Original Article

Prevalence of anaerobic bacteria in surgical site infections in Lagos University Teaching Hospital

Abstract

Background: Surgical site infection (SSI) is the second most common cause of nosocomial infection, after urinary tract infection. Sequelae of SSI include increased healthcare costs and worse patient outcomes. There is a paucity of research studies on the impact of anaerobic organisms on SSIs in Nigeria. The aim of this study was to determine the role of anaerobic bacteria in SSI encountered at the Lagos University Teaching Hospital (LUTH). **Materials and Methods:** A total of 438 patients were consecutively recruited into this study from general surgery, obstetrics and gynaecology and paediatric units of the LUTH from 1 July through 31 December 2019. Two surgical wound specimens were collected from all patients with suspected SSIs. One was for anaerobic culture using Brucella blood agar incubated in an anaerobic jar that secured anaerobiosis using the anaerobic gas pack. The other swab was used for aerobic culture on blood agar incubated on air at 37°C. Identifications and antibiotic sensitivity testing were performed according to standard laboratory procedures. **Result:** The overall incidence of SSI in the study was 12.3%. The incidence of anaerobic SSI was 1.1%. The distribution of anaerobic infections by medical specialty unit was as follows; general surgery (1.6%), obstetrics and gynaecology (0.8%) and paediatrics (0.9%). Bacteroides species was the only anaerobic isolate. The risk factors associated with the development of SSI by multiple logistic regression analysis were duration of surgery greater than 2 h (OR 1.418; 95% CI 1.834–9.286; P = 0.001) and NNIS risk index 2 and 3 – (OR 2.165; 95% CI 2.366–32.086; P = 0.001). **Conclusions:** The prevalence of anaerobic SSI was 1.1%. Duration of surgery greater than 2 h and NNIS risk index 2 and 3 were independent predictors of SSI.

Keywords: *Anaerobic aetiology, prevalence, risk factors, surgical site infections*

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Background

Surgical site infection (SSI) is defined as an infection involving the surgical site that occurs within 30 days of the surgery (or within 1 year in the cases of orthopaedic implants), affecting the superficial incision or deep tissues of the operation site.[1,2] A study from Tanzania reported SSIs as the second most common cause of healthcare-associated infection, after urinary tract infection.[3] SSIs are associated with considerable morbidity and in some instances, mortality. Prolonged hospital stays, increased treatment costs, and adverse patient outcomes are some of the sequelae of SSI.[4] There is an overwhelming burden of SSI in developing countries because of poverty, poor infection control, high antibiotic resistance rates, and inadequate laboratory services. For instance, studies from various parts of Nigeria revealed incidence rates of SSI between 12.5% and 17.4% for SSIs[5-8]

SSIs are classified as incisional or organ space infections and can be caused by aerobic or anaerobic bacteria.[2] Incisional SSI is further classified as superficial or deep.[2] Globally, several anaerobes are increasingly recognised as important causative agents of SSI because of significant improvements in their laboratory identification.[9] In Nigeria however, the isolation of anaerobes is in its rudimentary phase as many hospitals lack the facilities and expertise.[7,8] This has affected the overall interpretation and treatment of SSI and is partly responsible for the inappropriate use of antibiotics in the nation.[8]

Anaerobic infections can involve all body systems and sites such as the abdomen, pelvis, respiratory, skin, and soft tissues.[10] Surgically important anaerobes include: *Bacteroides fragilis*, *Prevotella*

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spp., *Porphyromonas* spp., *Fusobacterium* spp. and *Peptostreptococcus* spp.[10] Risk factors for anaerobic surgical infections are patient-related or treatment-related. These include: malnutrition, anaemia, emergency procedures, inadequate/inappropriate antibiotic prophylaxis, prolonged preoperative hospitalisation/prolonged operative time, inadequate skin antisepsis, ventilation, and instrument sterilisation.[9] Several of these conditions are known to be prominent in developing countries. However, there are few reports on anaerobic SSI from these regions. Isolation of anaerobes can be time-consuming, and expensive compared to routine aerobic bacterial isolation procedures.[11] Some of these reasons may account for paucity of reports on anaerobic wound sepsis in developing countries like Nigeria.

