protocols, and poor physiological status of patients largely contribute to this.[11,12] Again, healthcare workers many times may not have the requisite knowledge of infection control strategies and may also be limited by the unavailability of support facilities. Poor funding of health care has precluded the necessary training and retraining of staff, so developing a culture of effective infection prevention strategies is difficult.

Late presentation of cases is common in low-income countries occasioned by poverty, lack of health insurance, and poor access to healthcare facilities. No doubt, these patients most times present at advanced infective stages and complications, sometimes after failed interventions from nonmedically qualified health providers.

Emergency surgical conditions directly correlated with a high SSI rate, with SSI occurring more than 3.5 times when compared to elective surgeries. This is not surprising as the majority of the emergency cases were infective abdominal conditions leading to peritonitis. Earlier studies done in Nigeria and Tanzania reported similarly increased rates of 43.6% and 45.7%, respectively, of SSI among emergency cases.[12,13] These are essentially contributed by contaminated and dirty wounds class. Unlike in many other studies where emergencies were mostly done by trainee surgical residents, most of the emergencies in our study were done by consultants. This might have contributed to the relatively marginal lower SSI rate even among the contaminated and dirty wound classes when compared to other similar studies.[12]

The use of drains did not positively influence a reduction in the abdominal wound infection rate. In fact, there seems

Table 1: SSI variables

	SSI present (frequency %))	SSI absent (frequency %)	X^2	*P* value
Gender				
Female	12 (28.6	30 (71.3)	0.0022	0.963
Male	20 (29.0)	49 (71.1)		
Age group (years)				
≤5	9 (40.9)	13 (59.1)	3.7701	0.583
6–15	5 (29.4)	12 (70.6)		
16–30	6 (27.3)	16 (72.3)		
31–50	7 (28.0)	18 (72.0)		
51–70	3 (15.0)	17 (85.0)		
>70	2 (40.0)	3 (60.0)		
Wound class				
Clean	6 (10.9)	49 (89.1)		
Clean contaminated	7 (31.8)	15 (68.2)	20.8460	0.001
Contaminated	6 (54.5)	5 (45.5)		
Dirty	13 (56.5)	10 (43.5)		
Type of surgery				
Emergency	18 (46.2)	21 (53.8)	8.7957	0.003
Elective	14 (19.4)	58 (80.6)		
Smoking				
Yes	1 (20.0)	4 (80.0)	0.1732	0.677
No	31 (29.2)	75 (71.7)		
ASA				
I	7 (20.0)	38 (80.0)	9.841	0.043
II	14 (33.3)	28 (66.7)		
III	6 (22.2)	21 (77.7)		
IV	4 (80.0)	1 (20.0)		
V	1 (50.0)	1 (50.0)		
Surgeon				
Consultant	26 (23.3)	60 (69.7)	8.2413	0.084
Specialist resident	4 (28.6)	10 (71.4)		
Resident	2 (18.1)	9 (81.8)		
Duration of surgery				
≤2 h	28 (28.3)	71 (71.2)	0.5665	0.753
>2 h	4 (33.3)	8 (66.7)		
Time of hair removal				
No hair	30 (32.6)	62 (67.4)	4.3412	0.114
In the theatre	2 (16.7)	10 (83.3)		
Night before surgery	0 (0)	7 (100.0)		
Use of drain				
No	23 (24.0)	73 (76.0)	8.2133	0.004
Yes	9 (60.0)	6 (40.0)		
Incision site				
Abdomen	24 (30.4)	55 (69.6)	35.6384	0.045
Perineum	5 (83.3)	1 (16.7)		
Chest	1 (14.3)	6 (85.7)		
Head and neck	0 (0)	11 (100)		
Limbs	1 (14.3)	6 (85.7)		
Back	1 (16.7)	5 (83.3)		
Length of incision				
≤5 cm	9 (28.1)	23 (71.9)	2.4312	0.297
>5 and ≤10 cm	10 (22.2)	35 (77.9)		
>10 cm	13 (38.2)	21 (61.8)		
Duration of surgery				
≤2 h	28 (28.3)	71 (71.7)	0.1331	0.715
>2 h	4 (33.3)	8 (66.7)		

Table 2: Risk factors of SSI (linear logistic regression analysis)

Variable	Odds ratio	Std error (*b*)	*P* > *[z]*	95%CI of OR
Clean wound	0.12	0.053	0.000	0.0525–0.2858
Clean contaminated wound	3.81	2.400	0.034	1.1091–13.0950
Contaminated wound	9.8	7.293	0.002	2.2794–42.1345
Dirty wound	10.62	6.405	0.000	3.2542–34.6368
Emergency surgery	3.55	1.555	0.004	1.5050–8.3788
Use of drain	4.76	2.755	0.007	1.5313–14.8020

CI: confidence interval, OR: odds ratio, SSI: surgical site infection

to be an increased risk of infection with the use of a drain. Other studies have also documented an increased risk of SSI with drains. This, however, may be dependent on the wound class, duration of drainage, and site of the drain.[14] We used drains essentially for septic abdominal conditions involving bowel perforations. These are wounds that are already heavily contaminated or dirty. The benefit of drainage and its role in reducing SSI in these situations is still a matter for further research.

