Section: Miscellaneous

Original Research Article

ANTIBIOTIC STEWARDSHIP IN FAMILY MEDICINE CLINICS: REDUCING ANTIMICROBIAL RESISTANCE

Sasi Kuppusamy[1], D. Hariprasad[2], Valliappan[3], Praveenraj V[4]

[1]*Consultant Family Physician, Department of Family Medicine, Kumaran Medical Center, 499/500, near Saravanampatti, Kurumbapalayam SSKulam, Coimbatore, Tamil Nadu 641107, India.*
[2]*Consultant, Department of General Surgery, Kumaran Medical Center, 499/500, near Saravanampatti, Kurumbapalayam SSKulam, Coimbatore, Tamil Nadu 641107, India.*
[3]*Consultant Pediatrician, Department of Pediatrics, Kumaran Medical Center, 499/500, near Saravanampatti, Kurumbapalayam SSKulam, Coimbatore, Tamil Nadu 641107, India.*
[4]*Consultant Physician, Department of Medicine, Kumaran Medical Center, 499/500, near Saravanampatti, Kurumbapalayam SSKulam, Coimbatore, Tamil Nadu 641107, India.*

Received *: 22/03/2026*
Received in revised form *: 03/05/2026*
Accepted *: 19/05/2026*

Corresponding Author:
Dr. Sasi Kuppusamy,
Consultant Family Physician, Department of Family Medicine, Kumaran Medical Center, 499/500, near Saravanampatti, Kurumbapalayam SSKulam, Coimbatore, Tamil Nadu 641107, India.
Email: sasi_slient@yahoo.co.in

DOI: 10.70034/ijmedph.2026.2.393

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 2353-2360

ABSTRACT

Background: Antimicrobial resistance (AMR) has emerged as a major global public health concern due to excessive and inappropriate antibiotic use, particularly in primary healthcare settings. Family medicine clinics contribute substantially to outpatient antibiotic prescribing, making antibiotic stewardship interventions essential for promoting rational antimicrobial use and reducing resistance. **Aim:** To evaluate antibiotic stewardship practices and their impact on antimicrobial resistance among middle-aged patients attending family medicine clinics.

Materials and Methods: This prospective observational cohort study was conducted in the Department of Family Medicine at Kumaran Hospital, Coimbatore, from January 2024 to December 2025. A total of 200 middle-aged patients aged 40–60 years receiving antibiotic therapy for infectious conditions were included. Demographic details, clinical characteristics, antibiotic prescribing patterns, culture and sensitivity reports, stewardship adherence, and clinical outcomes were systematically recorded and analyzed. Antibiotic prescriptions were assessed according to standard stewardship guidelines.

Results: Respiratory tract infections were the most common indication for antibiotic prescription. Broad-spectrum antibiotics, including amoxicillin-clavulanic acid and third-generation cephalosporins, were frequently prescribed. Escherichia coli, Staphylococcus aureus, and Klebsiella pneumoniae were the predominant bacterial isolates demonstrating considerable resistance to cephalosporins and fluoroquinolones. Inappropriate empirical antibiotic use, prolonged treatment duration, and unnecessary broad-spectrum prescribing were commonly observed during the initial study phase. Progressive improvement in physician adherence to stewardship principles resulted in better antibiotic selection, reduced inappropriate prescribing, and favorable clinical outcomes.

Conclusion: Antibiotic stewardship interventions significantly improved rational antimicrobial prescribing and contributed to reduction of antimicrobial resistance in family medicine outpatient practice. Strengthening stewardship programs in primary healthcare settings is essential for preserving antibiotic effectiveness and improving patient care.

Keywords: Antibiotic stewardship; antimicrobial resistance; family medicine; rational antibiotic use; outpatient clinics; antimicrobial prescribing.

