Comment [S1]: Antibiotic resistance in Pseudomonas aeruginosa and Acinetobacter baumannii isolates from the Conakry region, Guinea

Study of antibiotic resistance in Pseudomonas aeruginosa and Acinetobacter baumannii species isolated in the Conakry region, Guinea

Abstract

Objectives: This study aimed to investigate the antibiotic resistance of Pseudomonas aeruginosa and Acinetobacter baumannii strains isolated in the Conakry region from 2022 to 2024.

Study type: This cross-sectional study was conducted from 2022 to 2024 in the Conakry region.

Study location and duration: National Institute of Public Health (INSP), Biomar-24 medical biology laboratory, and Donka University Hospital Center, between 2022 and 2024.

Methods: Bacterial identification and antibiotic susceptibility testing were performed using VITEK 2 Compact, following EUCAST guidelines.

Results: Eighty bacterial strains were isolated, of which 57.5% were Acinetobacter baumannii and 42.5% were Pseudomonas aeruginosa. Regarding the origin of the samples, urine samples were the most common at 57.5%, followed by pus (15%) and blood (13.75%). There was high resistance to ticarcillin (43.75%), ceftazidime (32.5%), and piperacillin-tazobactam (31.25%), and low resistance to colistin (5%) and imipenem (7.52%), making them the most effective antibiotics. In addition, there was notable resistance to tobramycin (33.75%), especially in Acinetobacter baumannii.

Conclusion: This study highlights an alarming frequency of resistance. It calls for a strengthening of surveillance policies and better management of antibiotics in Guinea.

Keywords: resistance, *Pseudomonas aeruginosa, Acinetobacter baumannii,* Conakry.

INTRODUCTION

Antimicrobial resistance (AMR) is now a major global public health issue, causing more than 700,000 deaths per year (Krug, 2023), particularly in developing countries (Pragasam et al., 2016; Thompson, 2024). Infections caused by multidrug-resistant bacterial pathogens are often associated with high morbidity and mortality (Herindrainy, 2018). Among these pathogens of concern, Pseudomonas aeruginosa and Acinetobacter baumannii are prominent, with mortality rates of 24.5% and 30.5% within 90 days of infection (Vivo et al., 2022) and their ability to rapidly develop resistance to multiple classes of antibiotics (Organization, 2022).

According to the World Health Organization (WHO), without effective measures, AMR could be responsible for more than 10 million deaths per year by 2050 (O'Neill, 2016). Furthermore, in 2019, carbapenem-resistant A. baumannii and P. aeruginosa were responsible for 57,700 and 38,100 deaths worldwide, respectively (Antimicrobial Resistance Collaborators, 2022).

In Ethiopia in 2022, Araya et al (Araya et al., 2023) found an overall multi-resistance rate of 73.7% and 58.9% for A. baumannii and P. aeruginosa, respectively. In Mali in 2022, Doumbia et al (Doumbia, 2022) reported multidrug resistance in 44.66% of isolated germs, with 33.01% of Acinetobacter baumannii and 11.65% of Pseudomonas aeruginosa.

In Guinea, epidemiological data on the prevalence and resistance profiles of Pseudomonas aeruginosa and Acinetobacter baumannii are still limited. In this context, the present study aimed to investigate the antibiotic resistance profile of these two bacterial species isolated in the Conakry region, to better understand their local epidemiology and contribute to the development of more effective therapeutic and prevention strategies in Guinean healthcare facilities.

MATERIAL AND METHODS

Type and duration of study

This was a cross-sectional study conducted in the Conakry region over a three-year period from 2022 to 2024.

General context

The Republic of Guinea is a country in West Africa, bordered by Guinea-Bissau, Senegal, Mali, Ivory Coast, Liberia, and Sierra Leone. Its population is estimated at around 14.5 million. The Guinean healthcare system is pyramid-shaped, with health centers at the base, regional hospitals, and national hospitals for more serious cases (guinee_-_politique_nationale_sante_aout_2015).

