

Bacteriological Spectrum and Antimicrobial Resistance Patterns of Surgical Site Infections in a Private Healthcare Facility in Southern Nigeria

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Abstract

Background: Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and prolonged hospitalisation in both public and private healthcare settings. They contribute to increased healthcare costs, delayed wound healing and adverse clinical outcomes. The microbial profile of surgical wound infections varies across institutions and geographical regions, making local bacteriological surveillance essential for effective management. This study investigated the bacteriological profile of surgical wound infections among inpatients and outpatients in a private healthcare facility in Port Harcourt, Nigeria.

Methods: Thirty wound swab specimens were collected from surgical patients, comprising 20 inpatients and 10 outpatients. Samples were processed using standard microbiological techniques. Primary isolation was performed on appropriate culture media, and bacteria were identified based on colonial morphology, Gram staining characteristics and relevant biochemical tests. Antimicrobial susceptibility testing was conducted using the disc diffusion method, and zones of inhibition were measured in millimetres.

Results: Out of the 30 specimens analysed, 27 yielded positive bacterial growth. *Staphylococcus aureus* was the most frequently isolated bacterium (50%), followed by *Pseudomonas* spp (17.9%), *Streptococcus* spp (10.7%), *Bacillus* spp (7.1%), *Proteus* spp (7.1%), *Escherichia coli* (3.6%) and *Klebsiella* spp (3.6%). Susceptibility testing demonstrated variable resistance patterns among isolates. Imipenem and meropenem exhibited activity against several bacteria, whereas amoxycillin showed resistance across the isolates tested.

Conclusion: Surgical wound infections in this study were predominantly associated with *Staphylococcus aureus*, with notable antimicrobial resistance among isolates. These findings emphasise the importance of routine bacteriological investigation and antimicrobial susceptibility testing to guide appropriate therapeutic interventions.

Keywords: Surgical wound infection; Bacteriological profile; *Staphylococcus aureus*; Antimicrobial susceptibility; Orthopaedic surgical site; Nigeria

1. INTRODUCTION

Surgical site infections (SSIs) are defined as infections occurring within 30 days after a surgical procedure or within one year when an implant is left in situ (Mangram et al., 1999). These infections may involve the superficial incision, deep soft tissues, or organ spaces manipulated during surgery. SSIs represent a considerable burden to patients and healthcare systems due to increased morbidity, prolonged hospital stay and additional treatment costs. They remain among the most frequently reported hospital-acquired infections worldwide (Emori & Gaynes, 1993). Despite improvements in aseptic techniques, operating theatre practices, sterilisation procedures and the appropriate use of antimicrobial prophylaxis, SSIs continue to occur at significant rates (Anderson et al., 2014). The development of infection is influenced by multiple factors, including patient-related variables, wound classification, duration of surgery and microbial contamination at the operative site (Haley et al., 1985; Mangram et al., 1999). Microorganisms responsible for SSIs may originate from the patient's endogenous flora or from exogenous sources within the surgical environment (Mangram et al., 1999). Orthopaedic procedures are particularly associated with the risk of surgical wound infection, especially when implants are used, as foreign materials may facilitate bacterial colonisation and

persistence (Lee et al., 2006). The spectrum of causative bacteria varies across institutions and geographical locations, and antimicrobial resistance patterns continue to evolve, complicating empirical therapy (Anderson et al., 2007).

Understanding the local bacteriological profile of surgical wound infections is therefore essential for guiding effective antimicrobial therapy and strengthening infection prevention strategies. Continuous surveillance provides important data for monitoring pathogen distribution and resistance trends within healthcare facilities. This study aimed to determine the bacteriology of surgical wound infection among outpatients and inpatients in a private hospital.

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted in Port Harcourt City Local Government Area, Rivers State, Nigeria. Port Harcourt is a major urban centre in the Niger Delta region and serves as a referral hub for surrounding communities. Laboratory analyses were carried out in the Medical Microbiology Laboratory of the Department of Medical Laboratory Science, Rivers State University. All microbiological investigations were performed under standard laboratory conditions to ensure the accuracy and reliability of results.

2.2. Sample Collection

A total of thirty (30) wound swab specimens were collected from patients who had undergone surgical procedures at Rehoboth Specialist Hospital, located in Port Harcourt. Of the 30 samples obtained, twenty (20) were collected from inpatients admitted to the hospital, while ten (10) were obtained from out-patients attending follow-up clinics. Sterile swab sticks were used for specimen collection to minimise contamination. The samples were transported promptly to the laboratory for immediate processing.

2.3. Laboratory Procedures

All specimens were cultured using standard microbiological techniques. Primary inoculation was performed on Nutrient agar, MacConkey agar, Blood agar, Chocolate agar and Sabouraud dextrose agar, as appropriate. The inoculated plates were incubated under suitable conditions and examined for growth. Identification of isolates was based on colonial morphology, including characteristics such as colour, elevation, margin and consistency. Further characterisation was performed using Gram staining to differentiate Gram-positive and Gram-negative bacteria. Biochemical tests, including catalase, coagulase, oxidase and indole tests, were conducted to confirm the identity of bacterial isolates. These procedures enabled accurate differentiation of the bacteria recovered from the surgical wound specimens.

