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Blood culture correlation and antibiotic susceptibility profile of *Acinetobacter* species isolated from meningitis patients: a retrospective record-based study from a tertiary care centre in Delhi.

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ABSTRACT
Background:
Acinetobacter species, particularly *A. baumannii*, have emerged as important causes of hospital-acquired meningitis, especially among critically ill and pediatric patients. Increasing antimicrobial resistance among these organisms has become a major therapeutic challenge.

Aim:
To determine the prevalence of *Acinetobacter* species isolated from cerebrospinal fluid (CSF) and blood cultures of meningitis patients and to evaluate their antimicrobial susceptibility profile.

Methods:
A retrospective record-based study was conducted in the Department of Microbiology, Lady Hardinge Medical College, New Delhi, over a 12-month period (01 January 2023 to 31 December 2023). Data from 44 patients clinically suspected of meningitis were analysed. CSF and blood samples were cultured and isolates identified using standard microbiological techniques. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to CLSI guidelines.

Results:
Among the 44 patients studied, *Acinetobacter* species were predominantly isolated from patients admitted to intensive care units and pediatric wards. *A. baumannii* was the most common species identified. CSF culture positivity was higher compared to blood culture positivity. Antimicrobial susceptibility testing showed high resistance to third-generation cephalosporins and carbapenems, while moderate susceptibility was observed with aminoglycosides and colistin. Similar resistance patterns were observed in isolates recovered from patients with both CSF and blood culture positivity.

Conclusion:
The study demonstrates the increasing prevalence of multidrug-resistant *Acinetobacter* infections in meningitis patients in tertiary care settings, highlighting the need for continuous antimicrobial surveillance and strict infection control measures.

Keywords: *Acinetobacter meningitis, antimicrobial resistance, A. baumannii, multidrug resistance, colistin sensitivity.*
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INTRODUCTION
The emergence of multi-drug resistant (MDR) *Acinetobacter* spp. as the causative organism for bacterial meningitis has resulted in therapeutic challenges[1]. The predominance of meningitis caused by this bacterium will rise because there are few effective treatments for multidrug-resistant *A. baumannii*[2]. The management of

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meningitis caused by *Acinetobacter* is limited due to variable penetration of antibiotic agents through the blood-brain barrier into the cerebrospinal fluid (CSF)[3]. Meningitis caused by *Acinetobacter* has a significant mortality rate of up to 15-71%, and the highest is observed in neonates[4].

Meningitis caused by *Acinetobacter* species has emerged as a serious healthcare challenge, particularly in hospital environments and intensive care units (ICUs). These opportunistic pathogens are known for their ability to survive under adverse conditions and develop resistance to multiple classes of antibiotics. *A. baumannii*, the most common species implicated in meningitis, often leads to poor clinical outcomes due to limited treatment options and high rates of multidrug resistance. Monitoring the antimicrobial susceptibility pattern of *Acinetobacter* isolates is therefore crucial for guiding empirical therapy and infection control strategies. In tertiary care hospitals like Lady Hardinge Medical College, New Delhi, routine surveillance of *Acinetobacter* isolates from cerebrospinal fluid (CSF) and blood samples provides valuable insight into the prevailing resistance trends and helps in the formulation of effective antibiotic policies.

The study aims to determine the percentage positivity of *Acinetobacter spp.* from CSF and blood samples and assess the antibiotic sensitivity and its correlation. Also, to stratify the patients based on their demographics.

METHODOLOGY

Study Design

This study was a **retrospective record-based observational study**

Study Setting

This study was a **retrospective record-based observational study** conducted in the Department of Microbiology at Lady Hardinge Medical College and associated hospital, New Delhi.

Study Duration

The study was conducted over a **12-month period from 01 January 2023 to 31 December 2023**.

Sample Size

A total of **44 samples** were included in the study. These comprised both cerebrospinal fluid (CSF) and blood samples obtained from patients who were suspected of central nervous system (CNS) infections and had samples submitted for routine culture and sensitivity testing.

Participants

The study included records of patients whose CSF and/or blood samples were processed for microbiological culture and antibiotic susceptibility testing in the Department of Microbiology, LHMC. Both inpatients and outpatients were included, irrespective of age and sex.

Inclusion Criteria

All CSF and blood samples received in the Department of Microbiology, LHMC, during the study period from both outpatient and inpatient departments, irrespective of patient age and gender, were included for analysis. Samples that yielded growth of *Acinetobacter* species were included in the final study cohort.

Exclusion Criteria

Samples with incomplete clinical or microbiological data, contaminated samples, or those showing mixed bacterial growth were excluded from the study to maintain data accuracy and reliability.

