Original Article

Evaluating the Impact of an Emergency Department-Focused Antibiotic Stewardship Program on Prescribing Practices and Clinical Outcomes

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Abstract

Background: Antimicrobial resistance (AMR) is a growing global health crisis, with inappropriate antibiotic prescribing in acute care settings such as the Emergency Department (ED) contributing significantly to its development. Despite the critical role of EDs in initial infection management, antibiotic stewardship programs (ASPs) have been underutilized in this setting. This study evaluates the impact of an ED-focused antibiotic stewardship program on antibiotic prescribing practices, treatment appropriateness, and clinical outcomes. **Material and Methods:** A prospective, observational study was conducted over 6 months at Venkateshwara Medical College, Pondicherry, involving 100 patients presenting to the ED with suspected infections. The study compared antibiotic prescribing practices before and after the implementation of a multifaceted ASP that included clinician education, real-time decision support, and rapid diagnostic testing. Data on antibiotic prescriptions, appropriateness, clinical outcomes, and costs were collected and analyzed. **Results:** Post-intervention, the overall rate of antibiotic prescriptions in the ED decreased from 85% to 60%. Broad-spectrum antibiotics dropped from 70% to 45%, while narrow-spectrum antibiotics increased from 30% to 55%. The appropriateness of antibiotic prescriptions significantly improved, rising from 50% to 80%. Clinical outcomes, including infection resolution, hospital admission rates, and length of stay, remained unchanged, and no increase in adverse reactions was observed. Notably, the program resulted in an 83.7% reduction in antibiotic-related costs, primarily driven by lower use of high-cost broad-spectrum antibiotics. **Conclusion:** The ED-focused antibiotic stewardship program successfully reduced unnecessary antibiotic prescribing, improved treatment appropriateness, and yielded significant cost savings without negatively affecting patient outcomes. These findings support integrating antibiotic stewardship initiatives in EDs as a critical strategy to combat AMR and optimize patient care.

Keywords: Antibiotic Stewardship, Emergency Department (ED), Antibiotic Prescribing Practices, Antimicrobial Resistance (AMR), Clinical Outcomes, Rational Antibiotic Use, Infection Management, Antibiotic Optimization, Healthcare Quality Improvement.

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Introduction

Antimicrobial resistance (AMR) has become one of the most pressing global health threats of the 21st century, jeopardizing the effectiveness of antibiotics and leading to significant morbidity, mortality, and economic burdens. The World Health Organization (WHO) has identified AMR as a critical issue, warning that without urgent and coordinated action, the world will face a future in which common infections, including respiratory, sepsis, and urinary tract infections, could become untreatable (WHO, 2020). A major contributor to the acceleration of AMR is the overuse and inappropriate prescribing of antibiotics, a practice that occurs not only in hospital settings but also within community healthcare settings. Particularly concerning is the prescription of antibiotics in emergency departments (EDs), where clinicians often face the challenge of diagnosing complex conditions under time pressure, which may lead to the overprescription of broad-spectrum antibiotics.[1-3]

The ED plays a pivotal role in the initial management of infectious diseases, where rapid decision-making is essential, and antibiotics are frequently prescribed. In many cases, antibiotics are administered empirically, even before definitive microbiological data are available. While this is often necessary to prevent complications in critically ill patients, it can also lead to unnecessary or inappropriate antibiotic use. The over-prescription of antibiotics in the ED not only contributes to AMR but also exposes patients to unnecessary drug side effects, increases healthcare costs, and raises the risk of hospital-acquired infections (HAIs). Given these concerns, there is growing recognition of the need to implement targeted interventions in the ED to optimize antibiotic prescribing.[4-6]

Antibiotic stewardship programs (ASPs) have been widely implemented in hospitals worldwide to address the challenges of antibiotic overuse and resistance. These programs focus on ensuring appropriate antibiotic use, including selecting the correct drug, dose, route, and duration of therapy in accordance with evidence-based guidelines. Successful ASPs have been

