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Research Article

Prevalence of Multidrug-Resistant and Carbapenem-Resistant Acinetobacter baumannii among Clinical Specimens in Baghdad, Iraq

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ABSTRACT

Background: Acinetobacter baumannii is a healthcare associated pathogen with marked capacity to develop multidrug resistance and carbapenem resistance. Local resistance data are essential for empirical antimicrobial therapy.
Objective: This study investigated antibiotic resistance profiles of A. baumannii isolated from clinical specimens, determined the prevalence of multidrug resistant and carbapenem resistant isolates, and assessed associations with gender and specimen type in Baghdad, Iraq.
Materials and Methods: A total of 220 clinical specimens were collected from patients in Baghdad. Isolates were identified using standard microbiological methods and the VITEK 2 Compact system. Multidrug resistance was defined as resistance to at least one agent in three or more antimicrobial classes, while carbapenem resistance was defined as resistance to carbapenem antibiotics. Data were analyzed using SPSS, R, and PAST, and statistical significance was set at 0.05.
Results: Thirty nine non duplicate A.baumannii isolates were recovered. Urine was the most common source, accounting for 51.3 percent of isolates, and females represented 59 percent of cases. The highest resistance rates were recorded against cefotaxime, at 76.9 percent, and ampicillin sulbactam, at 61.5 percent, while colistin remained most active antibiotic, with 5.1 percent resistance. Rates of multidrug resistance and carbapenem resistance were 69.2 percent and 23.1 percent, respectively. Resistance patterns were more associated with specimen type than with gender.
Conclusion: Multidrug resistant and carbapenem resistant A. baumannii isolates are prevalent among specimens in Baghdad, especially urine specimens. Continuous antimicrobial resistance surveillance and evidence based empirical therapy are needed to improve treatment decisions and limit resistance dissemination.

1. INTRODUCTION

Acinetobacter baumannii is an opportunistic pathogen that leads to various types of HAIs, particularly in ICU where ventilatory assistance is required [1]. It has been reported that A. baumannii can cause a range of infections, including pneumonia, blood stream infection, urinary tract infection, and wound infection [2]. It is well-known that this type of bacteria can become resistant to multiple drugs, including carbapenems, which are the last line of antibiotics for the treatment of MDR infections [3]. Infections caused by MDR or CRAB strains of A. baumannii have been associated with long stays in hospitals and poor prognosis [4, 5].

The development of MDR and CRAB strains constitutes a serious problem at the global level and stresses the necessity of implementing infection control and surveillance policies [6, 7]. The knowledge of AMR patterns in the local setting is necessary in order to prescribe the empiric treatment and prevent the transmission of the resistant strains [8, 9]. Antibiograms that are based on the local setting can offer healthcare professionals valuable information concerning the resistance patterns of pathogens in their local environment and help them modify their treatment approaches accordingly [10, 11].

Although A. baumannii is recognized as an important pathogen all over the world, there are very few studies concerning the prevalence and AMR patterns of this organism in Baghdad hospitals. In light of this knowledge gap, the present study aimed to determine the antibiotic resistance patterns of A. baumannii isolated from different types of clinical specimens, identify MDR and CRAB strains, investigate possible correlation between antibiotic resistance patterns and sex of patients and type of specimen collected, and contribute to the formulation of antibiogram for the hospital.

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2. MATERIALS AND METHODS

2.1 Study Design

This is a cross-sectional study carried out during November 2025 to April 2026 in City of Medicine Hospital, Baghdad, Iraq. Samples collected in the experiment amounted to 220 samples of hospitalized patients, which included urine, sputum, wound, blood, and tissue samples. The non-repeated A. baumannii isolates were isolated from all the samples collected. The inclusion criteria of the study are those suspected of containing bacterial infection, whereas duplicate cultures and contaminated samples formed the exclusion criteria.