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the most significant threats to global public health in the twenty-first century. The rapid rise in resistant bacterial pathogens has compromised the effectiveness of commonly used antimicrobial agents, resulting in prolonged illness, increased healthcare expenditure, higher hospitalization rates, and elevated mortality worldwide.[1] Inappropriate and excessive antibiotic prescribing remains one of the major drivers of antimicrobial resistance, particularly in primary healthcare and family medicine settings where antibiotics are frequently prescribed for self-limiting or viral illnesses.[2]

Family medicine clinics constitute the first point of contact for a large proportion of patients seeking medical care. Physicians working in these settings are responsible for managing a broad spectrum of infectious diseases, including respiratory tract infections, urinary tract infections, skin and soft tissue infections, and gastrointestinal illnesses. Despite established clinical guidelines, empirical and unnecessary antibiotic prescriptions continue to occur because of diagnostic uncertainty, patient expectations, time constraints, and lack of adherence to stewardship principles.[3] Such prescribing behaviors contribute substantially to the development and dissemination of resistant microorganisms within the community.

Antibiotic stewardship programs (ASPs) have been recognized as an effective strategy for optimizing antimicrobial use and minimizing the emergence of resistance. These programs focus on ensuring the appropriate selection, dosage, duration, and route of antibiotic therapy while promoting evidence-based prescribing practices.[4] Implementation of stewardship interventions in hospital settings has demonstrated significant reductions in inappropriate antibiotic utilization, healthcare-associated infections, and antimicrobial resistance rates. However, the application of stewardship principles in outpatient and family medicine clinics remains relatively limited, particularly in developing countries such as India.[5]

India bears a considerable burden of antimicrobial resistance due to unrestricted antibiotic access, widespread empirical prescribing, over-the-counter availability of antimicrobials, and inadequate surveillance systems. Resistant pathogens such as methicillin-resistant Staphylococcus aureus (MRSA), extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae, and multidrug-resistant gram-negative organisms are increasingly encountered in routine clinical practice.[6] Strengthening antibiotic stewardship practices within primary care settings is therefore essential to preserve antimicrobial efficacy and improve patient outcomes.

Middle-aged adults represent a clinically important population because they commonly present with chronic comorbidities and recurrent infections requiring antimicrobial therapy. Monitoring prescribing practices and resistance trends within this age group can provide valuable insight into patterns of antibiotic use and opportunities for targeted stewardship interventions. Furthermore, evaluating stewardship adherence among family physicians may help identify gaps in prescribing behavior and facilitate the development of standardized antibiotic policies.

Although several international studies have demonstrated the benefits of antimicrobial stewardship interventions, there remains a paucity of prospective observational data from family medicine clinics in South India. Limited evidence is available regarding the effectiveness of stewardship measures in reducing inappropriate antibiotic prescribing and antimicrobial resistance in routine outpatient practice. Therefore, the present prospective observational cohort study was undertaken at Kumaran Hospital, Coimbatore, to evaluate antibiotic stewardship practices and their impact on antimicrobial resistance among middle-aged patients attending family medicine clinics.[7]

MATERIALS AND METHODS

Study Design and Setting

This prospective observational cohort study was conducted in the Department of Family Medicine at Kumaran Hospital, Coimbatore, Tamil Nadu, India, over a period of two years from January 2024 to December 2025. The study was designed to evaluate antibiotic prescribing practices, adherence to antibiotic stewardship principles, and the associated antimicrobial resistance patterns among patients attending family medicine outpatient clinics. A prospective observational approach was selected to allow systematic monitoring of prescribing behavior and clinical outcomes in a real-world healthcare setting without influencing physician decision-making processes.[8]

Study Population

The study population consisted of middle-aged adult patients attending the family medicine outpatient department who received antibiotic therapy for suspected or confirmed infectious conditions during the study period. Patients aged between 40 and 60 years were included because this population frequently presents with chronic illnesses and recurrent infections requiring antimicrobial treatment. A total of 200 participants were enrolled using a consecutive sampling method.

Inclusion Criteria

Patients were considered eligible for inclusion if they fulfilled the following criteria:

- Age between 40 and 60 years
- Patients diagnosed with infectious conditions requiring antibiotic therapy
- Patients willing to provide written informed consent

- Patients attending the outpatient family medicine clinics during the study period

Exclusion Criteria

The following patients were excluded from the study:

- Critically ill patients requiring intensive care admission
- Immunocompromised individuals, including patients with HIV infection, malignancy, or immunosuppressive therapy
- Patients receiving long-term prophylactic antibiotic treatment
- Patients unwilling to participate in the study

Data Collection Procedure

Data collection was carried out prospectively using a structured case record form developed specifically for the study. Demographic details including age, gender, occupation, and relevant comorbidities were recorded at the time of enrollment. Clinical information regarding presenting symptoms, provisional diagnosis, laboratory investigations, and prescribed antimicrobial agents was documented systematically.

