ORIGINAL ARTICLE

CIPROFLOXACIN AND STREPTOMYCIN AS DRUGS OF CHOICE IN TREATMENT OF SURGICAL SITE INFECTIONS IN MAIDUGURI

[1]Akanmu AO, [2]Anonde CE, [1]Balogun ST, [1]Paul LM, [1]Sodipo OA

[1]Department of Clinical Pharmacology and Therapeutics, Faculty of Basic Medical Sciences, College of Medical Science, University of Maiduguri, Maiduguri, Nigeria
[2]Department of Medical Laboratory Science, Faculty of Allied Health Sciences, College of Medical Sciences, University of Maiduguri, Maiduguri, Nigeria

Correspondence and reprint request to: Prof. Sulayman Tunde Balogun, Department of Clinical Pharmacology and Therapeutics, Faculty of Basic Medical Sciences, College of Medical Science, University of Maiduguri, P.M. B.1069, Maiduguri Nigeria
Phone: +234 806 598 0029

ABSTRACT

Background: Surgical site infections (SSIs) are medical events that have direct unintended consequences on patients. They often result in increased hospitalization and a greater number of diagnostic and therapeutic procedures. In Maiduguri, they are a major source of post-operative illness among hospitalized patients. Hence, it is important to determine the scope of bacteria involvement and identify suitable antibacterial agents for effective treatment. **Objectives:** The study was designed to determine the prevalence of SSIs in patients with surgical wounds, determine the antibiogram of the bacteria involved and drug of choice in the treatment of SSIs. **Methodology**: The study design was cross-sectional using the qualitative approach. Patients with surgically created wounds infected (>30 days post-surgery) were enrolled between April and May 2018 at UMTH following informed consent. Swab samples were aseptically collected from the patients. The isolation and identification of bacterial isolates were done by cultural, microscopic and biochemical characterization. The antibiogram of the bacterial isolates was determined using disc diffusion method. Appropriate statistical tools were used. **Results**: A total of 70 patients with surgically created wounds were enrolled. The prevalence of SSIs in patients with surgically created wounds was 95.7% (67/70). Three bacterial species were identified with *S. aureus* accounting for the highest proportion of 68.7% (46/67) while *Klebsiella spp* was (19.4 %, 13/67) and *E. coli* was (11.9 %, 8/67) [p<0.05]. Ciprofloxacin had the highest proportion of sensitivity against *S. aureus* isolates with a value of 87 %. Streptomycin is the most sensitive drug against the Gram negative organisms isolated with a sensitivity of 87.5 % and 85 % for *E. coli* and *Klebsiella spp.*, respectively. **Conclusions**: These findings suggest that there is a high prevalence of SSIs in patients with surgically created wounds seen at UMTH. Ciprofloxacin and streptomycin are suitable antibacterial agents in the treatment of the condition and this could contribute to effective treatment of patients with SSIs.

Key words: *Antibiogram, Bacterial isolates, Ciprofloxacin, Streptomycin, Surgical site infections*

INTRODUCTION

Surgical Site Infections (SSI) are severe events that have direct unintended consequences on patients. These events are directly related to an increase in hospitalisation time and a greater number of diagnostic and therapeutic procedures.[1] "The invasion of surgical wound by bacterial pathogen within thirty days of an operation or within one year of surgery if an implant is placed in a patient is called surgical site infection".[2] Surgical site infections have been reported as having the highest prevalence of all nosocomial infections recorded in orthopaedic wards.[3] It is the major source of post-

Access this article online

Quick Access Code

WEBSITE: www.kjmsmedicaljournal.com

DOI: 10.36020/kjms.2021.1501.002

operative illness, infrequent and the highest cause of death among surgical patients in the U.S.[4] Morbidity, mortality, increase in hospitalization and hospital cost is a burden to hospital resources which are caused by surgical site infection.[5] SSIs are of 3 different types according to the American Center for Disease Control and Prevention (CDC) viz: superficial incisional Surgical site infections, deep incisional surgical site infections and infections involving organs or body spaces. The degree of contamination at the time of surgery influences the probability of occurrence of SSI. Surgically created wounds can also be classified as clean, clean-contaminated wounds, contaminated wounds and dirty wounds.[6] The most commonly isolated organism in SSI is *Staphylococcus aureus,* other organisms include coagulase-negative staphylococci (CoNS), *Enterococcus spp*., *Escherichia coli*, *Pseudomonas aeruginosa,* and *Enterobacter spp.*[7]

