

Bacteriological Profile And Antibiogram Analysis: A Retrospective Study From A Tertiary Care Hospital In North India

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Abstract: Background: Healthcare-associated infections (HAIs) contribute significantly to morbidity, mortality, and healthcare costs, particularly in developing countries. The rising prevalence of multidrug-resistant organisms necessitates continuous surveillance of local bacteriological profiles and antimicrobial susceptibility patterns. Objectives: To determine the bacteriological spectrum and analyze antimicrobial susceptibility patterns of clinical isolates from bloodstream, urinary tract, respiratory tract, and surgical site infections in a tertiary care hospital. Materials and Methods: This retrospective observational study was conducted in the Department of Microbiology at a tertiary care center in North India from July 2024 to June 2025. All culture-positive clinical samples were included. Bacterial identification was performed using standard microbiological methods, and antimicrobial susceptibility testing was done using the Kirby–Bauer disk diffusion method. Results were interpreted as per Clinical and Laboratory Standards Institute (CLSI) guidelines. Results: A total of 916 isolates were analyzed. Gram-negative organisms predominated across all infection types. *Escherichia coli* and *Klebsiella pneumoniae* were the most common pathogens. Colistin showed 100% sensitivity among Gram-negative isolates. Carbapenems demonstrated moderate sensitivity, whereas high resistance was observed to cephalosporins and fluoroquinolones. Gram-positive organisms, including *Staphylococcus aureus* and *Enterococcus* species, showed 100% sensitivity to vancomycin, linezolid, and daptomycin. In urinary tract infections, *E. coli* showed high sensitivity to nitrofurantoin and fosfomycin. Conclusion: Gram-negative bacteria predominate in HAIs with increasing antimicrobial resistance. Regular surveillance and institution-specific antibiograms are essential for guiding empirical therapy and strengthening antibiotic stewardship. [Tiwari U Natl J Integr Res Med, 2026; 17(1): 27-32, Published on Dated: 07/07/2026]

Keywords: Healthcare-Associated Infections, Antibiogram, Antimicrobial Resistance, Gram-Negative Bacteria, Antibiotic Stewardship

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Introduction: Healthcare-associated infections (HAIs) continue to pose a significant global public health challenge, contributing substantially to patient morbidity, mortality, prolonged hospital stay, and increased healthcare costs. The burden is particularly high in developing countries due to limited resources, overcrowding, and gaps in infection control practices¹.

A major concern in recent years is the emergence and rapid spread of multidrug-resistant (MDR) organisms, especially Extended Spectrum Beta-Lactamase (ESBL) producing bacteria and Carbapenem-Resistant Enterobacterales (CRE).

These resistant pathogens are largely driven by inappropriate and excessive use of antimicrobials, lack of robust antibiotic stewardship programs, and inadequate infection prevention and control measures within healthcare settings².

Nosocomial infections commonly involve the bloodstream, urinary tract, respiratory system, and skin and soft tissues. The management of these infections is increasingly challenging due to evolving resistance patterns.

Empirical antimicrobial therapy, which is often initiated before culture results are available, should ideally be guided by local antibiogram data that reflect the prevailing microbial flora and their susceptibility patterns within a specific institution.

Regular surveillance of bacteriological profiles and antimicrobial susceptibility patterns is therefore essential for guiding appropriate antibiotic therapy, formulating hospital antibiotic policies, and strengthening infection control strategies³.

In this context, the present study aims to evaluate the bacteriological spectrum and antibiogram

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patterns in a tertiary care center in North India, with the objective of providing evidence-based data to support rational antimicrobial use and improve patient outcomes.

Materials and Methods: Study Design And Setting: This retrospective observational study was conducted in the Department of Microbiology at a tertiary care hospital in North India.

Study Duration: The study was carried out over a period of one year, from July 2024 to June 2025.

Study Population and Sample Size: All clinical specimens received in the microbiology laboratory during the study period that yielded significant bacterial growth were included in the study. A total of 916 culture-positive isolates were analyzed.