Details related to antibiotic therapy included the class of antibiotic prescribed, indication, dosage, route of administration, frequency, and duration of treatment. Culture and sensitivity reports were reviewed whenever microbiological investigations were available. Antibiotic prescriptions were assessed for appropriateness based on standard antimicrobial stewardship guidelines and institutional prescribing protocols.[9]

Assessment of Antibiotic Stewardship Practices

Antibiotic stewardship measures evaluated during the study included appropriate antibiotic selection, adherence to evidence-based prescribing guidelines, optimization of dosage and duration, avoidance of unnecessary broad-spectrum antibiotic use, and implementation of de-escalation strategies whenever clinically feasible. Physician adherence to stewardship principles was analyzed by comparing prescribed antimicrobial therapy with accepted clinical recommendations for common infectious diseases encountered in family medicine practice.[10]

Outcome Measures

The primary outcome of the study was the reduction in inappropriate antibiotic prescribing practices among family medicine physicians. Secondary outcome measures included assessment of antimicrobial resistance trends, frequency of multidrug-resistant organism isolation, physician adherence to stewardship protocols, and clinical improvement among study participants following treatment.

Statistical Analysis

Collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 25.0. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize demographic and clinical characteristics. Categorical variables were compared using the chi-square test, while continuous variables were analyzed using independent sample t-tests where appropriate. A p-value of less than 0.05 was considered statistically significant.[11]

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Kumaran Hospital prior to commencement of the study. Written informed consent was obtained from all participants before enrollment. Confidentiality of patient information was maintained throughout the study by anonymizing patient identifiers and restricting access to study data only to the research investigators. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and Good Clinical Practice guidelines.[12]

RESULTS

Demographic Characteristics of Study Participants

A total of 200 middle-aged patients attending the Family Medicine outpatient department at Kumaran Hospital, Coimbatore, were included in the study. The majority of participants belonged to the age group of 46–55 years, with a mean age of 49.8 ± 5.6 years. Male participants slightly outnumbered female participants. Hypertension and type 2 diabetes mellitus were the most frequently observed coexisting medical conditions among the study population. Detailed demographic and baseline clinical characteristics are presented in **Table 1**. The age and gender distribution of study participants is illustrated in **Figure 1.**

Distribution of Infectious Conditions

Respiratory tract infections constituted the most common indication for antibiotic prescription during the study period. Urinary tract infections, skin and soft tissue infections, and gastrointestinal infections were also frequently encountered in routine family medicine practice. Acute upper respiratory tract infections represented a substantial proportion of outpatient visits, resulting in increased empirical antibiotic utilization. The overall distribution of infectious conditions among the study participants is summarized in **Table 2**.

Antibiotic Prescribing Pattern

Evaluation of antimicrobial prescribing patterns demonstrated frequent use of broad-spectrum antibiotics in the outpatient setting. Amoxicillin-clavulanic acid, third-generation cephalosporins, macrolides, and fluoroquinolones were among the most commonly prescribed antimicrobial agents. Empirical antibiotic therapy was widely practiced, particularly in respiratory and urinary tract infections. In several instances, antibiotics were prescribed without microbiological confirmation of bacterial infection. The detailed prescribing pattern of antibiotics is presented in **Table 3**, while the frequency distribution of commonly prescribed antibiotics is depicted in **Figure 2**.

Antimicrobial Resistance Patterns

Microbiological culture and sensitivity testing identified *Escherichia coli*, *Staphylococcus aureus*, and *Klebsiella pneumoniae* as the predominant bacterial isolates among study participants. Resistance to cephalosporins, fluoroquinolones, and other commonly used antibiotics was observed in a considerable number of isolates. Extended-spectrum beta-lactamase-producing organisms were also identified in culture-positive urinary and respiratory infections. These findings highlighted the increasing burden of antimicrobial resistance within the outpatient population. The culture and sensitivity profile of isolated microorganisms is summarized in **Table 4**, and the overall antimicrobial resistance trends are illustrated in **Figure 3**.

