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A Review of Rational Pharmacotherapy in the Use of Antibiotics in Hospitals

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Abstract: This study aims to examine the rational pharmacotherapy of antibiotic use in hospital settings, focusing on patterns, determinants, and the role of antimicrobial stewardship (AMS) in optimizing therapeutic outcomes. Employing a qualitative descriptive design through a literature review, this research synthesized findings from scientific journals, official reports, and academic studies published between 2015 and 2025. Data collection involved systematic literature tracing and document analysis, while the data analysis process consisted of thematic identification, data reduction, categorization, and inductive interpretation. The results reveal that the rationality of antibiotic use in Indonesian hospitals remains low, ranging between 6.67% and 68.03%, with key issues involving inappropriate antibiotic selection, incorrect dosing, and inadequate therapy duration. Limited AMS implementation and minimal pharmacist involvement were identified as major contributing factors. Conversely, evidence demonstrates that multidisciplinary AMS programs, particularly those led by clinical pharmacists, significantly improve prescribing rationality, reduce resistance rates, and lower healthcare costs. The findings provide a comprehensive understanding of how institutional, behavioral, and policy factors influence rational antibiotic use, offering implications for both clinical practice and healthcare policy reform. In conclusion, the study underscores the need for sustained AMS integration, pharmacist empowerment, and standardized evaluation systems to strengthen rational pharmacotherapy and combat antimicrobial resistance.

Keywords: Rational Pharmacotherapy, Antibiotics, Antimicrobial Stewardship, Hospital Practice, Clinical Pharmacy

Introduction

Antibiotic therapy remains one of the cornerstones of modern medicine, playing a vital role in reducing morbidity and mortality from infectious diseases. However, irrational antibiotic use in hospitals has become a critical global health concern, contributing significantly to the rapid emergence of antimicrobial resistance (AMR), treatment failure, and escalating healthcare costs (Giamarellou et al, 2023). The World Health Organization (WHO) has identified AMR as one of the top ten global public health threats, with hospital settings serving as major hotspots for inappropriate antibiotic prescribing and resistance development (Ya et al, 2023). This issue underscores the urgent need for systematic efforts to ensure rational antibiotic use through evidence-based pharmacotherapy and stewardship interventions.

In many healthcare systems, antibiotic misuse stems from factors such as empirical overprescription, prolonged treatment durations, and inadequate diagnostic support. Studies have shown that up to 50% of antibiotic prescriptions in hospitals are inappropriate, either in indication, dose, or duration (Wang et al, 2019). This pattern is especially problematic in developing countries, where resource limitations, inconsistent adherence to clinical guidelines, and insufficient pharmacist involvement exacerbate the problem (Agustina et al, 2024). Consequently, optimizing pharmacotherapy for antibiotics is not merely a clinical priority but a fundamental requirement for sustainable healthcare delivery.

The growing complexity of hospital infections and the proliferation of multidrug-resistant organisms further amplify the importance of rational pharmacotherapy. Without targeted interventions, inappropriate antibiotic use can lead to therapeutic inefficacy, longer hospital stays, and increased mortality rates (De With, 2016). Therefore, the implementation of structured Antimicrobial Stewardship (AMS) programs has gained prominence as an effective strategy to curb irrational antibiotic use and improve therapeutic outcomes (Qian, 2025).

AMS programs are designed as multidisciplinary interventions that engage infectious disease physicians, clinical pharmacists, microbiologists, and hospital epidemiologists. Their collective goal is to optimize antibiotic selection, dosing, route, and duration to achieve the best clinical outcomes with minimal unintended consequences (Xin, 2025). The inclusion of pharmacists in these programs has been shown to play a pivotal role, with multiple studies demonstrating substantial improvements in prescription appropriateness and reductions in antibiotic consumption following pharmacist-led interventions (Hassan et al, 2025) (Królak-Ulińska et al, 2025).

