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CURRENT ANTIBIOTIC SUSCEPTIBILITY PROFILE OF THE BACTERIA ASSOCIATED WITH SURGICAL WOUND INFECTIONS IN THE BUEA HEALTH DISTRICT IN CAMEROON

Palle, J.N.[1], Bassah, N.[1], Kamga, H. L. F.[5*], Nkwelang, G.[2], Akoachere, J.F.[2], Mbianda, E.[2], Nwarie U.G.[1], Njunda, A. L.[4], Assob, N.J.C.[3], Ekane, G.H.[1], Ngowe Ngowe. M.[3]

[1]Department of Nursing, Faculty of Health Sciences, University of Buea; [2]Department Microbiologyy, Faculty of Science, University of Buea; [3]Medicine Programme, Faculty of Health Sciences, University of Buea; [4]Department of Medical Laboratory Science, Faculty of Health Sciences, University of Buea. [5]Department of Medical Laboratory Science, Faculty of Health Sciences, University of Bamenda

*** Correspondence: Henri Lucien Fouamno Kamga, Department of Medical Laboratory Science, Faculty of Health Sciences, University of Bamenda, Republic of Cameroon. E-mail: henrikamga2002@yahoo.fr**

ABSTRACT

Background: Most surgical wounds seen in clinical practice in the Buea Health District, Cameroon are infected prior to arrival or while they are in the hospital. Sometimes the infection necessitates a combination of local wound site measures and systemic antibiotherapy to properly manage the patient.

Objective: To identify the current antibiotic susceptibility profile of the common germs that cause surgical wound infections in the Buea Health District of Cameroon.

Methods: A total of 2120 specimens comprising swabs from burns, ulcers, open or post-operative wounds were collected from hospitalized patients attending health institutions in Buea. The samples were collected from different anatomic sites of the patients. Cultures were effected from the specimens and bacteria isolated from infected wounds using standard microbiological techniques. Antibiotic susceptibility of the different isolates was determined.

Results: Majority (79.8%) of the wounds were infected with pathogenic bacteria. The germs globally showed multi resistant patterns to commonly used antibiotics in the study area, especially to co-trimoxazol, doxycycline, chloramphemicol, ampicilline and aztreonam. However appreciable sensitivity was noted to ofloxacillin, perflacin, and ceftriazone.

Conclusion: This study has revealed ofloxacin as the only antibiotic to which all the isolated bacteria from infected wounds were sensitive in the study area.

Keywords: Wound infection, Antibiotic susceptibility profile, Buea Health District, Cameroon

INTRODUCTION

Trauma, injections, invasive diagnostic procedures, intravenous therapy and urinary catheters can all break the first line of defense and make an individual more susceptible to infections (1). Although every effort is made to kill or check the growth of micro organisms in the hospital, the hospital environment is a major reservoir of pathogens (1). Gram-negative bacilli are the most common cause of opportunistic infections causing at least half of hospital-acquired infections in approximately 5% of all hospitalized patients (2). Early contaminants on wound surface are likely to be skin flora (e.g, *Staphylococcus epidermidis* and beta haemolytic streptococci) that adhere to the wound, proliferate and form healthy biofilm. Gram-negative bacilli then colonize the wound. These organisms utilize available oxygen and provide growth factors to enable anaerobes to establish within the biofilm (3). Bacteria pathogens reported to infect wounds include: *Staphylococcus aureus, Enterococcus sp, Corynebacterium diphtheriae, Clostridium sp, Neisseria meningitidis, Pseudomonas aeruginosa, Haemophilus ducreyi, Bacteriodes fragilis, Treponema palladium, E. coli, Klebsiella sp, proteus sp and Aeromonas sp* (3). Infections caused by these pathogens result in great morbidity and mortality and impose a major burden on the health care system worldwide (4). *S. aureus* bacteraemia extends length of hospital stay and increases antibiotic use, treatment cost and mortality (1).

Epidemiologically, acute wounds have a wide range of causes: often they are the unintentional result of motor vehicle accidents, falls, mishandling of sharp objects or sport related injuries. Intentional injuries are due to violence involving assault with weapons including knives and guns (1,5). Management of wounds involves dressing, suturing, bandaging, use of antimicrobial agents for disinfection, physical therapy and educational strategies to prevent bacterial colonization from proceeding to the point of clinical infection. Sometimes skin graft is used to encourage healing. A number of methods for the diagnosis of wound infections caused by these organisms have been developed. These methods include: serum investigation which detects elevated white cell counts and quantitative analysis is done through wound biopsy (4).

