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Prevalence of bacteremia and antimicrobial resistance profile in patients in South Morocco

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Abstract

Bacteremia is a major cause of hospital morbidity and mortality. Effective management depends on up-to-date knowledge of the bacteriological profile and antibiotic resistance. This retrospective descriptive study, carried out over three years (2022-2024) at the Avicenne Military Hospital in Marrakech, analyzed strains isolated from positive blood cultures. Of 1,480 blood cultures received, 142 (9.6%) were actually positive. Analysis revealed a predominance of *Staphylococcus aureus* (21.3%), followed by *Escherichia coli* (13.9%), *Klebsiella* spp (12.7%), and *Acinetobacter baumannii* (9.3%). *Enterobacter*iaceae accounted for 41.78% of isolates, with a high proportion of ESBL strains (38.3%) and 2.8% of carbapenemase-producing strains. The highest rates of resistance were to amoxicillin (78.5%), amoxicillin-clavulanic acid (61%), and fluoroquinolones (43.3%). *A. baumannii* showed a worrying multi-resistance profile, with exclusive sensitivity to colistin. These results underline the importance of microbiological surveillance and rationalization of antibiotic therapy.

Keywords: Bacteremia; Antibiotic resistance; Blood culture; Multidrug-resistant bacteria; Antimicrobial surveillance

1. Introduction

Hospital-acquired bacteremia is a major worldwide problem in terms of mortality and morbidity [1]. Their incidence is on the rise, paradoxically with the progress made in medicine [2-4]. The clinical consequences of bacteremia range from signs of sepsis to septic shock, thereby worsening the prognosis and increasing the risk of morbidity [5,6].

Blood culture remains the routine and reference test for detecting bacteremia. However, it takes a long time to obtain the results (24 hours to a few days, depending on the case), so an initial probabilistic antibiotic treatment must be instituted, followed by a second course depending on the blood culture results [7].

In this paper, we report data collected in the bacteriology laboratory of the Avicenne military hospital in Marrakech over a 3-year period, with discussion of the results of the bacteria identified and their resistance to antibiotics in the light of literature data.

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2. Materials and methods

This is a descriptive retrospective study conducted over a three-year period, from January 1, 2022 to December 31, 2024, and covering all bacterial strains isolated from blood cultures from patients hospitalized at the Avicenne Military Hospital in Marrakech.

Samples were taken from patients presenting clinical signs suggestive of bacteremia, including chills, fever or hypothermia. For each patient, a blood volume of 40 to 60 mL was drawn, divided into two to three pairs of vials, each pair comprising one aerobic and one anaerobic vial.

All the blood cultures received in the laboratory were immediately incubated using the BD BACTEC™ FX automaton, for 5 days. Bacteremia was diagnosed when at least two blood cultures were positive. Identification of isolated organisms was based on morphological, cultural and biochemical characteristics, using the BD Phoenix™ M50 automated system.

In addition to conventional microbiological methods, a multiplex molecular biology assay, the FilmArray® Blood Culture Identification Panel, was used for positive blood cultures from patients in critical clinical condition, particularly those hospitalized in the intensive care unit or emergency resuscitation area, in order to enable rapid identification of the main pathogens responsible for bacteremia as well as selected antibiotic resistance genes, directly from positive blood culture bottles.

Positive flasks were plated on fresh blood agar, Chapman agar and chocolate agar. Antibiotic susceptibility testing was performed using the agar diffusion technique and automated liquid antibiotic susceptibility testing. Results were interpreted in accordance with the recommendations of the EUCAST 2024 committee [8]. Data were entered and analyzed using Microsoft Excel 2024.

3. Results

During the study period, a total of 1,480 blood cultures were received, of which 9.6% (n=142) were positive and 2.1% (n=31) contaminated.

Of the 173 cases analyzed, a predominance of males was noted, with an M/F sex ratio of 2.6 (125 males to 48 females).

The majority of positive blood cultures came from the intensive care unit (48%), followed by medicine (29.5%), emergency (16.7%) and surgery (5.8%).