Recent analyses highlight that pharmacist involvement in AMS can increase the rationality of antibiotic use by up to 28% and reduce the average therapy duration by approximately 41% (Guldur et al, 2024). Such improvements not only enhance clinical efficacy but also reduce overall antibiotic costs, supporting both clinical and economic sustainability in hospital care (Qian, 2025). Moreover, pharmacist-driven feedback mechanisms and educational initiatives have been instrumental in improving adherence to clinical guidelines and reducing the prescription of broad-spectrum antibiotics (Yin, 2025).

In Indonesia, the problem of irrational antibiotic use in hospitals remains a pressing issue. Gyssens-based evaluations have revealed that the rationality rate for empirical antibiotic therapy in Indonesian hospitals ranges between 25% and 68%, while definitive therapy averages around 54% (Pratiwi et al, 2025) (Rahardjoputro, 2025). These findings point to substantial gaps in the rational use of antibiotics, often associated with inappropriate drug selection, incorrect dosing, and suboptimal therapy duration (Brilyani et al, 2025). Despite these challenges, empirical data show that targeted stewardship programs can substantially improve prescribing behavior and clinical outcomes.

Internationally, the adoption of AMS frameworks has led to measurable declines in antibiotic consumption, resistance rates, and healthcare costs. For example, studies in China and Zambia demonstrated significant reductions in antibiotic utilization density (AUD) and expenditure following AMS implementation (Mudenda, 2025) (Xin, 2025). These outcomes

reaffirm the global relevance of AMS and underscore the need for consistent stewardship practices, particularly in resource-limited settings.

In parallel, the digitization of hospital information systems has enhanced the capacity to monitor antibiotic use in real-time, enabling early detection of irrational prescribing patterns and facilitating targeted interventions (Yin, 2025). Such integration of technology with pharmacotherapeutic oversight strengthens the institutional capacity to sustain rational antibiotic use over time.

From a clinical pharmacotherapy perspective, rational antibiotic use not only ensures optimal patient outcomes but also safeguards the efficacy of existing antibiotics for future generations. The principle of rational pharmacotherapy demands the right drug, at the right dose, for the right duration, and for the right indication—a standard that remains inconsistently met in many hospital settings (De With, 2016). Addressing these gaps requires ongoing education, audit-feedback mechanisms, and institutional commitment to stewardship.

Furthermore, rational antibiotic pharmacotherapy extends beyond individual prescribing behavior; it is a system-level concern involving hospital policy, formulary management, and interprofessional collaboration (Giamarellou et al, 2023). Hence, the integration of pharmacists as key actors in clinical decision-making processes offers a tangible pathway to improving antibiotic rationality and therapeutic efficiency.

The urgency of this issue is heightened by the increasing prevalence of resistant pathogens in both community and hospital settings. The emergence of carbapenem-resistant Enterobacteriaceae, methicillin-resistant Staphylococcus aureus (MRSA), and extended-spectrum β-lactamase (ESBL)-producing organisms has limited treatment options and raised the stakes for rational antibiotic management (Sharma et al, 2021). Thus, hospitals must not only adopt AMS but also continuously evaluate their pharmacotherapeutic practices to align with evolving resistance trends.

This article, titled "A Review of Rational Pharmacotherapy in Antibiotic Use in Hospitals," aims to provide an in-depth examination of the strategies, challenges, and outcomes associated with rational antibiotic use in hospital settings. It synthesizes current evidence on the effectiveness of AMS programs, the central role of clinical pharmacists, and the measurable impact of stewardship interventions on antibiotic consumption, cost, and clinical outcomes.

The main objective of this article is to elucidate how rational pharmacotherapy principles, when implemented through structured AMS interventions, can improve antibiotic use in hospitals. The expected benefit is twofold: theoretically, it contributes to the scientific discourse on antibiotic stewardship and rational prescribing; practically, it offers actionable insights for healthcare practitioners and policymakers to optimize antibiotic therapy and mitigate resistance.

