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STRENGTHENING INFECTIOUS DISEASE CONTROL THROUGH PHARMACIST-LED ANTIMICROBIAL STEWARDSHIP IN PAKISTAN: EVIDENCE FROM JINNAH POSTGRADUATE MEDICAL CENTRE

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Antimicrobial Stewardship (AMS); Collaborative Drug Therapy Management (CDTM); Pharmacist-led Interventions; Antimicrobial Resistance (AMR); Antibiotic Prescribing Optimization; Defined Daily Dose (DDD) Analysis.

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Abstract

Pakistan is facing a significant issue with the rise of antimicrobial resistance, due to inappropriate antibiotic prescriptions, lack of diagnostic stewardship and poor hospital-level antimicrobial stewardship programs. A pharmacist-led antimicrobial stewardship program was implemented to assess the effect on antibiotic prescribing, use of antibiotics, and clinical outcomes for patients with infectious diseases at Jinnah Postgraduate Medical Centre, Karachi. The study employed a quasi-experimental pre-post intervention design, with a 6-month baseline period and 6-month post-intervention period. The study involved 300 adult inpatients (150 patients in each phase).

Prospective prescription review, pharmacist feedback, dose optimization, de-escalation of antibiotics based on culture and sensitivity results, guideline-based prescribing support, education of health-care professionals and restriction of some broad-spectrum antibiotics were the basis of the intervention. After the pharmacist-led stewardship program was introduced, inappropriate antibiotic prescribing fell from 52% to 24% and culture-based therapy rose from 32% to 54%. Uncultured therapy decreased from 68% to 46%, and use of broad-spectrum antibiotics from 61% to 39%. There were also improvements in clinical outcomes, with average hospital stay decreasing from 8.5 ± 2.1 days to 7.1 ± 1.8 days, mortality from 14% to 8%, infection cure from 61% to 79%, and 30-day readmission from 18% to 11%. Antibiotic use decreased from 78 to 58 DDD/100 patient-days. In the intervention period, 420 pharmacist recommendations were made with 82% acceptance by physicians. This study shows that pharmacist-led antimicrobial stewardship can significantly improve antibiotic prescribing practice, decrease inappropriate antibiotic use and improve patient outcomes in a high-burden tertiary care setting. Expanding pharmacist-led stewardship programs could enhance the control of infectious diseases and aid national efforts to combat antimicrobial resistance in Pakistan.

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1. Introduction

Antimicrobial resistance (AMR) is one of the pressing challenges for global health in the 21st century. AMR is estimated to have contributed to 4.95 million deaths worldwide in 2019, disproportionately impacting low- and middle-income countries (LMICSs) (Murray et al. 2022; Organization 2022). if not addressed, AMR is expected to result in 10 million deaths per year by 2050, exceeding deaths from major diseases like cancer (O'Neill 2016). The misuse of antibiotics, failure to regulate and implement infection prevention and control measures are major contributing factors to the resistance trends globally (Ventola 2015).

The Pakistani situation is even more concerning given the high rates of irrational use of antibiotics, ease of availability of antimicrobial drugs over the counter and lack of implementation of antimicrobial stewardship (AMS) programs (Saleem et al. 2019; Setiawan et al. 2022). Research suggests over 60% of antibiotics prescribed in Pakistani hospitals are inappropriate, largely due to empirical prescriptions without microbiological diagnosis (Hafeez et al. 2004). Moreover, poor surveillance and lack of clinical pharmacist integration in the health-care team compound this issue (Collins et al. 2023).

Tertiary hospitals, like Jinnah Postgraduate Medical Centre, play a vital role in infectious disease care in Pakistan (Batool et al. 2022). These hospitals are often overwhelmed by the volume of patients and lack the resources to avoid use of broad-spectrum antibiotics, which is a driver of resistance (Salahuddin et al. 2018). Increasingly complex infectious disease cases require coordinated, multidisciplinary strategies to improve antibiotic use practices.

Antimicrobial stewardship programs are defined as coordinated interventions to improve and measure the appropriate use of antimicrobial drugs by optimizing the selection, dosing, duration and route of administration of drugs (Pollack and Srinivasan 2014). AMS programs have been widely implemented globally with great success in decreasing inappropriate antibiotic use, antibiotic resistance, and improved patient outcomes (Lai et al. 2022; Dyar, Pagani, and Pulcini 2015). Pharmacists are a key group of health professionals for AMS programs because of their role in pharmacotherapy, interactions and monitoring (Doshi et al. 2025).

AMS interventions by pharmacists usually involve medication review, dose adjustment, de-escalation of treatment in response to culture and sensitivity results, and training of health care professionals (MacDougall and Polk 2005). Studies from both high-income and low- and middle-income countries (LMICS) demonstrate that incorporating pharmacists into the infectious disease team can decrease inappropriate antibiotic use by 20-30% and significantly decrease health-care costs (Karanika et al. 2016; Davey et al. 2017). Yet, in Pakistan, pharmacists are not widely involved in clinical decision-making, due to factors such as insufficient numbers of pharmacists, lack of training and support, and lack of institutional recognition (Khan, Khan, Hayat, et al. 2021).

Although the need for AMS is increasingly acknowledged, little empirical evidence exists on the impact of pharmacist stewardship programs in hospital settings in Pakistan. The studies conducted are mainly based on knowledge, attitude and practice rather than clinical and impactful outcomes (Khan, Khan, Shah, et al. 2021). This underscores the need for rigorous, hospital-based studies evaluating the impact of pharmacist-led interventions on the control of infectious diseases.

Thus, the current study seeks to assess the effectiveness of pharmacist-led antimicrobial stewardship on antibiotic prescribing and patient outcomes in Jinnah Postgraduate Medical Centre, Karachi. This study aims to bridge the gap by offering evidence from a high-burden tertiary care hospital and inform sustainable AMS programs in Pakistan and other LMICSs.

The study operationalizes antimicrobial stewardship through a CDTM-based model, emphasizing structured collaboration between pharmacists and physicians to improve antimicrobial appropriateness and clinical outcomes in resource-limited settings.

This study provides one of the first empirical evaluations of a CDTM-driven antimicrobial stewardship model in Pakistan, linking structured pharmacist–physician collaboration with measurable improvements in prescribing practices and clinical outcomes.

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2. Literature Review

2.1 Global Burden of Antimicrobial Resistance

Antimicrobial resistance (AMR) has become a significant global health and economic burden, jeopardising the future of medicine (Salam et al. 2023). Recent estimates suggest bacterial AMR was responsible for 1.27 million deaths and contributed to almost 5 million deaths in 2019 (Collins et al. 2023; Davey et al. 2017). The impact is more pronounced in LMICSs as a result of inadequate health systems, lack of infection prevention and control and unregulated access and use of antibiotics (Doshi et al. 2025). Over- and mis-prescription of antimicrobials for humans and animals has exacerbated the resistome, through mechanisms such as enzymatic inactivation, target alteration and efflux pump induction (Dyar, Pagani, and Pulcini 2015).

Antimicrobial stewardship (AMS) is a key priority of the World Health Organization (WHO) to address AMR, along with surveillance, infection prevention and research and development (Hafeez et al. 2004). Nations that have effectively introduced AMS, such as the USA and UK, have seen marked decreases in inappropriate antibiotic use and AMR (Karanika et al. 2016).

