

Antimicrobial Resistance Patterns in Intensive Care Units and the Effectiveness of Targeted Antibiotic Stewardship Programs: A Systematic Review

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ABSTRACT:

Background: Antimicrobial resistance (AMR) represents a major global health challenge, particularly in intensive care units (ICUs), where critically ill patients are frequently exposed to invasive procedures and broad-spectrum antimicrobial therapy. The high prevalence of multidrug-resistant organisms in these settings complicates infection management and may contribute to increased morbidity, mortality, healthcare costs, and length of hospital stay. Antibiotic stewardship programs (ASPs) have been increasingly implemented to optimize antimicrobial use and reduce the development and spread of resistance.

Objective: This systematic review aims to synthesize the available evidence on antimicrobial resistance patterns in intensive care units, examine variations across geographic and clinical settings, identify the main components of targeted antibiotic stewardship programs, and evaluate their effectiveness in reducing antimicrobial resistance and antibiotic consumption and improving clinical outcomes.

Methods: This systematic review will be conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search will be performed in PubMed, Scopus, Web of Science, and the Cochrane Library. Eligible studies will include randomized controlled trials, observational studies, cohort studies, and quasi-experimental studies involving patients admitted to intensive care

COPYRIGHT STATEMENT: Copyright: © 2026 Authors. Open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).	units and reporting antimicrobial resistance patterns and/or the effects of antibiotic stewardship interventions. Two independent reviewers will perform study selection, data extraction, and risk-of-bias assessment using appropriate methodological appraisal tools. A narrative synthesis will be conducted, and a meta-analysis will be performed when sufficient clinical and methodological homogeneity exists among the included studies. Expected Results: The review is expected to identify the predominant multidrug-resistant pathogens encountered in ICUs, including <i>Acinetobacter</i> species, <i>Pseudomonas aeruginosa</i>, <i>Klebsiella pneumoniae</i>, and methicillin-resistant <i>Staphylococcus aureus</i> (MRSA), and to characterize regional variations in resistance patterns. It will also evaluate the effects of targeted stewardship interventions, including antibiotic de-escalation, prospective audit and feedback, formulary restriction, and guideline-based prescribing, on antibiotic consumption, antimicrobial resistance, and patient outcomes. Conclusion: This systematic review will provide a comprehensive synthesis of current evidence regarding antimicrobial resistance patterns and targeted antibiotic stewardship interventions in intensive care units. The findings are expected to support evidence-based clinical practice, inform institutional antimicrobial stewardship policies, and contribute to the development of effective strategies for reducing antimicrobial resistance while optimizing patient outcomes. Keywords: Antimicrobial Resistance, Intensive Care Units, Antibiotic Stewardship, Multidrug-Resistant Organisms, Antibiotic Consumption, Systematic Review.
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Background

Antimicrobial resistance has emerged as one of the most pressing global health challenges, particularly within hospital environments where antibiotic use is frequent and often complex. Intensive care units represent a unique setting in which critically ill patients are highly vulnerable to infections, and broad-spectrum antimicrobial agents are commonly administered empirically. This combination creates ideal conditions for the development and spread of resistant pathogens (Ture et al., 2022).

Patients admitted to intensive care units often require invasive procedures such as mechanical ventilation, central venous catheterization, and urinary catheterization. These interventions, while life-saving, significantly increase the risk of healthcare-associated infections. The pathogens

involved in these infections are frequently multidrug-resistant, complicating treatment strategies and worsening patient outcomes (De Waele et al., 2018).

The widespread use of antibiotics in intensive care settings is driven by the need for rapid and effective management of life-threatening infections. However, empirical therapy, especially when prolonged or inappropriate, contributes significantly to the emergence of resistance. In many cases, antibiotics are continued without reassessment, even when microbiological data become available, leading to unnecessary exposure (Minotti et al., 2023).

Antimicrobial resistance patterns in intensive care units vary widely depending on geographical location, institutional practices, and patient populations. Common resistant organisms

include Gram-negative bacteria such as *Acinetobacter* species, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*, as well as Gram-positive organisms like methicillin-resistant *Staphylococcus aureus*. These organisms are associated with high morbidity and mortality rates (Sekandarzad et al., 2025).