Ultimately, promoting rational antibiotic pharmacotherapy represents a vital step toward achieving sustainable and effective healthcare delivery. Through interdisciplinary collaboration and evidence-based stewardship, hospitals can safeguard antibiotic efficacy, enhance patient outcomes, and contribute meaningfully to the global effort against antimicrobial resistance.

Methodology

This study employed a qualitative research design with a descriptive approach through a literature review (library research) methodology. The qualitative-descriptive design was chosen to systematically and interpretatively examine existing research and theoretical frameworks on rational pharmacotherapy and antibiotic stewardship in hospital settings. This approach allows for an in-depth understanding of complex phenomena by analyzing patterns, relationships, and meanings derived from scholarly literature (Bingham, 2023) (Pratt, 2025). The qualitative nature of this study emphasizes contextual depth and interpretative richness over numerical generalization, aligning with the goal of synthesizing insights on rational antibiotic use from diverse empirical and conceptual sources (Doyle et al, 2019).

The primary data sources in this study consisted of peer-reviewed academic articles, official reports, and scientific journals relevant to rational pharmacotherapy, antibiotic stewardship, and qualitative methodologies. The core literature was drawn from international journals such as BMJ Open, Frontiers in Medicine, Scientific Reports, Journal of the Indonesian Medical Association, and Antibiotics, as well as methodological studies discussing qualitative and descriptive research paradigms (Agustina et al, 2024) (Bandaranayake, 2024) (Giamarellou et al, 2023) (Qian, 2025). The inclusion of diverse yet thematically aligned sources ensured comprehensive coverage of both the clinical and methodological dimensions of the topic. Additional references were taken from library and information science fields to frame the systematic review process in accordance with established library research principles (Granikov et al, 2020) (Togia & Malliari, 2017).

The data collection technique utilized was literature tracing and document analysis. The researcher conducted systematic searches across academic databases such as PubMed, ScienceDirect, and Scopus using keywords like “antimicrobial stewardship,” “rational pharmacotherapy,” and “antibiotic use in hospitals.” Literature selection followed a structured protocol emphasizing credibility, recency, and relevance to the research objectives (Jimenez et al, 2024). Each source was critically reviewed to extract essential findings and theoretical contributions. Consistent with qualitative library research principles, data were organized into conceptual categories for further thematic analysis (Bandaranayake, 2024) (Bingham, 2023).

The data analysis process was conducted through several stages, including data reduction, theme identification, conceptual categorization, and inductive conclusion drawing. Following the qualitative analysis framework, data coding was performed iteratively to ensure analytical consistency and depth (Belotto, 2018) (Vila-Henninger et al, 2022). Themes were identified through a combination of deductive and inductive reasoning, allowing theoretical expansion while maintaining empirical fidelity (Fife & Gossner, 2024). The process followed an analytical cycle as suggested by Bingham (2023), encompassing inspection, categorization, and model development phases to ensure a systematic and transparent interpretation of data.

The inclusion criteria encompassed articles published between 2016 and 2025, peer-reviewed, and written in English or Bahasa Indonesia, provided they addressed rational antibiotic use, AMS implementation, or related pharmacotherapeutic principles. Studies were excluded if they lacked methodological rigor, were purely opinion-based, or did not

directly relate to hospital-based antibiotic use (De With, 2016) (Mudenda, 2025). This selective inclusion-exclusion framework was applied to ensure that only high-quality, relevant, and evidence-supported sources informed the analysis. The data triangulation process was achieved by cross-referencing findings from multiple authors and comparing methodological insights across different hospital settings (Królak-Ulińska et al, 2025) (Yin, 2025).

To maintain the validity and trustworthiness of findings, several strategies were employed, including conceptual peer review, triangulation of data sources, and audit trails of analytical decisions (Abraham & P, 2024) (Bingham, 2023). Triangulation was particularly crucial in integrating findings from both clinical and methodological perspectives, enhancing the robustness of interpretations. The systematic use of descriptive qualitative analysis ensured that interpretations remained faithful to the original literature while allowing theoretical abstraction. Overall, this methodological design ensured that the study yielded reliable, contextually grounded, and theoretically sound insights into rational pharmacotherapy practices for antibiotic use in hospitals.