Surgical procedures create widespread challenges due to undesirable events related to post-surgical infection in both developing and developed countries.[8] Early treatment of SSI is an essential step in reducing its associated cost, morbidity and mortality. Gadzama *et al*.[9] reported that *Proteus spp* and *Pseudomonas aeruginosa* were the most important gram-negative bacteria found in the isolates from infected wounds in Maiduguri. However, scientific data on the drug of choice in treatment of SSI in Maiduguri is lacking. Although, antibiotics used in preventing surgical wound infections such as: open fractures, prosthetic joint placement, puncture wounds or infected surgical wounds have long been recognized.[10] However, the prevalence of antibiotic-resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA), multi drug-resistant pathogens and others, have made the drug treatment difficult and led to an increase in the incidence of surgical site infection.[4] Moreover, there is a paucity of surveillance data and scientific data in the treatment of SSI[11]. By the use of evidence-based drug treatment in preventing SSI and their adverse effects, one can increase patient safety, circumvent additional health care costs and ameliorate health care quality. Therefore, this study was designed to assess the prevalence of surgical site infection and serve as a guide to treat patients in surgical wards in Maiduguri.

MATERIALS AND METHOD

Study Area

The study was conducted in Maiduguri, Borno State, Nigeria with an area of about 69,436km^2 located at latitude 10-30^0 N and longitude 12-15^{0}E. It lies within the savannah vegetation zone with low rainfall. Maiduguri is a major livestock producing area with an estimated livestock population put at 40% of national ruminant population count.[12] The climate of the region is classified as hot semi-arid with a temperature peak of 44°C (April- May) during the hot dry season and lowest (<20°C) during the dusty harmattan (December-January). It has a short rainy season (June-September) with an annual rainfall of 500-1000 mm. [13,14]

Study Population

The study was conducted on patients with surgically created infected wounds in the surgical wards of the University of Maiduguri Teaching Hospital (UMTH).

Sample Size Determination

The sample size for the study was determined using Thrushfield formula (2007) for random sampling[15]. The required sample size was thus determined (70).

Ethical Consideration and Informed Consent

Before sample collection, ethical clearance was sought from the ethical committee of the UMTH and approval was given. Patients in the surgical wards gave their consent and confidentiality of information collected was assured.

Method of Specimen Collection

Specimens were collected from surgical ward patients with surgically created wounds. The selection criteria involved wounds that were surgically created and were infected (>30 days post-surgery). Wounds identified with pus draining, red and painful/hot to touch were selected and swabbed aseptically using sterile swab stick with gloved hands. Non-pus draining (uninfected) wounds were excluded. Samples were collected between April 1st and 31st May 2018.

Sample Processing

Swab specimens were transported immediately to the laboratory and were processed within two hours of collection.

Culturing Procedure

Each specimen on reaching the laboratory was cultured on blood, MacConkey and Chocolate agar to check for the presence of *Staphylococcus species*, Lactose fermenters such as *Escherichia Coli* and *Klebsiella species* as described by Carter, Quinn *et al.*,

Ochei and Kolhatkar.[16-18] They were incubated aerobically for 24 hours at 37^0 C and the plates were examined macroscopically for colonial morphological characteristics on the following day.

Biochemical Reaction and Identification

The bacterial isolates were subjected to biochemical tests which are catalase, coagulase, indole, urea and citrate according to the description of Ochei and Kolhatkar.[18]

Antibiotic Susceptibility Testing

The antibiotic susceptibility testing was determined by disc diffusion method according to Clinical Stanford Laboratory Institute[19]guidelines. Both gram-positive and gram-negative discs were used. Seven to eight discreet colonies of bacterial pathogens were inoculated into 5ml of sterile distilled water, to give fine bacterial suspensions equivalent to 0.5 in Mcfarland standard. A sterile swab was dipped into the bacterial suspension and it was used to swab the surface of the labelled Nutrient agar plate to give a confluent growth. Antibiotics discs were applied on the plate and incubated at 37°c for 24 hours. The zone of inhibition was measured with a standard calibrator to determine the isolate resistance or sensitivity to the applied antibiotics.[19]

Data Analysis

The data generated from this study were analyzed using the statistical software, Statistical Package for the Social Sciences (SPSS) version 21[20]. Data are expressed as mean, standard deviation and range and significance was inferred at $p<0.05$.