This study was undertaken to establish our local data on the scale and susceptibility pattern of anaerobes in SSIs in various surgical specialties at Lagos University Teaching Hospital (LUTH), Nigeria. Findings from this study were needed to establish guidelines for the management of anaerobic SSIs and contribute to the planning of surveillance, prevention, and control of these infections in surgical practice.

Materials and Methods

Setting

The study was a hospital-based descriptive longitudinal survey carried out at the LUTH, Idi-Araba, Lagos. The study was conducted in the general surgery, obstetrics/gynaecology, and paediatric surgery units of the hospital from July through December 2019. Consecutive participants from these units who had surgery (elective and emergency) complicated by SSI were recruited into the study.

Definitions

SSI was defined according to Centre for Disease Control and Prevention (CDC) guidelines.[12] Patients who had surgeries at other referring hospitals were excluded. Approval for the study was obtained from the LUTH Ethics Committee (ADM/DCST/HREC/2172). Written informed consents were obtained from all participants.

Sample size

We determined the sample size for the study based on the Cochran formula:[13] $N = Z^2\, p\, q/d^2$, where N is the expected sample size, Z is the critical value at 95% confidence level (usually set at 1.96), p is prevalence, $q = 1–p$ and d is precision that is usually 5%. Using a prevalence of 17.4% for abdominal wound infection as reported by Mofikoya *et al.*,[14] this gives a calculated sample size of 220. Attrition rate for the study was calculated using the formula: $q = n/R$, where q is the attrition, and n is the calculated sample size and response rate. With an assumed 90% response rate, attrition rate $q = 244$. The estimated sample size was approximated to 250 patients.

Study participant recruitment and data collection instrument

The method of subject selection was continuous recruitment using a simple random sampling technique. Participants who had surgical operations in the units mentioned above and were admitted to the hospital were recruited for the study. Informed consent was obtained from all participants. All day surgeries were excluded.

Simple-structured questionnaires were administered to the eligible participants from which socio-demographic data, age and gender were obtained. Other relevant information obtained were the type of surgery, surgical unit involved, urgency of surgery, American Society of Anesthesiologists (ASA) score, the National Nosocomial Infection Surveillance (NNIS) risk Index, the duration of surgery, wound category, and patient-related risk factors for SSI. Prophylactic antibiotics were administered to all participants.

Sample collection, transport and processing

Two surgical wound specimens (biopsy, aspirate or wound swabs) were collected by the attending surgeon from all participants with suspected SSI, one for anaerobic culture and the other for aerobic culture. Aspirates were collected using a needle and syringe into an anaerobic transport vial (Anaerobes System, USA). Wound biopsies were taken after the surface had been cleaned with normal saline and put into Robertson's Cooked Meat Broth (RCMB), and all specimens were put in a sealable plastic bag (Becton Dickinson [BD], USA) that generates an anaerobic atmosphere. Samples collected with swab sticks were immediately cultured on Brucella anaerobic agar and put into the anaerobic jar with an anaerogen gas pack, at the patient's bedside. All samples were transported immediately to the Medical Microbiology Laboratory, LUTH for processing. Each specimen was Gram-stained, one cultured aerobically and the other anaerobically. The aerobic specimens were inoculated onto Sheep Blood agar, Chocolate and MacConkey (Oxoid, Cambridge, UK) agar plates, while Brucella blood Agar, Bacteroides bile esculin agar and Phenylethyl alcohol agar were used for anaerobic culture. Inoculated culture media were immediately placed in an anaerobic jar containing Anaerogen Gas Pak (Oxoid Ltd, UK) plus Resazurin (Oxoid Ltd) anaerobic indicator, and incubated at 37°C, for 2 days. Aerobic cultures were incubated for 18–24 h at 37°C.