The consequences of antimicrobial resistance extend beyond individual patient outcomes. Increased resistance leads to prolonged hospital stays, higher healthcare costs, and increased burden on healthcare systems. In intensive care units, where resources are already limited and patient acuity is high, the impact is particularly profound (Zhang & Singh, 2015).

Antibiotic stewardship programs have been developed as a strategic response to combat antimicrobial resistance. These programs aim to optimize antibiotic use by ensuring appropriate selection, dosing, route, and duration of therapy. In intensive care units, stewardship interventions often involve multidisciplinary teams, including physicians, pharmacists, and microbiologists (MacVane, 2016). Targeted antibiotic stewardship programs in intensive care settings focus on interventions such as de-escalation of therapy, prospective audit and feedback, formulary restriction, and adherence to evidence-based guidelines. These approaches are designed to reduce unnecessary antibiotic use while maintaining or improving patient outcome (Moniz et al., 2021).

The effectiveness of antibiotic stewardship programs in intensive care units has been explored in various studies, with many reporting reductions in antibiotic consumption and improvements in resistance patterns. However, results are not always consistent, and differences in study design, implementation strategies, and outcome measures make it difficult to draw definitive conclusions (Saharman et al., 2021).

Systematic reviews provide an opportunity to synthesize existing evidence on antimicrobial resistance patterns and the effectiveness of stewardship programs. By critically analyzing multiple studies, such reviews can identify trends, gaps in knowledge, and areas requiring further

research. This is particularly important in intensive care settings, where clinical decision-making must be both rapid and evidence-based (Codru et al., 2025).

Understanding the relationship between antimicrobial resistance patterns and the implementation of targeted antibiotic stewardship programs is essential for improving patient care in intensive care units. A comprehensive systematic review can help inform clinical practice, guide policy development, and support the design of effective interventions to combat antimicrobial resistance (Elsawah et al., 2022).

Problem Statement

Antimicrobial resistance in intensive care units has become increasingly prevalent, leading to significant challenges in the management of critically ill patients. Despite the implementation of antibiotic stewardship programs, variability in resistance patterns and inconsistent effectiveness of these interventions persist. There is a need for a comprehensive synthesis of current evidence to better understand resistance trends and evaluate the true impact of targeted stewardship programs in intensive care settings.

Research Questions

1. What are the most common antimicrobial resistance patterns observed in intensive care units?
2. How do these resistance patterns vary across different regions and healthcare settings?
3. What types of targeted antibiotic stewardship interventions are implemented in intensive care units?
4. How effective are these stewardship programs in reducing antimicrobial resistance?
5. What impact do stewardship interventions have on clinical outcomes such as mortality, length of stay, and antibiotic consumption?

Research Hypotheses

1. There are consistent patterns of multidrug-resistant organisms prevalent in intensive care units worldwide.

2. Targeted antibiotic stewardship programs significantly reduce inappropriate antibiotic use in intensive care settings.
3. Implementation of stewardship programs leads to a measurable reduction in antimicrobial resistance rates.
4. Antibiotic stewardship interventions improve clinical outcomes, including reduced mortality and shorter hospital stays.

Research Aim

To systematically review and synthesize available evidence on antimicrobial resistance patterns in intensive care units and evaluate the effectiveness of targeted antibiotic stewardship programs.

Research Objectives

1. To identify and analyze the predominant antimicrobial resistance patterns reported in intensive care units.
2. To examine variations in resistance trends across different geographic and clinical settings.
3. To evaluate the types and components of targeted antibiotic stewardship programs implemented in intensive care units.
4. To assess the effectiveness of these programs in reducing antimicrobial resistance and optimizing antibiotic use.
5. To determine the impact of stewardship interventions on patient outcomes and healthcare resource utilization.

Methodology

Study Design

This study will be conducted as a systematic review designed to comprehensively evaluate antimicrobial resistance patterns in intensive care units and assess the effectiveness of targeted antibiotic stewardship programs. The review will follow established methodological standards for systematic reviews to ensure transparency, reproducibility, and rigor in identifying, selecting, and synthesizing relevant evidence.