2.4. Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was carried out using the disc diffusion method. Standard antibiotic discs were placed on inoculated agar plates, which were subsequently incubated. After incubation, zones of inhibition were measured in millimetres (mm) using a ruler. The results were recorded and interpreted based on the observed zone diameters.

3. RESULTS

A total of 30 surgical wound samples were analysed in this study. Of these, 20 (66.7%) were obtained from in-patients, while 10 (33.3%) were from out-patients (Table 1).

Table 1. *Distribution of Patients with Surgical Wound Infection*

No of Patient	Frequency	Percentage
In-patient	20	66.7
Out-patient	10	33.3
Total	30	100

The sex distribution among patients is presented in Table 2. The majority of the study population consisted of female patients.

Table 2. Sex Distribution of Patients

Sex	Frequency	Percentage
Male	6	20
Female	24	80
Total	30	100

Twenty-seven (27) out of the 30 specimens yielded positive bacterial growth, while three (3) samples showed no growth. Table 3 presents the frequency distribution of pathogenic bacteria isolated from the surgical wound sites.

Table 3. Frequency of Pathogenic Bacteria Isolated

Bacteria	Frequency	Percentage
<i>Staphylococcus aureus</i>	14	50
<i>Pseudomonas Spp</i>	5	17.9
<i>Escherichia coli</i>	1	3.6
<i>Bacillus</i>	2	7.1
<i>Proteus</i>	2	7.1
<i>Streptococcus</i>	3	10.7
<i>Klebsiella Spp</i>	1	3.6
Total	28	100

Staphylococcus aureus was the predominant isolate recovered from the surgical wound samples. Mixed growth was observed in several specimens, indicating polymicrobial infection in some cases.

Table 4. Antimicrobial Susceptibility Patterns of Bacterial Isolates from Surgical Site Infections

Antibiotic	<i>S.aureus</i>	<i>Klebsiella spp.</i>	<i>Streptococcus spp.</i>	<i>Bacillus spp.</i>	<i>E. coli</i>	<i>P.aeruginosa</i>	<i>Proteus spp.</i>
Gentamicin	8 mm	R	R	11 mm	15 mm	R	10 mm
Imipenem	4 mm	5 mm	7 mm	12 mm	8 mm	6 mm	15 mm
Amikacin	9 mm	4 mm	10 mm	9 mm	R	5 mm	—
Ciprofloxacin	10 mm	R	15 mm	R	R	R	8 mm
Meropenem	20 mm	8 mm	12 mm	10 mm	—	R	—
Cefuroxime (Ceforitin)	R	R	R	R	R	8 mm	—
Tigecycline	R	R	R	2 mm	10 mm	R	—
Amoxicillin	R	R	R	R	R	R	—

Table 4 summarises the antimicrobial susceptibility profiles of bacterial isolates recovered from surgical site infections. The notation ‘R’ indicates resistance, defined as the absence of a measurable zone of inhibition around the antibiotic disc under the test conditions employed.

4. DISCUSSION

The findings of this study demonstrated that *Staphylococcus aureus* was the most frequently isolated bacterium from surgical wound infections. This observation is consistent with previous studies, which reported *S. aureus* as a leading cause of postoperative wound infection in both community and hospital settings (Cantlon et al., 2006; Mawalla et al., 2011; Anderson & Kaye, 2009). The predominance of *S. aureus* in surgical wound infections may be attributed to its role as a common constituent of normal skin flora and its well-documented ability to adhere to damaged tissue surfaces and implanted materials (Mangram et al., 1999). Furthermore, compromised host defence mechanisms following surgical intervention may facilitate colonisation and subsequent infection, particularly in procedures involving tissue manipulation and implantation.

In addition to *S. aureus*, *Pseudomonas* spp and other Gram-negative bacteria were isolated. Similar microbial distributions have been documented in other healthcare environments, where Gram-negative bacilli contribute substantially to the burden of surgical site infections (Cantlon et al., 2006; Adegoke et al., 2010). The detection of Gram-negative bacteria in surgical wounds may reflect environmental contamination within the hospital setting or endogenous sources from the patient’s own flora (Mangram et al., 1999). The recovery of multiple bacteria from certain specimens suggests the occurrence of polymicrobial infections, a phenomenon previously described in studies of complex

or contaminated surgical wounds (Schnuriger et al., 2010). Polymicrobial involvement may complicate treatment strategies and influence clinical outcomes.

The antimicrobial susceptibility patterns observed in this study revealed resistance to several commonly prescribed antibiotics. Imipenem and meropenem demonstrated activity against multiple isolates, whereas amoxicillin exhibited resistance. The emergence and spread of antimicrobial resistance among surgical pathogens have been widely reported and remain a significant clinical concern (Anderson et al., 2007; Blomberg et al., 2007). Increasing resistance to first-line antibiotics may result in limited therapeutic options, prolonged hospitalisation and increased treatment costs. These findings highlight variability in susceptibility profiles among isolates and reinforce the necessity of routine antimicrobial sensitivity testing to guide targeted therapy and reduce the risk of selecting resistant strains (Mangram et al., 1999).

