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RESEARCH PAPER

Burden and Antimicrobial Resistance Pattern of Multidrug-Resistant *Acinetobacter baumannii* in Burn Patients at a Tertiary Care Hospital in Dhaka

Jannatul Ferdous Mustary[1*], Kazi Imran Ahmed[2], Raisa Enayet Badhan[1], Shaila Akhtar[3]

[1]Department of Microbiology, National Institute of Burn & Plastic Surgery, Dhaka, [2]Department of Plastic and Reconstructive Surgery, National Institute of Burn & Plastic Surgery, Dhaka, [3]Department of Microbiology, Green Life Medical College, Dhaka

Abstract

Background: *Acinetobacter* species, particularly *Acinetobacter baumannii*, are among the most prevalent Gram-negative pathogens responsible for hospital-acquired infections worldwide. These infections are widespread in Intensive Care Units (ICUs) and burn wards. Due to the organism's ability to survive on surfaces for extended periods; its eradication from healthcare environments remains a significant challenge. In recent years, the alarming rise in antibiotic resistance among *A. baumannii* strains has become a major global health concern.

Objectives: To explore the burden and antimicrobial resistance patterns of Multidrug-resistant (MDR) *Acinetobacter baumannii* isolates among burn patients admitted to a tertiary care burn hospital in Dhaka city.

Method: This cross-sectional study was carried out on 200 samples over six months in the Department of Microbiology at the National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh. Wound swab specimens were obtained from burn patients from the Intensive Care Unit (ICU) and High Dependency Unit (HDU) and general burn wards. *Acinetobacter baumannii* isolates were identified by conventional culture and biochemical methods. Antimicrobial susceptibility was done using the conventional disc diffusion method as well as the VITEK® 2 automated system due to the high burden of MDR organisms. Antimicrobial susceptibility testing was conducted in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines-2025. Tigecycline was used, as most of the isolates were MDR pathogens. Based on predefined criteria, the isolates were categorized as MDR organisms.

Results: A total of 200 *Acinetobacter* spp. isolates were analyzed. The majority of patients were aged under 20 and the mean age was 23.3 ± 21.1 years, with a male-to-female ratio of 1.1:1. Overall, 98.5% of the isolates were classified as MDR, whereas only 1.5% were non-MDR. Resistance to cephalosporins and fluoroquinolones was markedly high. Carbapenem resistance to meropenem and imipenem was also high. Similarly, high resistance rates were observed for aminoglycosides, including gentamicin and amikacin. Relatively better susceptibility was noted for minocycline, tigecycline, colistin, and cefoperazone-sulbactam. The majority of susceptible isolates were MDR. Universal resistance to co-trimoxazole was observed. Overall, the findings demonstrate a high burden of multidrug resistance among *Acinetobacter* spp., with limited therapeutic options remaining effective.

Conclusion: The study reveals a high burden of MDR *Acinetobacter* spp. in burn patients, with limited sensitivity to most antibiotics. The findings highlight the urgent need for antimicrobial stewardship and strict infection control in burn units.

Keywords: Antimicrobial resistance, *Acinetobacter baumannii*, burn patient, multidrug-resistant bacteria.

Introduction

Burn injury is a common form of injury across the world, statistically more common in non-developed countries due to fewer prevention strategies.[1] Despite remarkable advances in the management of burn injuries, infection is still a considerable problem. For example, a report shows that 73% of burn patients die because of infection within the initial five days of the injury.[2] Burn injury dramatically weakens the barrier function of the integumentary system against bacterial pathogens.[3,4] The most frequent and

***Correspondence:** Jannatul Ferdous Mustary, Department of Microbiology, National Institute of Burn & Plastic Surgery, Dhaka.*

Email: drmustary@yahoo.com

ORCID ID: 0009-0002-4847-884X

devastating pathogens are *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*.[5,6]

Acinetobacter spp. is one of the most common Gram-negative MDR nosocomial agents. They constitute a major cause of wound infection besides pneumonia, endocarditis, meningitis, and urinary tract infections in hospital settings.[7,8] *Acinetobacter* species are commonly found in soil and water. They can survive in harsh environments and even in exposure to various common disinfectants. These features, along with their ability to grow at a wide range of temperatures, allow them to survive in hospitals, especially ICUs.[2,9,10] The MDR strains are defined as isolates resistant to at least three classes of antimicrobial agents, such as Aminoglycosides, Carbapenems, Cephalosporins, Fluoroquinolones, Folate pathway inhibitors, Penicillins + β-lactamase inhibitors, Polymyxins, and Tetracyclines / Glycylcyclines.[11]

