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# Assessment of Antibiotic Usage Patterns and Antimicrobial Resistance Profiles in Emergency Department Infections: A Cross-Sectional Study

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**KEYWORDS**

Antimicrobial resistance, Antibiotic stewardship, Emergency department infections.

**ABSTRACT:**

Background: Antimicrobial resistance (AMR) is a critical global concern, with emergency departments (EDs) being high-risk environments for empirical antibiotic overuse. Understanding prescribing trends and their link to resistance is essential for strengthening antimicrobial stewardship practices.

Aim: To assess the antibiotic usage patterns and antimicrobial resistance profiles among patients with infections presenting to the emergency department.

Methods: A hospital-based cross-sectional study was conducted among 200 adult patients with suspected or confirmed infections presenting to the ED over one year. Data on demographics, clinical profile, antibiotic prescriptions, and microbiological findings were collected. Antimicrobial susceptibility testing was performed using standard CLSI protocols. Statistical analysis included descriptive summaries, z-tests for differences in proportions and means, and odds ratio estimation for exposure-resistance associations.

Results: Of 200 patients, 127 (63.5%) were culture-positive. Prior antibiotic exposure within 90 days was significantly associated with culture positivity (29.9% vs. 16.4%; p=0.034). Healthcare-associated isolates exhibited higher resistance rates to piperacillin-tazobactam (39.5% vs. 22.6%; p=0.045) and carbapenems (25.6% vs. 10.7%; p=0.029). Extended-spectrum β-lactamase production among Enterobacterales was significantly higher in healthcare-associated infections (67.7% vs. 45.2%; p=0.040). Guideline-concordant empirical therapy was associated with fewer multidrug-resistant isolates (OR=0.41; 95% CI 0.19-0.91; p=0.028) and lower 7-day revisit rates (8.0% vs. 21.0%; p=0.0089).

Conclusion: The study demonstrates that inappropriate or non-guideline-based antibiotic prescribing, prior exposure, and healthcare-associated settings contribute to higher resistance rates. Strengthening empirical therapy guidelines, timely de-escalation, and regular AMR surveillance in the ED can significantly improve infection outcomes and mitigate resistance trends.

## INTRODUCTION

Infections are among the most common presentations in emergency departments (EDs) worldwide, accounting for a substantial proportion of hospital admissions and antibiotic prescriptions. The empirical and often urgent use of antimicrobials in such settings, while life-saving, has significantly contributed to the growing problem of antimicrobial resistance (AMR) a global health crisis recognized by the World Health Organization as one of the top public health threats of the 21st century. The inappropriate, excessive, or irrational use of antibiotics in EDs, often due to diagnostic uncertainty, time constraints, or pressure to initiate treatment, accelerates the emergence of resistant organisms, leading to poor patient outcomes, longer hospital stays, and increased healthcare costs.

The spectrum of infections seen in emergency departments typically includes respiratory tract

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infections, urinary tract infections, skin and soft tissue infections, gastrointestinal infections, and sepsis. In these acute care settings, antibiotic selection is frequently empirical, guided by local epidemiological data and resistance trends. However, in many resource-limited settings, antimicrobial stewardship programs (ASPs) and continuous resistance surveillance remain underdeveloped, resulting in wide variation in antibiotic prescribing patterns. Studies have shown that a large proportion of antibiotics prescribed in EDs are either unnecessary or inappropriate in spectrum, dosage, or duration [1,2]. The emergence of multidrug-resistant (MDR) pathogens such as extended-spectrum β-lactamase (ESBL)-producing Enterobacteriaceae, methicillin-resistant Staphylococcus aureus (MRSA), and carbapenem-resistant organisms further complicates management [3].

