ORIGINAL ARTICLE

# Antibiotic resistance of bacteria responsible for postoperative wound infections seen in the laboratory of the University Hospital of Befelatanana

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**Abstract.** The management of postoperative wound infections is a major problem in hospitals due to the frequent ineffectiveness of antibiotic treatment. The objectives of this study are to identify the bacteria responsible for postoperative wound infections and to describe these antibiotic resistances in order to improve the management of these infections. It is a prospective study of 52 bacteriological results of postoperative wounds for a period of six months from January 2021 to June 2021 in the laboratory of the University Hospital of Befelatanana. This study showed 26 (50%) isolates of staphylococci, 17 (32.7%) isolates of enterobacteria, 6 (11.5%) isolates of streptococci and 3 (5.8%) isolates of nonfermenting gram-negatif bacilli. Antibiotic resistance, varies from 0% (vancomycin) to 92.3% (penicillin G) for staphylococci isolates, 0% (imipenem, amikacin) to 94.1% (amoxicillin) for enterobacteria isolates, 0% (vancomycin) to 50% (penicillin G) for streptococci isolates and 33% (imipenem, amikacin) to 100% (cotrimoxazole) for the isolates of nonfermenting gram-negatif bacilli. The knowledge of antibiotic resistance of bacteria responsible for postoperative wound infections allows better patient management.

## Introduction

Postoperative wound infections, also known as surgical site infections (SSIs), complicate the recovery course of many patients. As defined by the Centers for Disease Control and Prevention (CDC), these infections typically occur within 30 days of an operation at the site or part of the body where the surgery took place, or within a year if an implant is left in place and the infection is thought to be secondary to surgery (1). The organism most often isolated is Staphylococcus aureus (2). Overall, it is estimated that SSIs occur following 1-3.1% of all surgical procedures and account for approximately 2.0% of deaths due to health care-associated infections (HAIs) (3). With regard to abdominal surgery, the rate of wound infection may be much higher, with several prospective studies reporting an incidence of 15-25% depending on the level of contamination (4-6). Knowledge of the bacterial species responsible for these infections and knowledge of their sensitivity to antibiotics are important to improve patient management.

Thus, the objectives of this study are to identify the bacteria responsible for postoperative wound infections and to describe these antibiotic resistances in order to improve the management of these infections.

## Materials and methods

*Study design*. It is a prospective study of 52 bacteriological results of postoperative wounds for a period of six months from January 2021 to June 2021 in the laboratory of the University Hospital Center Joseph Raseta Befelatanana (CHUJRB) in Antananarivo Madagascar.

*Study setting*. This study was carried out in the laboratory of the CHUJRB which is located in Antananarivo city in the Analamanga region in Madagascar. This laboratory is a general-purpose medical analysis laboratory open 24 h a day, 7 days a week. This laboratory receives biological samples from patients hospitalized in Antananarivo hospitals or outpatients. The biological analyzes carried out in this laboratory are represented by hematological, biochemical, immunological, virological, parasitological and bacteriological analyses.

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*Study population*. All bacteria identified in postoperative wounds during the study period were included in this study. All bacteria identified in other samples were exclude from the study. Similarly, all bacteria identified in postoperative wounds outside the study period were also exclude from the study.

*Variables*. The dependent variable was represented by the positivity of the bacteriological examination of the postoperative wound. The independent variables were represented by the different bacterial isolates identified and the results of the antibiogram of each bacterium isolated.

*Procedures in laboratory*. Postoperative suppuration is collected in a swab and quickly transported to the laboratory. The bacterial culture is done on the first day, the bacterial identification on the second day and the antibiogram on the third day to determine the sensitivity and resistance of bacteria to antibiotics. The antibiotics tested are represented by penicillins, amoxicillin-clavulanic acid (AMC), 3rd generation cephalosporins (3CG), penemes, aminoglycosides, quinolones, macrolides, lincosamides, cyclins, sulfonamides, amphenicols and glycopeptides. Resistance to antibiotics was determined by the Mueller/Hinton agar diffusion method, according to the recommendations of the 'comité de l'antibiogramme de la société française de Microbiologie' (7).

*Data collection*. Data are collected from register notebooks and antibiogram result sheets.

*Statistical analyses*. The entry and processing of Data were performed on Microsoft excel 2016 and Epi-info 3.5.2 software.

