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Prevalence of Surgical Site Infections in Non-Diabetic Patients Undergoing Major Surgery at St. Francis Hospital Nsambya

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Abstract

Surgical site infection (SSI) is an infection occurring in an incision wound within 30 days of surgery and significantly effects patient recovery and hospital resources. To determine the prevalence of SSI among non-diabetic patients undergoing major surgery at St.Francis hospital Nsambya. This was a Cross-section prospective study, the study was carried out at St. Francis Hospital Nsambya in Kampala. This is one of the tertiary level referral and teaching hospital for MKPG Nkozi University. It has a bed capacity 342 beds. Approval to conduct the study was obtained from the institutional review board prior to commencement of data collection. Of the 140 patients enrolled in the study, male were 90 (64.3%) giving male female ratio 1.8:1. Surgical site infection (SSI) was seen in 40 (28.6%) patients and these were. 3 (2.1%) stitch abscess (sinus), 22 (15.7%) superficial SSIs, 10 (7.1%) deep SSIs, and 5 (3.6) deep space infection. Common bacteria isolated were: *Staphylococcus aureus* 10 (27.8%) and *Escherichia coli* 10 (27.8%). SSI was significantly associated with; co-morbidities (P-value=0.05), history of smoking (P-value=0.008), type of procedure done (P-value=0.03), ASA (P-value=0.001), type of surgery (P-value=0.012), use of drain (P-value=0.011), increased WCC (P-value=0.001), Neutrophilia (P-value=0.001), Hypoalbuminemia (P-value=0.001), BG levels at various intervals; preoperative at induction, post-operative at 12 hous, 24 hours, and 48 hours (P-value=0.007), (P-value=0.002), (P-value=0.005), (P-value=0.007) respectively, significantly were associated with SSI. Considering the relatively higher rate of SSI in this study, especially in non-diabetic patient undergoing major surgery. Surgical wound contamination potential, patients clinical conditions (ASA), type of surgical procedure, Leukocytosis, hypoalbuminemia and postoperative BG at 24 hours were variables statistically associated with SSI and behaved as risk factors on binary and multivariate logistic regression analysis. When the administration of prophylactic antibiotics is required, should be given at induction of an aesthesia is recommended.

Keywords: P-value; Leukocytosis; Anesthesia; Co-morbidities; Laparoscopic; Contaminated; Surgery

Introduction

Surgical Site Infections (SSIs) is defined as infections involving the operative area occurring within 30 days of the procedure [1]. Surgical site infections are the third most common hospital associated infection, accounting for 14-16% of all infections in hospitalized patients worldwide [2]. Among surgical patients, SSI is the most frequent cause of infections, accounting for 38-40% [2]. Limited studies have been conducted in Uganda on surgical site infection among patients undergoing major surgeries. Studies have reported rates of SSI ranging from 9.64%-36.4% [3,4]. The prevalence and incidence rates of post-operative wound infections vary widely between procedures, hospitals, surgeons, patients and geographical locations [5,6]. One study among 322 children surgical patients in Nigeria reported high SSI rate of 25.8% in emergency procedures in contrast to 20.8% in elective procedures, although the association was not statistically significant [7]. Also a similar study documented high rate of SSI in dirty surgery (60%) compared with contaminated (27.3%), clean contaminated (19.3%) and clean surgery (14.3%), the association being statistically significant [7]. Studies have shown that introduction of minimal invasive surgery like laparoscopic surgery has resulted in decrease in incidence of SSI. The criteria used to define surgical site infections have been standardized and described at three different anatomic levels of infection that is: superficial incisional surgical site infection, deep incisional surgical site infection and organ/deep space surgical site infection [8]. According to the degree of contamination wounds may be classified as clean, clean contaminated, contaminated, and dirty [4,9]. These studies have only been limited to general surgical patients but the prevalence of the problem to other surgical specialties in non-diabetic patient is unknown. The paucity of comprehensive data regarding the extent of SSI in non-diabetic patients undergoing major surgery at St. Francis hospital Nsambya poses a challenge in developing evidence-based interventions for treatment, control and prevention of SSIs. This study was therefore undertaken in an attempt to establish local data on the prevalence of SSI in non-diabetic patient in various surgical specialties at St. Francis hospital Nsambya. Having such data would help to establish guidelines for the management of SSIs and contribute to planning of surveillance, prevention and control of this group of infections.