Specific setting

The bacteriology unit of the laboratory department of the Guinea National Public Health Institue (INSP) served as the setting for this study. The INSP is a public institution under the supervision of the Guinean Ministry of Health and Public Hygiene. Its role is to monitor and control the quality of food products (testing for toxins) and medicines, carry out biological diagnostics, and conduct public health research (Lesage, 2025). Its bacteriology unit, a benchmark in antimicrobial resistance surveillance in Guinea, has the capacity to diagnose bacterial infectious diseases and conducts external quality assessments of various bacteriology laboratories at the national level, as well as training laboratory staff through professional coaching and training sessions.

Site selection

We selected three laboratories such as Guinea National Public Health (INSP), University Hospital Center Donka, and Biomedical laboratory Biomar-24, in the Conakry region because they have the automated platform (VITEK 2 Compact) for performing identification and sensitivity tests. Regional laboratories that do not have this automated platform were not selected.

Study population

The study included all patients who visited the laboratories and in whom Gram-negative non-fermentative bacteria were identified during the study period.

Inclusion criteria

All patients who visited the selected laboratories for a cytobacteriological examination during the study period were included.

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Exclusion criteria

Patients whose identification tests reported bacterial strains not belonging to the Gram-negative non-fermentative bacteria family were excluded.

Study variables

The study variables were sociodemographic (age, sex), isolated bacterial strain (Pseudomonas aeruginosa and Acinetobacter baumannii), sample type (blood, pus, urine, semen, cerebrospinal fluid, and pleural fluid), and antibiotics tested (beta-lactams, aminoglycosides, and fluoroquinolones/others).

Laboratory procedures

For the cytobacteriological tests, biological materials such as pus, urine, semen, cerebrospinal fluid, blood, and pleural fluid were tested.

For the microbiological analysis itself, cytobacteriological tests on the samples were performed through microscopic observation in fresh state followed by Gram staining of the slides prepared for this purpose. Bacterial cultures were grown on various culture media such as Cled agar, MacConkey agar, and chocolate agar. After inoculation on the culture media, an incubation period of 18 hours in an incubator was allowed. Isolated monomorphic colonies from the cultures were stained using the Gram staining method to confirm the purity of the colonies. The automatic “VITEK 2 Compact” method was used for bacterial identification, antibiogram, and determination of minimum inhibitory concentrations (MIC). The European Committee for Antimicrobial Susceptibility Testing (EUCAST) (Giske et al., 2022) served as our guide for selecting the antibiotics to be tested and determining their MICs.

Data analysis

Our data collected using Microsoft Excel was analyzed using SPSS software, version 26. Sociodemographic characteristics, different proportions, and antibiotic resistance profiles were presented in tables and figures.

Ethical considerations

The Institutional Review Board of the National Institute of Public Health authorized this study (Approval No. 07/LabINSP/2025). In alignment with national ethical guidelines, all data were anonymized to ensure the protection of participant confidentiality and used exclusively for scientific purposes.

RESULTS AND DISCUSSION

Figure I shows that a total of 7,629 samples from all causes were received in the three bacteriology laboratories (INSP, Biomar-24, and CHU Donka) included in the study in the Conakry region. Of those that tested positive, 80 constituted our study population and consisted of 57.5% Acinetobacter baumannii and 42.5% Pseudomonas aeruginosa between 2022 and 2024.

In addition, the emergence of multidrug-resistant Acinetobacter isolates is a major concern in hospitals in many parts of the world (Papp-Wallace et al., 2011). Our results corroborate those found by Doumbia et al. (Doumbia, 2022) with 54.37% and 45.63% respectively.

