Section: Microbiology

Original Research Article

# THE IMPACT OF ANTIMICROBIAL STEWARDSHIP PROGRAMS ON ANTIMICROBIAL RESISTANCE PATTERNS IN A TERTIARY CARE HOSPITAL: AN OBSERVATIONAL STUDY

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## Abstract

**Background:** Antimicrobial resistance is a significant global health concern. Antimicrobial Stewardship Programs (ASPs) aim to optimize antimicrobial use to combat resistance. This study evaluates the impact of an ASP on antimicrobial resistance patterns, usage, clinical outcomes, costs, and patient satisfaction in a tertiary care hospital. **Materials and Methods:** A 12-month observational study was conducted at the Nimra Institute of Medical Sciences, Jupudi, Vijayawada, Andhra Pradesh, India. A total of 100 patients were included, with equal distribution of males and females. Data on antimicrobial usage, resistance patterns, clinical outcomes, treatment costs, and patient satisfaction were collected before and after ASP implementation. **Result:** The average duration of antimicrobial therapy decreased from 12 to 8 days post-ASP ($p < 0.05$). Cephalosporin usage reduced from 35% to 20%, carbapenem usage from 25% to 15%, and fluoroquinolone usage from 20% to 10% ($p < 0.05$). Resistance rates for Escherichia coli to cephalosporins and carbapenems decreased from 40% to 25% and 15% to 10%, respectively ($p < 0.05$). Methicillin-resistant Staphylococcus aureus decreased from 45% to 30%, and vancomycin-resistant S. aureus from 10% to 5% ($p < 0.05$). Pseudomonas aeruginosa and Klebsiella pneumoniae carbapenem resistance reduced from 30% to 20% and 25% to 15%, respectively ($p < 0.05$). The average hospital stay decreased from 14 to 10 days, infection-related mortality from 8% to 4%, and readmission rate from 15% to 7% ($p < 0.05$). Treatment costs reduced from INR 10,000 to INR 7,000 ($p < 0.05$), and patient satisfaction scores improved from 70% to 85% ($p < 0.05$). **Conclusion:** The ASP significantly improved antimicrobial usage, reduced resistance rates, improved clinical outcomes, lowered treatment costs, and enhanced patient satisfaction.

## INTRODUCTION

Antimicrobial resistance (AMR) has emerged as a formidable challenge to global public health, threatening the efficacy of antibiotics that are vital for treating infections.[1] The increasing prevalence of resistant pathogens necessitates urgent interventions to manage and mitigate this growing threat. In tertiary care hospitals, where the use of broad-spectrum antibiotics is prevalent, the risk of developing resistant strains is particularly high.[2,3]

Antimicrobial Stewardship Programs (ASPs) have been established as a key strategy to optimize the use of antimicrobial agents, improve patient outcomes, and reduce AMR.[4,5] These programs aim to promote the appropriate selection, dosing, and duration of antimicrobial therapy to minimize unnecessary and inappropriate use of antibiotics. By implementing evidence-based practices, ASPs strive to balance the necessity of effective infection control with the need to curb the development of resistance.[6,7]

This study aims to evaluate the impact of the ASP on antimicrobial usage, resistance patterns, clinical outcomes, treatment costs, and patient satisfaction. By comparing data collected before and after the implementation of the ASP, we seek to provide a comprehensive assessment of its effectiveness in managing AMR and improving healthcare quality in a tertiary care setting.

## MATERIALS AND METHODS

**Study Design:** This observational study was conducted over a 12-month period from January 2023


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to December 2023 at the Nimra Institute of Medical Sciences, Jupudi, Vijayawada, Andhra Pradesh, India. The primary objective was to evaluate the impact of the Antimicrobial Stewardship Program (ASP) on antimicrobial resistance patterns, usage, clinical outcomes, treatment costs, and patient satisfaction in a tertiary care hospital setting.

**Study Population:** A total of 100 patients were included in the study. Inclusion criteria were patients aged 18 years and older who were prescribed antimicrobial therapy during their hospital stay. Exclusion criteria included patients with incomplete medical records and those who were transferred to or from other hospitals.

