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# PREVALENCE OF METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* AND EXTENDED SPECTRUM Β–LACTAMASE PRODUCERS AMONG BACTERIA ISOLATED FROM INFECTED WOUNDS IN A TERTIARY HOSPITAL IN IBADAN CITY

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RUNNING TITLE: MRSA AND ESBL PRODUCING BACTERIA

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**ABSTRACT**

**Wound colonization by microorganisms is most frequently polymicrobial and incidences of high level resistance among bacterial isolates from wounds have been reported. Methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum beta-lactamase (ESBL) producing Gram-negative bacteria both constitute serious challenge to physician in their choice of antibiotic treatment of infections caused by these bacteria. This study determined the antibiotic susceptibility profiles and prevalence of MRSA and ESBL producers among wound bacterial isolates from a tertiary hospital in Ibadan City.**

**Forty (40) clinical bacterial isolates from five wound sources were collected from the Microbiology unit of the University College Hospital (UCH), Ibadan and were authenticated with standard bacteriological techniques. Antibiotic susceptibility test was done by disc-diffusion method using 19 antibiotics belonging to 12 classes. MRSA strains were detected by their resistance to cefoxitin and/or oxacillin antibiotics. Presumptive ESBL production was by double-disc synergy test using 30 µg cefotaxime and ceftazidime around 20/10 µg amoxicillin-clavulanic acid discs. ESBL confirmation was by minimum inhibitory concentration (MIC) using agar-dilution method.**

**The authenticated isolates include *Proteus* spp (47.5%), *Staphylococcus aureus* (27.5%), *Pseudomonas aeruginosa* (12.5%), *Klebsiella* spp (7.5%), *Acinetobacter baumanii* (2.5%) and *E. coli* (2.5%). Distribution of the isolates collected according to wound sources includes: acute soft tissue wounds (35%), leg ulcer (32.5%), surgical wounds (17.5%), burn wounds (12.5%) and diabetic foot ulcer (2.5%). Distributions according to patients' gender are: male (65%), female (35%), and according to age-groups are: 0 – 19 years (22.5%), 20 – 39 years (35%), 40 – 59 years (32.5%) and ≥ 60 years (10%). All (100%) the isolates were multidrug resistant (MDR) being resistant to ≥ 3 classes of antibiotics. Percentages of isolates resistance to each of the antibiotic include: piperacillin, piperacillin-tozobactam and amoxicillin-clavulanic acid were 100%, ceftazidime, cefuroxime, cefixime, aztreonam, sulphamethoxazole-trimethoprim, erythromycin, chloramphenicol and doxycyclin were > 70%, cefoxitin (62.5%), Nitrofurantion (52.5%), ciprofloxacin (45%), ofloxacin (35%), perfloxacin (37.5%), gentamicin (32.5%) and imipenem (2.5%). Of the 11 *Staphylococcus aureus* collected, 54.5% were detected to be MRSA strains while ESBL production was detected in 55.2% of the Gram negative isolates.**

**This study revealed 100% MDR phenotype constituting high level of MRSA strains (54.5%) and ESBL producers (55.2%) among Gram-positive and Gram-negative bacterial wound isolates respectively. Hence, this calls for caution in the use of extended spectrum antibiotics in treating patients with infected wounds.**

## LA PREVALENCE DES STAPHYLOCOQUES AUREUS RESISTANTS A LA METHICILINE ET LES PRODUCTEURS DE B – LACTAMASE SPECTRE ETENDU PARMI LES BACTERIES ISOLEES DE PLAIES INFECTEES DANS UN HOPITAL TRETIAIRE A LA VILLE D'IBADAN.

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TITRE COURANT: SARM ET BLSE BACTERIES PRODUCTRICES.