## Results

*Demographic characteristics of the bacteria responsible for postoperative wounds*. The bacteria are represented by 32 Gram positive cocci et 20 Gram negative bacilli. The Gram positive bacilli are represented by the staphylococci and the streptococci. The Gram negative bacilli are represented by the enterobacteria and the non-fermenting gram-negatif bacilli (NFGNB).

*Bacteriological results of postoperative wounds*. The 52 bacteriological results of postoperative wounds showed 26 (50%) isolates of staphylococci, 17 (32.7%) isolates of enterobacteria, 6 (11.5%) isolates of streptococci and 3 (5.8%) of NFGNB. NFGNB are represented essentially by the species *A. baumannii*, and *P. aeruginosa*. Enterobacteria are represented essentially by the species *K. pneumoniae*, *E. cloacae* and *E. coli* (Fig. 1).

*Antibiotic resistance of bacteria responsible for postoperative wounds*. Regarding the isolates of staphylococci, the antibiotic resistance varies from 0% (vancomycin) to 92.3% (penicillin G) (Fig. 2). 3.8% of isolates were represented by methicillin-resistant *S. aureus* (MRSA). Concerning the isolates of enterobacteria, the antibiotic resistance varies from 0% (imipenem, amikacin) to 94.1% (amoxicillin) (Fig. 3). 41.2% of isolates were represented by extended spectrum beta-lactamase (ESBL)-producing enterobacteria. The antibiotic resistance of the isolates of streptococci varies from 0% (vancomycin) to 50% (penicillin G) (Fig. 4). And the antibiotic resistance varies from 33% (imipenem, amikacin) to 100% (cotrimoxazole) for the isolates of NFGNB (Fig. 5).

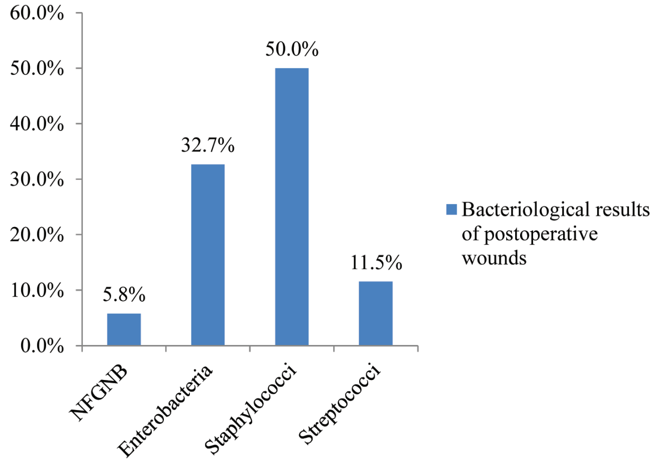


Figure 1. Bacteriological results of postoperative wounds.

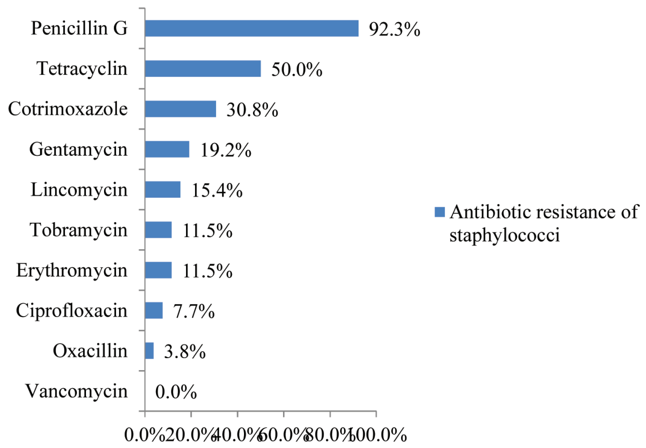


Figure 2. Antibiotic resistance of staphylococci.

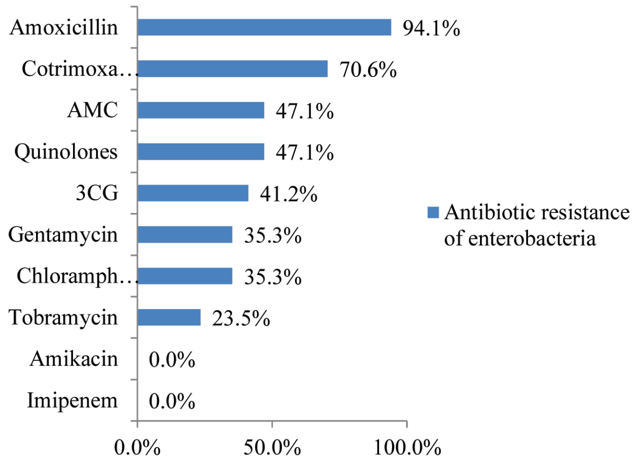


Figure 3. Antibiotic resistance of enterobacteria.

