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Antimicrobial susceptibility profile in Madagascar

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ABSTRACT

Introduction: Antimicrobial resistance (AMR) is a major threat to global public health in the 21st century. The aim of this study was to assess the antimicrobial susceptibility profile of bacteria in Madagascar in the year 2023.
Methods: a descriptive cross-sectional study was conducted in public hospitals from January 01, 2023 to December 31, 2023. The study population consisted of patients who had undergone bacterial culture. Patients were included exhaustively.
Results: a total of 403 patients were recruited. The most frequently encountered germs were *Escherichia coli* (25.30%), *Staphylococcus aureus* (21.60%) *and Klebsiella pneumoniae* (11.20%). This study showed greater sensitivity to nitrofurantoin for *Escherichia coli*, cefoxitin for *Staphylococcus aureus* and imipenem for *Klebsiella pneumoniae*.
Conclusion: a change in bacterial susceptibility to molecular antibiotics has been observed, hence the need for continuous microbiological monitoring to detect resistance.

Keywords: Antibiotic; Antimicrobial resistance; Pathogens; Susceptibility profile.

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1 Introduction

Antimicrobial resistance (AMR) occurs when microorganisms (bacteria, viruses, fungi and parasites) acquire resistance to a drug to which they were previously susceptible [1]. It represents a major threat to global public health in the 21st century [2-3]. In 2014, while an estimate of 6.4 million deaths from third-generation cephalosporin-resistant strains of *Escherichia coli* and *Klebsiella pneumoniae* in 193 countries was reported, the 2016 Antimicrobial Resistance (AMR) Report estimates 10 million deaths per year due to AMR by 2050[4 -5]. In Africa, for *Staphylococcus aureus* isolates, a high overall resistance rate was observed for gentamicin (57.96%, 95% CI [40.32-74.69]), followed by ciprofloxacin (52.45%, 95% CI [25.42-78.85]). A study in Africa showed that *E. coli* and *K. pneumoniae* had amoxicillin resistance rates of 72.42%, 95% CI [49.54-90.82] and 62.67%, 95% CI [34.32-87.41] respectively [6]. According to a study carried out on the territories of residence of the islands of the South-West Indian Ocean, high rates of colonization by antibiotic-resistant bacteria were observed in patients residing in Seychelles (61.5%) and Madagascar (41.3%) [7]. It is evident that a number of antibiotics are essential medicines, but their choice in the context of rationalization is delicate and subject to a number of economic, pharmaceutical and medical constraints. Among the latter, their effectiveness against pathogenic bacteria present

in the environment under consideration is essential. Equally important is the understanding of their ecological impact on bacterial susceptibility, which is particularly crucial for antibiotics that are frequently prescribed as part of standardized treatments. [8]. The aim of this study was to assess the antimicrobial susceptibility profile of bacteria in Madagascar in 2023.

2 Methods

A descriptive cross-sectional study was carried out in public hospitals in Madagascar from January 01, 2023 to December 31, 2023. Patients with bacterial cultures constituted the study population, without gender or age discrimination. Patients with positive bacterial culture results were included. Patients with positive bacterial culture results but incomplete data were excluded. Exhaustive patient inclusion was carried out. The variables studied were gender, age, pathogens identified and antibiotic susceptibility test results. Data were entered into Excel and analyzed using Epi-info 3.5.2 software. Ethical considerations and confidentiality were respected, with data.

3 Results

A total of 403 patients were recruited.
The mean age of patients was 37 years, with a standard deviation of 25 years. The sex ratio was 1.08.