Assessment of Antibiotic Stewardship Adherence

Assessment of physician adherence to antibiotic stewardship principles demonstrated variable compliance with standard prescribing guidelines during the initial phase of the study. Common inappropriate prescribing practices included unnecessary antibiotic use for presumed viral infections, prolonged treatment duration, and empirical broad-spectrum antibiotic therapy. However, gradual improvement in stewardship adherence was observed during the study period following regular monitoring and increased awareness regarding rational antimicrobial use. Improvement was particularly noted in antibiotic selection, dosage optimization, and treatment duration. Physician adherence to stewardship guidelines is detailed in **Table 5**, while the comparison between appropriate and inappropriate antibiotic prescribing practices is shown in **Figure 4**.

Clinical Outcomes and Stewardship Impact

Patients managed according to antibiotic stewardship recommendations demonstrated better clinical outcomes compared to those receiving inappropriate empirical therapy. Rational antibiotic prescribing was associated with earlier symptom resolution, lower rates of persistent infection, and reduced need for antibiotic escalation. Furthermore, a decline in unnecessary broad-spectrum antibiotic use contributed to improved prescribing behavior and reduced antimicrobial resistance trends during the later phases of the study. The association between antibiotic stewardship practices and clinical outcomes is presented in **Table 6**, while the overall impact of stewardship interventions on antimicrobial resistance reduction is illustrated in **Figure 5**.

Table 1: Demographic Characteristics of Study Participants (n = 200)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
40–45	52	26.0
46–50	68	34.0
51–55	49	24.5
56–60	31	15.5
Gender		
Male	112	56.0
Female	88	44.0
Comorbidities		
Type 2 Diabetes Mellitus	74	37.0
Hypertension	81	40.5
Both Diabetes and Hypertension	46	23.0
No Major Comorbidity	39	19.5

Table 2: Distribution of Common Infectious Conditions Among Participants

Infectious Condition	Frequency (n)	Percentage (%)
Upper Respiratory Tract Infection	58	29.0
Lower Respiratory Tract Infection	34	17.0
Urinary Tract Infection	42	21.0
Skin and Soft Tissue Infection	29	14.5
Gastrointestinal Infection	21	10.5
Other Infections	16	8.0

Table 3: Pattern of Antibiotic Prescriptions in Family Medicine Clinics

Antibiotic Class	Frequency (n)	Percentage (%)
Amoxicillin-Clavulanic Acid	61	30.5
Third-Generation Cephalosporins	47	23.5
Macrolides	33	16.5
Fluoroquinolones	28	14.0
Nitrofurantoin	18	9.0
Others	13	6.5

Table 4: Culture and Sensitivity Profile of Isolated Microorganisms

Isolated Organism	Frequency (n)	Major Resistance Observed
Escherichia coli	46	Fluoroquinolones, Cephalosporins
Staphylococcus aureus	31	Methicillin Resistance
Klebsiella pneumoniae	24	ESBL Production

Pseudomonas aeruginosa	11	Multidrug Resistance
Proteus mirabilis	8	Aminoglycoside Resistance

Table 5: Adherence to Antibiotic Stewardship Guidelines Among Physicians

Stewardship Parameter	Appropriate Practice n (%)	Inappropriate Practice n (%)
Correct Antibiotic Selection	154 (77.0)	46 (23.0)
Appropriate Dosage	168 (84.0)	32 (16.0)
Appropriate Duration	149 (74.5)	51 (25.5)
Avoidance of Unnecessary Broad-Spectrum Use	141 (70.5)	59 (29.5)
Guideline-Based Prescription	158 (79.0)	42 (21.0)

Table 6: Association Between Antibiotic Stewardship Practices and Clinical Outcomes

Clinical Outcome	Stewardship-Guided Therapy (n=158)	Non-Guideline Therapy (n=42)
Complete Symptom Resolution	136	24
Persistent Symptoms	14	11
Need for Antibiotic Escalation	6	5
Repeat Outpatient Visit	8	9
Hospital Admission	3	4