2.2 Specimen Collection

Specimen collection was done according to standardized microbiology methods, which involved the use of midstream clean-catch for the urine samples, sterile swab aseptically collected from the wound, pus, and venous blood sample obtained by phlebotomy. All samples were transported at the right temperatures and processed accordingly. Patients' sexes, type of specimen, and antibiotic sensitivity patterns were documented confidentially.

2.3 Isolation and Identification of Isolates

Isolation was done by culture in blood agar and MacConkey agar with aerobic conditions at 37°C for 18 to 24 hours. Initial identification was done based on Gram staining reaction, colony characteristics, and biochemical properties, whereas species identification and antimicrobial susceptibility were determined using the VITEK® 2 Compact instrument (bioMérieux, France) with GN and AST cards according to manufacturer's protocols. Minimum inhibitory concentration was automatically determined. The reference strain of A. baumannii ATCC 19606 was used for quality control [12, 13].

2.4 Antimicrobial Susceptibility Testing

Susceptibility testing to antimicrobial agents was performed on all isolated A. baumannii strains through the use of the VITEK® 2 Compact system. MIC values determined by the system were interpreted according to CLSI 2025 criteria, and susceptibility status of each isolate was determined as susceptible, intermediate, or resistant [14]. Antibiotics used in this study include ampicillin/sulbactam, piperacillin/tazobactam, cefotaxime, ceftazidime, cefepime, imipenem, meropenem, gentamicin, amikacin, ciprofloxacin, colistin, and trimethoprim/sulfamethoxazole. Because automated systems such as VITEK® 2 may have limitations in detecting colistin susceptibility accurately, colistin results were interpreted carefully and, when required, confirmed using the broth micro dilution method [15].

2.5 Determination of Multidrug Resistance (MDR)

The term multidrug resistance was characterized based on Magiorakos et al. 2012 to imply resistance against one or more drugs from three antibiotic categories [١٦]. Isolates resistant to carbapenems were categorized as carbapenem-resistant A. baumannii (CRAB). The categorization of MDR and CRAB isolates was based on VITEK® 2 results, and percentages were determined with respect to the total isolates [١٧].

2.6 Statistical Analysis

Analysis of data was done using IBM SPSS statistics software version 26.0. Frequencies and percentages of sex of patients, sources of specimens, antimicrobial susceptibility pattern, MDR status, and presence or absence of CRAB were done. Association of categorical data was tested using Chi-Square or Fisher's Exact Test where necessary. Other tests carried out included correlation analysis and dendrogram using R & PAST. Significant value was taken to be $p<0.05$.

3. RESULTS

3.1. Sample Collection and Isolate Recovery

Samples from 220 clinical sources consisting of urine, sputum, wound, blood, and tissue were collected from the hospital patients. Out of these, 39 strains of A. baumannii isolates were isolated, which accounted for 17.7% of all clinical sources, as seen in Figure 1.

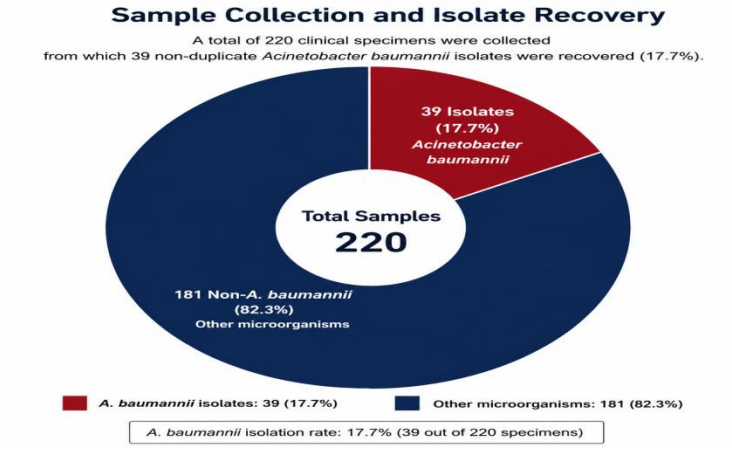

Fig. 1. Distribution of Acinetobacter baumannii isolates recovered from clinical specimens.