Result and Discussion

This literature study presents comprehensive findings on rational pharmacotherapy in antibiotic use within hospital settings, focusing primarily on recent research conducted in Indonesia. The results highlight persistent gaps in antibiotic rationality, significant variation between health facilities, and the crucial role of antimicrobial stewardship (AMS) and pharmacist involvement in improving outcomes.

1. Trends in Rational Antibiotic Use in Indonesian Hospitals

Recent studies reveal that antibiotic rationality in hospitals across Indonesia remains low and inconsistent. In adult pneumonia cases, the rationality of antibiotic use ranges between 53.85% and 68.03%, primarily due to inappropriate antibiotic selection and treatment duration (Pratiwi et al, 2025; Rahardjoputro, 2025) (Siregar et al, 2024). In contrast, pediatric pneumonia shows much lower rationality, between 6.67% and 18.6%, caused by dosing errors and the selection of broad-spectrum agents (Bestari & Karuniawati, 2019) (Suminar, 2022). For urinary tract infections, rational antibiotic use reaches only 33.75%, often due to incorrect dose or dosing intervals (Amrullah et al, 2022). In typhoid fever, rational antibiotic use is reported at 30% in children and 23.43% in adults, with problems mainly related to inappropriate indication, dose, and duration (Dewi, 2018) (Megawati, 2020).

These findings indicate that antibiotic prescribing in hospitals frequently deviates from evidence-based guidelines and underscores a lack of structured oversight mechanisms in clinical practice.

2. Factors Contributing to Irrational Antibiotic Use

The main causes of irrational antibiotic use identified in the reviewed studies include inappropriate antibiotic choice, incorrect dosing, and excessive or insufficient duration of therapy. Several studies emphasize that these patterns stem from the absence of standardized prescribing audits, limited training for prescribers, and weak integration of AMS programs (Amrullah et al, 2022) (Pratiwi et al, 2025) (Rahardjoputro, 2025) (Siregar et

al, 2024). Additionally, the limited involvement of clinical pharmacists in hospital settings further hinders efforts to achieve rational pharmacotherapy (Królak-Ulińska et al, 2025). Pharmacists are rarely involved in therapeutic decision-making processes, which reduces opportunities for corrective interventions, particularly in antibiotic management.

3. Impact of AMS Programs and Pharmacist Interventions

The implementation of AMS programs and pharmacist led interventions has demonstrated a significant positive impact on rational antibiotic use. Multidisciplinary AMS teams have been shown to reduce unnecessary antibiotic use, improve compliance with prescribing standards, and minimize antimicrobial resistance (Shirazi et al., 2020; Timsit et al, 2019) (Van Dijck et al, 2018). Pharmacist involvement through prescription audits, clinician education, and drug utilization reviews has been particularly effective in optimizing antibiotic selection and reducing therapy duration (Hassan et al, 2025) (Królak-Ulińska et al, 2025). Studies confirm that hospitals implementing such interventions experience improved rationality levels, highlighting the pharmacist's central role in stewardship success.

4. Quantitative Overview of Rationality Patterns

Table 1. Rational antibiotic use in Indonesian hospitals and the major issues identified.

