e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(6); 841-844

Original Research Article

Distribution of Clinical Bacterial Isolates and Antimicrobial Resistance Patterns in a Tertiary Care Hospital: A Six-Month Cross-Sectional Resistogram Study

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Received: 01-03-2026 / Revised: 15-04-2026 / Accepted: 21-05-2026

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Conflict of interest: Nil

Abstract

Background: Antimicrobial resistance (AMR) has evolved into a formidable challenge for contemporary healthcare systems, particularly within tertiary care hospitals where extensive antimicrobial exposure accelerates selective pressure. Institutional resistogram surveillance provides a dynamic and evidence-based framework for understanding local resistance ecology and for guiding rational empirical therapy.

Objectives: This study aimed to delineate the spectrum of bacterial pathogens isolated from diverse clinical specimens and to comprehensively analyze their antimicrobial resistance patterns in a tertiary care hospital setting.

Methods: A cross-sectional resistogram-based study was conducted over a six-month period (June–November 2025). Clinical specimens including urine, blood, sputum, pus/wound swabs, endotracheal tube secretions, and bronchoalveolar lavage fluid were processed using standard bacteriological methods. Antimicrobial susceptibility testing was performed by disc diffusion and interpreted as per established guidelines.

Results: Among 2392 clinical samples analyzed, culture positivity demonstrated marked specimen-wise variability, ranging from 15.77% in blood to 81.48% in wound swabs. Gram-negative bacilli constituted the predominant isolates, with Klebsiella spp. and Acinetobacter spp. emerging as the most frequent pathogens. Alarmingly high resistance rates were observed against third-generation cephalosporins, fluoroquinolones, and carbapenems. Conversely, fosfomycin, netilmicin, aztreonam, and tigecycline retained notable activity against multidrug-resistant organisms.

Conclusion: The findings reveal a concerning escalation of antimicrobial resistance alongside a clinically significant re-emergence of susceptibility to selected older antimicrobials. Periodic, institution-specific resistogram analysis remains indispensable for optimizing empirical therapy and reinforcing antimicrobial stewardship strategies.

Keywords: Antimicrobial Resistance; Institutional Resistogram; Multidrug-Resistant Organisms; Hospital Surveillance; Empirical Therapy.

DOI: 10.25258/ijcpr.18.6.137

Introduction

Antimicrobial resistance (AMR) represents one of the gravest threats to global health in the twenty-first century, undermining the effectiveness of standard therapeutic regimens and increasing morbidity, mortality, and healthcare costs. The problem is particularly accentuated in tertiary care hospitals, where critically ill patients, invasive medical devices, prolonged hospital stays, and extensive antimicrobial use collectively create an ideal environment for the emergence and dissemination of resistant pathogens [1,2]. Recognizing the magnitude of this crisis, World Health Organization has identified AMR surveillance as a central pillar of its global action plan. Hospital-specific antibiograms or resistograms serve as practical tools for translating microbiological surveillance into actionable clinical guidance. These cumulative susceptibility profiles enable clinicians to tailor empirical antibiotic therapy according to local resistance trends rather

than relying on generalized or outdated data [3]. Importantly, pathogen distribution and resistance patterns are not uniform; they vary according to specimen type, clinical unit, patient population, and institutional prescribing practices [4]. In recent years, Gram-negative bacilli—particularly Klebsiella spp. and Acinetobacter spp.—have emerged as dominant pathogens in hospital-acquired infections, often exhibiting multidrug resistance and carbapenem non-susceptibility [5,6]. Continuous and specimen-stratified resistogram surveillance is therefore essential not only for detecting emerging resistance but also for identifying unexpected shifts in susceptibility, including the renewed effectiveness of older antimicrobial agents [7].

Against this backdrop, the present study was undertaken to generate a comprehensive institutional resistogram, capturing both pathogen distribution and antimicrobial resistance patterns across multiple clinical specimens over a six-month period.

Justification of the Study: Routine resistogram surveillance is an integral component of the infection control and antimicrobial stewardship framework at our institution. Over recent surveillance cycles, clinicians and microbiologists observed an increasing frequency of multidrug-resistant organisms, a progressive decline in carbapenem susceptibility among Gram-negative isolates, and sporadic detection of glycopeptide-resistant Gram-positive cocci.

These observations underscored the need for a systematic and detailed analysis of recent resistance trends. The present study was therefore designed to generate updated, specimen-specific resistance data that reflect real-world clinical antibiotic pressure. By identifying emerging resistance patterns as well as potential therapeutic alternatives, this analysis aims to support evidence-based optimization of empirical treatment protocols in both general wards and critical care units.

Objectives:

1. To characterize the distribution of bacterial pathogens isolated from different clinical specimens.
2. To evaluate antimicrobial resistance patterns among these isolates.
3. To identify emerging susceptibility trends and potential therapeutic options.
4. To estimate the burden of multidrug-resistant organisms in hospital-acquired infections.