Identification of anaerobic isolates

The morphology of each colony was carefully examined using a hand lens and recorded. An aerotolerance test was carried out on isolates from anaerobic plates (Brucella blood agar) to differentiate between the obligate anaerobes and facultative anaerobes (which were not processed further). Biochemical identifications of both

Gram-positive and Gram-negative anaerobes were done using VITEK 2 COMPACT SYSTEM (BioMérieux) following the manufacturer's instructions.

Susceptibility testing

The antimicrobial susceptibility test was performed using the Etest (AB Biodisk, BioMérieux). A suspension of each isolate was prepared and adjusted to 0.5 McFarland standards and with a sterile swab stick a lawn of the organism was made on 90 mm diameter Brucella blood agar and an E-test strip (bioMérieux) containing any of these antibiotics: amoxicillin-clavulanate, clindamycin, metronidazole, meropenem, and piperacillin-tazobactam was placed on the prepared plates and incubated at 37°C for 24–48 h in an anaerobic environment. The minimum inhibitory concentrations (MICs) were read at the point where the ellipse intersects the scale on the E-test calibrated strip, were interpreted as sensitive, intermediate, or resistant using the CLSI interpretative values. *Bacteroides fragilis* ATCC 25285 and *Clostridium defficile* ATCC 700057 were used as control strains for quality control.

Risk index calculation

The National Nosocomial Infection Surveillance (NNIS) risk index was calculated for each patient using the following classifications: Surgical wound class (clean/clean contaminated = 0 points, contaminated/dirty = 1 point), ASA score (1 or 2 = 0 points and 3, 4 or 5 = 1 point) and duration of surgery (operation shorter than an hour = 0–point, operation longer than an hour = 1 point). Risk stratification was obtained by combining these scores for each participant, which puts each participant into groups that allowed reasonable comparisons within and between types of operation. For ease of statistical analysis, NNIS risk index 0 and 1 risk index constituted group 1 and 2 and 3 constituted group 2.

Data analysis

The data obtained were entered into a Microsoft Excel sheet and exported to statistical software SPSS version 20 for analysis. Categorical variables were summarised as frequencies and proportions and presented as texts and tables. Quantitative variables were summarised using the mean and standard deviation. The incidence of anaerobes in SSI was calculated from the number of persons with any anaerobic SSI among all the sampled participants. Associations between independent variables such as sociodemographic variables, clinical departments, and the occurrence of anaerobic SSI were explored using bivariate analyses and a value of $P < 0.05$ was considered statistically significant. Variables that were statistically significant from bivariate analyses were explored further using multivariate analysis to identify those factors most significantly associated with the risk of infection. The p-value was set at 0.05 and results are presented with an odd ratio (OR) and a 95% confidence interval (CI).

Results

Socio-demographic and clinical characteristics of the study population

In the search for more potential positive cases, a total of 438 participants (instead of the estimated 250), were recruited for this study. There were 160 (36.5%) males and 278 (63.5%) females with a mean age of 31.55 ± 20.98 years. The majority (26.9%) of the participants were between 31 and 40 years. Most participants in the study belonged to NNIS category 2 and had 157(35.8%) contaminated wounds. Exploratory laparotomy (37.4%) was the most common procedure performed in the study [Table 1].

Incidence of SSIs in general surgery, obstetrics and gynaecology, and paediatrics

The distribution of patients according to specialty was as follows: general surgery 192 (43.8%), obstetrics and gynaecology 132 (30.1%), and paediatrics surgery 114(26.0%).

