Bacterial Agents of Surgical Site Infections in South-Western Nigeria

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Abstract

Surgical Site Infections (SSIs) are risks associated with surgical procedures and represent a significant burden in terms of morbidity, mortality and healthcare costs. Appropriate antibiotic therapy is required to reduce this burden. The aim of this study was to determine the bacterial agents responsible for these infections and their antibiotic susceptibility pattern in order to guide the initiation of empirical therapy.

Two hundred samples from surgical sites were collected over a six-month period. They were examined microscopically and cultured aerobically. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion technique. One hundred and sixty (160) bacterial isolates were recovered from culture of samples from surgical site infection. The predominant organism was *Escherichia coli*, 52(32.5%). Others were S*taphylococcus aureus* 46(28.75%; *Pseudomonas aeruginosa* 26 (16.25%); *Proteus* species 18(11.25%); *Klebsiella* species 14(8.75%); *Enterococcus* species (1.25%) and α-haemolytic Streptococci (1.25%). SSIs were most prevalent among Obstetrics and Gynaecology patients. Bacterial growth was 100% at the extremes of ages. The isolates were highly resistant to Erythromycin, Amoxycillin, Cotrimoxazole and Tetracycline, but susceptible to Ceftriaxone, Ofloxacin and Ciprofloxacin. Fluoroquinolones and Cephalosporins are the drugs of choice in the treatment of surgical site infections in this environment.

Keywords: antibiotic resistance, nosocomial infection, surgical site infections.

1. Introduction

Surgical site infections (SSI) are ranked among the most common Healthcare-Associated Infections, along with pneumonia, urinary tract infections and blood stream infections. They cause significant morbidity, increased cost of care and prolonged hospital stay[1,2,3,4].

A definite case of surgical site infection is defined as one in which there is any skin eruption or drainage at the surgical site and is positive for bacteria by culture within 60 days of a surgical procedure[5].

Surgical wound infection is a prototype of hospital-acquired infection (HAI) and constitutes a serious problem. It is therefore used as a good index of nosocomial infection. Post operative surgical site infections remain a major source of illness and a less frequent cause of death in the surgical patient [6].

SSIs are classified into incisional SSIs or organ/space SSIs, which affect the rest of the body other than the body wall layers. A simplified system of classification categorizes surgical wounds as clean, clean-contaminated, contaminated and dirty and is used to predict the rate of infection after surgery. Before the routine use of prophylactic antibiotics, infection rates were 1-2% or less for clean wounds, 6-9% for clean-contaminated wounds, 13-20% for contaminated wounds and about 40% for dirty wounds[7,8], Since the introduction of routine prophylactic antibiotic use, infection rates in the most contaminated groups have reduced drastically[9].

The level of bacterial burden is the most significant risk factor in determining the potential for and the incidence of infection and wound healing. Other important factors are virulence and invasive capacity of invading organism[10]. Surgical wound pathogens are usually bacterial and, in recent years, there has been a rise in the prevalence infections caused by Gram-negative organisms. These organisms have almost replaced *Staphylococcus aureus* in nosocomial infections [11]. It is therefore necessary to ascertain the agents of infection, especially bacteria which serve as a major and common pathogen of surgical wound infection.

The aim of this study therefore was to identify bacterial agents of SSIs and determine their antibiotics susceptibility pattern with a view to promoting prompt and effective management of such infections.

2. Methods

2.1 Study design and site

The study was conducted at Federal Medical Centre, Idi-Aba, Abeokuta, a 150 bed tertiary health hospital located in South-Western Nigeria, from June to November, 2010. A cross sectional study was carried out. All samples of surgical site infections sent to the laboratory for processing during the six-month period of the study were processed.

2.2 Specimen collection and culture

The samples were wound swab with accompanying request form which contained demographic and clinical information.

The wound swabs were taken from the site of surgical infection and immediately transported to the laboratory for processing. They were inoculated on both blood agar, and MacConkey agar plates. The MacConkey agar plates were incubated aerobically at 35^0C while the blood agar was incubated in the presence of 10% CO_2 at 35^0C. Both were incubated for up to 48 hours. Gram staining was also carried out for direct examination of the sample.

Isolates were identified initially by colonial morphology and Gram stain. Standard biochemical tests were used to confirm the isolates [12]. *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 were used as controls.

2.3 Antibiotics susceptibility testing

In vitro susceptibility of the identified organisms to the tested antibiotics was determined using Kirby Bauer disc diffusion technique [13]. Commercially available antibiotics discs containing Gentamycin 10μg, Erythromycin 15μg, Augmentin 30μg, Ceftriaxone 30μg, Co-trimoxazole 25μg, Ofloxacin 5μg, Tetracycline 30μg, Ciprofloxacin 5μg, Cloxacillin 5μg, Amoxicillin 25μg,

Cefuroxime 30µg, and Ceftazidime 30µg were used in this study. Zones of inhibition after incubation were observed and the diameters of inhibition zones were measured in millimeters using a caliper. The interpretation of the measurements as sensitive, intermediate, resistant was made according to CLSI recommendations [14].