The germs isolated are shown in figure 1: Microbiological analysis revealed a predominance of *Staphylococcus aureus* with 37 cases, a prevalence of 21.3%, followed by *Escherichia coli* with 24 cases (13.9%), *Klebsiella* spp 22 cases (12.7%), *Acinetobacter baumannii* 16 cases (9.3%), *Pseudomonas aeruginosa* 11 cases (6.4%) and *Enterobacter cloacae* 10 cases (5.7%). Other less frequent bacteria included *streptococci, enterococci, Stenotrophomonas maltophilia, Salmonella sp, Serratia marcescens* and *Proteus mirabilis.*

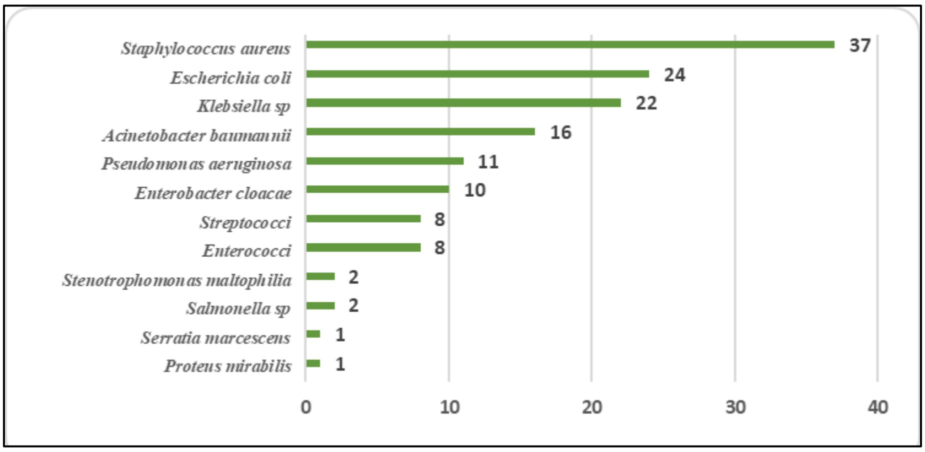

Figure 1 Distribution of bacteria isolated (n=142)

The resistance profile of *S. aureus* strains showed high resistance to penicillin G (94%), and moderate resistance to tetracycline (34%), meticillin (27%), cotrimoxazole (27%), and fusidic acid (28%) All strains were sensitive to glycopeptides (vancomycin and teicoplanin) (Figure 2).

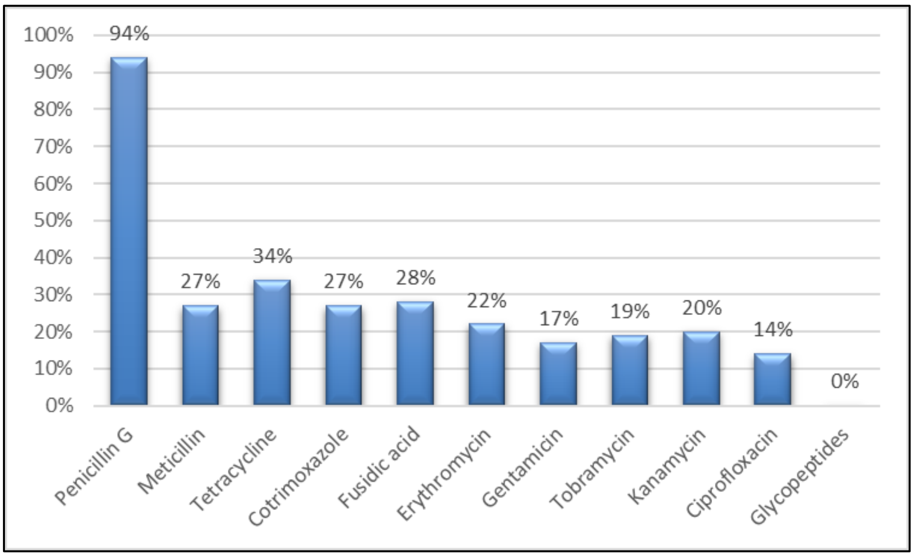

Figure 2 Antibiotic resistance of isolated *S. aureus* strains (n=37)

