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Antibiotic susceptibility patterns of bacteria isolates from post-operative wound infections among patients attending Mama Lucy Kibaki Hospital, Kenya

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Surgical site infections account for high mortality, morbidity, and elevated costs of treatment for surgical patients. The study sought to determine the prevalence and antibiotic susceptibility patterns of bacterial isolates from postoperative wound infections among patients attending Mama Lucy Kibaki Hospital. A cross-sectional descriptive study was carried out between October 2018 and March 2019. It included patients of all age groups with surgical site infections following general, obstetrics, and gynecological surgeries. Pus swabs were obtained aseptically from 58 consented patients with clinical evidence of surgical site infections. Gram stain, culture, biochemical tests, and antibiotic susceptibility tests were done for each pus swab. The preponderant isolate was *Staphylococcus aureus* (28.2%) followed by *Escherichia coli* (15.4%). Whereas *Methicillin-resistant S. aureus* accounted for 65.4% (n=17) of the total *Staphylococcus* species. Chloramphenicol was the most sensitive drug to all the bacteria isolates. Ampicillin and amoxycillin recorded resistance rates >90% against gram-positive and gram-negative bacteria. The majority of the gram-negative rods were highly resistant. Hence, this calls for continuous monitoring of the susceptibility patterns to determine the profile of surgical site infections bacteria isolates found in the hospitals.

Key words: Surgical site infection, antibiotic susceptibility, bacteria prevalence, Mama Lucy Kibaki Hospital.

INTRODUCTION

Surgical site infections (SSI) are a worldwide problem in surgery accounting for increased deaths, morbidity, and elevated healthcare costs in surgical patients (Badia et al., 2017; Gelhorn et al., 2018). The rates of these infections worldwide vary, with most studies observing incidence rates of between 2.6 and 58% (Rosenthal et al., 2013; Apanga et al., 2014; Kaur et al., 2017). A previous report has placed the SSI incidence rate in Kenya at 37.7% with *Staphylococcus aureus* as the main isolate (Opanga et al., 2017; Okello et al., 2018). The

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pathogens however vary between settings while exhibiting variant antibiotic susceptibility pattern. For instance *S. aureus, Pseudomonas aeruginosa* (39.13%), *Escherichia coli* and *Klebsiella pneumoniae* (25.5%) are seen as the leading cause of surgical site infection in different regions of the world (Banashankari et al., 2014; Patel et al., 2019; Nwankwo et al., 2014; Billoro et al., 2019).

An increasing proportion of these infections are due to multi-drug resistant bacteria and this has complicated the treatment of SSI (Manyahi et al., 2014). This resistance is attributed to the irrational use of antimicrobial agents which has exerted selective pressure on bacteria leading to the emergence of resistant bacterial strains (Oz et al., 2014). Moreover, the decline in antibiotic development pipeline has further complicated the treatment of SSI (Nicholson, 2019). The successful treatment of these infections depends on the correct identification of etiological agents and their antibiogram profiles. However, there is a paucity of clinical microbiological data especially in developing countries that have hampered the management of these infections (Allegranzi et al., 2011).

In Kenya and the current setting, the situation is the same concerning the paucity of this essential data. Hence, this study was done to determine the prevalence and antibiotic susceptibility profiles of bacteria isolates in post-operative wound infections among patients attending Mama Lucy Kibaki Hospital. The results are intended to help clinicians when formulating a comprehensive treatment protocol for SSIs.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional descriptive study carried out at Mama Lucy Kibaki Hospital for a period of 6 months, between October 2018 and March 2019. Mama Lucy Kibaki Hospital is a level 5 public health facility located in the eastern part of Nairobi city, Kenya.

Study population

These were surgical patients with surgical site infections. These patients were drawn from the surgical wards, maternity wards and pediatric ward.

Inclusion and exclusion criteria

The study included patients of all age groups with surgical site infection following general, obstetrics and gynecological surgeries. Those patients who did not consent were excluded.

Sampling

Patients with surgical site infection were identified by surgeons during routine ward rounds and the clinical information documented in the patient file. The same information was relayed to the principal investigator through the clinicians. The identified patients were taken through the research process and informed consents obtained. A serialized structured questionnaire was used to collect additional patient clinical data.