Protocol Development and Registration

A detailed review protocol will be developed prior to the initiation of the study. The protocol will outline the objectives, eligibility criteria,

search strategy, and methods for data extraction and analysis. It will be registered in an international prospective register of systematic reviews such as PROSPERO to enhance transparency and reduce the risk of duplication.

Reporting Guidelines

The systematic review will be conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, specifically PRISMA. A PRISMA flow diagram will be used to document the study selection process, including identification, screening, eligibility, and inclusion stages.

Eligibility Criteria

Studies will be selected based on predefined inclusion and exclusion criteria. Eligible studies will include observational studies, randomized controlled trials, quasi-experimental studies, and cohort studies that investigate antimicrobial resistance patterns in intensive care units and/or evaluate antibiotic stewardship interventions. Studies must involve human participants admitted to intensive care settings. Articles published in English within a specified time frame, such as the last 10–15 years, will be considered.

Exclusion criteria will include case reports, editorials, conference abstracts without full text, and studies not specifically addressing intensive care units or stewardship interventions.

Information Sources

A comprehensive literature search will be conducted across multiple electronic databases to ensure broad coverage of relevant studies. These databases will include PubMed, Scopus, Web of Science, and Cochrane Library. Additional sources such as reference lists of included studies and gray literature will also be explored to minimize publication bias.

Search Strategy

A structured search strategy will be developed using a combination of controlled vocabulary terms and free-text keywords. Key search terms will include combinations of “antimicrobial

resistance,” “intensive care unit,” “ICU,” “antibiotic stewardship,” and “drug resistance patterns.” Boolean operators (AND, OR) and truncation will be applied to refine the search. The search strategy will be adapted for each database to ensure optimal retrieval of relevant studies.

Study Selection Process

All retrieved records will be imported into a reference management software, and duplicates will be removed. Two independent reviewers will screen titles and abstracts for relevance based on the eligibility criteria. Full texts of potentially eligible studies will then be assessed independently by the same reviewers. Any disagreements will be resolved through discussion or consultation with a third reviewer to ensure unbiased selection.

Data Extraction

A standardized data extraction form will be developed and piloted prior to use. Data will be extracted independently by two reviewers to ensure accuracy and consistency. Extracted information will include study characteristics (author, year, country, study design), patient population details, types of pathogens and resistance patterns, description of antibiotic stewardship interventions, and key outcomes such as resistance rates, antibiotic consumption, mortality, and length of hospital stay.

Quality Assessment and Risk of Bias

The methodological quality of included studies will be assessed using appropriate appraisal tools depending on study design. For randomized controlled trials, the Cochrane Risk of Bias tool will be used, while observational studies will be evaluated using tools such as the Newcastle-Ottawa Scale. Each study will be assessed independently by two reviewers, and discrepancies will be resolved through consensus.

Data Synthesis and Analysis

A narrative synthesis of the findings will be conducted to summarize antimicrobial resistance patterns and the effectiveness of stewardship programs. Where sufficient homogeneity exists among studies in terms of design, interventions, and outcomes, a meta-analysis will be performed using statistical software. Heterogeneity will be assessed using appropriate statistical measures, and subgroup analyses may be conducted based on geographic region, type of intervention, or pathogen profile.

Subgroup and Sensitivity Analyses

Subgroup analyses will be performed to explore variations in outcomes across different categories, such as types of intensive care units, specific pathogens, and different stewardship strategies. Sensitivity analyses will also be conducted to assess the robustness of the findings by excluding studies with high risk of bias or those with incomplete data.

Assessment of Publication Bias

Publication bias will be evaluated using visual inspection of funnel plots and statistical tests where applicable. Efforts will be made to include gray literature to minimize the impact of selective publication.

Ethical Considerations

As this study will be based on previously published data, it will not involve direct human participation or require ethical approval. However, all efforts will be made to ensure proper citation and ethical use of data throughout the review process.

Timeline and Dissemination Plan

The study will be conducted over a defined timeline, including phases for literature search, screening, data extraction, analysis, and manuscript preparation. The findings will be disseminated through publication in peer-reviewed journals and presentations at relevant scientific conferences to inform clinical practice and policy development.

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