ORIGINAL ARTICLE

PATTERN OF PATHOGENS AND THEIR SENSITIVITY ISOLATED FROM SURGICAL SITE INFECTIONS AT THE AGA KHAN UNIVERSITY HOSPITAL, NAIROBI, KENYA

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ABSTRACT

***BACKGROUND:** In low income countries, surgical site infections (SSIs) are costly and impose a heavy and potentially preventable burden on both patients and healthcare providers. This study aimed to determine the occurrence of SSI, pathogens associated with SSI, the antibiogram of the causative pathogens and specific risk factors associated with SSI at the hospital. **METHODS:** Two hundred and sixty-eight respondents admitted for general surgical procedures (other than neurological and cardiothoracic surgeries) at the Aga Khan University Hospital were eligible to take part in the study. Post-surgery patients were observed for symptoms of infection. Follow ups were done through the consulting clinics, breast clinic and casualty dressing clinic by a team of surgeons. In cases of infection, pus swabs were collected for culture.*

***RESULTS:** SSI incidence rate was 7.0%, pathogens isolated from SSI included gram negative enteric bacilli and S. aureus which was the most prevalent bacterial isolate. Only one isolate of MRSA was found and all staphylococci were susceptible to Vancomycin. Preoperative stay ≥ 2 days and wound class were the risk factors associated with SSI.*

***CONCLUSION:** The SSI incidence rates (7.0%) observed in this study were relatively lower than the ones documented in other studies in Kenya. S. aureus is the most prevalent pathogen associated with SSI. Similar to findings from other studies done in the region; prolonged hospital stay and dirty wounds were the risks associated with postsurgical sepsis at the hospital.*

***KEYWORDS:** Surgical sites, Infection, Surveillance, Antibiotics*

INTRODUCTION

Post-operative infections have always been a feature of human life. Sepsis in modern surgery continues to be a significant problem for healthcare practitioners across the globe. Patients that are undergoing surgery or surgical procedures are at risk of acquiring infections at the site of incision as a result of the same surgical procedure. Surgical site infections (SSIs) are real risks associated with any surgical procedure and represent a significant burden contributing to morbidity and mortality, and increased cost to health services around the world (1).

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SSI remains one of the critically serious problems in post-operative complications, constituting approximately 20% of all of health care-associated infections (2).

Although data on SSI in Kenya is scant, reports indicate that the situation is not that good. Reports from studies in Nigeria, Ethiopia, Sudan, Tanzania and some of the Kenyan hospitals are in harmony in terms of indicating that the situation warrants more attention (3-8).

Although surgical site infection is a relatively serious problem in our health institution, there are scanty published reports on the bacterial pathogens that are involved in SSIs in our local hospitals. The sporadic reports from the public sector hospitals are mainly from the microbiology laboratory records which may not show the complete clinical picture. Paucity of published data on risk factors for SSIs has impacted negatively on management of patients particularly in the resource strained setup. Data from this study could be used to benchmark for a large scale study that could be useful for policy makers to make informed decisions on issues of infection control pertaining to surgical wound sepsis.

The objective of this study was to determine the incidence of SSI, the bacteria isolated, their antimicrobial susceptibility patterns and the risk factors associated with surgical site infections (SSIs) among patients undergoing surgery at the Aga Khan University Hospital, Nairobi (AKUH-N).

MATERIALS AND METHODS

Study Population: Two hundred and sixty-eight (268) successive adult patients who were referred for surgery to the Aga Khan University Hospital, Nairobi between March 2008 and May 2009 and who had not undergone any surgical procedure in the previous one month were recruited into this study. This study excluded patients who were referred for surgery out of disease complications that were being managed and those on multiple antimicrobial exposures due to chronic care prior to the surgical procedure. All diagnostic surgical procedures were also excluded.