3.1 Pathogens

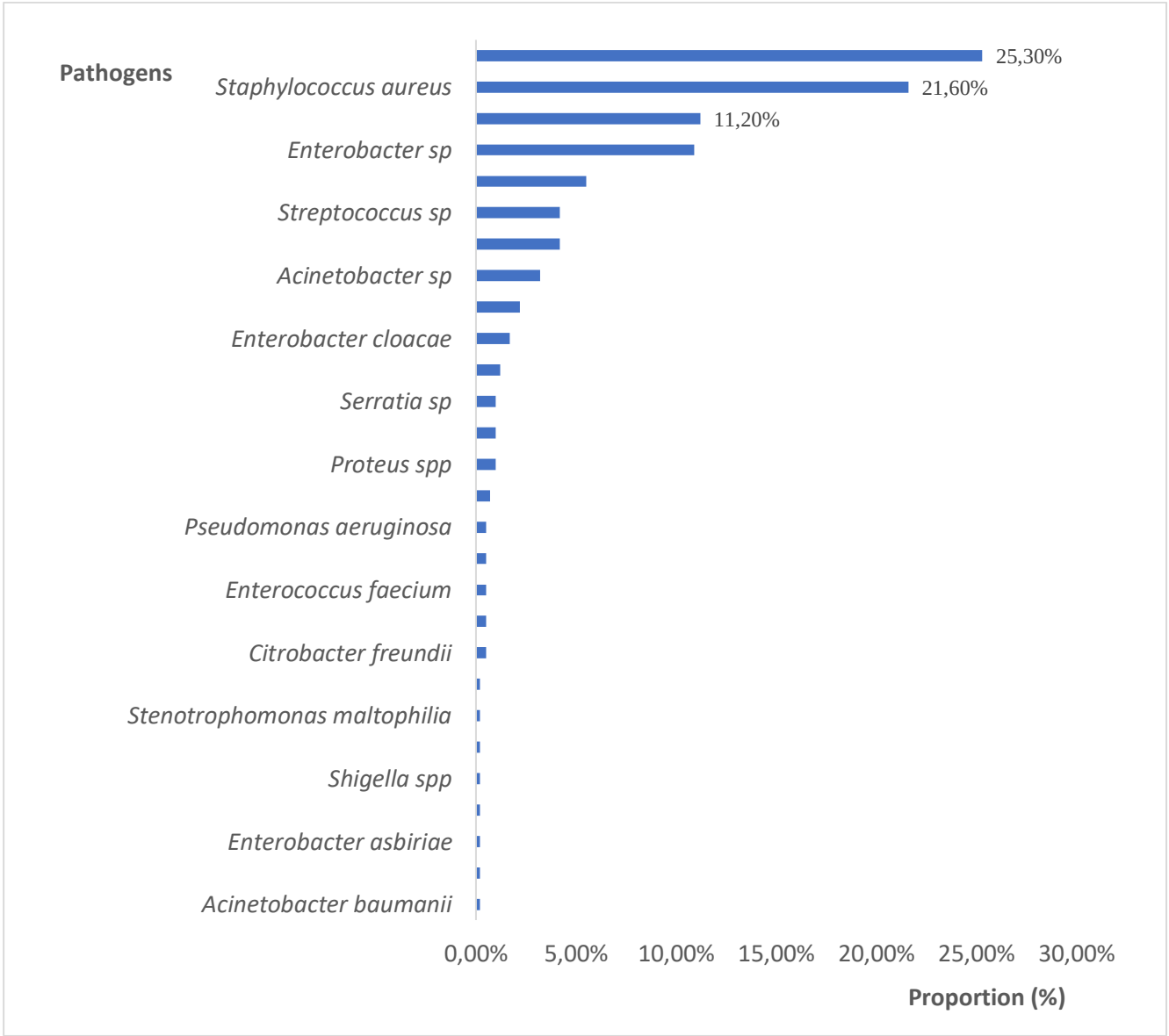

Figure 1. Distribution of positive bacterial cultures by pathogen in Madagascar

The 3 most common pathogens were *Escherichia coli* (n=102), *Staphylococcus aureus* (n=87) and *Klebsiella pneumoniae* (n=45) (Figure 1).