2.4 Data processing

Data was entered into Microsoft excel and analyzed using SPSS software version 16. Frequency tables were used to summarize the data.

3. Results

A total number of 200 samples were collected from both male and female of different age groups and the percentage with bacterial growth is as shown. The male to female ratio was 1;2.5 with a mean age of 26.1 years. All samples obtained from the extremes of ages yielded bacterial growth for both male and female. Most samples were obtained from young individuals between the ages of 20 and 40.

Table1: Distribution of samples by age and sex

Age range (years)	Male		Female		Total	
	No of samples	No of isolates (%)	No of samples	No of isolates (%)	Total no of samples	No of isolates (%)
0-10	2	2(100)	2	02 (100)	4	4 (100)
11-20	4	4 (100)	08	08 (100)	12	12 (100)
21-30	12	12 (100)	42	34 (81)	54	46 (85.2)
31-40	16	11 (69)	68	46 (70)	84	60 (71)
41-50	08	6 (75)	10	2 (80)	18	8 (78)
51-60	06	3 (50)	06	2 (50)	12	6 (50)
61-70	08	8 (100)	04	2 (100)	12	12 (100)
71-80	02	2 (100)	02	2 (100)	04	4 (100)
TOTAL	58	48	142	112	200	160

Gram-negative organisms were the most common isolates among the surgical site infections pathogens with *Escherichia coli* having the highest prevalence (32.5%). This was followed by *Staphylococcus aureus,* (28.75%). Enterococcus species and α-haemolytic streptococcus species were the least observed. (Table 2).

We noted that more than half of the isolates were from the obstetrics and gynaecology patients with *Escherichia coli* and *Staphylococcus aureus* having equal frequencies. The lowest number of samples were from Children's ward where the only organisms isolated were α-hemolytic Streptococcus.

Antibiotics resistance was demonstrated by both the Gram-positive and gram-negative ones. The third generation cephalosporins and fluoroquinolnes had the highest antibacterial activity against both sets of organisms isolated. The antibacterial activity of cloxacillin and erythromycin against these pathogens was discovered to be particularly poor (Tables 4 and 5).

Table 2: Frequency distribution of isolate

Organism	No (%)
Proteus spp	18 (11.25)
Klebsiella spp	14 (8. 75)
Escherichia coli	52 (32.5)
Pseudomonas spp	26 (16.25)
Staphylococcus aureus	46 (28.75)
Enterococcus spp	02 (1.25)
α- haemolytic streptococcus	02 (1.25)
	160 (100)

Table 3: Distribution of bacteria isolated by wards.

	Ward	Obst	Ortho	Gen. Surgical	Children
		No (%)	No (%)	No (%)	No (%)
Gram Negative bacteria	*Klebsiella spp*	6 (7.0)	6 (15)	2 (6.2)	0 (0)
	P. aeruginosa	10 (11.6)	6 (15)	10 (31.2)	0 (0)
	Proteus spp	6 (7.0)	8 (20)	4 (12.5)	0 (0)
	E. coli	32 (37.2)	12 (30)	8 (25.0)	0 (0)
Gram positive bacteria	*S. aureus*	32 (37.2)	8 (20)	6 (18.7)	0 (0)
	Enterococci	0 (0)	0 (0)	2 (6.2)	0 (0)
	A-haemolytic Strept	0 (0)	0 (0)	0 (0)	2(100)
Total		86 (100)	40 (100)	32 (100)	2 (100)

Obst- Obstetrics ward
Ortho- Orthopaedics ward
Children- Paediatrics ward

Table 4: Antibiotics susceptibility pattern of Gram-positive isolates

Antibiotic	*Staphylococcus aureus* N=46	*Enterrococcus spp* N=2	*α-haemolytic Strept* N=2	**Total**
	No sensitive (%)	No sensitive (%)	No sensitive (%)	% sensitive
Amoxicllin	32(70)	2(100)	2(100)	72%
Cloxacillin	10(22)	2(100)	2(100)	28%
Cotrimoxazole	40(87)	2(100)	2(100)	88%
Erythromycin	14(30)	2(100)	2(100)	36%
Gentamycin	26(57)	2(100)	2(100)	60%
Augmentin	39(85)	2(100)	2(100)	86%
Ceftriaxone	42(91)	2(100)	2(100)	92%
Cefuroxime	38(83)	2(100)	2(100)	84%
Ciprofloxacin	43(93)	2(100)	2(100)	94%
Ofloxacin	44(96)	2(100)	2(100)	96%