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RESUME

La colonisation de la plaie par des microorganismes est le plus souvent poly microbiennes et l'incidence de haut niveau de la résistance par des isolats de plaies ont été rapportés. Staphylocoque aureus résistant à la Méthicilline (SARM) et bêta–

Lactamases spectre étendu (BLSE) produisant des bactéries à Gram – négatif, les deux constituent un sérieux défi pour le médecin dans le choix du traitement antibiotique des infections causées par ces bactéries. Cette étude a déterminé les profils de sensibilité aux antibiotiques et la prévalence des producteurs de SARM et BLSE parmi les isolats bactériens des plaies d'un hôpital tertiaire dans la ville d'Ibadan. Quarante (40) isolats bactériens clinique provenant de cinq sources de plaies ont été recueillis de l'unité de microbiologie de l'University College Hospital (UCH), Ibadan et ont été authentifiés avec des techniques bactériologiques standard. Test de sensibilité aux antibiotiques a fait par la méthode de diffusion sur disque en utilisant 19 antibiotiques appartiennent à 12 classes. Les souches SARM ont été détectés par la résistance aux antibiotiques cefoxitin et /ou oxacilline. La production de BLSE présomptif était par le test de synergie double dique en utilisant 30µg cefotaxime et ceftaxidime autour de 20/10 µg disques d'acide amoxicilline – clavunique. La confirmation de BLSE a été par la concentration minimale inhibitrice (CMI) en utilisant agar · méthode de dilution. Les isolats authentifiés comprennent Proteus spp (47,5%), Staphylococcus aureus (27,5%), Pseudomonas aeruginosa (12,5%), Klebsiella spp (7,5%), Acinetobacter baumannii (2,5%),et E. Coli (2,5%).
La distribution des isolats collectés selon des sources de plaies comprend: plaies aigües des tissus mous (35%) , ulcère de jambe,(32%) les plaies chirurgicales (17,5%), les plaies de brule (12,5%)et les ulcères du pied diabétique (2,5%). La répartition selon le sexe des patients sont : male(65%), femelle (35%), selon les groupes d'âge sont :0 –19 ans (22,5%),20 –39ans (35%), 40 –59 ans (32,5%) et ≥ 60 ans (10%). Tous (100%) les isolats étaient multiresistants (MDR) etant resistant a ≥ 3 classes d'antibiotiques. Les pourcentage de la résistance des isolats à chaque antibiotique comprend: piperacilline, piperacilline ·tozobactam et acide amoxicilline – clavulanique etaient 100%, ceftazidime, cefuroxime, cefixime, aztreonam, sulphamethoxazole – trimethoprim, erythromycin, chloramphenicol et doxycyline etaient >70%, cefoxitin (62,5%), nitrofurantoïne (52,5%), ciprofloxacine (45%), l'ofloxacine (35%),perfloxacin (37,5%), gentamicine (32,5%), et imipénème (2,5%). Du 11 Staphylocoque aereus recueillis, 54,5% ont été détectés comme des souches de SARM alors que la production de BLSE a été détectée dans 55,2% des isolats Gram négatif. Cette étude a révélé 100% phénotype constituant un niveau élevé des souches de SARM (54,5%) et les producteurs de BLSE (55,2%) chez les Gram – positif et Gram – négatif des isolats bactérien de plaies. Par conséquent, il faut la prudence dans l'utilisation des antibiotiques à spectre étendu dans le traitement des patients avec plaies infectées.

## INTRODUCTION

Human or animal skin if not broken or damaged, prevents agents of infection from entering into the body. However, when the dermis of the skin is damaged usually by chemical or mechanical injury, the subcutaneous tissue becomes exposed and thus provides a moist, warm, and nutritious environment for the colonization and proliferation of microbes (1, 2). The term wound, is given to a compromised skin and can be classified either as open or closed wound (1, 3). In open wound, the skin is torn, cut, punctured or as a result of avulsion, thereby exposing the subcutaneous layer of the body (3). In the case of closed wound, the skin developed hematoma either through blunt force trauma resulting into contusion or through internal blood vessel pathology resulting into ecchymosis, purpura and petechiae (3). Wounds can also be categorized as accidental, pathological and post-operative wounds depending on its nature (4, 5).