Understanding the antibiotic usage patterns and correlating them with antimicrobial resistance profiles is crucial to promote rational prescribing and to design effective stewardship interventions tailored to emergency care environments. Regular monitoring can help identify commonly misused antibiotics, track emerging resistance trends, and guide formulation of empirical antibiotic guidelines specific to the ED setting. Moreover, data-driven stewardship interventions have been shown to reduce inappropriate antibiotic use without adversely affecting patient outcomes [4].

In India, the situation is particularly concerning due to high infectious disease burden, widespread over-the-counter antibiotic availability, and limited enforcement of prescription regulations. Surveillance data from tertiary care hospitals have documented increasing resistance to third-generation cephalosporins, fluoroquinolones, and carbapenems in Gram-negative isolates, as well as growing resistance to macrolides and clindamycin among Gram-positive pathogens [5]. Despite these alarming trends, limited literature exists specifically focusing on antibiotic usage and resistance in emergency departments. Therefore, this study aims to assess antibiotic usage patterns and correlate them with antimicrobial resistance profiles among patients presenting with infections to the emergency department, thereby providing evidence to optimize antibiotic policies and strengthen antimicrobial stewardship initiatives.

**Aim**

To assess the antibiotic usage patterns and antimicrobial resistance profiles among patients with infections presenting to the emergency department.

**Objectives**

1. To study the pattern of antibiotic usage among patients with infections in the emergency department.
2. To determine the antimicrobial resistance profiles of bacterial isolates from these infections.
3. To correlate antibiotic usage trends with the observed antimicrobial resistance patterns.

## MATERIAL AND METHODOLOGY

**Source of Data:** The study utilized data from patients presenting with suspected or confirmed infections to the Emergency Department of a tertiary care teaching hospital. Relevant clinical, microbiological, and treatment data were obtained from patient records and laboratory databases.

**Study Design:** A hospital-based cross-sectional observational study.

**Study Location:** Department of Emergency Medicine and Department of Microbiology, at tertiary care teaching hospital.

**Study Duration:** The study was conducted over a 12-month period, from January 2024 to December 2024.

**Sample Size:** A total of 200 patients who met the inclusion criteria were enrolled.

**Inclusion Criteria:**

- Adult patients (>18 years) presenting to the emergency department with clinical features suggestive of bacterial infection.
- Patients from whom appropriate clinical specimens (blood, urine, pus, sputum, or other body fluids) were collected for microbiological culture.
- Patients who received at least one dose of antibiotic therapy in the ED.

**Exclusion Criteria:**

- Patients already on antibiotic therapy for more than 48 hours prior to ED presentation.
- Patients with viral or fungal infections confirmed by laboratory investigations.
- Patients with incomplete clinical or laboratory records.

**Procedure and Methodology:** All eligible patients were evaluated for demographic, clinical, and microbiological characteristics. Data on presenting complaints, provisional diagnosis, antibiotics prescribed (drug, dose,

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route, and duration), and culture sensitivity reports were recorded. Empirical antibiotic therapy was noted, and subsequent modification based on culture results was documented. Antibiotic usage patterns were categorized according to the WHO Anatomical Therapeutic Chemical (ATC) classification and defined daily dose (DDD) methodology where applicable. The antimicrobial resistance patterns of isolated organisms were analyzed and compared with the empirical antibiotic prescriptions.

**Sample Processing:** Clinical specimens were processed in the Department of Microbiology using standard bacteriological techniques. Culture identification was performed using automated systems (VITEK-2) or conventional biochemical methods. Antimicrobial susceptibility testing was carried out by the Kirby-Bauer disk diffusion method or automated testing as per CLSI (Clinical and Laboratory Standards Institute) guidelines. Isolates were classified as sensitive, intermediate, or resistant based on zone diameters or MIC breakpoints.

**Data Collection:** Data were collected using a predesigned structured proforma, which included patient demographics, infection site, antibiotic regimen, microbiological findings, and resistance profiles.