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shown to improve clinical outcomes, reduce AMR rates, and lead to cost savings by preventing unnecessary drug use and minimizing the incidence of resistant infections. However, while ASPs have been established and proven effective in inpatient hospital wards, their impact in the ED has not been as extensively studied. The ED setting is unique, characterized by its high patient turnover, diverse case mix, and time-sensitive clinical decisions, which may pose barriers to the successful implementation of antibiotic stewardship interventions.[7-9]

In this context, ED-focused antibiotic stewardship programs are gaining attention as a vital strategy to improve antibiotic prescribing practices. Such programs are designed to address the specific challenges ED clinicians face in managing infections under time constraints. These programs emphasize real-time decision support, tailored interventions, and continuous education for ED providers to enhance their knowledge of appropriate antibiotic use. Additionally, they seek to promote the judicious use of antibiotics by incorporating rapid diagnostic tests, which provide timely microbiological data and guide more targeted therapy. The aim is not only to reduce inappropriate antibiotic prescriptions but also to improve patient care by promoting the use of antibiotics that are best suited to the clinical scenario.[10]

While there is growing evidence supporting the implementation of ASPs in the ED, the extent to which these programs can successfully modify prescribing habits and improve patient outcomes remains under investigation. Variability in ED settings, local antibiotic resistance patterns, and differences in institutional resources can affect the success of these programs. Moreover, there is limited data on the long-term impact of such programs on clinical outcomes, such as reductions in AMR or in the incidence of antibiotic-related adverse events.[11]

This study aims to evaluate the effectiveness of an ED-focused antibiotic stewardship program in changing antibiotic prescribing practices and promoting more judicious antibiotic use in the ED. Specifically, this research will examine whether implementing the program reduces unnecessary antibiotic prescriptions, improves adherence to evidence-based guidelines, and improves clinical outcomes for patients presenting to the ED with infections. The findings of this research are expected to contribute valuable insights into the role of antibiotic stewardship programs in the ED, offering evidence on how targeted interventions can help curb the growing threat of AMR and enhance patient care in emergency settings. Additionally, the results may provide a framework for implementing similar programs in other healthcare institutions, ultimately contributing to a more sustainable approach to managing antibiotic use in acute care environments.

As the threat of antimicrobial resistance continues to rise, implementing effective antibiotic stewardship programs in the ED will be critical to mitigating the impact of resistant pathogens. This research will not only provide valuable evidence on the effectiveness of such programs but also highlight the broader implications for hospital policy, patient safety, and public health.

Materials and Methods

Study Design and Setting

This study is a prospective, observational cohort study conducted at the Emergency Department (ED) of Venkateshwara Medical College, Pondicherry. The ED is a high-traffic area that serves a diverse patient population with acute illnesses, including infections. The study was conducted over 6 months, from [start date] to [end date], to evaluate the impact of an antibiotic stewardship program (ASP) on antibiotic prescribing practices in the ED.

Study Population

The study included 100 consecutive patients who presented to the ED with signs and symptoms of infectious disease and required antibiotic treatment. Patients were selected based on the following inclusion and exclusion criteria:

Inclusion Criteria:

- Patients aged 18 years or older.
- Patients presenting to the ED with clinically suspected infections (e.g., respiratory infections, urinary tract infections, sepsis).
- Patients who required antibiotic treatment as part of their initial management.

Exclusion Criteria:

- Patients with non-infectious conditions or diagnoses.
- Patients who were not prescribed antibiotics.
- Patients with a known history of allergy to common antibiotics.
- Pregnant women (due to ethical considerations related to antibiotic use).

A total of 100 patients were enrolled in the study, with informed consent obtained from each participant. Ethical approval for the study was obtained from the Institutional Review Board (IRB) at Venkateshwara Medical College, Pondicherry (reference number: [IRB approval number]).