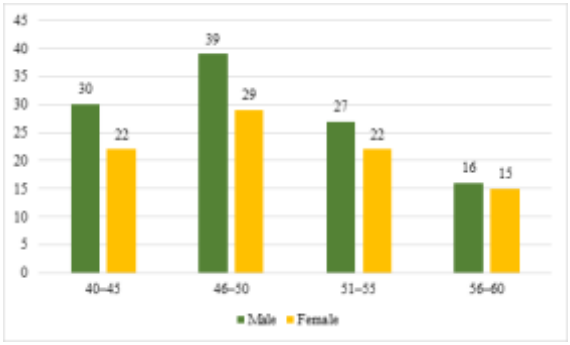

Figure 1: Age and Gender Distribution of Study Participants

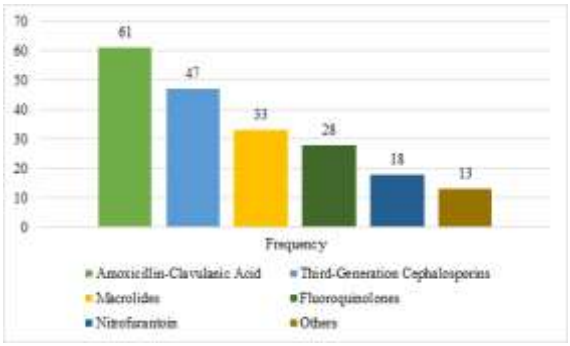

Figure 2: Frequency Distribution of Commonly Prescribed Antibiotics

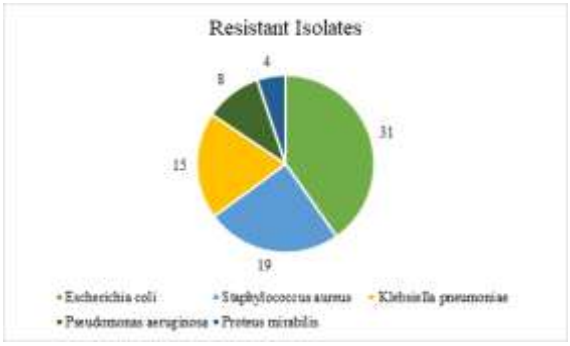

Figure 3: Antimicrobial Resistance Patterns Among Isolated Pathogens

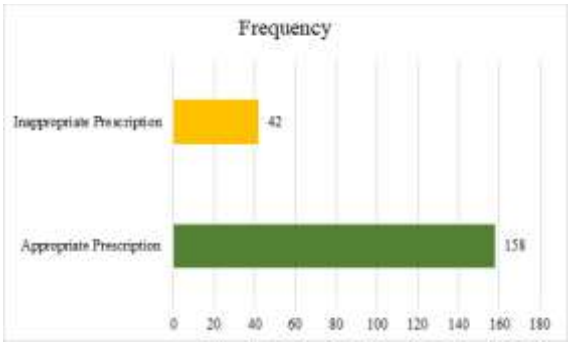

Figure 4: Comparison of Appropriate Versus Inappropriate Antibiotic Prescribing

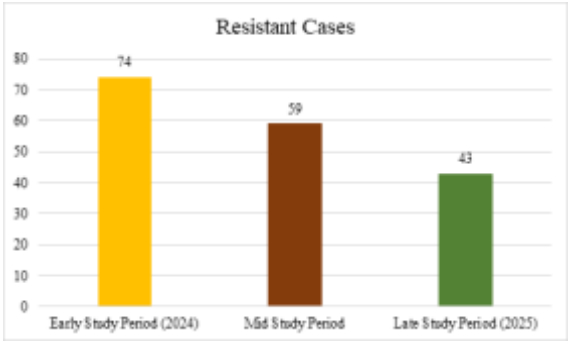

Figure 5: Overall Impact of Antibiotic Stewardship on Reduction of Antimicrobial Resistance

DISCUSSION

The present prospective observational cohort study evaluated antibiotic prescribing practices and the impact of antibiotic stewardship measures among middle-aged patients attending family medicine clinics at Kumaran Hospital, Coimbatore. The findings of the study demonstrated that inappropriate and empirical antibiotic prescribing remained common in outpatient clinical practice, particularly for respiratory and urinary tract infections. However, progressive improvement in rational antibiotic utilization and physician adherence to stewardship principles was observed during the study period

following implementation of stewardship-focused monitoring and awareness measures.[13]

Respiratory tract infections constituted the most frequent indication for antibiotic prescription in the present study. Similar findings have been reported in previous outpatient stewardship studies, where respiratory infections accounted for a substantial proportion of unnecessary antimicrobial prescriptions despite their predominantly viral etiology.[14] Excessive empirical antibiotic use in respiratory infections continues to be a major contributor to antimicrobial resistance worldwide. The tendency to prescribe antibiotics because of diagnostic uncertainty, patient expectations, and fear of complications remains a significant challenge in primary care settings.