Among *Enterobacter*ia (n=60), high rates of resistance were observed to amoxicillin (78.5%), ticarcillin (63.5%) and amoxicillin-clavulanic acid (62%). Resistance to 3rd-generation cephalosporins ranged from 27.5% to 33%. Resistance levels were also worryingly high for ciprofloxacin (43.5%) and cotrimoxazole (35%). In contrast, resistance rates to amikacin (15%), gentamicin (22%) and imipenem (13.5%) remained relatively low (Figure 3).

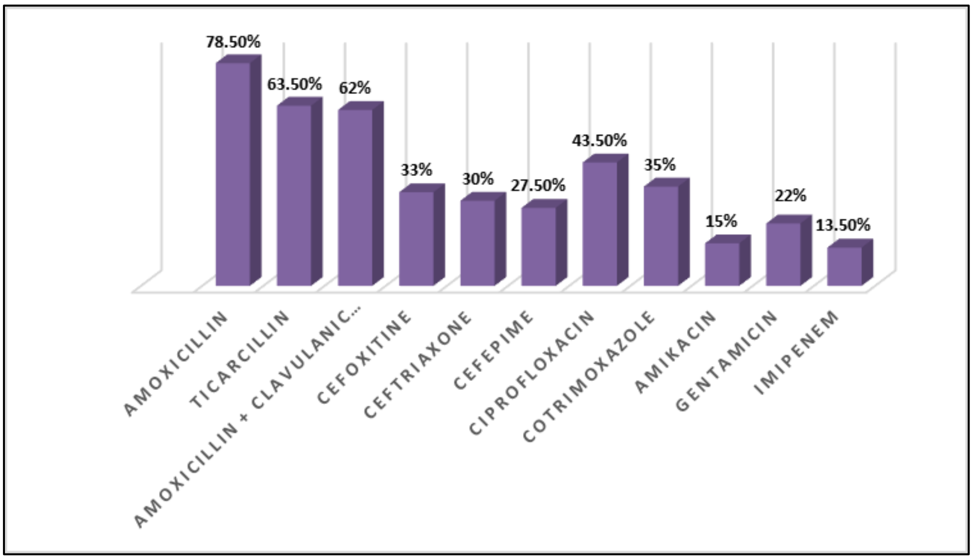

Figure 3 Antibiotic resistance in isolated *Enterobacter*iaceae (n=60)

23 (38.3%) strains were identified as producing an extended-spectrum beta-lactamase (ESBL), mainly *Escherichia coli* (52.2%), *Klebsiella pneumoniae* (30.4%) and *Enterobacter cloacae* (17.4%). Carbapenemase production was also detected in 8 patients, including 5 cases due to *Klebsiella pneumoniae*, giving an overall prevalence of 2.8%.

In the case of *Pseudomonas aeruginosa*, a resistance rate of 18% was observed for both ceftazidime and fluoroquinolones. On the other hand, all strains isolated proved sensitive to cefepime, imipenem, aztreonam, aminoglycosides (tobramycin, amikacin, gentamicin) and colistin.

Finally, all *Acinetobacter baumannii* strains showed a multidrug resistance profile, with total resistance to ceftazidime, fluoroquinolones and carbapenems, retaining only sensitivity to colistin (100%).

4. Discussion

The importance of blood culture for the detection of bacteremia is well known. Numerous studies have focused on the same theme. These include Diekema DJ et al and Takeshita N et al [9,10]. Indeed, according to a study carried out in India in 2016, the positivity rate of blood cultures was 16.5% [11]. Similarly, in the series by Bhandari P. et al and Eshetu S. et al, blood cultures were positive in 15.4% and 15.2% of cases [12,13]. On the other hand, in a Moroccan study carried out in Meknes and another in Algeria, the rates of bacteremia in relation to blood cultures taken were higher, with percentages of 34.90% and 31.48% of cases respectively [14,15]. In our study, the rate of confirmed bacteremia was 9.6%. However, this result is lower than the rates observed in these studies.

