(RESEARCH ARTICLE)

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Acinetobacter baumannii: Epidemiological profile and antibiotic resistance in patients from the intensive care unit of Avicenne military hospital in Marrakech

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Abstract

Acinetobacter baumannii (A. baumannii) is an opportunistic bacterium that has emerged in recent decades as a major cause of potentially epidemic nosocomial infections. This bacterium has impressively developed resistance to most antibiotics, which explains the therapeutic challenges encountered.

The aim of this study is to determine, through a retrospective analysis, the epidemiological profile and antibiotic resistance of *A. baumannii* strains isolated from diagnostic samples collected at Avicenne Military Hospital in Marrakech (HMA), and to track their evolution over the past 3 years (2020-2023). During our study, 105 strains of *Acinetobacter baumannii* were isolated from various samples received in the laboratory, with a male predominance of 74%. The results show that A. baumannii was identified in 48% of cases from bronchoalveolar lavage, 13% from blood cultures, 11% from sputum, 6% from urine cultures, 5% from bronchial aspiration, 8% from venous catheter samples, 4% from pus samples, 3% from protected distal samples, and 2% from biopsies. The isolates exhibited a high level of resistance to tested beta-lactams: 88.57% for piperacillin-tazobactam, 89.52% for imipenem, and 77.14% for ceftazidime. Regarding other classes of antibiotics, 75.23% of strains were resistant to trimethoprim-sulfamethoxazole, 81.9% to amikacin, and 91.42% to ciprofloxacin.

These results confirm the multidrug-resistant nature of A. baumannii and its nosocomial character. This resistance poses a serious therapeutic and epidemiological problem, underscoring the need for a microbial environmental monitoring system in the hospital and the strict implementation of preventive measures.

Keywords: *Acinetobacter baumannii*; Nosocomial infections; Antibiotic resistance; Multidrug resistance; Preventive measures

1. Introduction

Acinetobacter baumannii (A. baumannii) is a Gram-negative, non-fermenting coccobacillus, a saprophyte, and ubiquitous organism that has garnered significant attention as a major emerging bacterial pathogen [1]. This germ is considered an opportunistic pathogen, occasionally responsible for sporadic or epidemic nosocomial infections [2].

A. baumannii is involved in a wide range of infections such as ventilator-associated pneumonia, bacteremia, urinary tract infections, wound infections, and postoperative meningitis [3,4]. These infections are often associated with risk factors such as a history of surgery, stays in intensive care units, prior antibiotic therapy, and the presence of invasive devices (mechanical ventilation, urinary catheters, intravascular catheters) [5].

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Currently, this bacterium holds a significant place in hospital pathology worldwide. It is capable of colonizing both biotic and abiotic surfaces with high resistance to disinfectants as well as desiccation due to its strong ability to form biofilms [6,7]. The persistence of this bacterium in the patient's environment, coupled with transmission via contaminated materials (humidifiers, ventilation equipment) through the hands of healthcare personnel, explains the extent and duration of epidemic phenomena [8].

A. baumannii exhibits a remarkable ability to acquire antibiotic resistance mechanisms, leading rapidly to multidrug resistance and sometimes therapeutic dead-ends. Indeed, it has been classified among the 6 most common and severe multidrug-resistant pathogens responsible for healthcare-associated infections, known by the acronym "ESKAPE" for Enterococcus faecium, Staphylococcus aureus, K. pneumoniae, A. baumannii, P. aeruginosa, and Enterobacter spp [4,9]. In 2017, the World Health Organization (WHO) classified A. baumannii among the critical priority pathogens for antibiotic resistance [10].

Understanding the local epidemiology is crucial for monitoring trends in bacterial resistance to antibiotics, determining the extent of this phenomenon, adapting empirical antibiotic therapy protocols to the resistance profile of this germ, and evaluating control measures against this bacterium [11]. The objective of this study is to determine, through a descriptive study spanning 3 years (2020-2023), the evolution of the epidemiological profile of A. baumannii isolated at Avicenne Military Hospital in Marrakech and to assess the levels of resistance to various antibiotics.