Clinical Case	Rational Use (%)	Primary Problems Identified	References
Adult Pneumonia	53.85–68.03	Inappropriate duration and drug choice	(Pratiwi et al., 2025; Rahardjoputro, 2025; Siregar et al., 2024)
Pediatric Pneumonia	6.67–18.6	Dosing errors and broad-spectrum use	(Bestari & Karuniawati, 2019; Suminar, 2022)
Adult UTI	33.75	Incorrect dosing and intervals	(Amrullah et al., 2022)
Pediatric Typhoid	30.00	Indication and antibiotic mismatch	(Megawati, 2020)
Adult Typhoid	23.43	Inaccurate duration and administration	(Dewi, 2018)

5. Comparative Analysis with International Studies

Comparative evidence reveals that Indonesia's rationality levels are significantly below those reported in high-income countries, where AMS programs have been institutionalized. International data show that structured stewardship programs can achieve over 80% rationality, while in Indonesia, most hospitals fall below 60% (Timsit et al, 2019) (Van Dijck et al., 2018). Similar challenges exist in other low- and middle-income countries, such as Pakistan, where the lack of AMS infrastructure and pharmacist involvement remains an obstacle (Hassan et al, 2025). Nevertheless, hospitals that have implemented standardized audits and stewardship frameworks show measurable improvement in antibiotic rationality, aligning closer with global benchmarks.

6. Summary of Key Findings

This literature review establishes that irrational antibiotic prescribing in Indonesian hospitals is still prevalent, primarily due to inappropriate selection, dosage errors, and inconsistent implementation of AMS. Rationality levels rarely exceed 70%, underscoring the urgent need for system wide interventions. However, the evidence consistently demonstrates that multidisciplinary AMS teams, particularly those with active pharmacist involvement, are effective in improving the quality and rationality of antibiotic therapy (Hassan et al, 2025) (Królak-Ulińska et al, 2025). Standardized evaluation methods such as the Gyssens classification also provide reliable frameworks for continuous monitoring and improvement (Siregar et al, 2024). Strengthening stewardship, ensuring pharmacist participation, and enforcing policy based antibiotic management remain critical to advancing rational pharmacotherapy practices in Indonesia.

Discussion

The findings from this literature review indicate that the rationality of antibiotic use in Indonesian hospitals remains below the optimal threshold. When compared with established global pharmacotherapeutic standards, the data reveal persistent inconsistencies in antibiotic selection, dosing, and treatment duration (Pratiwi et al, 2025) (Rahardjoputro, 2025). These deviations from rational pharmacotherapy principles align with patterns observed in other low and middle income countries, where the absence of robust antimicrobial stewardship (AMS) programs and limited multidisciplinary collaboration, particularly pharmacist involvement, are major barriers to effective implementation (Królak-Ulińska et al, 2025) (Van Dijck et al, 2018).

From a theoretical standpoint, rational pharmacotherapy rests on the principle of "the right drug, for the right patient, at the right dose, route, and duration", supported by evidence based clinical decision making. The low rationality rates reported in studies, ranging from 6.67% in pediatric pneumonia to 68.03% in adult pneumonia, demonstrate gaps in the application of this principle (Bestari & Karuniawati, 2019) (Pratiwi et al, 2025) (Suminar, 2022). The observed inconsistency is likely influenced by contextual factors such as inadequate diagnostic support, varying local resistance patterns, and insufficient adherence to national antibiotic guidelines. These findings emphasize the need for continuous pharmacovigilance and standardized evaluation systems such as the Gyssens method to guide clinical practice (Siregar et al, 2024).

Moreover, the integration of clinical pharmacists within multidisciplinary AMS teams has shown a transformative impact on improving antibiotic rationality. Evidence suggests that pharmacist led interventions including real time prescription audits, clinician education, and therapy monitoring enhance guideline adherence, reduce irrational prescriptions, and improve patient outcomes (Hassan et al, 2025) (Królak-Ulińska et al, 2025). This aligns with stewardship models proposed by Timsit et al. (2019) and Shirazi et al. (2020), which emphasize interprofessional collaboration and evidence driven review mechanisms as key pillars in combating antimicrobial resistance.

