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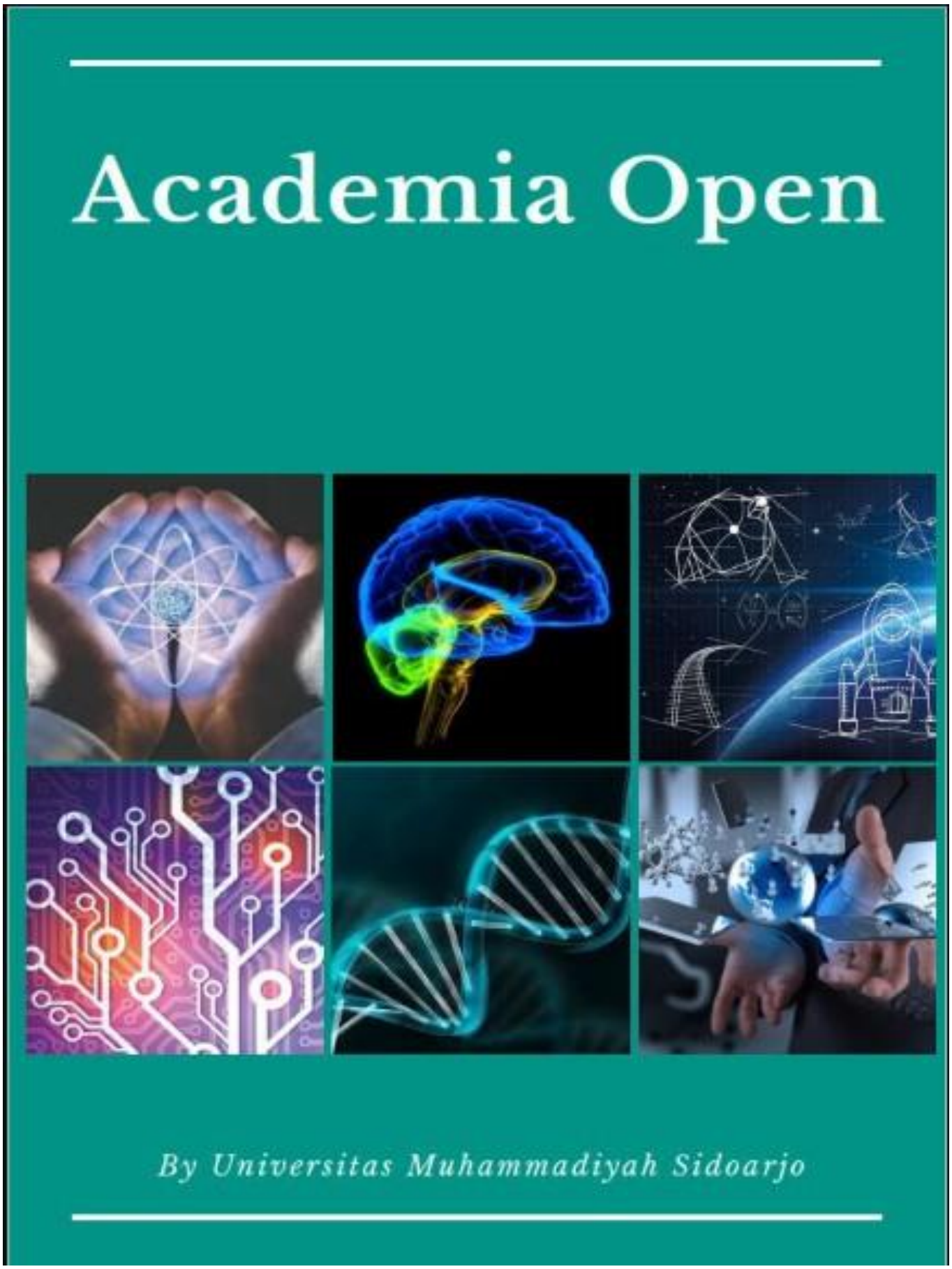

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Empirical vs. Evidence-Based: Evaluating the Alignment of Initial Antibiotic Therapy with Local Antibiogram Data