2. Materials and methods

- **Study Site:** Our study was conducted at the microbiology laboratory of Avicenne Military Hospital in Marrakech (HMA).
- **Study Period:** The study was carried out from 2020 to 2023.
- **Statistical Analysis:** All data were analyzed using SPSS software. The results were presented as percentages.
- **Nature of the Samples Studied:** The samples included in the study were: protected distal samples (PDP), urine cytobacteriological examinations (ECBU), blood cultures (HC), pus examinations, catheter samples (KT), sputum examinations (CR), end-of-drain studies, urinary catheters and osteosynthesis materials, lumbar punctures (PL), ascitic punctures (PA), pleural punctures (PP).
- **Inclusion Criteria:** The study focused on all strains of A. baumannii isolated from diagnostic samples at the microbiology laboratory of HMA, from patients hospitalized in the intensive care unit aged over 18 years.
- **Exclusion Criteria:**
  - Samples collected as part of an epidemiological investigation.
  - Redundant strains.
- **Isolation and Identification of Bacteria:** Cultures of the received samples were performed on enriched and selective agar media. Incubation was carried out at 37° C for 24 to 48 hours.

Bacterial identification was done according to conventional morphological, cultural, and biochemical characteristics. Biochemical identification was performed using the API 20E and NE galleries from BioMérieux.

Once the bacterium was identified, an antibiogram was performed to confirm the bacterial identification, provide insight into the epidemiological spread of the bacterium, and determine the antibiotics to which the bacterium is sensitive to relay this information to the clinician. The phenotypic techniques typically used in practice were based on:

- Automated antibiogram in liquid medium: using an analysis automaton (BD Phoenix®),
- Standard antibiogram according to the Mueller Hinton (MH) agar diffusion method.

The identification of antibiotic resistance regarding methodology and interpretation was based on reference standards developed by expert committees.

- **Biological Diagnosis of Multidrug-Resistant A. baumannii Strains:** Multidrug resistance in A. baumannii is generally defined by resistance to Ceftazidime and/or Imipenem with resistance affecting other antibiotic families, notably aminoglycosides and fluoroquinolones. This resistance is noted by any reduction in critical diameters or MICs for Ceftazidime and/or Imipenem according to the recommendations established by CASFM/EUCAST [12].

3. Results

During the study period from January 1, 2020, to January 13, 2023, A. baumannii accounted for 21.96% (n=105) of all isolated pathogens in the intensive care unit (478 pathogens).

The distribution of isolates by sex showed a male predominance with 78 strains, representing 74.3% (Figure 1).
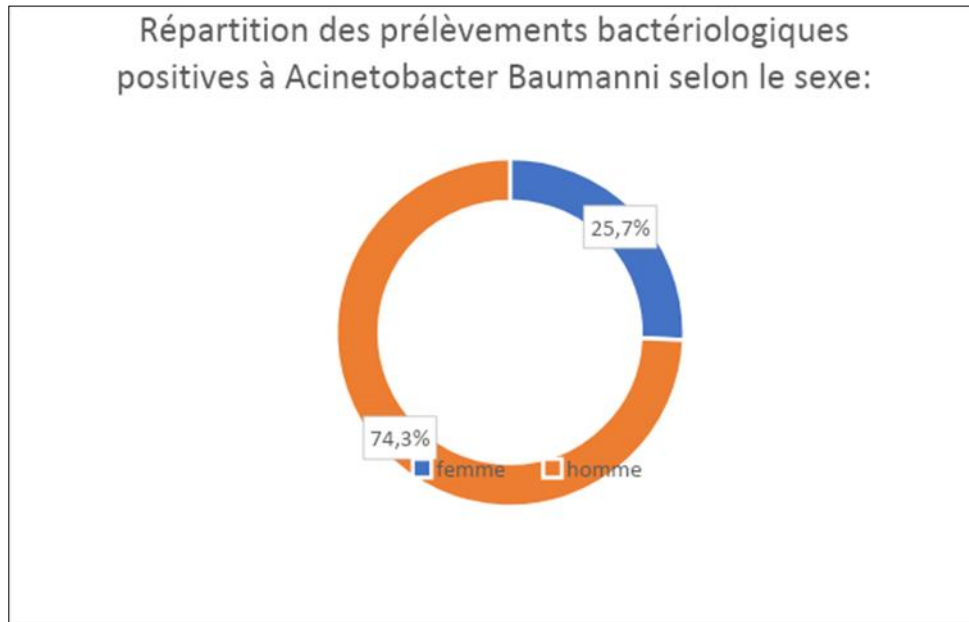

Figure 1 Distribution of positive bacteriological samples for Acinetobacter baumannii by sex

The results indicate that A. baumannii was identified in 48% of cases from bronchoalveolar lavage, 13% from blood cultures, 11% from sputum samples, 8% from venous catheters, 6% from urine cultures, 5% from bronchial aspiration, 4% from pus samples, 3% from protected distal samples, and 2% from biopsies.