3.2. Distribution of Isolates According to Patient Sex

Out of the total of 39 isolates, females were 23 isolates (59%) and males were 16 isolates (41%). It is seen that there were more isolates from the females than the males, as presented in Table I.

TABLE I. GENDER DISTRIBUTION OF A. BAUMANNII CLINICAL ISOLATES FROM HOSPITALIZED PATIENTS.

Gender	Count	Percentage
Female	23	59%
Male	16	41%

3.3. Distribution of Isolates According to Sample Types

Urine samples recorded the highest frequency of isolation (n = 20; 51.3%) followed by sputum, wounds, and pus which recorded five isolations each (12.8% each). Three isolations were recovered from blood (7.7%) and one isolate was recovered from tissue specimens (2.6%), as displayed in Figure 2.

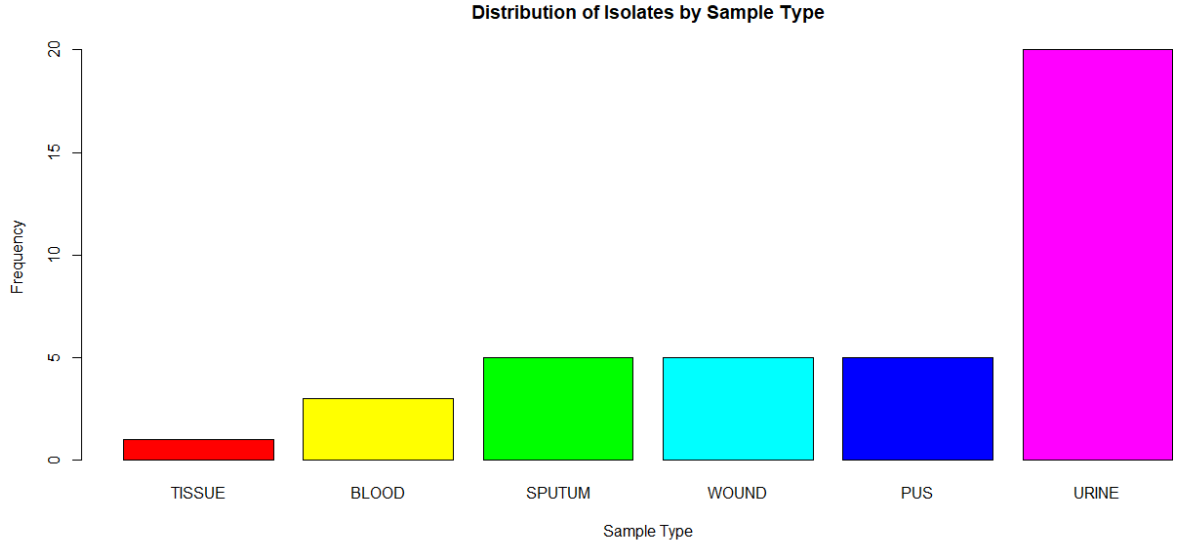

Fig. 2. Distribution of Isolates across Different Sample Types.

3.4. Antimicrobial Resistance Profiles

Resistance pattern to antimicrobials of all the 39 isolates of A. baumannii showed great variability towards all the studied antibacterial agents. High resistance level was recorded with Cefotaxime in which 30 isolates (76.9%) were resistant, followed by Ampicillin/Sulbactam in which resistance was seen in 24 isolates (61.5%), then Ceftazidime showed resistance in 23 isolates (59.0%). Resistance levels with Piperacillin/Tazobactam and Ciprofloxacin were 21 (53.8%) and 19 (48.7%)

respectively, while moderate resistance level was noted in Cefepime, Meropenem, and Amikacin. Low resistance levels were found with Imipenem and Trimethoprim/Sulfamethoxazole; while Gentamicin was resistant in 12 isolates (30.8%). However, colistin had the least percentage of resistance, with only 2 (5.1%) strains found to be resistant, thus suggesting that colistin was still the most active antimicrobial in vitro against the isolates examined, as illustrated in Figure 3.