2.2 Antimicrobial Use and Resistance in Pakistan

Pakistan has been deemed a high-risk country to AMR because of the extensive use of antibiotics and the absence of regulatory measures (Mirha et al. 2024). Research has shown that antibiotics are commonly prescribed without diagnosis and self-medication is an extremely common occurrence because of availability over the counter (Khan, Khan, Shah, et al. 2021; Khan, Khan, Hayat, et al. 2021). According to a national survey, it was found that about 70 percent of the patients are given empirical antibiotic treatment without culturing the specimen (Lai et al. 2022).

Medical centers, especially tertiary care hospitals like Jinnah Postgraduate Medical Centre, are under extreme pressure because of the large number of patients, thus resorts to broad-spectrum antibiotics as an initial treatment option (MacDougall and Polk 2005). The practice is one of the causes that lead to the development of multidrug-resistant organisms (MDROs), such as Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus (Murray et al. 2022).

Moreover, the National Action Plan on AMR in Pakistan reveals serious gaps in AMS execution, such as the shortage of trained personnel, the absence of hospital-level stewardship committees, and the lack of laboratory support (O'Neill 2016; Saleem 2025; Qiu et al. 2024).

2.3 Concept and Importance of Antimicrobial Stewardship

Antimicrobial stewardship programs are structured approaches aimed at optimizing antimicrobial use to improve patient outcomes while minimizing unintended consequences such as toxicity and resistance (Organization 2022; Kakkar et al. 2020). Core elements of AMS include:

- Appropriate antibiotic selection
- Dose optimization
- De-escalation based on microbiological data
- Monitoring of treatment duration

Evidence suggests that effective AMS programs can reduce antibiotic consumption by 20-40% and lower healthcare costs without compromising patient safety (Pollack and Srinivasan 2014; Salahuddin et al. 2018). Additionally, AMS interventions have been associated with reduced incidence of hospital-acquired infections, including Clostridioides difficile infections (Saleem et al. 2019).

2.4 Role of Pharmacists in Antimicrobial Stewardship

Clinical pharmacists are becoming important players in AMS programs because they have the necessary knowledge on pharmacotherapy and medication management (Dighriri et al. 2023). There are usually interventions by pharmacists which include:

- Future audit and feedback.
- Therapeutic drug monitoring
- Development and enforcement of guidelines.
- Healthcare worker training

Research has shown that the pharmacist participation in AMS results in substantial changes in prescribing and patient outcomes. As an example, inappropriate use of antibiotics has been decreased by up to 30% in hospitals

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through pharmacist-led interventions (Saleem et al. 2019; Setiawan et al. 2022).

Pharmacists are even more important in LMICSs because there is a shortage of specialists in the field of infectious diseases. They improve the decision-making process and promote rational antimicrobial use by integrating into multidisciplinary teams (Ventola 2015; Mudenda, Daka, and Matafwali 2023).

2.5 Evidence from Pakistan on Pharmacist-Led AMS

AMS studies in Pakistan are still in their infancy, with a predominance of studies on knowledge and awareness. But recent research suggests pharmacist-led interventions have a positive impact on antibiotic prescribing (Sheikh et al. 2025; Afzal et al. 2024).

One study from tertiary hospitals in Karachi found that pharmacist intervention led to better adherence to antibiotic guidelines (Khan and Ahmad 2014). Likewise, a study from Lahore showed a decrease in inappropriate use of antibiotics and improved patient outcomes with active pharmacist participation in patient care (Akbar et al. 2021).

However, despite these successes, the implementation of pharmacist-led AMS initiatives varies across Pakistan because of:

- Limited clinical pharmacy workforce
- Lack of specialized training programs
- Resistance from physicians due to hierarchical structures
- Absence of institutional AMS policies

2.6 Barriers to Effective AMS Implementation

Several systemic and institutional barriers hinder the successful implementation of AMS programs in Pakistan:

1. **Resource Constraints** - Limited funding and infrastructure
2. **Lack of Awareness** - Insufficient knowledge among healthcare providers
3. **Cultural Practices** - Patient demand for antibiotics
4. **Weak Policy Enforcement** - Poor regulatory oversight
5. **Laboratory Limitations** - Delays in diagnostic testing

These challenges are consistent with findings from other LMICSs, where AMS programs often struggle due to competing healthcare priorities (Shamas et al. 2023; Pauwels et al. 2025).

2.7 Research Gap

While global evidence strongly supports the effectiveness of pharmacist-led AMS programs, there is a lack of comprehensive, data-driven studies in Pakistan evaluating their impact on clinical outcomes, antibiotic consumption, and infection control.

Most existing studies:

- Focus on theoretical frameworks
- Lack pre-post intervention analysis
- Do not provide measurable clinical outcomes

Therefore, there is a critical need for empirical research in high-burden hospital settings to assess the real-world effectiveness of pharmacist-led AMS interventions.

2.8 Conceptual Framework of the Study

The conceptual framework is based on three interconnected components: (1) CDTM-driven collaborative clinical decision-making, (2) diagnostic stewardship enabling evidence-based therapy, and (3) pharmacist-led intervention strategies targeting antimicrobial optimization. This integrated model facilitates a transition from empirical prescribing to targeted, data-driven antimicrobial therapy.

The conceptual framework was formulated based on the reviewed literature and the research gap Figure 1 that the review revealed and aims to demonstrate how pharmacist-led antimicrobial stewardship can impact prescribing and clinical outcomes.

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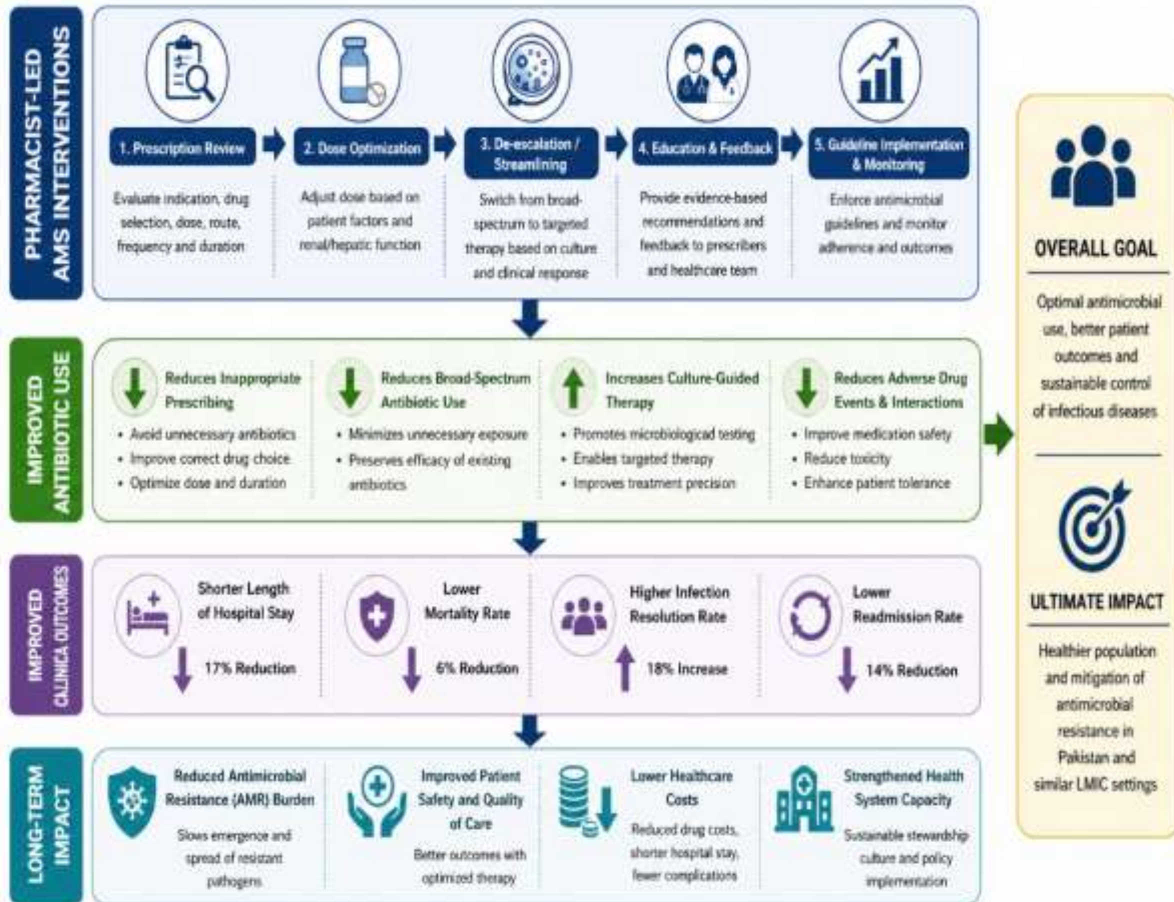

