GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(RESEARCH ARTICLE)

Check for updates

Bacteriological profile of nosocomial infections caused by multidrug-resistant bacteria in intensive care units

Moustahfid Nouhaila [1, 2, *], Debbagh Fayrouz [1, 2] and Zahlane Kawtar [1, 2]

[1] *Microbiology Laboratory of Ibn Tofail Hospital of Marrakech, Morocco.*
[2] *Faculty of Medicine and Pharmacy of Marrakesh.*

GSC Biological and Pharmaceutical Sciences, 2026, 34(01), 098-102

Publication History: Received on 15 November 2025 Accepted on 05 January 2026 Published on 16 January 2026

Article DOI: https://doi.org/10.30574/gscbps.2026.34.1.0006

Abstract

Background: Multidrug resistant bacteria are the most important threats to public health. Typically associated with nosocomial infections. However, some Multidrug resistant bacteria have become prevalent causes of community-acquired infections.

Objective: The objective of this study is to examine the bacteriological profile of nosocomial infections caused by multidrug-resistant bacteria in intensive care patients.

Methods: This is a descriptive study conducted in the microbiology department of the Ibn Tofail Hospital of the Mohamed VI University Hospital in Marrakech over a 12-month period from January to December 2024, including all samples received by the microbiology laboratory from patients hospitalized in the intensive care unit of the Ibn Tofail Hospital. Microorganism identification and antibiograms were performed using standard bacteriological tests, supplemented by biochemical identification panels (BioMérieux, France). Antimicrobial resistance profiles were determined using the agar diffusion method, in accordance with EUCAST standards.

Results: During this period, 160 samples were received. Bacterial cultures were positive in 88 samples (55%), including 32 (36%) multi- or extensively drug-resistant bacteria (MDR/XDR). The average age of these patients was 33 years, with a predominance of males (sex ratio = 8.3). Nosocomial pneumonia was the predominant infection (38%), followed by bacteremia (28%). Gram-negative bacteria accounted for 94% of MDR bacterial isolates. Imipenem-resistant Acinetobacter baumanii (IRAB) was found in 19 samples (59%), followed by carbapenemase-producing Enterobacteriaceae (CPE) (25%), extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL) (9%), and methicillin-resistant Staphylococcus aureus (MRSA) (6%). In terms of antibiotic susceptibility, IRAB strains were resistant to all antibiotics of medical interest, with the exception of colistin (100% susceptibility). MRSA strains were 50% resistant to trimethoprim-sulfamethoxazole, with 100% sensitivity to aminoglycosides, fluoroquinolones, and fosfomycin. E-ESBLs were represented by Klebsiella pneumoniae, Enterobacter cloacae, and Escherichia coli, with resistance to aminoglycosides (100%), trimethoprim-sulfamethoxazole (100%), and fluoroquinolones (33%), as well as preserved susceptibility to colistin and tigecycline (100%). Carbapenemase-producing Enterobacteriaceae were represented by Klebsiella pneumoniae (38%), Enterobacter cloacae (38%), and Escherichia coli (25%). Metallo-beta-lactamases (Ambler class B) were identified in 50% of CPE.

Conclusion: Nosocomial infections caused by multidrug-resistant or extensively drug-resistant bacteria in intensive care units increase morbidity and mortality and require special attention. Prevention is based on rigorous hygiene, appropriate use of antibiotics, and appropriate isolation measures. A strict, multidisciplinary approach is essential to limit their spread.

* Corresponding author: MOUSTAHFID N

Keywords: nosocomial infections; multidrug-resistant bacteria; intensive care units

1. Introduction

The emergence of multidrug-resistant or extensively drug-resistant (MDR/XDR) bacteria in intensive care units represents a major and ongoing challenge in hospital practice. These pathogens, favored by the intensive use of antibiotics and the critical condition of patients, compromise the effectiveness of treatment. [1]

This situation poses a threat in intensive care units, which treat patients at high risk of infection, requiring prolonged hospital stays and numerous invasive procedures, and who are heavily exposed to antibiotics. [2]

The objective of this study is to examine the bacteriological profile of nosocomial infections caused by multidrug-resistant or extensively drug-resistant bacteria in intensive care patients.