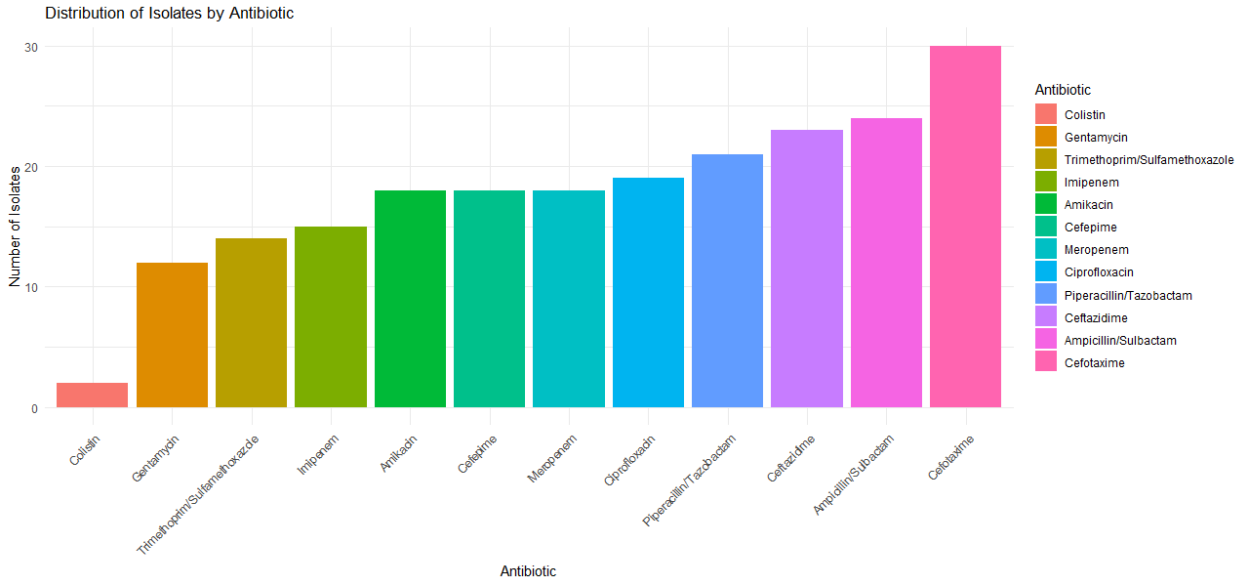

Fig. 3. Antimicrobial Resistance Pattern of Acinetobacter baumannii Isolates against Different Antibiotics.

3.5. Prevalence of MDR and CRAB Isolates

In the study group consisting of 39 isolates of A. baumannii, 27 of these isolates (69.2%) were found to be MDR strains, and nine isolates (23.1%) CRAB. None of the isolates was found to be XDR or PDR. The distribution of MDR and CRAB strains is documented in Table II.

TABLE II. DISTRIBUTION OF MDR AND CRAB A. BAUMANNII ISOLATES BY SAMPLE TYPE

Specimen Type	Total Isolates	MDR N (%)	CRAB N (%)
Urine	20	15 (75%)	5 (25%)
Sputum	5	3 (60%)	1 (20%)
Wound	5	4 (80%)	2 (40%)
Pus	5	3 (60%)	1 (20%)
Blood	3	2 (66.7%)	0 (0%)
Tissue	1	0 (0%)	0 (0%)
Total	39	27 (69.2%)	9 (23.1%)

3.6. Correlation of Resistance Patterns with Sample Sources

The analysis of correlation showed different patterns of resistance against various samples. The heatmap analysis revealed a high degree of positive correlation between carbapenems, aminoglycosides, and cephalosporins, meaning that there is a trend towards convergence of the resistance pattern. On the other hand, urine isolates had weak correlation while the correlation in blood and wound isolates was stronger compared to multidrug resistance, as indicated in Figure 4.