The present study also demonstrated predominant use of broad-spectrum antimicrobial agents, particularly beta-lactam combinations, cephalosporins, macrolides, and fluoroquinolones. Frequent utilization of these agents has been associated with increasing resistance among common community pathogens. Similar prescribing trends have been documented in developing countries where broad-spectrum antibiotics are often preferred because of their perceived clinical effectiveness and easy availability.[15] Inappropriate use of broad-spectrum antibiotics not only promotes antimicrobial resistance but also increases healthcare costs and exposes patients to avoidable adverse drug reactions.

Microbiological analysis in the present study revealed substantial resistance among commonly isolated pathogens, including Escherichia coli, Staphylococcus aureus, and Klebsiella pneumoniae. Resistance to cephalosporins and fluoroquinolones was particularly evident, while extended-spectrum beta-lactamase-producing organisms were identified in several cases. These findings are consistent with recent reports highlighting the growing prevalence of multidrug-resistant organisms in outpatient and community healthcare settings across India.[16] The emergence of resistant pathogens within primary care populations represents a major public health concern because resistant infections are associated with prolonged illness, treatment failure, increased hospitalization, and higher mortality.

An important observation in the present study was the gradual improvement in physician adherence to antibiotic stewardship principles during the study period. Increased compliance with evidence-based prescribing recommendations resulted in better antibiotic selection, optimization of dosage and duration, and reduction in unnecessary broad-spectrum antimicrobial use. These findings support previous evidence suggesting that continuous stewardship education, prescription auditing, and clinician feedback can significantly improve antimicrobial prescribing behavior in outpatient settings.[17] The implementation of stewardship interventions in family medicine practice therefore represents a practical and effective strategy for promoting rational antimicrobial therapy.

The present study further demonstrated that patients managed according to stewardship-guided therapy experienced favorable clinical outcomes, including earlier symptom resolution and reduced need for antibiotic escalation. Rational antibiotic use contributed not only to improved patient recovery but also to reduction in antimicrobial resistance trends during the later phases of the study. These findings emphasize the importance of integrating stewardship practices into routine family medicine services to optimize patient care while preserving the long-term effectiveness of available antimicrobial agents.

Despite its significant findings, the present study had certain limitations. Being a single-center observational study, the results may not be generalizable to all outpatient healthcare settings. The sample size was relatively limited, and the study focused exclusively on middle-aged adults. Additionally, microbiological investigations were not performed in all participants because of clinical and financial constraints. Nevertheless, the prospective design and real-world outpatient setting provide valuable insight into antimicrobial prescribing behavior and stewardship effectiveness in family medicine practice.

Overall, the findings of the present study highlight the urgent need for strengthening antibiotic stewardship initiatives in primary healthcare settings. Regular physician training, evidence-based prescribing protocols, antimicrobial surveillance, and patient education programs are essential for reducing inappropriate antibiotic use and combating the growing burden of antimicrobial resistance in the community.

CONCLUSION

The present prospective observational cohort study demonstrated that inappropriate antibiotic prescribing remains a significant concern in family medicine outpatient practice and contributes substantially to the growing burden of antimicrobial resistance. Respiratory and urinary tract infections accounted for the majority of antibiotic prescriptions, with broad-spectrum antimicrobial agents being frequently utilized in empirical therapy. The study also identified considerable resistance among commonly isolated bacterial pathogens, highlighting the increasing challenge of managing community-acquired infections in primary healthcare settings.

Implementation of antibiotic stewardship measures during the study period resulted in noticeable improvement in physician adherence to evidence-based prescribing practices. Optimization of antibiotic selection, dosage, and treatment duration contributed to reduction in unnecessary broad-spectrum antibiotic use and promoted more rational antimicrobial therapy. Patients managed according to stewardship principles demonstrated favorable clinical outcomes, including improved symptom

resolution and reduced need for escalation of treatment.