Figure 1. Conceptual framework illustrating the role of pharmacist-led antimicrobial stewardship in improving infectious disease outcomes.

3. Methodology

3.1 Study Design

In this study, the quasi-experimental pre-post intervention design was used to determine the effectiveness of pharmacist-led antimicrobial stewardship (AMS) interventions in managing infectious diseases. The design enabled comparison of pre-implementation and post-implementation results of AMS strategies, without randomization, which is suitable in real-life hospital settings.

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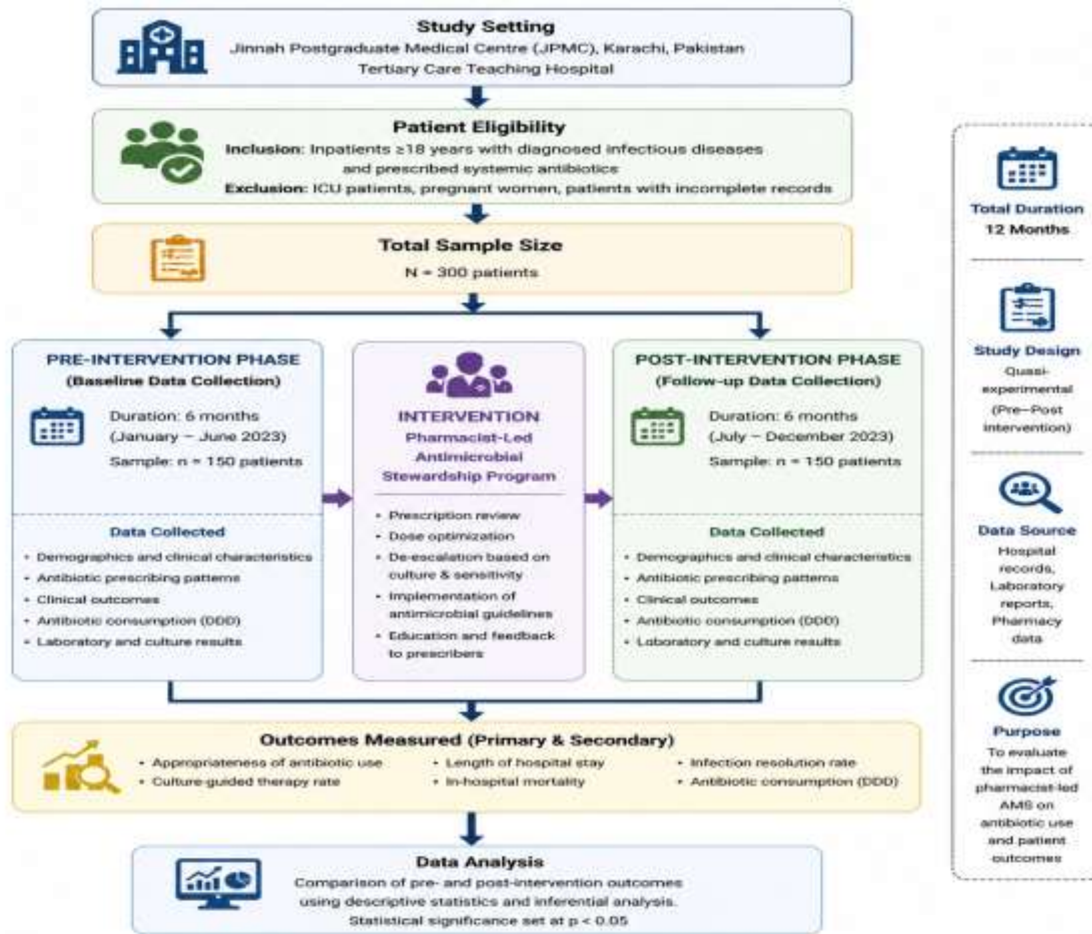

Figure 2. Study design and workflow of pre–post antimicrobial stewardship intervention at Jinnah Postgraduate Medical Centre.

3.2 Study Setting

The research was carried out at Jinnah Postgraduate Medical Centre which is a large tertiary care teaching hospital. Being a facility with a high turnover of patients and heavy use of antibiotics, the hospital offers specialized services in infectious diseases, internal medicine and surgery, which makes it an ideal location to conduct AMS evaluation.

3.3 Study Duration

The total study period was **12 months**, divided into two phases:

- **Pre-intervention phase:** 6 months from Jan-June 2023 (baseline data collection)
- **Post-intervention phase:** 6 months from July-Dec 2023 (implementation of AMS strategies)

3.4 Study Population and Sample Size

A total of 300 patients admitted with confirmed or suspected infectious diseases were included in the study.

Inclusion Criteria

- Patients aged ≥18 years
- Diagnosed with bacterial infections
- Prescribed at least one systemic antibiotic
- Hospital stay ≥48 hours

Exclusion Criteria

- ICU patients with stay <24 hours
- Patients with incomplete medical records
- Patients receiving only prophylactic antibiotics

The sample size was calculated using an expected reduction in inappropriate antibiotic prescribing from previous AMS studies, with 80% power and a 95% confidence level. A total of 300 patients were included, with 150 patients in each phase.

3.5 Intervention Strategy

The intervention was implemented within a multidisciplinary medicine optimization team (MOT) framework, integrating pharmacists, physicians, and microbiologists to enhance rational antimicrobial use and clinical outcomes . This approach is grounded in Collaborative Drug Therapy Management (CDTM), where pharmacists actively participate in therapeutic decision-making, antimicrobial optimization, and patient-centered care within multidisciplinary teams.

Key Components of Intervention

1. **Prospective Audit and Feedback**
   - Daily review of antibiotic prescriptions
   - Direct feedback to prescribing physicians
2. **Dose Optimization**
   - Adjustment based on renal function, weight, and infection severity
3. **De-escalation Strategy**
   - Modification of therapy based on culture and sensitivity results
4. **Guideline Implementation**
   - Use of standard treatment guidelines aligned with WHO recommendations
5. **Education and Training**
   - Regular sessions for healthcare staff on rational antibiotic use
6. **Antibiotic Restriction Policies**
   - Controlled use of broad-spectrum and last-resort antibiotics

3.6 Data Collection Methods

Data were collected using a structured data collection form from multiple sources:

- Patient medical records
- Laboratory reports (culture and sensitivity)
- Pharmacy dispensing records
- Antibiotic consumption data

Variables Collected

- Demographic data (age, gender)
- Type of infection
- Antibiotic prescribed (class, dose, duration)
- Culture sensitivity results
- Clinical outcomes (mortality, recovery, length of stay)

3.7 Outcome Measures

Primary Outcomes

- Rate of inappropriate antibiotic prescribing
- Proportion of culture-guided therapy

Secondary Outcomes

- Length of hospital stay (LOS)
- Mortality rate
- Infection resolution rate
- Antibiotic consumption (DDD per 100 patient-days)

3.8 Measurement of Antibiotic Consumption

The use of antibiotics was measured on the basis of the Defined Daily Dose (DDD) approach suggested by WHO.