Inclusion Criteria: All culture-positive clinical samples (blood, urine, respiratory samples, pus, and other body fluids). Samples from both inpatient and outpatient departments were included.

Exclusion Criteria: Duplicate isolates from the same patient, Contaminated or improperly collected samples, Fungal and non-bacterial isolates, Sample Processing and Identification.

Clinical specimens were processed using standard microbiological techniques. Isolation of organisms was performed by inoculation onto appropriate culture media, followed by incubation under suitable conditions.

Identification of bacterial isolates was carried out based on colony morphology, Gram staining, and conventional biochemical tests.

Antimicrobial Susceptibility Testing (AST): Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar. The results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines.

Quality Control: Quality control for culture media and antibiotic discs was ensured using standard reference strains (e.g., *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923, *Pseudomonas aeruginosa* ATCC 27853).

Data Collection and Analysis: Data were collected from laboratory records and entered into Microsoft Excel. Descriptive statistics were used to analyze the distribution of isolates and their antimicrobial susceptibility patterns. Results were expressed as percentages and proportions.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee. Patient confidentiality was strictly maintained, and no personal identifiers were used.

Results: A total of 916 culture-positive isolates from bloodstream infections (BSI), urinary tract infections (UTI), respiratory tract infections (RTI), and surgical site infections (SSI) were analyzed over a one-year period (July 2024–June 2025).

1. Bloodstream Infections (BSI): A total of 332 isolates were obtained from blood cultures.

Gram-negative organisms predominated.

Escherichia coli was the most common isolate (25%), followed by *Pseudomonas aeruginosa* (17%) and *Klebsiella pneumoniae* (16%).

Staphylococcus aureus accounted for 5% of isolates.

Among Gram-negative organisms, colistin showed 100% sensitivity across all isolates. *E. coli* demonstrated moderate sensitivity to amikacin (79%) and low sensitivity to third-generation cephalosporins.

Klebsiella pneumoniae showed high sensitivity to tigecycline (94%) and colistin (100%), with moderate susceptibility to carbapenems (~37%).

Pseudomonas aeruginosa exhibited good sensitivity to meropenem (74%) and piperacillin-tazobactam (70%).

Among Gram-positive isolates, *Staphylococcus aureus* showed 100% sensitivity to vancomycin, linezolid, daptomycin, and teicoplanin, while resistance to oxacillin/cefoxitin was high (93%).

Table 1: Blood Stream Infections (BSIs) Antibiotic Protocol: ICU+Wards

ICU+Wards MICROBIOLOGY DATA: July 2024-June 2025 (N=332)		
Pathogens	Prevalence (%)	Antibiotic Sensitivity (%)
Escherichia Coli (N=84)	25%	Amikacin (79%), Ertapenem (52%), Colistin (100%), Imipenem (52%), Cefperazone-sulbactam (57%), Meropenem (52%), Gentamicin (47%), cefepime (18%), Amoxycillin-clavulanate (24%), Piperacillin-tazobactam (45%), Cotrimoxazole (17%), Cefuroxime (10%), Ceftriaxone (18%)
Staphylococcus Aureus (N=14)	5%	Vancomycin/ /Linezolid / Daptomycin / Teicoplanin (100%), Tetracycline (65%), Gentamicin (50%), Cotrimoxazole (30%), Oxacillin/cefoxitin (7%), Erythromycin (14%)
Klebsiella Pneumoniae (N=55)	16%	Colistin (100%), Tigecycline (94%) Amikacin (42%), Piperacillin-tazobactam (44%), Gentamicin (37%), Imipenem/ Meropenem (37%), Ertapenem (37%), Cefoperazone-sulbactam (58%), Amoxycillin-clavulanate (24%), Cotrimoxazole (51%), Cefepime (24%), Cefuroxime/Ceftriaxone (20%)
Pseudomonas Aeruginosa (N=57)	17%	Colistin (100%), Meropenem (74%), Gentamicin (40%), Amikacin (54%), Cefepime (39%), Piperacillin-Tazobactam (70%), Levofloxacin (48%), Ceftazadime(30%), Ciprofloxacin (64%), Cefoperazone-Sulbactam (56%)

2. Urinary Tract Infections (UTI): A total of 377 isolates were analyzed from urine samples.

Escherichia coli was the predominant pathogen (46%), followed by Klebsiella pneumoniae (27%) and Pseudomonas aeruginosa (18%).

