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# Postoperative infections in trauma surgery: Experience of the microbiology department at Ibn Tofail Hospital in Marrakech

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## Abstract

**Introduction**: Postoperative infections in traumatology represent a serious complication in trauma surgery that limits the potential benefits of surgical interventions. The objective of this study is to investigate the epidemiological profile and the level of resistance of the bacteria responsible for these infections at Ibn Tofail Hospital, to improve the management of these patients

**Materials and Methods:** This is a retrospective descriptive study conducted over an 8-year period, from January 2015 to December 2023. Samples were collected from the trauma and orthopedics department and analyzed in the bacteriology laboratory at Ibn Tofail Hospital.

**Results**: During the study period, 304 postoperative infections were diagnosed. All patients were adults, with a male-to-female ratio of 2.4. The majority of samples were deep-site cultures (67%). A total of 499 pathogens were isolated. The distribution by species was dominated by *Staphylococcus aureus*, which accounted for 15.4% of isolates, followed by *Enterobacter aerogenes* (12.6%), *Proteus mirabilis* (11.2%), and *Acinetobacter baumannii* (9.8%). Resistance rates showed that 87% of Enterobacteriaceae were resistant to the amoxicillin-clavulanic acid combination, 56% to fluoroquinolones, and 49% to third-generation cephalosporins. Resistance to imipenems founded in 81% of *Acinetobacter baumannii* strains, and the rate of methicillin-resistant *S. aureus* was 20%. Analysis of the correlation between the level of consumption of the antibiotics studied and antibiotic resistance rates showed that a 49% increase in the consumption of the amoxicillin-clavulanic acid combination and an 11% increase in ciprofloxacin consumption increased resistance to AMC by 87% but also resistance to C3G by 49%, resulting in an increase in multidrug resistance (36%).

**Conclusion**: In our setting, postoperative infections are typically deep-seated and caused by multidrug-resistant bacteria, which can lead to serious complications such as bacteremia and amputations. Management therefore requires a multidisciplinary approach, with particular emphasis on the laboratory's role in monitoring treatment adherence and progress, thereby ensuring the appropriate use of antibiotic therapy.

**Keywords:** Postoperative infection; Trauma surgery; Antibiotics; Microbiology department; Epidemiology; Resistance

## 1. Introduction

Any surgical procedure carries a risk of surgical site infection, which should be minimized as much as possible but can never be completely eliminated, since the skin barrier has been breached [1]. Postoperative infections are defined as

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the onset of new phenomena (incidents or accidents) occurring in the postoperative period. These infections are referred to as nosocomial because they are acquired during the hospital stay, even though they were neither present nor incubating at the time of the patient's admission, within at least 48 hours after admission [2]. Postoperative hospital infections rank third among nosocomial infections. They lead to increased morbidity, mortality, length of hospital stay, and patient care costs [3]. In orthopedic and trauma surgery, postoperative infection is a serious complication that jeopardizes functional outcomes and can be life-threatening in vulnerable patients. Its occurrence is influenced by various factors that are either specific to the patient or related to the surgical procedure and the hospital setting. Furthermore, postoperative osteoarticular infections pose a significant therapeutic challenge, as the bacteria responsible are often capable of evading the host's defenses as well as antibiotics by developing protective mechanisms against the environment (biofilm) and through phenotypic regulation of their metabolism, allowing them to survive at minimal cost in a hostile environment. Antibiotics represent one of the greatest advances in modern medicine. Antibiotic resistance constitutes one of the most serious threats to global health, worsening patient prognosis.

Consequently, infection prevention depends on numerous factors, each of which requires specific measures; the failure of a single element can undermine all the efforts made [4, 5, 6].

The objectives of our study were to examine the epidemiological aspects of bacterial strains isolated during post-surgical infections , to assess their level of antibiotic resistance, to study the correlation between antibiotic use and antibiotic resistance within the trauma department, and ultimately to determine the therapeutic impact in orthopedic and trauma surgery.

## 2. Materials and Methods

This is a retrospective descriptive study conducted over an 8-year period, from January 2015 to December 2023. Samples collected from the trauma and orthopedic department and analyzed in the bacteriology laboratory at Ibn Tofail Hospital. Bacterial strain identification and the corresponding antibiotic susceptibility testing performed using manual techniques, and resistance phenotypes determined by agar diffusion methods in accordance with the recommendations of the Antibiogram Committee of the French Society of Microbiology. The results of the analysis of the correlation between antibiotic use and antibiotic resistance in the trauma unit were recorded and analyzed using descriptive and analytical statistical methods with SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA).