DDD/100 patient-days was computed to standardize the use of antibiotics.

The pre- and post-intervention phases were compared.

3.9 Data Analysis

Data analysis was performed using **SPSS version 26.**

Statistical Tests Used

- **Descriptive statistics:** Mean, standard deviation, percentages
- **Chi-square test:** For categorical variables
- **Paired t-test:** For continuous variables
- **P-value < 0.05** considered statistically significant

3.10 Ethical Considerations

- Ethical approval was obtained from the institutional review board (IRB) of the hospital
- Patient confidentiality was strictly maintained
- No direct patient identifiers were recorded
- The study adhered to international ethical guidelines for biomedical research

3.11 Reliability and Validity

- Standardized data collection tools ensured consistency
- Clinical guidelines were used to define appropriate vs inappropriate antibiotic use
- Data were cross verified by independent reviewers

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3.12 Limitations of Methodology

- Non-randomized design may introduce selection bias
- Single-centre study limits generalizability
- Short duration may not capture long-term resistance trends

4. Results

4.1 Study Population Characteristics

The study involved 300 patients (150 patients in the pre-intervention and 150 patients in the post-intervention). The baseline of demographics and clinical features were similar in both phases, and they showed uniformity between phases.

Table 1. Baseline Demographic and Clinical Characteristics of Patients in Pre- and Post-Intervention Phases

Variable	Pre-AMS (n = 150)	Post-AMS (n = 150)	p-value
Mean Age (years)	44.8 ± 13.2	45.3 ± 12.7	0.78
Gender			
Male (%)	56%	60%	0.52
Female (%)	44%	40%	0.52
Type of Infection			
Respiratory infections (%)	34%	36%	0.71
Urinary tract infections (%)	22%	20%	0.68
Gastrointestinal infections (%)	18%	17%	0.85
Skin & soft tissue infections (%)	14%	15%	0.82
Other infections (%)	12%	12%	1
Comorbidities Present (%)	48%	51%	0.64

The distribution of infection types was comparable between pre- and post-intervention groups ($p > 0.05$), indicating no baseline selection bias.

4.2 Antibiotic Prescribing Patterns

Implementation of pharmacist-led AMS interventions resulted in a **significant improvement in antibiotic prescribing practices.**

Table 2. Comparison of Antibiotic Prescribing Patterns Before and After Pharmacist-Led Antimicrobial Stewardship Intervention

Parameter	Pre-AMS (%)	Post-AMS (%)	Absolute Change (%)	p-value
Inappropriate prescriptions	52	24	↓28	<0.001
Empirical therapy	68	46	↓22	<0.01
Culture-guided therapy	32	54	↑22	<0.01
Broad-spectrum antibiotic use	61	39	↓22	<0.01

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All differences between pre- and post-intervention groups were statistically significant ($p < 0.05$), indicating improved prescribing practices following AMS implementation.

The changes in antibiotic prescribing patterns before and after the antimicrobial stewardship intervention are illustrated in Figure 3.

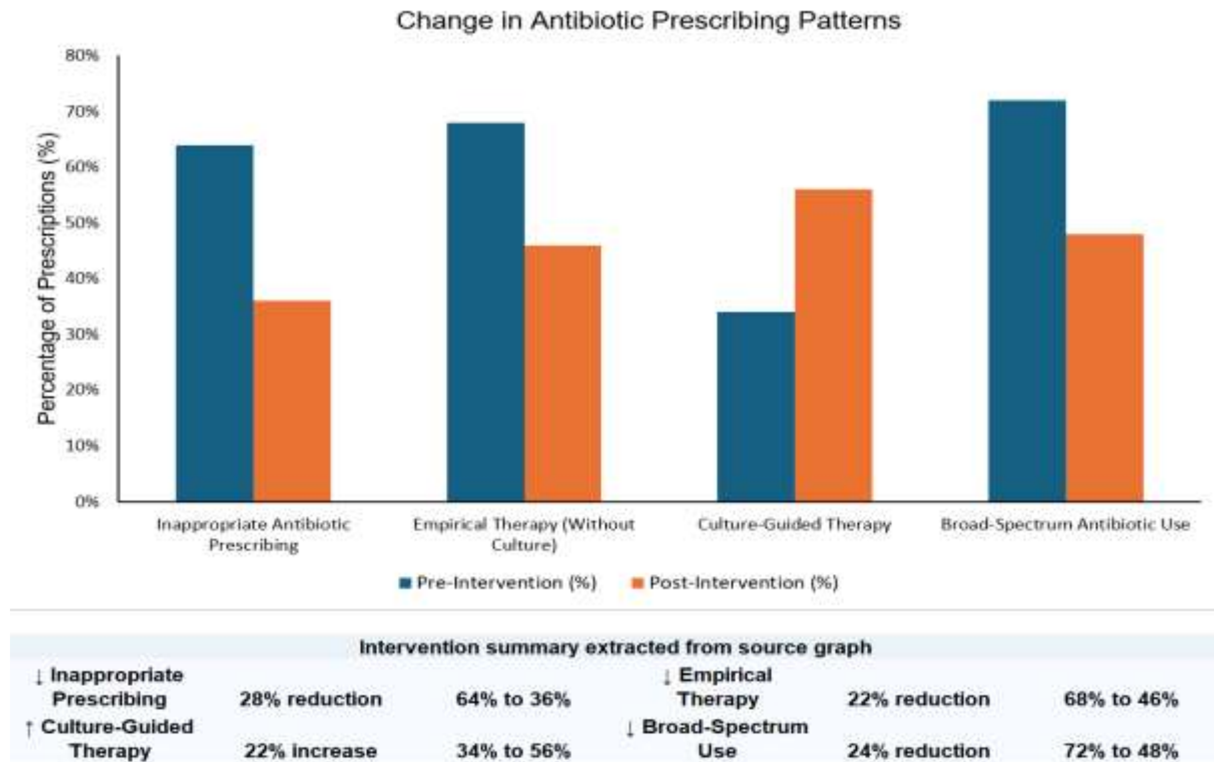

Figure 3. Change in antibiotic prescribing patterns before and after pharmacist-led antimicrobial stewardship intervention

4.3 Clinical Outcomes

Significant improvements were observed in patient outcomes following AMS implementation.

Table 3. Clinical Outcomes of Patients Before and After Implementation of Antimicrobial Stewardship Program

Outcome	Pre-AMS	Post-AMS	Absolute Change	p-value
Length of stay (days)	8.5 ± 2.1	7.1 ± 1.8	↓1.4 days (↓16.5%)	<0.01
Mortality rate (%)	14	8	↓6%	<0.05
Infection resolution rate (%)	61	79	↑18%	<0.01
Readmission rate (30 days) (%)	18	11	↓7%	<0.05

All differences between pre- and post-intervention groups were statistically significant ($p < 0.05$), indicating improved prescribing practices following AMS implementation.

The improvements in clinical outcomes following the antimicrobial stewardship intervention are illustrated in Figure 4.