Sample collection

The pus swabs were aseptically obtained from 58 patients with clinical evidence of surgical site infection (drainage from an incision) within the research period. After the wound immediate surface exudates and contaminants were cleansed off with sterile moistened gauze and normal saline solution. The pus was collected using a moistened sterile cotton swab from the deep viable tissues of the wound by the Levine method (Cooper, 2010). The collected swab was then placed in a tube with Stuart transport medium and the replaced cap tightened. Two pus swabs were collected from each patient, one for gram stain and the other for culture. All the swabs were carefully labeled and transported immediately to Kenyatta university laboratory in appropriate leak-proof specimen transport bags.

Bacterial culture and identification

Upon reaching the laboratory, all the pus swabs were carefully checked and their details entered into the investigator’s booklet. Smears of the pus swabs were prepared, gram stained and examined microscopically. The other swabs from each patient were inoculated on MacConkey agar and blood agar and the inoculated plates incubated at 35 to 37°C for 24 h. After incubation, the plates were examined for growth. Colony characteristics such as swarming growth and hemolysis on blood agar, changes in physical appearance in differential media, and enzymatic activities of the organisms were used for preliminary bacterial identification. Biochemical tests such as catalase, coagulase, urease, indole, methyl red, Voges Proskauer and citrate (IMViC) tests were performed for the identification of the various bacteria.

Antibiotic susceptibility testing

Antibiotic susceptibility testing was performed on Mueller Hinton agar using various antibiotics by Kirby Bauer disc diffusion method as per standards prescribed in bacteriology (Hudzicki, 2016). Using a sterile swab, Mueller Hinton agar surface was uniformly coated with the suspension of the test organism matching 0.5 McFarland turbidity standard. Following incubation of test plates and controls at 35°C for 24 h, the plates were examined for confluent growth. *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 were used as control strains. The zones of inhibitions were determined using breakpoints provided by the Clinical and Laboratory Standards Institute and British society for antimicrobial chemotherapy (CLSI, 2016; BSAC, 2013). The following antibiotics were tested for resistance; Chloramphenicol (50 ug), Vancomycin (30 ug), Amoxycillin (30 ug), Doxycycline (30 ug), Ciprofloxacin (30 ug), Cefepime (30 ug), Ceftriaxone (30 ug), Amikacin (30 ug), Gentamicin (30 ug), Oxacillin (1 ug), Cotrimoxazole (25 ug), Azithromycin (15 ug) and Ampicillin (10 ug). These antibiotics were selected based on the availability and prescription frequency of these drugs in the study area.

Data analysis

Data were entered in excel, cleaned, and the information exported to IBM statistical package for the social sciences version 20.

Table 1. Proportions of bacteria isolated from different wound sites at Mama Lucy Kibaki Hospital.

Wound site	Types and proportions of bacteria isolates		
	Gram-positive bacteria N (%)	Gram-negative bacteria N N (%)	Total isolates N (%)
Abdomen	24(51.1)	23(48.9)	47(60.3)
Lower limbs	7(30.4)	16(69.6)	23(29.5)
Arms	1(33.3)	2(66.7)	3(3.8)
Other body regions	1(20.0)	4(80.0)	5(6.4)

Descriptive statistics; mean and percentages were determined. Pearson chi-square test was used to determine the association of social demographic data and the different bacteria isolates. P-value of < 0.05 was considered to indicate statistically significant differences. Finally, the results were presented using tables.

Ethical consideration

Ethical approval was given by Kenyatta University Ethics Review Committee (KUERC) reference no PKU/700/1772. Informed consent was obtained by the signing of informed consent forms by adults. For participants below 18 years, parents or legal guardians would sign the consent forms on their behalf. All patients' records were kept anonymous.

RESULTS

Socio-demographic data of patients

A total of 58 cases of surgical site infection were observed at the facility between October 2018 and March 2019. Of these, 19 (32.8%) were men while 39 (67.2%) were women with pediatric patients accounting for 3 (5.2%) of the total cases. The patients' mean age was 31.12 years, with the youngest and eldest patient being 7 and 61 years, respectively.

Proportion of bacteria isolated from surgical wounds

A total of 78 bacteria were isolated from the culture positive swabs, with monomicrobial and polymicrobial growth occurring in 60.3% (35/58) and 34.5% (20/58) of the swabs, respectively. Whereas only 5.2% (3/58) of the swabs were culture negative. S. *aureus* 28.2% (n=22) was the prevalent isolate followed by *E. coli* 15.4% (n=12), *Acinetobacter* species (spp.) 14.1% (n=11), *Pseudomonas aeruginosa* 9.0% (n=7), *Enterobacter* spp. 9.0% (n=7), Bacillus spp. 9.0% (n=7), *Coagulase negative staphylococci* 5.1% (n=4), Proteus spp. 5.1% (n=4), *Klebsiella pneumoniae* 2.6% (n=2), *Morganella morganii* 1.3% (n=1) and *Citrobacter freundii 1.3*% (n=1).