Microbial contamination of wounds usually occur either at the time of injury that lead to the wound or as a result of improper handling of the wound by the patient concern (4). Sources of nosocomial bacterial contaminants in wounds could be exogenous or endogenous. Exogenous sources are other sources of microbial contamination order than the patient's own bacterial flora and they include: contaminated objects that caused the wound in the case of accidental wound, carelessness of patient with wound resulting in bacterial contamination from the hospital environment, contaminated medical materials, surgical equipments and use of poorly or non sterile gloves by the surgeon in the case of post-operative wounds (4, 5). Endogenous sources on the other hand are bacterial contamination from the patient's own microbial flora such as *Staphylococcus aureus* from the skin (6) and coliforms from the anus, which can contaminate open wounds when hands are not adequately washed after using the toilet. If these contaminating bacteria persist, grow and multiply and become established at the site of invasion will result into wound infection (2).

Several factors influence the diversity of microorganisms that can be found in any wound. Such factors includes: the type and location of the wound, the depth and level of tissue perfusion, and the host immune response (3). In most instances, wound colonization is polymicrobial involving numerous microorganisms that may be pathogenic (7, 8, 9). Infected wound has actively multiplying pathogenic organisms with clinical signs of infection such as pain, redness, oozing of pus and yellowing of the wound site. This usually prolongs wound healing and the patient concern suffers increased trauma with increased treatment costs (2, 3).

The rapid increase and spread of multidrug resistant (MDR) bacteria particularly involving nosocomial infections has added a tedious dimension to the problem facing the physicians in the treatment of wound infections among in-patients (2). Of the several antibiotics of choice that can be used in the treatment of infected wounds, extended-spectrum beta-lactam antibiotics such as the third generation cephalosporins are reserved for treatment of serious and life threatening wound infections. However, several studies have reported high level bacteria resistance to this class of antibiotic (10, 11, 12). Several resistant determinants have been detected in bacterial isolates from infected wounds and the distribution of the types detected is usually based on the level of dissemination among bacterial isolates in that location (11, 12, 13). Most interesting and widely studied resistant determinants are the beta-lactamases, particularly the extended-spectrum beta-lactamases (ESBLs). ESBLs are different variants of beta-lactamase enzymes derived from the classical beta-lactamase enzymes by mutation at one or multiple points in their gene sequences and are known to mediate resistance against all beta-lactams especially the extended-spectrum beta-lactam antibiotics including the third generation cephalosporins (14). *Staphylococcus aureus* that are resistance to oxacillin and currently cefoxitin are multidrug resistant strains denoted as methicillin-resistant *Staphylococcus aureus* (MRSA) because they were previously detected to show resistance to methicillin, an improved penicillin derivative antibiotic against penicillinases producing Gram-positive bacteria (15). MRSA are usually one of the commonest nosocomial agents that are responsible for high morbidity and mortality in hospitals especially in the newborn nurseries (15, 16). Occurrence of MRSA and ESBL-producing Gram-negative bacteria within hospital setting have been established and their emergent as causative agents of nosocomial wound infections have been reported in many countries including Nigeria (2, 10, 12, 17). For effective treatment of wound infections in this multiple antibiotic resistance era, there is need for continuous isolation and screening of bacterial isolates from wound infections (18) with the view to assist physicians in making rational selection of antibiotics in the treatment of wound infections.

This study therefore phenotypically determined the susceptibility profiles, percentage frequency of MRSA strains and ESBL producers among bacterial isolates from nosocomial wound infections in a tertiary hospital in Ibadan City, Southwest Nigeria.

## MATERIALS AND METHODS

### COLLECTION AND IDENTIFICATION OF ISOLATES

Forty bacterial isolates were collected through the Microbiology unit of the University College Hospital (UCH) Ibadan by random sampling within one month, on sterile nutrient agar slants. It was checked on the laboratory record that the bacterial isolates collected were from patients suffering from different wounds types that were infected while still on admission in the hospital wards. Information on the patients' age, sex and the type of wounds was also obtained from the laboratory record. The clinical isolates were re-identified using cultural characteristics, Gram staining and standard biochemical test to further confirm their identities.

