International Journal of Pathogen Research

7(2): 9-17, 2021; Article no.IJPR.69880
ISSN: 2582-3876

Prevalence, Sensitivity Profile and Resistance of Gram-Positive Bacteria in Wounds to Conventional Antibiotics

Mercy Alabi[1*], Michael Bayode[1], Ikeoluwa Aina[2], Jeremiah Adesanya[1] and Oluwaseun Areo[3]

[1]Department of Microbiology, Federal University of Technology, Akure, Nigeria.
[2]Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.
[3]Department of Animal Nutrition and Biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author MA designed the experiment, conducted the study and corrected the manuscript. Author MB corrected the manuscript and did the proof read. Authors IA and JA wrote the first draft of the manuscript. Author OA analyzed the data obtained. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPR/2021/v7i230177
Editor(s):
(1) Dr. Rafik Karaman, Al-Quds University, Palestine.
Reviewers:
(1) Ahmed Orabi, Cairo University, Egypt.
(2) Biswajit Batabyal, Serum Analysis Centre Private Limited, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/69880

Original Research Article

Received 18 April 2021
Accepted 23 June 2021
Published 28 June 2021

ABSTRACT

Aim: The prevalence, sensitivity profile and resistance of Gram-positive bacteria in wounds to commercial antibiotics were ascertained in this study.
Place and duration of study: University of Medical Sciences Teaching Hospital, Akure, Nigeria, between January and June 2019.
Methodology: Wound swabs sample collection, isolation of bacteria, identification of Gram-positive bacteria isolates and antibiotics sensitivity testing of isolated bacteria were determined employing standard protocols.
Result: Three Gram-positive bacteria were isolated and presumptively identified to be *S. aureus, S. epidermidis* and *S. pyogenes. S. aureus* had the highest prevalence of 53% followed by *S. epidermidis* with 42% and *S. pyogenes* accounting for the least occurrence of 5%. Ninety percent

**Corresponding author: Email: alabimercy14@gmail.com;*

(90%) of ten *S. aureus* strains were resistant to ciprofloxacin while only 10% had intermediate activity. The least resistance of *S. aureus* strains was against pefloxacin (40%), while to streptomycin, 87.5% of eight *S. epidermidis* strains were resistant and 12.5% had intermediate sensitivity. Susceptibility was observed in *S. epidermidis* against pefloxacin (12.5%) while 50% had intermediate sensitivity and 37.5% were resistant. The highest zone of inhibition of *S. epidermidis* was observed in strain 7 against pefloxacin (16.00±1.00 mm) and in *S. aureus* by strain 5 against pefloxacin (16.50±2.50 mm).

Conclusion: Pefloxacin-sensitive *Staphylococcus* and *Streptococcus* species from wound swabs could become resistant overtime and this calls for incessant vigilance on Gram-positive wound bacteria antibiotic-susceptibility appraisal particularly in an antibiotics-abuse setting.

Keywords: Antibiotic; antibiotics sensitivity; Gram-positive bacteria; wound swab; prevalence.

1. INTRODUCTION

Every living organism evolves with survival instincts overtime. They do this by adapting to hostile environmental conditions resulting in resistance to harmful substances they are exposed to, majorly antibiotics [1]. Antibiotic resistance of bacteria refers to the genetic capability of bacteria to reduce the efficacy of a particular antibiotic through its physiological or structural traits [2]. Antibiotic resistance has accumulated over the last few decades, to become a major public health challenge globally. This resistance has been attributed to the consistent use and abuse of antibiotics and the reluctance of pharmaceutical industries to produce more efficacious antibiotics due to financial burden [3].

A wound is a type of injury on the skin either from accidents, surgery or puncture resulting in damage of the underlying tissue [4]. Wound contamination refers to the presence of microorganisms within a wound. Wound infection results due to the colonization of wound surface by pathogenic bacteria. Bacteriological studies have shown that wound infection is common and the bacteria types that occupy the wound vary geographically [5]. Wound infection by bacteria could result from direct contact with the pathogen through contaminated surgical equipment during surgery or airborne dispersal from a contaminated environment. Wound infection may also be self-inflicted by physical migration of patient's endogenous microflora present on the skin, mucous membrane or gastrointestinal tract to the surgical site [6].

Gram positive bacteria include the group of bacteria with thick cell walls which enables them to yield a positive result to the Gram stain test [7]. Gram positive bacteria have played a major role in prolonging wound infections majorly due to their resistance to antibiotics and the continuous upsurge in the number of severely ill patients [8]. The appropriate knowledge of the pathogens and their resistant characteristics would play an important role in wound treatment process as well as infection control and prevention measures. Therefore, this study was intended to determine the antibiotic susceptibility profile of Gram-positive bacteria responsible for wound contamination and infection.