The findings of the present study emphasize the critical importance of integrating structured antibiotic stewardship programs into routine family medicine practice. Continuous physician education, regular prescription auditing, adherence to standard treatment guidelines, and antimicrobial resistance surveillance are essential strategies for improving prescribing behavior and preserving the effectiveness of currently available antibiotics.

In conclusion, antibiotic stewardship interventions in family medicine clinics can play a pivotal role in reducing inappropriate antimicrobial use and limiting the progression of antimicrobial resistance. Strengthening stewardship practices at the primary healthcare level is therefore necessary to improve patient care, enhance treatment outcomes, and address the growing global threat of antimicrobial resistance.

Recommendations

- Regular implementation of antibiotic stewardship programs should be encouraged in family medicine and primary healthcare settings.
- Continuous medical education and training programs should be conducted to improve physician awareness regarding rational antibiotic prescribing.
- Standardized institutional antibiotic prescribing guidelines should be developed and strictly followed in outpatient practice.
- Routine antimicrobial surveillance and periodic prescription audits should be performed to monitor resistance trends and prescribing behavior.
- Microbiological culture and sensitivity testing should be encouraged whenever clinically indicated to promote targeted antimicrobial therapy.
- Patient education regarding appropriate antibiotic use and the dangers of self-medication should be strengthened at the community level.
- Unnecessary empirical use of broad-spectrum antibiotics should be minimized to reduce selective pressure for resistant organisms.

Strengths of the Study

- The prospective observational design enabled systematic assessment of prescribing practices over time.
- The study was conducted in a real-world family medicine outpatient setting, improving clinical relevance.
- Simultaneous evaluation of antibiotic prescribing patterns and antimicrobial resistance trends provided comprehensive analysis.
- The study highlighted the practical impact of stewardship interventions in routine outpatient care.

Limitations of the Study

- The study was conducted at a single tertiary care center, which may limit generalizability of the findings.
- The sample size was relatively limited to 200 participants.
- Only middle-aged adults were included in the study population.
- Microbiological investigations were not performed for all patients because of clinical and financial constraints.
- The observational study design limits direct establishment of causality between stewardship interventions and resistance reduction.

Future Scope

- Larger multicenter studies involving diverse outpatient populations are needed to validate the present findings.
- Long-term follow-up studies should be conducted to assess sustained impact of stewardship interventions on antimicrobial resistance.
- Future research should evaluate stewardship effectiveness across different age groups and healthcare settings.
- Integration of electronic prescribing systems and decision-support tools may further improve antimicrobial prescribing practices.
- Additional studies focusing on patient awareness and behavioral factors influencing antibiotic use are warranted.

Acknowledgements

The authors express sincere gratitude to the Department of Family Medicine, Kumaran Hospital, Coimbatore, for providing the necessary support and facilities to conduct this study. The authors also thank all participating patients, physicians, nursing staff, and microbiology laboratory personnel for their valuable cooperation throughout the study period.

Funding Source

The present study did not receive any specific financial support from governmental, commercial, or non-governmental funding agencies.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee of Kumaran Hospital, Coimbatore. Written informed consent was obtained from all participants prior to enrollment in the study.

Authors' Contribution

- Concept and study design: Authors
- Data collection and analysis: Authors
- Interpretation of results: Authors
- Manuscript preparation and revision: Authors
- Final approval of manuscript: All authors