RESULTS

Overall, 70 patients with various surgical wounds were enrolled into the study. The majority of the patients who participated in the study were males (60.0%, 42/70). Out of the 70 samples collected, 67 (95.7 %) bacteria were isolated and no bacteria growth was recorded in 3 (4.3 %) of the total wound swabs. Table 1 shows the distribution of bacterial isolates according to the sex of the patients. Males accounted for 41 (62.2 %) of the samples while females accounted for 26 (38.8 %).

Table 2 shows the distribution of bacterial isolates recovered in surgical wound samples. Three bacterial species were identified with *Staphylococcus aureus* accounting for the highest proportion of 68.7% (46/67).

Table 3 shows the antibiogram of the *Staphylococcus aureus* isolated from the surgical wounds of the patients. Ciprofloxacin had the highest proportion of sensitivity against the isolates with a value of 87 %.

Table 4 shows the results of the antibacterial sensitivity testing for the isolated Gram negative organisms (*E. coli* and *Klebsiella spp*). Streptomycin is the most sensitive drug with a sensitivity percentage of 87.5% and 85% against *E. coli* and *Klebsiella spp,* respectively.

Table 1: Prevalence of bacterial Isolates in surgical wound samples

Bacteria isolates	Frequency	Percentage (%)
Esherichia coli	8	11.9
Klebsiella spp	13	19.4
Staphylococcus aureus	46	68.7
Total	67	100.0

Table 2: Distribution of bacterial isolates according to sex

Bacteria isolates	Male	Female	Total
Esherichia coli	5	3	8
Klebsiella spp	9	4	13
Staphylococcus aureus	27	19	46
Total	41	26	67
Percentage (%)	62.2	38.8	100

Table 3: Antibiotic Susceptibility pattern of the isolated *S. aureus*

	CPX	CH	NB	AMX	RD	GN	LEV	E	APX	S
Sensitive %	87	54	52	65	63	59	63	57	54	65
Resistance%	13	46	48	35	37	41	37	43	46	35

CPX (Ciprofloxacin), CH (Chloramphenicol), NB (Norfloxacin), AMX (Amoxicillin) RD (Rifampicin), GN (Gentamycin), LEV (Levofloxacin), E (Erythromycin), APX (Ampiclox), S (Streptomycin).

Table 4: Antibiotic susceptibility pattern of Gram negative isolates

Bacteria isolates		CPX	AU	CN	OFX	S	SXT	CH
Escherichia coli	Sensitive %	50	62.5	75	62.5	87.5	25	75
(n=8)	Resistance %	50	37.5	25	37.5	12.5	75	25
Klebsiella spp	Sensitive %	69	23	46	54	85	31	61
(n=13)	Resistance %	31	77	54	46	15	69	39

CPX (Ciprofloxacin), AU (Augumentin), CN (Gentamycin), OFX (Ofloxacin), S (Streptomycin), SXT (Trimethoprim-sulpathoxazole), CH (Chloramphenicol)

DISCUSSION

Surgical site infection has posed a serious problem in hospitals for a long time and advances in the control of infections have not completely eradicated the problem. Factors that contribute to the problem include drug resistance, low level of personal hygiene and poverty.[9] The present study examined the prevalence of surgical site bacterial infection among patients with surgical wounds attending UMTH and determined the antibiogram of the bacteria involved.

In this study, *Staphylococcus aureus* (69 %) ranked highest in occurrence compared with other bacterial isolates encountered. This finding agrees with the study conducted by Gadzama *et al*.[9] who reported *Staphyloccocus aureus* as the most prevalent agent of surgical wound infections in health institutions in Maiduguri with a prevalence of 57 %. Therefore, this result shows that there is an increase in the proportion of wound infection caused by *Staphyloccocus aureus* in UMTH compared to that of Gadzama *et al*.[9] The events leading to the infection depend on an array of factors that may be environmental or patient-related. The postulated sequence of events leading to infection could be initiated by *Staphylococcus aureus* nasal carriage via inhalation of infected droplets and contact with infected persons or objects which is then disseminated by the hands to other sites in the body where infection can occur through broken skin surfaces.[21]

The emergence of *Klebsiella spp* (19.4 %) and *Escherichia coli (*11.9 %) as the most common Gram negative organisms in this study suggests that the isolates could be strains with high infectivity and resistance to the commonly used antibiotics in the hospital community.