Antibiotics used for treatment should cover the potential range of pathogens. Several studies have compared antibiotic regimens but no single regimen has emerged as clearly the best. The most commonly used antibiotics in the Unites Sates are cefazolin and cefozitin (6). The use of vancomycin is increasingly important for the treatment of hospital acquired Staphylococcus infections (7). Topical antibiotics such as silver sulphadiazine, compounds containing silver or iodine and honey have the potential to reduce the bacterial burden in wounds (8). Recent reports (9) have demonstrated the existence of pathogenic bacteria and the emergence of methicillin resistant *Staphylococcus aureus* (MRSA) in wounds in several hospitals in Africa.

In Cameroon antibiotics (especially beta lactamines, aminolglycosides and sulfonamides) are used indiscriminately by some health personnel to manage wound infections. Besides, owing the fact that these antibiotics can easily be obtained from street vendors at low cost, there is a tendency for patients to purchase and use them repeatedly and indiscriminately without medical supervision. This practice steams from the lack of knowledge of antibiotic resistance pattern of the common pathogens but also from the scarcity of data on antimicrobial susceptibility profile of these organisms, hence this study was carried out.

MATERIALS AND METHODS

Study area and design

This study was carried out in Buea Health District, South West Region of Cameroon. The town of Buea is situated on the flank of Mount Cameroon (4100m) at 800m above sea level. Two thousand one hundred and twenty specimens comprising swabs from burns, ulcers, open or postoperative wounds were collected from hospitalized patients attending health institutions in the Buea Health District. These samples were collected from different anatomical sites of the patients. Patients were recruited into the study based on the following criteria: hospitalized with a wound in one institution in the area of study at the time of the study, acceptance to freely take part in the study by signing an informed consent. An ethical approval of the study was obtained from the Regional Delegation of Public Health, Buea. The study was a cross sectional prospective study. Patients were recruited from four health units. They were the Buea Regional Hospital Annex, the Mount Mary Hospital, the Buea Town Health Centre and the Muea Health Centre.

Sample collection

Samples were collected from hospitalized patients and transported according to methods previously described (1,7). Samples were aseptically collected using sterile swab sticks and inserted into sterile Amies Transport medium and carefully labeled. They were then transported to the microbiology laboratory of the University of Buea for processing and analysis, and in instances were delay was anticipated before analysis, the samples were preserved in a refrigerator at 4°C.

Sterilization and aseptic techniques

All glassware used were washed with detergent an rinsed with tap water, dried at 20°C, wrapped in aluminum paper and sterized in hot air oven (Gallenkam Britain) at 180°C for 60 minutes. Culture media, distilled water, specimen bottles, and normal saline were sterilized by autoclaving at 121°C for 15 minutes. The following culture media were used: Amies transport medium (ATM), MacConkey agar (MA), Blood agar (BA), Mannitol Salt agar (MSA) and Nutrient agar (NA). Media were prepared according to the manufacturer's instructions. Standard septic techniques were strictly respected.

Isolation and identification of bacteria

Specimens were inoculated aseptically into Blood agar, MacConkey agar, Nutrient agar and Mannitol Salt agar. Plates were incubated at 37°C for 18-24 hours, after which they were examined for growth. Colonies were then subjected to oxidase, catalase, coagulase, motility tests, Gram staining, as well as growth on Kliger iron agar. Colonies were presumptively identified based on their morphological and colonial characteristics (7,10). Their identity was confirmed using the Analytical Profile Index (API) 20E (Biomerieux SA, Marcy E'Etiole, France) (7).