Pre-operative, intra-operative, post-operative and management related factors were recorded in detail on a structured questionnaire. Antibiotic prophylaxis was administered according to the institutional policy. The surgical sites were examined on the 2nd post-operative day and then daily for pain, redness, warmth, and swelling and purulent drainage at the incision site. SSIs were diagnosed and defined by the surgeon according to the CDC definition (10). All patients' charts, including laboratory reports were reviewed six times a week. Post-discharge examination of the surgical site was performed for all patients in the outpatient clinic for any evidence of SSIs. All patients were reviewed at follow-up clinics after seven days after discharge and other subsequent follow-ups were carried out at the consulting surgical clinics, breast clinic and casualty dressing clinic for the purpose of SSI surveillance. The follow-up process involved four consultant surgeons assisted by two resident surgeons and a team of infection control nurses. The surveillance was extended for up to 30 days after surgery.

Immediately on admission to the hospital, surveillance cultures were performed by swabbing the anterior nares, axilla, groin and perianal regions. Pus swabs were collected from infected surgical sites suspected of SSI and transported to the laboratory in Stuart's transport medium. Culture was done using standard bacteriological procedures. Bacterial identification was done by colony morphology analysis, Gram stain, routine biochemical tests and analytic profile indexing (bioMerieux, Inc., Hazelwood, MO). Susceptibility testing was done using the disk diffusion technique according to CLSI 2009 guidelines (11).

Standard operating procedures for sample collection, transport, culture and susceptibility testing for isolated organisms were followed to ensure procedural quality. *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 25923 and *Enterococcus faecalis* ATCC 29212 were used as control organisms. The microbiology laboratory at the Aga Khan University Hospital is a participant in UKNEQAS program in addition to being an internationally accredited laboratory (ISO 15189 -2007).

Data were analyzed using SPSS version 17.0. Descriptive statistics was used to show simple frequencies and means. The chi-square test was used to determine the relationship between the dependent and the independent variables.
Institutional approval was obtained and the study was conducted according to the ethical guidelines of the declaration of Helsinki as revised in 2000 (9). All subjects provided written informed consent before entering the study. No one was recruited solely for the purpose of the study; results obtained were used in the improved management of the patients.

RESULTS

Two hundred and sixty-eight respondents were enrolled, 262 were followed through one month, and 6 were lost during follow-up. The respondents had a mean age of 38yrs; median age of 37 years and modal age of 45 years. More SSI cases were noted in adult patients (above 30 years) than younger patients below (30 years). A total of 189 females and 79 males were recruited in the study. Out of these, 24 (13.6%) of the female and 15(18%) of males patients developed SSI, although there was no statistically significant correlation between sex and SSI (Table 1).

Table 1: Incidence rates of surgical site infection

				Frequency	**Incidence %**	***p ≤0.05***
Overall		All infections after surgery		39(268)	14.60	
		True SSI		12(171)	7.00	
Wound class	**Class I**	Clean wound surgery		5(91)	5.50	0.506
	Class II	Clean contaminated wound surgery		7(80)	8.80	0.613
	Class III	Contaminated wound surgery		6(30)	20.00	0.09
	Class IV	Dirty wound surgery		20(67)	29.90	0.003
Sex		Male		15(79)	18.90	0.082
		Female		24(189)	12.70	0.075
Operation Sites		Abdominal		10 (39)	25.64	0.093
		Neck		2 (38)	5.26	1.348
		Thorax		7 (39)	17.95	0.276
		Head		0(40)	0.00	-
		Perineum		10(39)	25.64	0.093
		Upper Limbs		3 (39)	7.69	0.308
		Lower Limbs		7 (39)	17.95	0.543
BMI		≤18.4		5(74)	6.76	0.073
		18.5-24.9		14(158)	8.86	0.098
		≥25		20(36)	55.56	0.156
Preoperative operative stay		Less than a day		4(23)	17.39	0.135
		1 day		14(178)	7.87	0.106
		2 days		5(15)	33.33	0.002
		3 days		3(12)	0.25	0.05
		4 days		2(2)	100.00	0.04
		5 days		3(3)	100.00	0.048
		7 days		2(4)	50.00	0.037
		> 7days		6(30)	20.00	0.024
ASA Grade scores			ASA Grade 1	27(197)	13.71	0.079
			ASA Grade 2	9(46)	19.56	0.084
			ASA Grade 3	3(25)	12.00	0.068
Intraoperative Prophylaxis		No		25(190)	13.16	0.459
		Yes		14 (78)	17.95	0.067