2. MATERIALS AND METHODS

2.1 Sample Collection and Isolation of Bacteria

A total of 57 wound swabs were collected from patients in medical and surgical wards of University of Medical Sciences Teaching Hospital, Akure, Ondo State, Nigeria. The samples were carefully collected by medical personnel using sterile cotton swabs and immediately transported to the Department of Microbiology laboratory, Federal University of Technology, Akure, Nigeria. The samples were inoculated on nutrient agar and blood agar and incubated at 37 ^{o}C for 24 hours [9]. Each colony was sub-cultured to obtain pure cultures and Gram-stained to identify the Gram-positive isolates which were stored at 4^{o}C.

2.2 Identification of Gram-Positive Bacterial Isolates

Bacterial isolates were presumptively identified using colonial characteristics including opacity, colour, elevation, surface, edge and shape and biochemical characteristics including Gram's reaction, catalase, citrate, urease, oxidase and sugar fermentation tests [10].

2.3 Antibiotics Sensitivity Testing

The sensitivity of bacterial isolates to a panel of conventional antibiotics was performed using the

Kirby-Bauer method. Isolates were cultured at 37 ^{o}C for 24 hours and standardized to 0.5 McFarland standard as described by Alabi et al. [11]. A panel of ten antibiotics inclusive of pefloxacin (10 µg), gentamicin (10 µg), ampliclox (30 µg), zinacef (20 µg), amoxicillin (30 µg), rocephin (25 µg), ciprofloxacin (10 µg), streptomycin (30 µg), septrin (30 µg) and erythromycin (10 µg) was used to determine the sensitivity of each Gram-positive bacterium. The antibiotics discs were aseptically placed on the inoculated agar plates using sterile forceps and seeded plates were then incubated at 37 ^{o}C for 18 hours [12]. After incubation, diameters of zones of inhibition were measured to the nearest millimetre (mm) using a transparent meter rule and interpreted as stated by Clinical laboratory standard institute [13].

2.4 Statistical Analysis

Analysis of data was done using Statistical Package for Social Sciences (SPSS) version 26. Data obtained were subjected to one-way Analysis of Variance (ANOVA) and means separated by Duncan's New Multiple Range Test. Results are presented as mean± standard error.

3. RESULTS AND DISCUSSION

Three Gram-positive bacteria were isolated from wound swab samples and presumptively identified to be *Staphylococcus aureus, Staphylococcus epidermidis and Streptococcus pyogenes* (Table 1). The frequency of occurrence of the bacterial isolates is presented in Fig. 1 with *S. aureus* having the highest prevalence of 53% followed by *S. epidermidis* with 42% and *S. pyogenes* accounting for the least occurrence of 5%. This finding is cohesive with the observations from Almeida et al. [14], Ekwati et al. [15] and Baba et al. [5] which confirm the prevalence of the same isolates in wounds of hospitalised patients. Ohabughiro et al. [16] also reported the dominance of *S. aureus* and *S. pyogenes* in their study on orthopaedic wound infection in medical centres in South East Nigeria.

Tables 2-4 show the zones of inhibition of *S. epidermidis, S. aureus and S. pyogenes* respectively to a panel of ten antibiotics each. The zones of inhibition for *S. epidermidis* ranged from 6.00 to 16.00 mm, the recorded zones of inhibition for *S. aureus* ranged from 6.00 to 16.50 mm and the zones of inhibition ranged from 7.00 to 14.50 mm for *S. pyogenes*. The values of the zones of inhibition showed that *S. epidermidis, S. aureus* and *S. pyogenes* isolated from wounds vary in sensitivity to different commercially available antibiotics. However, the overall result showed extensive resistance of bacteria to the antibiotics which agrees with the result of Ohabughiro et al. [16] and Mahat et al. [17]. This elevated level of resistance of the isolates may be as a result of the promiscuous use of antibiotics without laboratory tests and doctor's prescription.

The antibiotic susceptibility test carried out on the isolated Gram-positive bacteria showed that all ten (10) strains of *S. aureus* isolates were resistant to erythromycin, gentamicin, ampliclox, zinacef, amoxicillin and rocephin. Ninety percent (90%) of *S. aureus* strains were resistant to ciprofloxacin while only 10% had intermediate activity. The least resistance of *S. aureus* strains was against pefloxacin (40%) (Fig. 2). All eight (8) strains of *S. epidermidis* showed resistance to ciprofloxacin, septrin, erythromycin, gentamicin, ampliclox, zinacef, amoxicillin and rocephin. To streptomycin, 87.5% of the strains were resistant while 12.5% had intermediate sensitivity. Susceptibility (12.5%) was observed against pefloxacin while 50% had intermediate sensitivity and 37.5% were resistant (Fig. 3). A single strain of *S. pyogenes* was isolated in the experiment. *S. pyogenes* strain was resistant to eight of the ten antibiotics tested (ciprofloxacin, septrin, erythromycin, gentamicin, ampliclox, zinacef, amoxicillin and rocephin) while intermediate sensitivity was observed against streptomycin and pefloxacin (Fig. 4).