Most of the bacteria were recovered from the abdomen 60.3% and the lower limbs 29.5%, with the arms and other body sites accounting for 3.8 and 6.4% of the total bacteria (Table 1). The majority of these isolates were gram-negative rods 57.7% (45) with gram-positive bacteria accounting for 42.3% (33) of the total bacteria. This number was high in female patients [73.1% (57)] than male patients [26.9% (21)] but the difference was not statistically significant (p=0.136).

Antibiotic susceptibility pattern of SSI bacteria isolates

In the present study, Chloramphenicol 90.9% (n=30/33), Vancomycin 87.9% (n=29/33) and Doxycycline 75.8% (n=25/33) had the highest sensitivity rates for gram-positive bacteria. However, Azithromycin 36.4% (n=12/33) and Ampicillin (3.0%) (n=1/33) recorded the lowest sensitivity rates for gram-positive bacteria (Table 2). Cefepime, Gentamicin and Amikacin showed 100% resistance to Acinetobacter spp. and *K. pneumoniae,* respectively. Chloramphenicol 53.3% (n=24/45) was the only drug that had the highest sensitivity for gram-negative rods*.* Multi-drug resistance (resistance to ≥ 4 antibiotics) was observed with *K. pneumoniae* and *E.coli* (Table 3). Among gram-positive bacteria, *Methicillin resistant S. aureus (MRSA)* accounted for 65.4% (n=17/26) of the total Staphylococcus species (Table 2).

DISCUSSION

The present work observed monomicrobial growth in 60.3% (35/58) of the swabs that were cultured, with polymicrobial and culture negative growth occurring in 34.5% (20/58) and 5.2% (3/58) of the swabs, respectively. These results were comparable to findings from a study carried out in Nigeria which observed single growth in 48 (75%) samples, with polymicrobial growth occurring in 16 (25%) samples (Adegoke et al., 2010). Both of these studies observed a high isolation rate of bacteria, except that in the present work three swabs failed to yield any growth which could be attributed to antibiotic use prior to sample collection.

The research revealed a total of 78 bacteria with *S. aureus* as the preponderant bacteria. These results concurred with those of a similar study conducted at Moi

Table 2. Antibiotic susceptibility pattern of gram-positive bacteria at Mama Lucy Kibaki Hospital.

Types of bacteria isolates		Tested antibiotics						
		VA, 30 ug (%)	**CIP, 30 ug (%)**	**C, 50 ug (%)**	**DO, 30 ug (%)**	**AX, 10 ug (%)**	**AZM, 15 ug (%)**	**OX, 1 ug (%)**
Staphylococcus aureus	S	90.9	77.3	95.5	86.4	4.5	50.0	27.3
	I	0.0	9.1	0.0	9.1	0.0	4.5	13.6
	R	9.1	13.6	4.5	4.5	95.5	45.5	59.1
Coagulase negative staphylococci	S	75.0	100.0	100.0	50.0	0.0	25.0	0.0
	I	25.0	0.0	0.0	25.0	0.0	0.0	0.0
	R	0.0	0.0	0.0	25.0	100.0	75.0	100.0
Bacillus species	S	85.7	28.6	71.4	57.1	0.0	0.0	-
	I	0.0	42.9	14.3	14.3	0.0	14.3	-
	R	14.3	28.6	14.3	28.6	100.0	85.7	-

VA=vancomycin, CIP=ciprofloxacin, C=chloramphenicol, DO=doxycycline, AX=ampicillin, AZM=azithromycin, OX=oxacillin, S=sensitive, I=intermediately sensitive, R=resistant.

Table 3. Antibiotic susceptibility pattern of gram-negative bacteria at Mama Lucy Kibaki Hospital.