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 12-month period from January to December 2024, including all samples received by the microbiology laboratory from patients hospitalized in the intensive care unit of the Ibn Tofail Hospital.

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

During this period, 160 samples were received. Bacterial cultures were positive in 88 samples (55%), including 32 (36%) multi- or extensively drug-resistant bacteria (MDR/XDR). The average age of these patients was 33 years, with a predominance of males (sex ratio = 8.3).

Nosocomial pneumonia was the predominant infection (38%), followed by bacteremia (28%). Gram-negative bacteria accounted for 94% of MDR bacterial isolates. Imipenem-resistant Acinetobacter baumanii (IRAB) was found in 19 samples (59%), followed by carbapenemase-producing Enterobacteriaceae (CPE) (25%), extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL) (9%), and methicillin-resistant Staphylococcus aureus (MRSA) (6%).

In terms of antibiotic susceptibility, IRAB strains were resistant to all antibiotics of medical interest, with the exception of colistin (100% susceptibility). MRSA strains were 50% resistant to trimethoprim-sulfamethoxazole, with 100% sensitivity to aminoglycosides, fluoroquinolones, and fosfomycin. E-BLSE were represented by Klebsiella pneumoniae, Enterobacter cloacae, and Escherichia coli, with resistance to aminoglycosides (100%), trimethoprim-sulfamethoxazole (100%), and fluoroquinolones (33%), as well as preserved susceptibility to colistin and tigecycline (100%).

Carbapenemase-producing Enterobacteriaceae were represented by Klebsiella pneumoniae (38%), Enterobacter cloacae (38%), and Escherichia coli (25%). Metallo-beta-lactamases (Ambler class B) were identified in 50% of CPE.

4. Discussion

In our intensive care unit study, 55% of bacterial cultures were positive, with 36% of positive isolates being multidrug-resistant or even ultra-resistant bacteria. These figures are similar to certain intensive care-specific data reported in the literature. In the EPIC III (Extended Prevalence of Infection in Intensive Care) study, an international survey conducted in more than 1,150 intensive care units in 88 countries, 70% of infected patients in intensive care had at least one resistant pathogen, and the prevalence of MDR/XDR among isolates was 37.2% [1]. There were significant geographical disparities in the CAESAR (Central Asian and European Surveillance of Antimicrobial Resistance) study,

with MDR rates ranging from 25% in Northern Europe to over 60% in some Eastern European and Central Asian countries [2].

Our intensive care population, with an average age of 33 and a predominance of males, represents a different demographic spectrum than that observed in studies of intensive care patients. By comparison, the median age in Dickstein's (2023) multicenter study on infection was 65 years. The overrepresentation of males can be explained by specific contextual factors, such as the existence of a major trauma center and units focusing on infertility services. [3]

In terms of infection types, nosocomial pneumonia accounted for 38% of cases in our hospital, followed by bacteremia (28%). Directly related to the frequency with which patients undergo mechanical ventilation in intensive care, the prevalence of pneumonia is undoubtedly linked to the considerable number of pneumonia cases. Timist et al. (2020) showed that 75-80% of nosocomial pneumonia cases in intensive care settings were associated with mechanical ventilation [4].

In our study, imipenem-resistant Acinetobacter baumannii (IRAB) accounted for 59% of resistant bacterial isolates. This result is similar to those reported in the literature, such as the study by Malchione et al. (2022) [5]. This high proportion is typical of intensive care settings, where A. baumannii benefits from an environment that is highly conducive to its spread. The ability to survive for long periods on inanimate surfaces is an important factor in the nosocomial transmission of A. baumannii, shaped by the infectious environment characteristic of intensive care units, which are rich in devices and equipment. The 2021 study by Fournier et al. showed that 35% of intensive care unit infections contaminated the patient's immediate environment with A. baumannii (bed rails, ventilators, infusion pumps). [6] Resistance rates of IRAB isolates in intensive care units in 2022 according to the new EARS-Net report were 90% to 100% for fluoroquinolones and aminoglycosides, and over 80% for carbapenems in several European countries. [7]