The antimicrobial susceptibility patterns observed in this study reveal substantial resistance to several commonly prescribed antibiotics. In particular, amoxicillin and cefuroxime demonstrated widespread resistance across nearly all isolates tested. This pattern suggests limited clinical utility of these agents for empirical treatment of surgical site infections within the study setting. Similar findings have been reported in previous Nigerian and international studies, where increasing resistance to beta-lactam antibiotics among surgical pathogens has been documented (Adegoke et al., 2010; Anderson et al., 2007). The persistence of beta-lactam resistance may be attributed to indiscriminate antibiotic use, inappropriate prophylactic regimens, and selective pressure within hospital environments.

Carbapenems, particularly meropenem, exhibited comparatively better activity against several isolates, notably *Staphylococcus aureus* and *Bacillus spp.*, as evidenced by larger zones of inhibition. Imipenem also demonstrated measurable activity against multiple bacteria, although the inhibition diameters varied. These findings are consistent with reports from Blomberg et al. (2007) and Schnuriger et al. (2010), who observed retained in vitro efficacy of carbapenems against multidrug-resistant bacteria in surgical infections. Nevertheless, the reduced susceptibility noted among certain Gram-negative isolates, including *Pseudomonas aeruginosa*, may indicate emerging resistance trends that warrant close monitoring. The overall susceptibility profile underscores the importance of routine antimicrobial sensitivity testing, rational antibiotic selection, and strengthened antimicrobial stewardship programmes to optimise therapeutic outcomes and limit further resistance development.

5. CONCLUSION

Surgical wound infections in this study were predominantly associated with orthopaedic procedures, reflecting the vulnerability of surgical sites involving bone and implant-related interventions. Orthopaedic surgeries often involve extensive tissue manipulation and, in many cases, the insertion of prosthetic materials, which may provide a surface for bacterial adherence and persistence. These factors can increase the likelihood of postoperative infection when contamination occurs. The high level of antimicrobial resistance observed among the bacterial isolates further emphasises the clinical challenge posed by surgical wound infections. Resistance to commonly prescribed antibiotics may limit treatment options and potentially contribute to delayed recovery, prolonged hospitalisation and increased healthcare costs. These findings highlight the necessity of routine microbiological culture and antimicrobial susceptibility testing in the management of suspected surgical wound infections. Early laboratory confirmation of causative bacteria and determination of their resistance patterns are essential to guide targeted antimicrobial therapy, improve patient outcomes and support effective infection control strategies within healthcare facilities.

6. RECOMMENDATIONS

Routine microbiological culture and antimicrobial susceptibility testing should form the basis for guiding antibiotic therapy in cases of suspected surgical wound infection. Empirical treatment without laboratory confirmation may contribute to inappropriate antibiotic selection, which can promote resistance and compromise patient outcomes. By identifying the specific causative bacteria and determining their susceptibility profiles, clinicians are better positioned to prescribe targeted and effective antimicrobial agents, thereby improving therapeutic success and reducing unnecessary exposure to broad-spectrum antibiotics.

In addition, strict and clearly defined guidelines for antibiotic prescription should be established and consistently implemented within healthcare facilities. Such guidelines should emphasise rational antibiotic use, appropriate dosing and duration of therapy, and adherence to antimicrobial stewardship principles. The development and enforcement of institutional protocols can help to minimise indiscriminate antibiotic use and curb the emergence of resistant strains.

Continuous surveillance of antimicrobial susceptibility patterns is also recommended. Ongoing monitoring allows healthcare institutions to detect shifts in resistance trends over time and to update treatment policies accordingly. Sustained surveillance efforts contribute to improved infection control practices, support evidence-based clinical decision-making, and enhance overall patient safety.

7. ETHICS STATEMENT

This study involved the laboratory analysis of surgical wound swab samples collected as part of routine clinical management in a private healthcare facility. The specimens were obtained during standard diagnostic procedures, and no additional samples were collected specifically for research purposes. The investigation was conducted retrospectively using anonymised laboratory data.

No direct patient contact occurred during the study, and no identifiable personal or clinical information was accessed, recorded or disclosed at any stage. All data were handled in strict accordance with institutional policies on confidentiality and data protection.

In line with institutional guidelines governing laboratory audit, surveillance and quality assurance activities involving de-identified routine diagnostic specimens, formal ethical approval and informed consent were not required. The study was conducted in accordance with accepted ethical standards for research involving human-derived clinical materials.

8. CONFLICT OF INTEREST

The authors declare that there are no financial, professional or personal relationships that could be construed as potential conflicts of interest in relation to this study. The research was conducted independently, and the findings presented represent the objective interpretation of the data obtained.

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