European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Original Research Article

Microorganisms Responsible for Healthcare-Associated Infections in Patients Within the Medical Intensive Care Unit

Article History:

Name of Author:
Dr Anil Kumar[1], Dr Sandeep Kumar Yadav[2], Emmanuel Jabakumar[3] and Dr Anusha Sharma[4]

Affiliation: *[1]Assistant Professor Microbiology deptt, VCSGGIMSR Srinagar Pauri Garhwal*
[2]Senior Resident, ESIC Hospital Basaidarapur, New Delhi.
[3]PG-JR, Lady Hardinge Medical College New Delhi
[4]Senior Resident, Baba Saheb Ambedkar Medical College New Delhi

Corresponding Author:
Anil Kumar

Received: 12-05-2025
Revised: 05-06-2025
Accepted: 20-06-2025
Published: 04-07-2025

Abstract: In medical ICUs, healthcare-associated infections are predominantly caused by multidrug-resistant Gram-negative bacilli (Klebsiella pneumoniae, Pseudomonas aeruginosa, Acinetobacter spp., Escherichia coli) and Gram-positive cocci (MRSA, coagulase-negative staphylococci), consistent with tracheal aspirate isolate. Therefore, in our study we have decided to assess the pathogens Causing HAI in MICU Patients among 81 patients using questionanire study in different samples like pus, blood (5-10ml), urine, sterile fluids. We have found that, Tracheal aspirates comprised the majority of isolates [9 (75%)], with Klebsiella pneumoniae predominating in 6 (50%) and Acinetobacter lwoffii, Escherichia coli, and MRSA each isolated from 1 (8.3%). Thus, we come to conclude that, alarming carbapenem resistance (83% in K. pneumoniae) among MICU tracheal isolates in India, with colistin and amikacin as viable options, mirroring the escalating MDR crisis in Indian ICUs that demands urgent stewardship and surveillance.

Keywords: Microbial Profile, Gram-Negative Bacilli, Multidrug-Resistant, Amikacin, Carbapenem.

INTRODUCTION

Healthcare-associated infections (HAIs) in Medical Intensive Care Units (MICUs) specially country like India pose a formidable public health challenge, disproportionately affecting critically ill patients who rely on invasive devices like central venous catheters, mechanical ventilators, and urinary catheters, amid systemic issues such as overcrowding, suboptimal infection control, and high antimicrobial selective pressure.[1] Study have also shown that its prevalence rates had ranged from 9-32% in Indian ICUs far exceeding global averages of 4-6% in high-income settings these nosocomial infections, occurring 48 hours post-admission, manifest primarily as ventilator-associated pneumonia (VAP; 30-49% of cases), catheter-related bloodstream infections (CRBSI; 12-33%), catheter-associated urinary tract infections (CAUTI; 13-25%), and surgical site infections (SSI; 6-7%), leading to prolonged stays (by 5-13 days), case fatality rates of 21-52%, and annual burdens of over 2 million cases and 80,000 deaths nationwide.[1]

Furthermore, microbial profiles in Indian MICUs are skewed toward multidrug-resistant (MDR) gram-negative bacilli, reflecting rampant empirical carbapenem and colistin use. Klebsiella pneumoniae, the predominant isolate (24-35%), frequently harbors carbapenemases like NDM-1 and OXA-48b (resistance up to 92%), driving VAP and CRBSI outbreaks, followed by Acinetobacter baumannii complex (24-32%; polymyxin-resistant

strains common) linked to environmental reservoirs like ventilators and sinks, Pseudomonas aeruginosa (9-15%; ESBL and fluoroquinolone-resistant), and Escherichia coli/Enterobacter spp. in urinary and respiratory sources. Gram-positives contribute 20-25%, led by Enterococcus spp. (22%; 30% vancomycin-resistant Enterococci [VRE]), coagulase-negative staphylococci from biofilms, and sporadic methicillin-resistant Staphylococcus aureus (MRSA), while Candida spp. (9-15%, e.g., C. albicans, C. tropicalis, C. glabrata) cause candidemia in prolonged neutropenia or TPN cases, with azole resistance complicating therapy and mortality surpassing 40%.[2]