The overall incidence of SSI among all participants was 12.3 per 100 (54/438) persons. The incidence of SSI in general surgery was 14.1 per 100(27/192) persons, obstetrics and gynaecology had 10.6 per 100(14/132) persons while paediatric surgery had 11.4 per 100(13/114) persons. Among the participants with SSI, 42 (77.8%) were superficial, 7 (12.9%) were deep and 5 (9.3%) were organ SSI. However, no significant difference was observed in the rate of SSI among the units ($P > 0.05$) [Table 2]. The incidence of anaerobic SSI was 1.1% (5/438). Among the units, the incidence of anaerobic SSI was 1.6% (3/192) in general surgery, 0.8% (1/132) in obstetrics and gynaecology, 0.9% (1/114) in paediatric surgery. There was no significant difference in the rate of anaerobic SSI among the units ($P = 0.61$) [Table 2].

Anaerobic organisms isolated and their susceptibility pattern

Both anaerobic and aerobic organisms (all polymicrobial in nature) were isolated from the participants. Anaerobic organisms isolated included the following: *Bacteroides fragilis* 3(60.0%) from a deep SSI and two organ space infections in general surgery, *Bacteroides stecoris* 1(20.0%) from an organ space SSI in paediatric surgery and *Bacteroides uniformis* 1(20.0%) from a deep SSI in obstetrics and gynaecology. The anaerobes isolated was 100% susceptible to the antibiotics tested as shown in the table below with their range of MIC [Table 3]. Aerobic organisms isolated includes *Enterococcus faecalis* 2(3.2%), *Enterococcus faecum* 1(1.6%), *Staphylococcus aureus* 1(1.6%), *Staphylococcus hominis* 1(1.6%), *Staphylococcus saprophyticus* 1(1.6%), *Staphylococcus epidermidis* 4(6.5%), *Escherichia coli* 12(19.4%), *Klebsiella oxytoca* 1(1.6%), *Klebsiella pneumoniae* 20(32.3%), *Proteus mirabilis* 2(3.2%), *Proteus penerri* 1(1.6%), *Acinectobacter haemolyticus*

Table 1: Socio-demographic and clinical characteristics of the study population

Variables	Frequency (*N* = 438)	%
Gender		
Male	160	36.5
Female	278	63.5
Age group (years)		
<1	46	10.5
1–10	59	13.5
11–20	30	6.8
21–30	46	10.5
31–40	118	26.9
41–50	57	13.0
51–60	40	9.1
>60	42	9.6
Mean age (years)	31.55 ± 20.98	
Unit		
General surgery	192	43.8
Obstetrics and gynaecology	132	30.1
Paediatric	114	26.0
Risk index		
0	17	3.9
1	192	43.8
2	200	45.7
3	29	6.6
Wound category		
Clean	40	9.1
Clean contaminated	150	34.2
Contaminated	157	35.8
Dirty	90	20.5
Urgency of surgery		
Elective	262	59.8
Emergency	176	40.2
ASA score		
1	274	62.6
2	102	23.3
3	62	14.2
Types of surgery		
Abdominal myomectomy	25	5.7
Exploratory laparotomy	164	37.4
Ovarian cystectomy	4	1.0
TAH/others	11	2.5
C/S	52	11.9
Adhesiolysis+others	16	3.7
Appendectomy	25	5.7
Mastectomy	22	5.0
Colostomy	21	4.8
Hernioplasty/herniorrhaphy	18	4.1
Thyroidectomy	12	2.7
Urethroplasty	15	3.4
Open manual reduction	18	4.1
Valvectomy	35	8.0

TAH = total abdominal hysterectomy, Ex-lap+others = exploratory laparotomy + any other procedures example repair of perforated intestine, drainage of abscess, etc., C/S = caeserean section

1(1.6%), *Acinectobacter baumanii* 3(4.8%), *Acinectobacter iwoffi* 2(3.2%), *Morganella morganii* 1(1.6%), *Pseudomonas aeruginosa* 3(4.8%), *Enterobacter cloacea sp cloacea* 1(1.6%), *Enterobacter cloacea sp. disolvens* 1(1.6%), *Citrobacter freundii* 1(1.6%), *Citrobacter amalonaticus* 2(3.2%), *Providencia rettgeri* 1(1.6%) and *Providencia stuartii* 1(1.6%).