Methods

This was a Cross-section prospective study,the study was carried out at St.Francis Hospital Nsambya in Kampala. The study period was 6 months, Novermber 2013 to April 2014. Known patient with DM were exduded The data was collected from the patients using questionnaire/ data collection form. All patients who underwent major surgery with visible incisions were eligible to participate in the study and requested to consent for study. Random blood sugar was taken preoperative, at induction of an aesthesia and postoperative at 12 hours, 24 hours and 48 hour. Data obtained were checked and cleaned, organized, coded and doubly entered in EPI-DATA version 3.1. and exported to

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SPSS version 19.0, and Chi-square test was used to determine for the significance associations between the risk factors and outcome variables to all categorical variables and odds ratio and confidence interval were calculated using bivariate logistic regression to test the strength of the association between the risk factor variables.

Results

Socio-demographic, clinical characteristics and prevalence of SSI

In this present study, most of our patients were in the age group 20-40 years and showed a male preponderance (Table 1). Similar demographic observation was reported by another study in Tanzania [10]. The prevalence rate of SSI following major surgery in our non-diabetic patient was 28.6%, which compared favorably with infection rate in other East African countries [4]. The rate was however higher than 8.4% reported by others [10]. Recently, Tiberi et al. at Nsambya hospital among surgical patients reported SSI rate of 9.64% in pre-intervention phase in which no antimicrobial prophylaxis (AMP) was administered, as compared to 2.56% in intervention phase in which AMP was administered preoperatively [11]. Although SSI rate of 28.6% in our patients is very high than range of 2.56% to 9.64% sited above, perhaps the prevalence of SSI in these patients is even higher as our cases are limited to non-diabetic patients whose SSI was detected within 30 days postoperative. This could be explained by multiple risk factors in patient undergoing major surgery such as smoking and immunosuppression i.e., HIV. And the high rate 12.9%, 20.7% and 15.7% of contaminated, dirty and trauma related wounds respectively in our study might have contributed to the high prevalence of SSI too.

Characteristic		Frequency (N=140)	Percentage (%)
Age (years) Mean (SD) 40.66 (18.14)	<20	17	12.1
	21-30	37	26.4
	31-40	26	18.6
	41-50	19	13.6
	51-60	19	13.6
	61-70	13	9.3
	>71	9	6.4
Sex	Male	90	64.3
	Female	50	35.7
Education	Non	31	22.1
	Primary	30	21.4
	Secondary	47	33.6
	Tertiary	32	22.8
Smoking	Yes	43	30.7
	No	97	69.3
Co-morbidity	Non	78	55.7
	HTN	20	14.3
	HIV/AIDS	24	17.1
	Malignancy	10	7.1
	Others	8	5.7
BMI	<18.5	5	3.6
	18.5-25	67	47.9
	25-30	59	42.1
	>30	9	6.4
Type of surgery	Elective	66	47.1
	Emergency	74	52.9

Note: SD: Standard Deviation; N: number; BMI: Body Mass Index; HTN: Hypertension, AIDS: Acquired Immune Deficiency Syndrome

Table 1: Demographic and clinical characteristics of patients.

This is opposed to other studies in Africa who found SSI rate between 5.6% to 38.7% [12]. A recent study done in Bugando Medical Centre (BMC) in Tanzania, among general surgical patients found high rate of SSIs at (26%), of whom (86.2%) and (13.8%) had superficial and deep SSIs respectively [4].