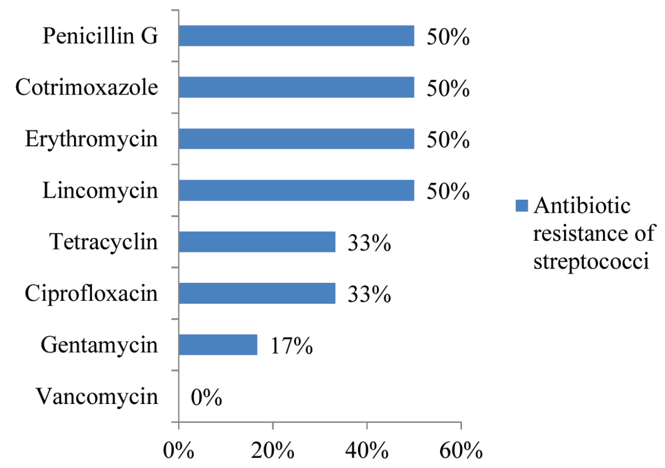


Figure 4. Antibiotic resistance of streptococci.

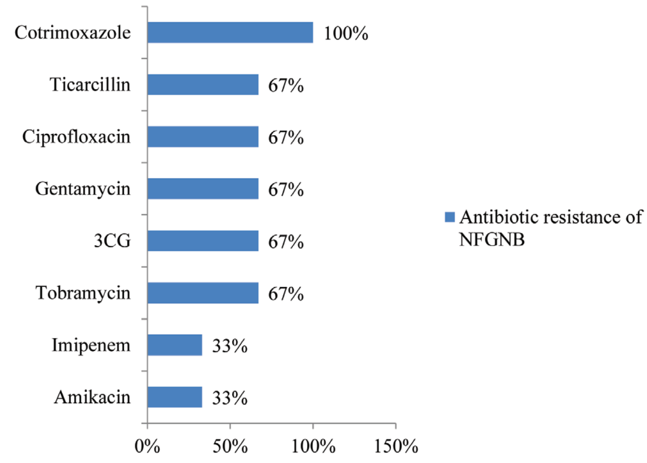


Figure 5. Antibiotic resistance of NFGNB.

## Discussion

This study has shown the isolation of staphylococci in 50% of postoperative wound infections. Other studies have also found that the most commonly implicated pathogens in superficial SSIs include gram-positive bacteria, mainly *S. aureus*, and coagulase-negative staphylococci (3,8). Concerning the antibiotic resistance, these isolates were highly resistant to penicillin G, tetracycline and cotrimoxazole. Indeed, these 3 classes of antibiotics are used frequently by the population. Tetracycline and cotrimoxazole are sold in small grocery stores. Misuse of these antibiotics increases antibiotic resistance. Similarly, self-medication reinforces this high resistance. Fortunately, MRSA isolates are uncommon in this study. Antimicrobial therapy should target these organisms as well as MRSA in patients with specific risk factors (eg, presence of non-penetrating trauma, MRSA infection elsewhere, and history of intravenous drug abuse). First line empiric therapy consists of a first-generation cephalosporin (eg, cefazolin). Vancomycin, daptomycin, linezolid, or an equivalent antibiotic are appropriate when targeting MRSA (3). Indeed, all isolates of staphylococci were sensitive to vancomycin in this study.