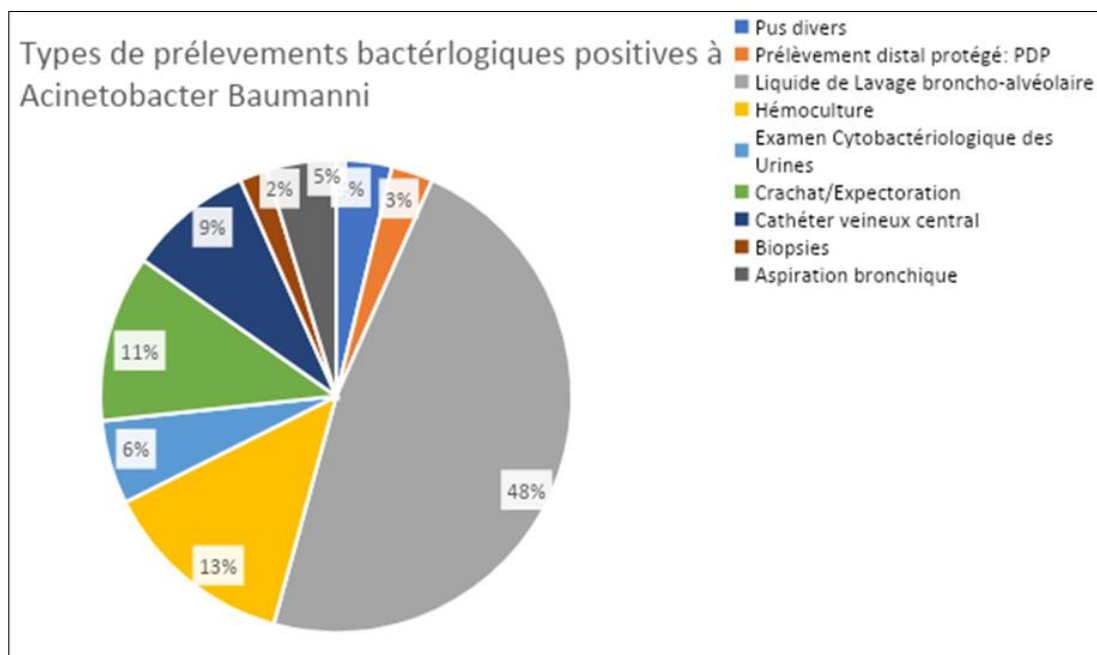The distribution of Acinetobacter baumannii strains by the nature of the samples is shown in Figure 2.

Figure 2 Distribution of positive bacteriological samples for Acinetobacter baumannii by sample type

The isolates exhibited a high level of resistance to the tested beta-lactams: 88.57% for piperacillin-tazobactam, 89.52% for imipenem, and 77.14% for ceftazidime. Regarding other classes of antibiotics, 75.23% of the strains were resistant to trimethoprim-sulfamethoxazole, 81.9% to amikacin, and 91.42% to ciprofloxacin. All strains remained sensitive to colistin (Table 1).

Table 1 Antibiotic Resistance Profiles of Acinetobacter baumannii Isolates

Amikacin	caz	cipro	imipenem	sxt	tzp	colistin
81,9%	77,14%	91,42%	89,52%	75,23%	88,57%	0%

4. Discussion

Infections with A. baumannii were more frequent in the male population compared to females, with a sex ratio of 2.89. This male predominance is reported by several national, Maghrebian, and international studies (Table 2) [13, 14, 15, 16, 17, 18]. This predominance may be explained by the association of A. baumannii with underlying conditions such as smoking, alcoholism, diabetes, and other chronic pulmonary diseases [19].

Table 2 Comparison of sex ratios

	HMM Meknès 2017 [13]	CHU Marrakech 2015 [14]	Rabat 2017 [16]	Tunisia 2017 [17]	Poland 2016 [18]	Pakistan 2016 [15]	Our study
Sex Ratio	2.07	1.70	1.87	1.77	1.90	1.30	2.89

Patients in intensive care units have a higher risk of developing an A. baumannii infection, which is explained by the severity of underlying conditions, prolonged hospitalization, broad-spectrum antibiotic use, and multiple invasive procedures such as intubation, urinary catheters, and central catheters [20].

Protected distal samples were the main site of A. baumannii isolation (48%). This result aligns with several studies reporting a predominance of A. baumannii in protected distal samples, with rates similar to or lower than ours: 33% at CHU Marrakech in 2015, 44% in Rabat in 2017, and 28% in India in 2015 [14, 16, 21]. In contrast, a study conducted at HMMI Meknes reported that the main site of A. baumannii isolation was in urine cultures with a rate of 42.5% (Table 3) [13].