In the present study, the sex ratio (M/F) was 2.6. This result is similar to that of the Moroccan study carried out at the Meknes military hospital (M/F=2.1) [14]. Male predominance has also been observed in other series, but with different sex ratios [10,16,17].

The rate of gram-positive bacteria in our study was 37.3%. This rate is different from that of the Moroccan study carried out at the Meknes military hospital by Maman R. (2015), who found 67% gram-positive bacteria [14]. Takeshita N. et al (Japan 2017) and Banik A .et al (India 2018) also found gram-positive bacteria rates of 56.02% and 62.37% respectively, higher compared to gram-negative bacteria [10,17]

Staphylococcus aureus was the most isolated bacterium during our study period, accounting for 21.3% of all bacteremia. Similarly, in the series by Banik A. et al, *Staphylococcus aureus* was the predominant bacterium, responsible for 42.14% of bacteremia [17]. In the Moroccan study by Maman R., coagulase-negative *Staphylococci* ranked first in terms of bacteremia, with a rate of 35.29%, followed by *Staphylococcus aureus* with a rate of 21.17% [14].

Escherichia coli was the most isolated Gram-negative bacterium in our study, ranking second after *Staphylococcus aureus* in terms of bacteremia, with an isolation rate of 13.9% among all bacteria identified. This result is close to those of Maman R., Takeshita N. et al and Gupta S. et al, who reported rates of 20.82%, 18.1% and 22.40% respectively [10,11,14]. *Escherichia* rates similar to our own were also reported by Diekema DJ. et al in their work, which found that between 2013 and 2016, *Escherichia coli* occupied first place in terms of bacteremia in Europe and Asia-Pacific, with rates of 27% and 33.7% respectively. On the other hand, the study by Lakhe N. et al, showed an *Escherichia coli* rate of 8.1%, and the study by Banik A. et al, showed an *Escherichia coli* rate of 4% of bacterial isolates [17,18].

As for bacterial resistance, data from our study show that 94% of *Staphylococcus aureus* isolates are resistant to penicillin-G. Rates similar to ours are observed at CHU Ibn Sina (91.3%) and Mohamed V Military Training Hospital (86.8%). [19]. In Mauritania, a study carried out in 2016 reported rates of 96% to 100% (depending on the nature of the sample) [20]. The high rates of resistance to penicillin G are explained by the fact that most *Staphylococcus aureus* currently possess penicillinase, an enzyme capable of hydrolyzing all penicillins except oxacillin and cloxacillin [21].

In the case of tetracycline, *S.aureus* were resistant in 34% of cases. This percentage is close to those noted in a study carried out in Rabat and Tunisia, with rates of 29% and 29.3% respectively [19,22].

Methicillin-resistant *Staphylococcus aureus* (MRSA) accounted for 27% of the *S.aureus* isolated in our study. This rate is higher than the results obtained in the two studies carried out in 2014 at the University Hospital of Fes and Rabat, which had respectively objectified MRSA rates of 6.2% and 10% [23,24]. A study carried out at the Ibn Tofail University Hospital in Marrakech in 2018, based on samples taken between 2010 and 2014, reported an overall MRSA rate of 17.82% [25].

In our study, *Enterobacter*iaceae accounted for 34.7% of isolates, making them the bacterial family most frequently encountered in bacteremia.

Escherichia coli, *Klebsiella* and *Enterobacter* accounted for 40%, 36.7% and 16.70% of these isolates respectively, and 13.9%, 12.7% and 5.7% of all bacteremia. The other *Enterobacter*ia identified did not exceed a frequency of 2% of bacteremia.

The rate of ESBL-producing *Enterobacter*iaceae (E-BLSE) was around 38.3%, with *Escherichia coli* accounting for 65% of all *Enterobacter*iaceae, followed by *Klebsiella* spp.