In burn patients, *Acinetobacter* can be transmitted by invasive clinical procedures, such as mechanical ventilation and indwelling devices, including the central venous (CV) line and urinary catheters.[2] The transmission rate can be reduced if (a) healthcare staff pay proper attention to hand hygiene and consider standard precaution protocols; (b) patients are screened regularly for possible infections; (c) the hospital environment is disinfected continuously; and (d) proper air conditioning is applied to remove dust from the ward.[12,13]

Effective antibiotics against *A. baumannii* are not limited to carbapenems, cephalosporins, aminoglycosides, colistin (the most effective drug *in vitro*), and tigecycline, which can be administered alone or in combination regimens.[14] Tigecycline represents a promising option in infections from MDR pathogens.[15] The remarkable increase in antibiotic resistance among *A. baumannii* strains and frequent outbreak reports in ICUs have raised a great deal of concern in recent years.[16,17] Nosocomial infections are mostly caused by *Acinetobacter baumannii,* particularly in burn patients and intensive care units (ICUs).[18,19] This bacterium is a serious hospital pathogen due to its high persistence on hospital surfaces over extended periods and its capacity to develop antibiotic resistance.[20,21] Burn patients are thought to be a source of environmental contamination and are prone to the organism colonizing in the hospital setting.[22]

Treatment of MDR *A. baumannii* infections is a significant health issue. Carbapenems have been suggested as the preferred treatment for infections caused by MDR *A. baumannii* strains due to the rise in antibiotic resistance.[23] Regrettably, throughout the past ten years, reports of *A. baumannii* strains becoming more resistant to carbapenems have been made in several countries worldwide.[24,25] A growing resistance inside this bacterium makes it more difficult to choose an appropriate empirical treatment for severe infections, such as burn wound injuries. Most people agree that carbapenems are a good choice when treating severe infections brought on by *A. baumannii* that is multidrug resistant (MRAB).[26] Carbapenem-resistant *A. baumannii* (CR-AB) infections are becoming more common in low-income countries, particularly among hospitalized burn patients.[27] The study aims to identify the burden and antimicrobial resistance profile of Multi-Drug-Resistant (MDR) *Acinetobacter baumannii* in burn patients.

Materials and Methods

This was a cross-sectional study and duration was six months from January 2025 to June 2025. This study was conducted at the Department of Microbiology, National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh.

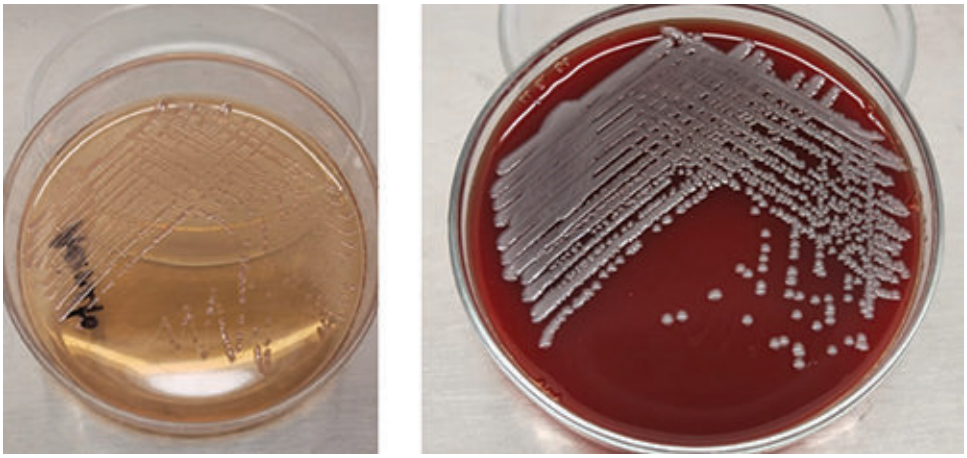
About 200 wound swabs were collected from burn patients admitted to the National Institute of Burn and Plastic Surgery, and sent to the Microbiology Laboratory for culture and sensitivity testing. Only those samples from which suspected colonies of *Acinetobacter* spp. were isolated and subsequently confirmed through standard microbiological identification techniques were included in the study.

The exclusion criterias were wound swabs that did not yield *Acinetobacter* spp. upon culture, samples contaminated with mixed bacterial growth that prevented the reliable identification of *Acinetobacter baumannii*.