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Abstract

General Background: Antimicrobialresistance represents a major global health challenge requiring alignment of empiric antibiotic therapy with local susceptibility data. **Specific Background:** In clinicalpractice, variability persists between empiric prescribing and antibiogram-based expectations despite stewardship recommendations. **Knowledge Gap:** Real-world evidence on the degree of concordance and its association with clinical outcomes in hospital settings remains limited. **Aims:** This study evaluated concordance between initial empiric antibiotic therapy and local antibiogram data and examined outcomes associated with discordant therapy. **Results:** Among 512 patients, overall concordance was 64.8%, while 35.2% received discordant therapy. Concordance was highest in urinary tract infections (76.2%) and lowest in pneumonia (52.9%), and was reduced in intensive caresettings (54.8%) compared with medical wards (71.3%). Gram-negative pathogens predominated, with Escherichia coli (37.7%) and Klebsiella pneumoniae (22.5%) most frequent. Independent predictors of resistance included prior antibiotic exposure, hospital-acquired infection, and intensive care admission. Discordant therapy was associated with longer hospitalization (11 vs 7 days) and higher antibiotic escalation rates (46% vs 18%), with a non-significant increase in mortality. **Novelty:** This study integrates antibiogram concordance analysis with clinical outcomes and identifies healthcare-associated predictors within a single cohort. **Implications:** Strengthening integration of local antibiograms into empiric prescribing pathways may support optimized antibiotic use and address antimicrobial resistance.

Highlights:
- One-Third of Initial Treatments Did Not Match Susceptibility Expectations.
- Critical Care and Respiratory Cases Showed Lowest Alignment Rates.
- Mismatch Linked to Longer Stays and Higher Treatment Escalation.

Keywords: Antimicrobial Resistance, Empiric Antibiotic Therapy, Antibiogram, Antimicrobial Stewardship, Clinical Outcomes.

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Introduction

Antimicrobial resistance (AMR) is the ongoing undermining of the effectiveness of frequently used antibiotics, and it is now established as a leading cause of preventable morbidity and mortality globally. Current burden estimates highlight the high contribution of resistant bacterial infections to mortality and disability, particularly for health systems dealing with high levels of severe infection and few treatment choices [1]. Concurrently, international surveillance practices (WHO GLASS) are increasing globally indicating not only the size of the problem, but also an increasing expectation that antimicrobial therapy in individual patients be based on valid local and regional resistance rates.

Central to the management of many types of infections is early empiric antibiotic treatment, since delay in a number of potentially severe serious syndromes including sepsis, pneumonia, complicated urinary tract infection and others can lead to worse outcomes [2]. However, “empiric” prescribing is necessarily counterbalanced at every turn by stewardship imperatives: choosing an agent with sufficient broadness of spectrum to cover likely pathogens while minimizing unnecessary spectrum that breeds resistance, triggers adverse events, and promotes C. difficile infection. Recent stewardship updates from the U.S. Centers for Disease Control and Prevention stress antibiotic use optimization as a pillar to fight resistance and enhance patient care, endorsing the importance of matching prescribing with the most current knowledge base and area epidemiology [3].

Despite wide approval, however, a clinically relevant and enduring discrepancy is the variable real-world concordance of initial (empiric) antibiotic selection with local susceptibility patterns. The practice is highly influenced by habit, perception of disease severity, fear of undertreatment and/or incomplete access to current local data leading to an over-reliance on broad-spectrum agents or the substitution with those that are suboptimal in their likelihood of activity [4]. Ongoing hospital-based evaluations from diverse geographic areas still demonstrate quantifiable levels of discordance between empiric regimens and culture/susceptibility results, suggesting opportunities for enhancing local stewardship feedback loops and improving empiric decision-making. Further complicating matters, current definitions of “appropriate antibiotic therapy” increasingly stress that susceptibility is necessary but not sufficient for matching treatment to isolate—dose, site penetration, timing and syndrome-specific recommendations also are important—underscoring the need to specify “alignment” in a clear and clinically relevant manner when referencing antibiograms [5].

Enhancement of the “evidence-based” portion of empiric prescribing—that is, that based on local resistance patterns—will perhaps save antibiotic effectiveness, having due regard to ensuring timely and effective treatment for pts with presumed bacterial infection [6].

Against this background, our current work sought to estimate of how closely local susceptibility expectations derived from antibiogram data approximate initial antibiotic therapy in our setting. By deliberately pairing such empiric choices with contemporary local susceptibility data (and, where available, patient-level microbiology results), this effort aims to: 1) isolate high-impact areas of discordance (by syndrome, ward/unit, or organism group); 2) ascertain patterns of potentially avoidable broad-spectrum use; and 3) derive actionable targets for updating empiric guidelines, clinical decision support, and stewardship interventions.