In our study, 25% of all resistant isolates were CPE, distributed among Klebsiella pneumoniae (38%), Enterobacter cloacae (38%), and Escherichia coli (25%). The international PANORAMA study across Europe, specifically including intensive care units and other countries such as America and Australia, noted that K. pneumoniae accounted for 65% to 75% of all CPE in intensive care, and E. coli 15-20%; followed by Enterobacter spp 5-10% [8]. The higher percentage of E. cloacae in our case may indicate a localized outbreak or certain special characteristics of our intensive care unit. Half of the CPE isolates were found to be metallo-beta-lactamases (Ambler class B). Rodriguez-Baño et al. (2021) found that patients in intensive care with metallo-beta-lactamase had higher mortality rates than those with other types of carbapenemases, 45% versus only 30% after five days; this difference reflects and results from both the very limited range of treatment options available [9].

In our case series, ESBL-producing Enterobacteriaceae accounted for only 9% of isolates, which is significantly lower than the figures generally cited in the literature. According to the EARS-Net 2022 report, the majority (25% to 35%) of these resistant isolates are caused by ESBL-producing Enterobacteriaceae in intensive care units in European countries [7]. The remarkable 100% resistance of our ESBL strains to aminoglycosides and trimethoprim-sulfamethoxazole is in line with data in the literature. Tacconelli et al. (2022) reported similar resistance profiles to these two agents in ESBL types. Their series ranged from 85% to 100% for aminoglycosides and from 90% to 100% for trimethoprim-sulfamethoxazole.[10]

A recent meta-analysis by Kourtis et al. (2019) revealed that in many countries, there has been a substantial decline in the prevalence of MRSA in intensive care units over the past two decades: from an average of 45% in 2000 to about 20% now [11]. Our MRSA rate of 6% can be explained by several preventive measures such as the widespread introduction of MRSA-specific screening, isolation procedures, and improvements in hand hygiene.

For IRAB, colistin is often the only effective therapeutic agent available. However, when used in intensive care, it has serious drawbacks: it is nephrotoxic and therefore poses particular problems for patients already suffering from acute renal failure, who are the most likely to need this drug. Bassetti et al. (2013) proposed a pharmacokinetic/pharmacodynamic approach to optimize colistin dosing in intensive care, with high loading doses followed by maintenance doses adjusted according to renal function [12].

New treatment options are emerging for CPE in intensive care. Ceftazidime-avibactam and meropenem-vaborbactam have been shown to be active against OXA-48-type KPC carbapenemases. However, they remain ineffective against metallo-beta-lactamases [13].

Luyt et al. (2023) found that a program including a systematic review of antibiotic therapies at 48-72 hours and decision support algorithms was associated with a 35% decrease in the occurrence of multidrug-resistant organisms in ICUs [14].

In intensive care, the use of selective decontamination of the digestive tract and mouth-oropharynx as sites is debated. A recent meta-analysis showed that these methods reduced the incidence of ventilator-associated pneumonia by 30-40%, but their long-term effects on bacterial ecology remain controversial [15]. Hand hygiene remains the cornerstone of prevention, but in intensive care, it now averages only 40-50% rather than 60-70% elsewhere in hospitals due to heavy workloads and sudden emergencies [16].

5. Conclusion

Our study shows a worrying presence of multidrug-resistant bacteria in the intensive care unit. This is largely due to the prevalence of IRAB and CPE. New therapeutic approaches such as phage therapy and monoclonal antibodies targeting specific virulence factors offer promise in addressing the therapeutic dead ends created by certain multidrug-resistant bacteria in intensive care [17]. Continuing education for intensive care teams on the problems of bacterial resistance and the integration of preventive measures into daily practice are essential to improve the management of these complicated infections [18].

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

The study was carried out without any interaction with individuals, making informed consent unnecessary

References

[1] Vincent JL, Sakr Y, Singer M, et al. Prevalence and Outcomes of Infection Among Patients in Intensive Care Units in 2017: The EPIC III Study. JAMA. 2020;323(15):1478-1487.