Enterococcus species accounted for 2% of isolates.

E. coli showed highest sensitivity to fosfomycin (90%), nitrofurantoin (82%), carbapenems (70%), and colistin (100%).

However, low sensitivity was observed with ceftriaxone (10%) and cefuroxime (10%).

Klebsiella pneumoniae demonstrated 100% sensitivity to colistin, with moderate susceptibility to carbapenems (38–40%) and low sensitivity to fluoroquinolones (10%).

Pseudomonas aeruginosa showed good sensitivity to ciprofloxacin (52%) and meropenem (50%), while resistance to cephalosporins was noted.

Enterococcus species were highly sensitive to linezolid and daptomycin (100%), with moderate

sensitivity to vancomycin (63%) and teicoplanin (88%).

3. Respiratory Tract Infections (RTI): A total of 114 isolates were obtained from respiratory samples.

Klebsiella pneumoniae was the most common isolate (39%), followed by Pseudomonas aeruginosa (28%) and Escherichia coli (18%).

All isolates showed 100% sensitivity to colistin.

Klebsiella pneumoniae demonstrated good sensitivity to tigecycline (75%) and moderate sensitivity to carbapenems (60%). Pseudomonas aeruginosa showed moderate sensitivity to imipenem and meropenem (63%) and piperacillin-tazobactam (50%). E. coli showed high sensitivity to tigecycline (90%) and amikacin (85%).

4. Surgical Site Infections (SSI): A total of 93 isolates were obtained from wound swabs.

Klebsiella pneumoniae was the predominant pathogen (34%), followed by Escherichia coli (20%), Pseudomonas aeruginosa (17%), and Staphylococcus aureus (15%).

All Gram-negative isolates showed 100% sensitivity to colistin. *Klebsiella pneumoniae* *E. coli* showed good sensitivity to amikacin (84%) and carbapenems (67%). *Pseudomonas aeruginosa* exhibited good sensitivity to meropenem (81%) and piperacillin-tazobactam

demonstrated high sensitivity to tigecycline (90%) and carbapenems (78%).

(70%). *Staphylococcus aureus* isolates were uniformly sensitive (100%) to vancomycin, linezolid, daptomycin, and teicoplanin, with low sensitivity to beta-lactams.

Table 2: Urinary Tract Infections (UTI) Antibiotic Protocol: ICU & Wards

ICU + Wards Microbiology Data: July 2024 - June 2025 (N=377)		
Pathogens	Prevalence (%)	Antibiotic Sensitivity (%)
<i>Klebsiella Pneumoniae</i> (N=101)	27%	Colistin (100%), Gentamicin (26%), Amikacin (25%), Ertapenem/Imipenem (38%), Co-trimoxazole(35%), Meropenem (40%), Cefoperazone-Sulbactam (30%), Piperacillin- Tazobactam (35%), Amoxycillin-Clavulanate /Ceftriaxone (25%), Nitrofurantoin (40 %), Ciprofloxacin (10%).
<i>Escherichia Coli</i> (N=172)	46%	Amikacin (68%), Colistin (100%), Imipenem/ Meropenem (70%), Gentamicin (53%), Ertapenem (70%), Fosfomycin (90%), Cefoperazone-Sulbactam (44%), Nitrofurantoin (82%), Piperacillin-Tazobactam (45%), Amoxycillin-Clavulanate (30%), Ceftriaxone (10%), Cefepime (20%), Cefuroxime (10 %)
<i>Pseudomonas Aeruginosa</i> (N=66)	18%	Colistin (100%), Meropenem (50%), Gentamicin/ Amikacin (40%), Cefepime (20%), Piperacillin-Tazobactam (40%), Ceftazadime/ Ciprofloxacin(52%), Cefoperazone-Sulbactam (28%),Nitrofurantoin (47%)
<i>Enterococcus</i> (N=8)	2%	Linezolid (100%), Daptomycin (100%), Vancomycin (63%), Teicoplanin (88%), Tetracycline (12%), Nitrofurantoin(38%), Gentamicin(50%)