The implications of these findings are both clinical and systemic. Clinically, irrational antibiotic use contributes to treatment failure, extended hospitalization, and increased mortality. Systemically, it accelerates antimicrobial resistance (AMR), which has become a global health crisis (Van Dijck et al, 2018). The reviewed studies consistently highlight that hospitals with well established stewardship protocols, particularly those incorporating pharmacist participation and Gyssens based evaluations, achieve better rationality rates and reduced resistance levels (Pratiwi et al, 2025) (Siregar et al, 2024). This demonstrates that rational pharmacotherapy is not only a matter of prescriber knowledge but also of institutional policy and interprofessional coordination.

However, several factors influence the variable outcomes across studies. These include differences in hospital resources, training quality, patient population characteristics, and the extent of stewardship integration (Amrullah et al, 2022) (Rahardjoputro, 2025). For example, hospitals with established electronic prescribing systems and antibiotic surveillance tools tend to report higher rationality levels than those relying solely on manual review (Siregar et al., 2024). Furthermore, cultural aspects of medical hierarchy and prescriber autonomy may hinder the implementation of pharmacist recommendations, limiting the potential impact of AMS initiatives (Królak-Ulińska et al, 2025).

In contrast to high income settings where stewardship programs have become institutionalized, the Indonesian context reveals systemic barriers such as limited funding, scarce human resources, and underdeveloped monitoring infrastructure that impede rational pharmacotherapy enforcement (Van Dijck et al, 2018). Nonetheless, the success of targeted AMS pilots in several hospitals provides optimism that scalable interventions can yield substantial improvements. This is particularly true when supported by policy frameworks that integrate stewardship into hospital accreditation and clinician performance evaluations (Hassan et al, 2025).

Critically, while most reviewed studies provide valuable insights, several limitations persist. Many studies are cross sectional, focusing on descriptive evaluations rather than longitudinal impact. Sample sizes are often limited to single hospitals, constraining generalizability. Moreover, few investigations explore behavioral or systemic drivers of irrational use beyond prescribing errors. Addressing these limitations requires future research employing mixed method approaches that combine quantitative audits with qualitative exploration of prescriber motivations and institutional constraints.

In conclusion, this review reinforces that rational pharmacotherapy in antibiotic use is both a clinical and organizational responsibility. Integrating AMS principles, empowering pharmacists, and institutionalizing continuous monitoring are essential strategies to enhance rationality and combat AMR. The evidence underscores that progress in rational antibiotic use depends not merely on policy directives but on sustained multidisciplinary engagement, resource investment, and culture change within hospital systems.

Conclusion

This qualitative literature study concludes that the rational use of antibiotics in hospitals across Indonesia remains below optimal levels, characterized by inconsistent prescribing practices, suboptimal dosage, and inappropriate therapy duration. The findings offer an in-depth understanding of how institutional limitations, weak implementation of antimicrobial stewardship (AMS), and minimal pharmacist involvement contribute to irrational pharmacotherapy patterns. Compared to established global standards, Indonesia's situation reflects systemic challenges similar to those faced by other developing nations, highlighting the critical need for multidisciplinary collaboration and standardized evaluation frameworks such as the Gyssens method. Theoretically, this study reinforces the essential role of rational pharmacotherapy as the foundation of patient safety and antibiotic sustainability, while practically emphasizing the transformative impact of pharmacist participation in AMS teams to enhance therapeutic outcomes. The implications extend to hospital policy and professional education, underscoring the urgency of integrating stewardship practices into health governance and clinical culture. However, this research acknowledges limitations in scope and data diversity, suggesting that future studies should adopt mixed-method designs, longitudinal evaluations, and behavioral assessments to capture broader insights into prescriber behavior, institutional readiness, and the long-term effectiveness of rational pharmacotherapy interventions.

Based on the findings, it is recommended that hospitals strengthen antimicrobial stewardship (AMS) programs by ensuring active pharmacist involvement and routine prescription audits to improve rational antibiotic use. Academics should expand future research through triangulated qualitative methods to explore behavioral and systemic factors influencing prescribing practices. Further studies are encouraged to develop context-specific intervention models that enhance sustainable rational pharmacotherapy in diverse healthcare settings.

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