Purposive sampling technique was applied for data collection. After taking informed written concent, the information, like age, sex, and laboratory data like sample collection date and time, was recorded and stored in a password-protected Excel file. After collection the wound swabs were inoculated onto blood agar and MacConkey agar and incubated at 37°C for 24 hours. Confirmation of *A. baumannii* isolates was made using Gram staining and standard biochemical tests. *A. baumannii* is Gram-negative coccobacilli arranged singly or in pairs in microscopic examination.

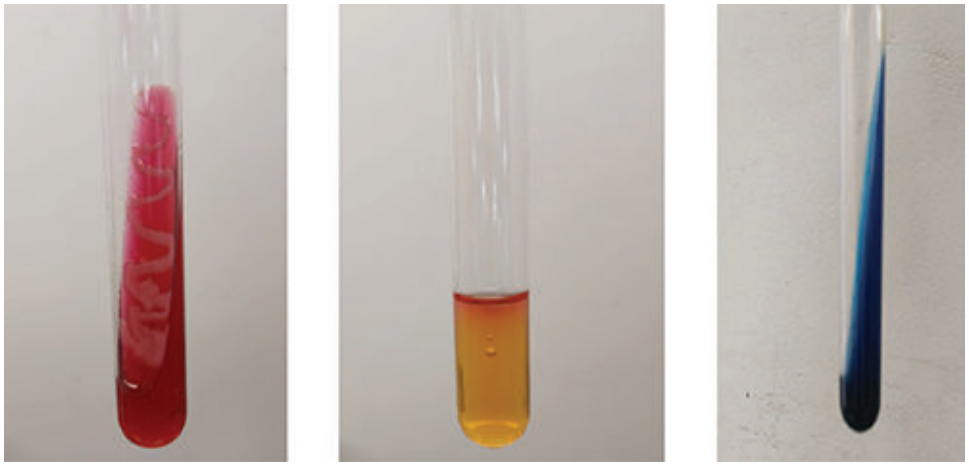
On MacConkey agar, *A. baumannii* produced non-lactose-fermenting colonies, which appeared small to medium-sized, pale, smooth, and slightly translucent, without any pink discoloration of the medium. On blood agar, the organism formed smooth, round, opaque to grayish-white colonies with a non-hemolytic pattern, which is characteristic of *Acinetobacter* species. (Figure 1)

Biochemical identification is shown in Figure 2. On Triple Sugar Iron (TSI) agar, the isolate demonstrated a non-fermentative reaction, showing no change in the slant or butt, with the absence of gas and hydrogen sulfide production. In Motility Indole Urea (MIU) medium, the organism was non-motile, indole negative, and urease negative. On Simmons' citrate agar, a positive citrate reaction was observed, indicated by a color change from green to blue. They are oxidase-negative.



A B

Figure 1: Colonies of *A. baumannii* on MacConkey agar media (A) and Blood agar media (B).



A B C

Figure 2: Biochemical test for *A. baumannii* on (A) Triple sugar iron agar, (B) Motility indole urea agar and (C) Simmon's Citrate Agar.

All the isolated *A. baumannii* were inoculated in a nutrient agar slant in 2 ml screw cap vial with liquid paraffin and stored in a 4°C refrigerator for further use.

The antimicrobial susceptibility of *A. baumannii* was determined by using the disk diffusion method as recommended by Clinical and Laboratory Standards Institute (CLSI) 2025 guidelines. Effective antibiotics against *A. baumannii* include sulbactam–durlobactam (preferred for carbapenem-resistant strains), ampicillin–sulbactam, carbapenems when susceptible, minocycline, cefiderocol, and polymyxins (colistin/ polymyxin B), while most cephalosporins and aztreonam are intrinsically ineffective.[28] The antibiotic plates were tested containing: Piperacillin-tazobactam (100/10µg), Cefepime (30µg), Ceftriaxone (30µg), Imipenem (10µg), Meropenem (10µg), Ciprofloxacin (5µg), Levofloxacin (5µg), Ceftazidime (30µg), Gentamicin (10 µg), Amikacin (30µg), Minocycline (30µg), Tigecycline (15µg) and Trimethoprim/ sulfamethoxazole (1.25/23.75µg). The antimicrobial susceptibility was also done in the VITEK® 2 automated machine with antimicrobial susceptibility testing (AST) cards (BioMérieux, France). Piperacillin/ Tazobactam, Ceftazidime, Cefoperazone/ Sulbactam, Cefepime, Imipenem, Meropenem, Amikacin, Gentamicin, Ciprofloxacin, Levofloxacin, Minocycline, Colistin, and Trimethoprim/ Sulfamethoxazole susceptibility were done in VITEK. Due to the high burden of MDR organisms, we used both conventional and automated methods depending on antimicrobial availability. MDR *A. baumannii* isolates were defined as acquired non-susceptible to at least one agent in three or more antimicrobial classes (Table I).[29]