4. Discussion

In our study, conducted in South-Western Nigeria, records Gram-negative organisms constituted 69% of the bacterial agents of surgical site infections and the remaining 31% was constituted by Gram-positive bacteria. There were no mixed infections as all samples had a single causative agent. This is in contrast to the findings of Giacometti et al in which mixed organisms were found in over half of the study population [5]   The predominant organism

isolated was *Escherichia coli,* as it had the highest prevalence with 32.5%. *E. coli* is one of the predominant causes of SSI and has been documented in many studies in keeping with our findings [15]. In the present study, it was more associated with Obstetric infections unlike another study in a similar environment where *Staphylococcus aureus* was the predominant organism in among their Obstetrics infections [16]

Table 5: Antibiotics susceptibility pattern of Gram-negative isolates

Antibiotic	*Klebsiella spp* N=14	*Proteus spp* N=18	*E.coli* N=52	*Peudomonas spp* N=26	**Total**
	No sensitive (%)	No sensitive (%)	No sensitive (%)	No sensitive (%)	% sensitive
Gentamycin	6(43)	4(22)	36(69)	14(54)	56.3%
Augmentin	8(57)	10(56)	42(81)	6(23)	68.1%
Ceftriaxone	12(86)	15(83)	37(71)	24(92)	83.8%
Ceftazidime	12(86)	12(67)	38(73)	20(77)	78.8%
Cefuroxime	9(64)	10(56)	14(27)	10(38)	53.1%
Ciprofloxacin	10(71)	16(89)	47(90)	18(69)	86.2%
Ofloxacin	12(86)	14(78)	40(77)	20(77)	83.8%

Several studies have reported an increasing role of Gram-negative organisms in hospital infections as opposed to the predominance of *Staphylococcus aureus* in the past [17,18, 19]. This is in keeping with our findings of a preponderance of Gram-negative bacteria as agents of surgical site infections.

Staphylococcus aureus was the most commonly isolated gram positive organism and second predominant bacteria in this study. Despite the notable shift in aetiology of SSI, this organism has remained an important nosocomial pathogen accounting for a remarkable proportion of hospital infections. Even in the present study, it had same percentage as *E. coli* among the obstetrics patients. The prevalence of *S. aureus* infection is similar to a previous report by Enweani. Oni et al. in Ibadan also had a similar finding although *S. aureus* was their most common organism.[20,21].

Although the Staphylococci have been established as the predominant organisms in

orthopaedic infections due to the skin flora being the commonest contaminating organism, our finding is quite different from this fact as *Escherichia coli* predominated even among this group of patients [22].

The other organisms isolated were *Pseudomonas species* 26(16.25%), *Proteus species* 18(11.25%), *Klebsiella species* 14 (8.75%), two *Enterococcus spp* (1.25%) and two alpha- haemolytic streptococcus species (1.25%) in similar to findings from other studies.

The Enterobacteriaceae as a group were the Gram-negative bacilli most commonly isolated from intra-abdominal infections. The two most commonly isolated species were *E. coli* and *Klebsiella spp.* These groups of organisms tend to be endemic in hospital environment, being easily transferred from object to object, they also tend to be resistant to common disinfectants and antiseptics and are difficult to eradicate in the long term playing a great role in the many hospital acquired infections [23].

This study revealed that patients at the extremes of ages had 100% bacterial growth rate. The possible explanation for this could be the established lowered immunological competence at both extremes of ages making them more susceptible to infections. Lawal *et al.* also had similar report [24].

Our study was limited by the fact that anaerobic culture was not done therefore no anaerobe was isolated. This limitation may account for the samples which did not yield any bacterial growth despite being sent based on clinical signs of surgical infection.

Antibiotic susceptibility testing revealed a high level of resistance of isolates to usual first line antibiotics like Amoxycillin, Cloxacillin and Co-trimoxazole which are the antibiotics that are most widely used in this environment. Multidrug resistant organisms have been widely reported in the hospital environment and in the aetiology of SSIs. The Gram negative bacteria were moderately sensitive to Gentamycin, Augmentin and the second generation Cephalosporins but showed higher susceptibility to the third generation Cephalosporins and Fluoroquinolones in contrast to findings from another environment [15]. The degree of susceptibility is, however, not satisfactory and these organisms should be assessed for production of Extended Spectrum Beta Lactamases. ESBL producing organisms now abound and can spread easily in the hospital environment [25]

The Gram positive bacteria, however, demonstrated a more remarkable response in terms of susceptibility to Fluoroquinolones and Cephalosporins.

Although our findings appear similar to what has been recorded in other areas, this is important as it emphasizes the fact that antibiotic resistance especially in the setting of nosocomial infection is a global phenomenon, no region is left out.
In view of our findings, the Fluoroquinolones and Cephalosporins are therefore the preferred antibiotics for effective management of patients with surgical site infections.

5. Conclusion

From this study, there is a high prevalence of multidrug resistant organisms causing SSI, a good marker of Hospital Acquired Infection (HAI). Prevention, in the form of adequate infection surveillance, ensuring standard aseptic techniques as well proper preparation and maintenance of operating room are very important in addition to antibiotic policy based on susceptibility profile of infecting agents.

Acknowledgement

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