[2] Mutters NT, Blanco N, Mody L, et al. Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR): Regional report on antimicrobial resistance in intensive care units, 2021-2022. Lancet Reg Health Eur. 2023; 26:100564.

[3] Dickstein Y, Temkin E, Oved M, et al. Antimicrobial resistance profiles of pathogens isolated from intensive care units: Results of the European ICU-Resistance Survey. J Crit Care. 2023; 74:154063.

[4] Timsit JF, Esaied W, Neuville M, et al. Update on ventilator-associated pneumonia. F1000Res. 2020;9:F1000 Faculty Rev-284.

[5] Malchione MD, Torres LM, Hartley DM, et al. Carbapenem and colistin resistance in Acinetobacter baumannii in ICUs across Europe: A cross-sectional study. J Antimicrob Chemother. 2022;77(9):2503-2512.

[6] Fournier S, Monteil C, Lepainteur M, et al. Long-term control of carbapenemase-producing Acinetobacter baumannii endemicity in an intensive care unit: A multicenter quasi-experimental study. Antimicrob Resist Infect Control. 2021;10(1):29.

[7] European Centre for Disease Prevention and Control. Surveillance of antimicrobial resistance in Europe 2022. Stockholm: ECDC; 2023.

[8] van Duin D, Arias CA, Komarow L, et al. Molecular and clinical epidemiology of carbapenem-resistant Enterobacterales in the intensive care unit: the PANORAMA multicenter ICU study. Clin Infect Dis. 2022;74(4):581-590.

[9] Rodriguez-Baño J, Gutierrez-Gutierrez B, Machuca I, et al. Treatment of Infections Caused by Extended-Spectrum-Beta-Lactamase-, AmpC-, and Carbapenemase-Producing Enterobacterales. Clin Microbiol Rev. 2021;34(1):e00079-19.

[10] Tacconelli E, Carrara E, Savoldi A, et al. Rapid bacterial diagnostics to reduce empirical glycopeptides use (RAPIDO trial): a multicentre, cluster-randomised, interventional study in European intensive care units. Lancet Infect Dis. 2022;22(5):678-690.

[11] Kourtis AP, Hatfield K, Baggs J, et al. Vital Signs: Epidemiology and Recent Trends in Methicillin-Resistant and in Methicillin-Susceptible Staphylococcus aureus Bloodstream Infections - United States. MMWR Morb Mortal Wkly Rep. 2019;68(9):214-219.

[12] Bassetti M, Peghin M, Vena A, et al. Treatment of Infections Due to MDR Gram-Negative Bacteria. Front Med (Lausanne). 2023; 10:598374.

[13] Shields RK, McCreary EK, Marini RV, et al. Early experience with meropenem-vaborbactam for treatment of carbapenem-resistant Enterobacteriaceae infections. Clin Infect Dis. 2020;71(3):667-671.

[14] Luyt CE, Chastre J, Wendel Garcia PD, et al. Antibiotic stewardship in intensive care units: a position paper from the European Society of Intensive Care Medicine. Intensive Care Med. 2023;49(7):773-803.

[15] Wittekamp BH, Plantinga NL, Cooper BS, et al. Decontamination Strategies and Bloodstream Infections With Antibiotic-Resistant Microorganisms in Ventilated Patients: A Randomized Clinical Trial. JAMA. 2018;320(20):2087-2098.

[16] Clack L, Zingg W, Saint S, et al. Implementing infection prevention practices across European hospitals: an in-depth qualitative assessment. BMJ Qual Saf. 2018;27(10):771-780.

[17] Theuretzbacher U, Outterson K, Engel A, et al. The global preclinical antibacterial pipeline. Nat Rev Microbiol. 2020;18(5):275-285.

[18] Kollef MH, Bassetti M, Francois B, et al. The intensive care medicine research agenda on multidrug-resistant bacteria, antibiotics, and stewardship. Intensive Care Med. 2022;48(6):657-667.