***Key**
SSI occurence (number of surgery in the category)
True SSI Rate = (SSI occurrence in Clean and clean contaminated/Total Clean and Clean contaminated Surgical procedure X 100)

Table 2: Bacteria isolated from the study subjects

	Preoperative culture				Intraoperative	Postoperative
Organisms	**Nasal**	**Axilla**	**Groin**	**Perianal**		*n* =39
Coagulase negative *Staphylococcus*	94	62	20	0	1	6(15.4%)
E. coli	0	0	8	58	2	5(12.8%)
S. aureus	34	27	0	0	1	12(30.8%)
Klebsiella spp	1	0	2	10	0	5(12.8%)
Kluyvera spp	0	0	5	8	0	5(12.8%)
Citrobacter frendii	0	3	2	0	0	0 (0)
Enterococcus spp.	0	0	8	5	0	0 (0)
P. aeruginosa	0	0	1	0	0	4 (10.3%)
Proteus spp.	0	0	0	4	0	0 (0)
Acinetobacter spp.	0	0	0	1	0	0 (0)
E. cloacae	0	0	0	0	0	1(2.6%)
Serratia marscence	0	0	0	0	0	1 (2.6%)
Total	**129**	**92**	**46**	**86**	**4**	**39**

Table 2 shows the frequencies of bacterial isolates from three stages of samples: Preoperative (Nasal, Axilla, Groin and Perianal), Intra-operative and Postoperative. Coagulase negative staphylococci showed high frequency in preoperative samples, *E. coli* in intra-operative and *S. aureus* in postoperative samples. Thirty-nine (39) cases of SSI were detected, 29 of the cases were culture positive, and 3 of the cases had multiple organisms (*S. aureus* with Coagulase negative *staphylococci*; *S. aureus* with *E. coli; Klebsiella spp* with *E. coli*). Repeat samples were excluded from the analysis. In 3 cases of SSI, *S. aureus* isolates with the same antibiogram were isolated from both nasal swab and pus swab, indicating a possible case of nasal carriage resulting in endogenous infection. Also, in one case of SSI, a *P. aeruginosa* isolate with the same antibiogram was isolated from the groin swab and surgical site pus swab. The preoperative cultures were included to show the relationship between bacteria isolated from the SSI and bacterial carriage by the respondents.

Table 3 shows the resistance patterns of S. aureus and CN staphylococcus on selected antibiotics as outlined by AKUH (N) protocols for first line testing for gram positive.

Table 3: Antibiotic susceptibility pattern for S. aureus and CN staphylococcus isolated from SSI

	Frequency of Resistance	
Antibiotic	***S. aureus* (n= 10)**	**CN *Staphylococcus* (n=5)**
Ampicillin	**6 (60%)**	**4(80%)**
Doxycycline	**4(40%)**	**3(60%)**
Azithromycin	**3(30%**	**3(60%)**
Augmentin	**1(10%)**	**2(40%**
Cefuroxime	**1(10%)**	**3(60%)**
Ciprofloxacin	**5(50%)**	**1(20%)**
Chloramphenicol	**2(20%**	**2(40%**
Oxacillin	**1(10%)**	**0**
Netilmicin	**0**	**0**
Vancomycin	**0**	**0**

Table 4 shows the resistance patterns of gram negative bacteria on selected antibiotics as outlined by AKUH(N) protocols for first and second line testing for gram negative (*P.aeruginosa* was tested on second line antibiotics while the rest were tested on first line for gram negative bacteria).

Table 4: Antibiotic susceptibility pattern for gram negative bacteria isolated from SSI