Resistance to amino-penicillins combined with amoxicillin clavulanic acid was 66.6% for *E. coli*, 80% for *Enterobacter* and 59.1% for *Klebsiella pneumoniae*. 15% of *Enterobacter*ia were resistant to amikacin and 22% to gentamicin.

Table 1 Resistance of the main *Enterobacter*iaceae to Aminopenicillins combined with amoxicillin clavulanic acid, according to various studies

Series	Pays	*E. coli*	*Klebsiella*	*Enterobacter*
Lakhe A. et al [18]	Senegal	100%	100%	83,3%
Gupta S. et al [11]	Inde	88,8%	97,28%	50%
Maman R. [14]	Maroc (Meknes)	76%	-	-
El Mouali A. [25]	Maroc (Rabat)	77,7%	93%	
Our series	Maroc	66,6%	59,1%	80%

Pseudomonas aeruginosa is one of the opportunistic bacteria that can cause nosocomial infections, which are both frequent and serious. In the hospital environment, this germ is endemo-epidemic, varying from department to department and from patient to patient [26]. This bacterial species is characterized by its rapid acquisition of antibiotic resistance, and by a high level of natural antibiotic resistance [27].

In our study, 11 cases of bacteremia (6.4%) were due to *P. aeruginosa*. Analysis of the resistance profile of *P. aeruginosa* strains in accordance with the standards of the French Microbiology Society's antibiotic susceptibility testing committee (EUCAST 2024) [8], showed variable rates of resistance of *P. aeruginosa* to ceftazidime (18%), fluoroquinolones (18%), cefepime (0%), aminoglycosides (0%) and imipenem (0%). Table (2) shows our results compared with other studies.

Table 2 Resistances of *Pseudomonas aeruginosa* isolated from blood cultures, according to different studies

Series / Antibiotic	Surbhi K. et al Inde 2016 [28]	Boukerouaz A. et al Algeria 2016-2017 [15]	Chinbo M. et al Marrakech CHU- Ped [29]	Our series
Ceftazidime	58%	48%	20%	18%
Cefepime	55%	-	-	0%
Imipenem	42%	20%	11%	0%
Gentamicin	-	50%	14%	0%
Amikacin	61%	63%	6%	0%
Ciprofloxacin	71%	53%	13%	18%

Acinetobacter species are bacteria marked by their extreme capacity to acquire resistance mechanisms to most new antibiotics [30].

In our study, *Acinetobacter baumannii* accounted for 9.3% of bacteremia. In 87.5% of cases, the strains isolated came from the intensive care unit. Analysis of the sensitivity profile of *Acinetobacter baumannii* strains, in accordance with EUCAST 2024 standards [8], showed high levels of resistance to most of the antibiotics tested, except colistin, for which it was sensitive in 100% of cases.

In our study, the results were alarming, showing resistance rates of 100% to Imipenem. High resistance rates have been reported nationally in Meknes, Rabat, Casablanca and Fez [31,32,33,34]. Studies carried out in other countries have also raised close or similar rates, including a study carried out in Egypt in 2018% with a resistance rate of 100%, in Greece (89%), and in India (92%) [28,35,36].

In our study, all strains retained 100% sensitivity to colistin. Our results concur with most of the data in the literature, although some studies, such as those carried out in China, Greece and Iran, note the presence of colistin resistance, with percentages of 1.9%, 3.4% and 16% respectively [36,37,38].

5. Conclusion

Bacteremia is a frequent occurrence in hospitals. Their evolution, generally unfavorable in the absence of effective antibiotic treatment, is a source of mortality, morbidity and considerable additional costs.

In view of the emergence and growth of bacterial resistance to antibiotics, up-to-date studies of the epidemiological profile of bacteria and assessment of their sensitivity profiles are needed to rationalize the initial antibiotic treatment of bacteremia.

Our study has enabled us to describe the bacteriological profile and resistance of agents responsible for bacteremia in our facility, thus providing a reliable basis for adapting probabilistic antibiotic therapy and developing strategies to combat the emergence and spread of multi-resistant bacteria.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Ethical approval was obtained according to institutional guidelines.

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