Antibiotic Stewardship Program Implementation

The antibiotic stewardship program (ASP) was implemented in the ED with the following components:

1. **Educational Interventions:**
- Educational sessions were held for ED clinicians (emergency physicians, residents, and nurses) on the principles of antimicrobial stewardship, focusing on appropriate antibiotic prescribing, empirical antibiotic guidelines, and the role of rapid diagnostic tests.
- Evidence-based guidelines for the treatment of common infectious diseases in the ED were provided, with particular attention to the appropriate use of narrow-spectrum antibiotics.

2. **Decision Support Tools:**
- A computerized decision support system was integrated into the ED's electronic health record (EHR) system. The system provided real-time recommendations for antibiotic therapy based on patient characteristics (e.g., age, comorbidities, and suspected infection type) and local microbiological data.

3. **Antibiotic Review Process:**
- A dedicated antibiotic stewardship team, consisting of an infectious disease specialist, clinical pharmacist, and ED physician, conducted daily reviews of antibiotic prescriptions in the ED. The team provided recommendations for de-

escalation or cessation of antibiotics, when appropriate, based on clinical progress and microbiological results.

4. **Rapid Diagnostic Testing:**

- The use of rapid diagnostic tests (e.g., blood cultures, urinalysis, and PCR testing) was encouraged to facilitate early identification of the causative pathogen and guide more targeted antibiotic therapy.

Data Collection: Data on antibiotic prescriptions were collected before and after the implementation of the ASP. The following variables were recorded for each patient:

- **Demographics:** Age, sex, and comorbidities (e.g., diabetes, hypertension, immunocompromised state).
- **Clinical Presentation:** Symptoms on presentation (fever, cough, dysuria, etc.), suspected infection site (respiratory, urinary, gastrointestinal, etc.).
- **Antibiotic Therapy:** Type of antibiotics prescribed, including empiric therapy and any adjustments based on culture results or clinical response.
- **Antibiotic Appropriateness:** Assessment of whether the antibiotic prescribed was appropriate according to evidence-based guidelines, considering factors such as pathogen susceptibility and local resistance patterns.
- **Outcomes:** Clinical outcomes such as infection resolution, length of ED stay, need for hospital admission, and adverse effects of antibiotic therapy.

Data were collected by reviewing anonymized patients' medical records.

Statistical Analysis: Descriptive statistics were used to summarize patient demographics and clinical characteristics. The primary outcome of the study was the change in the rate of inappropriate antibiotic prescriptions before and after the implementation of the ASP. A secondary outcome was the assessment of patient outcomes, including clinical resolution of infection and length of hospital stay.

Paired t-tests or chi-square tests (depending on the data type) were used to compare pre- and post-ASP antibiotic prescribing practices. A p-value of <0.05 was considered statistically significant. Data analysis was performed using SPSS statistical software.

Ethical Considerations: The study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Informed consent was obtained from all participants, and patient confidentiality was maintained by anonymizing all personal and medical information. The study was approved by the Institutional Review Board (IRB) at Venkateshwara Medical College, Pondicherry.

Results

Patient Demographics: A total of 100 patients were included in this study, comprising 60 males (60%) and 40 females (40%). The mean age of the patients was 42.5 years (range: 18-85 years). The most common presenting complaints included fever (65%), cough (48%), dysuria (30%), and abdominal pain (25%). The majority of patients had a history of comorbidities such as hypertension (22%), diabetes (18%), and asthma (10%).

Pre-Intervention Antibiotic Prescribing: Before the implementation of the antibiotic stewardship program (ASP), empirical antibiotic prescribing in the ED was high. Of the 100 patients, 85 (85%) received antibiotics empirically based on their clinical presentation, with 70% of prescriptions being broad-spectrum antibiotics, such as ceftriaxone and piperacillin-tazobactam. The appropriateness of these prescriptions was assessed based on the infection type, local resistance patterns, and current guidelines. Only 50% of these prescriptions were deemed appropriate, while the remaining 35% were either overprescribed (e.g., unnecessary broad-spectrum antibiotics for viral infections) or mismatched for the suspected pathogen.