The antibiogram profile of *staphylococcus aureus* showed that most of the strains encountered were mostly susceptible to Ciprofloxacin (87 %). This could be because Ciprofloxacin being a new generation antibiotic is not as widely abused as most of the old generation antibiotics, hence, its high degree of efficacy. However, relatively high resistance was observed for Chloramphenicol (46 %), Norfloxacin (48 %) and Ampiclox (46 %) and this could be because these drugs are often abused.

In the antibiogram profile of *Escherichia coli* and *Klebsiella spp*; the organisms were 87.5 % and 85 % susceptible to Streptomycin respectively, followed by 75 % and 61 % susceptibility to Chloramphenicol and Ciprofloxacin 50 % and 69 % respectively, while they were highly resistant to Augmentin (77

%), Trimethoprim-sulphamethoxazole (75 %) and Gentamycin (54 %). The rise in the antibiotic resistance noticed agrees with earlier report by Obasweiki-Ebor *et al*.[21] where antibiotic abuse and prevalence of self-medication with antibiotics were identified as some of the factors being responsible for the antibiotic resistant bacterial strains.

Generally, Ciprofloxacin, Streptomycin and Gentamycin appeared to be much efficacious than all other antibiotics against the entire Gram-positive and Gram negative isolates. This is in agreement with reports from a Tertiary care hospital in Gujarat, India.[23]

In conclusion, there is a high prevalence of surgical site bacterial infections in patients with surgical wound admitted in UMTH with *S. aureus, Klebsiella spp*. and *E. coli* being the bacteria of concern. The isolated *S. aureus* was largely sensitive to ciprofloxacin; the *E. coli* was largely sensitive to gentamicin, chloramphenicol and streptomycin. Therefore, the result of this study will assist surgical wound care practitioners in the choice of prophylactic antimicrobial agents that would prevent wound complications, increase healing rates and reduce the risk of cross-infection in health institutions in this region.

Ethical Approval

Authors hereby declared that the experimental protocol was approved by the ethical committee, University of Maiduguri Teaching Hospital and consent of patients in surgical wards was sought as well. All rules were followed as specified by national laws where applicable.

Conflict of Interests

There is no conflict of interest to declare.

REFERENCES

1. Parvizi, J., Gehrke, T. and Chen, A. F. (2013) Proceedings of the international consensus on periprosthetic joint infection. *Bone joint*, **95**(11):1450-1452.
2. Horan, T. C., Gaynes, R. P., Martone, W. J., Jarvis, W. P. and Emori, T. G. (1992). CDC definition of Surgical Wound Infections, **13**(10): 606-608.
3. Maksimović, J., Marković-Denić, L., Bumbaširević, M., Marinković, J. and Vlajinac, H. (2008). Surgical Site Infections in Orthopedic Patients: Prospective Cohort Study. *Croatian Medical Journal,* **49**:58-65.
4. Mangram, A. J., Horan, T. C., Pearson, M. L., Silver, L. C. and Jarvis, W. R. (1999). Guideline for Prevention of Surgical Site Infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practices Advisory Committee. *American Journal of Infection Control*, **27**(2):97-134.
5. Awad, S. S., Palacio, C. H., Subramanian, A., Byers, P. A., Abraham, P. and Lewis, D. (2009). Implementation of Methicillin Resistant Staphylococcus aureus (MRSA) prevention bundle results in decreased MRSA surgical site infections. *American Surgeon,* **198**: 607-610.
6. Di Leo, A., Piffer, S., Ricci, F., Manzi, A., Poggi, E., Porretto, V., Fambri, P., Piccini, G., Patrizia, T., Fabbri, L. and Busetti, R. (2009). Surgical site infections in an Italian surgical ward: a prospective study. *Surgical Infection (Larchmt)*, **10**(6):533-5338.
7. Zahran, W. A., Zein-Eldeen, A. A., Hamam, S. S. and Elsayed-Sabal, M. S. (2017). Surgical site infections: Problem of multidrug-resistant bacteria. *Menoufia Medical Journal*, **30**(4):1005-1013.
8. Tariq, A., Ali, H., Zafar, F., Sial, A. A., Hameed, K. Naveed, S., Shafiq, Y., Salim, S., Mallick, N. and Hasnain, H. (2017). A Systemic Review on Surgical Site Infections: Classification, Risk Factors, Treatment Complexities, Economical and Clinical Scenarios. *Journal of Bioequivalence and Bioavailability*, **9**(1):336-340.
9. Gadzama, G. B., Zaillani, S. B., Abubakar, D. and Bakari, A. A. (2007). Bacterial pathogens associated with wound infection at the University of Maiduguri, Nigeria. *Kanem Journal of Medical Science*, **1**(1): 26-28.
10. Enzler, M. J., Berbari, E. and Osmon, D. R. (2011). Antimicrobial Prophylaxis in adults. *Mayo Clinic Proceedings*, **86**(7):686-701.
11. Pathak, A., Saliba, E. A., Sharma, S., Mahadik, V. K., Shah, H. and Lundborg, C. S. (2014). Incidence and factors associated with surgical site infections in a teaching hospital in Ujjain, India. *American Journal of Infection Control*, 42:e11-e15