INICC data from 40 Indian hospitals (2004-2013) report pooled CLABSI rates of 5.1-12.1/1000 central line-days and CAUTI of 2.1-8.3/1000 catheter-days, with medical ICUs showing BSI rates of 5.3-7.3/1000 patient-days 3-6 times higher than US benchmarks exacerbated by risk factors like mechanical ventilation (OR=18.57), urinary catheters (OR=7.89), stays >7 days, diabetes, and central air-conditioning. Recent tertiary center audits confirm 31-32% HAI incidence, with bloodstream (33%) and respiratory (31%) infections dominating, 90%+ MDR in Klebsiella/Acinetobacter, and acquisition doubling mortality odds.[3] Regional studies highlight Acinetobacter surges in northern India and Klebsiella in southern ICUs, underscoring poor hand hygiene (staff-to-patient ratios <1:2), device overuse, and sanitation lapses as transmission vectors.[3-5]

This resistant polymicrobial milieu demands urgent, India-specific interventions: antimicrobial stewardship, bundle compliance (reducing HAIs 30-50%), active surveillance via local antibiograms, and infrastructure upgrades, as emphasized in national guidelines and INICC reports, to mitigate the vicious cycle of resistance and mortality in resource-constrained MICU.[6]

Thus in our study we have decided to assess microbial profile responsible for HAI in MICU in India.

AIM

To evaluate the Pathogens Causing HAI in MICU Patients

MATERIAL AND METHOD

This prospective observational cohort study was conducted in the Department of Microbiology, Lady Hardinge Medical College, in collaboration with the Department of Medicine, Smt. Sucheta Kripalani Hospital, New Delhi, from November 2019 to March 2021. Eighty-one patients admitted to the Medical Intensive Care Unit (MICU) with clinical suspicion of healthcare-associated infections, as assessed and referred by treating physicians, were enrolled; diverse clinical specimens including pus, blood (5-10 mL), urine, and sterile body fluids (e.g., tracheal aspirates, subhepatic drains) were collected and transported to the laboratory for processing within 2 hours. Delayed urine samples were refrigerated at 2-8°C in sterile containers, while pus swabs and blood (in culture bottles) were maintained at ambient temperature (22-25°C); all specimens underwent microbiological analysis within 24 hours to identify putative pathogens, with serum aliquots stored at -20°C in a deep freezer. Data on demographics (age, gender), dietary history, prior antimicrobial/steroid exposure, clinical manifestations, specimen types, and laboratory methodologies were captured using a pretested, self-designed proforma to ensure standardized collection and managemen

INCLUSION CRITERIA

1. Age of patients above 18years.
2. Patients initially admitted and has remained in for at least 48 hours in MICU.
3. Cases meet the criteria of HAI (as defined by CDC).

EXCLUSION CRITERIA

Patients having infection at admission/ manifestation of any infective illness within 48 hour of admission as suggested by clinical picture and investigations.

STATISTICAL ANALYSIS

Data were transformed, coded, and entered into SPSS version 20. Categorical variables were presented as proportions; continuous variables were reported as mean (± SD) or median (IQR). Between two groups, normally distributed continuous variables were compared using the t-test, while non-normally distributed ones used the Wilcoxon rank-sum test. Categorical variables were analyzed with the chi-square or Fisher's exact test. For three or more groups, comparisons employed ANOVA or the Kruskal-Wallis test. Statistical significance was set at $p < 0.05$

RESULT

S.NO.	ISOLATE	N=12(%)
1.	***Klebsiella Pneumonia***	6 (50)
2.	***Pseudomonas aeruginosa***	2 (16.6)
3.	***Acinetobacter lwoffii***	2 (16.6)
4.	***Escherichia coli***	1 (8.3)

5.	***MRSA***	1 (8.3)