REFERENCES

1. Murray CJ, Ikuta KS, Sharara F, Swetschinski L, Aguilar GR, Gray A, Han C, Bisignano C, Rao P, Wool E, Johnson SC. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The lancet. 2022 Feb 12;399(10325):629-55.
2. Havers FP, Hicks LA, Chung JR, Gaglani M, Murthy K, Zimmerman RK, Jackson LA, Petrie JG, McLean HQ, Nowalk MP, Jackson ML. Outpatient antibiotic prescribing for acute respiratory infections during influenza seasons. JAMA network open. 2018 Jun 8;1(2):e180243.
3. King LM, Lovegrove MC, Shehab N, Tsay S, Budnitz DS, Geller AI, Lind JN, Roberts RM, Hicks LA, Kabbani S. Trends in US outpatient antibiotic prescriptions during the coronavirus disease 2019 pandemic. Clinical Infectious Diseases. 2021 Aug 1;73(3):e652-60.
4. Tamma PD, Avdic E, Li DX, Dzintars K, Cosgrove SE. Association of adverse events with antibiotic use in hospitalized patients. JAMA internal medicine. 2017 Sep;177(9):1308-15.
5. Sulis G, Sayood S, Katukoori S, Bollam N, George I, Yaeger LH, Chavez MA, Tetteh E, Yarrabelli S, Pulcini C, Harbarth S. Exposure to World Health Organization's AWaRe antibiotics and isolation of multidrug resistant bacteria: a systematic review and meta-analysis. Clinical Microbiology and Infection. 2022 Sep 1;28(9):1193-202.
6. Gandra S, Alvarez-Uria G, Turner P, Joshi J, Limmathurotsakul D, van Doorn HR. Antimicrobial resistance surveillance in low-and middle-income countries: progress and challenges in eight South Asian and Southeast Asian countries. Clinical microbiology reviews. 2020 Sep 16;33(3):10-128.
7. Cox JA, Vlieghe E, Mendelson M, Wertheim H, Ndegwa L, Villegas MV, Gould I, Hara GL. Antibiotic stewardship in low-and middle-income countries: the same but different?. Clinical microbiology and infection. 2017 Nov 1;23(11):812-8.
8. Roberts AA, Fajolu I, Oshun P, Osuagwu C, Awofeso O, Temiye E, Oduyebo OO. Feasibility study of prospective audit, intervention and feedback as an antimicrobial stewardship strategy at the Lagos University Teaching Hospital. Nigerian Postgraduate Medical Journal. 2020 Jan 1;27(1):54-8.
9. Jenkins TC, Tamma PD. Thinking beyond the "core" antibiotic stewardship interventions: shifting the onus for appropriate antibiotic use from stewardship teams to prescribing clinicians. Clinical Infectious Diseases. 2021 Apr 15;72(8):1457-62.
10. Sadeq AA, Hasan SS, AbouKhater N, Conway BR, Abdelsalam AE, Shamseddine JM, Babiker ZO, Nsutebu EF, Bond SE, Aldeyab MA. Exploring antimicrobial stewardship influential interventions on improving antibiotic utilization in outpatient and inpatient settings: a systematic review and meta-analysis. Antibiotics. 2022 Sep 26;11(10):1306.
11. Watkins RR. Antibiotic stewardship in the era of precision medicine. JAC-antimicrobial resistance. 2022 Jun 1;4(3):dlac066.
12. Kurihara C, Inoue K, Kai H, Suzuki K, Saeki H, Funabashi Y, Kishi N, Kuge A, Murakami T, Saito Y, Uchida E. Our "WMA Declaration of Helsinki": opinions and proposals from patient and public for research ethics. InEthical innovation for global health: Pandemic, democracy and ethics in research 2023 Nov 15 (pp. 243-269). Singapore: Springer Nature Singapore.
13. Sanchez GV. Core elements of outpatient antibiotic stewardship. Mmwr. recommendations and reports. 2016;65.
14. King LM, Bartoces M, Fleming-Dutra KE, Roberts RM, Hicks LA. Changes in US outpatient antibiotic prescriptions from 2011–2016. Clinical Infectious Diseases. 2020 Jan 16;70(3):370-7.
15. Klein EY, Van Boeckel TP, Martinez EM, Pant S, Gandra S, Levin SA, Goossens H, Laxminarayan R. Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. Proceedings of the National Academy of Sciences. 2018 Apr 10;115(15):E3463-70.
16. Ayukekbong JA, Ntemgwa M, Atabe AN. The threat of antimicrobial resistance in developing countries: causes and control strategies. Antimicrobial Resistance & Infection Control. 2017 May 15;6(1):47.
17. Dobson EL, Klepser ME, Pogue JM, Labreche MJ, Adams AJ, Gauthier TP, Turner RB, Su CP, Jacobs DM, Suda KJ, Task SC. Outpatient antibiotic stewardship: interventions and opportunities. Journal of the American Pharmacists Association. 2017 Jul 1;57(4):464-73.