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Carriage of multidrug-resistant bacteria and nosocomial infections in intensive care unit patients: Experience at Ibn Tofail Hospital

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Abstract

methods: This is a descriptive study conducted in the microbiology department of the Ibn Tofail Hospital at the Mohamed VI University Hospital in Marrakech over a four-month period from January to May 2024. It included biological and environmental samples received by the microbiology laboratory from patients hospitalized in the intensive care unit at Ibn Tofail Hospital who had developed nosocomial infections caused by multidrug-resistant (MDR) bacteria. Microorganism identification and antibiotic susceptibility testing were performed using standard bacteriological methods, supplemented by biochemical identification panels (BioMérieux, France). Antimicrobial resistance profiles were determined by the agar diffusion method, in accordance with EUCAST standards.

Results: During this period, 45 patients developed nosocomial infections within 48 hours of admission. The mean age of patients was 42 years, with a predominance of males (sex ratio = 2.46). All patients were exposed to at least one invasive procedure, such as tracheal intubation (97%), open surgery (93%), and arterial and urinary catheterization (91%).

The laboratory received 138 samples, with a positive culture rate of 75.4%. Multidrug-resistant bacteria were isolated in 68% of cases, mainly represented by imipenem-resistant Acinetobacter baumannii (IRAB) in 90 isolates (87%), followed by extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL) (13%). Enterobacter cloacae dominated ESBL-producing isolates with 48%, followed by Escherichia coli (35%) and Klebsiella pneumoniae (17%).

A total of 180 samples were collected from the patients' environment. Seventy-two of the samples from the patients' environment were positive (40%) for MDR bacteria. Bed rails had the highest number of positive samples (38%), followed by the respiratory system (29%) and door handles (19%). Imipenem-resistant Acinetobacter baumannii was predominant (96%).

Conclusion: Detecting multidrug-resistant bacterial colonization plays a key role in controlling and preventing healthcare-associated infections. Strengthening surveillance systems, improving diagnostic techniques, and raising awareness among healthcare workers are essential strategies for mitigating the impact of antimicrobial resistance and ensuring better outcomes for patients.

Keywords: Multidrug-resistant bacteria; Nosocomial infections; Intensive care unit

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1. Introduction

Bacteria are said to be multidrug-resistant when, due to the accumulation of resistance acquired to several families of antibiotics, they are no longer sensitive to a small number of antibiotics that can be used therapeutically. Multidrug resistance is a step towards therapeutic deadlock. The World Health Organization (WHO) has indicated that the global process of discovering new antibiotics is inadequate to address the growing threat of antimicrobial resistance, which is expected to cause approximately 10 million deaths per year by 2050 [1]. A group of pathogenic bacteria, abbreviated as ESKAPE (Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter spp.) is the leading cause of multidrug-resistant nosocomial infections worldwide, causing life-threatening infections in critically ill and immunocompromised patients [1].

The aim of this study is to demonstrate the importance of detecting multidrug-resistant bacteria in patients in intensive care units.

2. Materials and methods

2.1. Ethical Considerations

The study was carried out without any interaction with individuals, making informed consent unnecessary. Anonymity and confidentiality were respected for all personal data collected

2.2. Study Population and Setting

This is a descriptive study conducted in the microbiology department of the Ibn Tofail Hospital at the Mohamed VI University Hospital in Marrakech, over a period of four months from January to May 2024. It included biological and environmental samples received by the microbiology laboratory from patients hospitalized in the intensive care unit of Ibn Tofail Hospital who had developed nosocomial infections caused by multidrug-resistant (MDR) bacteria.

2.3. Antimicrobial Susceptibility Testing

Susceptibility testing was performed by automated CMI testing by BD Phoenix M50 (BECTON DICKINSON) and/or qualitative disk diffusion according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST) (http://www.eucast.org, last access on «1st June 2025).

3. Results

The population is characterized by a clear male predominance, representing 71% of the sample, compared to 29% women, giving a sex ratio of 2.46. All 45 patients included had undergone at least one invasive procedure. These procedures were distributed as follows: 80% had a urinary catheter, 91% had a catheter inserted, more than 97% were intubated with an endotracheal tube, and 42 out of 45 patients (93%) underwent surgery. The length of hospital stay varied greatly among patients. Of the 45 patients included, 14 (31%) required hospitalization for more than 30 days, while 4 patients (9%) were admitted for less than 7 days. In addition, 27 patients (60%) had a length of stay ranging from more than one week to less than one month.