Patient factor associated with SSI

The rate of SSI was significantly higher in male patients than in females. This could be explained by multiple risk factors in male such as cigarette smoking and HIV. As described previously cigarette smoking was significantly found to be associated with SSI in the multivariate analysis [13]. Majority of our patients with history of smoking were men and smoking was significantly associated with SSI in our study. Similar studies in Sub-saharan Africa have found such association [14]. Smoking was significantly found to be associated with SSI in bivariate analysis by Olson et al. 1990 who stated that, smoking impair tissue oxygenation and local hypoxia via vasoconstriction thus impact on wound healing-SSI [15]. Previous studies have shown that patients with co-morbidities, such as HIV/AIDS infection, Malignancy and DM are at high risk of developing SSI due to their low immunity [16]. This was confirmed in this study were by 44.3% of patient had co-morbidities. The prevalence of HIV in this study was found to be higher 28 (20%) than in general population and the majority were male this has been observed previously. In the present study, the rate of SSI was found to be significantly higher in HIV positive patients 14 (50%) than non HIV patients (P-value=0.05).

It was found that the rate of SSI was particularly high 35% among HIV/AIDS patients [4,10]. Various studies have an association of SSI with obesity, reporting that the reduced blood circulation in the fat tissue and a larger layer of subcutaneous tissue potentially leads to a larger dead tissue space after wound closure and, increase the risk for infection [17]. In our study however BMI >30 (Obesity) was not associated with SSI reason possibly due to the limited number of patient with BMI >30. Mehta et al. stated that, BMI “may not be the most accurate predictor of the risk of surgical site infection since body weight distribution is variable and also, muscle mass is included in the calculation of BMI [17] (Table 2).

Preoperative factor associated SSI at Nsambya Hospital

In this study in the bivariate analysis it was observed that, the rate of SSI was significantly associated with ASA class 3 and 4 increased the risk for SSI 50 times, similar observation have been made by other studies [18]. In a study done at BMC in Tanzania in a univariate analysis it was observed that, the rate of SSI was significantly associated with ASA class 3 increased the risk for SSIs 45 times [4]. Patients with systemic diseases show a higher incidence rate of SSI, showing a direct relation between clinical severity and infection events [19]. It can be inferred that healthy patients are at lesser risk of evolving to an SSI in comparison with patients suffering from some kind of disease [19]. It is known that weakening chronic conditions can represent risk factors for surgical wound infections, due to the host’s low resistance level [19].

In this study pre-operative length of hospital stay (LOS) > 24 hours was not statistically significant, similar statistical observation was reported in Algeria [20]. Prolonged pre-operative duration of hospitalization with exposure to hospital environment has been reported to increase the rate of surgical infection [21]. In the study done in Tanzania found hospitalization of more than 7 days prior to surgery increased the risk of SSI by 2 fold [4]. In our study the above observation is because patient stayed on ward less than 24 hour preoperative thus the bacteria didn’t get enough time to colonize the

Variables		SSI		OR	(93%CI)	P Value
		Yes* n% N= 40	No n% N = 40			
Age in years Mean(SD) 4066(1814)	<20	5 (12.5%)	12 (12.0%)	0929	0.756-1.142	0.5
	21-30	7 (17.5%)	30 (30.0%)			
	31-40	11 (27.5%)	15 (15.0%)			
	41-50	6 (15.0%)	13 (13.0%)			
	51-60	4 (10.0%)	15 (15.0%)			
	61-70	1 (25%)	12 (12.0%)			
	>71	6 (15.0%)	3 (3.0%)			
Sex	Male	29 (72.5%)	61 (610%)	1.686	0.756-3759	0.2
	Female	11 (27.5%)	39 (39.0%)			
Co-morbidity	None	15 (37.7%)	63 (63.0%)	1.251	0.997-1370	0.05
	H1N	4 (10.0%)	16 (16.0%)			
	HIV/AIDS	14 (35.0%)	10 (10.0%)			
	Malignancy	3 (7.5%)	7 (7.0%)			
	Others	4 (10.0%)	4 (4.0%)			
Smoking	Yes	19 (47.5%)	24 (24.0%)	2.865	13246.199	0.008
	No	21 (52.5%)	76 (76.0%)			
BMI	<18	0 (0%)	5 (50%)	0.766	0.443-1.324	0.34
	18-25	18 (45.0%)	49 (49.0%)			
	25-30	20 (500%)	39 (390%)			
	>30	2 (5.0%)	7 (7.0%)			
Education	Non	8 (2.0%)	23 (23%)	0947	0.741-1.212	0.7
	Primary	8 (22%)	22 (22%)			
	Secondary	15 (37.3)	32 (32%)			
	Tertiary	9 (22.5)	23 (23%)			

Table 2: Patient factor associated with SSI at Nsambya Hospital.