### ANTIBIOTIC SUSCEPTIBILITY STUDY

The clinical isolates were subjected to antibiotic screening using the disc-diffusion method as described by Etok *et al*. (2012) (12) and result interpreted according to the Clinical Laboratory Standard Institute (CLSI) guidelines (2012) (19). The isolates, after dilution to 0.5 McFarland standard suspensions were inoculated on the surface of Mueller Hinton agar plate by surface spreading using sterile swab sticks to give a monolayer of bacterial cell over the agar surface. With the aid of sterile forceps the standard antibiotic discs were place on the inoculated agar surface and after 30 minutes of pre-incubation diffusion the agar plates were incubated in an inverted position for 24 hours at $37^0$C. The following antibiotics were tested: piperacillin (30 µg), piperacillin-tozobactam (110 µg), oxacillin (1 µg), ceftazidime (30 µg), cefuroxime (30 µg), cefixime (5 µg), cefoxitin (30 µg), aztreonam (30 µg), amoxicillin-clavulanic acid (20/10 µg), imipenem (10 µg), gentamicin (10 µg), ciprofloxacin (5 µg), ofloxacin (5 µg), perfloxacin (5 µg), nitrofurantoin (300 µg), chloramphenicol (30 µg), doxycycline (30 µg), sulphamethoxazole-trimethoprim (25 µg) and erythromycin (30 µg). Isolates resistant to three or more classes of antibiotics will be considered multidrug resistant strain (20).

### DETECTION OF METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) STRAINS

All the *Staphylococcus aureus* isolates collected were subjected to antibiotic susceptibility test by disc-diffusion using oxacillin (1 µg) antibiotics as described by Etok *et al.* (12) as well as cefoxitin (30 µg) as described by CLSI guidelines (19). Isolates resistant to either oxacillin, cefoxitin or both were taken to be MRSA strains.

### DETECTION OF EXTENDED-SPECTRUM $\beta$-LACTAMASES (ESBL) PRODUCTION

Presence of ESBL production among the Gram-negative bacterial isolates was first determined by double-disk synergy test using 30 µg cefotaxime and ceftazidime disc arranged 20mm centre to centre around 20/10 µg amoxicillin-clavulanic acid disc on Mueller Hinton agar plate already inoculated with 0.5 McFarland standard bacterial suspensions as described by Okesola and Fowotade (10). Those with positive result were then further confirmed by minimum inhibitory concentration determination involving the two cephalosporins alone and the cephalosporins with inhibitor (clavulanic acid) using agar dilution method as described by Ogbolu *et al.* (11). The agar plates were incubated in an inverted position for 24 hours at $37^0$C. The results were interpreted according to the Clinical Laboratory Standard Institute (CLSI) guidelines (19).

## RESULTS

### DISTRIBUTION OF BACTERIAL ISOLATES ACCORDING TO WOUND TYPES

The number and percentage distribution of clinical isolates collected and the type of wound infections from which they were isolated is presented in tables 1 and 2. Among the isolates, *Proteus* spp (47.5%)

recorded the highest collection followed by *Staphylococcus aureus* (27.5%), *Pseudomonas aeruginosa* (12.5%) and *Klebsiella* spp (7.5%) while both *Acinetobacter baumanii* and *E. coli* recorded 2.5% collection each. *Proteus* spp make up 80% of the isolates from burn wounds, 42.9% from surgical wounds and 53.8% from leg ulcer. *Staphylococcus* spp. make up 20% of isolates from burn wounds, 42.9% from acute soft tissue wounds, 14.3% from surgical wound and 23.1% from leg ulcer. *Klebsiella* spp make up 100% isolates from diabetic foot ulcer and 15.4% from leg ulcer while *E. coli* make up 14.3% of isolates from surgical wound infections.