Table I: Antibiotic classes were defined as follows

Antibiotic Class	Representative Antibiotics
Aminoglycosides	Gentamicin, Amikacin
Carbapenems	Imipenem, Meropenem
Cephalosporins	Ceftazidime, Cefepime, Ceftriaxone
Fluoroquinolones	Ciprofloxacin, Levofloxacin
Folate Pathway Inhibitors	Trimethoprim sulfamethoxazole (Co-trimoxazole)
Penicillins+β-lactamase inhibitors	Piperacillin-tazobactam
Polymyxins	Colistin (Polymyxin E)
Tetracyclines/ Glycylcyclines	Minocycline, Tigecycline

Statistical analysis was performed using descriptive methods only. Categorical variables were summarized as frequencies and percentages. No inferential statistical tests were applied, as the study aimed to describe percentage of MDR organism and their patterns of antimicrobial resistance.

Patient identity and personal information were strictly protected. Samples were anonymized by using laboratory codes, and no identifiable patient data were accessed or disclosed during analysis, data interpretation, or publication. All microbiological samples were handled following standard biosafety guidelines. Appropriate personal protective equipment (PPE) and containment procedures were used to minimize risk to laboratory personnel and the environment. The study protocol was reviewed and approved by the Institutional Ethical Review Committee (ERC) of the National Institute of Burn and Plastic Surgery approved the study (NIBPS/ECC/2025/41), dated 25 December 2024.

Results

In this study, the majority were under 20 years old (53.5%), followed by those aged 21–40 years (26.0%) and 41–60 years (20.5%). The mean age was 23.3 ± 21.1 years, median 19 years, with an age range from 8 months to 81 years. Among the 200 respondents, 53.5% were male and 46.5% were female, resulting in a male-to-female ratio of 1.1:1 (Table II).

Table II: Age and sex distribution of the study participants (N=200)

Variables	Frequency (%)
Age group (years)	
<20	107 (53.5)
21-40	52 (26.0)
41-60	41 (20.5)
Mean ± SD	23.3±21.1
Median	19
Range (min–max)	8 months– 81 years
Sex	
Male	107(53.5%)
Female	93 (43.5)

Among the isolates, 98.50% were MDR, and only 1.50% were non-MDR (Table III).

Table III: Distribution of *Acinetobacter* spp. isolates by resistance type (N = 200)

Resistance type	Number of isolates (n)	Percentage (%)
Multidrug-resistant (MDR)	197	98.50
Non-MDR	3	1.50
Total	200	100.00

Tables IV-A to IV-D illustrate the distribution of antimicrobial resistance patterns among multidrug-resistant (MDR) and non-MDR *Acinetobacter* spp. isolates (n = 200) against different antibiotic classes.

A very high level of resistance was observed to cephalosporins such as ceftazidime, cefepime, and ceftriaxone, with nearly all resistant isolates belonging to the MDR category. Only a small proportion of isolates remained sensitive to these agents, and these were predominantly MDR, indicating extensive co-resistance to other antimicrobial classes (Table IV-A).

Resistance to fluoroquinolones (ciprofloxacin and levofloxacin) was markedly high, with all resistant and intermediate isolates classified as MDR. Sensitive isolates constituted a small fraction and were mostly MDR, reflecting limited effectiveness of fluoroquinolones against *Acinetobacter* spp. in the study population (Table IV-B).

The carbapenem resistance was notably high for both meropenem and imipenem, with nearly all resistant isolates being MDR. Similarly, aminoglycosides such as gentamicin and amikacin showed substantial resistance, and all resistant and intermediate isolates belonged exclusively to the MDR group, highlighting extensive multidrug resistance among these isolates (Table IV-C).

The susceptibility patterns to other antibiotic classes, including β-lactam/β-lactamase inhibitor combinations, tetracyclines/glycylcyclines, polymyxins, and folate pathway inhibitors. Relatively higher susceptibility was observed for minocycline, tigecycline, colistin, and cefoperazone–sulbactam compared to other agents; however, the majority of susceptible isolates were still classified as MDR. Universal resistance to co-trimoxazole was observed, emphasizing its limited therapeutic value against *Acinetobacter* spp. in this setting (Table IV-D).