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Comment [S34]: The study variables included sociodemographic characteristics (age and sex), the isolated bacterial strains (Pseudomonas aeruginosa and Acinetobacter baumannii), the type of clinical sample (blood, pus, urine, semen, cerebrospinal fluid, and pleural fluid), and the antibiotics tested, which included beta-lactams, aminoglycosides, and fluoroquinolones/other agents.

Comment [S35]: For the cytobacteriological tests, biological specimens including pus, urine, semen, cerebrospinal fluid, blood, and pleural fluid were analyzed. The microbiological analysis began with microscopic examination of fresh samples, followed by Gram staining of prepared slides. Bacterial cultures were grown on various media, including CLED agar, MacConkey agar, and chocolate agar. After inoculation, the cultures were incubated for 18 hours. Monomorphic colonies isolated from the cultures were Gram-stained to confirm purity.

Bacterial identification, antimicrobial susceptibility testing, and determination of minimum inhibitory concentrations (MICs) were performed using the automated VITEK 2 Compact system. The European Committee for Antimicrobial Susceptibility Testing (EUCAST) guidelines were used to select the antibiotics for testing and to determine their MICs (Giske et al., 2022

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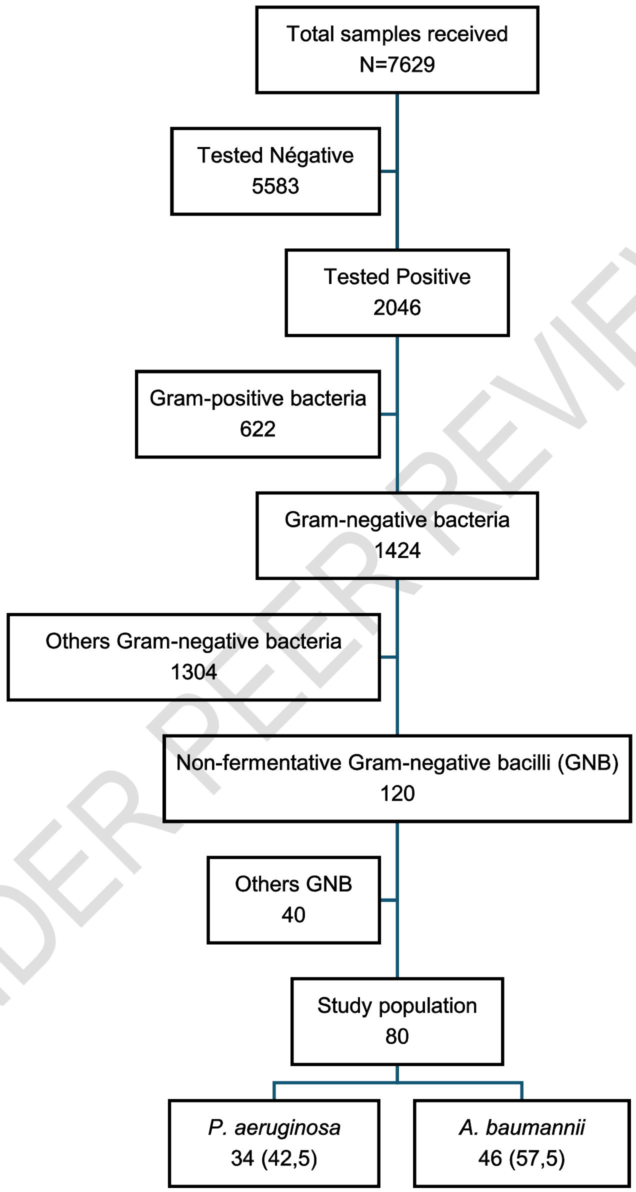

Figure I: Flow chart showing the isolation of strains in Conakry laboratories from 2022 to 2024.

Comment [S47]: indicate that males predominated

Comment [S48]: The results indicate that males predominated, with a male-to-female ratio (M/F) of 1.42. The most represented age group was over 50 years, accounting for 32.5% of the study population, followed by the 36–50 years age group (28.7%). The mean age was 41.05 ± 20.97 years.