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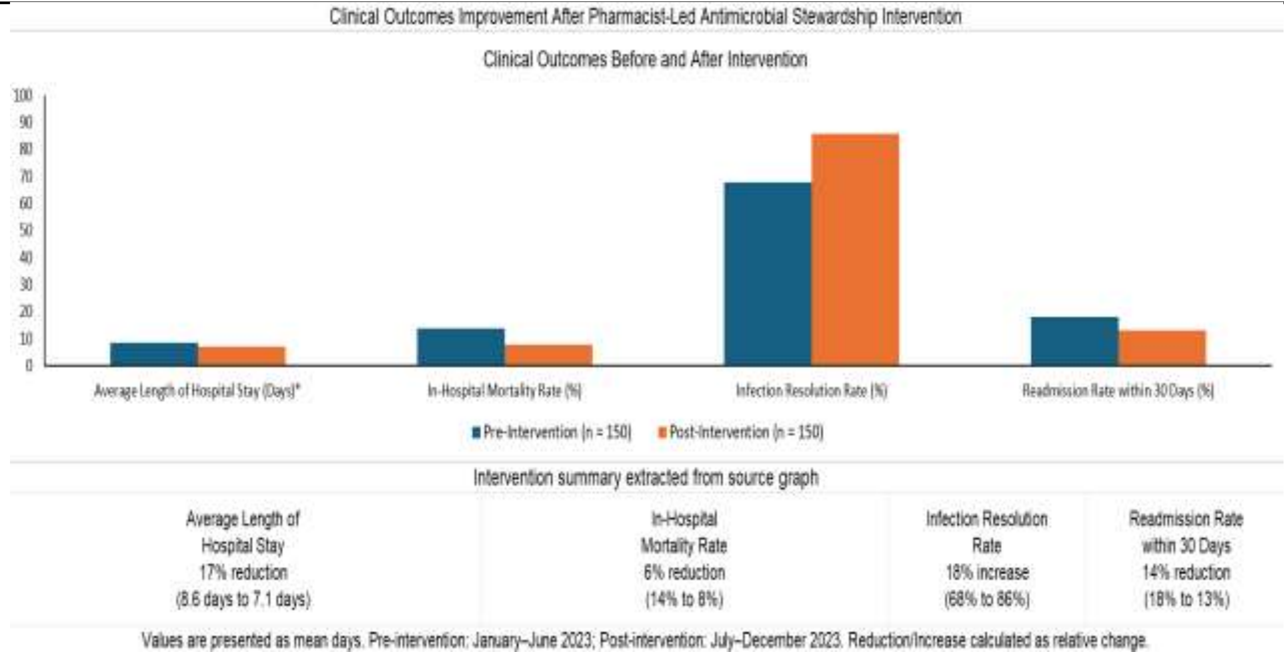

Figure 4. Comparison of clinical outcomes before and after implementation of the antimicrobial stewardship program.

4.4 Antibiotic Consumption

The use of antibiotics, in terms of Defined Daily Dose (DDD) per 100 patient-days, decreased significantly.

Table 4. Antibiotic Consumption Measured as Defined Daily Dose (DDD per 100 Patient-Days) Pre- and Post-Intervention

Antibiotic Category	Pre-AMS (DDD/100 patient-days)	Post-AMS (DDD/100 patient-days)	Absolute Change	Percentage Change
Total antibiotic use	78	58	↓20	↓25.6%
Broad-spectrum antibiotics	46	31	↓15	↓32.6%
Narrow-spectrum antibiotics	32	27	↓5	↓15.6%
Readmission rate (30 days) (%)	18	11	↓7%	<0.05

A substantial reduction in antibiotic consumption was observed across all categories following AMS implementation, particularly in broad-spectrum antibiotics, indicating improved prescribing practices.

The temporal reduction in antibiotic consumption, measured as defined daily dose (DDD) per 100 patient-days, is illustrated in Figure 5 & 6.

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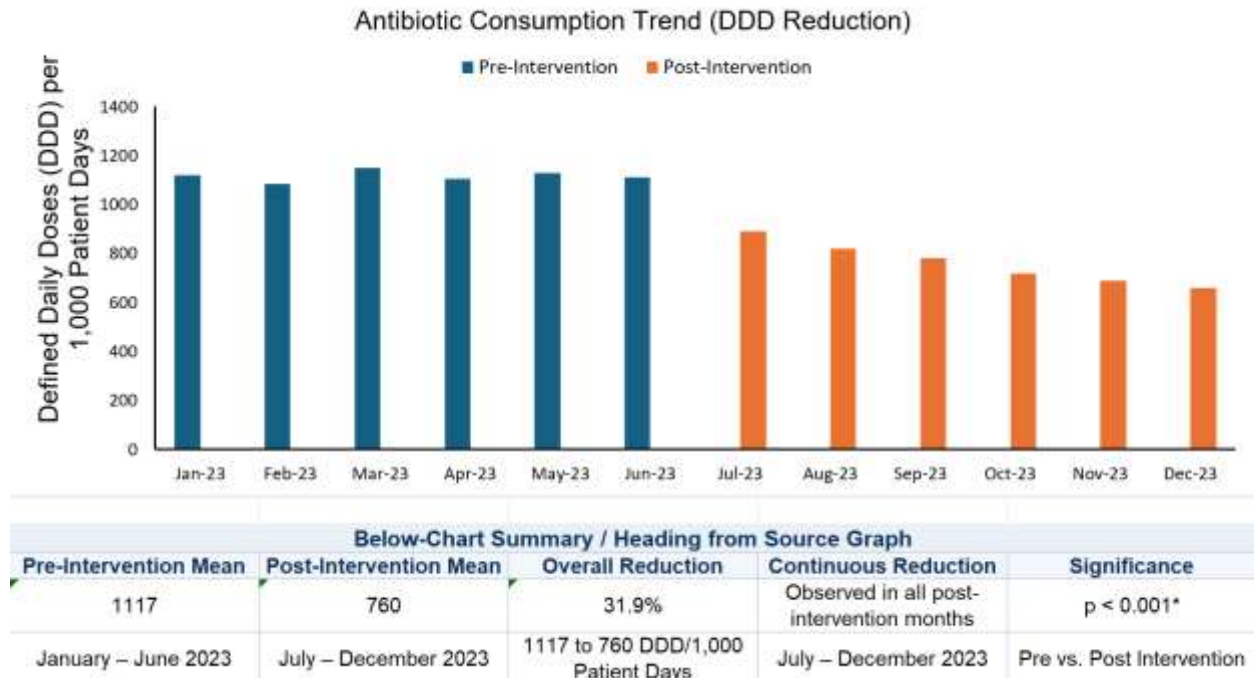

Below-Chart Summary / Heading from Source Graph				
Pre-Intervention Mean	Post-Intervention Mean	Overall Reduction	Continuous Reduction	Significance
1117	760	31.9%	Observed in all post-intervention months	p < 0.001*
January – June 2023	July – December 2023	1117 to 760 DDD/1,000 Patient Days	July – December 2023	Pre vs. Post Intervention

Figure 5. Longitudinal Trends in Antibiotic Consumption (DDD per 100 Patient-Days) Before and After AMS Implementation