The high level of resistance of bacteria to antibiotics reported in this study agrees with the findings of Nagaraju and Divakar [18] who reported high resistance of bacteria to amoxicillin, streptomycin, ceftriaxone, gentamicin and erythromycin. Another experiment on the susceptibility pattern of Gram-positive bacteria from blood culture by Abebaw et al. [19] also reported the resistance of bacteria to ampicillin, amoxicillin and erythromycin which supports the findings of this study. However, the high resistance of bacteria in this study to ciprofloxacin negates the study of Mohammed et al. [20] who reported that ciprofloxacin had great inhibitory effect on *S. aureus*. This can be as a result of the level of exposure of the bacterial isolates to antimicrobials which in turn increases its resistance.

Table 1. Biochemical Tests for the Bacteria Isolates

Isolate number	Gram's Reaction	Catalase	Citrate	Oxidase	Urease	Glucose	Fructose	Lactose	Sucrose	Mannitol	Maltose	Probable identity
1	+	+	-	-	+	A	A	A	A	-	A	*Staphylococcus epidermidis*
2	+	+	+	-	+	AG	AG	AG	AG	AG	AG	*Staphylococcus aureus*
3	+	-	ND	ND	ND	A	-	A	A	-	A	*Streptococcus pyogenes*

Key: + is Positive; - is Negative; A is Acid producing; AG - Acid and gas producing; ND – Not determined

Table 2. Zones of inhibition (mm) of *Staphylococcus epidermidis* isolated from wound swabs against antibiotics

Strains	CPXS = ≥21 I =16-20 R = ≤15	SS = ≥16 I =12-14 R = ≤11	SXTS = ≥16 I =11-15 R = ≤10	ES = ≥23 I =14-22 R = ≤13	PEFS = ≥16 I =13-15 R = ≤12	CNS = ≥15 I =13-14 R = ≤12	APXS = ≥17 I =14-16 R = ≤13	ZS = ≥23 I =15-22 R = ≤14	AMS = ≥17 I =14-16 R = ≤13	RS = ≥23 I =20-22 R = ≤19
1	12.00 ± 1.00^{bc}	8.50 ± 0.50^{a}	10.50 ± 0.50^{abc}	9.00 ± 1.00^{ab}	13.00 ± 1.00^{c}	7.50 ± 0.50^{a}	8.00 ± 1.00^{a}	9.00 ± 1.00^{ab}	10.00 ± 1.00^{abc}	10.50 ± 1.50^{abc}
2	14.00 ± 1.00^{d}	8.50 ± 0.50^{abc}	8.50 ± 0.50^{abc}	9.00 ± 0.00^{abc}	13.00 ± 1.00^{d}	6.00 ± 0.00^{a}	8.00 ± 0.00^{ab}	9.00 ± 0.00^{abc}	12.00 ± 2.00^{cd}	11.00 ± 2.00^{bcd}
3	13.50 ± 1.50^{b}	7.50 ± 0.50^{a}	8.50 ± 0.50^{a}	7.50 ± 0.50^{a}	13.50 ± 0.50^{b}	7.50 ± 0.50^{a}	12.00 ± 1.00^{b}	13.00 ± 1.00^{b}	8.50 ± 0.50^{a}	8.50 ± 0.50^{a}
4	15.00 ± 1.00^{d}	9.00 ± 0.00^{ab}	9.00 ± 1.00^{ab}	7.00 ± 1.00^{a}	14.00 ± 0.00^{cd}	9.00 ± 1.00^{ab}	10.00 ± 2.00^{abc}	11.00 ± 1.00^{abc}	10.00 ± 1.00^{abc}	12.00 ± 2.00^{bcd}
5	14.00 ± 1.00^{d}	9.00 ± 1.00^{abc}	7.00 ± 1.00^{ab}	8.00 ± 1.00^{abc}	11.50 ± 1.50^{cd}	6.50 ± 0.50^{a}	6.50 ± 0.50^{a}	10.50 ± 0.50^{bc}	9.00 ± 2.00^{abc}	8.50 ± 0.50^{abc}
6	14.00 ± 1.00^{c}	7.50 ± 0.50^{a}	6.50 ± 0.50^{a}	6.50 ± 0.50^{a}	9.00 ± 1.00^{ab}	6.50 ± 0.50^{a}	6.50 ± 0.50^{a}	11.00 ± 1.00^{b}	7.00 ± 1.00^{a}	7.00 ± 1.00^{a}
7	15.00 ± 1.00^{e}	10.00 ± 1.00^{cd}	7.00 ± 1.00^{ab}	8.00 ± 1.00^{abc}	16.00 ± 1.00^{e}	6.50 ± 0.50^{a}	7.00 ± 1.00^{ab}	11.50 ± 0.50^{d}	7.50 ± 0.50^{abc}	9.50 ± 0.50^{bcd}
8	13.50 ± 0.50^{a}	13.50 ± 2.50^{a}	9.00 ± 1.00^{a}	12.50 ± 0.50^{a}	12.50 ± 0.50^{a}	12.50 ± 1.50^{a}	13.50 ± 2.50^{a}	13.00 ± 1.00^{a}	10.00 ± 0.00^{a}	11.50 ± 0.50^{a}