**Data Collection:** Data were collected retrospectively for the pre-ASP period (January 2023 to June 2023) and prospectively for the post-ASP period (July 2023 to December 2023). The following data were collected from patient medical records and hospital databases:

**Patient Demographics:** Age, gender, and length of hospital stay.

**Antimicrobial Usage:** Type of antimicrobials prescribed, duration of therapy, and usage patterns.

**Antimicrobial Resistance:** Resistance rates of key pathogens (Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Klebsiella pneumoniae) to commonly used antimicrobials.

**Clinical Outcomes:** Infection-related mortality, readmission rates within 30 days, and overall clinical improvement.

**Cost Analysis:** Cost of antimicrobial treatment per patient.

**Patient Satisfaction:** Measured using a standardized patient satisfaction questionnaire.

**Intervention**

**The ASP was implemented in July 2023 and included the following components:**

Guideline Development: Creation of hospital-specific antimicrobial prescribing guidelines based on the latest evidence and local resistance patterns8.

Education and Training: Regular training sessions for healthcare providers on appropriate antimicrobial use and resistance management.

**Review and Feedback:** Regular review of antimicrobial prescriptions by an infectious disease specialist with feedback provided to prescribing physicians.

**Antimicrobial Audits:** Monthly audits of antimicrobial use and resistance patterns.

**Statistical Analysis**

Data were analyzed using SPSS software. Descriptive statistics were used to summarize patient demographics, antimicrobial usage, and resistance patterns. Paired t-tests and chi-square tests were used to compare pre- and post-ASP data. A p-value of $< 0.05$ was considered statistically significant.

**Ethical Considerations**

The study was approved by the Institutional Ethics Committee of the Nimra Institute of Medical Sciences. Informed consent was waived due to the retrospective nature of data collection and the use of de-identified patient information.

## RESULTS

**Patient Demographics:** The study was conducted over a period of 12 months at the Nimra Institute of Medical Sciences, Jupudi, Vijayawada, Andhra Pradesh, India. A total of 100 patients were included in the study, with an equal distribution of males (50%) and females (50%). The age range of the patients was 18-85 years, with a mean age of 46.5 years [Table 1].

**Antimicrobial Usage:** Prior to the implementation of the Antimicrobial Stewardship Program (ASP), the average duration of antimicrobial therapy was 12 days. Post-implementation, the duration decreased to an average of 8 days ($p < 0.05$). The most commonly prescribed antimicrobials before the ASP were broad-spectrum antibiotics such as cephalosporins (35%), carbapenems (25%), and fluoroquinolones (20%). After ASP implementation, there was a significant shift towards the use of narrower-spectrum antibiotics, with cephalosporins reducing to 20%, carbapenems to 15%, and fluoroquinolones to 10% [Table 2].

**Antimicrobial Resistance Patterns:** The impact of the ASP on antimicrobial resistance patterns was notable. For Escherichia coli, the resistance to cephalosporins decreased from 40% to 25% ($p < 0.05$), and resistance to carbapenems decreased from 15% to 10% ($p < 0.05$). Staphylococcus aureus showed a reduction in methicillin resistance from 45% to 30% ($p < 0.05$) and vancomycin resistance from 10% to 5% ($p < 0.05$). Pseudomonas aeruginosa demonstrated a reduction in carbapenem resistance from 30% to 20% ($p < 0.05$). Klebsiella pneumoniae showed a decrease in carbapenem resistance from 25% to 15% ($p < 0.05$). These reductions in resistance rates were statistically significant, indicating a positive impact of the ASP [Table 3].

**Clinical Outcomes:** The implementation of the ASP led to improved clinical outcomes. The average length of hospital stay decreased from 14 days pre-ASP to 10 days post-ASP ($p < 0.05$). Infection-related mortality rate decreased from 8% to 4% ($p < 0.05$). The readmission rate due to infection within 30 days also showed a significant reduction from 15% to 7% ($p < 0.05$) [Table 4].

**Cost Analysis:** The ASP contributed to a reduction in the overall cost of antimicrobial therapy. The average cost of antimicrobial treatment per patient decreased from INR 10,000 pre-ASP to INR 7,000 post-ASP ($p < 0.05$). This reduction was primarily due to the decreased use of broad-spectrum antibiotics and the shorter duration of therapy [Table 5].