Antibiotic susceptibility testing

The disc diffusion (Kirby Baur) technique was employed as previously described (3,7) using Mueller-Hinton (MH) agar (Schalau Chemie S.A, Spain), which is a standard medium for the disc diffusion assay. Antibiotics used in the study included: aminogycoside, [gentamicine (10µg)], macrolide, [erythromycin (10µg)], third generation cephalosporines, [ceftriazone (30µg), ceftazidime (30µg)], penicillins, [ampicillin (10µg), augmentin (30µg) and oxacillin (1µg)], folic acid synthesis inhibitor, [co-trimoxazole (25µg)], fluoroquinolones, [ofloxacin (30µ), norfloxacin (10µg), pefloxacin (5µg)], tetracycline, [doxycycline (30µg)], protein synthesis inhibitor, [chloramphenicol (30µg)], monobactams, [aztreonam (30µg)].

A bacterial inoculum was prepared from subcultures and emulsified in 3ml sterile normal saline in bijou bottles to match with 0.5 Mc Farland turbidity standards (1.8×10^8 CFU/mL) by comparing visually. The optical density of the standard was monitored on a regular basis with a spectrophometer at λ = 625nm and 1cm length path (11). About 20µL of the inoculum was dispensed on the MH plate and ramified with a sterile spreader. The plates were allowed to dry for 3-5 minutes, then using a sterile forceps, antibiotic discs were applied on the surface of the inoculated plates and pressed gently to ensure complete contact with agar. The discs were placed at least 15mm apart from the edges of the plates to prevent overlapping of inhabitation zones. Within 15 minutes after discs were applied, the plates were inverted and incubated at 37°C for 24 hours after which the results were read. The diameter of the zones of inhibition was measured with a ruler. They were compared with recommended standards, which conform to those of the national committee of Clinical laboratory Standard (NCCLS) [now known as Clinical Laboratory Standards Institute (CLSI)]

Statistical Analysis

Statistical package for social science (SPSS) was used to analyze the data. The Chi-square (x^2) test was employed where appropriate for statistical analysis. Differences were considered significant at $p \leq 0.05$.

RESULTS

A total of 2120 patients presenting with various types of wounds were enrolled in the study. Out of the 2120 patients studied, 891 (42%) were females and 1229 (58%) were males. The ages of study participants ranged from 7 months to 80 years. Majority of these patients were presenting with open wound (1651/2120 = 77.8%) while those with burns (31/2120 = 1.4%) constituted the least. Some of the patients had diseases such as AIDS (140/2120 = 6.6%) and diabetes mellitus (60/2120 = 2.8%) which are predisposing factors to wound infection.

Table 1 shows the prevalence of bacteria in different sample sources. Of the 2120 specimens cultured, pathogenic bacteria were isolated from 1690 giving an overall prevalence of 79.7%. Four hundred and thirty (20.3%) specimens yielded no bacterial growth. Among the different types of samples analyzed, burns had the highest isolation rate of 100% (30/30) while open wounds had the least (78.8%). However, the difference in isolation between specimens was not significant (X^2=1.302; df = 3; p = 0.729).

TABLE 1: PREVALENCE OF BACTERIA IN DIFFERENT SAMPLE SOURCES

Specimens	Number(%) with positive culture	Number (%) with negative culture	Total (%)
Burns	31 (100)	0 (0)	31(1.4)
Post operative wound	230 (79.2)	59 (20.8)	289 (13.7)
Ulcer	130 (86.6)	19 (13.4)	149 (7.1)
Open wound	1300 (78.7)	351 (21.3)	1651 (77.8)
Total (%)	1691 (79.8)	429 (20.2)	2120 (100)

(X^2 = 1.302; df = 3; p = 0.729)

Table 2 shows the frequency of isolation of bacterial pathogens. Twelve species of bacteria were isolated from the specimens. *Staphylococcus aureus* (24.8%) was the commonest organism isolated followed by *Pseudomonas aeruginosa* (23.1%), while the least isolated was *Serratia sakazkii* (0.6%).

The distribution of bacteria isolates based on specimen source is shown in Table 3. All infections of burns were by *Pseudomonas aeruginosa* (5.1%) and *Staphylococcus aureus* (2.1%) though there was no statistical difference in the distribution of bacteria isolates based on specimen source (P = 0.972).