Results are presented as mean ± SE. Values carrying the same alphabet in similar row are not significantly dissimilar (P=0.05); Key: CPX= Ciprofloxacin; S= Streptomycin; SXT= Septrin; E= Erythromycin; PEF= Perfloxacin; CN= Gentamicin; APX= Ampliclox; Z= Zinacef; AM= Amoxicillin; R= Rocephin

Table 3. Zones of inhibition (mm) of *Staphylococcus aureus* isolated from wound swabs against antibiotics

Strains	CPXS = ≥21 I =16-20 R = ≤15	SS = ≥16 I =12-14 R = ≤11	SXTS = ≥16 I =11-15 R = ≤10	ES = ≥23 I =14-22 R = ≤13	PEFS = ≥16 I =13-15 R = ≤12	CNS = ≥15 I =13-14 R = ≤12	APXS = ≥17 I =14-16 R = ≤13	ZS = ≥23 I =15-22 R = ≤14	AMS = ≥17 I =14-16 R = ≤13	RS = ≥23 I =20-22 R = ≤19
1	13.00±1.00^{c}	7.00±1.00^{a}	9.00±1.00^{abc}	6.00±0.00^{a}	12.00±1.00^{bc}	8.00±2.00^{ab}	10.00±2.00^{abc}	9.00±1.00^{abc}	7.50±0.50^{a}	9.50±0.50^{abc}
2	12.00±1.00^{de}	7.00±1.00^{a}	8.50±0.50^{abc}	7.50±1.50^{ab}	13.50±0.50^{e}	7.50±0.50^{ab}	9.00±1.00^{abc}	10.50±0.50^{bcd}	7.50±0.50^{ab}	11.00±1.00^{cde}
3	14.00±1.00^{d}	7.00±1.00^{a}	10.50±0.50^{abcd}	11.00±3.00^{abcd}	13.00±1.00^{cd}	7.00±1.00^{a}	9.00±1.00^{abc}	10.50±0.50^{abcd}	8.00±1.00^{ab}	11.50±0.50^{bcd}
4	12.00±1.00^{d}	7.50±0.50^{a}	9.50±0.50^{abcd}	8.00±1.00^{ab}	12.00±1.00^{d}	7.00±1.00^{a}	9.00±1.00^{abc}	10.50±0.50^{bcd}	8.00±1.00^{ab}	11.50±0.50^{cd}
5	13.50±0.50^{cd}	9.00±0.00^{ab}	7.00±1.00^{a}	7.00±1.00^{a}	16.50±2.50^{d}	6.00±0.00^{a}	12.00±2.00^{bc}	8.50±0.50^{ab}	7.00±1.00^{a}	9.50±0.50^{ab}
6	17.00±1.00^{c}	10.00±1.00^{ab}	7.00±1.00^{a}	9.50±0.50^{ab}	12.50±1.50^{b}	7.00±1.00^{a}	7.00±1.00^{a}	12.50±2.50^{b}	7.00±1.00^{a}	11.00±1.00^{ab}
7	12.00±1.00^{bc}	7.50±0.50^{a}	12.00±2.00^{bc}	9.50±0.50^{ab}	13.00±1.00^{c}	7.00±1.00^{a}	6.50±0.50^{a}	8.50±0.50^{a}	7.00±1.00^{a}	8.50±0.50^{a}
8	12.50±1.50^{bcd}	12.00±2.00^{bcd}	8.50±0.50^{ab}	9.00±1.00^{abc}	15.00±1.00^{d}	7.50±0.50^{a}	8.50±0.50^{ab}	13.00±1.00^{cd}	13.50±1.50^{d}	14.00 ±2.00^{d}
9	9.00±1.00^{ab}	8.00±1.00^{ab}	9.00±1.00^{ab}	7.50±1.50^{a}	9.50±0.50^{ab}	10.00±2.00^{ab}	12.00±1.00^{b}	7.00±1.00^{a}	7.00±1.00^{a}	7.50±1.50^{a}
10	12.50±1.50^{b}	7.50±0.50^{a}	7.00±1.00^{a}	8.50±0.50^{a}	13.00±1.00^{b}	7.00±1.00^{a}	7.50±1.50^{a}	7.00±1.00^{a}	7.00±1.00^{a}	10.50±1.50^{ab}