During the study period, we received 138 samples, 104 of which tested positive, representing a positivity rate of 75.4%. This distribution of positive results revealed diversity in the types of samples, with a predominance of certain categories. More specifically, 4% of positive samples were CSF, 6% were blood cultures, 40% were urine cultures, 30% were PDP, and finally, 20% were urinary catheters (KT).

The majority of isolated bacteria were Gram-negative bacilli (GNB), accounting for 86% of samples. Among these GNB, non-fermentative GNB constituted 64% of isolates, mainly dominated by Acinetobacter baumanii. Enterobacteria accounted for 22% of isolates, with Enterobacter cloacae predominating at 12% and Escherichia coli at 10%. Gram-positive cocci accounted for the remaining 14%, comprising mainly coagulase-negative Staphylococcus at 11% and Staphylococcus aureus at 4%.

Multidrug-resistant bacteria were isolated in 68% of cases, with imipenem-resistant Acinetobacter baumanii (ABRI) being widely represented at a rate of 87%. Next were extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBLES), which were identified in 13% of cases. Enterobacter cloacae dominated ESBLES isolates with 48%, followed by Escherichia coli (35%) and Klebsiella pneumoniae (17%).

Ninety nasal and rectal swabs were collected to detect MDR bacterial colonization in intensive care unit patients, resulting in an MDR-positive rate of 81% (n=73). The most frequently isolated bacteria were imipenem-resistant Acinetobacter baumannii (89%), followed by extended-spectrum beta-lactamase (ESBL)-producing Enterobacter cloacae, Escherichia coli (3%), and Klebsiella pneumoniae (1%).

Of a total of 180 samples taken from the patients' environment, 72 (40%) tested positive for MRB. Bed rails had the highest number of positive samples (38%), followed by the respiratory system (29%) and door handles (19%). Imipenem-resistant Acinetobacter baumannii was predominant (96%), followed by Enterobacter cloacae with a percentage of 4%.

4. Discussion

4.1. Prevalence and epidemiological characteristics of MRB

In our study, 68% of positive cultures corresponded to multidrug-resistant bacteria, with a clear predominance of imipenem-resistant A. baumannii (87% of MRB isolates). This predominance is consistent with recent literature, where A. baumannii is frequently reported as a major nosocomial pathogen in intensive care units [1]. According to recent data from the United States, A. baumannii is considered one of the leading causes of ventilator-associated pneumonia, central line-associated bloodstream infections, and urinary tract infections in hospitalized adult patients [2]. The World Health Organization has classified carbapenem-resistant A. baumannii as a critical priority pathogen, highlighting the urgent need to develop new therapeutic approaches [3].

Our results show a male predominance (sex ratio = 2.46), similar to that reported by Al-Anazi et al. in their retrospective study, where 68.7% of patients infected with A. baumannii were men [4]. However, the average age of our patients (42 years) is lower than that reported in several studies, which generally place the average age between 55 and 65 years [5]. This difference could be explained by variations in the demographic characteristics of the populations studied.

4.2. Risk factors associated with MRB infections

Our study identified several significant risk factors associated with MRB infections, including exposure to invasive procedures such as tracheal intubation (97%), open surgery (93%), and arterial and urinary catheterization (91%). These findings are consistent with those reported in the international literature. According to Dobrović et al., invasive procedures are a major contributing factor to the risk of healthcare-associated infection because they bypass the skin barrier, the body's natural defense, and provide a direct route for MRB to sterile compartments [6]. In a recent study, Harris et al. also highlighted the importance of mechanical ventilation as a major risk factor for A. baumannii infection [7].

Prolonged hospitalization is also a significant risk factor. In our series, more than 60% of patients had a hospital stay of between 8 and 30 days. This observation is consistent with data in the literature that identify prolonged stays in intensive care as a major risk factor for acquiring MDROs, particularly A. baumannii [8]. A recent study published in 2023 demonstrated that longer hospital stays significantly increased the risk of nosocomial MRB infections both before and during the COVID-19 period [9].

4.3. Antimicrobial resistance profiles

The resistance to imipenem in A. baumannii isolates (87%) in our study is comparable to the rates reported in other regions. According to a recent study, the rate of carbapenem resistance in A. baumannii can reach 85.9% to 88% in some intensive care units [10] . These high rates of carbapenem resistance are particularly concerning because they significantly limit the available treatment options. Carbapenem resistance in A. baumannii is significantly associated with an increased risk of mortality (up to 55% all-cause mortality and 16% attributable mortality) and prolonged hospitalization [11].