TABLE 1: BACTERIAL ISOLATES FROM THE ENROLLED PATIENTS

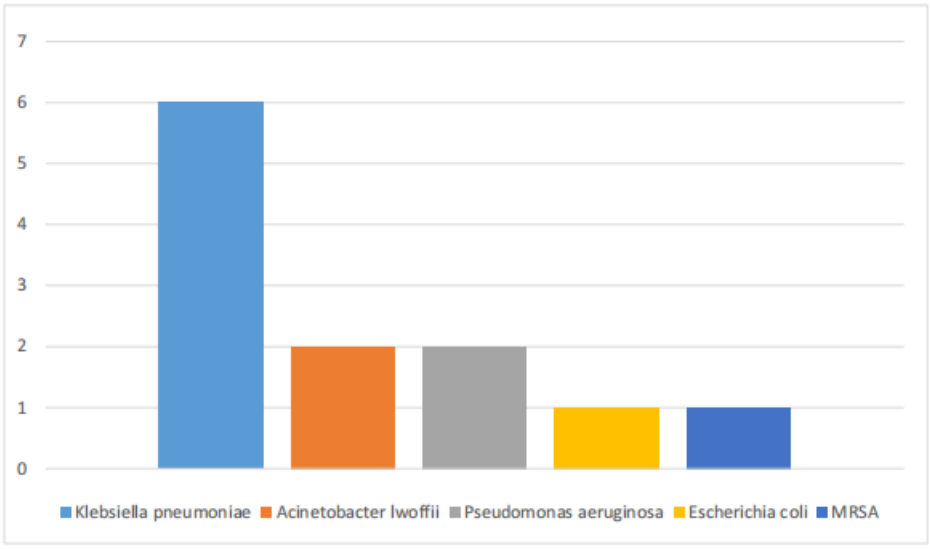

FIGURE 1 : BACTERIAL PRESENCE

In our study, we have found that, Klebsiella Pneumonia was seen in majority with 6 in number (50%) followed by Pseudomonas aeruginosa and Acinetobacter lwoffii with 4 in number (16.6%) and finally, Escherichia coli and MRSA with 1 in number (8.3%) respectively.

S.NO.	CHARACTERISTICS	HAI PRESENT N=12	HAI ABSENT N=69	P value
1.	***Age, years, mean (±SD)***	51.2 (±13.4)	46.4 (±17.0)	0.36
2.	***Male gender, n (%)***	6 (50)	38 (55)	0.1
3.	***Hospital stay, days, mean (±SD)***	7.6 (±4.1)	5.8 (±2.9)	**0.07**
4.	***Central Line insertion, n (%)***	12 (100)	69 (100)	1
5.	***Duration of Central Line, days, mean (±SD)***	7.6 (±4.1)	5.6 (±3.1)	**0.056**
6.	***Duration of Urinary Catheter, days, mean (±SD)***	7.8 (±4.2)	6.1 (±2.9)	0.1
7.	***Mechanical ventilation, n (%)***	9 (75)	55 (79.7)	0.89
8.	***Duration of Mechanical ventilation, days, mean (±SD)***	7.5 (±4.5)	5.4 (±2.4)	**0.04**
9.	***Mortality, n (%)***	4 (33.3)	15 (22.1)	0.54

TABLE 2 : COMPARISON OF CHARACTERISTICS

In our study we have found that, only 3 character showed statistically significant difference as the p value was 0.07, 0.05 and 0.04 respectively for Hospital stay,Duration of Central Line, days and Duration of Mechanical ventilation, days respectively. On the other hand, all remaining characteristics were non- significant respectively.

S.NO.	ISOLATES BY SPECIMEN TYPE	HAI, N = 12 (%)
1.	***Tracheal aspirate***	
	Klebsiella pneumonia	6 (50)
	Acinetobacter lwoffii	1 (8.3)
	Escherichia coli	1 (8.3)
	MRSA	1 (8.3)

2.	***Sputum*** Pseudomonas aeruginosa	1 (8.3)
3.	***Pus*** Pseudomonas aeruginosa	1 (8.3)
4.	***Sterile fluid**** Acinetobacter lwoffii	1 (8.3)

TABLE 3 : ISOLATES BY SPECIMEN TYPE

In our study we have found that, there were 12 bacterial isolates from the population, with tracheal aspirates accounting for the majority [9 (75%)]. Among these nine, Klebsiella pneumoniae was predominant in 6 (50%), while Acinetobacter lwoffii, Escherichia coli, and MRSA each grew in 1 (8.3%) respectively.