Results are presented as mean ± SE. Values carrying the same alphabet in similar row are not significantly dissimilar (P=0.05); Key: CPX= Ciprofloxacin; S= Streptomycin; SXT= Septrin; E= Erythromycin; PEF= Pefloxacin; CN= Gentamicin; APX= Ampliclox; Z= Zinacef; AM= Amoxicillin; R= Rocephin

Table 4. Zones of inhibition (mm) of *Streptococcus pyogenes* isolated from wound swabs against antibiotics

Strains	CPXS = ≥21 I =16-20 R = ≤15	SS = ≥16 I =12-14 R = ≤11	SXTS = ≥16 I =11-15 R = ≤10	ES = ≥23 I =14-22 R = ≤13	PEFS = ≥16 I =13-15 R = ≤12	CNS = ≥15 I =13-14 R = ≤12	APXS = ≥17 I =14-16 R = ≤13	ZS = ≥23 I =15-22 R = ≤14	AMS = ≥17 I =14-16 R = ≤13	RS = ≥23 I =20-22 R = ≤19
1	12.50±1.50^{bcd}	13.00±2.00^{cd}	7.00±1.00^{a}	7.50±1.50^{ab}	14.50±0.50^{d}	7.00±1.00^{a}	9.00±1.00^{abc}	8.00±2.00^{abc}	8.00±2.00^{abc}	12.50±1.50^{bcd}

Results are presented as mean ± SE. Values carrying the same alphabet in similar row are not significantly dissimilar (P=0.05); Key: CPX= Ciprofloxacin; S= Streptomycin; SXT= Septrin; E= Erythromycin; PEF= Pefloxacin; CN= Gentamicin; APX= Ampliclox; Z= Zinacef; AM= Amoxicillin; R= Rocephin