Overall, these tables highlight a high burden of multidrug resistance across nearly all antibiotic classes, with only a limited number of agents retaining partial activity against *Acinetobacter* spp.

Table IV-A: Resistance pattern of Acinetobacter spp. against Cephalosporins (N = 200)

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Ceftazidime	Sensitive	29	26 (89.65%)	3 (10.34%)
	Resistant	171	171 (100%)	–
Cefepime	Sensitive	16	13 (81.25%)	3 (18.75%)
	Resistant	179	179 (100%)	–
	Intermediate	5	5 (100%)	–
Ceftriaxone	Sensitive	4	4 (100.0%)	–
	Resistant	195	192 (98.46%)	3 (1.53%)
	Intermediate	1	1 (100.0%)	–

Table III-B: Resistance pattern of Acinetobacter spp. against Fluoroquinolones (N = 200)

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Ciprofloxacin	Sensitive	33	30 (90.90%)	3 (9.09%)
	Resistant	166	166 (100%)	–
	Intermediate	1	1 (100.0%)	–
Levofloxacin	Sensitive	24	21 (87.50%)	3 (12.50%)
	Resistant	157	157 (100%)	–
	Intermediate	19	19 (100%)	–

Table III-C: Resistance pattern of Acinetobacter spp. against Carbapenems and Aminoglycosides (N = 200)

Carbapenems

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Meropenem	Sensitive	50	47 (94%)	3 (6%)
	Resistant	148	148 (100%)	–
	Intermediate	2	2 (100%)	–
Imipenem	Sensitive	39	39 (100%)	–
	Resistant	147	147 (100%)	–
	Intermediate	14	13 (92.85%)	1 (7.14%)

Aminoglycosides

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Gentamicin	Sensitive	50	47 (94%)	3 (6%)
	Resistant	146	146 (100%)	–
	Intermediate	4	4 (100%)	–
Amikacin	Sensitive	39	36 (92.30%)	3 (7.69%)
	Resistant	160	160 (100%)	–
	Intermediate	1	1 (100%)	–

Table III-D: Resistance pattern of Acinetobacter spp. against Other Antibiotic Classes (N = 200)

Penicillins + β-lactamase inhibitors

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Piperacillin–tazobactam (PTZ)	Sensitive	57	54 (94.73%)	3 (5.26%)
	Resistant	139	139 (100%)	–
	Intermediate	4	4 (100%)	–
Cefoperazone–sulbactam	Sensitive	105	102 (97.14%)	3 (2.85%)
	Resistant	76	76 (100%)	–
	Intermediate	19	19 (100%)	–

Tetracyclines / Glycylcyclines

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Minocycline	Sensitive	113	110 (97.34%)	3 (2.65%)
	Resistant	72	72 (100%)	–
	Intermediate	15	15 (100%)	–
Tigecycline	Sensitive	166	163 (98.19%)	3 (1.80%)
	Resistant	31	31 (100%)	–
	Intermediate	3	3 (100%)	–

Polymyxins

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Colistin	Sensitive	135	132 (81.5%)	3 (0.7%)
	Resistant	30	30 (100%)	–
	Intermediate	35	35 (100%)	–

Folate Pathway Inhibitor

Antibiotic	Resistant pattern	n	MDR	Non-MDR
Co-trimoxazole	Sensitive	0	0 (0.0%)	0 (0.0%)
	Resistant	200	197 (98.50%)	3 (1.50%)

Discussion

Despite remarkable improvements in burn patients' management, nosocomial infections caused by bacterial pathogens remain a major cause of morbidity and mortality among these patients. [31,32] The control of *A. baumannii* as a prevalent cause of infection among burn patients has been a laborious process, especially in developing countries, mostly because of MDR strains.[33] The primary challenge is to select the most effective antibiotic(s) to combat these infections.[34] *Acinetobacter* has low nutritional requirements. It can be found in water, soil, dust, and sewage, and is frequently detected in healthcare settings.[32] Different studies have reported high resistance of *A. baumannii* to the majority of antibiotics.[35-37]

This study highlights the microbiological patterns of *Acinetobacter* species isolated from patients in a burn unit, with a particular focus on antibiotic resistance profiles. The findings reflect both local challenges and global trends in managing infections caused by multidrug-resistant organisms in high-risk settings like burn units.