Table I shows that males were in the majority, with a ratio (M/F) = 1.42. The most represented age group was over 50 years old, with 32.5%, followed by the 36 to 50 age group (28.7%), with a mean ± standard deviation of 41.05 ± 20.97 years.

Table I: Distribution of patients according to sociodemographic characteristics

Variables	**Frequency**	**Percentage**
Sex		
Masculine	47	58,8
Feminine	33	41,3
Age (years)		
< 10	8	10,0
11 -18	6	7,5
19 -35	17	21,3
36 – 50	23	28,7
> 50	26	32,5
Mean ± Standard Deviation : 41,05 ± 20,97 ans		

Comment [S49]: The results show that, overall, these two species were most frequently isolated from urine samples, followed by pus, with respective frequencies of 57.5% and 15%. These findings are consistent with those reported by Makanera et al. (2017) but higher than the rates observed in India (Ravella Venkatasubramanyam et al., 2024). Other sample types in which P. aeruginosa and A. baumannii were detected included blood (13.75%), cerebrospinal fluid (3.75%), and urinary catheter samples (3.75%). Additionally, P. aeruginosa was isolated from puncture fluid and semen samples, while A. baumannii was detected in an ascitic fluid sample.

Table II shows that, in general, these two species were predominant in urine samples, followed by pus, with respective frequencies of 57.5% and 15%. These results corroborate those reported by Makanera A. et al. (Makanera et al., 2017) but are higher than those found in India (Ravella Venkatasubramanyam et al., 2024). The other types of samples in which *P. aeruginosa and A. baumannii* were isolated were blood (13.75%), cerebrospinal fluid (3.75%), and urinary catheter (3.75%), respectively. However, the *P. aeruginosa* strain was also detected in puncture fluid and semen samples, while *A. baumannii* was isolated in an ascites fluid sample.

Table II: Distribution of *P. aeruginosa* and *A. baumannii* strains isolated according to the type of samples tested in laboratories from 2022 to 2024.

	Isolated bacterial strains		
	***Acinetobacter baumannii* (n=46)**	***Pseudomonas aeruginosa* (n=34)**	**Total N=80**
Type of samples			
CSF	2 (4,34)	1 (2,94)	3 (3,75)
Ascites fluid	1 (2,17)	0 (0,0)	1 (1,25)
Puncture fluid	0 (0,0)	2 (5,88)	2 (2,5)
Pus	1 (2,17)	11 (32,35)	12 (15,0)
Blood	9 (19,56)	2 (5,88)	11 (13,75)
Semen	0 (0,0)	2 (5,88)	2 (2,5)
Urine	32 (69,56)	14 (41,17)	46 (57,5)
Urinary catheter	1 (2,17)	2 (5,88)	3 (3,75)

Table III shows that the highest rates of resistance to beta-lactams were found in ticarcillin and ceftazidime, followed by piperacillin + tazobactam, with varying frequencies of 43.75%, 32.5%, and 31.25%, respectively. In contrast, in Ethiopia (Mekonnen et al., 2021) and Uganda (Agaba et al., 2017), resistance rates of 87.5% and 80% were observed with piperacillin-tazobactam, respectively. With regard to Pseudomonas aeruginosa, similar resistance (32%) to piperacillin-tazobactam was observed in India (Ravella Venkatasubramanyam et al., 2024) and high resistance (69%) to ceftazidime was reported by another study in Uganda (Kateete et al., 2016). Imipenem was the most active molecule on both strains, with only 7.52% resistance.

Regarding aminoglycosides, we observed an overall resistance of 33.75% to tobramycin, including 43.47% resistance in A. baumannii and 20.58% in P. aeruginosa. Low resistance to amikacin was observed for Acinetobacter baumannii and Pseudomonas aeruginosa, unlike the rates observed in Ethiopia, which were 12.5% and 11.1%, respectively (Mekonnen et al., 2021).