Risk factors of development of SSI using univariate and multivariate logistic regression analyses

Results of the univariate logistic regression analysis performed to ascertain the individual effects of gender, age, and other risk factors on the likelihood that participants will have SSI, showed significant values for female gender (P = 0.030), emergency surgery(P = 0.003), duration of surgery >2 h (P = <0.001), contaminated wound category (P = 0.001) and NNIS risk group 2 ($P < 0.001$). In contrast, age group, ASA score and patient-related risk factors did not correlate significantly with the development of SSI [Table 4]. Multivariate logistic regression analysis showed that the duration of surgery and NNIS risk index were found to contribute significantly to the model ($P < 0.05$) [Table 5].

Discussion

Our study showed a significant association between gender and incidence with a higher predisposition among male participants. This finding agrees with that of Alkaaki *et al*.[15] These gender differences may be due to skin colonisation that may be associated with differences in skin thickness, sebum production, and the skin PH.[16,17] Hence, SSI surveillance plays an important role in hospital infection control and quality improvement programs, with feedback on SSI rates being an important component of SSI reduction strategies.[18]

The overall incidence of SSI in this study was 12.3%. Lower incidence has been reported earlier in a study on abdominal wound infection from our centre and in a similar study from Abuja.[19] Heterogeneity in the type of surgeries complicated by SSI in these studies may explain the disparity in the data. For instance, SSI from orthopaedics and plastic surgeries which formed part of the Abuja study, was not captured by our study. However, a similar specialty-related incidence rate of SSI in general Surgery compares with findings from participants who had general Surgical operations in Abuja. Similarly, in the obstetrics and gynaecology unit, an incidence rate of 10.6% was observed which is comparable to that reported in Nnewi following Caesarean section.[5] The incidence rate of paediatric surgery in our study is comparable to that reported from Kano[20] as the surgeries were performed on the same paediatric age group. Incidence rates for SSI are known to vary from one location to the other, hospital to hospital, from surgeon to surgeon, from one surgical procedure to another, and most importantly, by the patient type, thereby making comparison very difficult.[14] The incidence of SSI in this

Table 2: Incidence of SSIs in general surgery, obstetrics and gynaecology, and paediatric surgery

Department	Patients with SSI $N = 54$ (12.3)	Patients without SSI $N = 384$ (87.7)	Total $N = 438$	χ^2	*P* Value
General surgery	27 (14.1)	165 (85.9)	192	0.987	**0.611**
Obstetrics and Gynaecology	14 (10.6)	118 (89.4)	132		
Paediatric surgery	13 (11.4)	101 (88.6)	114		
Incidence of anaerobic SSI	***N* = 5**	***N* = 433**			
General surgery	3 (1.6)	189 (98.4)	192	0.545	†**0.862**
Obstetrics and gynaecology	1 (0.8)	131 (99.2)	132		
Paediatric surgery	1 (0.9)	113 (99.1)	114		

†Fisher exact *P*

Table 3: Susceptibility pattern of anaerobes isolated

Organism/Antibiotics MIC values (S, I, R)	Amoxicillin clavulanate	Clindamycin	Metronidazole	Piperacillin tazobactam	Meropenem
Bacteroides fragilis	0.25 (S)	1.0 (S)	0.50 (S)	1.0 (S)	0.125 (S)
Bacteroides stercoris	1.0 (S)	0.25 (S)	1.0 (S)	1.5 (S)	0.25 (S)
Bacteroides fragilis	0.75 (S)	1.0 (S)	0.75 (S)	2.0 (S)	0.50 (S)
Bacteroides uniformis	0.50 (S)	0.75 (S)	1.0 (S)	1.5 (S)	0.064 (S)
Bacteroides fragilis	2.0 (S)	0.75 (S)	2.0 (S)	4.0 (S)	4.0 (S)