Bias

To minimise selection bias, all samples received during the defined study period that met the inclusion criteria were included. Information bias was minimised by utilising standardised microbiological techniques and reporting formats. The laboratory procedures followed the CLSI 2022 guidelines to ensure consistency in sensitivity results.

Data Collection

Data were collected retrospectively from microbiology laboratory records, which included patient demographic details (age, sex, and clinical status), CSF and blood culture results, and antimicrobial susceptibility profiles. All laboratory procedures were performed as per the department's standard operating protocols and documented in laboratory registers.

Statistical Analysis

Data were entered and analysed using **SPSS software version 23.0**. Descriptive statistics, including percentages and ratios, were applied to summarise the predominance and resistance patterns of *Acinetobacter* species. Results were presented in tabular and graphical formats using **Microsoft PowerPoint**, highlighting the distribution of isolates and their antimicrobial susceptibility profiles.

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Ethical Consideration

Ethical approval for the study was obtained from the **Institutional Ethics Committee of Lady Hardinge Medical College, New Delhi** (Approval No: IEC/LHMC/2023/104; Date of Approval: 15 December 2022). As this was a retrospective record-based study, patient confidentiality was strictly maintained, and no personal identifiers were used.

RESULTS

Overall Findings

A total of 44 patients with suspected meningitis were included in the study. The study population consisted of patients ranging from infancy to 45 years of age, with a male predominance (59.1%). Pediatric patients (≤18 years) accounted for three-fourths of the cases, indicating a higher vulnerability in this age group.

Most samples were received from the intensive care unit (36.4%) and general wards (31.8%), reflecting increased surveillance and infection burden in critically ill patients. Cerebrospinal fluid cultures showed a higher positivity rate compared to blood cultures.

Among the *Acinetobacter* isolates, *A. baumannii* was the most prevalent species, followed by *A. lwoffii*, *A. radioresistens*, and *A. jejuni*. Blood culture correlation revealed that a minority of patients had concurrent bacteremia, suggesting either secondary meningitis due to bloodstream infection or clearance of bacteremia following antibiotic therapy with persistence of organisms in the CSF.

Antimicrobial susceptibility testing demonstrated that *A. baumannii* isolates exhibited high resistance to cephalosporins and carbapenems, with comparatively lower resistance to aminoglycosides. The susceptibility patterns of *A. baumannii* isolates from CSF and blood samples were similar in patients with dual-site isolation, indicating infection by the same strain.

Overall, pediatric patients and ICU admissions showed higher culture positivity and multidrug resistance, emphasizing the need for targeted antimicrobial policies and vigilant microbiological surveillance.

Table 1. Demographic Distribution of Participants (n = 44)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	26	59.1
	Female	18	40.9
Age Group (years)	Up to 2	21	47.72
	>2 to 18	12	27.28
	>18 to 65	11	25
	>65	00	00

Table 1 shows that the majority of meningitis cases were reported from intensive care units, followed by pediatric wards, indicating higher susceptibility among critically ill patients.

Table 2. Ward-Wise Distribution of Samples

Ward	No. of Samples (n)	Percentage (%)
ICU	16	36.4
General Ward	14	31.8
Pediatrics	6	13.6
Post-Operative	4	9.1
Others	4	9.1

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Figure 1. A. Species-wise distribution of *Acinetobacter* isolated from CSF sample; B. Result of blood culture from the patients showing *Acinetobacter* in CSF sample.

