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## Research Article

# Surgical Site Infection: The Rate and Antimicrobial Sensitivity Pattern in Electively Operated Surgical and Gynecological Patients at Kilimanjaro Christian Medical Centre, Northern Tanzania

## Abstract

**Background:** Surgical site infections are dreaded by many as they impose a greater economic costs, morbidity and mortality that in developing countries place a burden on an already burdened healthcare system. In Tanzania previously studies done in different centers reported high rates of Surgical Site Infection. This study aimed to quantify in a low income, tertiary hospital, the rate of Surgical Site infections, microorganisms implicated and their respective sensitivity pattern to local antibiotics, and associated perioperative risk factors in electively operated surgical and gynecological patients at Kilimanjaro Christian Medical Centre.

**Method:** 301 patients admitted for elective procedures in the surgical and gynecological units were enrolled consecutively after consenting for the study. A standardized data collection form was used to record patients' information on perioperative risk factors. Patients were followed up in surgical outpatient clinic up to one month post discharge. Swabs from wounds showing signs of infection were taken for culture and sensitivity and processed at the laboratory as per standard operating procedures.

**Results:** Out of a total of 301 patients, 181 patients were from general surgical ward and 115 from gynecological wards. Females were more than males (3:1) with most, 43.9% within the age group 40 to 60 years. Overall, 21.3% of the patients developed surgical site infection. 71 organisms were isolated. S. Aureus species were the leading cause of surgical site infections making 52% of the total isolates. Most of the gram positive organisms were resistant to ampicillin, the common antibiotic used in the gynecology unit. Contaminated wounds were 10 times more likely to develop surgical site infections, and clean contaminated wounds five times when compared to clean wounds. Duration of procedure, Surgeons skills, wound class and number of people in theater showed significant association with surgical site infection, however only wound class and duration of procedure remained statistically significant after a multivariate analysis.

**Conclusion:** We found an SSI rate of 21.3%, slightly higher than previous studies in the same center. The wound class and duration of procedure remained significant risk factors after logistic regression analysis. As with other studies, S. Aureus was the most common causative organism for SSI isolated from our study.

## Introduction

Surgical site infection (SSI) is among the most common Healthcare Associated infections (HAIs) accounting for 13% of all HAIs in hospitalized patients in the USA [1]. SSI has been found to be a major cause of morbidity and mortality resulting in a 3% mortality rate that has been reported in the

USA [2]. Furthermore, SSI is increasingly used as a measure of the quality of patient care by surgeons, infection control practitioners and health planners [3].

The magnitude of surgical site infection varies from developed to developing countries as the quality of health services differs in these various settings. In developed countries

such as the USA, the incidence of surgical site infections was estimated to be 1.9% whereas in developing countries such as India, the incidence is estimated at 8.75% [4,5]. In Africa surgical site infections have been estimated to have an incidence as high as 27.9% [6,7].

In Tanzania past studies have reported different rates, ranging from 35% in Muhimbili National Hospital to 19.1% in KCMC [8–11]. This variability noted, compounded with limited publications, prompts for further research into the magnitude of the problem in various settings as well as noting trends in SSI over time.

Various perioperative risk factors have been associated with acquiring SSIs. They include patient related factors and surgery related factors [12]. Antibiotic therapy plays a crucial role in prevention of SSI. Therefore the choice of antibiotics in both prevention and treatment of SSI should consider the common pathogens responsible for SSIs [12].

Surgical site infections are diverse in terms of the trend of microbial agents involved. Different microbes have been listed with *Staphylococcus aureus* being the most common causative agent of SSI [13]. Other microbial agents which have been regularly isolated include gram negative bacilli, coagulase-negative *Staphylococci*, *Enterococci* species and *Escherichia coli* [14,15].

Identification of specific modifiable risk factors for SSIs can aid the development of prevention strategies, targeting risk practices especially in countries with limited resources and thus reduce morbidity, mortality and health care cost associated with SSI [16,17]. This study was done to determine the SSI rate, antibacterial sensitivity pattern and associated perioperative factors in electively operated patients in surgical and gynecological units at KCMC.