S = sensitive, I = intermediate, R = resistant, MIC = minimum inhibitory concentration

current study was found to be higher than incidence rates reported from high- and middle-income-countries. For instance, the reported incidence rates from the United States and Thailand were 4.7% and in the Europe an incidence rate as low as 2.5% has been reported.[21] In these climes, lower incidence of reported SSI may be attributed to better theatre environment/structure, guided policies and infection surveillance protocols are in place and effective.[21]

The prevalence of anaerobic SSI in this study was 1.1% (5/438). This is lower compared to the work done by Mofikoya *et al.*[14] with had an incidence rate of 9.7%. The lower incidence rate observed may be due to the inability to do this work in an anaerobic chamber, the shorter duration of the study period (6 months versus more than 1 year), the higher number of deep and organ space SSIs, and the exclusion of the paediatric age range in their study.

Data generated from our study showed that SSI was polymicrobial, having both anaerobic and facultative aerobic components. The anaerobes were all *Bacteriodes* spp.; namely *Bacteriodes fragilis, Bacteriodes stecoris* and *Bacteriodes unformis. Bacteriode*s spp. especially *B. fragilis* are the most common anaerobic organisms found in the gastrointestinal tract and causing SSI. Similar finding was documented by Mofikoya *et al*.[14] Most existing local studies on SSI lack reports on anaerobic components of wound infection.[5-8,19] Anaerobic organisms isolated in this study were from deep and organ SSI involving the gastrointestinal tract. This agrees with other reports that anaerobes are the predominant organisms in the gastrointestinal tract.[15,22] The anaerobes isolated were all sensitive to the following antibiotics tested: amoxicillin clavulanate, clindamycin, metronidazole, piperacillin-tazobactam and meropenem. These findings are in line with those of Kings *et al.*[23] whose test isolates (>1000 isolates) were all sensitive to metronidazole; Jamal *et al.*[24] and Glupczynski *et al*.[25] The sensitivity pattern of the anaerobes isolated in this study may not be a good representation of the anaerobic antibiogram because of the small number of isolated anaerobes. The lower incidence of anaerobes in this study may also be that the majority of the patients received metronidazole post-operatively which the anaerobes are sensitive to.

Duration of Surgery >2 h and NNIS risk Index 2 were the only significant factors associated with increased risk of SSI. Prolonged surgeries are associated with SSI due to increased duration of exposure of tissues to microorganisms in the operating room, decreasing levels of tissue antibiotic concentration and a greater chance of breach of the aseptic technique in the procedure. This was in line with many other studies.[19,22,26] Although some factors were not significant in the multivariate logistic regression analysis, they were found significant in the univariate logistic regression analysis of this study. They included gender, the urgency of surgery, and wound class.

NNIS Group 2 was found to be statistically significant for the development of SSI. This is expected because participants in risk index 2 and 3 are found in this group and they had a longer duration of surgeries, higher wound class and ASA score and these indices may represent the most important factors in the development of SSI. These findings agree with other studies.[15,27]

Table 4: Risk factors with development of SSI using univariate logistic regression analysis