Concerning other bacteria, this study found 32.6% of enterobacteria isolated in postoperative wounds. Other studies have also found these bacteria in SSIs (3,9). These isolates are also highly resistant to cotrimoxazole like the staphylococci isolates because of the misuse of this antibiotic. Likewise, they are highly resistant to beta-lactams like amoxicillin, AMC and 3CG. The high consumption of beta-lactams by the population may be responsible for this antibiotic resistance (10) 41.2% of enterobacteria isolated were represented by ESBL-producing enterobacteria. Therefore, broad-spectrum antimicrobial coverage active against gram-negatives should be used in these cases. Indeed, all enterobacteria isolates tested in this study were susceptible to amikacin and imipenem. Another study in Douala also found that imipenem (1.3% of resistance) and amikacin (12.9% of resistance) are the most effective antibiotics against enterobacteria (11). These data suggest that penems (imipenem, meropenem) and aminoglycosides especially amikacin could be an effective alternative choice in enterobacteria infections especially in SSIs. The other aminoglycosides like gentamicin and tobramycin are less effective because they are used frequently in the hospital resulting in the antibiotic resistance of enterobacteria.

Concerning the streptococci isolates, this study has shown 11.5% isolates in postoperative wounds. Other studies have also found streptococci in SSIs (3,12). These isolates are also highly resistant to cotrimoxazole and penicillin G like the staphylococci isolates because of the misuse of these antibiotics. Macrolides, lincosamides, and streptogramins (MLS) are recommended as alternate antibiotics for the treatment of *S. pyogenes* infections in patients who are allergic to β-lactams or in cases of penicillin failure (13). However, the streptococci isolated in this study were highly resistant to macrolide (erythromycin) and lincosamide (lincomycin). Therefore, broad-spectrum antimicrobial coverage active against streptococci should be used in these cases. In this study, all streptococci isolates tested were susceptible to vancomycin. These data suggest that glycopeptides (teicoplanin and vancomycin) could be an effective alternative choice in streptococci infections especially in SSIs.

Concerning other bacteria, this study found 5.7% of NFGNB isolated in postoperative wounds. Other studies have also found these bacteria in SSIs (3,14). The importance of isolation of NFGNB has increased in last decade, after more and more reports are correlating them with the either infection outbreaks in hospitals, or healthcare-associated infections (15). Concerning antibiotic resistance, this study showed a high resistance of isolates of NFGNB to antibiotics. It is 100% for cotrimoxazole. As mentioned previously, this antibiotic is improperly prescribed in Madagascar and is sold in small grocery stores. Thus, self-medication reinforces this high resistance. Moreover, the molecules of choice, such as penemes and aminoglycosides, are becoming less and less effective, showing 33% (imipenem) and 33% (amikacin) of resistance. These NFGNBs are represented essentially by the species *A. baumannii* and *P. aer*uginosa. Similarly, another study in Iran showed resistance *A. baumannii* with cefixime (99%), ceftazidime (99%), ciprofloxacin (98%), meropenem (99%), trimethoprim-sulfamethoxazole (99%), imipenem (91.5%), ceftriaxone (99%), levofloxacin (96.5%), amikacin (70%) and gentamycin (85%) (16). The emerging challenges of multidrug resistance, both intrinsic and acquired, among NFGNB, are of serious concern to the treating physician. Improved antibiotic stewardship and infection control measures will be needed to prevent or slow down the emergence and spread of multi-drug-resistant NFGNB in the healthcare setting. Identification of NFGNB and monitoring their susceptibility patterns will help in improving the empirical therapy (17).

*Limitations*. The sample size in the study was limited to 52. Indeed, bacteriological examinations for pus are rare because post-operative patients all receive prophylactic antibiotic treatment to avoid bacterial superinfections. Nevertheless, if we extend the study period, we may have more cases and the results of the study could be representative of the general population.

## Conclusions

In brief, the bacteria responsible for postoperative wound infections or SSIs have been represented by staphylococci, enterobacteria, streptococci and NFGNB. The majority of these bacteria are resistant to penicillins and cotrimoxazole due to the misuse of these antibiotics and self-medication in the population. All streptococci and staphylococci isolates tested were susceptible to vancomycin. Similarly, all enterobacteria isolates were susceptible to imipenem and amikacin. Among these bacteria, NFGNB were the most resistant to antibiotics. Thus, In view of the antimicrobial resistance of NFGNB, detection in a patient must be the subject of an official declaration of the circulation of this strain at Coordination Center for the Fight against Nosocomial Infections.

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## Contributions

ZDRR, design of the study, laboratory analysis, and writing of the article; FMR, statistical analysis and bibliographic research; JNRR, writing of the article and bibliographic research; ALR, correction of the article. All the authors approved the final version to be published.

## Ethics approval and consent to participate

Not applicable.

## Informed consent

Not applicable.

## Conflict of interest

The authors declare no conflict of interest.

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