

A Systematic Review on Multi-Drug Resistant Pathogens and Therapeutic Interventions for Hospital-Associated Infections

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Abstract

Background: Multi-drug resistant (MDR) pathogens are a critical global health issue, significantly impacting healthcare costs, mortality, and morbidity. Hospital-associated infections (HAIs) are primarily caused by ESKAPE pathogens, including *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species. This systematic review examines the burden of ESKAPE pathogens in hospital settings, explores MDR trends, and evaluates therapeutic approaches for HAIs.

Methodology: A comprehensive review was conducted using different databases. Data from the past five years were analyzed.

Results: From an initial pool of 3,231 articles, 982 were screened after removing duplicates. Following rigorous screening, 55 full-text articles were assessed, and 10 high-quality studies were included for detailed evaluation. Key findings highlight the clinical relevance and resistance patterns of extended-spectrum β -lactamase (ESBL) producing *Escherichia coli*, MDR *Pseudomonas aeruginosa*, and MDR *Acinetobacter baumannii* in hospital settings.

Conclusion: This review underscores the knowledge gaps regarding the prevalence of MDR ESKAPE pathogens and highlights the need to prioritize therapeutic strategies for managing HAIs.

Keywords: Multi-drug resistance, ESKAPE pathogens, Hospital-associated infections, Antibiotic resistance

Introduction

Hospital-associated infections caused by multidrug-resistant pathogens impose a significant burden on healthcare systems due to elevated morbidity and mortality rates. The overuse and misuse of antibiotics have facilitated the evolution of pathogens resistant to most existing treatments (Chaudhary et al., 2022). These infections result in approximately 68,000 deaths annually across the EU/EEA and the United States, with an economic loss of €1.6 billion and \$55 billion, respectively (Ahmad and Khan, 2019). Recognizing this global health threat, the World Health Organization (WHO) emphasizes the urgency of implementing a coordinated action plan to address MDR (World Health Organization, 2024).

High-risk pathogens like ESKAPE (Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter species) are prevalent in ICUs, where they form biofilms on medical equipment, complicating treatment strategies (Chaudhary et al., 2023). Studies reveal the emergence of resistance mechanisms to last-resort antibiotics such as polymyxins, further exacerbating the challenge (Ayoub, 2020; Mohapatra et al., 2021).

This review addresses the prevalence, resistance trends, and therapeutic interventions for MDR pathogens in hospital settings. It also highlights the need for rapid diagnostic technologies and robust disinfection strategies to mitigate the spread of MDR pathogens effectively.

Methodology: A comprehensive review was conducted using different databases. Data from the past five years were analyzed.

Data Collection

Data were collected following PRISMA guidelines through a systematic literature review conducted on July 19, 2024. Articles published in English over the last five years were included.

Research Design

Research data were sourced from databases such as Medline/PubMed, EMBASE, Cochrane Library, Google Scholar, and ScienceDirect. Keywords like "multidrug resistance pathogens," "ESKAPE pathogens," "hospital-associated infections," and "antibiotic resistance trends" were used. Boolean operators were applied to combine search terms, and citations were manually reviewed.

Data Analysis

The review included studies focusing on the prevalence of MDR pathogens and HAIs. Non-English articles, unpublished data, studies older than 2020, and unrelated editorials were excluded. Screening and quality assessment processes ensured the inclusion of high-quality studies.

Results

Search Strategy and Screening

A total of 4,131 articles were retrieved. After filtering duplicates, 1,082 articles remained. Title and abstract screening reduced the pool to 65 full-text articles, of which 10 met the inclusion criteria for in-depth analysis.

Quality Assessment

The SANRA criteria evaluated articles based on aim clarity, literature description, scientific reasoning, data representation, and overall study quality. High-quality studies, such as Murray et al. (2022) and Cruz-López et al. (2023), demonstrated strong scientific rigor.

Discussion

MDR pathogens pose a severe challenge to healthcare, particularly in ICUs, where their prevalence is highest among males and elderly patients (≥ 60 years). Regional disparities, such as the high incidence of carbapenem-resistant *Acinetobacter baumannii* in Southeast Asia, underscore the need for targeted interventions (Teerawattanapong et al., 2018). Resistance trends vary, with some pathogens like MRSA showing a decline, while others, such as ESBL-producing *Escherichia coli*, exhibit an upward trend due to community transmission (Tilahun et al., 2022).

Novel therapeutic interventions, including alternative therapies and modern antibiotics, are crucial. Hospital environments, as reservoirs of MDR pathogens, require effective infection control programs, disinfection strategies, and robust microbiology laboratory capacities. Collaboration on global surveillance and policy development is essential for mitigating MDR pathogens.

Conclusion

This review emphasizes the interconnected challenges of HAIs and MDR pathogens. Addressing these issues requires interdisciplinary research, enhanced healthcare infrastructure, and global collaboration. Future efforts must focus on innovative diagnostic and therapeutic approaches to combat this growing public health threat.

Consent for Publication: Not applicable

Conflict of Interest: The authors declare no conflict of interest.

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