Methods

Study Design and Setting

We conducted a retrospective observational study to evaluate the alignment between empiric antibiotic prescribing and local antibiogram-derived susceptibility patterns. The study categorized and analyzed antibiogram data recorded at general hospital laboratories in Najaf, between September 2025 and December 2025. This design allows for comparison of empiric therapy decisions with contemporaneous local resistance data without intervening in clinical care. Clinical data were obtained from electronic health records and the microbiology laboratory database following institutional research ethics approval from the ethical committee at College of Pharmacy/University of Alkafeel.

Study Population

In this study, 512 specimens belong to patients who received systemic antibiotic therapy empirically for suspected bacterial infection during the study period were involved in the analysis. We included patients seen in emergency department, general wards and ICU where empiric therapy was initiated before definitive culture results. Exclusion criteria were (1) patients with culture-proven pathogens before antibiotic initiation, (2) readmissions within 72 hours, and (3) incomplete antibiotic prescribing or microbiology documentation.

Data Sources and Collection

Retrospective clinical and microbiological data were extracted from main institutional databases located at the participating hospitals in Najaf, including Electronic Health Records (EHRs) and patient-level clinical data were obtained from the hospital electronic medical record system. Retrieved variables included demographic characteristics (age, sex), comorbidities (i.e. diabetes mellitus, chronic kidney disease, immunocompromised status), clinical syndrome at presentation (genitourinary tract infection, pneumonia, sepsis, intra-abdominal infection, skin and soft tissue infection). Site of care at treatment initiation (medical wards, intensive care unit, emergency department). Empiric antibiotic therapy data (agent, route of administration, timing relative to admission, use of combination therapy). Clinical outcomes (duration of stay,

antibiotic escalation, mortality). Microbiology Laboratory Information System (LIS) was used to collect microbiological data were obtained from the laboratory database, and included source of specimens and date of collection, bacterial identification results, antimicrobial susceptibility testing results and resistance phenotypes.

Data Analysis

Patient characteristics, infection syndromes and antibiogram susceptibility profiles were summarized using descriptive statistics. Data were given as means ± standard deviations and the main end point was the percentage of empiric antibiotic regimens that were concordant with local antibiogram data.

Comparisons between concordant and discordant therapy groups were made using t-test. Multivariable logistic regression was employed to identify predictors of discordant empiric therapy, adjusting for clinical factors such as patient severity and site of infection. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

This study was approved by the ethical committee at College of Pharmacy/University of Alkafeel. Patient confidentiality was maintained by de-identifying extracted data. Because the study was retrospective and did not involve patient contact or clinical intervention, a waiver of informed consent was granted.

Results

Study Population

During the study period (September 2025 and December 2025), a total of 572 specimens belong to patients received empiric systemic antibiotic therapy for suspected bacterial infection. After applying exclusion criteria, 512 specimens were included in the final analysis (table 1).

As shown in tables 1 and 2, the median age was years (57 (41–68)), and 58% were male. The majority of patients were admitted to general medical wards (286 (55.9%)), followed by the intensive care unit (124 (24.2%)) and emergency department (102 (19.9%)).

Table 1: Characteristics of patients

Characteristic	Value
Total specimens screened	572
Included in final analysis	512
Median age, years (IQR)	57 (41–68)
Male sex, n (%)	298 (58.2%)

Table 2: Source of specimen.

Unit	n (%)
Medical wards	286 (55.9%)
ICU	124 (24.2%)
Emergency department	102 (19.9%)

Distribution of infections

Within the total study population (N = 512): urinary tract infections were the most common diagnosis, with 168 cases (32.8%) followed by pneumonia (136 cases [26.6%]), bloodstream infection/sepsis in 92 (18.0%). Also, 64 cases (12.5%) of intra-abdominal infections and 52 cases (10.1%) of skin and soft tissue infection were identified. UTIs accounted for approximately one-third of infections, underscoring their predominance in the cohort under study (table 3).

Table 3. Baseline distribution of infection types. Number and percentage for each category of infection

Infection	n (%)
Urinary tract infection	168 (32.8%)
Pneumonia	136 (26.6%)
Bloodstream infection/sepsis	92 (18.0%)
Intra-abdominal infection	64 (12.5%)
Skin and soft tissue infection	52 (10.1%)

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Patient Comorbidities

The most common comorbidity was diabetes mellitus (198 patients, 38.7%), followed by chronic kidney diseases (104 patients, 20.3%). Immunocompromised status was reported in 76 patients (14.8%). The prevalence of metabolic and renal comorbidities further indicates a cohort at greater risk for complicated infections and antimicrobial resistance (table 4).