Materials and Methods

A cross-sectional observational study was conducted in the Department of Microbiology of a tertiary care hospital over six months (June–November 2025). A total of 2392 clinical specimens were received from inpatient wards and intensive care units, including urine, blood, sputum, pus/wound swabs, endotracheal tube secretions, and bronchoalveolar lavage fluid.

All specimens were processed using standard microbiological techniques. Bacterial identification was carried out using conventional phenotypic methods. Antimicrobial susceptibility testing was performed by the Kirby–Bauer disc diffusion method, and results were interpreted in accordance with Clinical and Laboratory Standards Institute guidelines [8]. Multidrug resistance was defined as resistance to at least one antimicrobial agent in three or more distinct classes [9].

Results

Sample Distribution and Culture Positivity: Out of 2392 samples, the highest culture positivity was observed in pus/wound swabs (81.48%), followed by ET tube secretions (68.75%) and sputum (60.56%). Blood cultures showed the lowest positivity rate (15.77%).

Urine Samples: Among culture-positive urine samples (21.63%), Klebsiella spp. (50.75%) and Escherichia coli (41.49%) were predominant.

High resistance was noted against third-generation cephalosporins (75.66%) and quinolones (81.2%). Fosfomycin (75.61%), netilmicin (88.31%), and polymyxins (87.14%) demonstrated good activity.

Blood Samples: Bloodstream infections were predominantly caused by MRSA (26.08%) and Enterobacteriaceae. Two isolates of vancomycin-resistant Enterococcus were identified.

Polymyxins (91%) and fosfomycin (86.36%) showed maximum efficacy against Gram-negative isolates. Aztreonam (75%) emerged as a promising option.

Lower Respiratory Samples (Sputum, ET Tube, BAL): Klebsiella spp. and Acinetobacter spp. dominated respiratory samples, with a high proportion of MDROs. Carbapenem resistance exceeded 80% in sputum isolates. Colistin remained the most reliable agent across invasive respiratory samples.

Notably, no Streptococcus pneumoniae or MRSA were isolated from sputum samples.

Pus and Wound Swab Samples: Klebsiella spp. (36.36%) and MRSA (22.75%) were the most common isolates. Tigecycline showed 100% sensitivity against Gram-negative isolates. A VRSA isolate was sensitive to teicoplanin and tigecycline.

Discussion

The present study demonstrates a clear predominance of Gram-negative bacilli among clinical isolates, a finding consistent with resistance patterns reported from tertiary care centers across India and other resource-limited settings [10–12].

The high prevalence of multidrug-resistant organisms, particularly in respiratory and device-associated samples, reflects the cumulative impact of broad-spectrum antibiotic exposure, prolonged hospitalization, and invasive interventions commonly encountered in critical care environments [13].

One of the most compelling observations of this study is the re-emergence of susceptibility to older aminoglycosides such as netilmicin and amikacin, particularly in urinary and bloodstream isolates.

This phenomenon likely reflects reduced clinical utilization of these agents over time, resulting in diminished selective pressure. Similar reversals of resistance trends have been documented in longitudinal surveillance studies, highlighting the dynamic and potentially reversible nature of antimicrobial resistance [14,15].

Fosfomycin demonstrated consistent and robust activity against multidrug-resistant Gram-negative organisms across specimen types, reinforcing its renewed clinical relevance as a valuable option for the management of complicated infections [16].

Although the detection of vancomycin-resistant Enterococcus and vancomycin-resistant Staphylococcus aureus was limited, their presence is epidemiologically significant and underscores the necessity for stringent infection prevention and control measures [17].

The absence of Streptococcus pneumoniae in sputum samples may reflect widespread prior antibiotic exposure among hospitalized patients or a changing epidemiological pattern of respiratory infections in tertiary care settings [18].

Uniqueness and Novelty of the Study: Unlike conventional studies focusing on single pathogens or isolated specimen types, this investigation presents a comprehensive institutional resistogram integrating data from six distinct clinical specimens, thereby providing a holistic representation of antimicrobial resistance within the hospital ecosystem.

The study uniquely captures the re-emergence of susceptibility to older, under-utilized antimicrobials (netilmicin, amikacin, and fosfomycin), challenging the deterministic perception of irreversible resistance and highlighting the adaptive nature of resistance dynamics.

Specimen-specific resistance profiling reveals distinct resistance “signatures” across urinary, bloodstream, respiratory, and wound isolates—patterns that are frequently obscured in aggregated antibiogram reports.

By correlating resistance trends with viable empirical treatment options, the study transcends passive surveillance and delivers clinically actionable intelligence that directly informs antimicrobial stewardship and bedside decision-making.

Conclusion

This cross-sectional resistogram analysis reveals a substantial burden of antimicrobial resistance in a tertiary care hospital, particularly among Gram-negative pathogens.

Simultaneously, it highlights encouraging re-emerging susceptibility to selected older antimicrobial agents. Regular, specimen-stratified institutional surveillance is essential for guiding rational empirical therapy, optimizing antibiotic utilization, and mitigating the escalating threat of antimicrobial resistance.

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