## 3. Results

During the study period, 304 samples received. Patients were predominantly male, with a male-to-female ratio of 2.4; the mean age was 47 years, ranging from 16 to 85 years. All patients underwent bacteriological sampling, with 67% of samples being deep and 33% superficial, collected via swabbing. Direct examination revealed a predominance of Gram-negative bacilli (GNB) in 64% of the samples, while abundant and polymorphic bacterial flora suggestive of anaerobes observed in 15% of the samples. Culture results were most often monomicrobial (88% of cases) and polymicrobial in 12% of cases. A total of 499 bacteria were isolated, representing 16 different species, with Gram-negative rods and Gram-negative cocci accounting for 75% and 25% of the isolates, respectively. The distribution by species showed a predominance of *Staphylococcus aureus*, which accounted for 15.4% of the isolates, followed by *Enterobacter aerogenes* at 12.6%, and *Proteus mirabilis* at 11.2%. Analysis of bacterial resistance showed that 81% of *Acinetobacter baumannii* strains were resistant to imipenem (ABRI), the MRSA rate was 20%, 18% of *Enterobacteriaceae* exhibited high-level resistance, and 14% of *Pseudomonas aeruginosa* were resistant to ceftazidime (PARC). Extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae dominated the multidrug-resistant (MDR) bacteria and accounted for 41% of MDR bacteria, followed by carbapenem-resistant Enterobacteriaceae (27% of MDR bacteria), imipenem-resistant A. baumannii (21% of MRBs), MRSA (8%), and PARC (3%). ESBL-producing Enterobacteriaceae (ESBL-PE) and carbapenemase-producing Enterobacteriaceae (CPE) showed a high level of resistance to aminoglycosides and quinolones, with the exception of amikacin, which retained good activity against these isolates. For MRSA, only teicoplanin and vancomycin remained active. ABRI and PARC were resistant to all antibiotic classes, but all strains were susceptible to colistin.

Analysis of the correlation between the consumption levels of the antibiotics studied and antibiotic resistance rates showed that a 49% increase in the consumption of the amoxicillin-clavulanic acid combination and an 11% increase in ciprofloxacin consumption increased resistance to AMC by 87% but also resistance to C3G by 49% and, consequently, an increase in multidrug resistance (36%).