The hierarchical clustering through dendrogram analysis helped identify isolate similarities depending on resistance patterns. High similarity was seen in isolate groups like Iso-16, Iso-19, and Iso-29, implying high resistance similarity. Low similarity in resistance was evident in isolate groups such as Iso-1, Iso-7, and Iso-20. Similarity levels in the dendrogram analysis ranged from 0.1(low) to 1.0(high) along the vertical axis, as summarized in Figure 5.

There were very small effects of the patient's sex on the pattern of resistance, as there was little difference noted between strains isolated from male and female patients. However, the sample source appeared to be a more important determinant of the pattern of antimicrobial resistance than patient sex.

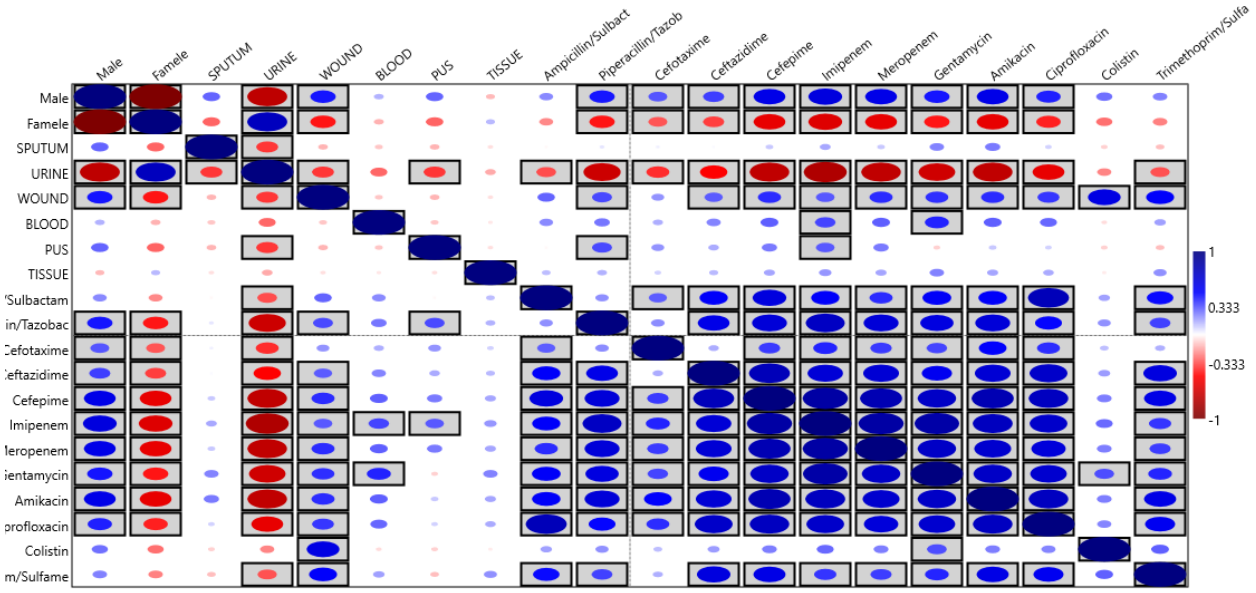

Fig. 4. Correlation heatmap of antimicrobial resistance patterns among Acinetobacter baumannii clinical isolates.
Blue indicates strong positive correlations (high resistance similarity), while red indicates weaker or negative correlations. The intensity of color and circle size reflects the strength of correlation between patient gender, sample sources, and resistance patterns.