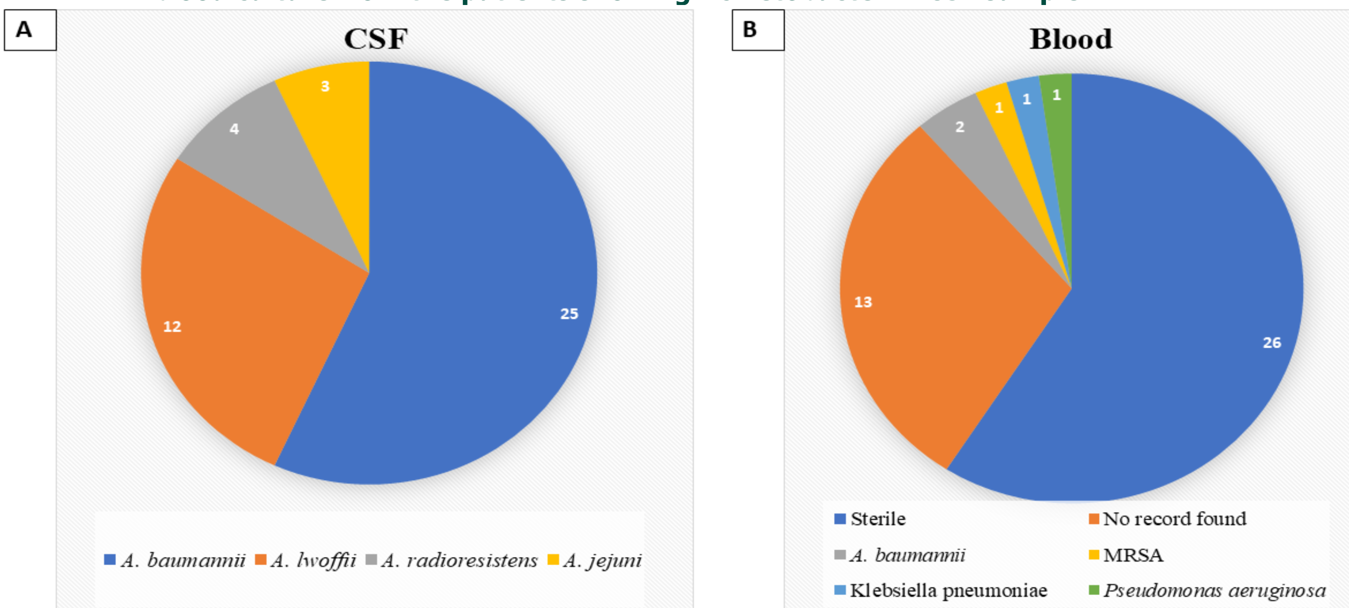

Table 3. Antibiotic susceptibility pattern of *Acinetobacter* from CSF sample

	A. baumannii (%) (n=25)	*A. lwoffii* (%) (n=12)	*A. jejuni* (%) (n=3)	*A radioresistens* (%) (n=4)
Piperacillin-tazobactam	60	00	00	00
Cefepime	76	50	00	00
Ceftazidime	72	25	00	00
Imipenem	72	8.33	00	00
Meropenem	68	8.33	00	00
Amikacin	52	00	00	00
Gentamicin	52	8.33	00	00
Ciprofloxacin	64	25	00	00
Trimethoprim-sulfamethoxazole	68	25	00	00
Colistin	00	00	00	00

High resistance was observed against third-generation cephalosporins and carbapenems, whereas relatively higher sensitivity was noted with aminoglycosides and colistin.

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Table 4. Comparative Analysis of Antibiotic Susceptibility Pattern of *A. baumannii* isolated from CSF and Blood samples

	Patient 1		**Patient 2**	
	CSF	**Blood**	**CSF**	**Blood**
Piperacillin-tazobactam	Resistant	Resistant	Sensitive	Sensitive
Cefepime	Resistant	Resistant	Resistant	Resistant
Ceftazidime	Resistant	Resistant	Resistant	Resistant
Imipenem	Resistant	Resistant	Resistant	Resistant
Meropenem	Resistant	Resistant	Resistant	Resistant
Amikacin	Resistant	Resistant	Sensitive	Sensitive
Gentamicin	Resistant	Resistant	Sensitive	Sensitive
Ciprofloxacin	Resistant	Resistant	Sensitive	Sensitive
Trimethoprim-sulfamethoxazole	Resistant	Resistant	Resistant	Resistant
Colistin	Intermediately sensitive	Intermediately sensitive	Intermediately sensitive	Intermediately sensitive

DISCUSSION

A total of **44 patients** were enrolled in the study, ranging in age from **0 month and 45 years**. The majority of participants were **male (59.1%)**, with the largest age group being **0 to 18 years (75%)**, suggesting that the paediatric population was the most affected population in this cohort. The **distribution of samples by ward** revealed that most samples came from the **ICU (36.4%)** and **general wards (31.8%)**, reflecting the higher monitoring and testing of critically ill patients.

Laboratory findings showed that in the CSF sample, among *Acinetobacter* spp., *A. baumaannii* (56.81%) was the most prevalent, followed by *A. lwoffii* (27.27%), *A. radioresistens* (9.1%), and *A. jejuni* (6.82%). Blood sample of the CSF culture positive patients were traced and the results showed that 59.1% of the samples were sterile, no record of the blood sample was found for 29.54% of the patients while positive blood culture was recorded in 5 patients showing growth of *A. baumannii* in 2 samples, *Pseudomonas aeruginosa* in 1 sample, *Klebsiella pneumoniae* in 1 sample, and methicillin resistant *Staphylococcus aureus* (MRSA) in 1 sample. The above findings suggest that in 2 patients in whom *A. baumannii* was isolated from both blood and CSF, meningitis might be the secondary infection of bacteremia. In other patients, meningitis might be the primary infection, or due to the use of antibiotics, bacteremia might get cleared off, but due to difficulty in blood-brain barrier penetration, bacteria remained in CSF.