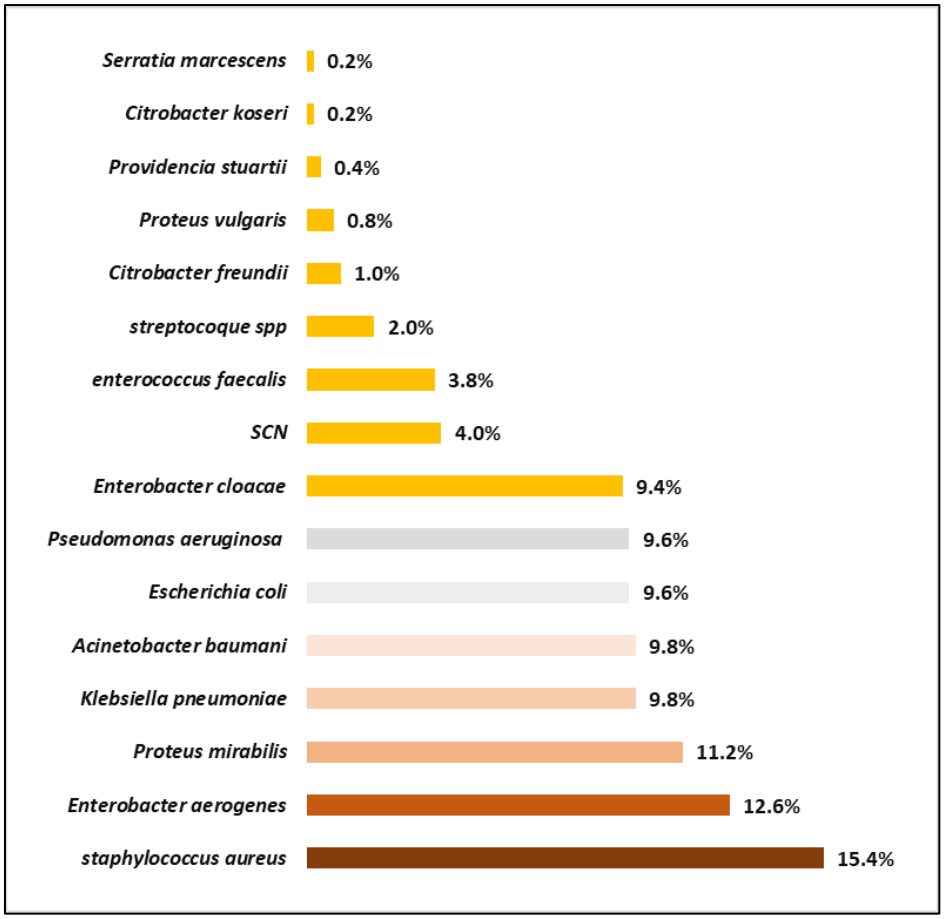


**Figure 1** Distribution of isolated bacteria by species

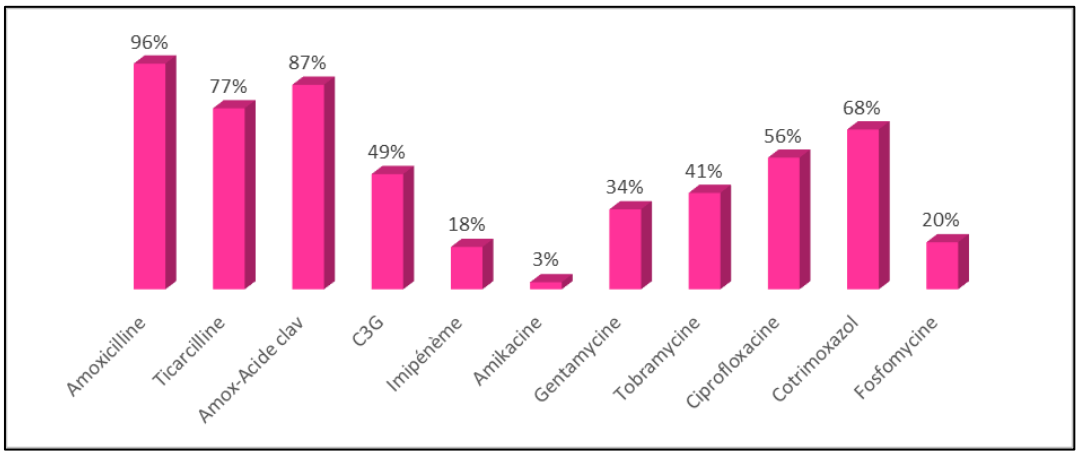


**Figure 2** Resistance rates of Enterobacteriaceae isolates

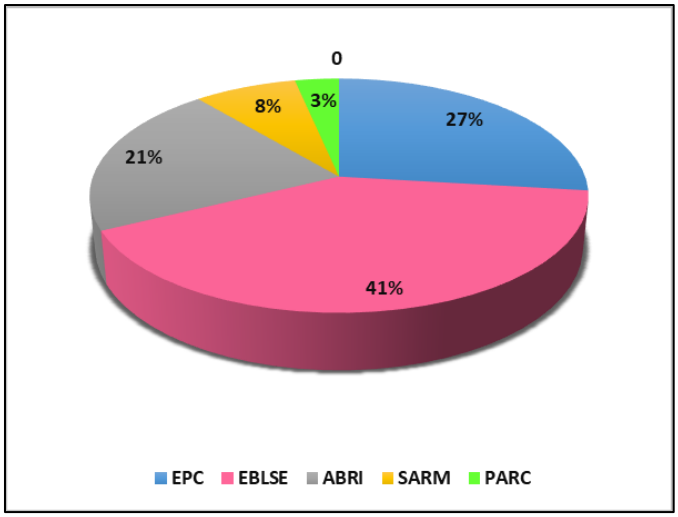


**Figure 3** Distribution of BMRs

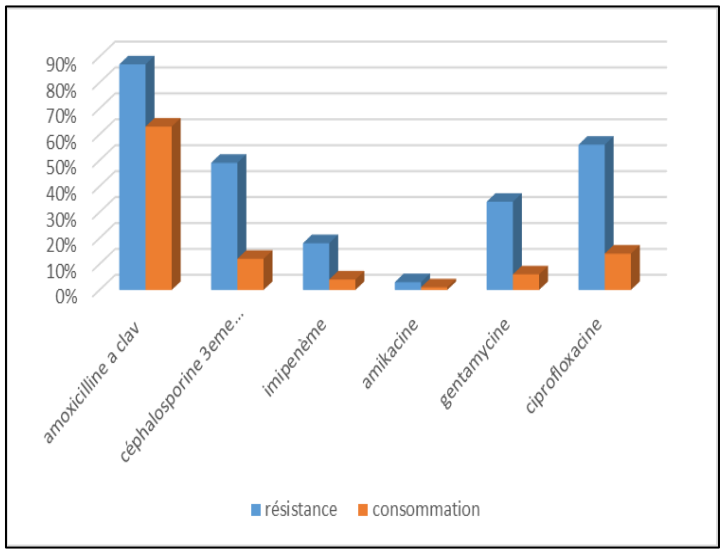


**Figure 4** Antibiotic Use and Antibiotic Resistance in the Trauma Unit

**Table 1** The correlation analysis shows that there is a very strong, statistically significant positive correlation between antibiotic resistance rates and antibiotic consumption.