3.2 Susceptibility profile of the most common pathogens

3.2.1 *Escherichia coli* susceptibility profile

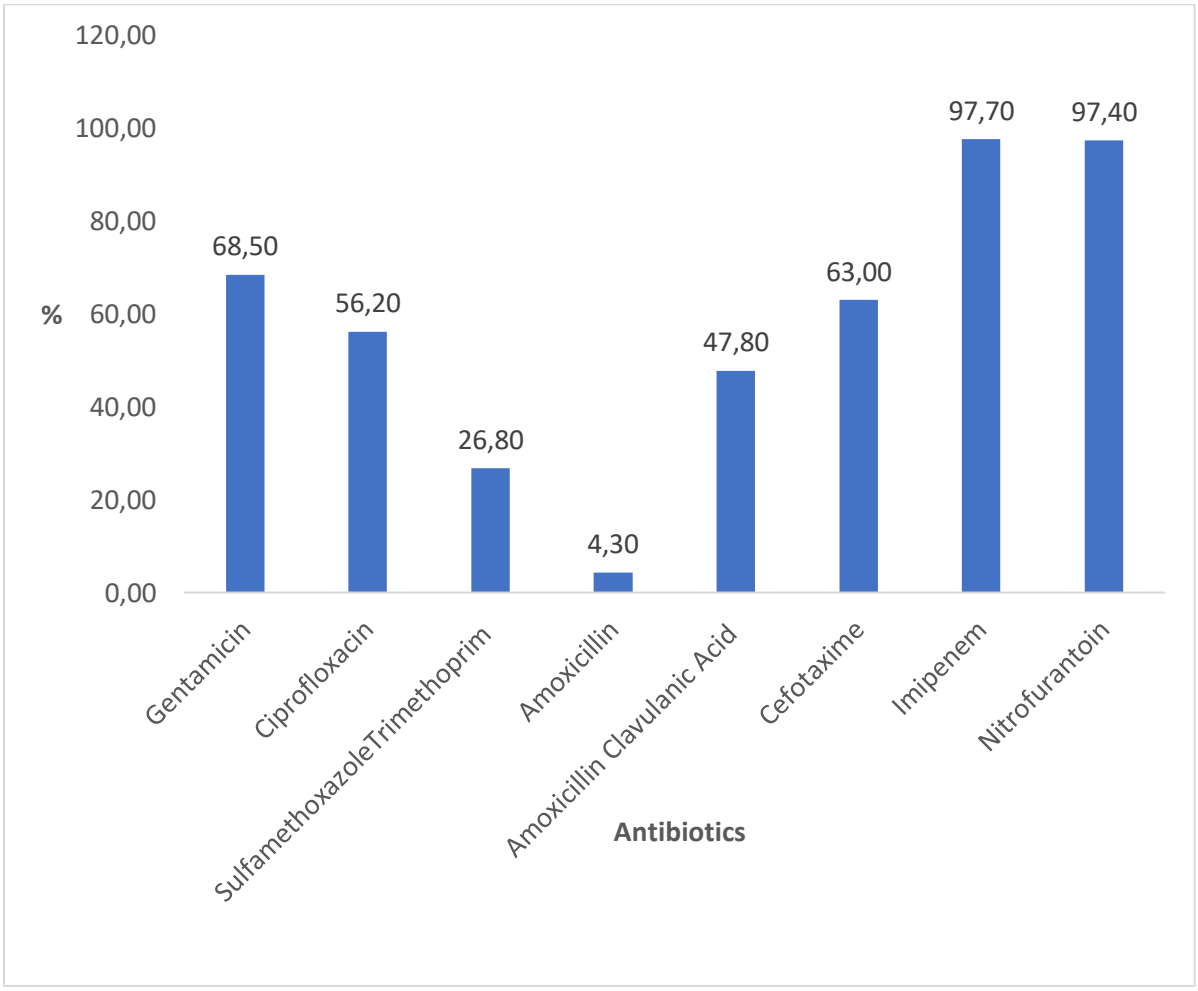

Figure 2. Susceptibility profile of *Escherichia coli* to antibiotics

Escherichia coli is susceptible to imipenem and nitrofurantoin with 97.7% and 97.10% respectively (Figure2).