About fluoroquinolones, a resistance frequency of 28.75% to ciprofloxacin followed by 12.5% to ofloxacin was obtained. Our results are similar to those reported by Doumbia et al. (Doumbia, 2022) in their study in Mali, with frequencies of 48.94% and 34.04%, respectively. In addition, a quarter of our strains were resistant to the combination of trimethoprim and sulfamethoxazole. These results differ from those reported by Makanera A. et al (Makanera et al., 2019) and Odjadjare et al (Odjadjare et al., 2012), who found that nearly 90% of their strains were resistant to this combination. The lowest resistance was observed with colistin. Our results are like those of Ravella V. et al (Ravella Venkatasubramanyam et al., 2024) and Jiménez et al (Jiménez-Guerra et al., 2018), with a resistance rate of around 5%. These differences could be explained by the variation in sample size on the one hand. Furthermore, the higher level of resistance to ticarcillin, ceftazidime, and piperacillin-tazobactam could be linked to the excessive and inappropriate use of these antibiotics in the Conakry region, as antibiotic policies and mechanisms for controlling the use of antimicrobials in Guinea are not respected in most cases.

Table III: Antibiotic resistance of *A. baumannii* and *P. aeruginosa* strains isolated in laboratories from 2022 to 2024.

Antiotic families	***Acinetobacter baumannii***	***Pseudomonas aeruginosa***	
	Resistance (%) n=46	**Resistance (%) n=34**	**Total n=80**
Bêta-lactamin			
Piperacillin + Tazobactam	16 (34,78)	9 (26,47)	25 (31,25)
Ticacillin	22 (47,83)	13 (38,24)	35 (43,75)
Ceftazidim	17 (36,95)	9 (26,47)	26 (32,5)
Imipénèm	5 (10,87)	1 (2,94)	6 (7,50)
Aminosides			
Amikacin	2 (4,35)	3 (8,82)	5 (6,25)
Gentamycin	18 (39,13)	4 (11,76)	22 (27,5)
Tobramycin	20 (43,47)	7 (20,58)	27 (33,75)
Fluoroquinolones and others			
Ciprofloxacin	17 (36,95)	6 (17,64)	23 (28,75)
Ofloxacin	7 (15,21)	3 (8,82)	10 (12,5)
Colistin	2 (4,34)	2 (5,88)	4 (5,0)
Nitrofurantoine	4 (8,69)	2 (5,88)	6 (7,50)
Triméthroprime/Sulfaméthoxazole	19 (41,30)	1 (2,94)	20 (25,0)

Comment [S50]: ceftazidime, followed by piperacillin–tazobactam, with respective frequencies of 43.75%, 32.5%, and 31.25%. In contrast, higher resistance rates to piperacillin–tazobactam were reported in Ethiopia (87.5%) (Mekonnen et al., 2021) and Uganda (80%) (Agaba et al., 2017). Regarding Pseudomonas aeruginosa, similar resistance to piperacillin–tazobactam (32%) was observed in India (Ravella Venkatasubramanyam et al., 2024), while a higher resistance rate (69%) to ceftazidime was reported in Uganda (Kateete et al., 2016). Imipenem was the most effective antibiotic against both strains, with only 7.52% resistance.

Comment [S51]: Regarding aminoglycosides, an overall resistance rate of 33.75% to tobramycin was observed, including 43.47% in Acinetobacter baumannii and 20.58% in Pseudomonas aeruginosa. Low resistance to amikacin was noted for both A. baumannii and P. aeruginosa, in contrast to the rates reported in Ethiopia, which were 12.5% and 11.1%, respectively (Mekonnen et al., 2021).