## Methodology

A hospital based prospective cohort study was done between July 2013 to March 2014. The study center was KCMC, a referral hospital with 630 official beds that caters for over 15 million people in Northern Tanzania [18]. Gynecological and general surgery patients who were operated under elective basis within the study period were included. Patients who consented for the study were consecutively enrolled and followed up for 30 days post-surgery. Demographic characteristics, category of surgery and wound class, occurrence of surgical site infection, culture status, culture results on antibiotic sensitivity were recorded using standardized data collection form. Wound specimens (Swab) were collected aseptically from wound that showed signs of SSI according to CDC criteria [19]. Wound specimens were processed as per standard operative procedures, culture and antibiotic sensitivity testing was done to positive cultures against specific antibiotics commonly available at KCMC, for both gram positive and gram negative organisms.

Data analysis: SPSS version 20 was used. Frequencies and percentages were used for descriptive statistics. The association between the exposure of interest (perioperative factors) and outcome (Surgical site infection) was obtained using a chi

square test, and a P value of  $< 0.05$  was considered statistically significant. The likelihood ratio was obtained by use of odds ratio. A logistic regression model was done to identify the risk factors for SSI.

## Results

A total of 301 patients were enrolled in a period of 8 months. 5 patients were lost follow up, leaving 296 patients who were followed up for the outcome of interest. 181 patients were from general surgical ward and 115 from gynecological wards. Females were more than males (3:1) with the majority of patients (43.9%) within the age group of 40 to 60 years [Table 1].

A total of 63 patients developed SSI, with an overall rate of 21.3%. 55% of all SSI occurred in gynecological patients with a rate of 30.4% (35/115) and OR 2.3 (1.36– 4.21) as compared to a rate of 15.5% in general surgical patients [Table 2]. A total of 71 organisms were isolated with some wounds showing polymicrobial infection (Figure 1). *S.aureus* species were the leading cause of SSI accounting for 52% of SSIs followed by *E.coli* 11%, *Pseudomonas* species 10%, *Proteus* species 9% and *Klebsiella* species 7%. Most of the gram positive organisms were resistant to ampicillin and cotrimoxazole. Ceftriaxone, ciprofloxacin and gentamycin were effective but with some organisms showing resistance [Table 3].

Clean contaminated wounds contributed more than half of the SSI. However when compared to clean wound, contaminated wounds were 10 times more likely to develop SSI followed by clean contaminated wounds (OR 10 and 5.3 respectively). Again, majority of the SSI (88.9%) occurred in patients whose operative time was beyond one hour. Patients whose operative time was more or equal to 3 hours were 2 times more likely to develop SSI as compared to those with in 1 hour [Table 2].

About 30% (n=117) of patients who got prophylactic antibiotics (ampicillin) developed SSI as compared to 15.6% (n=179) who didn't get prophylactic antibiotics. Although it

**Table 1:** Demographic characteristics of participants (N=296)

Variable	Frequency (%)	SSI	
		Yes	No
<b>Sex:</b>			
Male	76(25.7)	14(18.4)	62(81.6)
Female	220(74.3)	49(22.3)	171(77.7)
Total	296(100.0)	63(21.2)	233(78.7)
<b>Age group (years):</b>			
<20	25(8.4)	1(4)	24(96)
21-40	101(34.1)	16(15.8)	85(84.2)
41-60	130(43.9)	37(28.5)	93(71.5)
61-80	37(12.5)	9(24.3)	28(75.7)
81-100	3(1.0)	0(0)	3(100)
Total	296(100)	63(21.2)	233(78.7)
Median *(IQR)	43 (34-52)		
*Inter Quartile Range			

appears that prophylactic antibiotics are not protective in this study, this association is no longer apparent after accounting for other factors suggesting a confounding effect [Table 3].

SSI was less likely to occur in theater with few people ( $\leq 8$  people), rate 17.8% (n=56) with an OR of 0.767 (0.363 -1.62) as compared to other theaters with more than 8 people (rate 22.1%; (n=240)) during the procedure. This was not statistically significant. Also Patients who were operated by consultant surgeons were less likely [OR =0.5 (0.19-1.34)] to develop infection as compared to senior and junior residents [Table 2], again showing no statistically significant association.