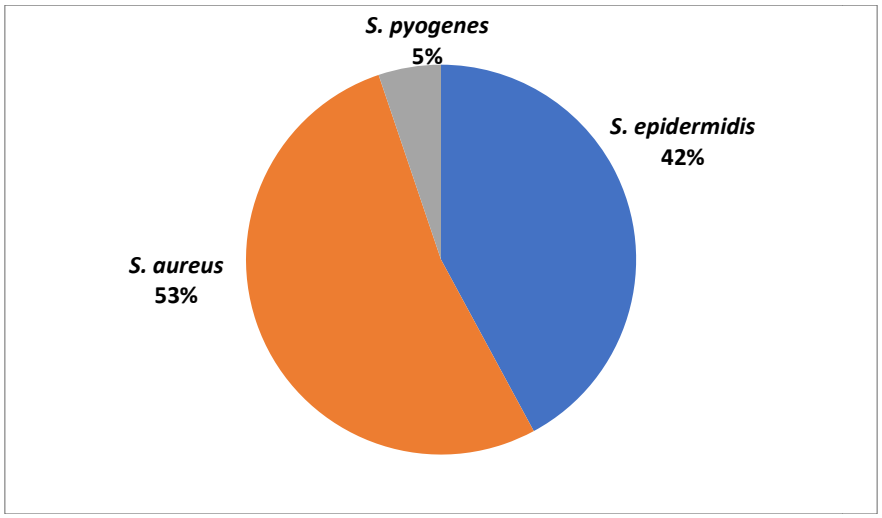

Fig. 1. Prevalence of gram-positive bacteria in wound swab samples

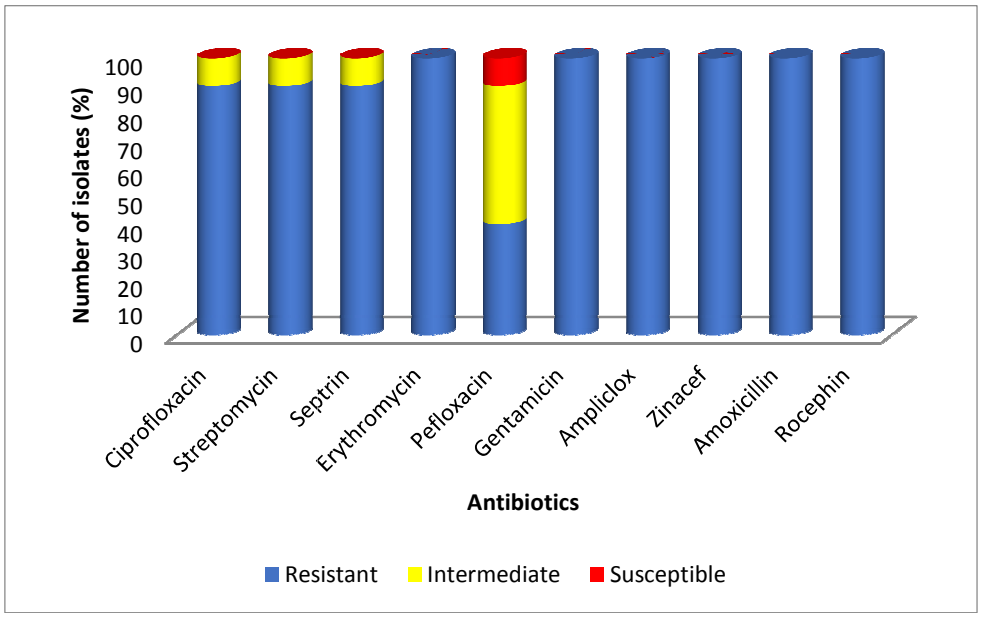

Fig. 2. Sensitivity pattern of *Staphylococcus aureus* strains isolated from wounds

Strain 7 of *S. epidermidis* was susceptible to pefloxacin with zone of inhibition of 16.00±1.00 mm (Table 2). *S. aureus* strain 5 was also susceptible to pefloxacin with zone of inhibition of 16.50±2.50 mm (Table 3). *S. pyogenes* displayed intermediate sensitivity to pefloxacin at 14.50±0.50 mm (Table 4). Generally, the least resistance of Gram-positive bacteria in this study was against pefloxacin (Figs 2-4). Hence, it can be opined that pefloxacin is an effective antibiotic in treatment of bacterial infections. Sani et al. [21] also reported the high effectiveness of pefloxacin against Gram-positive bacteria from wounds.

Owing to the great resistance of bacteria against antibiotics, combination therapy (use of more than one antibiotic) can be an effective treatment option [22]. However, the indiscriminate use of antibiotics must be reduced to the barest minimum to avoid further increase in the rate of resistance. Another alternative is the use of natural products such as plant extracts as antimicrobials. These natural products have

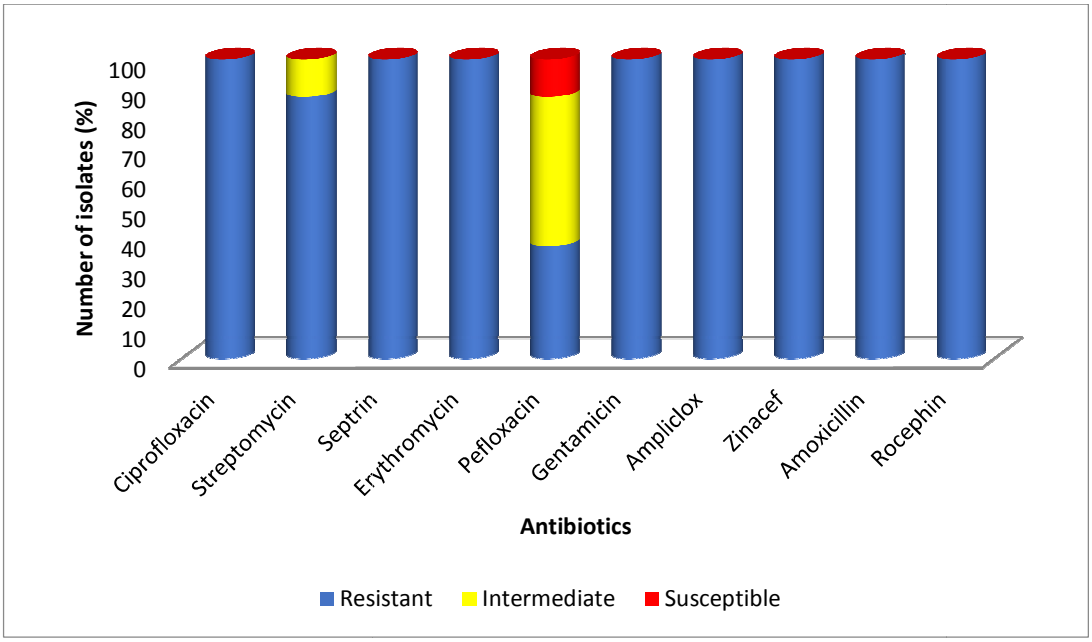

Fig. 3. Sensitivity pattern of *Staphylococcus epidermidis* strains isolated from wounds