We were not able to do wound microscopy and culture to isolate infective organisms at the time of the study; the institution was in the process of reactivating the microbiology department to provide these services. Again the high cost of services from surrounding laboratories and the indigence of patients prevented access to such services. This has made infection control and surveillance difficult and has rendered the responsible unit nonfunctional. The sequelae of this is that surgeons used prophylactic antibiotics for almost all surgical cases. The extended use of prophylactic antibiotics might have reduced the incidence of SSI but at the risk of developing antibiotic-resistant micro-organisms. The anticipated profiling of responsible organisms, when the laboratory becomes operational, is expected to change this and reduce the risk of antibiotic resistance, which is already common in low-income countries.[11]

Recent Global Surgery Collaborative studies have fortunately concluded that expensive skin preparation and closure agents work just as well as the cheap and common alternatives in the prevention of SSI. In its landmark randomized controlled trial publication, it showed that the use of alcohol/chlorhexidine compared to povidone–iodine; and triclosan-impregnated sutures compared to nonimpregnated sutures did not differ in the rate of development of SSI.[15] This is good news for surgeons in LMICs as the cheaper and more available alternatives can now be used with confidence. Our study shows a similar outcome. However, we did not randomize the use of alcohol/chlorhexidine and povidone–iodine. The use of the agents was largely influenced by the availability and, in a few other cases, the surgeon's preference. There was no statistical difference in infection rates in the use of the two agents.

Limitations

The study depended only on clinical and radiologic assessments in making the diagnosis of SSI.

To understand fully and have a holistic picture of the risk factors for SSI, several environmental factors also need to be further evaluated. Nonassessment of health worker's knowledge and practice of SSI prevention strategies, the impact of unavailability of materials and consumables like antiseptics, sutures, etc., poor training of health workers in SSI prevention, absence of infection control unit are the limitations of the current study and can form a focus for future research.

Conclusion

Though comparable to other low-income countries, the SSI rate in our study is high at 28.8%. Abdominal surgeries, emergencies, and wound class (dirty and contaminated wounds) accounted for the majority of the SSIs. It is expected that this baseline data will be used to formulate quality improvement strategies to reduce the SSI rate in the hospital as well as associated patients, health workers, and environmental risk factors.

Authors contribution

OHE was responsible for the dtudy concept. design, analysis and writeup. OSS, FLN and FAJ took part in data collection and data review. PSC, KTM, IES, RGM, SM, AND, BGB, AKC, MYW participated in the study design, draftiing of the metodology and review of the work. All authors approved of the final article draft.

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Conflicts of interest

There are no conflicts of interest.

References

1. Nepogodiev D, Martin J, Biccard B, Makupe A, Bhangu A, Ademuyiwa A, *et al*. Global burden of postoperative death. Lancet 2019;393:401.
2. CollaboratorsGBDCoD. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: A systematic analysis for the Global Burden of Disease Study

2016. Lancet 2017;390:1151-210.1.

3. Bhangu A; GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: A prospective, international, multicentre cohort study. Lancet Infect Dis 2018;18:516-25.
4. Astagneau P, Rioux C, Golliot F, Brücker G; INCISO Network Study Group. Morbidity and mortality associated with surgical site infections: Results from the 1997–1999 INCISO surveillance. J Hosp Infect 2001;48:267-74.
5. Ekwunife OH, Ameh A, Abdur-Rahman L, Ademuyiwa A, Akpanudo E, Alakaloko F. Burden and outcome of neonatal surgical conditions in Nigeria: A countrywide multicenter cohort study. J Neonatal Surg 2022;11:3.
6. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in children: An international, multicentre, prospective cohort study. BMJ Global Health 2020;5:e003429.
7. Ngaroua, Ngah JE, Bénet T, Djibrilla Y. Incidence of surgical site infections in sub-Saharan Africa: Systematic review and meta-analysis. Pan Afr Med J 2016;24:171.
8. Sawyer RG, Evans HL. Surgical sit infection—the next frontier in global surgery. Lancet Infect Dis 2018;18:477-8.
9. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. The hospital infection control practices advisory committee. Guideline for the prevention of surgical site infection. Infect Control Hosp Epidemiol 1999;20:247-80.
10. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, *et al*. The Clavien–Dindo classification of surgical complications five-year experience. Ann Surg 2009;250:187-96.
11. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. Lancet Infect Dis 2018;18:516-25.
12. Adejumo AA, Nuhu M, Afolaranmi T. Incidence of and risk factors for abdominal surgical site infection in a Nigerian tertiary care centre. Int J Infect Control 2015;11:i4.
13. Akoko LO, Mwanga AH, Fredrick F, Mbembati NM. Risk factors of surgical site infection at Muhimbili National Hospital, Dar es Salaam, Tanzania. East Cent Afr J S 2012;17:1-6.
14. Mujagic E, Zeindler J, Coslovsky M, Hoffmann H, Soysal SD, Mechera R, *et al*. The association of surgical drains with surgical site infections—A prospective observational study. Am J Surg 2018;217:17-23.
15. NIHR Global Research Unit on Global Surgery. Reducing surgical site infection in low-income and middle income countries (FALCON): A pragmatic, multicentre, stratified, randomized controlled trial. Lancet 2021;398:1687-99.