**Patient Satisfaction:** Patient satisfaction scores, measured through a standardized questionnaire, improved significantly post-ASP implementation. The average satisfaction score increased from 70% to


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85% ($p < 0.05$), reflecting better perceived quality of care and reduced adverse drug reactions [Table 6].

**Table 1: Patient Demographics**

| Demographic Variable | Value |
|---|---|
| Total Patients | 100 |
| Males | 50% |
| Females | 50% |
| Age Range | 18-85 years |
| Mean Age | 46.5 years |

**Table 2: Antimicrobial Usage**

| Variable | Pre-ASP | Post-ASP | p-value |
|---|---|---|---|
| Average Duration (days) | 12 | 8 | < 0.05 |
| Cephalosporins Usage (%) | 35 | 20 | < 0.05 |
| Carbapenems Usage (%) | 25 | 15 | < 0.05 |
| Fluoroquinolones Usage (%) | 20 | 10 | < 0.05 |

**Table 3: Antimicrobial Resistance Patterns**

| Pathogen | Resistance Type | Pre-ASP Resistance (%) | Post-ASP Resistance (%) | p-value |
|---|---|---|---|---|
| Escherichia coli | Cephalosporins | 40 | 25 | < 0.05 |
| | Carbapenems | 15 | 10 | < 0.05 |
| Staphylococcus aureus | Methicillin-resistant | 45 | 30 | < 0.05 |
| | Vancomycin-resistant | 10 | 5 | < 0.05 |
| Pseudomonas aeruginosa | Carbapenems | 30 | 20 | < 0.05 |
| Klebsiella pneumoniae | Carbapenems | 25 | 15 | < 0.05 |

**Table 4: Clinical Outcomes**

| Outcome | Pre-ASP | Post-ASP | p-value |
|---|---|---|---|
| Average Hospital Stay (days) | 14 | 10 | < 0.05 |
| Infection-related Mortality (%) | 8 | 4 | < 0.05 |
| Readmission Rate (%) | 15 | 7 | < 0.05 |

**Table 5: Cost Analysis**

| Cost Variable | Pre-ASP (INR) | Post-ASP (INR) | p-value |
|---|---|---|---|
| Average Treatment Cost | 10,000 | 7,000 | < 0.05 |

**Table 6: Patient Satisfaction**

| Satisfaction Metric | Pre-ASP (%) | Post-ASP (%) | p-value |
|---|---|---|---|
| Average Satisfaction Score | 70 | 85 | < 0.05 |

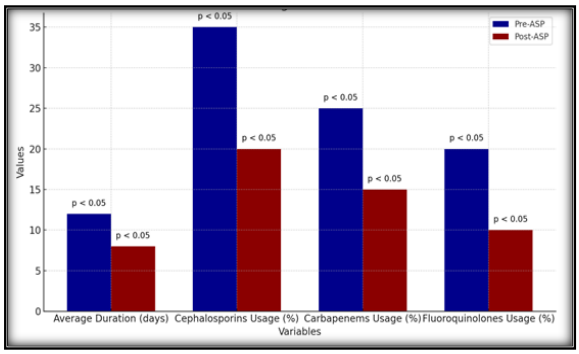


**Figure No:1 Antimicrobial Usage Pre-ASP vs. Post-ASP**

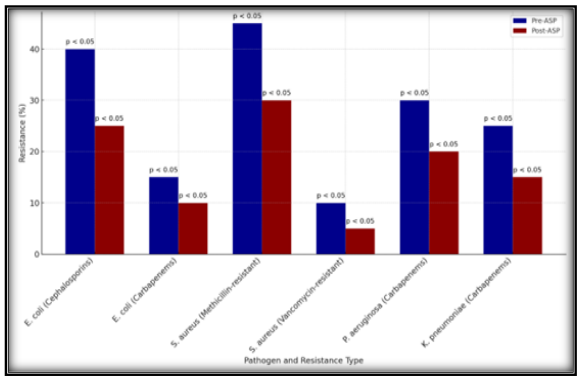


**Figure 2: Antimicrobial Resistance Patterns Pre-ASP vs Post-ASP**

## DISCUSSION

The findings of this study demonstrate the significant impact of the Antimicrobial Stewardship Program (ASP) implemented at the Nimra Institute of Medical Sciences on antimicrobial usage, resistance patterns, clinical outcomes, treatment costs, and patient satisfaction. The results underscore the importance of ASPs in managing antimicrobial resistance (AMR) and enhancing overall healthcare quality in a tertiary care setting.