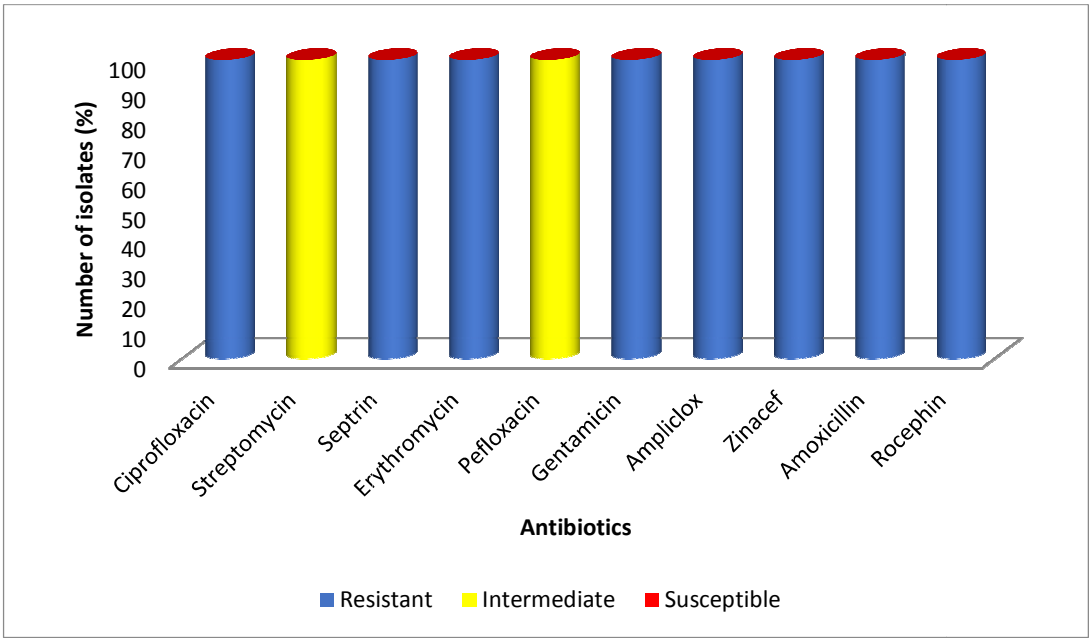

Fig. 4. Sensitivity pattern of *Streptococcus pyogenes* strain isolated from wound

multiple mechanism of action against bacteria and it is therefore difficult for bacteria to develop resistance against them [23]. However, in the use of these natural products, there is a need for standardisation for appropriate dosage and to prevent other adverse effects that can result from the use of herbal and other natural products [24].

4. CONCLUSION

Gram-positive bacteria isolated from wound swab samples are *S. aureus, S. epidermidis and S. pyogenes*. The sensitivity of Gram-positive bacteria in wounds to antibiotics varies proving the need for antimicrobial sensitivity testing