On controlling for confounders, wound class OR 2.278 (1.366 -3.801), P value 0.002, and duration of procedure OR 1.530 (1.001 -2.337), P value 0.049 were found to be significantly associated with SSI [Table 4].

### Discussion

SSI continues to be a significant problem for surgeons worldwide. This study that looked into surgical site infection

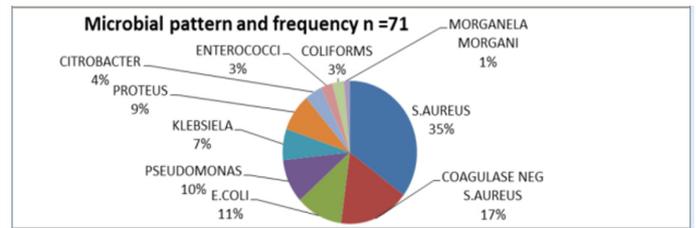


Figure 1: Microbial pattern and frequency (N=71).

in a referral hospital in Northern Tanzania, a low income country showed an overall SSI rate of 21.3%. A previous study done in the same centre in 2003 reported an SSI rate of 19.4% [8]. Contrary to the previous study, we included gynecological surgeries, which proved to have a significantly higher (30.4%) rate of SSI compared to general surgery (15.5%) in our setting. Hence taking into account of the surgical cases only, according to these studies, the rate of SSI has not appeared to increase in ten years. Furthermore, previous studies done in 2006 and 2010 within the country reported even higher rates of 24.1% in St. Francis Designated Hospital Ifakara and 35% at Muhimbili National Hospital respectively [11,13].

We note the different SSI occurrence rates observed in the general surgical and gynecological departments. There are two main reasons that could explain the observed SSI rate difference in the two departments. The first is that most of the elective procedures in the gynecological cohort of patients in this study were clean contaminated procedures (total abdominal hysterectomy and tubal-ovarian surgeries), a factor which is known to have a higher risk of progressing into a SSI compared to clean procedures [4,12,20-22]. The second reason was the finding that the prophylactic antibiotic used is now found to be less effective due to a higher resistance trend shown by the microbes. Prophylactic antibiotics play a role in reducing SSI, therefore ensuring adequate cover of the appropriate antibiotic according to local profile is paramount [21]. In this study, ampicillin was the major antibiotic given in the gynecological patients which was found to be less effective to the microbes identified. Possibly this is one of the major contributors to the rate of SSI seen in gynecology department (on top of the increased risk due to wound class). The finding that those who were given antibiotics were more likely to develop SSI in this study can be attributed to this factor, given the ineffective antibiotics administered with the microbial resistance. The general surgery department at the time of this research did not have a clear protocol on administering antibiotics hence difficult to quantify the effect of prophylactic antibiotics for this group.

Several factors tallied with what is already known on risk factors for SSIs. We found that number of people in theatre, surgeon's skills, duration of procedure and wound class all affected the rate of SSI [12,22]. Only the last two factors remained statistically significant in multivariate analysis. The duration of procedure was directly proportional to SSI risk and

Table 2: Perioperative factors for SSI (N=296)