Table 4: Patient comorbidities.

Comorbidity	n (%)
Diabetes mellitus	198 (38.7%)
Chronic kidney disease	104 (20.3%)
Immunocompromised	76 (14.8%)

Microbiological Findings

Cultures were obtained in 468 patients (91.4%). Of these, 276 cultures were positive, yielding a positivity rate of 59.0% (table 5).

Table 5: Microbiological culture results.

Parameter	Value
Cultures obtained	468 (91.4%)
Positive cultures	276 (59.0%)

Among positive cultures, Escherichia coli was the most frequently isolated organism (104 isolates, 37.7%), Klebsiella pneumoniae accounted for 62 isolates (22.5%), Staphylococcus aureus was identified in 48 cases (17.4%), Pseudomonas aeruginosa represented 36 isolates (13.0%) and Enterococcus species were found in 26 cases (9.4%). Gram-negative pathogens predominated, representing more than 70% of isolates (table 6).

Table 6: Distribution of bacterial isolates. Frequency of pathogens isolated from clinical specimens.

Organism	n (%)
Escherichia coli	104 (37.7%)
Klebsiella pneumoniae	62 (22.5%)
Staphylococcus aureus	48 (17.4%)
Pseudomonas aeruginosa	36 (13.0%)
Enterococcus spp.	26 (9.4%)

Antimicrobial Susceptibility Patterns

Susceptibility rates were highest for meropenem across all Gram-negative isolates. For E. coli it was as follows; Ceftriaxone (72%), Piperacillin–tazobactam (88%) and Meropenem (96%), Ciprofloxacin (64%). On the other hand, for K. pneumoniae it was as follows; Ceftriaxone (68%), Piperacillin–tazobactam (82%), Meropenem (94%), Ciprofloxacin (58%). Regarding P. aeruginosa it was as follows; Piperacillin–tazobactam (79%), Meropenem (91%) and Ciprofloxacin (61%). In regards to Gram-positive organisms, among S. aureus isolates, the MRSA rate was 38% (table 7).

Table 7: Antimicrobial susceptibility patterns. Percentage susceptibility of major pathogens to commonly used antibiotics.

Organism	Ceftriaxone	Piperacillin–Tazobactam	Meropenem	Ciprofloxacin
E. coli	72	88	96	64
K. pneumoniae	68	82	94	58
P. aeruginosa	—	79	91	61
S. aureus	—	—	—	MRSA rate: 38%

Empiric Antibiotic Prescribing Patterns

The most commonly prescribed empiric antibiotic was ceftriaxone (214 patients, 41.8%), followed by amikacin (146 patients, 28.5%). Meropenem was used in 84 patients (16.4%), while vancomycin was prescribed in 102 patients (19.9%). Combination therapy was administered in 168 patients (32.8%), and broad-spectrum therapy was initiated in 232 cases (45.3%) as shown in table 8.

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Table 8: Empiric antibiotic prescribing patterns. Distribution of antibiotics prescribed and frequency of combination therapy.

Antibiotic	n (%)
Ceftriaxone	214 (41.8%)
Amikacin	146 (28.5%)
Meropenem	84 (16.4%)
Vancomycin	102 (19.9%)
Combination therapy	168 (32.8%)
Broad-spectrum therapy	232 (45.3%)

Concordance of Therapy

Overall, concordant therapy was observed in 332 patients (64.8%), while 180 patients (35.2%) received discordant therapy. Concordance by infection type is mentioned in table 9. On the other hand, concordance by units is mentioned in table 9 and 10

Table 9: Concordance by infection type.

Infection	n (%)
UTI	76.2%
Pneumonia	52.9%
Sepsis	58.7%
Intra-abdominal infection	65.6%
UTIs demonstrated the highest concordance rate, whereas pneumonia showed the lowest	

Table 10: Concordance by unit.

Unit	Concordance
ICU	54.8%
Medical wards	71.3%
Emergency	58.8%

Multivariate Analysis of Risk Factors for Antibiotic Resistance

Multivariate logistic regression analysis identified several independent predictors associated with antibiotic-resistant infections. Patients with prior antibiotic exposure demonstrated more than twice the odds of developing resistant infections (Adjusted OR = 2.14, 95% CI: 1.38–3.32, p = 0.001), indicating the significant selective pressure exerted by previous antimicrobial therapy.