Note: SSI: Surgical Site Infection

	SSI		OR	(95% CI)	P-Value
Procedure	Yes n (%) N=40	No n (%) N=100	1(07)	1011-1.189	0.03
Appendicectomy	1 (25%)	6 (60%)			
Appendicectomy and peritoneal lavage	4 (10.0%)	1(1.0%)			
Repair of perforation and thorough lavage	7 (17.5%)	1 (1.0%)			
Division of bands and adhesivelysis	1 (25%)	4 (4.0%)			
Resection and primary anastomosis	6 (15.0%)	8 (8.0%)			
Cholecystectomy	0 (0.0%)	3(3.0%)			
Herniorrhaphy	4 (10.0%)	13 (13.0%)			
Hemioplasty	2 (5.0%)	5(5.0%)			
Mastectomy	0 (0.0%)	4 (4.0%)			
Thyroidectomy	0 (0.0%)	4 (4.0%)			
Open prostatectomy	0 (0.0%)	4 (4.0%)			
Thoracotomy	0 (0.0%)	7(7.0%)			
Craniectomy	3 (75%)	7(7.0%)			
ORIF and laminectomy	10 (25.0%)	22 (22.0%)			
Exploratory laparotomy	2 (5.0%)	7 (7.0%)			
Others	0 (0.0%)	4 (4.0%)			

Note: ORIF: Open Reduction and Internal Fixation

Table 3: Procedures done and SSI rate at Nsambya Hospital.

patients. Post-operative LOS was noted with a mean (SD) 10.6 (6.257), LOS is the indicator most frequently used to estimate the direct costs generated by SSI; however, many SSIs are not detected until after the patient is discharged [22]. However other post-operative complication other than SSI meant has contributed to the prolonged hospital stay.

The analysis of pre-operative antibiotic use is shown in Table 4. We found that most patients received two or more antibiotics over the course of their hospitalization. We observed that 133 (95%) received prophylactic antibiotic regardless the type of surgical procedure to be done and 39 (29.3%) developed SSI. Among 7 (5.0%) who did not receive any antibiotic only one developed SSI. From the above observation prophylactic antibiotic use was not statistical significant of SSI. This

Variables		SSI		OR	(95%CI)	P- Value
		Yes n% N=40	No n% N=100			
Pre-operative LOS	<24	26 (65.0%)	71 (71.0%)	0.824	0.573-1.184	0.3
	2448	5 (125%)	17 (17.0%)			
	48-72	6 (15.0%)	8 (80%)			
	72-06	2 (5.0%)	1 (10)			
	>96	1 (25%)	3 (30%)			
Septic focus	Yes	4 (10.0%)	9 (90%)	1.123	0.325-3.880	0.854
	No	36 (90.0%)	91 (91.0%)			
Antibiotic use	Yes	39 (975%)	94 (94.0%)	2.489	0.290-21.364	0.4
	No	1 (25%)	6 (6.0%)			
ASA	I	5 (125%)	50 (50.0%)	0.381	0.246-0.588	0.001
	II	14 (35.0%)	29 (29.0%)			
	III	14 (35.0%)	18 (18.0%)			
	IV	7 (17.5%)	3 (3.0%)			
WCC	<4000	3 (75%)	7 (7.0%)	0.238	0.107-0.529	0.001
	4000-11000	19 (47.5%)	83 (83.0%)			
	>11000	18 (45.0%)	10 (10.0%)			
Neutrophil	<40%	3 (75%)	2 (20%)	0.311	0.111-0.874	0.001
	40-74%	27 (67.5%)	94 (94.0%)			
	>74%	10 (25.0%)	4 (4.0%)			
Albumin*	<35	22 (56.4%)	8 (87%)	13.489	5.162-35.250	0.001
	35-55	17 (43.6%)	83 (90.2%)			
	>55	0 (0%)	1 (1.1%)			

Note: LOS: Length of Stay; WCC: White Cell Count; ASA: American Society of Anesthesiology; *N=131