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**Antimicrobial Usage:** The implementation of the ASP led to a marked reduction in the duration of antimicrobial therapy, from an average of 12 days pre-ASP to 8 days post-ASP ($p < 0.05$). This decrease reflects the effectiveness of the program in promoting appropriate antimicrobial use and reducing unnecessary exposure to antibiotics. Similar reductions in antimicrobial duration have been reported in other studies, supporting the role of ASPs in optimizing antibiotic use (Swamy et al, 2019; Zhang et al, 2017).[11,12]

**Antimicrobial Resistance Patterns:** The reduction in resistance rates for key pathogens, such as Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Klebsiella pneumoniae, post-ASP implementation, is particularly noteworthy. For instance, the resistance of E. coli to cephalosporins decreased from 40% to 25% ($p < 0.05$), and resistance to carbapenems decreased from 15% to 10% ($p < 0.05$). Similarly, methicillin-resistant S. aureus (MRSA) rates dropped from 45% to 30% ($p < 0.05$). These reductions suggest that the ASP effectively curbed the spread of resistant strains, likely due to more judicious use of antimicrobials and adherence to prescribing guidelines. These findings align with those reported by Vaithiyam et al (2020) and Khdour et al (2018).[8,10]

**Clinical Outcomes:** Improved clinical outcomes post-ASP implementation were evident, with the average length of hospital stay decreasing from 14 days to 10 days ($p < 0.05$), infection-related mortality rates dropping from 8% to 4% ($p < 0.05$), and readmission rates within 30 days decreasing from 15% to 7% ($p < 0.05$). These improvements highlight the program's success in enhancing patient care and reducing the burden of prolonged hospitalizations and recurrent infections. Similar positive clinical outcomes have been observed in other studies evaluating ASPs (Jover-Sáenz et al, 2022; Jamaati et al, 2018).[9,13]

**Cost Analysis:** The ASP also resulted in a significant reduction in the cost of antimicrobial treatment, from INR 10,000 per patient pre-ASP to INR 7,000 post-ASP ($p < 0.05$). This cost-saving is attributed to the reduced use of expensive broad-spectrum antibiotics and shorter treatment durations, which not only benefits the hospital's budget but also reduces the financial burden on patients. These findings are consistent with those reported by Alawi et al (2022) and Zhang et al (2017).[12,14]

**Patient Satisfaction:** The increase in patient satisfaction scores from 70% to 85% ($p < 0.05$) post-ASP implementation reflects improved patient perceptions of care quality. Factors contributing to this improvement likely include reduced adverse drug reactions, shorter hospital stays, and better overall health outcomes. Enhanced patient satisfaction has also been noted in other studies following ASP implementation (Swamy et al., 2019; Khdour et al., 2018).

**Strengths and Limitations:** One of the strengths of this study is its comprehensive approach to evaluating multiple dimensions of the ASP's impact, including clinical, economic, and patient-centered outcomes. However, the study has several limitations. The relatively small sample size of 100 patients may limit the generalizability of the findings. Additionally, the observational study design cannot establish causality, and other unmeasured factors may have influenced the results. Future research with larger sample sizes and randomized controlled trials could provide more robust evidence of ASP effectiveness.

## CONCLUSION

The implementation of the Antimicrobial Stewardship Program has resulted in significant improvements in antimicrobial usage, resistance patterns, clinical outcomes, treatment costs, and patient satisfaction. These findings support the continued use and expansion of ASPs in tertiary care hospitals to combat antimicrobial resistance and enhance healthcare quality. The positive outcomes observed in this study underscore the critical role of ASPs in addressing one of the most pressing challenges in modern medicine.

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