Variables	Patients with SSI *N* = 54 (12.3%)	Patients without SSI *N* = 384 (87.7%)	OR (95% CI)	*P* Value
Age group (years)				
<1 (reference)	2 (4.3)	44 (95.6)	1	
1–10	9 (15.3)	50 (84.7)	2.973 (0.545–16.227)	0.208
11–20	5 (16.7)	25 (83.3)	0.751 (0.232–2.426)	0.632
21–30	12 (26.1)	34 (73.9)	0.676 (0.177–2.579)	0.566
31–40	11 (9.3)	107 (90.7)	0.383 (0.122–1.200)	0.100
41–50	7 (12.3)	50 (87.7)	1.314 (0.428–4.034)	0.633
51–60	3 (7.5)	37 (92.5)	0.965 (0.284–3.282)	0.955
>60	5 (11.9)	37 (88.1)	1.667 (0.371–7.485)	0.505
Gender				
Male (reference)	27 (16.9)	133 (83.1)	1	
Female	27 (9.7)	251 (90.3)	0.530 (0.299–0.940)	0.030*
Urgency of surgery				
Elective (reference)	22 (8.4)	240 (91.6)	1	
Emergency	32 (18.2)	144 (81.8)	2.424 (1.356–4.333)	0.030*
ASA score				
1 (reference)	35 (12.8)	239 (87.2)	1	
2	9 (8.8)	93 (91.2)	1.313 (0.612–2.819)	0.485
3	10 (16.1)	52 (83.9)	1.987 (0.759–5.202)	0.162
Duration of surgery				
≤2 h (reference)	8 (3.9)	196 (96.1)	1	
>2 h	46 (19.7)	188 (80.3)	1.796 (2.771–13.109)	<0.001*
Wound category				
Clean (reference)	2 (5.0)	38 (95.0)	1	
Clean contaminated	8 (5.3)	142 (94.7)	1.786 (0.924–3.452)	0.084
Contaminated	23 (14.6)	135 (85.4)	5.783 (1.286–26.006)	0.022*
Dirty	21 (23.3)	69 (76.7)	5.402 (2.278–12.812)	<0.001*
Patient related risk factors				
Cancer (reference)	7 (7.5))	86 (92.5)	1	
Blood transfusion	1 (10.0)	9 (90.0)	2.0E+10(0.000)	1.000
Jaundice	0	2 (100.0)	1.5E+10(0.000)	1.000
Malnutrition	5 (25.0)	20 (75.0)	2.6E+18(0.000)	0.999
Diabetes mellitus	0	4 (100.0)	6.5E+9(0.000)	1.000
Alcohol	0	1 (100.0)	2.6E+18(0.000)	0.999
Smoking	0	2 (100.0)	2.6E+18(0.000)	0.999
Steroid	1 (100.0)	0	2.6E+18(0.000)	0.999
Risk index				
1 (reference)	6 (2.9)	203 (97.1)	1	
2	48 (20.9)	181 (79.1)	2.194 (3.751–21.460)	<0.001*

SSI = surgical site infection, OR = odds ratio , C1 = confidence interval
*Statistically significant

Conclusion

The overall prevalence of SSI and anaerobic SSI in this study were 12.3% and 1.1%, respectively. General surgery has the highest incidence of anaerobic SSI, followed by paediatric surgery. *Bacteroides species* constitute the major anaerobic component and were sensitive to all the tested antibiotics. Duration of surgery greater than 2 h and NNIS risk index 2& 3 were found to be independent predictors of SSI.

Limitations of the study

The small number of anaerobic isolates could not permit a complete anaerobic antibiogram therefore more robust, sponsored and a further structured study with a larger sample size is recommended where a larger number of anaerobes will be used to determine the antibiogram in this centre.

Financial support and sponsorship

Nil.

Table 5: Risk factors for the development of surgical site infection (SSI) using multivariate logistic regression analysis

Patient characteristics	MLRA OR	95% CI (upper–lower limit)	MLRA (*P*)
Gender			
Female	–0.040	0.498–1.853	0.905
Male (reference)	1		
Urgency of surgery			
Emergency	0.337	0.704–2.783	0.337
Elective (reference)	1		
Wound category			
Contaminated	–0.087	0.171–4.931	0.920
Dirty	0.580	0.489–6.528	0.380
Clean contaminated	0.069	0.287–4.002	0.918
Clean (reference)	1		
Duration of surgery			
>2 h	1.418	1.834–9.286	0.001*
≤2 h (reference)	1		
Risk index			
2	2.165	2.366–32.086	0.001*
1 (reference)	1		

SSI = surgical site infection, OR = odds ratio, MLRA = multivariate logistic regression analysis

Conflicts of interest

There are no conflicts of interest.

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