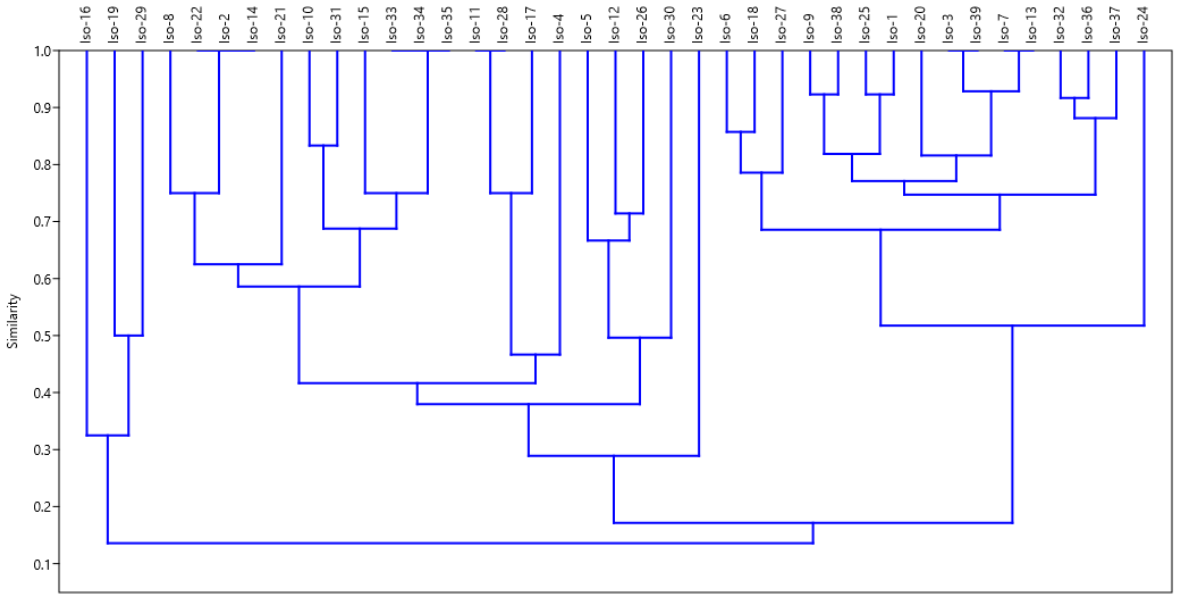

Fig. 5. Hierarchical Clustering of Acinetobacter baumannii Clinical Isolates Based on Antimicrobial Resistance Patterns**.**
The dendogram shows the clustering of A. baumannii isolates based on the similarities of their resistance pattern against antimicrobials. The isolates that have been clustered at a higher level of similarity (those closer to 1.0 on the vertical axis) have similar resistance pattern, whereas those isolates that have been clustered at a lower level of similarity (closer to 0.1) have different patterns of resistance. It is evident from the dendrogram that there is a considerable degree of heterogeneity in terms of resistance patterns among the clinical isolates.

4. DISCUSSION

Acinetobacter baumannii continues to be among the difficult nosocomial pathogens because of its capability to survive in the hospital setting, colonization at various sites within the body and development of resistance to various antibiotics [1^]. The prevalence rate, distribution among patients and specimen and the antibiotic resistance are crucial for determining appropriate management of the infections caused by the pathogen [19].

In the current study, 220 samples of patients admitted to the hospital have been obtained, from which 39 non-duplicate isolates of A. baumannii have been identified, giving an isolation rate of 17.7%. Such findings reflect the frequent isolation of A. baumannii in hospitalized patients, emphasizing its significance as a nosocomial organism. The findings of the current study corroborate with a recent Iraqi study carried out by Alkhawaja and Hadi (2025), where high prevalence of A. baumannii isolates has been documented [20]. The high frequency of isolates can be explained by the capability of A. baumannii to survive for long time within hospital environment, survival on dry and non-living surfaces, forming biofilms on medical devices and hospital surfaces, and acquiring antimicrobial resistance genes especially due to the selection pressure of extensive antibiotic therapy. The above-mentioned traits allow it to spread among patients staying in hospitals and make it a hard nosocomial pathogen to control [21].