Post-Intervention Antibiotic Prescribing: Following the introduction of the ED-focused antibiotic stewardship program, antibiotic prescribing patterns improved significantly. After 3 months of program implementation, only 60% of patients required empirical antibiotics, resulting in a 25% reduction in overall antibiotic prescribing. Additionally, the proportion of broad-spectrum antibiotic prescriptions dropped to 45%, while narrow-spectrum antibiotics such as amoxicillin and ciprofloxacin increased, reflecting a more appropriate use for the identified infections.

Appropriateness of Antibiotic Prescriptions: The rate of appropriate antibiotic prescriptions significantly improved after the ASP intervention. In the post-intervention group, 80% of antibiotic prescriptions were deemed suitable, a notable increase from the pre-intervention rate of 50%. This improvement can be attributed to several factors, including the availability of rapid diagnostic testing and the real-time support provided by the antibiotic stewardship team, which included a clinical pharmacist and an infectious disease specialist who reviewed prescriptions daily.

Impact of Rapid Diagnostic Testing: The introduction of rapid diagnostic tests, such as urine culture analysis and PCR testing for respiratory pathogens, played a critical role in reducing unnecessary antibiotic use. These tests provided clinicians with timely, pathogen-specific data, leading to a more targeted approach to antibiotic therapy. Rapid diagnostics were used in 30% of cases post-intervention, leading to more precise antibiotic selection and fewer patients receiving broad-spectrum antibiotics for infections that could be treated with narrow-spectrum agents.

Clinical Outcomes and Patient Safety: There was no significant difference in infection resolution between the pre- and post-intervention groups. The overall hospital admission rate remained stable at 20%, and the length of stay in the ED did not change notably, indicating that the reduction in antibiotic prescribing did not negatively impact patient care. Importantly, no significant increase in adverse effects related to antibiotics was reported in the post-intervention group, suggesting that the reduced use of broad-spectrum antibiotics did not compromise patient safety.

Cost Implications: The reduction in the use of broad-spectrum antibiotics was also associated with lower drug costs. Based on the hospital's drug formulary, the cost savings from reducing the use of high-cost antibiotics like piperacillin-tazobactam and meropenem were approximately 15% over the study period. This represents a significant financial saving for the institution without compromising clinical outcomes.

Table 1: Antibiotic Prescribing Rates – Pre- and Post-Intervention

Category	Pre-Intervention (%)	Post-Intervention (%)	Change (%)
Total Prescribed Antibiotics	85%	60%	-25%
Broad-Spectrum Antibiotics	70%	45%	-25%
Narrow-Spectrum Antibiotics	30%	55%	+25%
Antibiotics Prescribed Appropriately	50%	80%	+30%
Antibiotics Prescribed Inappropriately	35%	15%	-20%

Table 2: Clinical Outcomes Comparison (Pre- and Post-Intervention)

Outcome	Pre-Intervention (%)	Post-Intervention (%)	Change (%)
Resolution of Infection	98%	99%	+1%
Hospital Admission Rate	20%	20%	0%
Adverse Reactions to Antibiotics	2%	2%	0%
Length of Stay in ED (≥ 4 hours)	4%	4%	0%
Return Visits for Infection	5%	3%	-2%

Table 3: Antibiotic Cost Savings (Pre- and Post-Intervention)

Antibiotic Type	Cost Pre-Intervention (INR)	Cost Post-Intervention (INR)	Change in Cost (INR)	% Change in Cost
Piperacillin-Tazobactam	1500	0	-1500	-100%
Meropenem	2000	0	-2000	-100%
Ciprofloxacin	100	90	-10	-10%
Amoxicillin	40	35	-5	-12.5%
Ceftriaxone	800	600	-200	-25%
Total Cost Savings	4440	725	-3715	-83.7%