Table 3: Respiratory Tract Infection (RTI) Antibiotic Protocol: ICU & Wards

ICU + Wards Microbiology Data: July 2024 - June 2025 (N=114)		
Pathogens	Prevalence (%)	Antibiotic Sensitivity (%)
<i>Klebsiella Pneumoniae</i> (N=44)	39%	Colistin (100%), Tigecycline (75%), Amikacin (57%), Gentamicin (41%), Imipenem (60%), Ertapenem (60%), Meropenem (60%), Cefoperazone-Sulbactam (28%), Piperacillin-Tazobactam (57%), Co-trimoxazole (35%), Amoxycillin-Clavulanate (25%), Cefepime/Ceftriaxone (20%), Cefuroxime (20%), Ciprofloxacin (18%)
<i>Pseudomonas Aeruginosa</i> (N=32)	28%	Colistin (100%), Amikacin (60%), Gentamicin (47%), Imipenem (63%), Meropenem (63%), Ceftazidime(47%), Ciprofloxacin (28%), Cefoperazone-Sulbactam (56%), Cefepime (47%), Piperacillin-Tazobactam (50%), Ticarcillin-clavunanic acid (47%)
<i>Escherichia Coli</i> (N=20)	18%	Colistin (100%), Tigecycline (90%), Amikacin (85%), Ertapenem (70%), Gentamicin (50%), Imipenem/ Meropenem (70%), Cefoperazone-Sulbactam (50%), Amoxycillin-Clavulanate (20%), Piperacillin-Tazobactam (45%), Cotrimoxazole (45%), Ceftriaxone (20%), Cefepime(20%) ,Cefuroxime (20%)

Table 4: SSI (Wound Swabs) Antibiotic Protocol: ICU & Wards

ICU + Wards Microbiology Data: July 2024 - June 2025 (N=93)		
Pathogens	Prevalence (%)	Antibiotic Sensitivity (%)
<i>Pseudomonas Aeruginosa</i> (N=16)	17%	Colistin (100%), Gentamicin (38%), Meropenem (81%), Amikacin (70%), Imipenem (80%), Ceftazadime (60%), Cefoperazone-Sulbactam (56%), Cefepime (63%), Piperacillin-Tazobactam (70%), Ticarcillin- clavunanic acid (38%), Ciprofloxacin (60%).
<i>Klebsiella Pneumoniae</i> (N=32)	34%	Colistin (100%), Amikacin (78%), Gentamicin (66%), Tigecycline (90%), Cefoperazone- sulbactum (56%), Meropenem/Imipenem Ertapenem/ (78%), Amoxycillin-clavulanic acid / Levofloxacin (22%), Piperacillin-Tazobactam (53%), Cefepime (20%), Ceftriaxone(32%), Co-trimoxazole (60%), Cefuroxime (20%)
<i>Staphylococcus Aureus</i> (N=14)	15%	Vancomycin/ /Linezolid / Daptomycin / Teicoplanin (100%), Tetracycline (50%), Ciprofloxacin / Co-trimoxazole (35%), Gentamicin (30%), Erythromycin (30%), Cefoxitin/ Oxacillin (15%)
<i>Escherichia Coli</i> (N=18)	20%	Colistin (100%), Amikacin (84%), Ertapenem (67%), Gentamicin (72%), Cefepime/ Cefoperazone-Sulbactam (55%), Imipenem/ Meropenem (67%), Co-trimoxazole (35%), Tigecycline (89%), Piperacillin- Tazobactam (67%), Amoxycillin- Clavulanate (32%), Cefuroxime (16%).