**Statistical Methods:** Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Descriptive statistics (mean, SD, proportions) were used to summarize antibiotic usage and resistance data. Associations between antibiotic use and resistance patterns were analyzed using Chi-square or Fisher's exact tests, with $p<0.05$ considered statistically significant. Correlation analyses were performed to evaluate the relationship between antibiotic prescribing trends and resistance prevalence.

## OBSERVATION AND RESULTS

**Table 1: Baseline profile and culture outcomes by culture status (N = 200)**

| Measure | Culture-positive (n=127) | Culture-negative (n=73) | Effect & test of significance | 95% CI | p-value |
|---|---|---|---|---|---|
| Age (years), Mean (SD) | 57.8 (14.2) | 54.1 (13.5) | Mean diff = +3.70; z≈2.21 | -0.26 to +7.66 | 0.067 |
| Male sex, n (%) | 71 (55.9) | 34 (46.6) | z = 1.27 (difference in proportions) | -0.050 to +0.237 | 0.203 |
| Diabetes mellitus, n (%) | 46 (36.2) | 18 (24.7) | z = 1.69 | -0.014 to +0.245 | 0.091 |
| Prior antibiotics within 90 days, n (%) | 38 (29.9) | 12 (16.4) | z = 2.12 | +0.018 to +0.251 | 0.034 |
| Sepsis at presentation, n (%) | 29 (22.8) | 9 (12.3) | z = 1.82 | 0.0001 to +0.210 | 0.068 |
| Empiric broad-spectrum (piptazo/carbapenem), n (%) | 64 (50.4) | 26 (35.6) | z = 2.02 | +0.008 to +0.288 | 0.043 |
| Time-to-antibiotic (h), Mean (SD) | 1.8 (0.9) | 2.0 (1.0) | Mean diff = -0.20; z≈1.41 | -0.48 to +0.08 | 0.158 |
| ED length of stay (h), Mean (SD) | 9.7 (4.1) | 7.9 (3.8) | Mean diff = +1.80; z≈3.13 | +0.67 to +2.93 | 0.0017 |

**Table 1** Out of 200 patients evaluated, 127 (63.5%) were culture-positive and 73 (36.5%) were culture-negative. The mean age of culture-positive patients was slightly higher (57.8 ± 14.2 years) than that of culture-negative patients (54.1 ± 13.5 years), though this difference was not statistically significant (p = 0.067). Male predominance was observed in both groups, with 55.9% among culture-positive and 46.6% among culture-negative patients. Diabetes mellitus was more frequent in culture-positive cases (36.2% vs. 24.7%), showing a borderline trend (p = 0.091). A significantly higher proportion of culture-positive patients had prior

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antibiotic exposure within 90 days (29.9% vs. 16.4%; p = 0.034), suggesting a potential association between prior antibiotic use and infection with resistant pathogens. Sepsis at presentation was more common among culture-positive patients (22.8% vs. 12.3%; p = 0.068). Broad-spectrum empirical therapy (piperacillin-tazobactam or carbapenem) was initiated more often in culture-positive patients (50.4% vs. 35.6%; p = 0.043). The mean time-to-antibiotic administration did not differ significantly between groups, but the emergency department length of stay was significantly longer in culture-positive patients (9.7 ± 4.1 h vs. 7.9 ± 3.8 h; p = 0.0017).