Amongst the 39 non-repetitive isolates of A. baumannii, 23 isolates (59%) were isolated from females, while 16 isolates (41%) were isolated from males. This means that the prevalence of A. baumannii isolates is relatively high amongst female patients than male patients in this study. In this regard, there have been documented incidences of sex-related differences in A. baumannii prevalence in previous research works such as the one by Liu et al. (2025) conducted in China; the one by Alharbi et al. (2025) in Saudi Arabia [22,23]. These differences could be attributed to several non-biological and epidemiological reasons, including differential rates of hospital admission, the number and type of samples obtained from both sexes, sampling technique, ward distribution, disease background, and experience of invasive procedures. This is why the interpretation of the effect of sex on the frequency of isolation should be done with caution [24].

Samples of urine were the most common sources of isolates of A. baumannii, with 20 out of 39 isolates (51.3%), in the present study. The second most common sources were samples of sputum, wound, and pus, with 5 isolates (12.8%) each, while samples of blood and tissue were less common. Results are partially similar to those obtained by Alharbi et al. (2025) that demonstrated the highest prevalence of A. baumannii isolates in samples of sputum and wound [23].

Despite the high number of isolates recovered from urine samples in the current study, the isolation of A. baumannii from sputum, wounds, and pus samples indicates that A. baumannii can infect different clinical sites in hospitalized individuals. Such infection pattern could be attributed to the frequent use of invasive devices, especially urinary catheters and respiratory devices, by the patients admitted to the hospitals, as well as the existence of wounds in such individuals. Consequently, the high recovery rate from urine samples can be attributed to healthcare-associated UTIs, whereas the isolation from sputum, wounds, and pus samples shows that A. baumannii is a major opportunistic nosocomial pathogen responsible for UTIs, respiratory infections, wound infections, and sepsis [25, 26].

Resistance profiles to the selected antibiotics were found to be highly variable within the A. baumannii isolates. Resistance was highest for cefotaxime (76.9%; 30/39 isolates), ampicillin/sulbactam (61.5%; 24/39 isolates), and ceftazidime (59.0%; 23/39 isolates). However, resistance to gentamicin was relatively low (30.8%; 12/39 isolates). Colistin had the least resistance profile (5.1%; 2/39 isolates). Although colistin had the lowest resistance rate (5.1%; 2/39 isolates), suggesting that colistin still possessed appreciable in vitro activity against most of the isolates tested.

This result is in agreement with the findings obtained from the systematic review and meta-analysis carried out by Bostanghadiri et al. (2024), which revealed that the global pooled prevalence of colistin resistance among clinical A. baumannii isolates was relatively low, at 4%, although there was a trend toward increased prevalence over time [27]. The study also highlighted the fact that colistin is one of the last line drugs against XDR A. baumannii isolates.

The high resistance rates to β-lactams, especially cefotaxime, ceftazidime, and ampicillin/sulbactam, can be attributed to the strong selective pressure due to the common clinical application of these drugs and the inherent resistance potential of A. baumannii. Several factors can contribute to the β-lactam resistance exhibited by this bacterium, which includes the formation of β-lactamases, alteration in the penicillin-binding proteins, decreased permeability in the outer membrane, and the induction of multidrug efflux systems. The fluoroquinolones resistance, when present, occurs via the mutations in gyrA and parC genes and efflux mechanisms [28].

The relatively lower resistance to colistin in the present study can be attributed to the fact that colistin has limited use in clinical settings and is reserved for the treatment of MDR/XDR infections caused by Gram-negative bacteria. Thus, less exposure to colistin may contribute to its efficacy relative to extensively used β-lactam antibiotics [2٩]. Nevertheless, this conclusion must be made with caution since colistin resistance, which can develop through alteration of lipid A or LPS structure, alterations in pmrCAB genes or loss of lipopolysaccharide biosynthesis, remains clinically important even though it is rare [30].