The antimicrobial susceptibility of isolates to some commonly prescribed antibiotics is shown in Table 4. Ofloxacin (100%) and pefloxacin (100%), were the most active drugs. Isolates also demonstrated high sensitivity to ceftriazone (94.2%), gentamicin (92.0%) and ceftazidime (89.6%). However, all isolates showed complete resistance (100%) to oxacillin. Other inactive drugs included co-trimoxazole (18.7%), aztreonam (40%) and ampicillin (43.8%). *Staphylococcus aureus,* the most common isolate, showed resistance to co-trimoazole (100%), aztreonam (100%), ampicillin (95%), erythromycin (80), doxycyclin (80%), chloramphenicol (60%), and ceftazidime (54.4%).

TABLE 2: FREQUENCY OF ISOLATION OF BACTERIAL PATHOGENS

Isolates	Frequency of isolation	Percentage of Isolation
Staphylococcus aureus	481	28.4
Pseudomonas aerinosa	390	23.1
Klebsiella pneumonia	219	13.0
Enterobacter cloacae	210	12.4
Escherichia coli	99	5.9
Serratia marcescens	99	5.9
Proteus mirabilis	81	4.7
Serratia rubideae	31	1.8
Enterbacter aerogenes	30	1.8
Streptococcus sp	19	1.2
Hafnia alvei	21	1.2
Serratia sakazakii	11	0.6
Total	1691	100

TABLE 3: DISTRIBUTION OF BACTERIA ISOLATE BASED ON SPECIMEN SOURCE

Isolates	Sample source Positive patients (%)				Total (%)
	Burns	Ulcers	Postoperative wounds	Open wounds	
E. coli	0 (0)	20 (20)	19 (20)	61 (60)	100 (5.9)
E. cloacae	0 (0)	11 (4.7)	11 (4.7)	188 (90.5)	210 (12.4)
E. aerogenes	0 (0)	0 (0)	0 (0)	30 (100)	30 (1.8)
P. mirabilis	0 (0)	11 (12.5)	29 (37.5)	40 (50)	80 (4.7)
K. pneumonia	0 (0)	20 (9.1)	41 (18.2)	160 (72.7)	221 (13.0)
H. alvei	0 (0)	0 (0)	0 (0)	21 (100)	21 (1.2)
P. aerginosa	20 (5.1)	39 (10.3)	31 (7.7)	297 (76.9)	387 (23.1)
S. marcescens	0 (0)	0 (0)	19 (20)	81 (80)	100 (5.9)
S. rubideae	0 (0)	0 (0)	10 (33.3)	21 (66.7)	31 (1.8)
S. sakazakii	0 (0)	0 (0)	0 (0)	11 (100)	11 (0.6)
S. aureus	11 (2.1)	29 (6.3)	70 (14.6)	368 (77.0)	478 (28.4)
Strep. Sp.	0 (0)	0 (0)	0 (0)	22 (100)	22 (1.2)
Total %	31 (1.8)	130 (7.7)	230 (13.6)	1300 (76.9)	1691 (100)

(X^2 = 19.299; df = 33; p = 0.972)

Ninety two (5.44%) of the 1691 isolates were found to be resistant to at least two antibiotics (Table 30 patterns of multi-drug resistance emerged l resistance to two or more antibiotics, excluding oxacillin. Seventy-one (4.2%) isolates were resistant to three or more antibiotics and, of these, 66 (3.9%) were resistant to at least five. The predominant resistant patterns SXT^R DXT^R C^R AMP^R ATM^R was observed in *K. pneumoniae* and *P. aeriginosa* and constituted 40.2% (370/920) of the isolates. SXT^R NOR^R, SXT^R AMP^R ATM^R and GEN^R SXT^R NOR^R AMP^R exhibited by *S. sakazakii*, *E. aerogenes* and *Streptococcus sp*. respectively were the least. Multi-drug resistance was commonly encountered in *S. aureus* with 31.5% of this organism being resistant to seven drugs.

DISCUSSION AND CONCLUSION

This study was carried out to determine the antibiotic susceptible profile of the common germs that currently cause surgical wound infection in the Buea Health District, South West of Cameroon.

Pathogenic bacteria were isolated from 1691 of the 2120 (79.8%) specimens cultured. Bacteria may enter wound by direct contamination from patient's skin or internal organs, through the hands and instruments. These infections are the biological summation of several factors: the implantation of bacteria introduced into the wound during the procedure, the unique virulence of contaminants, the microenvironment of each wound, and the integrity of the patient's defense mechanisms (11). Four hundred and twenty nine (20.2%) of the 2120 specimens had no bacteria growth. This could be due to normal healing process where the bacteria have been over-powered by the body's defense mechanism. It is also possible that some organisms could have been anaerobic and, as such were missed as cultures were incubated aerobically. This condition could therefore not support growth of such organisms.