3.2.2 *Staphylococcus aureus* susceptibility profile

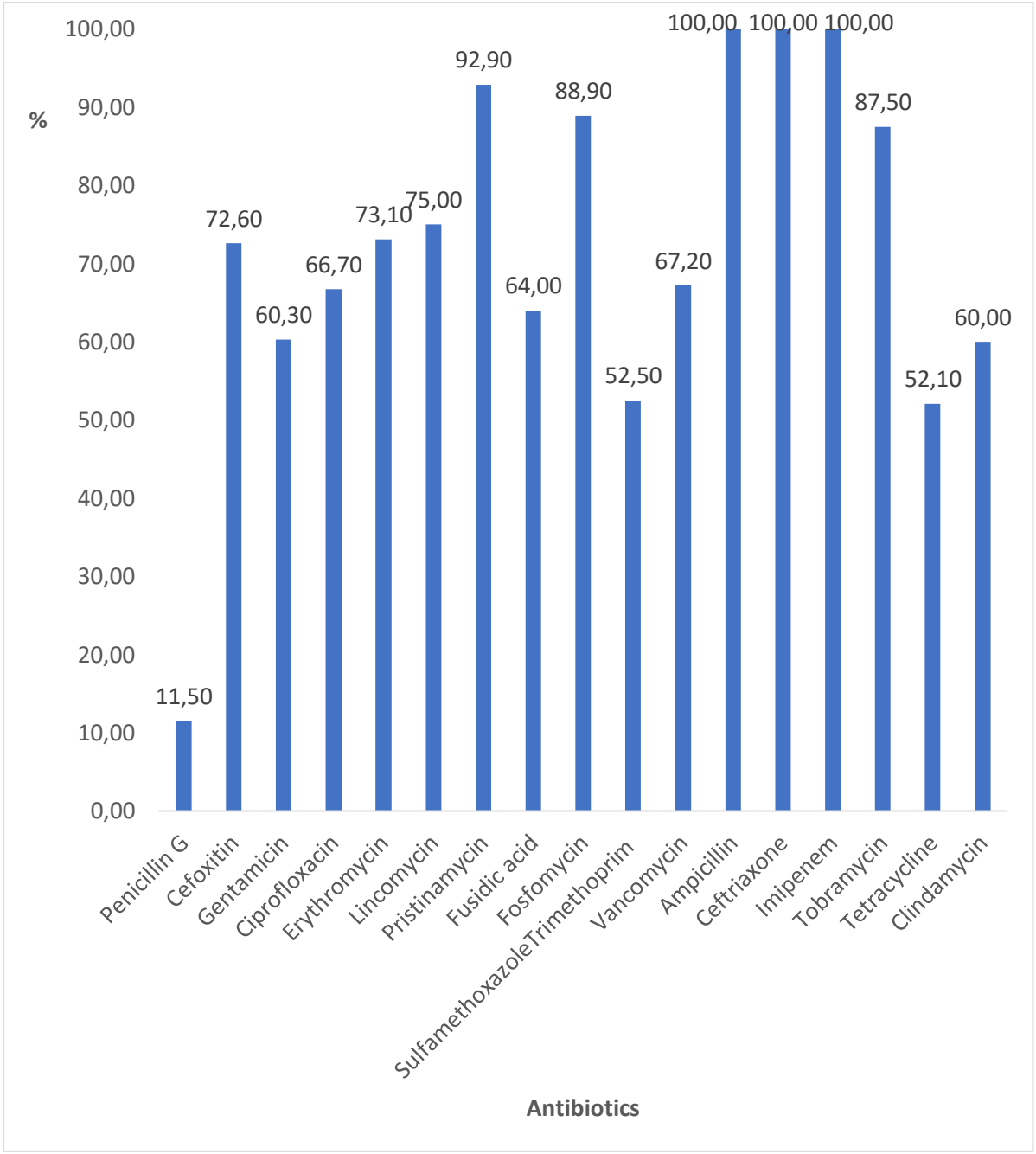

Figure 3. Profil de sensibilité du *Staphylococcus aureus* aux antibiotiques

Staphylococcus aureus was sensitive to beta-lactam (ampicillin 100%, ceftriaxone 100%, imipenem 100% and cefoxitin 72.5%), erythromycin (73.1%), ciprofloxacin (66.7%), but moderately sensitive to gentamicin (60.3%) and clindamycin (60%) (Figure 3).