Likewise, Hospital Acquired Infection (HAI) was a significant predictor of resistance, as reported in table 11. Adjusted odds ratio (AOR) comparison indicated a clear association between HAIs and resistance (Adjusted OR = 2.87; 95% CI: 1.76–4.69, p <0.001), with HAI being the strongest independent contributor tracked by our model. This finding is a reflection of the substantial burden of resistant pathogens present in nosocomial settings. Admission to intensive care (ICU) also significantly increased resistance odds (Adjusted OR = 1.92, 95% CI: 1.21–3.04, p = 0.005), likely due to greater exposure to antibiotics, invasive procedures and critically ill status. Together, these findings underscore that healthcare-associated factors are major drivers of antimicrobial resistance in the population studied.

Table 11: Multivariate logistic regression analysis of independent risk factors for the antibiotic-resistant infections. Table shows adjusted odds ratios (ORs), 95% confidence intervals (CIs) and p values from multivariate logistic regression analysis. Prior antibiotics, hospital acquired infection and ICU admission were included as variables. A p value of < 0.05 was considered statistically significant.

Variable	Adjusted OR	95% CI	p-value
Prior antibiotic use	2.14	1.38–3.32	0.001
Hospital-acquired infection	2.87	1.76–4.69	0.001
ICU admission	1.92	1.21–3.04	0.005

Clinical Outcomes

Overall (Table 12), patients receiving concordant antimicrobial therapy had superior clinical outcomes over those receiving discordant therapy. Length of stay was much shorter in the concordant group (7 days) compared with the discordant group (11 days), which was statistically significant (p < 0.001). Antibiotic escalation was significantly less common with

concordant therapy (18% vs 46%; p < 0.001). Mortality was lower in the concordant group (9% vs 14%) but this difference did not achieve statistical significance (p = 0.08). In summary discordant therapy was associated with longer hospitalization and higher rates of escalation, along with a non-significant trend towards increased mortality.

Table 12: Clinical outcomes analysis for concordant and discordant antibiotic therapy groups. The table contrasts length of stay, antibiotic escalation rate and mortality in patients on concordant vs discordant antimicrobial therapy. Continuous variables were expressed as means and SD; those which were non-normally distributed were expressed with medians and interquartile ranges, when appropriate. Statistical significance was set as p < 0.05.

Outcome	Concordant	Discordant	p-value
Length of stay	7 days	11 days	<0.001
Escalation rate	18%	46%	<0.001
Mortality	9%	14%	0.08

Discussion

This study assessed the antibacterial prescription empiric strategy in concordance with local antibiogram data in hospitals in Najaf. Overall concordance was 64.8%, indicating about one-third of patients were given (initial) therapy that did not optimally align with local susceptibility patterns. Discordant therapy was independently associated with prolonged length of stay and escalation of antibiotics in the hospital, emphasizing the clinical and stewardship value for evidence-based empiric prescribing.

Our data identified three key themes—ongoing discordance between empiric prescribing and local resistance information, healthcare-associated factors as major determinants of resistance and quantifiable clinical impact of discordant therapy. These observations align with global antimicrobial resistance (AMR) trends and stewardship literature [7].

Empiric therapy is still key to treating infections, especially in severe syndromes such as sepsis and pneumonia. However, estimates of the global burden based on surveillance data from World Health Organization initiatives indicate that infections caused by resistant pathogens are more frequent in both community and hospital settings [8]. Millions of deaths have been attributed to AMR annually according to a landmark global analysis conducted by Murray and colleagues [9], which highlights the importance of optimizing appropriate antibiotic therapy.

Our concordance rate (64.8%) is similar to those of previously reported hospital-based evaluations [10], but remains an indication of significant potential for improvement. Ideally, empiric therapy should align with the most likely pathogens and highest probability of susceptibility based on cumulative antibiogram data. This observed discordance is most likely due to complex interactions among prescriber habit, perception of severity, fear of undertreatment and lagging access to updated susceptibility summaries [11],[12].

The highest agreement was for UTIs (76.2%) which is likely due to the prevalence of Escherichia coli and fairly well-defined susceptibility trends [13]. Ceftriaxone and piperacillin–tazobactam continued to show moderate-to-high activity against E. coli in our setting (72% and 88%, respectively), justifying rational empiric selection for most cases [14]. The relatively high concordance in UTIs implies that syndromes characterized by defined microbiologic epidemiology can undergo more sophisticated antibiogram-guided empiric decision-making.