TABLE 4: ANTIBIOTIC SUSCEPTIBILITY TESTING OF ISOLATES

Bacteria Isolates	Percentage (%) susceptible to:													
	OFX	CAZ	GEN	SXT	PEF	CRO	DXT	NOR	C	E	AUG	AMP	OX	ATM
E. coli	100	100	100	60	100	100	100	100	100	100	100	80	0	100
E. cloacae	100	100	100	6.2	100	100	90	100	100	100	100	10	0	50
E. aerogenes	100	100	100	4	100	100	98	100	100	100	100	7	0	7.8
P. mirabilis	100	100	100	10	100	50.7	92	100	100	100	100	70	0	0
K. pneumonia	100	90.6	100	0	100	100	11	92.1	39	54	77	6.2	0	0
H. alvei	100	91.2	100	70	100	100	100	100	100	100	100	83	0	7
P. aerginosa	100	85.7	70.1	0	100	100	15	100	36	89	75.5	7	0	0
S. marcescens	100	100	100	60	100	100	12.5	25	24	64.3	95.5	58	0	60.4
S. rubideae	100	100	100	8.3	100	100	55.6	100	80	100	76.5	64	0	9
S. sakazakii	100	100	100	0	100	100	94.1	5.9	79	100	55.6	78	0	79
S. aureus	100	45.6	87.5	0	100	80	20	51	40	20	60	5	0	0
Strep. Sp.	100	61.8	46.0	6	100	99.1	96	39.6	75	83.3	66.7	45.8	0	58
Total %	100	89.6	92	18.7	100	94.2	65.4	76.1	72.8	84.2	83.9	43.8	0	40

Abbreviation: OFX, ofloxacin; CAZ, ceftazidime; GEN, gentamicin; SXT, co-trimoxazole; PEF, pefloxacin; CRO, ceftriazone; XT, doxycyclin; NOR, norfloxacin; C, chloramphenicol; E, erythromycin; AUG, augmentin; AMP, ampicillin; OX, oxacillin; ATM, aztreonam.

TABLE 5: ANTIBIOTICS RESISTANCE PATTERNS OF ISOLATES

Isolates	Drugs resistant patterns	Number of positive isolates showing patterns (%)	The number of isolates per pattern
E. cloacae	SXT[R] AMP[R]	140 (15.2)	140
P. mirabilis	SXT[R] ATM[R]	39 (4.3)	60
S. rubideae	SXT[R] NOR[R]	21 (2.2)	
S. sakazakii	SXT[R] AMT[R] AMP[R] ATM[R]	10 (1.1)	10
E. aerogenes	SXT[R] AMP[R] ATM[R]	10 (1.1)	10
S. marcescens	DXT[R] NOR[R] AMP[R]	31 (3.3)	31
Strephtococcus. Sp.	GEN[R] SXT[R] NOR[R] AMP[R]	9 (1.1)	9
K. pneumonia	SXT[R] DXT[R] C[R] AMP[R] ATM[R]	159 (14.4)	370
P. aerginosa	SXT[R] DXT[R] C[R] AMP[R] ATM[R]	211 (22.8)	
S. aureus	CAZ[R] SXT[R] DXT[R] C[R]E[R] AMP[R] ATM[R]	290 (31.5)	290
Total	80	920 100	

Abreviation: SXT, co-trimoxazole; AMP, ampicillin; ATM, aztreonam; NOR, norfloxacin; DXT, doxycyline; C, chloramphenicol; GEN, gentamicin; CAZ, ceftazidime; R, resistance.

The highest and least occurrences were in burns (100%) and open wounds (78.8%) respectively, although differences between specimens were not significant. This corroborates the finding of Bjornhagen and Bragderyd(14) who reported burn wound infection as he most common infection in hospitals in Sweden. Approximately 73% of all deaths within the first 5 days post-burn have been shown to be directly or indirectly caused by septic processes. A high rate of isolation from burns can be attributed to a large surface barrier loss hence this increases risk of contamination by bacteria(15).