12. Gadzama, U. N., Toyosi, R. I., Madakan, S. P. and Ali, A. F. (2011). Effect of livestock, human hosts and aquatic habitat distribution on the abundance of Anopheles gambiae complex in Borno State, Arid Zone of Nigeria. *International Journal of World Rural Observations*, **3**(4):71-77.
13. Molta, N. B., Watila, I. M., Out, T. I., Oguche, S. O., Daniel, H. I. and Gadzama, N. M. (1995). Malaria in Nigeria: an update on its chemotherapy with chloroquine, pyrimethamine/sulphadoxine and pyrimethamine/sulphalene and the need for alternative antimalarial drugs. *Research Journal of Science*, **1**(2):59-64.
14. Gim and Associates (2002). Environmental and human resources development consultant. Environmental impact assessment of Nigerian Bottling Company PLC. Coca-cola Maiduguri Plant 'A' Wastewater discharge project: *Draft report*, 1-81.
15. Thrusfiled, N. (2007). Survey. In: Veterinary Epidemiology, 3rd Edition, Blackwell Science, Oxford, UK pp 222-248.
16. Carter, G. R. (1984). Isolation and identification of bacteria from clinical specimens. Diagnostic Procedures in Veterinary Bacteriology and Mycology. 4th ed., Charles C. Thomas, USA. Pp 19-30.
17. Quinn, P. J., Carter, M. E., Markey, B. and Carter, G. R. (1994) Bacterial Pathogens: Microscopy, Culture, and Identification. In: Clinical Veterinary Microbiology. *Wolfe Publishing, London*, Pp 21-80.
18. Ochei, J. and Kolhatkar, A. (2010). Medical Laboratory Science Theory and Practice. Tata McGraw-Hill Publishing Company Limited pp; 537-658.
19. Clinical Laboratory and Standards Institute (CLSI) (2005). Analysis and presentation of cumulative antimicrobial susceptibility test data. Approved guideline, 2nd ed. CLSI document M39-A2, NCCLS, 940 West Valley Road, Suite 1400, Wayne Pennsylvania. pp 1809-1898.
20. SPSS (2007). Statistical Package for Social Science Windows version 16.0 SPSS Inc, Chicago, IL, USA.
21. Kluytmans, J., Van Belkum, A. and Verbrugh, H. A. (1977). Nasal carriage of *Staphylococcus aureus*: Epidemiology, underlying mechanisms, and associated risks. *Clinical Microbiology Revision*, **10**: 505-520.
22. Obasweki-Ebor, E. E., Akerele, J. O. and Ebea, P. O (1987). A survey of antibiotic self-medication. *Journal Antimicrobial Chemotherapy*, **20**: 759-763.
23. Nutanbala, N. G., Hiren R. T., Alpesh P. G., Tejas K. P. and Tripathi C. B. (2011). Antibiotic sensitivity profile of bacterial pathogens in postoperative wound infections at tertiary care hospital in Gujurat, India. *Journal of Pharmacology and Pharmacotherapeutics*, 2: 158-164.

Cite this article as: Akanmu AO, Anonde CE, Balogun ST, Paul LM, Sodipo OA. Ciprofloxacin and Streptomycin as Drugs of Choice in Treatment of Surgical Site Infections in Maiduguri. KJMS 2021; 15(1): 13 - 18.