In the current study, antimicrobial resistance phenotype profiling showed a high prevalence of resistance to antimicrobials in the isolated A. baumannii. Among the 39 isolates, 27 isolates (69.2%) were found to be MDR, while CRAB was detected in 9 isolates (23.1%). This concurs with the findings of a recent study in Iraq by Alkhawaja and Hadi (2025), which found high incidences of MDR and carbapenem-resistant A. baumannii in hospitals in Iraq [20]. Likewise, Alharbi et al. (2025) documented a high occurrence of MDR and CRAB A. baumannii isolates [23]. The large percentage of MDR isolates observed in this study can be attributed to the exceptional adaptability of A. baumannii. The bacteria have the capability to acquire several mechanisms that confer resistance to antimicrobial agents such as the production of β-lactamases, carbapenemases, decreased outer membrane permeability, target modification, and increased expression of multidrug efflux systems [31]. Moreover, the fact that A. baumannii is capable of surviving in dry hospital environments and forming biofilm structures makes it possible for it to spread between patients. It becomes even more crucial to detect CRAB isolates since carbapenems are among the main drugs utilized in the therapy of Gram-negative bacteria; thus, carbapenem resistance creates significant problems in terms of treatment options. However, there were no cases of XDR and PDR strains found. The high proportion of MDR strains indicates the necessity to carry out regular surveillance, practice infection control, and update the hospital antibiogram [32].

Results from the correlation analysis suggested that there was no randomness in the occurrence of resistance to antimicrobial agents among isolates of A. baumannii, rather, the resistance profiles seemed to be dependent on the sources of isolates. Significant differences were noted particularly among carbapenems, aminoglycosides, and cephalosporins. Resistance profiles seem to be influenced by the clinical origin of isolates. Isolates from urine samples had lower correlations compared to other sources, possibly due to higher variability in the background of patients, use of catheters, disease severity, and pre-existing antimicrobial treatments. On the contrary, isolates from wounds and blood samples demonstrated significant similarities in resistance profiles [22].

The hierarchical cluster analysis provided additional support to this interpretation by dividing the isolates into clusters showing highly similar resistance patterns and others that are more diverse. This phenomenon implies that some isolates can be regarded as those with resistance phenotypes that are preferred in particular clinical environments or specimen origins. Significantly, this phenomenon was more strongly linked to specimen origin than patient gender, which implies that the clinical environment, antimicrobial pressure, and anatomic location of the infection are more important determinants of the resistance behavior of these organisms than sex-dependent host factors. Thus, specimen origin should be taken into consideration in resistance studies [19].

This study has established that A. baumannii remains a significant nosocomial pathogen with high prevalence of MDR and CRAB strains in specimens of urine and wound. In this regard, this study highlights the need for continuous surveillance, application of best practices for infection control, and prudent use of last resort antibiotic such as colistin. Knowledge of the type of specimen with high prevalence of MDR is crucial for effective allocation of resources and implementation of appropriate empirical therapy, which helps in preventing nosocomial infection by this resistant pathogens.

5. CONCLUSION

Acinetobacter baumannii bacteria were isolated from 220 samples in 39 cases (17.7%) among which the majority were female patients (59%). Urine and wound swabs were the most frequent sample types, while the gender had almost no effect on isolation. Cefotaxime, Ampicillin/Sulbactam, and Ceftazidime showed maximum resistance to A. baumannii, whereas Colistin proved to be effective. In total, 69.2% of bacteria were MDR and 23.1% were classified as CRAB, yet no XDR or PDR bacteria could be found. Sample type greatly affected resistance patterns pointing out high risk specimen sources requiring targeted preventive measures against this pathogen. This research stresses the necessity to keep up surveillance, proper infection control, and prudent use of antibiotics.

Ethical Considerations

Ethical approval for this study was obtained from the Ethics Committee of the College of Science, Al-Mustansiriyah University, with approval granted on October 1, 2025, under reference number BCSMU/1125/00090Z.

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Conflicts of Interest:

The authors declare that no conflicts of interest exist in connection with this work.

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