**DISTRIBUTION OF THE CLINICAL ISOLATES ACCORDING TO PATIENT'S GENDER AND AGE GROUPS**

In this study all the *E coli*, *Klebsiella* spp, and *A. baumanii* and 63.2%, 80%, 45.5% of *Proteus* spp, *P. aeruginosa* and *S. aureus* collected respectively, were from infected wounds of male patients. Wound isolates from female patients constitute 54.5% of *S. aureus*, 36.8% of *Proteus* spp and 20% of *P. earuginosa* (table 3). Among the patients with *Staphylococcus* spp. infected wounds in this study, 45.5% of the patient fall within the age group 20 – 39 years, 27.2% fall within the age group 40 – 59 years and 18.2% within age group >60 years while *E. coli* infected wound was found to occur in one patient in the age group >60 years. Also, among the patients with *P. aeruginosa* infected wound, 40% were in the age group 0 – 19 years and 20 – 39 years while only one patient in the age group 20 – 39 years had *A. baumanii* infected wounds. Among the patients with *Proteus* spp infected wounds, 31.6% belongs to the age group 0 – 19 years, 26.3% to 20 – 39 years, 36.8% to 40 – 59 years and 5.3% to age group >60 years.

**ANTIBIOTIC SUSCEPTIBILITY TESTING**

The isolates showed varied antibiotic susceptibility profile to the different antibiotics used in this study as shown in table 4. All the clinical isolates exhibited multidrug resistant phenotype, being resistant to three or more classes of antibiotics.

The isolates exhibited 100% resistance to amoxicillin-clavulanic acid, piperacillin and piperacillin-tozobactam. Percentages of the isolates that showed resistance to sulphamethoxazole-trimethoprim, erythromycin, chloramphenicol, doxycyclin, cefixime, ceftazidime and aztreonam were greater than 70%.

High level of resistance (>50%) was observed among the Gram positive isolates against cefixime, ceftazidime, aztreonam, cefoxitin, amoxicillin-clavulanic acid, ciprofloxacin, ofloxacin, perfloxacin, doxycycline, chloramphenicol, sulphamethoxazole-trimethoprim, piperacillin and piperacillin-tozobactam while their susceptibility to nitrofurantoin and imipenem was 100%. Majority (>70%) of the Gram negative bacteria were resistant to amoxicillin-clavulanic acid, piperacillin, piperacillin-tozobactam, sulphamethoxazole-trimethprim, and doxycycline while most (97.5%) were sensitive to imipenem. *E. coli* showed 100% resistance to sulphamethoxazole-trimethoprim, erythromycin, chloramphenicol, doxycycline, perfloxacin, ofloxacin, ciprofloxacin, piperacillin, piperacillin-tozobactam but 100% susceptibility to aztreonam, cefoxitin, ceftazidime, nitrofurantoin, cefixime, gentamicin and imipenem. *Proteus* spp., *Klebsiella* spp. and *A. baumanii* showed 100% susceptibility to imipenem while *P aeruginosa* showed 80% susceptibility.

**MRSA AND ESBL PHENOTYPE**

Six (54.5%) out of the 11 strains of *Staphylococcus aureus* were methicillin resistant as they showed resistance to either oxacillin, cefoxitin or both (Table 5). The result of the ESBL detection is presented in table 5. A total of 16 (55.2%) organisms produced ESBL out of 29 Gram negative organisms that were tested. *E. coli*, *A. baumanii* and *Klebsiella* spp. had 100% ESBL production while *Proteus* spp., and *P. aeruginosa* had 42.1% and 60% respectively.