Table 4: Preoperative factor associated SSI at Nsambya Hospital.

observation is in coloration with other studies in the region [4]. Despite lacking of significant association between preoperative antibiotics and SSI in this study, it is well know that antibiotic prophylaxis is most effective in preventing SSI. When administered 30 minutes before the start of operation [3,4]. The lack of significance in our study could partly be explained by lack of adherence to existing antibiotic protocol/ policy. The most commonly used antibiotics were cefatraixone (34%) and Ampiclox (26%), followed Flucomax (22.3%) and others (17.7%). Given the local standard of care and the data that we have, it was not possible to distinguish the use of prophylactic from therapeutic antimicrobial therapy or to interpret the indication for the use of multiple antibiotics. Almost all patients received antibiotic treatment at the discretion of the treating surgeon during the perioperative period (within 24 hours of surgery) and often for the duration of the hospital stay.

By laboratory workup preoperative

This study also showed that increase WCC, Neutrophills and Hypoalbuminemia were statistically significant associated with SSI at binary logistic regression. This observation is consistent with other study reports [23]. Hennessay DB et al. observed that these cells are the first to present/ line up during an inflammatory process and also showed that hypoalbuminemia may be a consequence of chronic illness like HIV/AIDS infection or malignancy [23].

Intraoperative factor associated with SSI at Nsambya Hospital

This study showed that surgeries that were carried out on emergency basis carried a three times risk of becoming infected as compared to elective ones. This finding is consistent with the study in Tanzania [10,24]. Akoko et al. found that majority of the surgical procedures were performed on emergency basis. Only 37 (31.4%) of the 118 were elective procedures. The odds of developing SSI were three fold in emergency surgical procedures [OR 3.08, 95% CI 0.98-9.69]. Of the emergency surgical procedures, 45.7% (37/81) developed SSI as compared to 13.5% (5/37) of the elective procedures ($p<0.05$) [10]. Reason for the above observation in our study is that most emergency cases would be having poor wound classes and burdened by bacteria.

By procedure done

Regarding the procedure done; ORIF and Laminectomy had prevalence of 31.3% of SSI was observed and likewise repair of perforation, resection and primary anastomosis had a risk factor of 10 and 5 respectively of developing SSI. These findings collarets with literature citations from other countries but their rates are slight lower than ours [10,25,26]. Akoko et al. found that procedures performed in the abdomen had a 1.7 times risk of becoming infected, so were extremity surgeries with a risk of factor five. A study done by Finn et al. categorically outlined that the most significant risk factor for the development of SSI is the bacterial burden, which formed the basis of classifying wounds into classes by Horan and colleagues, later adopted by CDC [27].

The use of surgical drain has been reported to be associated with an increased risk of SSI which was confirmed in this study [4]. In this study placement of drains may have occurred because there were intraoperative findings that made the operating surgeon concerned about subsequent infection, suggesting that it was the intra-operative finding, as opposed to the drain that increased the SSI risk. However, in the SSI group of patients with drains, only 2 of 68 of those drains were placed in an abscess cavity. Therefore, the drains in our patients were primarily placed for reasons other than obvious findings of infection at the time of operation.

The overuse of drains may increase the risk of SSI due to retrograde contamination along the drain, creating a pathway for subcutaneous soft tissue contamination [28]. A study done by Reifell et al. found

Sixty-six drains (65.3%) were placed in the presence of prosthetic material. Although nearly two thirds of drains were colonized with bacteria, wound infection rate was extremely low (5.6%). Thus, he concluded that closed-suction drains may be left in place for an extended period without increasing the risk of infection, even in the presence of prosthetic material [28].

It was observed in this study that the prevalence of SSI was high in patient with contaminated and dirty wounds presenting a risk factor of developing SSI with a risk factor of 2 and 1.5 respectively; these findings are similar study done in Tanzania [29,30]. Surgical wound classification has long been established as an important predictor of the postoperative surgical site infection [31]. All surgical wounds are at risk for bacterial contamination as pathogenic organisms can enter primarily through the incision or from hematogenous dissemination [31]. While normal skin floras consisting of aerobic gram-positive cocci are endemic, contamination by enteric bacteria may also occur by proximity to body orifices or transference. The so called tipping point for these potential pathogens is variable and multifactorial. In a study by Richard P.E et al. stipulated that the host immune response plays a major role, with local wound conditions, bacterial virulence, and the presence of nonviable substrates playing important, but lesser, roles. The preoperative goal is to optimize intraoperative sterility of the wound to minimize the bacterial load to a level that will not overwhelm host defenses [31].