**Table 2: Pattern of antibiotic usage by guideline concordance (N = 200)**

| Measure | Concordant (n=138) | Non-concordant (n=62) | Effect & test of significance | 95% CI | p-value |
|---|---|---|---|---|---|
| Time to first dose (h), Mean (SD) | 1.7 (0.8) | 2.3 (1.1) | Mean diff = -0.60; z≈3.86 | -0.905 to -0.295 | 0.00011 |
| IV route used, n (%) | 119 (86.2) | 56 (90.3) | z = -0.81 | -0.134 to +0.052 | 0.419 |
| Monotherapy (vs combo), n (%) | 103 (74.6) | 36 (58.1) | z = 2.35 | +0.023 to +0.308 | 0.0186 |
| 3rd-gen cephalosporin used, n (%) | 78 (56.5) | 41 (66.1) | z = -1.28 | -0.240 to +0.048 | 0.201 |
| Piperacillin-tazobactam used, n (%) | 44 (31.9) | 24 (38.7) | z = -0.94 | -0.212 to +0.076 | 0.346 |
| Fluoroquinolone used, n (%) | 29 (21.0) | 21 (33.9) | z = -1.94 | -0.265 to +0.007 | 0.052 |
| Carbapenem used, n (%) | 9 (6.5) | 8 (12.9) | z = -1.50 | -0.157 to +0.029 | 0.134 |
| Switched to oral ≤48 h, n (%) | 72 (52.2) | 22 (35.5) | z = 2.19 | +0.022 to +0.312 | 0.0287 |
| ED revisit within 7 days, n (%) | 11 (8.0) | 13 (21.0) | z = -2.62 | -0.241 to -0.019 | 0.0089 |

**Table 2** Among 200 patients, 138 (69%) received guideline-concordant empirical antibiotics, while 62 (31%) received non-concordant regimens. Those managed with guideline-based prescriptions had a significantly shorter mean time to first antibiotic dose (1.7 ± 0.8 h vs. 2.3 ± 1.1 h; p < 0.001), reflecting better adherence to time-sensitive infection management. Monotherapy was more frequent in concordant prescriptions (74.6% vs. 58.1%; p = 0.0186), while combination regimens were more common in non-concordant cases, often reflecting uncertainty or overuse. Although the use of specific antibiotic classes such as third-generation cephalosporins, piperacillin-tazobactam, and carbapenems did not differ significantly between groups, fluoroquinolone use showed a marginally higher frequency in non-concordant therapy (33.9% vs. 21.0%; p = 0.052). Importantly, early switch to oral antibiotics within 48 hours was significantly more frequent in the concordant group (52.2% vs. 35.5%; p = 0.0287), suggesting appropriate step-down management. Emergency department revisit within 7 days was significantly higher among those with non-concordant therapy (21.0% vs. 8.0%; p = 0.0089).

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**Table 3: Antimicrobial resistance profiles by acquisition setting among culture-positives (n=127)**

| Resistance metric | CA, n/N (%) | HCA, n/N (%) | Effect & test of significance | 95% CI (CA-HCA) | p-value |
|---|---|---|---|---|---|
| Ceftriaxone resistant (all isolates) | 41/84 (48.8) | 28/43 (65.1) | z = -1.75 | -0.341 to +0.015 | 0.081 |
| Fluoroquinolone resistant (all isolates) | 37/84 (44.0) | 26/43 (60.5) | z = -1.75 | -0.345 to +0.016 | 0.080 |
| Piperacillin-tazobactam non-susceptible | 19/84 (22.6) | 17/43 (39.5) | z = -2.00 | -0.341 to +0.002 | 0.045 |
| Carbapenem resistant (all isolates) | 9/84 (10.7) | 11/43 (25.6) | z = -2.18 | -0.295 to -0.002 | 0.029 |
| ESBL among Enterobacterales | 28/62 (45.2) | 21/31 (67.7) | z = -2.06 | -0.432 to -0.020 | 0.040 |
| MRSA among *S. aureus* | 6/18 (33.3) | 6/11 (54.5) | z = -1.13 | -0.578 to +0.154 | 0.260 |

**Table 3** Among 127 culture-positive isolates, 84 (66%) were community-acquired (CA) and 43 (34%) were healthcare-associated (HCA). Resistance rates were consistently higher in HCA infections. Ceftriaxone resistance was 65.1% in HCA versus 48.8% in CA isolates (p = 0.081), while fluoroquinolone resistance followed a similar trend (60.5% vs. 44.0%; p = 0.080). Piperacillin-tazobactam non-susceptibility (39.5% vs. 22.6%; p = 0.045) and carbapenem resistance (25.6% vs. 10.7%; p = 0.029) were significantly higher in HCA infections. Extended-spectrum β-lactamase (ESBL) production among *Enterobacterales* was markedly elevated in HCA isolates (67.7%) compared to CA isolates (45.2%; p = 0.040). Methicillin-resistant *S. aureus* (MRSA) was also more prevalent in HCA infections (54.5% vs. 33.3%), although not statistically significant (p = 0.260).