	SSI		Total	OR(95% CI)	P-value
	YES N (%)	NO N (%)			
Department					
General Surgery	28 (15.5)	153 (84.5)	181		
Gynecology	35 (30.4)	80 (69.6)	115	2.391(1.36-4.21)	0.002
TOTAL	63 (21.3)	233 (78.7)	296		
Surgeon's skills					
Junior residents	8(12.7)	27(11.6)	35(11.8)		
Senior residents	42(66.7)	119(51.1)	161(54.4)	1.19 (0.50-2.83)	0.692
Consultants	13(20.6)	87(37.3)	100(33.8)	0.50 (0.19-1.34)	0.168
Total	63	233	296		
People in Theatre					
<8	10(15.9)	46(19.7)	56(18.9)	0.77 (0.36 - 1.62)	0.487
>8	53(84.1)	187(80.3)	240(81.1)		
TOTAL	63	233	296		
Prophylactic antibiotics given					
Yes	35(29.9)	82(70.1)	117(100)	0.43 (0.24 - 0.76)	0.003
No	28(15.6)	151(84.4)	179(100)		
Total	63	233	296		
Wound Class					
Clean	21(33.3)	122(52.4)	143(48.3)		
Clean contaminated	35(55.6)	107(45.9)	142(48.0)	5.3 (1.47-19.36)	0.005
Contaminated	7(11.10)	4(1.70)	11(3.70)	10 (2.7-37.7)	<0.001
Total	63	233	296		
Operative duration					
≤1 Hour	7(11.1)	48(20.6)	55(18.6)		
2 Hour	30(47.6)	112(48.1)	142(48.0)	1.8 (0.75-4.47)	0.17
≥3 Hour	26(41.3)	73(31.3)	99(33.4)	2.4(0.98-6.07)	0.05
TOTAL	63	233	296		

**Table 3:** Bacteria sensitivity to available antibiotics.

Bacteria	No	Ampicillin		Ceftriaxone		Ciprofloxacin		Erythromycin		Cotrimoxazole		Gentamycin	
		S	R	S	R	S	R	S	R	S	R	S	R
Gram Positive													
S.AUREUS	25	15/25	10/25	23/25	2/25	22/25	3/25	14/25	11/25	15/25	10/25	-	-
COAGULASE NEGATIVE S.AUREUS	12	5/12	7/12	8/12	4/12	10/12	2/12	9/12	3/12	8/12	4/12	-	-
ENTEROCOCCI	2	2/2	0/2	2/2	0/2	2/2	0/2	2/2	0/2	2/2	0/2	-	-
Gram Negative													
E.COLI	8	-	-	4/8	4/8	5/8	3/8	-	-	-	-	6/8	2/8
PSEUDOMONAS	7	-	-	6/7	1/7	7/7	0/7	-	-	-	-	5/7	2/7
KLEBSIELLA	5	-	-	5/5	0/5	5/5	0/5	-	-	-	-	4/5	1/5
PROTEUS n	6	-	-	5/6	1/6	5/6	1/6	-	-	-	-	6/6	0/6
CITROBACTER	3	-	-	2/3	1/3	3/3	0/3	-	-	-	-	0/3	3/3
COLIFORMS	2	-	-	1/2	1/2	2/2	0/2	-	-	-	-	1/2	1/2
MORGANELA	1	-	-	1/1	0/1	1/1	0/1	-	-	-	-	1/1	0/1

**Table 4:** Logistic regression model for factors associated with SSI

Variable	OR(95% CI)	P value
Number of people in theater	1.113(0.515 – 2.408)	0.785
Duration of procedure	1.530(1.001 -2.337)	0.049
Surgeon's skills	0.698(0.445 -1.095)	0.118
Wound class	2.278(1.366 -3.801)	0.002

showed increasing risk of SSI with increased operative time that was statistically significant with an operation time of 2 hours or more as compared to  $\leq 1$  hour. This is expected and demonstrated elsewhere [22]. In a multivariate analysis, we found that the two independent predictors of SSI in this cohort were the wound class ( $p=0.002$ ) and the duration of procedure ( $p=0.049$ ). Fehr et al observed a longer duration of the operation to be significant risk factor for SSI [23] Surgeon's skills and number of people in operating theater during the procedure did not continue to be important factors in multivariate analysis showing there were other factors contributing to this effect.

## Conclusion

SSI rates were more likely to occur in Gynecological patients than General surgical patients. This may be attributed to the difference in wound class in gynecological procedures clean contaminated versus relatively more clean surgeries for general surgery procedures. The observed high rates of SSI demands a change in the practice and preventive measures on the perioperative factors. A review of antibiotic protocols, to using more seemingly effective antibiotics in our center has been advised. The study outlines important challenges and identifies factors in our environment and similar settings that can provide guidance and thus must be considered in the perioperative period.

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