| **Correlation** | | | |
|---|---|---|---|
| | | **RESISTANCE RATE** | **CONSUMPTION** |
| RESISTANCE RATE | Pearson's correlation | 1 | 0.874* |
| | Sig. (bilateral) | | 0.023 |
| | N | 6 | 6 |
| CONSUMPTION | Pearson's correlation | 0.874* | 1 |
| | Sig. (bilateral) | 0.023 | |
| | N | 6 | 6 |
| *. The correlation is significant at the 0.05 level (two-tailed). | | | |

## 4. Discussion

Surgical site infections (SSIs) are nosocomial infections that occur following a surgical procedure [1].

In orthopedic and trauma surgery, an SSI is a serious complication that can negate the benefits of a procedure intended to repair the consequences of trauma or improve joint function. Often severe, they lead to reoperations and prolonged hospital stays [2].

In our study, three sampling methods used: deep sampling by curettage, fine-needle aspiration, and superficial swabbing. The majority of our samples were deep (67%). In the literature, only deep samples have indisputable value in the bacteriological diagnosis of osteoarticular infections [3; 4]. In contrast, superficial samples may isolate skin bacteria whose pathological relevance is uncertain, potentially leading to misinterpretation, and should not be considered decisive [5; 6]

The predominant bacteria in our series are mainly Gram-negative bacilli, accounting for 75% of isolates. This finding is consistent with several studies conducted in African countries [7; 8; 9].

The distribution of the implicated species shows a predominance of *Staphylococcus aureus*, which accounted for 15.4% of the isolates. In numerous studies, *Staphylococcus aureus* is identified as the leading cause of ISO, followed by various species of Enterobacteriaceae [10; 11; 12; 13].

However, the prevalence of *Staphylococcus aureus* in our study remains relatively low compared to what is reported in the literature. This disparity could be attributed to the high proportion of Gram-negative bacilli (GNB) in our study.

The frequency of isolation of multidrug-resistant bacterial strains suggests a high prevalence of these strains. Several factors explain this increase, notably prior and repeated exposure to antibiotics, particularly those prescribed in the hospital setting [14].

The 41% rate of Enterobacteriaceae isolates expressing ESBL underscores the reality of this situation in the hospital setting and highlights the need to consider this risk in surgical practice.

The emergence of MDR bacteria (estimated at 36% in our study) increases the likelihood of treatment failure, sometimes leading to therapeutic deadlocks. Such a situation serves as a wake-up call and requires coordinated action to preserve antibiotics through rational use and to combat the spread of multidrug-resistant bacteria.

In acute osteoarticular infections, including postoperative infections, antibiotic therapy should be probabilistic and initiated after microbiological testing. Amoxicillin-clavulanic acid covers, among others, MRSA, streptococci, and some Gram-negative bacteria (GNB). In adults, infections involving medical devices require treatment with parenteral penicillins, followed by oral continuation with quinolones and rifampicin. In GNB infections, a quinolone may be used as monotherapy if the isolated pathogen is susceptible. Rifampicin should never be prescribed as monotherapy, neither as a probabilistic treatment nor in cases of acute superinfection. The switch to oral therapy and the addition of another agent are determined based on the causative or suspected pathogen. The recommended duration of antibiotic therapy for arthritis in adults is 6 weeks. For osteitis in adults, treatment lasts 6 to 12 weeks. [6]

## 5. Conclusion

In our setting, postoperative infections are generally deep-seated and caused by multidrug-resistant bacteria, which can lead to serious complications such as bacteremia and amputations. A positive correlation between the use of certain antibiotics and high rates of antibiotic resistance in our study could explain the rapid spread of multidrug-resistant bacteria. Management therefore requires a multidisciplinary approach, with particular emphasis on the role of the laboratory in ensuring compliance and monitoring treatment, thereby enabling the appropriate use of antibiotic therapy.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

There is no conflict of interest.

*Statement of informed consent*

Informed consent was obtained from all individual participants included in the study by signing the Free and Informed Consent Form.

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