before drug prescription. The result of antibiotics sensitivity testing in this study showed high resistance to commonly used antibiotics. The least resistance was to pefloxacin. However, pefloxacin-sensitive *Staphylococcus* and *Streptococcus* species from wound swabs could become resistant overtime, hence, the need for caution in the use of antibiotics without prescription. Combination therapy and the use of natural products as antimicrobials are promising solutions to the problem of increasing resistance of bacteria to antibiotics.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical approval for the collection of wound swabs from patients of Medical Sciences Teaching Hospital, Akure, Nigeria was collected from Ondo State Health Research Ethics Committee, Ministry of Health, Ondo State with number NHREC/18/08/2016.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Salim S, Michel T, Loubna T. Bacterial resistance to antibiotics and associated factors in two hospital centers in Lebanon from January 2017 to June 2017. Infection Prevention in Practice. 2020;2(2): 100043.
2. Blair JM, Webber MA, Baylay AJ, Ogbolu DO, Piddock LJ. Molecular mechanisms of antibiotic resistance. Nat Rev. Microbiol. 2015;13:42-51
3. Lushniak BD. Antibiotic resistance: A Public Health Crisis. Public health Rep. 2014;129(4):314-316
4. Russell JA. Shock Syndrome related to Sepsis. Goldman I, Schafer AI, EdsMedicine, 24th ed. Philadelphia, Pa: Saunder Elsevier;2011.
5. Baba J, Olutimayin AT, Alalade OM, Aliyu MB, Ndaji GM. Isolation and Identification of some Bacteria associated with wound sepsis among the patients attending General Hospital Minna, Nigeria. Lapai Journal of App and Nat Science. 2020;1(1):104-110
6. Murray CK, Loo FL, Hospenthal DR, Cancio LC, Jones JA, Kim SH et al. Incidence of systemic fungal infection and related mortality following severe burns. Burns. 2008;34(8):1108-1112
7. Kirsten Nunez. Gram positive bacteria explained in simple terms. Health line;2019. Available:www.healthline.com/health/gram-positive Accessed 4th June 2021
8. Arias CA, Murray BE, The rise of the Enterococci: beyond vancomycin resistance. Nat Rev Microbiol. 2012;10:266-278
9. Garoy EY, Gebreab YB, Achila OO, Tekeste DG, Kesete R, Ghirmay R, et al. Methicillin-resistant *Staphylococcus aureus* (MRSA): Prevalence and antimicrobial sensitivity pattern among patients – a multicentre study in Asmara, Eritrea. Can J Infect Dis Med Microbiol; 2019. Article ID 8321834
10. Rahman A, Haque A, Ahmad T, Mahmud S, Sohana SN, Hossain R, et al., Isolation, identification and antibiotics sensitivity pattern of *Salmonella* spp from locally isolated egg samples. Am J Pure Appl Biosci. 2019;1(1):1-11
11. Alabi MA, Olusola-Makinde O, Oladunmoye MK. Evaluation of phytochemical constituents and antibacterial activity of *Chromolaena odorata* L. leaf extract against selected multidrug resistant bacteria isolated from wounds. South Asian J Res Microbiol. 2019;5(3):1-9
12. Sharma C, Gulati S, Thakur N, Singh BP, Gupta S, Kaur S, et al., Antibiotics sensitivity pattern of indigenous lactobacillus isolated from curd and human milk samples. 3 Biotech. 2017;7(1):53.
13. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing: Twenty-fourth information supplement, 2014;34(1):1-226. M100-S24
14. Almeida GCM, dos Santos MM, Lima NGM Cidral TA, Melo MCN, Lima KC. Prevalence and factors associated with wound colonization by *Staphylococcus spp.* and *Staphylococcus aureus* in hospitalised patients in inland North Eastern Brazil: a cross-sectional study. BMC Infect Dis. 2014;14:328

15. Ekwati ER, Darmanto W, Wahyuningsih SPA. Detection of Staphylococcus aureus in wound infection on the skin surface. IOP Conf. Ser. Earth Environ Sci. 2020;456:012038.
16. Ohabughiro BN, Onyenwe NL, Ogbulie JN. Bacteria isolates associated with orthopaedic wounds in two medical centres in southern Nigeria. J Global Biosci. 2014;3(1):255-262
17. Mahat P, Manadhar S, Baidya R. Bacteriological profile of wound infection and antibiotic susceptibility pattern of isolates. J Microbiol Exp. 2017;4(5):00126
18. Nagaraju EV, Divakar G. Antibiotics susceptibility of bacterial strains isolated from diabetic patients. International Journal of Advances in Pharmacy, Biology and Chemistry. 2012;1(4):546-550
19. Abebaw A, Tesera, H, Belachew T, Mihiretic GD. The bacterial profile and antibiotic susceptibility pattern among patients with suspected blood stream infections, Gondar, North-west Ethiopia. Pathology and Laboratory Medicine International. 2018;10:1-17
20. Mohammed A, Seid ME, Gebrecherkos T, Tiruneh M, Moges F. Bacterial isolates and their antimicrobial susceptibility patterns of wound infections among inpatients and outpatients attending the University of Gondar Referral Hospital, Northwest Ethiopia. Intl J of Microbiology. 2017;2017:1-10
21. Sani RA, Garba SA, Oyewole OA, Ibrahim A. Antibiotics profile of Gram positive bacteria isolated from wound infections in Minna, Bida, Kontagora and Suleja area of Niger State. J Health Sci. 2012;2(3):19-22
22. Coates ARM, Hu Y, Holt J, Yeh P. Antibiotics combination therapy against resistant bacterial infection: Synergy, rejuvenation and resistance reduction. Expert review of Anti-infective therapy. 2020 ;18(1):5-15
23. Alabi MA. Antibiotics sensitivity profile of wounds' bacterial isolates and antibacterial assessment of *Chromolaena odorata* aqueous and ethyl acetate extracts. South Asian Res J Nat Prod. 2020;3(1):1-9
24. Adeeyo AO, Edokpayi JN, Alabi MA, Msagati TAM, Odiyo JO. Plant active products and emerging interventions in water potabilization: disinfection and multidrug resistant pathogen treatment. Clin Phytoscience. 2021;7:31

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/69880