3.2.3 *Klebsiella pneumoniae* susceptibility profile

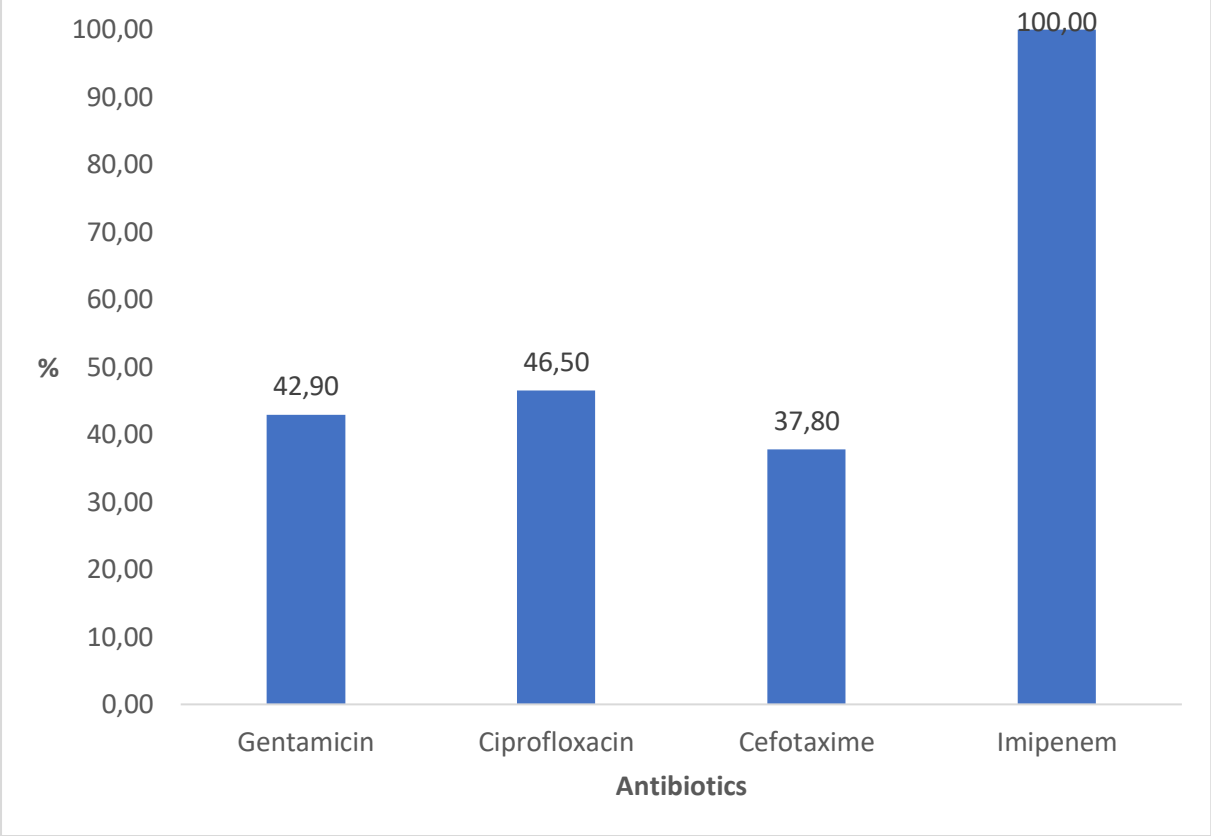

Figure 4. Susceptibility profile of *Klebsiella pneumoniae* to antibiotics

Klebsiella pneumoniae was 100% sensitive to imipenem (Figure 4).

4 Discussion

4.1 Pathogens

The present study showed that the most frequently encountered bacteria were *Escherichia coli*, followed by *Staphylococcus aureus* and *Klebsiella pneumoniae*. A study carried out in a hospital in Morocco showed similar results, with *Escherichia coli* (34.24%), *Klebsiella pneumoniae* (21.34%) and *Staphylococcus aureus* (20.59%) frequently encountered [9]. The results of our study can be explained by the fact that the majority of samples are urine. The germ most frequently implicated in urinary tract infections is *Escherichia coli* [10 - 11- 12]. *Staphylococcus aureus* is the second most common germ, especially in pus samples. In the majority of cases, these pus samples come from the orthopedic trauma department. A study carried out in Bamako showed that *Staphylococcus aureus* is one of the bacteria most frequently found in pus [13]. Nonetheless, a study carried out at the Point G University Hospital in Bamako showed that *Escherichia coli* were the germs most frequently encountered in pus examinations. Their results can be explained by the fact that postoperative wound infections of digestive origin are predominant [14].