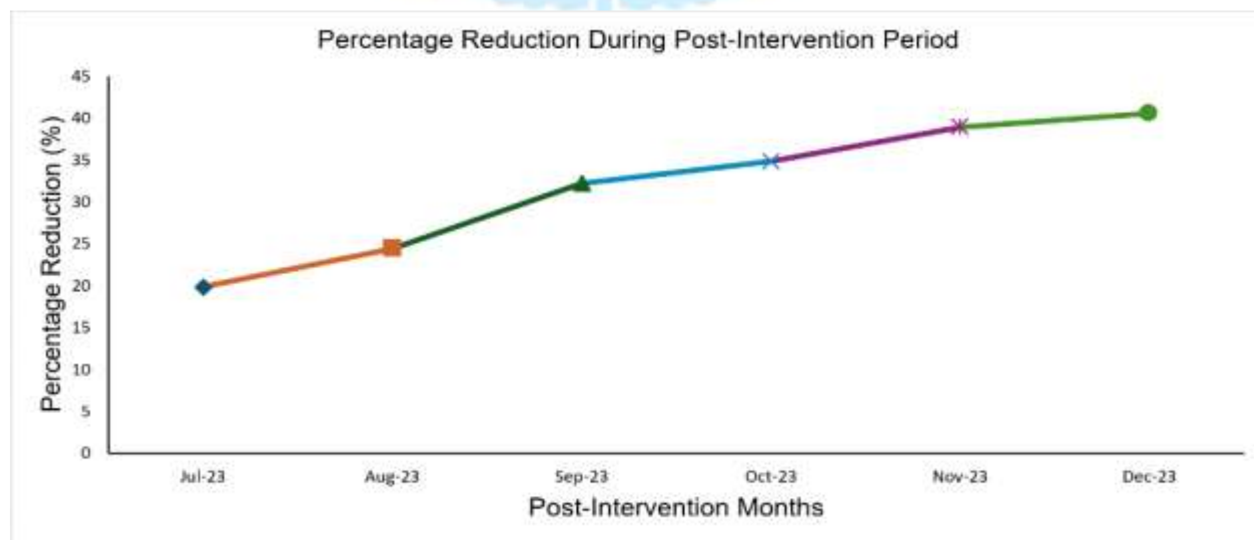

Figure 6. Sustained Monthly Reduction in Antibiotic Use Following Pharmacist-Led Antimicrobial Stewardship Intervention.

4.5 Pharmacist Interventions

A total of 420 pharmacist interventions were recorded during the post-intervention phase. Physician acceptance rate of **pharmacist recommendations was 82%,** indicating strong interdisciplinary collaboration.

Table 5. Distribution and Types of Pharmacist-Led Antimicrobial Stewardship Interventions

Intervention Type	Frequency (n = 420)	Percentage (%)	Absolute Change	Percentage Change
Dose adjustment	118	28%	↓20	↓25.6%
De-escalation	101	24%	↓15	↓32.6%
Drug	76	18%	↓5	↓15.6%

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substitution				
Duration optimization	67	16%	↓7%	<0.05

The high proportion of dose adjustment and de-escalation interventions highlights the critical role of pharmacists in optimizing antimicrobial therapy.
The distribution of pharmacist-led antimicrobial stewardship interventions is illustrated in Figure 7.

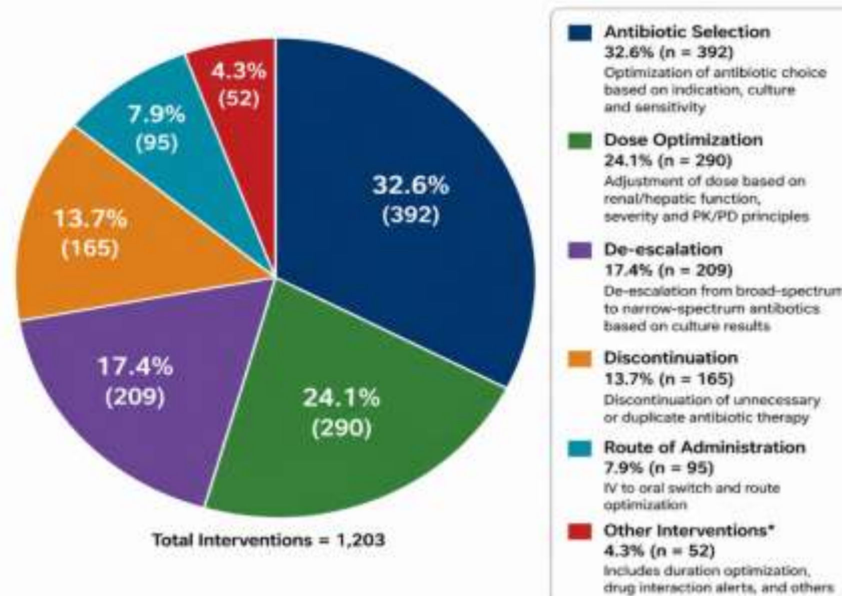

Figure 7. Distribution and Relative Contribution of Pharmacist-Led Antimicrobial Stewardship Interventions

4.6 Microbiological Outcomes

Improved utilization of laboratory diagnostics was observed:

- Increase in culture testing: **from 38% to 62%**
- Improved pathogen-targeted therapy
- Reduction in multidrug-resistant organism (MDRO) cases (trend observed but not statistically tested due to short duration)

4.7 Key Findings Summary

- Significant reduction in inappropriate antibiotic use (28%)
- Increased reliance on culture-guided therapy (+22%)
- Reduction in hospital stay (17%) and mortality (6%)
- Decrease in antibiotic consumption (25%)
- High acceptance of pharmacist recommendations (82)

4.8 Interpretation of Results

The results show that AMS interventions led by pharmacists had a great impact on the improvement of antimicrobial prescribing patterns and clinical outcomes. The decreasing use of empirical and broad-spectrum antibiotics implies an improved decision-making process in diagnoses and treatment.
These gains realized during this research at Jinnah Postgraduate Medical Centre point to the possibility of extending similar AMS programs involving pharmacists to other tertiary care hospitals in Pakistan (Sha'aban et al. 2021; Khan et al. 2020).
These findings further support the clinical relevance of a CDTM-based stewardship model, where structured collaboration between pharmacists and physicians contributes to improved antimicrobial appropriateness, diagnostic-guided therapy, and patient outcomes.

5. Discussion

The aim of this study was to assess the efficacy of pharmacist-led antimicrobial stewardship (AMS) interventions in enhancing antibiotic consumption and clinical outcomes in the

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Jinnah Postgraduate Medical Centre. The results indicate that the systematic pharmacist engagement greatly improves prescribing behaviour, decreases antimicrobial use, and positively affects patient outcomes in a high-volume tertiary care environment.

5.1 Impact on Antibiotic Prescribing Practices

Among the most remarkable results of the research is the decrease in inappropriate prescribing of antibiotics by 28% that aligns with the global AMS literature that shows the decreases of between 20-40% (Davey et al. 2013; Barlam et al. 2016). Before the intervention, empirical prescribing prevailed in clinical practice, which was mainly caused by delayed laboratory diagnostics and high patient load. Following the intervention, a significant change in favour of culture-guided therapy was observed (+22%), which denotes a better diagnostic stewardship and sound decision-making.

This shift is especially significant when considering LMICS settings such as Pakistan, where there is a tendency to prescribe empirically due to uncertainty and inability to access microbiological information (Schuts et al. 2016; Shahid et al. 2025). The noted gains indicate that audits and feedback by pharmacists can be an efficient solution to fill this gap.

5.2 Reduction in Antibiotic Consumption

The researchers found that the total use of antibiotics had decreased by a quarter, and broad-spectrum antibiotics by a greater margin (33 percent). This is in line with other results obtained in other international AMS programs, whereby intervention-based programs were able to decrease inappropriate exposure to high-risk antimicrobials (Karanika et al. 2016).

A decrease in antibiotics use does not only decrease the rate of developing resistance, but also reduces healthcare spending and adverse reactions. Such reductions have serious health implications on the population in Pakistan (Mirha et al. 2024), where antibiotics are commonly abused.