ANTIMICROBIAL	**PATTERN**	**KLEBSIELLA PNEUMONIA (N=6)**	**ESCHERICHIA COLI (N=1)**	**ACINETOBACTER LWOFFII (N=1)**	**MRSA (N=1)**
Ampicillin	S R	0 (0%) 6 (100%)	1 (100%) 0 (0%)	1 (100%) 0 (0%)	1 (100%) 0 (0%)
Gentamicin	S R	1 (16.66%) 5 (83.33%)	1(100%) 0(0%)	0(0%) 1(100%)	1(100%) 0(0%)
Ciprofloxacin	S R	2 (33.33%) 4 (66.67%)	1(100%) 0(0%)	0(0%) 1(100%)	0(0%) 1(100%)
Trimethoprim - Sulfamethoxazole	S R	1(16.66%) 5(83.33%)	0(0%) 1(100%)	0(0%) 1(100%)	1(100%) 0(0%)
Ertapenem	S R	1 (16.66%) 5 (83.33%)	1(100%) 0(0%)	0(0%) 1(100%)	1(100%) 0(0%)
Meropenem	S R	1(16.66%) 5(83.33%)	0(0%) 1(100%)	1(100%) 0(0%)	1(100%) 0(0%)
Imipenem	S R	1 (16.66%) 5 (83.33%)	0(0%) 1(100%)	0(0%) 1(100%)	0(0%) 1(100%)
Amikacin	S R	4(66.67%) 2(33.33%)	1(100%) 0(0%)	0(0%) 1(100%)	1(100%) 0(0%)
Colistin	S R	6(100%) 0 (0%)	1(100%) 0 (0%)	1(100%) 0 (0%)	1(100%) 0 (0%)

TABLE 4 : ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF VAP ISOLATES

In our study we have found that, multidrug resistance to most antibiotics (e.g., >80% R to ampicillin, carbapenems, ciprofloxacin), with colistin (100% S) and amikacin (up to 67% S) as the most reliable agents. K. pneumoniae exhibited consistent MDR, underscoring the need for targeted therapy and stewardship in likely respiratory infections.

ANTIMICROBIAL	**PATTERN**	**PSEUDOMONAS AERUGINOSA N=2**	**ACINETOBACTER LWOFFII N=1**
Ampicillin	S R	2 (100%) 0(0%)	0(0%) 1(100%)
Gentamycin	S R	1 (50%) 1 (50%)	0(0%) 1(100%)
Ciprofloxacin	S R	2(100%) 0(0%)	0(0%) 1(100%)
Trimethoprim -	S R	2(100%)	0(0%)

Sulfamethoxazole		0(0%)	1(100%)
Piperacillin - Tazobactum	S R	1 (50%) 1 (50%)	0(0%) 1(100%)
Ertapenem	S R	1 (50%) 1 (50%)	0(0%) 1(100%)
Meropenem	S R	1 (50%) 1 (50%)	0(0%) 1(100%)
Imipenem	S R	1 (50%) 1 (50%)	1(100%) 0(0%)
Amikacin	S R	2(100%) 0(0%)	0(0%) 1(100%)
Colistin	S R	2(100%) 0(0%)	1(100%) 0(0%)

TABLE 5 : ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF SPUTUM/PUS ISOLATES

In our study we have found that, 100% susceptibility to ciprofloxacin, trimethoprim-sulfamethoxazole, amikacin, and colistin (50% to others), while A. lwoffii (n=1) was resistant to most except colistin and imipenem, indicating viable options like colistin for these MDR Gram-negatives.

DISCUSSION

Our study revealed high carbapenem resistance among isolates, with 83% (5/6) of Klebsiella pneumoniae affected; all isolates remained susceptible to colistin. Carbapenem resistance is rising globally in ICU isolates, posing a critical challenge since carbapenems are mainstay therapy for critically ill patients. However, colistin, shows effective carries substantial risks, particularly nephrotoxicity, limiting its role as a safe alternative.