	Frequency of Resistance			
Antibiotics	*Kluyvera spp.(n=4)*	*E. coli(n=4)*	*Klebsiella spp.(n=3)*	*P. aeruginosa(n=4)*
Cotrimoxazole	**0(0%)**	**3(75%)**	**2(67%)**	-
Doxycycline	**3(75%)**	**3(75%)**	**1(33%)**	-
Augmentin	**2(50%)**	**3(75%)**	**2(67%)**	-
Cefotaxime	**2(50%)**	**1(25%)**	**2(67%)**	-
Chloramphenicol	**1(25%)**	**2(50%)**	**1(33%)**	-
Cefuroxime	**1(25%)**	**2(50%)**	**0(0%)**	-
Ciprofloxacin	**1(25%)**	**2(50%)**	**0(0%)**	**3(75%)**
Gentamicin	**1(25%)**	**2(50%)**	**2(67%)**	**2(50%)**
Tazo-piperacillin	-	-	-	**3(75%)**
Cefepime	-	-	-	**2(50%)**
Ceftazidime	-	-	-	**2(50%)**
Imipenem	-	-	-	**2(50%)**
Piperacillin	-	-	-	**2(50%)**
Ceftriaxone	-	-	-	**1(25%)**

Key

E. cloacae and *Serratia marcescens* susceptibility pattern not included because only one (1) of each was isolated in SSI

- Not tested

DISCUSSION

It was noted that the true incidence rate of SSI at the hospital was 7.0%. The findings of this study were at variance with the findings of a study by Brown *et al.,* (12) in Russia which reported a 9.5% incidence and Mitchell *et al.* (13) in Australia that reported an incidence rate of 10%. A study in Bolivia by Soleto *et al.* (14) reported an incidence rate of 12% whereas in Sudan, Abdalla *et al.* (3) reported a 13.8% SSI incidence rate; Ericksen *et al*., Tanzania reported SSI rate of 19.4% in 2003 (15).

Although the findings of the study are at variance with most SSI studies reviewed, the relatively low incidence rates observed were comparable with study findings by Petrosillo *et al.* (16) in Italy who reported the SSI incidence rate of 5.2% in 2008, and findings from the study by Fiorio *et al.,* in 2006 that reported incidence of SSI of 5.2% in 100 operations (17). Variable occurrence rates were observed in different groups in this study. Incidence rate among females was found to be lower than among males. It was, however, difficult to establish the reason for the variation, although this observation was also reported from a study by Brown *et al.,* (12) in Russia. It was proven that the SSI rate was higher in dirty wounds class than in any other class. These findings confirm that the dirtier the wound is, the higher the chances of infection and are in agreement with the findings from other studies (18-20).

This study found out that the pathogens involved in SSI at the AKUHN included *S. aureus* (30.8%), *Coagulase negative Staphylococcus* (15.4%), *Pseudomonas aeruginosa* (10.4%), *Kluyvera spp.* (12.8%), *E. coli* (12.8%), *Klebsiella species* (12.8%), *Serratia marcescens* (2.6 %) and *Enterobacter cloacae* (2.6%). A report (Internal audit Report 2007) from Aga Khan University Hospital, Nairobi, Microbiology section, agrees with the findings of this study in that the most prevalent pathogen isolated from the pus swabs taken from patients with postoperative history is *Staphylococcus aureus.*

Table 5: Association of corneal opacity and potential risk factors, eye level analysis (n=596)

Risk factor		Total no of eyes	Eyes with corneal opacity	Percentage of eyes with corneal opacity	Univariate analysis				Multivariate analysis			
					Odds Ratio	95% CI	P value	P value for trend	Odds Ratio	95% CI	P value	P value for trend
Sex	Male	188	29	15.4	1.0				1.0			
	Female	408	44	10.8	0.6	0.4-1.2	0.14		0.7	0.3-1.4	0.314	
Age	<45	197	12	6.1	1.0			<0.001	1.0			0.001
	45-64	325	43	13.2	2.8	1.3-6.3	0.01		3.0	1.3-6.6	0.008	
	≥65	74	18	24.3	5.5	2.2-13.7	<0.01		4.9	1.9-12.7	0.001	
Education	Illiterate	549	71	12.9	1.0							
	Non formal or formal education	47	2	4.3	0.2	0.04-1.1	0.06					
	Some formal	14	0	0.0								
Time since trichiasis surgery	0-12 months	495	54	10.9	1.0				1.0			
	>12 months	101	19	18.8	2.4	1.2-4.9	0.01		2.7	1.3-5.5	0.007	
Epilation prior to surgery	Yes	442	51	11.5	1.0							
	No	154	22	14.3	1.2	0.7-2.3	0.54					
Frequency of epilation	Once a week or more	223	21	9.4	1.0			0.24				
	< Once a week	218	30	13.8	1.6	0.8-3.1	0.20					
	Not at all	155	22	14.2	1.5	0.7-3.1	0.26					
Any surgical complication	No	511	54	10.6	1.0				1.0			
	Yes	85	19	22.4	2.5	1.3-4.7	0.01		2.9	1.4-5.9	<0.01	
Recurrence of trichiasis	No	556	63	11.3	1.0				1.0			
	Yes	40	10	25.0	2.7	1.1-6.4	0.03		2.5	1.0-6.3	0.042	