4.2 Susceptibility profile of the most common pathogens

4.2.1 *Escherichia coli* susceptibility profile

This study showed good sensitivity of *Escherichia coli* to nitrofurantoin. Susceptibility to cefotaxime and ciprofloxacin was around 50%. A study carried out by Yu SH in people presenting with uncomplicated cystitis in Korea showed that 96.8% of isolates were susceptible to fosfomycin, 98.9% to nitrofurantoin, 50.9% to

ciprofloxacin and 82.4% to cefotaxime [15]. A study carried out in India by Veeraraghavan showed low sensitivity to amoxicillin/clavulanic acid for Escherichia coli [16]. Devnikar showed in his study that nitrofurantoin was 82.4% sensitive, with low sensitivity for cefotaxime (18.3%) and ciprofloxacin (17.1%) in 2019 [17]. These results could be explained by the inappropriate use of molecules such as amoxicillin/clavulanic acid, ciprofloxacin and cefotaxime. It should be noted that the molecules that became resistant in the present study have nevertheless had an indication in the treatment of urinary tract infections. For treating *Escherichia coli* infections such as urinary tract infections, nitrofurantoin is the molecule with the best susceptibility.

4.2.2 *Staphylococcus aureus* susceptibility profile

Staphylococcus aureus is susceptible to cefoxitin (72.60%), erythromycin (73.1%), ciprofloxacin (66.7%), gentamicin (60.3%) and clindamycin (60%) according to the present study. Cefoxitin is used to identify methicillin-resistant *Staphylococcus aureus* (MRSA) in clinical practice. Resistance to this antibiotic suggests that alternative treatments such as Vancomycin, Daptomycin or linezolid may be considered. Sensitivity to cotrimoxazole is 52.5%. The study carried out by Veeraraghavan in India showed that the sensitivity of *Staphylococcus aureus* to clindamycin and gentamycin is high. However, it is low for ciprofloxacin [16]. A study carried out in a paediatric hospital in Italy found that only 13% of *Staphylococcus aureus* were sensitive to meticillin [18]. In view of the results of the present study, betalactam antibiotics (ampicillin 100%, Ceftriaxone 100% and Imipeneme 100%) and erythromycin (73.1%) can be recommended as first-line treatment for *S. aureus* infections. Nevertheless, it remains essential to perform an antibiogram to guide targeted antibiotic therapy, particularly in severe or resistant forms.

4.2.3 *Klebsiella pneumoniae* susceptibility profile

Regarding the sensitivity of *Klebsiella pneumonia*, this study showed that only imipenem had good sensitivity. These germs were predominant in blood cultures obtained in the majority of cases from intensive care and internal medicine departments. Gentamiycin is used almost systematically in intensive care. Sensitivity is low for gentamicin (42.9%), ciprofloxacin (46.5%) and cefotaxime (37.8%). A study in India by Veeraraghavan showed decreased sensitivity, from 80% to 68% from 2015 to 2016 [19]. Imipenem is recommended as first-line treatment for severe Klebsiella pneumoniae infections, particularly in cases of sepsis or severe nosocomial infections in the absence of an antibiogram result. However, carbapenems, including imipenem, should be limited to situations that are clinically and microbiologically justified, in order to limit the emergence of resistance. Indications for gentamicin in the intensive care setting should be respected.

5 Conclusion

A better susceptibility of nitrofurantoin for *Escherichia coli*, cefoxitin for *Staphylococcus aureus* and imipenem for *Klebsiella pneumonia* was shown in this study. Some pathogens have become resistant to normally susceptible molecules. Microbiological monitoring is essential to detect bacterial resistance to antimicrobials and to adapt treatment to bacterial infections. Antibiotic prescribers need to upgrade their knowledge. The fight against antimicrobial resistance in the context of "one health" is to be given priority.

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