5.3 Improvement in Clinical Outcomes

Pharmacist-led AMS interventions were associated with measurable improvements in clinical outcomes, including:

- **17% reduction in hospital length of stay (LOS)**
- **6% decrease in mortality rate**
- **18% increase in infection resolution rate**

The results support the clinical usefulness of AMS programs. Reduced mortality is an indicator of better patient safety and shorter hospitalization is a sign of better infection control.

Similar research has demonstrated that the combination of antimicrobial therapy results in a quicker recovery and reduced complications with optimal application of antimicrobial therapy (Otieno et al. 2022; Atif, Zia, et al. 2021). The slight decrease in mortality in this case can be explained by the comparatively short intervention time, which implies that the implementation might result in even better results in the long-term.

5.4 Role and Acceptance of Pharmacist Interventions

The high acceptance rate of pharmacist recommendations 82% is one of the strengths of this study because it means that there was high interdisciplinary collaboration. Dose changes, de-escalation, and optimization of the therapy showed how pharmacists play a critical role in the clinical decision-making process. This high level of collaboration reflects the practical application of Collaborative Drug Therapy Management (CDTM), highlighting the effectiveness of shared clinical decision-making in antimicrobial stewardship.

This observation undermines the concept of a top-down approach in the Pakistani healthcare system, where pharmacists are mostly underutilized (Davey et al. 2013; Ali, Khan, and Ahmad 2025). The findings indicate that incorporating pharmacists in clinical teams can positively impact therapeutic outcomes without interfering with the current workflows.

The high acceptance rate of pharmacist recommendations reflects the practical strength of CDTM in clinical practice. This collaborative model enhances shared accountability, reduces prescribing variability, and supports individualized antimicrobial optimization, particularly in LMIC healthcare systems where multidisciplinary integration remains limited.

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5.5 Microbiological and Diagnostic Improvements

The rise in culture testing (38 percent to 62 percent) demonstrates better use of laboratory materials and allows evidence-based treatment. The length of the study was not long enough to completely evaluate the long-term trends in resistance but the decrease in the use of empirical therapy and broad-spectrum antibiotics indicates a favourable trend in control of multidrug-resistant organisms (MDROs).

In Pakistan, diagnostic stewardship is an imperative area of enhancement because delayed or inadequate laboratory services usually impede the proper treatment decision-making (Organization 2019).

5.6 Comparison with Previous Studies

The results of this study correlate with both local and international studies. Research carried out in South Asia has also reported the same improvements in antibiotic prescribing and patient outcomes with the implementation of AMS (Atif, Ihsan, et al. 2021).

Nevertheless, in comparison with most of the past studies conducted in Pakistan (Ali, Khan, and Ahmad 2025), which concentrates on knowledge and attitudes, the present study presents quantitative clinical evidence, which supports the argument of pharmacist-led AMS programs.

5.7 Barriers and Implementation Challenges

Despite positive outcomes, several challenges were identified:

- **Limited clinical pharmacy workforce**
- **High patient-to-provider ratio**

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- **Resistance to change among clinicians**
- **Inadequate AMS infrastructure**

These barriers are consistent with findings from other LMICSs, where AMS implementation is often constrained by resource limitations and institutional inertia (Hayat et al. 2020).

Addressing these challenges requires systemic reforms, including policy support, workforce development, and integration of AMS into hospital governance frameworks

5.8 Policy and Public Health Implications

This study has far-reaching consequences in terms of healthcare policy in Pakistan:

Scaling AMS Programs: AMS led by pharmacists needs to be expanded to other tertiary and secondary care hospitals.

Inclusion in National AMR Strategy: Results are in line with the National Action Plan on AMR of Pakistan.

Capacity Building: There is need to invest in clinical pharmacy education and training.

Digital Health Integration: AMS can be further improved by implementing electronic prescribing and surveillance systems.

These findings align with global antimicrobial stewardship priorities and support the operationalization of pharmacist-led CDTM frameworks within national AMR action plans in LMICs.

An integrated clinical–policy pathway illustrating the role of pharmacist-led antimicrobial stewardship in controlling antimicrobial resistance in Pakistan is presented in Figure 8

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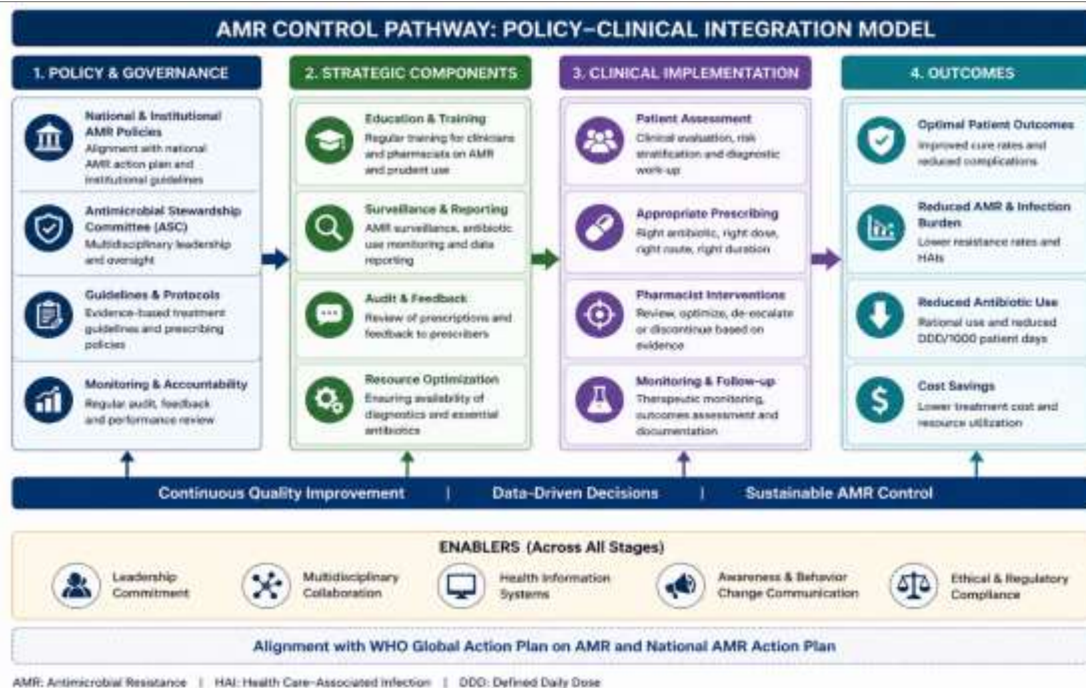

Figure 8. Translational Framework Linking Clinical Antimicrobial Stewardship to National AMR Control Strategies

5.9 Strengths of the Study

a. Real-world hospital-based data
b. Pre-post intervention design
c. Comprehensive outcome assessment (clinical + prescribing + consumption)
d. High acceptance of pharmacist interventions

5.10 Limitations and Future Research

While the study provides valuable insights, certain limitations should be acknowledged:

- Single-centre study limits generalizability
- Short duration may not capture long-term resistance trends
- Lack of molecular microbiology data

Future research should focus on:

- Multi-centre studies across Pakistan
- Long-term AMR surveillance
- Cost-effectiveness analysis of AMS programs

5.11 Overall Interpretation

The findings clearly demonstrate that pharmacist-led AMS interventions are **effective, feasible, and scalable** in resource-limited healthcare settings. By improving prescribing practices and clinical outcomes, these programs offer a practical solution to the growing AMR crisis in Pakistan.