The findings of other surveillance studies are in agreement with the findings of this study in terms of the distribution of the organism isolated from the surgical site. Ericksen *et al*, in Tanzania reported a prevalence of 54.5% (15), Tourmousoglou *et al* in 2008 in Greece reported *S.aureus* as the most common bacteria from infected surgical site among other pathogens recovered in that study (21); similar findings were reported in Sudan by Abdalla *et al.,* in 1998 (3).

Contrary to the findings of this study, a study done in Nigeria by Oguntibeju and Nwobu 2004 (22) reported *Pseudomonas aeruginosa* as the most prevalent pathogen recovered from SSI among microorganisms. The study revealed that *Pseudomonas aeruginosa* was the most prevalent pathogen causing sepsis post-surgery followed closely by *Staphylococcus aureus*. A study by Kohli *et al, in* 2010 at the Aga Khan University Hospital that also revealed *S. aureus* as the most prevalent organism also confirms the *S. aureus* high prevalence (23). Additionally, findings showed that infection occurred in all individuals irrespective of medical underlying condition. Intraoperative prophylaxis did not alter disease outcome as shown by the results. Varied SSI occurrence was noted on anatomical sites while abdominal and perineum surgery had the highest frequency among other anatomical sites.

Although the numbers of microorganisms isolated in the study were low, the sensitivity pattern revealed that the prevalence of MRSA (one (1) isolate) is low among the *staphylococcus* species isolated from SSI. Recent studies done at the Aga Khan University Hospital further revealed the absence of nasal carriage among the hospital care-givers (24). The MRSA prevalence in this study is comparatively lower compared with the study findings by Brown *et al.,* (12) in Russia and Thu *et al.,* (2006) in Vietnam (25).

This study found out that wound class IV and preoperative stay ≥2 days were the risk factors associated with SSI at the hospital. Different studies in the world have associated SSIs to different risk factors in varied settings. Fehr *et al.,* (4) at Ifakara Hospital, Tanzania, reported ASA score of 2 or higher, duration of surgery greater than 75th percentile of the duration for the relevant type of surgical procedure, type of intervention, and wound class. Brown *et al.,* (12), in Russia, in his study reported that emergency operation, male sex, ASA classification greater than 2, wound class greater than 2 and prolonged operation duration were significant predictors of SSI. Soleto *et al.,* (14), in Bolivia, reported that ASA scores, wound class, procedure duration and presence of drains were significantly associated with SSI. The above findings from different studies and settings identified wound class as a common risk factor associated with SSI which is similar to the findings of this study. Prolonged preoperative hospital stay is frequently suggested as a patient characteristic associated with increased SSI risk. However, length of preoperative stay is likely a surrogate factor for severity of illness and co-morbid conditions requiring inpatient workup and/or therapy before operation (26).

Pus swabs are not ideal specimens for study of SSI according to CDC definitions; however, it was clinically not practical to obtain ideal specimens from the study population due to patient acceptability and constrains of resources. Although the SSI was defined according to CDC protocol, the SSIs were not stratified according to superficial, deep and organ space. All precautions were taken to avoid skin contaminants. The lack of anaerobic culture system was additional limitation.

In conclusion, the SSI incidence rate (7.0%) observed in this study were relatively lower than the ones documented in other studies in Kenya. *S. aureus* is the most prevalent pathogen associated with SSI. Similar with the findings from other studies done in Kenya, prolonged hospital stays and dirty wounds were the risk associated with postsurgical sepsis at the target hospital.

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