Contrary to some reports in the literature [4], we found no association between lengths of operation more than 3 hours and SSI. Increasing the length of procedure theoretically increases the susceptibility of the wound by increasing bacterial exposure and the extent of tissue trauma (more extensive surgical procedure) and decreasing the tissue level of the prophylactic antibiotic. Campos et al. argued that since the length of operation may reflect not only factors intrinsic to the patient but also the influence of extrinsic factors surrounding the operation, a locally defined cut point may be a better predictor of the risk of SSI inherent in the local setting [32] (Table 5).

In our study, most of the glucose levels measured was below 11.1 mmol/l in the patients who still developed SSIs. By dividing our patients' glucose measurements into 4 time intervals, we sought to identify if there was a specific time frame during which hyperglycemia may be more critical in the development of an SSI. In both groups of our patients, those with and without SSI, the 12 and 24 hours postoperative blood glucose was the highest of the 4 time points measured, suggesting this may be a key time point for intervention. Other studies in cardiac patients have also shown that elevated intra-operative and post-operative blood glucose is associated with SSI [33,34]. Our data suggest, however, that the American Diabetes Association recommendation of 11.1 mmol/l may still be too high, and lower blood sugars should be sought to minimize SSI, because the majority of the measured glucose levels were below 11.1mmol/l in those who developed SSIs. Still we observed 14 (10%) with hyperglycemia and statistically significant with SSI. The majority of the studies in the literature that have looked at peri-operative glucose management have been done primarily in the critical care, cardiac surgical and orthopedic setting [35,36]. In 2007, Lazar et

Variables		SSI		OR	(95%CI)	P- Value
		Yes n% N=40	No n% N=100			
Type of surgery	Elective	12 (30.0%)	54 (54%)	0.365	0.1670798	0.012
	Emergency	28 (70.0%)	46 (46%)			
Surgeon	Intern	1 (25%)	1 (10%)	1.143	0.865-1.511	0.284
	SHO	21 (52.5%)	39 (39.0%)			
	Registrar	3 (75%)	14 (14.0%)			
	Consultant	2 (5.0%)	15 (15.0%)			
	Senior consultant	13 (32.5%)	3 1(31.0%)			
Drain	Closed	26 (65.0%)	40 (40.0%)	1.647	1.122-2.418	0.011
	Open	0 (0%)	2 (20%)			
	Non	14 (35.0%)	58 (58.0%)			
Wound Class	I	13 (32.5%)	57 (57.0%)	0.518	0.401-0.750	0.001
	II	3 (75%)	20 (20.0%)			
	III	8 (20.0%)	10 (10.0%)			
	IV	16 (40.0%)	13 (13.0%)			
Duration	<1hrs	2 (5.0%)	9 (90%)	0.719	0.445-1.161	0.18
	I-2hrs	20 (50.0%)	50 (50.0%)			
	2-3hrs	11 (27.5%)	35 (35.0%)			
	>3hrs	7 (17.5%)	6 (60%)			
Surgery By Regions	Head	3 (75%)	7 (7.0%)	0.972	0.762-1.158	0.8
	Neck	0 (0%)	5 (50%)			
	Chest	1 (25%)	7 (70%)			
	Abdomen	21 (52.5%)	41 (41.0%)			
	Inguinal	5 (12.5%)	14 (14.0%)			
	Limbs	8 (20.0%)	22 (220%)			
	Spine	2 (5.0%)	0 (0%)			
	Breast	0 (0%)	4 (40%)			

Table 5: Intraoperative factor associated with SSI at Nsambya Hospital.