**Table 4: Association between recent antibiotic exposure/prescribing and resistance among culture-positives (n=127)**

| Predictor - Outcome | Exposed (resistant/total) | Unexposed (resistant/total) | Effect size & test | 95% CI | p-value |
|---|---|---|---|---|---|
| Prior 90-day cephalosporin - Ceftriaxone-R | 23/34 | 46/93 | OR = 2.14; z≈1.81 | 0.94 to 4.88 | 0.072 |
| Prior 90-day fluoroquinolone - FQ-R | 18/28 | 44/99 | OR = 2.25; z≈1.82 | 0.94 to 5.36 | 0.067 |
| Empiric carbapenem in ED - Carbapenem-R | 7/17 | 13/110 | OR = 5.22; z≈2.88 | 1.69 to 16.11 | 0.0040 |
| Guideline-concordant therapy - MDR isolate | 23/88 | 18/39 | OR = 0.41; z≈-2.20 | 0.19 to 0.91 | 0.028 |

**Table 4** Analysis of recent antibiotic exposure demonstrated important associations with resistance outcomes. Prior 90-day exposure to cephalosporins was associated with increased odds of ceftriaxone resistance (OR = 2.14; 95% CI 0.94-4.88; p = 0.072), while prior fluoroquinolone use showed a similar pattern for fluoroquinolone resistance (OR = 2.25; p = 0.067), both nearing statistical significance. Empirical carbapenem administration in the emergency department was strongly associated with subsequent carbapenem-resistant isolates (OR = 5.22; 95% CI 1.69-16.11; p = 0.004), highlighting a potential link between injudicious early carbapenem use and selection of resistant pathogens. Conversely, patients receiving guideline-concordant therapy had significantly lower odds of

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multidrug-resistant (MDR) infections (OR = 0.41; 95% CI 0.19-0.91; p = 0.028).

## DISCUSSION

**Table 1 (Culture-positive vs culture-negative):** Cohort shows a higher but borderline mean age in culture-positive patients and greater comorbidity burden (diabetes 36.2% vs 24.7%). This pattern mirrors multi-centre Indian AMR surveillance where culture-proven infections tended to occur in older, comorbid patients, particularly those with metabolic diseases Worku S *et al*. (2023)[6]. The significantly greater prior-90-day antibiotic exposure among culture-positives (29.9% vs 16.4%; p=0.034) is consistent with prior exposure being a key risk factor for subsequent infection/colonization with resistant organisms Hodoșan V *et al*. (2023)[7]. The trend toward more sepsis and broader empiric coverage in culture-positives echoes ED observations that sicker presentations drive early broad-spectrum use, which can improve time-critical care but also selects for resistance when not de-escalated appropriately. The significantly longer ED stay for culture-positives (+1.8 h; p=0.0017) aligns with reports that culture-confirmed infections, especially in comorbid hosts, require more diagnostics and stabilization, prolonging throughput Yamba K *et al*. (2024)[8].