The age distribution of the participants revealed that a majority (53.5%) were under 20 years old, with a mean age of 23.3±21.1 years and a median of 19 years. This suggests a high burden of burn injuries among children and adolescents, which may be attributed to a lack of awareness, inadequate supervision, and unsafe domestic environments.[38] Similar trends were reported in a study from Nigeria, where 60% of burn patients were under 20 years, emphasizing the need for targeted prevention strategies in this age group.[39] In contrast, developed countries report a higher incidence of burns in elderly populations, likely due to age-related immobility and frailty,[40] highlighting a demographic difference in burn epidemiology between resource-rich and resource-limited settings.

The male-to-female ratio of 1.1:1 observed in our study aligns with regional patterns, where males are more likely to sustain burns due to occupational exposure, risk-taking behavior, and outdoor activities.[41] In contrast, studies from certain South Asian countries report a female predominance, often linked to domestic and accidental kitchen burns, particularly involving kerosene stoves,[42] underlining sociocultural influences on burn injury patterns.

The prevalence of multidrug resistance was remarkably high; 98.50% of isolates were MDR, and only 1.50% were non-MDR. These findings align with global concerns about increasing resistance in *Acinetobacter* spp., particularly in burn units, where prolonged hospitalization and the use of broad-spectrum antibiotics are common.[43] Similar prevalence rates were reported in Egypt, MDR 95% and Iran, MDR 96%.[44,45] These comparisons highlight the widespread nature of resistance and the urgent need for coordinated global surveillance.

The present study reveals a high prevalence of multidrug resistance among *Acinetobacter* spp. isolates, mirroring trends reported in other regions. Resistance to cephalosporins and fluoroquinolones was markedly high, with nearly all resistant and intermediate isolates classified as MDR, a pattern consistent with studies from burn units and intensive care settings in Asia and the Middle East where cephalosporin and fluoroquinolone resistance exceeded 80% in *A. baumannii* isolates.[3] Similarly, substantial carbapenem resistance to meropenem and imipenem was observed, aligning with global data that identify carbapenem-resistant *A. baumannii* (CRAB) as an urgent threat due to limited treatment options. High resistance rates to aminoglycosides such as gentamicin and amikacin further reflect reports from tertiary care centers where aminoglycoside susceptibility is increasingly compromised. Although relatively better susceptibility was noted for minocycline, tigecycline, colistin, and cefoperazone–sulbactam, the majority of isolates susceptible to these agents were still MDR, as observed in recent molecular epidemiology studies that highlight emerging but fragile therapeutic options. Universal resistance to co-trimoxazole in our cohort underscores its lack of clinical utility, in agreement with other surveillance reports.[44-46] Collectively, these findings not only underscore the heavy burden of multidrug resistance in *Acinetobacter* infections reinforce global concerns over effective antimicrobial options, emphasizing the urgent need for robust antimicrobial stewardship and infection control strategies.[47]

The findings highlight a critical challenge in the management of *Acinetobacter* infections and emphasize the urgent need for strengthened antimicrobial stewardship, routine surveillance of resistance patterns, and strict infection prevention and control measures. Rational antibiotic use, along with timely laboratory-guided therapy, is essential to curb the further emergence and spread of multidrug-resistant *Acinetobacter* spp.

Despite providing valuable insights into the antimicrobial resistance patterns of *Acinetobacter* spp., this study has several limitations. Clinical outcome data were not included; therefore, correlations between antimicrobial resistance and patient prognosis could not be assessed. Additionally, during sample collection, differentiation between true infection and bacterial colonization was not feasible. Nevertheless, the identification of colonizing strains remains epidemiologically significant, as such organisms may serve as reservoirs for hospital transmission and environmental contamination. Finally, species-level confirmation of *A. baumannii* was not performed using molecular methods such as polymerase chain reaction (PCR), which may have provided greater diagnostic precision. Future research should aim to assess environmental contamination sources and compare resistance profiles of environmental isolates with those from patients. Moreover, molecular investigations to detect specific resistance genes would offer deeper insights into the mechanisms of resistance.

Conclusion

This study demonstrates an alarmingly high prevalence of multidrug-resistant *Acinetobacter* spp., with nearly all isolates exhibiting resistance to multiple commonly used antimicrobial classes. Marked resistance to cephalosporins, fluoroquinolones, carbapenems, and aminoglycosides underscores the limited effectiveness of these agents in the studied setting. Although relatively higher susceptibility was observed to minocycline, tigecycline, colistin, and cefoperazone–sulbactam, most isolates susceptible to these drugs were still classified as MDR, indicating extensive co-resistance.

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