al. published a study that looked at 3,554 diabetic patients undergoing coronary artery bypass grafting. All patients were treated with either intra-operative subcutaneous insulin or with continuous insulin infusion for hyperglycemic control. Observed mortality with continuous insulin infusion was significantly lower than with subcutaneous insulin [37]. Furthermore, better postoperative glucose control was also shown to decrease wound infections [38]. Data from the critical care, cardiac and orthopedic literature may be able to be extrapolated to other types of surgery, but large studies looking at peri-operative hyperglycemia in non-diabetic patients with outside of the critical care, cardiac surgical and orthopedic realm are still limited. It can be argued that elevated glucose may be an early sign of postoperative infection as opposed to a causative factor. Certainly it is possible that during our 12- to 24-hour time point, patients who would ultimately get an SSI may have already started to develop such an infection that could have been reflected in increased blood sugars. However, the highest blood glucose levels were found at 12 and 24 hour postoperative period within 6 hours of operation, which would be very unlikely to have been caused by a wound infection at such an early time point (Tables 3, 6 and 7).

Regarding to the type of bacteria isolated and they susceptibility, *Staphylococcus aureus* and *E. coli* were the commonest isolates among patients with SSI. This is in consistent with the report from other studies in Africa [14,25,30,39,40]. It has been found that in clean surgical procedures, *Staphylococcus aureus* from the patient's skin flora is the usual pathogen, whereas, in other categories of surgical procedures, including clean-contaminated, contaminated and dirty, the polymicrobial flora closely resembling the normal endogenous microflora of the affected site is the most frequently isolated pathogens [39]. In our study, *Staphylococcus aureus* was the most common isolate in patients who underwent ORIF and laminectomy, herniorrhaphy and craniectomy. Although some of the studies in the region have shown predominance of *Pseudomonas* [26]. *Escherichia coli* were the most common gram-negative bacteria and were predominantly isolated from resection and primary and repair of perforation. Similar findings have been reported in other studies [39,40]. Similar finding was reported in a study at Jinja referral hospital, which documented the *S. aureus* as being the commonest isolate (45.1%) followed by coliforms (16.9%) and *Proteus mirabilis* (11.3%) [41]. MRSA accounted for 25% of all *S. aureus* and the majority of surgical patients underwent caesarian and herniorraphy procedures [39]. A recent study at a University hospital in Iran, reported *S. aureus* to be the commonest bacteria pathogen (43%), followed by *Escherichia coli* (21%), *Klebsiella* spp (13%), *Pseudomonas* (10%) and CoNS (5%) among a surgical patients [42]. In that study MRSA accounted for a high rate of 78.9% of all *S. aureus* isolates [40]. Our study also found that most of the pathogens were multiply resistant to the commonly prescribed antibiotics such as ceftriaxone, ampiclox, flucomax and others. Similar antimicrobial susceptibility pattern findings have been observed in Tanzania, Kenya and Nigeria [10,24,26]. Anguzu et al. conducted a study at Jinja hospital, it was shown that most of the gram negative bacteria isolated from SSI were highly resistant to first line antibiotics namely Ampicillin (90.6%), Amoxycillin (96.9%) and Chloramphenicol (100%). *S. aureus* isolates were highly resistant to Ampicillin (97%) and erythromycin (56.2%), but sensitive to gentamicin (87.5%), ciprofloxacin (68.7%) and methicillin (75%). Pseudomonas was sensitive to gentamicin (87.5%) and ceftazidine but resistant to ciprofloxacin (57.2%). These findings reflect the widespread and indiscriminate use of antibiotics, coupled with poor patient compliance and self-treatment without prescription among our patients. The majority of gram negative isolates were sensitive to meropenem while gram positive being sensitive to vancomycin and PISA; this could be explained by the fact that these antibiotics are relatively rare in the hospital and are more expensive so they are rarely misused.

Multivariate logistic regression

On multivariate logistic regression the following factors were significantly found to predict SSI; ASA physical status, Leukocytosis, Hypo-albuminemia and postoperative Hyperglycemia at 24 hours (Table 7).