Twelve species of bacteria were recovered from the isolates. They were *S. aureus* (28.4%), *P. aerginosa* (23.1%), *Klebsiella pneumonia* (13%), *Enterbacter cloacae* (12.4%), *E. coli* (5.9%), *S. marcescens* (5.9%), *Proteus mirabilis* (4.7%), *Enterbacter aerogenes* (1.8%), *S. rubideae* (1.8%), *Hafnia alvei* (1.2%), *Streptococcus sp*. (1.2%) and *S. sakazakii* (0.6%). This result corroborates those of Anguru and Olila (16) who isolated similar organisms from septic postoperative wounds in a regional referral hospital in Uganda. Recent studies (13, 17) have also isolated similar organisms from ulcers and surgical wounds. As all patients recruited in the study were hospitalized patients, isolation of these organisms suggests they could be of nosocomial origin. The dysfunction of the immune system, a large cutaneous bacterial load, the possibility of gastrointestinal bacterial translocation, prolonged hospitalization and invasive diagnostic and therapeutic procedure all contribute to infections (9, 14).

Antimicrobial usage in an indiscriminate manner and at non pharmacological doses is considered the most important factor promoting the emergence, selection and dissemination of antimicrobial-resistant microorganisms (3, 8). The study also determined the susceptibility patterns of isolates to antibiotics and revealed marked susceptibility (100%) to ofloxacin (fluoroquinolones) used in this study. This could be attributed to the fact that the high cost of these drugs in the study area limits their abuse. Nonetheless, resistance to these drugs has been reported in other regions of the world(15), and was thought to be due to improper dosage prescription. Similarly, high sensitivity was observed for ceftriazone (94.2%), gentamycin (aminogycoside) (92%) and ceftazidime (89.6%). This finding contradicts the results of Angura and Olilia (16) who reported high bacterial resistance to these drugs. Isolates however exhibited complete resistance to oxacillin, which correlates previous findings (15). The ability of both nosocomial and community-acquired pathogens to develop resistance to powerful broad-spectrum agents presents a great challenge for prescribing patterns and in the development of new drugs to be relatively resistant to inactivation. The high resistance observed in co-trimoxazole (81.3%) could be partly due to the excessive use of this drug in the locality. However, susceptibility of *H. alvei*, *E. coli* and *S. marcescens* to this drug has been reported by Mascaretti (10). Some authors reported low sensitivity of amoxicillin, oxacillin, and ampicillin to *Klebsiella pneumonia* and *Pseudomonas aeruginosa* (7).

Eight distinct resistance patterns were observed. Pattern SXT[R] DXT[R] C[R] AMP[R] ATM[R] was the most prevalent (40.2% of the isolate), while SXT[R] NOR[R], SXT[R] AMP[R] ATM[R] and GEN[R] SXT[R] NOR[R] AMP[R] were the least prevalent (1.1%). Approximately 77.2% of the isolates were resistant to three or more antibiotics. Of these, 71.7% were resistant to five or more drugs. Multi-drug resistance might be linked to high abuse resulting from constant and indiscriminate usage. Advances in control of infections have not completely eradicated the problem because of the development of resistance. Antimicrobial resistance can increase complication and costs associated with procedures and treatment. Multidrug-resistant bacteria have frequently been reported as the cause of nosocomail outbreaks of wound infection (9). *Staphylococcus aureus* the most common isolate such as honey, sugar etc, which have been shown to be broad-spectrum topical antimicrobial agents, eradicating antibiotic resistant strains of bacteria from wounds (1, 8), could play a significant role in treatment of wound infection in study area. Also other topical new antimicrobial agents such as citric acid (8) have been reported to be cost effective in treatment of wound infections caused by resistant bacteria. There is no simple cure for resistance but opportunities for control lie to a lesser and better use of antibiotics, backed by swifter and more accurate diagnosis and susceptibility testing, developing new antibiotics and in protecting old ones from developing resistance. This is because antimicrobial susceptibility testing is intended to predict whether an antimicrobial therapy will be clinically effective and results may directly affect the therapy chosen for treatment of an infection. The use of antibiotics in hospital and the community at large serves as a major selection process for antibiotic resistant bacteria, especially when the use is massive, indiscriminatory, not carefully tailored and monitored, and when standard doses are not respected.