Table 4: Rapid Diagnostic Testing Use and Impact

Rapid Diagnostic Test Type	Pre-Intervention (%)	Post-Intervention (%)	Change (%)
Blood Cultures	25%	40%	+15%
Urinalysis	20%	35%	+15%
PCR Testing (Respiratory Pathogens)	10%	30%	+20%
Pathogen-Directed Antibiotics	35%	60%	+25%

Table 5: Impact of Antibiotic Stewardship on Prescribing Practices (Physician Feedback)

Parameter	Pre-Intervention (%)	Post-Intervention (%)	Change (%)
Physicians Following Guidelines	60%	85%	+25%
Physicians Using Narrow-Spectrum Antibiotics	45%	70%	+25%
Physicians Adopting Stewardship Recommendations	50%	80%	+30%
Physicians' Satisfaction with ASP	45%	75%	+30%

Discussion

Antimicrobial resistance (AMR) is an escalating global health threat, exacerbated by inappropriate antibiotic use in both inpatient and outpatient settings, including the Emergency Department (ED). The ED, as a high-volume acute care setting, is particularly vulnerable to over-prescribing due to time pressures and the need for rapid treatment initiation. Our study aimed to evaluate the effect of an ED-focused antibiotic stewardship program (ASP) on antibiotic prescribing practices, antibiotic appropriateness, clinical outcomes, and cost implications. The results from our study demonstrate significant improvements in antibiotic prescribing practices, consistent with findings from similar studies, while also highlighting challenges that require ongoing attention.

The introduction of the ED-focused ASP led to a notable reduction in the overall rate of antibiotic prescriptions, from 85% pre-intervention to 60% post-intervention. This reduction mirrors findings from multiple studies that have consistently demonstrated that ASPs can reduce unnecessary antibiotic prescribing in the ED (Bellolio et al., 2020; Kaufman et al., 2020). The decrease in antibiotic prescribing, especially broad-spectrum agents, is crucial in the context of AMR, as these antibiotics contribute to resistance by killing a wide range of bacteria, including commensals that help prevent the overgrowth of resistant strains.

Our study showed that the proportion of broad-spectrum antibiotics decreased from 70% to 45% post-intervention, while narrow-spectrum antibiotics increased from 30% to 55%. The shift towards narrow-spectrum antibiotics is essential to reduce selective pressure on resistant pathogens. Several studies, such as that by Foschi et al. (2020), also report similar shifts toward more targeted antibiotic therapies, facilitated by improved diagnostic support and clinical education.

Moreover, our data also show that the appropriateness of antibiotic prescriptions improved significantly, increasing from 50% to 80% post-intervention. This improvement aligns with findings from studies such as those by Stenehjem et al. (2018) and Yadav et al. (2019), which show that ASPs not only reduced unnecessary antibiotic use but also ensured prescriptions were more in line with evidence-based guidelines. This increased appropriateness is likely due to the daily review and real-time feedback provided by the multidisciplinary stewardship team, which included infectious disease specialists and clinical pharmacists.

One of the key concerns in implementing any antibiotic reduction strategy is the potential impact on patient outcomes. In this study,

there was no significant change in clinical outcomes, such as resolution of infection, hospital admission rates, adverse reactions to antibiotics, or length of stay in the ED. These results align with similar studies, which have shown that reducing antibiotic use does not negatively affect patient outcomes. For example, Kaufman et al. (2020) found that, despite a significant reduction in antibiotic prescribing, clinical outcomes, including infection resolution, were unaffected in an ED setting. This is reassuring, as it suggests that careful selection and dose reduction of antibiotics do not compromise treatment efficacy in ED patients.

In our study, the resolution of infection was seen in 99% of cases post-intervention, a slight improvement from 98% pre-intervention. The stability in admission rates (20%) and ED length of stay (4%) further supports the notion that targeted antibiotic prescribing does not adversely affect patient care. These findings are consistent with those of Laude et al. (2020), who reported that more stringent antibiotic stewardship in the ED did not worsen patient outcomes but did reduce unnecessary antibiotic exposure.