In this study, the antibiotic susceptibility test (AST) of the isolates from CSF sample showed that *A. baumannii* had highest resistance rate in comparison to other species of *Acinetobacter*, ranging from 52 to 72 % with highest resisrance against ceftazidime and imipenem and lowest resistance against aminoglycoside. *A. lwoffii* had some level of resistance against cephalosporin, carbapenem, aminoglycoside, ciprofloxacin and cotrimoxazole, while *A. radioresistant,* and *A. jejuni* did not show any resistance against the tested antibiotics. The antibiotic susceptibility profile of *A. baumannii* in the blood sample was the same as that of the isolate from the CSF sample, revealing that the same strain was responsible for causing meningitis and bacteremia.

Recent studies from tertiary healthcare centres have demonstrated that *A. baumannii* remains a significant cause of meningitis, particularly in patients with prior neurosurgical interventions or prolonged hospital stays. High levels of multidrug resistance (MDR) have been reported across isolates from cerebrospinal fluid samples, showing near-complete resistance to cephalosporins, fluoroquinolones, and carbapenems. Colistin continues to show the highest efficacy, making it a last-line agent for severe infections[12].

Parvez et al. (2020) found that over 85% of *A. baumannii* isolates were resistant to carbapenems and aminoglycosides, highlighting a worrisome increase in extensively drug-resistant strains[12]. Similarly, Kumar et al. (2021) observed a rising trend in carbapenem resistance, especially among isolates from intensive care units and meningitis cases, with a notable decrease in susceptibility to imipenem and meropenem[13].

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A retrospective analysis by Chaudhary et al. (2019) on neurosurgical patients revealed that MDR *Acinetobacter* meningitis was associated with poor clinical outcomes and high mortality, emphasising the importance of stringent infection control protocols and antibiotic stewardship[14]. Patel et al. (2022) also reported comparable findings in a tertiary care centre, where colistin and tigecycline demonstrated the most reliable in vitro activity against MDR strains, while cephalosporins and fluoroquinolones were largely ineffective[15].

A systematic review by Li et al. (2023) provided a global perspective, noting that *A. baumannii* meningitis has shown an upward trend in antimicrobial resistance since 2018. The review further stressed that therapeutic options are becoming limited due to emerging colistin resistance, and regional surveillance data are crucial for guiding empirical therapy[16].

CONCLUSION

Among 44 patients with positive cerebrospinal fluid (CSF) cultures, *Acinetobacter baumannii* was the most commonly isolated organism, particularly in patients from the intensive care unit (ICU) and general wards within the pediatric age group. The isolates exhibited a resistant pattern. The **AST results emphasise the importance of antimicrobial stewardship** and the need for careful monitoring and tailored treatment strategies in high-risk wards. These findings support targeted infection control measures and continuous review of antibiotic policies to reduce morbidity and prevent the spread of resistant pathogens.

Limitations

This study had certain limitations. First, it was a retrospective record-based study with a relatively small sample size of 44 patients. Second, the study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other healthcare settings. Third, molecular characterization of resistance mechanisms was not performed.

RECOMMENDATIONS

Regular surveillance of antimicrobial resistance patterns should be conducted in tertiary care hospitals. Strict infection control practices, rational antibiotic use, and implementation of antibiotic stewardship programs are necessary to reduce the emergence and spread of multidrug-resistant *Acinetobacter* infections.

List of Abbreviations

Abbreviation	Full Form
AST	Antimicrobial Sensitivity Test
ATCC	American Type Culture Collection
CLSI	Clinical and Laboratory Standards Institute
CNS	Central Nervous System
CSF	Cerebrospinal Fluid
ICU	Intensive Care Unit
LHMC	Lady Hardinge Medical College
MALDI-TOF MS	Matrix-Assisted Laser Desorption Ionization–Time of Flight Mass Spectrometry
MDR	Multidrug Resistance
MIC	Minimum Inhibitory Concentration
SPSS	Statistical Package for the Social Sciences
SOP	Standard Operating Procedure
WHO	World Health Organization

AUTHOR BIOGRAPHY

Sadia Jabeen is a Senior Resident in the Department of Microbiology at Lady Hardinge Medical College, New Delhi. Her research interests include antimicrobial resistance, hospital-acquired infections, and clinical microbiology.

DATA AVAILABILITY

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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AUTHOR CONTRIBUTIONS

SJ: Conceptualization, data collection, manuscript drafting
SS and SS: Data analysis and literature review
ShS and YR: Supervision and manuscript editing
MBJ: Final review and approval of the manuscript

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