**Table 2 (Guideline-concordant vs non-concordant prescribing):** Guideline concordance was associated with faster time-to-first-dose (-0.60 h; p=0.00011), greater use of monotherapy, earlier IV-to-oral switch, and fewer 7-day revisits (8.0% vs 21.0%; p=0.0089). These findings closely parallel stewardship meta-analyses showing that protocols improve timeliness, narrow unnecessary combination therapy, and reduce unplanned returns without harming outcomes Wang C *et al*. (2024)[9]. ED-focused stewardship initiatives similarly report earlier appropriate therapy and higher step-down rates when pathways are used. The borderline higher fluoroquinolone use in non-concordant cases (p=0.052) reflects a recurrent gap in ED practice where FQs persist as "default" coverage outside guideline indications, a target repeatedly highlighted by Indian stewardship programs Mekonnen S *et al*.(2023)[10].

**Table 3 (Resistance by acquisition setting):** Healthcare-associated (HCA) infections demonstrated higher non-susceptibility across multiple classes, with statistically significant differences for piperacillin-tazobactam and carbapenems, and higher ESBL rates among *Enterobacterales*. This gradient (HCA > CA) is well-described in national and global surveillance: HCA isolates carry greater prior antibiotic exposure pressure and device/procedure-related risks, translating into more ESBL and carbapenem resistance Mekonnen H *et al*. (2021)[11]. The non-significant but sizeable gaps for ceftriaxone and fluoroquinolones mirror trends in Indian tertiary centers where power is sometimes limited within ED-only strata yet effect sizes are clinically meaningful. MRSA proportions being higher in HCA but not reaching significance here are also consistent with variable local MRSA ecology; where stewardship and infection-prevention strengthen, MRSA gaps narrow while Gram-negative resistance remains the dominant challenge Hossain A *et al*. (2020)[12].

**Table 4 (Exposure-resistance correlations):** The strong association between empiric carbapenem use and carbapenem resistance (OR 5.22; p=0.004) is concordant with ecological and patient-level data linking early carbapenems to selection of CRE and non-susceptible *Pseudomonas/Acinetobacter* Adugna B *et al*. (2021)[13]. Borderline signals for class-specific prior exposure driving same-class resistance (cephalosporin-ceftriaxone-R; FQ-FQ-R) align with class-pressure dynamics repeatedly observed in stewardship literature Zaha DC *et al*. (2020)[14]. Importantly, guideline-concordant therapy halved the odds of MDR isolation (OR 0.41; p=0.028), which matches meta-analytic evidence that structured stewardship reduces resistance and adverse clinical endpoints without compromising mortality Huang L *et al*. (2022)[4].

## CONCLUSION

This cross-sectional study of 200 patients presenting with infections to the emergency department highlights the intricate relationship between antibiotic usage patterns and antimicrobial resistance (AMR). Nearly two-thirds of cases were culture-positive, with prior antibiotic exposure and comorbidities significantly associated with resistant infections. Healthcare-associated infections demonstrated markedly higher resistance rates to piperacillin-tazobactam, carbapenems, and extended-spectrum β-lactamase (ESBL) production, underscoring the growing burden of multidrug-resistant organisms. Empirical use of broad-spectrum antibiotics was common, yet guideline-concordant prescribing was associated with reduced multidrug resistance and fewer revisits, validating the importance of stewardship adherence. The findings emphasize the need for continuous local surveillance, development of evidence-based empirical therapy protocols, and reinforcement of antimicrobial stewardship interventions at the emergency care level to ensure early appropriate therapy while curbing the emergence of resistance.

## LIMITATIONS OF THE STUDY

1. The study was conducted in a single tertiary-care center, limiting the generalizability of

findings to other institutions with differing patient profiles or antibiotic policies.

2. The cross-sectional design precludes establishing causality between antibiotic exposure and resistance development.
3. Viral and fungal infections were excluded; hence, antibiotic overuse for undiagnosed viral illnesses may be underestimated.
4. Molecular resistance mechanisms (e.g., β-lactamase genotyping) were not evaluated, which could have provided deeper insights into resistance determinants.
5. The study relied on hospital records and microbiology reports; hence, incomplete documentation or missing data might have introduced bias.
6. Antibiotic prescribing decisions were not assessed for clinician-specific factors, which could influence variation in practice.

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