A study reported that most Gram-negative bacilli (GNB) in their study were multidrug-resistant (MDR), showing resistance to at least three antibiotic classes, including cephalosporins, carbapenems, aminoglycosides, tetracyclines, and fluoroquinolones.[7] Another study found carbapenem resistance in 12.2% of 460 non-fermenting Gram-negative bacilli (NFGNB), with Pseudomonas aeruginosa (42.8%, n=24), Acinetobacter spp. (14.2%, n=8), and other NFGNB (42.8%, n=24); all resistant strains were also resistant to seven other tested antibiotics.[8] In a study researchers assessed & concluded that, carbapenem resistance rates and carbapenemase gene prevalence in Klebsiella pneumoniae and Escherichia coli isolates from a North Indian corporate hospital serving both domestic and international patients.[9]

Among 528 clinical isolates, 156 (29.5%) were carbapenem-resistant, with significantly higher rates in K. pneumoniae than E. coli (53.9% vs. 15.6%; $p < 0.05$). Carbapenemase genes included NDM (34.6%, 54/156), OXA-48 (31.4%, 49/156), and NDM+OXA-48 co-expression (15.3%, 24/156); VIM and KPC were absent. NDM predominated in E. coli ($p < 0.05$), with NDM-5 as the most common variant (15/22); all tested isolates formed transconjugants, underscoring the heavy carbapenem resistance burden in Indian ICUs.

CONCLUSION

This study highlights a high burden of multidrug-resistant Gram-negative pathogens in tracheal aspirates, with Klebsiella pneumoniae (50% of isolates) showing 83% carbapenem resistance and widespread resistance to multiple classes, alongside MDR E. coli, Acinetobacter lwoffii, Pseudomonas aeruginosa, and MRSA. Notably, colistin and amikacin emerged as the most reliable agents (100% and up to 67% susceptibility, respectively), while P. aeruginosa retained sensitivity to ciprofloxacin and trimethoprim-sulfamethoxazole. These findings, mirroring global ICU trends of escalating carbapenemase-mediated resistance (e.g., NDM, OXA-48), underscore the urgent need for antimicrobial stewardship, rapid molecular diagnostics, infection control, and novel therapeutic strategies to safeguard critically ill patients

REFERENCE

1. Balusu, C., (2022) "Addressing the Prevalence of Healthcare-Associated Infections in

India", Undergraduate Journal of Public Health 6.
2. Chenchula S, Sadasivam B, Shukla A, Pathan S, Saurabh Saigal. Health care associated infections, antimicrobial resistance and outcomes in patients admitted to intensive care unit, India: A five-Year retrospective cohort study. J Infect Prev. 2023 Jul;24(4):159-165.
3. Murhekar MV, Kumar CG. Health-care-associated infection surveillance in India. The Lancet Global Health. 2022 Sep 1;10(9):e1222-3.
4. Nair V, Sahni AK, Sharma D, Grover N, Shankar S, Chakravarty A, Patrikar S, Methe K, Jaiswal SS, Dalal SS, Kapur A, Verma R, Prakash J, Gupta A, Bhansali A, Batura D, Rao GG, Joshi DP, Chopra BK. Point prevalence & risk factor assessment for hospital-acquired infections in a tertiary care hospital in Pune, India. Indian J Med Res. 2017 Jun;145(6):824-832.
5. Narendranath V, Nandakumar BS, Sarala KS. Epidemiology of hospital-acquired infections in a tertiary care teaching hospital in India: a cross-sectional study of 79401 inpatients. Int J Community Med Public Health. 2017 Jan 25;4(2):335-9.
6. Gunasekaran S, Mahadevaiah S. Healthcare-associated Infection in Intensive Care Units: Overall Analysis of Patient Criticality by Acute Physiology and Chronic Health Evaluation IV Scoring and Pathogenic Characteristics. Indian J Crit Care Med. 2020 Apr;24(4):252-257.
7. Moolchandani K, Sastry AS, Deepashree R, Sistla S, Harish BN, Mandal J. Antimicrobial resistance surveillance among intensive care units of a tertiary care hospital in Southern India. Journal of clinical and diagnostic research: JCDR. 2017 Feb 1;11(2):DC01.
8. Gladstone P, Rajendran P, Brahmadathan KN. Incidence of carbapenem resistant nonfermenting gram negative bacilli from patients with respiratory infections in the intensive care units. Indian journal of medical microbiology. 2005 Jul 1;23(3):189-91.
9. Jaggi N, Chatterjee N, Singh V, Giri SK, Dwivedi P, Panwar R, Sharma AP. Carbapenem resistance in Escherichia coli and Klebsiella pneumoniae among Indian and international patients in North India. Acta microbiologica et immunologica Hungarica. 2019 Sep;66(3):367-76.