With regard to ESBL-producing Enterobacteriaceae (13% of MRBs in our study), the predominance of Enterobacter cloacae (48%) differs from the trends usually reported in the literature, where Klebsiella pneumoniae is often the dominant species. This difference may reflect local epidemiological peculiarities or characteristics specific to our study population. However, it is interesting to note that recent studies have reported a significant increase in the proportions of carbapenem-resistant Enterobacter cloacae and Klebsiella pneumoniae [12].

4.4. Colonization and carriage of MRB

A major finding of our study is the high rate of MRB colonization (81%) detected by nasal and rectal swabbing in intensive care unit patients. This colonization was mainly due to imipenem-resistant A. baumannii (89%). These results highlight the importance of systematic screening for MRB carriage in at-risk patients, as recommended by several international learned societies.

The literature indicates that intensive care units provide an environment conducive to the proliferation of opportunistic organisms such as A. baumannii, which can spread rapidly among vulnerable patients [13]. Colonization often precedes clinical infection and constitutes a potential reservoir for cross-transmission between patients. Serra-Burriel et al. emphasized that the acquisition of MRB in healthcare facilities is a complex process influenced by many factors, such as direct contact with contaminated surfaces, medical equipment, or healthcare personnel [14].

4.5. Environmental contamination

Our study revealed a significant rate of environmental contamination (40% of positive samples), with a predominance of imipenem-resistant A. baumannii (96%). Bed rails were the most common source of contamination (38%), followed by the respiratory system (29%) and door handles (19%).

These results are consistent with the well-documented characteristics of A. baumannii, including its ability to survive in the hospital environment for long periods of time. Cross-transmission occurs when MRBs are transmitted from one patient to another via the hands of caregivers or shared medical devices. This is a common route of transmission in healthcare facilities, particularly when infection control practices are not strictly followed [15]. The environmental persistence of A. baumannii poses a major challenge for infection control and requires rigorous cleaning and disinfection protocols.

4.6. Implications for clinical practice and infection control

The results of our study have several important practical implications. First, they highlight the need for systematic screening for MRB colonization in patients admitted to intensive care, particularly those with identified risk factors. This screening should ideally be performed on admission and regularly during the ICU stay.

Second, our data on environmental contamination highlight the importance of hygiene and disinfection measures targeting high-risk surfaces, such as bed rails and respiratory equipment. Specific and regular cleaning protocols should be implemented to reduce this potential reservoir of transmission. Bassetti et al. recommend appropriate early diagnosis and treatment for Gram-negative MRB infections, emphasizing the importance of a proactive approach [16].

Finally, the resistance profiles observed underscore the urgency of a policy of rational antibiotic use. The Infectious Diseases Society of America recently published updated guidelines on the treatment of antimicrobial-resistant Gram-negative infections, reflecting the importance of this issue [17].

Effective antimicrobial stewardship programs are essential to preserve the effectiveness of available treatment options.

4.7. Limitations and perspectives

Our study has certain limitations that are worth mentioning. First, it is a descriptive study covering a relatively short period (4 months), which may limit the generalizability of the results. Longer-term prospective studies would be needed to confirm our observations and identify possible seasonal variations in the epidemiology of MRB.

Second, we did not perform molecular characterization of the isolates, which could have provided valuable information on resistance mechanisms and clonal relationships between strains. McKay et al. emphasized the importance of the molecular epidemiology of carbapenem-resistant A. baumannii to better understand its spread and evolution [18]. Future studies should include these analyses to better understand the transmission dynamics of MRBs in our setting.

Finally, our study did not assess the impact of infection control measures on the prevalence of MRB. Targeted interventions, such as antimicrobial stewardship programs, enhanced environmental cleaning protocols, and hand hygiene campaigns, should be implemented and their effectiveness evaluated in future studies.

5. Conclusion

This study highlights the high prevalence of multidrug-resistant bacteria, particularly imipenem-resistant A. baumannii, among patients with nosocomial infections in the intensive care unit at Ibn Tofail Hospital. The high rates of colonization and environmental contamination underscore the importance of a multifaceted approach to infection control, including systematic screening, contact precautions, rigorous environmental cleaning, and rational use of antibiotics. Concerted efforts are needed to address this major public health challenge and improve outcomes for intensive care patients.

Our study of bacterial carriage in intensive care patients through rectal and oral swabs is part of a growing global concern about MRBs. The high prevalence of colonization, the predominance of resistant enterobacteria, and the association between colonization and subsequent infection underscore the importance of effective screening and prevention strategies. Multicenter studies with molecular characterization and longitudinal follow-up would be valuable in furthering our understanding of this phenomenon and developing targeted interventions to reduce the burden of MRB nosocomial infections in intensive

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Anonymity and confidentiality were respected for all personal data collected.

Statement of informed consent

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