**TABLE 1: PERCENTAGE FREQUENCY OF BACTERIAL ISOLATES FROM WOUND INFECTION**

| Clinical Isolates | Number (N) | Percentage (%) |
|---|---|---|
| ***Proteus* spp.** | **19** | **47.5** |
| ***Staphylococcus aureus*** | **11** | **27.5** |
| ***Pseudomonas aeruginosa*** | **5** | **12.5** |
| ***Klebsiella* spp.** | **3** | **7.5** |
| ***Acinetobacter baumanii*** | **1** | **2.5** |
| ***Escherichia coli*** | **1** | **2.5** |

**TABLE 2: DISTRIBUTION OF BACTERIAL ISOLATES ACCORDING TO WOUND TYPES**

| Wound types | Isolate Number/% | Bacteria isolated | Percentage (%) |
|---|---|---|---|
| Burns | 5 (12.5%) | *Proteus* spp | 80 |
| | | *Staphylococcus aureus* | 20 |
| Acute soft tissue | 14 (35%) | *Staphylococcus aureus* | 42.9 |
| | | *Proteus* spp | 35.7 |
| | | *Pseudomonas aeruginosa* | 21,4 |
| Surgical wound | 7 (17.5%) | *Proteus* spp | 42.9 |
| | | *Pseudomonas aeruginosa* | 28.5 |
| | | *Staphylococcus aureus* | 14.3 |
| | | *Escherichia coli* | 14.3 |
| Diabetic foot ulcer | 1 (2.5%) | *Klebsiella* spp | 100 |
| Leg ulcer | 13 (32.5%) | *Proteus* spp | 53.8 |
| | | *Staphylococcus aureus* | 23.1 |
| | | *Klebsiella* spp | 15.4 |
| | | *Acinetobacter baumanii* | 7.7 |

**TABLE 3: NUMBER AND PERCENTAGE DISTRIBUTION OF BACTERIAL ISOLATES ACCORDING TO PATIENTS' AGE GROUPS AND GENDER**

| Bacterial isolates | Gender distribution | | Patients' age group | | | |
|---|---|---|---|---|---|---|
| | Male | Female | 0 – 19 years | 20 – 39 years | 40 – 59 years | >60 years |
| *Staphylococcus aureus* | 5 (45.5%) | 6 (54.5%) | 1 (9.1%) | 5 (45.5%) | 3 (27.2%) | 2 (18.2%) |
| *Escherichia coli* | 1 (100%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (100%) |
| *Proteus* spp. | 12 (63.2%) | 7 (36.8%) | 6 (31.6%) | 5 (26.3%) | 7 (36.8%) | 1 (5.3%) |
| *Pseudomonas aeruginosa* | 4 (80%) | 1 (20%) | 2 (40%) | 2 (40%) | 1 (20%) | 0 (0%) |
| *Acinetobacter baumanii* | 1 (100%) | 0 (0%) | 0 (0%) | 1 (100%) | 0 (0%) | 0 (0%) |
| *Klebsiella* spp. | 3 (100%) | 0 (0%) | 0 (0%) | 1 (33.3%) | 2 (66.7%) | 0 (0%) |

## DISCUSSION

Wound colonization by microorganisms especially bacteria has been found to be a major contributing factor to delay or non-healing of wounds which could result to increased trauma and financial burden for the patient and the entire healthcare institution as a whole (2, 12). Therefore, correct identification of the etiological agents and the selection of effective antibiotics against the causative organisms are very important for effective management of patients with infected wounds.

In this study, more of the isolates were recorded to occur in wound infections of male patients (65%) than the females (35%), and microbial colonization of the wounds occurred more among patients in the age group 20 – 39 and 40- 59 years. These findings corresponded with previous reports on patients' gender distribution of bacterial isolates from wound infections in hospitals in Nigeria (3, 4).