Types of bacteria isolates		Tested antibiotics								
		C 50 ug (%)	**CIP, 30 ug (%)**	**DO 30 ug (%)**	**GEN 10 ug (%)**	**COT 25 ug (%)**	**AMX 30 ug (%)**	**CPM 30 ug (%)**	**AK 30 ug (%)**	**CTR 30 ug (%)**
Morganella morganii	S	100.0	0.0	0.0	100.0	0.0	0.0	-	-	-
	I	0.0	100.0	0.0	0.0	0.0	0.0	-	-	-
	R	0.0	0.0	100.0	0.0	100.0	100.0	-	-	-
Proteus species	S	50.0	50.0	0.0	100.0	50.0	0.0	-	-	-
	I	50.0	50.0	0.0	0.0	0.0	0.0	-	-	-
	R	0.0	0.0	100.0	0.0	50.0	100.0	-	-	-
Klebsiella pneumoniae	S	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
	I	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	-
	R	50.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	-
E. coli	S	41.7	25.0	33.3	41.7	0.0	0.0	16.7	-	16.7
	I	0.0	16.7	0.0	8.3	0.0	8.3	0.0	-	0.0
	R	58.3	58.3	66.7	50.0	100.0	91.7	83.3	-	83.3
Pseudomonas aeruginosa	S	57.1	71.4	28.6	57.1	-	-	28.6	71.4	-
	I	14.3	0.0	0.0	0.0	-	-	0.0	0.0	-
	R	28.6	28.6	71.4	42.9	-	-	71.4	28.6	-
Enterobacter species	S	85.7	71.4	42.9	42.9	42.9	0.0	-	-	-
	I	0.0	14.3	0.0	14.3	0.0	0.0	-	-	-
	R	14.3	14.3	57.1	42.9	57.1	100.0	-	-	-
Acinetobacter species	S	36.4	45.5	27.3	36.4	-	-	0.0	45.5	-
	I	45.5	27.3	9.1	0.0	-	-	0.0	0.0	-
	R	18.2	27.3	63.6	63.6	-	-	100.0	54.5	-
Citrobacter freundii	S	100.0	0.0	100.0	100.0	0.0	0.0	-	-	-
	R	0.0	100.0	0.0	0.0	100.0	100.0	-	-	-

CPM=Cefepime, AK=Amikacin, CTR=Ceftriaxone, CIP=Ciprofloxacin, COT=Cotrimoxazole C=Chloramphenicol, DO=Doxycycline, GEN=Gentamicin, AMX=Amoxycillin, S=Sensitive, I=Intermediately Sensitive, R=Resistant.

Teaching and Referral Hospital-Eldoret (Okello et al., 2018). The predominance of *S. aureus* observed at the current setting maybe because this bacterium is a skin flora; therefore, its presence in surgical wounds could be as a result of endogenous contamination of the surgical site during patient skin incision. Exogenous sources such as contaminated hospital surfaces or equipment and the hands of healthcare providers could also account for *S. aureus* preponderance (Gelaw et al., 2014).

However, findings by this work were inconsistent with other studies which identified *E. coli (32.8%), P. aeruginosa and Klebsiella* species as the leading causes of surgical site infection (Namıduru et al., 2013; Kokate et al., 2017; Patel Disha et al., 2011). The difference could be attributed to the invasive nature of the procedures performed by hospitals. This is because, patients undergoing procedures involving the gastro-intestinal tract may be at risk of developing SSI as a result of endogenous contamination of the surgical site with enteric rods during surgery.

The project also saw the predominance of gram-negative bacteria over gram-positive bacteria which was analogous with findings from a study by Tuon et al. (2019). But these results were incongruous with discoveries by a separate research worker who observed the preponderance of gram-positive bacteria over gram-negative bacteria (Khyati et al., 2014). The differences in the types of bacteria isolates can be attributed to the different microbiota present in different hospital environments. Besides, the high prevalence of gram-negative rods may be due to the increase in resistance rates of gram-negative rods at the current setting.

The high resistance rates of Amoxycillin and Ampicillin recorded by the present work were in harmony with observations by other workers (Kahsay et al., 2014). On the other hand, findings on the resistance rates of gram-negative rods were comparable to the results obtained from a study in Ethiopia (Dessie et al., 2016). Additionally, an MRSA rate of 65.4% observed in the present setting was in harmony with results from a study conducted in Uganda that reported an MRSA rate of 65.9% (George et al., 2018). These current occurrences were attributed to lack of effective surveillance programs for SSI etiologies and their antibiograms.

Limitations

The design of this study could not allow for follow-up of patients which meant that some of the cases were never captured.

Conclusion

The present work noted that a majority of the drugs were resistant to gram-negative bacteria. Therefore, there is need for continuous monitoring to determine the susceptibility patterns of the most common bacteria isolates which are found in the hospitals. These findings will assist in treatment and monitoring of bacteria resistance trends across institutions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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