Comment [S52]: Regarding fluoroquinolones, a resistance frequency of 28.75% to ciprofloxacin and 12.5% to ofloxacin was observed. Our findings are comparable to those reported by Doumbia et al. (2022) in Mali, who observed resistance rates of 48.94% and 34.04%, respectively. Additionally, 25% of our isolates were resistant to the combination of trimethoprim and sulfamethoxazole. These results differ from those reported by Makanera et al. (2019) and Odjadjare et al. (2012).

Comment [S53]: Nearly 90% of strains in previous studies were reported to be resistant to this combination (Makanera et al., 2019; Odjadjare et al., 2012). In our study, the lowest resistance was observed with colistin, consistent with the findings of Ravella et al. (2024) and Jiménez et al. (2018), with resistance rates of approximately 5%. These differences may be explained, in part, by variations in sample size. Furthermore, the higher levels of resistance observed for ticarcillin, ceftazidime, and piperacillin–tazobactam could be attributed to the excessive and inappropriate use of these antibiotics in the Conakry region, as antibiotic policies and mechanisms for controlling antimicrobial use are often poorly enforced in Guinea.

CONCLUSION

The study conducted on strains of *Acinetobacter baumannii* and *Pseudomonas aeruginosa* isolated in the Conakry region revealed a high level of antibiotic resistance. These results confirm the growing threat posed by these non-fermentative Gram-negative bacteria, known for their ability to develop multiple resistances and cause serious nosocomial infections.

Considering these results, it is imperative to strengthen microbiological surveillance, rationalize the use of antibiotics, and work to implement local programs to combat resistance. This study provides a useful database to guide clinical practices and contributes to a coordinated response to antibiotic resistance in the Conakry region.

Comment [S54]: The present study on Acinetobacter baumannii and Pseudomonas aeruginosa strains isolated in the Conakry region revealed a high level of antibiotic resistance. These findings underscore the growing threat posed by these non-fermentative Gram-negative bacteria, which are known for their capacity to develop multiple resistances and cause severe nosocomial infections.

In light of these results, it is imperative to strengthen microbiological surveillance, promote the rational use of antibiotics, and implement local programs to combat antimicrobial resistance. This study provides a valuable database to inform clinical practice and supports a coordinated response to antibiotic resistance in the Conakry region.

Comment [S55]: The sources need to be updated and increased in number because they do not cover the research.

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Annex

Table IV shows that, more than 60% of the samples were tested at the bacteriology laboratory of the Donka University Hospital Center, followed by those tested at the Biomar-24 medical biology laboratory and the Guinea National Public Health Institute, with proportions of 25.0% and 7.5%, respectively. The percentage of bacterial species detected varied from one laboratory to another.

Table IV: Distribution of bacterial strains isolated in different analytical laboratories from 2022 to 2024.

	Isolated bacterial strains		
Analytical laboratories	***A. baumannii***	***P. aeruginosa***	**Total**
Biomar-24	7 (8,75)	13 (16,25)	20 (25,0)
INSP-Guinée	1 (1,25)	5 (6,25)	6 (7,5)
CHU Donka	38 (47,5)	16 (20,0)	54 (67,5)

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and medicines, performing biological diagnostics, and conducting public health research (Lesage, 2025). Its bacteriology unit, recognized as a benchmark for antimicrobial resistance surveillance in Guinea, is equipped to diagnose bacterial infectious diseases. In addition, it conducts external quality assessments of bacteriology laboratories nationwide and provides professional training and coaching for laboratory staff.

20/09/2025 05:12:00 م	SSD	Page 2: [2] Comment [S28]

Institute (INSP), the University Hospital Center Donka, and the Biomedical Laboratory Biomar-24. These laboratories were chosen because they are equipped with the automated VITEK 2 Compact platform for bacterial identification and antimicrobial susceptibility testing. Regional laboratories lacking this automated system were not included in the study.

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The study included all patients who visited the selected laboratories and were found to be infected with Gram-negative non-fermentative bacteria during the study period.

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All patients who attended the selected laboratories for cytobacteriological examination during the study period were included in the study.