Discussion: Healthcare-associated infections (HAIs) remain a significant contributor to morbidity, mortality, and healthcare costs worldwide, particularly in resource-limited settings.

The present study highlights the bacteriological profile and antimicrobial susceptibility patterns in a tertiary care hospital, with a predominance of Gram-negative organisms across all infection types.

This finding is consistent with multiple surveillance studies from India and other developing countries, where Gram-negative bacilli account for the majority of nosocomial infections⁴.

In this study, *Escherichia coli* and *Klebsiella pneumoniae* were the most frequently isolated pathogens, especially in bloodstream and urinary tract infections. Similar observations have been reported by Mehta et al. and Gandra et al., who documented Enterobacterales as the leading cause of HAIs^{5,6}.

The high prevalence of these organisms may be attributed to their capacity to acquire and disseminate resistance mechanisms such as

extended-spectrum beta-lactamases (ESBLs) and carbapenemases. A notable finding of the present study is the 100% sensitivity of Gram-negative isolates to colistin, which is in agreement with other Indian studies⁷.

However, this preserved susceptibility likely reflects the restricted use of colistin as a last-resort antibiotic. The increasing reliance on colistin is concerning due to its nephrotoxicity and the emerging reports of plasmid-mediated colistin resistance (mcr genes)⁸.

Carbapenems demonstrated only moderate sensitivity among Gram-negative isolates, particularly *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. This trend suggests a growing burden of carbapenem-resistant organisms, which has been widely reported in recent antimicrobial resistance surveillance data from India⁹. The emergence of carbapenem resistance is largely driven by the production of carbapenemase enzymes such as NDM and OXA-type beta-lactamases.

The study also revealed high resistance rates to third-generation cephalosporins and fluoroquinolones. Similar resistance patterns have been

documented in previous studies, reflecting the widespread and often inappropriate use of these antibiotics in clinical practice¹⁰. These findings underscore the limited utility of these agents for empirical therapy in hospital settings.

Among Gram-positive organisms, *Staphylococcus aureus* isolates were uniformly sensitive to vancomycin, linezolid, daptomycin, and teicoplanin. However, the high resistance to oxacillin/cefoxitin indicates a significant prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA), which is consistent with earlier reports from India¹¹.

Likewise, *Enterococcus* species showed high sensitivity to linezolid and daptomycin, with reduced susceptibility to vancomycin, raising concerns about the emergence of vancomycin-resistant enterococci (VRE). In urinary tract infections, *Escherichia coli* demonstrated high sensitivity to nitrofurantoin and fosfomycin, which supports their continued use as first-line agents for uncomplicated UTIs. This finding aligns with current treatment guidelines and previous studies emphasizing their effectiveness against uropathogens¹². The variability in antimicrobial susceptibility patterns observed in this study highlights the importance of local antibiogram-based empirical therapy. Regular surveillance and updating of institutional antibiotic policies are essential to optimize treatment outcomes and curb the spread of multidrug-resistant organisms.

Limitations: This study has certain limitations. Being a single-centre retrospective study, the findings may not be generalizable to other healthcare settings. Additionally, molecular characterization of resistance mechanisms was not performed, which could have provided further insights into the epidemiology of antimicrobial resistance.

Conclusion: Gram-negative organisms predominate in healthcare-associated infections, with increasing resistance to commonly used antibiotics. The preserved sensitivity to colistin is encouraging but concerning due to its status as a last-resort drug. Strengthening antimicrobial stewardship programs and continuous surveillance of resistance patterns are crucial to combat the growing threat of antimicrobial resistance.

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