**TABLE 4: NUMBER AND PERCENTAGE ANTIBIOTIC RESISTANCE OF BACTERIAL ISOLATES**

| Antibiotics | *S. aureus* (n=11) | *E. coli* (n=1) | *Proteus* spp. (n=19) | *Klebsiella* spp. (n=3) | *A. baumanii* (n=1) | *P. aeruginosa* (n=5) | Total (N=40) |
|---|---|---|---|---|---|---|---|
| SXT | 9(81.8%) | 1(100%) | 11(56%) | 3(100%) | 1(100%) | 4(80%) | 29(72.5%) |
| E | 5(45.5%) | 1(100%) | 17(89%) | 3(100%) | 1(100%) | 5(100%) | 32(80%) |
| C | 6(54.5%) | 1(100%) | 14(74%) | 2(67%) | 0(0%) | 5(100%) | 28(70%) |
| DO | 7(63.6%) | 1(100%) | 16(84%) | 3(100%) | 1(100%) | 5(100%) | 33(82.5%) |
| PEF | 6(54.5%) | 1(100%) | 5(26%) | 1(33%) | 0(0%) | 2(40%) | 15(37.5%) |
| TZP | 11(100%) | 1(100%) | 19(100%) | 3(100%) | 1(100%) | 5(100%) | 40(100%) |
| PRL | 11(100%) | 1(100%) | 19(100%) | 3(100%) | 1(100%) | 5(100%) | 40(100%) |
| IPM | 0(0%) | 0(0%) | 0(0%) | 0(0%) | 0(0%) | 1(20%) | 1(2.5%) |
| GEN | 3(27.3%) | 0(0%) | 7(37%) | 1(33%) | 0(0%) | 2(40%) | 13(32.5%) |
| CXM | 11(100%) | 0(0%) | 15(79%) | 3(67%) | 1(100%) | 4(80%) | 34(85%) |
| OFL | 6(54.5%) | 1(100%) | 5(26%) | 1(33%) | 0(0%) | 1(20%) | 14(35%) |
| AMC | 11(100%) | 1(100%) | 19(100%) | 3(100%) | 1(100%) | 5(100%) | 40(100%) |
| NIT | 0(0%) | 0(0%) | 14(74%) | 2(67%) | 0(0%) | 5(100%) | 21(52.5%) |
| CPR | 6(54.5%) | 1(100%) | 8(42%) | 1(33%) | 0(0%) | 2(40%) | 18(45%) |
| CAZ | 11(100%) | 0(0%) | 14(74%) | 1(33%) | 1(100%) | 2(40%) | 29(72.5%) |
| CRX | 5(45.5%) | 1(100%) | 16(84%) | 2(67%) | 0(0%) | 4(80%) | 28(70%) |
| OX | 4(36.4%) | ND | ND | ND | ND | ND | ND |
| FOX | 6(54.5%) | 0(0%) | 14(74%) | 1(33%) | 0(0%) | 4(80%) | 25(62.5%) |
| AT | 11(100%) | 0(0%) | 17(89%) | 3(100%) | 1(100%) | 3(60%) | 35(87.5%) |

**SXT-sulphamethoxazole-trimethoprim, E-erythromycin, C-chloramphenicol, DO-doxycycline, PEF-perfloxacin, TZP-piperacillin/tozobactam, PRL-piperacillin, GEN-gentamicin, IPM-imipenem, CXM-cefixime, OFL-ofloxacin, AMC-amoxicillin-clavulanic acid, NIT-nitrofurantoin, CPR-ciprofloxacin, CAZ-ceftazidime, CRX-cefuroxime, OXA-oxacillin, FOX-cefoxitin, AT-aztreonam, ND-Not done**

In this study, six different bacteria belonging to six different genera: *Proteus* spp, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella* spp, *Escherichia coli, Acinetobacter baumanii*, were collected. This is similar to reports from other part of the country where similar bacterial isolates have been isolated from infected wounds (9, 21). *Proteus* spp (47.5%) was the most prevalent, followed by *Staphylococcus aureus* (27.5%). This result is in conformity with that reported by Etok *et.al*. (12) where they found *Proteus* spp. to be the most common isolate (33.3%) followed by *Staphylococcus aureus* (20%). We found *Proteus* spp (80%) to be most prevalent in burn wound infection as opposed to *Staphylococcus aureus* (42.9%) which was prevalent in acute soft tissue infection. Similar organisms were identified in acute soft tissue infections which include cutaneous abscesses, traumatic wounds, and necrotizing infection in which microbiological investigations showed that *Staphylococcus aureus* is the single causative bacterium in approximately 25 to 30% of cutaneous abscesses (22). This could be explained based on the fact that *Staphylococcus aureus* constitute the normal skin flora.