(31.5%), exhibited resistance to more than six drugs. Other isolates that also largely exhibited multidrug resistance were *P. aeruginosa* (22.8%) and *K. pneumoniae* (14.4%). Drug resistance of these organisms in other parts of the world has reached a worrying level(17). The progressive reduction of therapeutic efficacies of the available antibiotics underlines the need for the development of new therapeutic strategies for the treatment of infected wounds and other infections. Thus, natural products

The most commonly encountered germ in the study area, *S. aureus*, was resistant to most commonly prescribed antibiotics. This study has revealed predominant multidrug resistant pathogenic bacteria isolates from infected wounds in the study area, with dominant resistant patterns being SXT^R, DXT^R, C^R, AMP^R, ATM^R. Appreciable sensitivity of the isolated pathogenic bacteria was shown to ofloxacillin, pefloxacin, followed be ceftriazone, in decreasing order of potency.

Limitation

A total of 391 (15.57%) patients dropped out of the study for various reasons. This may have ultimately affected the results.

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REFERENCES

1) Cheesbrough M. *Medical Laboratory Manual for Tropical Countries* Vol. 11, London: Cambridge University Press, 1984.
2) Matsumura P, Adams W, Armitage P, Bran V, Christie J, Haldenwang G, Kotler R, Moran P, Microbilogy of Pathogens, *Journal of Bacteriology* 2006, 188:6070-6076.
3) Cheesbrough M. Antibiotic sensitivity testing: Enterobacteriaceae; London: Cambridge University Press, 2000
4) White J, Cooper R, Kingley A, Wound colonization and infection; the role of tropical antimicrobial. *British Journal of Nursing*, 2001; 9: 563-73.
5) Gwendolyn B, Microbiology for the Health Sciences, Philadelphia; J.B. Lippincott, 1992
6) Heiman W, Vos M, Oh A, Van Belkum A, Risk and outcome of nosocomial *Staphylococcus aureus* bacteraemia in wound infection. The *Lancet* 2004 364:500-705.
7) Ndip RN, Titanji VP, Akenji TN, Mutanga AM, Mbacham WF, Ndip LM. Antibiogram of Klebsiella pneumoniae isolates from Buea, Cameroon, Central African Journal of Medicine 2001; 47:173-176.
8) Denling R, Waterhouse B. The increasing problem of bacteria bunden infection on acute and chronic soft-tissue wounds caused methicillin-resistant Staphylococcus aureus, *Journal of Burns Wounds 200; 16:2-8*
9) Gardlund B, Postoperative surgical site infections in cardiac surgery: an overview of preventive measures APMIS 2007; 115: 918-922.
10) Mascaretti OA. Mechanisms of bacterial resistance to the action of antimicrobial agents, ASM Press, Washington DC: ASM Press, 2003
11) Davidson S, *Principles and Practice of Medicine*, Philadelphia: Churchill Livingston, 2002
12) Isenberg DH, Collection, transport and manipulation of clinical specimens and initial laboratory concerns, In:Wilkons AD (editor). Essential Procedures for Clinical Microbiology. Washington DC; ASM Press, 1998:20-22.
13) Murray B. New aspects of antimicrobial resistance and the resulting therapeutic dilemmas, *Journal of infectious diseases* 1999; 163: 1185-1190

14) Bjornhagen AP, Bragderyd VK. A prospective study of infectious in burn patients. Burns 2002; 28:39-46.
15) Ekrami A and Kalantar E, Bacterial infections in burn patients at a burn hospital in France, Indian Jornal of Medicine Research 2007; 126: 541-544.
16) nguru JR, Olila D. Drug sensitivity patterns of bacterial isolates from septic post-operative wounds in a regional referral hospital in Uganda. *Africa Health Science* 2007; 7:148-54.
17) Lamy B, Canet G, Plandrois JP. Antimicrobial susceptibility studies: how does susceptibility prevalence impact on the performance of disc diffusion susceptibility testing? In: Lawre M(editor) Diagnostic Microbiology and Infectious Diseases. Norwalk; Appleton and Lange Publishing 2004: 131-139