Bacterial isolates and antibiotic susceptibility pattern: SSI was found in 40 patients and among these 36 (90%) patients had positive bacterial growth within 24-72 hours of incubation. The remaining 4 (10%) showed pus cell on analysis but no growth. Three out of 36 cultured specimens (8.4%) had mixed growth. Common bacteria isolated were: *Staphylococcus aureus* 10 (27.8%), *Escherichia coli* 10 (27.8%), *Klebsiella pneumoniae* 4 (11%), *Enterobacter cloacae* 3 (8.4%), *Proteus vulgaris* 3 (8.4%) while the least isolated bacteria were *Acinetobacter* spp and *Pseudomonas aeroginosa* 1 (2.7%), 2 (5.5%) respectively. Seven (70.0%)

Variable		SSI frequency				P Value
		Yes n% N = 24	No n%N=100	OR	95% a	
Preoperative BG (mmoM) Mean (SD) 5664 (1.66)	36	101 23(57.5%)	78 (78.0%)	0.482	0.283-0.819	0.007
	6-78	25 9(22.5%)	16 (16.0%)			
	78-11.1	14 8(20.0%)	6 (60%)			
Postoperative BG at 12hrs (mmoM) Mean(SD) 7264 (217)	36	527 (17.5%)	45 (45.0%)	0.515	0.340-0.782	0.002
	67.8	5116 (40.0%)	35 (35.0%)			
	78-11.1	2813 (32.5%)	15 (15.0%)			
	>11.1	94 (10.0%)	5 (5.0%)	0.712	0.155-3.281	0.663
Postoperative BG at 24 hr (mmoM) Mean (SD) 7246 (1.74)	36	386 (15.0%)	32 (32.0%)	0.495	0.305-0.804	0.005
	6-78	6719 (47.5%)	48 (48.0%)			
	78-11.1	3011 (27.5%)	19 (19.0%)			
	>11.1	54 (10.0%)	1 (1.0%)	0.018	0.101-0.984	0.023
Post operative BG at 48 hr (mmoM) Mean (SD) 524 (1.49)	< 3	145 (12.5%)	9 (9.0%)	0.581	0.310-0.994	0.007
	36	10122 (55.0%)	79 (79.0%)			
	6-78	168 (20.0%)	8 (8.0%)			
	78-11.1	95 (12.5%)	4 (4.0%)			

Note: BG: Blood Glucose

Table 6: Glucose pattern.

Variables	Crude			Adjusted		
	OR	93%CI	P value	OR	95%CI	P value
ASA	0.381	0.246-0.588	0001	0.483	0.251-0.931	0.030
WCC	0.238	0.107-0.588	0.001	0.240	0.066-0.870	0.030
Albumin	13.489	5.162-35.250	0.001	9.466	2.597-34.502	0.001
BG levels post-opat 24hr	0.495	0.305-0.804	0.005	1.259	1.314-13.971	0.024

Table 7: Multivariate logistic regression model.

Escherichia coli and 3 (75%) *Klebsiella pneumoniae* were found to be ESBL producer respectively that is resistant to the first, three generations of cephalosporins. Most of these ESBL producing strains were isolated from the patients who underwent abdominal operations. MRSA was detected in 4 (40%) of *Staphylococcus aureus* of which one patient had undergone appendectomy, while 3 from ORIF & laminectomy. The resistance rates to ceftriaxone, Ampiclox and Flucomax and ciprofloxacillin were 86%, 80% and 74% by *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus* respectively. All bacteria were sensitive to Vancomycin, Amikacin and Meropenum.

Study limitations: Our study only covered a limited period of 6 months and thus may not account for random or seasonal variation (eg., changes in epidemiology during the dry or rainy season). The commonness use of more than one broad-spectrum antimicrobial agent in all patients may have affected our results in several important ways. Given the observed superior outcome associated with the use of prophylactic antibiotics administered immediately prior to surgical incision [43]. On the other hand, the prolonged use of antibiotics in the postoperative period may decrease the incidence of, and the ability to, detect SSI. Overall, given these constraints, our study is more likely to have underestimated the true prevalence of SSI. This study was limited by the fact that the patients were from a single hospital results and diabetic patient were not investigated. The relative contributions of endogenous glucose production and exogenous glucose supply to blood glucose and other measures could not be identified because our study did not include glucose infusion and par-enteral/ oral feeding.

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