Additionally, the absence of any significant increase in adverse reactions to antibiotics post-intervention supports the safety of the ASP. This is consistent with the findings from studies such as Percival et al. (2015), who demonstrated that reducing the use of broad-spectrum antibiotics can decrease the occurrence of drug-related side effects, including gastrointestinal issues and Clostridium difficile infections. Therefore, our findings suggest that optimizing antibiotic use not only helps combat AMR but also improves patient safety by minimizing the risk of adverse drug reactions.

Another significant finding of our study was the substantial cost savings from reduced use of high-cost antibiotics. The cost savings from lowering piperacillin-tazobactam and meropenem prescriptions were significant, resulting in an overall 83.7% reduction in antibiotic-related costs. This is consistent with other studies demonstrating the economic benefits of implementing ASPs in the ED. For example, Bellolio et al. (2020) found that reducing the use of broad-spectrum antibiotics, along with a shift to more cost-effective therapies, resulted in significant cost savings for healthcare institutions.

In our study, the total cost savings were mainly driven by the elimination of high-cost antibiotics such as piperacillin-tazobactam and meropenem, which are commonly used to treat severe infections but are costly. The findings suggest that ASPs can be both clinically and economically beneficial, aligning with the growing recognition that stewardship programs should not only focus on clinical outcomes but also on the judicious use of healthcare resources (Kaufman et al., 2020).

The introduction of rapid diagnostic tests, including blood cultures, urinalysis, and PCR tests for respiratory pathogens, played a key role in improving the appropriateness of antibiotic prescriptions. Our study showed a significant increase in the use of these diagnostic tests, with pathogen-directed therapy increasing from 35% pre-intervention to 60% post-intervention. This shift is consistent with the findings of Stenehjem et al. (2018), who noted that integrating rapid diagnostic testing into ASPs led to a more targeted approach to antibiotic therapy, reducing unnecessary broad-spectrum antibiotic use.

Rapid diagnostic tests help clinicians identify causative pathogens more quickly, allowing therapy to be adjusted to narrower-spectrum antibiotics, which are more likely to be effective against the identified pathogen. This not only ensures that patients receive the most appropriate treatment but also helps minimize the risk of resistance. Our findings align with those of Foschi et al. (2020), who observed that rapid diagnostics in an ED setting led to a significant reduction in broad-spectrum antibiotic use, reinforcing the idea that rapid diagnostics can be an essential tool for the success of an ASP.

Despite the successes observed in our study, several challenges were noted during the implementation of the ASP. The most significant challenge was the time pressure in the ED, which sometimes hindered full adherence to the program's recommendations. Clinicians often had to make quick decisions in high-volume patient environments, which made it difficult to implement stewardship recommendations consistently. This is a common issue highlighted in other studies on ASPs in the ED (Laude et al., 2020), where the fast-paced nature of care can be an obstacle to full program adherence.

Additionally, some resistance to the program was observed among certain ED clinicians, especially those less familiar with the guidelines or those with concerns about potential delays in starting treatment. This aligns with the findings of Bellolio et al. (2020), who reported that educational initiatives and regular feedback were essential for overcoming resistance and ensuring adherence to stewardship guidelines.

Conclusion

In conclusion, this study demonstrates that an ED-focused antibiotic stewardship program can significantly reduce inappropriate antibiotic use, improve prescribing appropriateness, and lead to substantial cost savings without negatively affecting patient outcomes. These findings are consistent with a growing body of literature that highlights the effectiveness of ASPs in the ED setting. However, challenges such as time pressures and clinician resistance underscore the need for continuous education and support to sustain these programs. The integration of rapid diagnostic testing was also a key factor in improving the appropriateness of antibiotic prescriptions and should be considered a critical component of future stewardship efforts.

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Conflicts of interest

There are no conflicts of interest.

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