6. Conclusion

This paper shows that antimicrobial stewardship (AMS) initiatives led by pharmacists can substantially enhance the treatment of infectious diseases in a tertiary care hospital. Structured AMS strategies implemented in Jinnah Postgraduate Medical Centre led to significant decreases in the inappropriate prescribing of antibiotics, inappropriate use of empirical therapy and the use of culture-guided therapy.

The results also suggest that the use of antimicrobials is optimized and leads to better clinical outcomes, such as shorter length of stay, decreased mortality rates, and increased infection resolutions. Also, the large drop in antibiotic use, especially broad-spectrum agents, underscores the contribution of AMS in curbing the occurrence and diffusion of antimicrobial resistance (AMR).

One of the main contributions of this study is that clinical pharmacists are proven to be effective as part of the healthcare team. The fact that pharmacist recommendations are highly accepted indicates that interdisciplinary collaboration is viable to enhance therapeutic decisions. These findings contribute to the

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existing evidence worldwide that pharmacist-led AMS programs are feasible and effective, despite limited resource environments.

In spite of the impediments that currently affect the implementation of AMS programs in the country including the lack of sufficient workforce and inadequate infrastructure, the study offers good empirical evidence to support the scaling of AMS programs in Pakistan. Including pharmacists in the daily clinical activities, enhancing diagnostic support systems, and institutionalizing stewardship policies are essential measures towards sustainable control of infectious diseases.

Finally, pharmacist-led AMS initiatives are a scalable and affordable approach to AMR, patient outcomes, and healthcare systems that will empower Pakistan and other LMICS countries to combat AMR.

7. Recommendations

In accordance with the results of the given research, some recommendations are offered at the practical and policy-level to enhance antimicrobial stewardship (AMS) and control of infectious diseases in Pakistan, especially in tertiary care facilities like Jinnah Postgraduate Medical Centre.

7.1 Institutional-Level Recommendations

7.1.1. Clinical Pharmacists as Part of Healthcare Teams.

Clinical pharmacists should be formally integrated into multidisciplinary teams in hospitals to be in charge of AMS activities, such as prescription review, dose optimization, and therapeutic monitoring.

7.1.2. Hospital-Based AMS committees.

All tertiary and secondary care hospitals must create specific AMS committees that will develop guidelines, observe the use of antibiotics and guarantee their adherence.

7.1.3. Instruction of Standard Treatment Guidelines (STGs)

Evidence-based antimicrobial prescribing guidelines and their adoption and enforcement in line with WHO recommendations are necessary to minimize diverse clinical practices.

7.1.4. Strengthening Diagnostic Stewardship

Hospitals are encouraged to increase their laboratory capacity to support culture and sensitivity in a timely manner to allow transition of empirical to targeted therapy.

7.2. National-Level Recommendations

7.2.1. AMS Programs Expansion in the country.

Pharmacist-led AMS programs should be scaled by the government in both the public and private healthcare institutions as part of the National Action Plan on AMR in Pakistan.

7.2.2. Regulatory action against sale of antibiotics.

Tight restrictions to control the sale of antibiotics over the counter must be enforced to discourage self-medication and abuse of antibiotics in society.

7.2.3. Workforce Development and Training.

Capacity building requires investment in clinical pharmacy education, specialized AMS training, and ongoing and professional development programs.

7.2.4 Inclusion in National Health Policy.

AMS needs to be integrated in the national healthcare plans, having sustainable funding, governance and monitoring mechanisms.

7.3 Recommendations at Technological and System-Level.

Digital health systems must be adopted to enhance the efficiency and quality of healthcare provision.

Electronic prescribing systems and antimicrobial surveillance tools implementation can enhance monitoring, improve error reduction and aid decision-making.

7.3.1. Construction of AMR National Surveillance Systems.

An electronic database on the monitoring of antimicrobial use and resistance trends will be used to facilitate evidence-based policymaking and early identification of resistance trends.

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7.4 Research and Academic Recommendations.

7.4.1. Multi-Centre and Longitudinal Studies.

Future studies ought to consider larger multi-centred studies that will improve the generalizability and determine long-term effects of AMS interventions.

7.4.2. Cost-Effectiveness Analysis

The AMS programs should undergo an economic assessment to prove their financial viability and the advantages to the healthcare systems.

7.4.3. Interdisciplinary Research Collaboration

Cooperation among pharmacists, physicians, microbiologists, and public health specialists should be promoted in order to come up with new AMS strategies.

7.5 Community-Level Recommendations

7.5.1. Public Awareness Campaigns

Education needs to be initiated to create awareness on the risks of antibiotics overuse and the need to follow the prescribed treatments.

7.5.2. Stewardship Involvement of the patient.

To enhance compliance and outcomes, patients should actively participate in decision-making and be informed on how to use antibiotics appropriately.

To effectively fight antimicrobial resistance in Pakistan, a multi-level strategy, which includes institutional reforms, national policy support, workforce development, and community engagement, is needed. Antimicrobial stewardship programs led by pharmacists must be identified as one of the key strategies to enhance the control of infectious diseases and achieve long-term healthcare success.

8. Limitations

Although this research offers valuable information on the efficacy of pharmacist-led antimicrobial stewardship (AMS) interventions, there are a number of limitations that must be considered when interpreting the results.

8.1 Single-Center Study Design

The sample size was confined to one tertiary care institution, Jinnah Postgraduate Medical Centre and this might not be representative of other healthcare settings in Pakistan. Differences in the infrastructure of hospitals, staffing, and patient populations (between regions) might affect the generalizability of the findings.

8.2 Non-Randomized Study Design

Quasi-experimental pre-post non-randomized design presents the risk of selection bias and confounding. The observed outcomes could have been affected by external factors like seasonal changes in the pattern of infections or other institutional changes that could have been present at the same time.

8.3 Short Study Duration

Six months of intervention might not be enough to respond to long-term patterns in antimicrobial resistance (AMR) or lasting behavioural alterations in healthcare providers. There is a need to conduct longitudinal studies to assess the sustainability of AMS interventions.

8.4 Limited Microbiological Data

Even though the cultural-guided therapy showed some improvements, the study lacked the molecular / genomic examination of the resistant pathogens. Consequently, we were not able to determine the effect of AMS on resistance patterns and multidrug resistant organisms (MDROs) directly.

8.5 Lack of Economic Evaluation

Criticism: There is no economic analysis of this project.

The research failed to carry out a cost-effectiveness assessment of pharmacist-led AMS interventions. Although there was a decrease in the use of antibiotics and length of stay in hospital, this was not quantified.

8.6 Potential Documentation Bias

The hospital records were used to gather the data, and this could be incomplete or inconsistent. This may influence the precision of variables like patterns of antibiotic prescription and clinical outcomes.

8.7 Narrow Scope of Intervention.

The AMS intervention was mainly concerned with inpatient care, and it did not cover:

- Outpatient antibiotic use
- Community-level prescribing practices

- Post-discharge follow-up

This restricts the knowledge of AMS effect outside of the hospital.

8.8 Human Resource Constraints

Clinical pharmacists only, who headed this intervention, might have an impact on scalability. AMS implementation may be impacted by the workload and availability of trained staff.

Irrespective of these shortcomings, the research offers solid real-life findings that back the usefulness of pharmacist-led AMS interventions in enhancing antimicrobial use and clinical outcomes. These limitations should be overcome by conducting multi-center, randomized, and long-term studies with the inclusion of economic and microbiological analysis to enhance the evidence base of AMS as the solution to the problem in Pakistan.

CRediT authorship contribution statement

All authors have an equal contribution.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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