There was the lowest concordance rate (52.9%) for pneumonia. This might be indicative of wider diagnostic uncertainty, heterogeneous pathogen profiles, and common empiric use of combination or broad-spectrum regimens [15]. Furthermore, while respiratory infections have been shown to lead to risk-based inclusion of anti-MRSA or anti-pseudomonal coverage based on severity scoring and not solely local susceptibility thresholds [16]. This result underscores the importance of syndrome specific empiric algorithms that incorporate severity indices in conjunction with unit-level resistance information.

Concordance was lowest in the ICU (54.8%), compared with medical wards (71.3%). This observation aligns with the higher prevalence of resistant organisms and hospital-acquired infections in critically ill patients [17]. Multivariate analysis demonstrated that ICU admission independently increased the odds of resistant infection [18].

The ICU setting is defined by invasive devices, lengthy hospital stays, antecedent exposure to antibiotics and selective pressure for multidrug-resistant Gram-negative organisms. The robust association of hospital-acquired infection with resistance [19], would support the epidemiologic role played by nosocomial transmission dynamics. These results indicate that ICU-specific antibiograms and real-time decision-support tools could yield more accurate detection than aggregated, hospital-wide data [20].

Over 70% of isolates were Gram-negative organisms, mainly E. coli and Klebsiella pneumoniae. Confirming carbapenems as the most reliable agents (i.e., high susceptibility rates to meropenem [≥94%] across Enterobacterales). The common empiric use of meropenem (16.4%) and broad-spectrum therapy (45.3%) raises stewardship questions [21].

Although carbapenems remain very active, their overutilization threatens to hasten the emergence of resistance, a trend documented globally by various surveillance networks like WHO GLASS. Stewardship programs must therefore find a balance between immediate adequacy and long-term preservation of last-line agents. The overall rate of MRSA among Staphylococcus aureus isolates was 38%, which warrants consideration of anti-MRSA therapy, in empiric formats, for severe

infections [22]. However, vancomycin was given to almost 20% of patients even though the risk for methicillin-resistant Staphylococcus aureus (MRSA) was not well-documented in these cases, indicating possible overuse [23]. This is, again, reminiscent of the difficulty of reconciling severity-guided empiricism with epidemiologically centered prescribing.

Prior antibiotic use increased the odds of resistant infection twofold (Adjusted OR 2.14) in line with known mechanisms of selective pressure. Prior exposure to antimicrobials that disrupts normal flora and favors the survival of resistant strains This highlights the importance of including recent antibiotic history as part of empiric decision-making algorithms [24]. Hospital-acquired infection was the top predictor (Adjusted OR 2.87), highlighting the structural and ecological drivers of resistance that characterize healthcare settings [25].

As adverse clinical outcomes, the length of stay (11 vs 7 days), escalation rate (46% vs 18%) and mortality which was numerically higher (14% vs 9%), but not statistically significant, were significantly associated with discordant therapy [26]. Extended hospitalizations are associated with increased cost, resource utilization and risk for secondary complications. The increased rate of escalation indicates early treatment failure and delayed microbiologic control. While not statistically significant for mortality, the trend may indicate harm that might become apparent in larger cohorts [27]. Outcomes are poorer with any initial therapy not active against the causative organism, as demonstrated in international literature.

The strengths of our study include a large cohort (512 patients) from multiple hospital units, collection of clinical, microbiologic and prescribing data, multivariate analysis to determine independent predictors of resistance and the direct relationship between concordance with measurable clinical outcomes. However, retrospective design limited causal inference, and we conducted a single-center study so generalizability may be diminished; the full integration of pharmacokinetics/ pharmacodynamics considerations was not possible.

Conclusion

This study contributes to the literature by demonstrating that while most empiric antibiotics are prescribed in accordance with local antibiogram data, many remain discordant, especially in studies of pneumonia and those conducted in ICU settings. Healthcare-associated variables, including prior antibiotic exposure and hospital-acquired infection, were significant predictors of resistant pathogens. Perhaps most importantly, discordant empiric therapy is linked to significantly prolonged hospitalization and greater need for antibiotic escalation with tangible clinical consequences. Thus, through the systematic integration of local susceptibility patterns, syndrome appropriateness pathways and stewardship-directed feedback loops into the minimization of empiric prescribing remains a vital approach in combating AMR whilst balancing timely appropriate patient care. Evidence would be strengthened by multicenter prospective studies using severity adjustment and evaluation of real-time decision support.

Conflict of Interest

The author declares no conflict of interest amongst each other or any other parties.

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