Table 3 Comparison of A. baumannii isolates by sample type

	CHU Marrakech 2015 [14]	HMM Meknès 2017 [13]	Rabat 2017 [16]	Pakistan 2016 [15]	India 2016 [21]	Our study
Protected Distal Specimens	33%	7,50%	44,67%	28%	_	48%
Urine Cyto-bacteriological Examination	15%	42,50%	12%	0,60%	12,70%	6%
Pus	14%	20%	21,47%	4,20%	27,60%	4%
Blood Cultures	14%	2,50%	14,15%	11,60%	2,10%	13%

Infections caused by Acinetobacter spp. are generally associated with anatomical sites with high fluid content, manifesting as pneumonia, bacteremia, urinary tract infections, meningitis, and wound infections [22].

Several studies have shown that the high frequency of A. baumannii pneumonia is associated with mechanical ventilation, leading to prolonged stays in intensive care units, rapid acquisition of resistance to commonly used antibiotics, and high mortality rates ranging from 45.6% to 84.3% according to different authors [22, 23].

The results regarding antibiotic resistance in this study are alarming. In our study, the majority of strains were resistant to beta-lactams, ranging from 77.14% to 98%. Recent national and international studies have reported similar results with high resistance rates to beta-lactams (Table 4) [13, 14, 24, 25].

Regarding carbapenems, the percentage of resistant strains was high, reaching 89.52% in intensive care units. Our results are consistent with those in the literature (Table 4) [13, 14, 25].

Resistance to amikacin in our study was 81.9%, with the highest reported rate being 100% in Iran [13, 24]. The resistance rate to ciprofloxacin reported in this study was 91.42%, which is close to that reported by national and international studies (Table 4).

Resistance to colistin was 0%. Our results align with literature data. Several studies have reported that most strains remain sensitive to colistin. The frequency reported by studies conducted at the CHU Marrakech and Meknes was similar (0%) [13, 14]. However, other studies note higher percentages of resistance to colistin in intensive care settings (3.4% in Greece and 16% in Iran) (Table 4) [25, 24].

Table 4 Comparison of resistance rates for A. baumannii

	CHU Marrakech 2015 [14]	HMM Meknès 2017 [13]	Greece 2016 [25]	Iran 2016 [24]	Our study
TIC	-	100%	-	97.6%	98%
CTX	-	100%	-	98.6%	98%
CAZ	95%	100%	-	97.8%	77.14%
IMP	92%	100%	76%	-	89.52%
AK	36%	78%	100%	62%	81.9%
CIP	92%	100%	96%	96.8%	91.42%
CS	0%	0%	16%	3.4%	0%

A. baumannii naturally possesses resistance mechanisms to beta-lactams, notably through hyperproduction of chromosomal cephalosporinase, which is compounded by its ability to easily acquire resistance through various mechanisms, including enzymatic resistance, efflux, and impermeability [26].

Carbapenems (imipenem) remain one of the most important therapeutic options for these infections, but carbapenem-resistant strains are increasing [27]. In our study, imipenem resistance was 89.52%. Recent national and international studies have reported similar results with high resistance rates [13, 14, 24, 16, 25, 21, 28].

Resistance to carbapenems in A. baumannii is often due to the expression of OXA-type carbapenemases, metallo-beta-lactamases (MBLs), and impermeability related to mutations affecting porins and the expression of efflux pumps [22].

These data highlight the concerning increase in imipenem resistance and the expression of carbapenemases, often linked to the excessive and inappropriate use of this drug in the intensive care unit of our hospital.

There is significant variability in antibiotic resistance rates between countries and even regions. This diversity is primarily related to antibiotic use policies and hygiene practices at each hospital [17].

5. Conclusion

A. baumannii holds a significant place in hospital pathology due to its high capacity to colonize and persist in the hospital environment, its increasing frequency, pathogenic potential, and ability to continuously acquire resistance. Consequently, this bacterium must be subject to national surveillance programs in all countries.

Our study provided a description of the epidemiological profile and resistance of Acinetobacter baumannii at the Hôpital Militaire Avicenne in Marrakech for the period from 2020 to 2023, based on the data available from the microbiology laboratory records.

Given the global development of resistance phenomena, the research and development of new antibiotics remain insufficient. However, prevention remains the primary solution to combat these infections, which cause significant damage both materially and humanly.

A. baumannii remains the most feared agent in nosocomial infections because it is a challenging adversary to control and eliminate, and optimal treatment for infections with multidrug-resistant strains is still to be established.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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