This study also showed variation in the susceptibility of bacterial isolates to different antibiotics. The result of the antibiogram revealed that gentamicin and the fluoroquinolones were effective against the clinical isolates, carbapenems such as imipenem, are still the most active class of antibiotic in the treatment of MDR infections as all the organisms except one were susceptible to it. High level resistance was observed against some of the antibiotics such as co-trimoxazole, piperacillin, piperacillin-tozobactam, doxycycline, erythromycin, chloramphenicol and amoxicillin-clavulanic acid particularly among the Gram-negative organisms. This may be due to high level of abuse through self-medication, of the penicillin and aminopenicillin, tetracycline and macrolide classes of antibiotics in this part of the world (23, 24).

**TABLE 5: NUMBER AND PERCENTAGE OF ISOLATES WITH MDR, ESBL -PRODUCING AND METHICILLIN RESISTANCE PHENOTYPE**

| Organisms | N/% of MDR isolates | N/% of ESBL producers | N/% MRSA |
|---|---|---|---|
| ***S. aureus*** **(n = 11)** | **11 (100%)** | **NA** | **6(54.5%)** |
| ***Escherichia coli*** **(n = 1)** | **1(100%)** | **1(100%)** | **NA** |
| ***Acinetobacter baumanii*** **(n = 1)** | **1(100%)** | **1(100%)** | **NA** |
| ***Proteus*** **spp. (n = 19)** | **19(100%)** | **8(42.1%)** | **NA** |
| ***Pseudomonas aeruginosa*** **(n = 5)** | **5(100%)** | **3(60%)** | **NA** |
| ***Klebsiella*** **spp (n = 3)** | **3(100%)** | **3(100%)** | **NA** |
| **Total (N = 40)** | **40 (100%)** | **16 (40%)** | **6(15%)** |

**n – Number, % - Percentage, NA – Not Applicable, MDR – Multidrug resistance, ESBL – Extended-Spectrum Beta-Lactamase, MRSA – Methicillin Resistant *Staphylococcus aureus***

Methicillin-resistant *Staphylococcus aureus* have been reported to cause high mortality and morbidity especially in surgical units and newborn nurseries (16). MRSA are known to show resistance to multiple classes of antibiotics including the beta-lactams, aminoglycosides, macrolides and fluoroquinolones (16). The prevalence of MRSA compared with the 11 *Staphylococcus aureus* collected in this study was moderately high (54.5%) and this suggest that possible increase in their prevalence in the future is eminent if care is not taking to curtail their spread.

Production of extended-spectrum β-lactamases have been reported in both community and hospital settings amongst Gram-negative bacterial isolates (10, 11) and this has led to the campaign for appropriate and rational use of extended-spectrum antibiotics so as to minimize cases of antibiotic resistance. In this study, although ESBL production varied among the organisms, it was produced in varied percentages among the individual Gram-negative bacteria tested. This confirms wide spread reports of ESBLs among various species of Gram-negative bacteria (25, 26). Of the 29 Gram-negative bacterial isolates tested for the production of ESBLs, only 55.2% produced the enzymes. This percentage prevalence is comparable with previous reports in Nigeria (10, 11).

In conclusion, strict antibiotics policy should be implemented in hospitals nationwide to reduce the spread of highly resistant bacteria. This when effectively enforced will help to improve health condition and reduce the cost of treatment of life threatening diseases. Prevention they say is better than cure, adequate measures should be placed on preventive procedures such as hand washing, disinfection, good nursing practice and good surgical techniques amongst others, in the hospitals to reduce bacterial contamination and spread.

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