

Meta-Analysis of Carbapenem Resistance in *Acinetobacter baumannii*: A Comparative Study of Community-Acquired and Hospital-Acquired Strains

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Abstract: This meta-analysis investigates the prevalence and mechanisms of carbapenem resistance in *Acinetobacter baumannii*, comparing strains acquired in community settings to those from hospital environments. Analyzing data from multiple studies, the review identifies a notable difference in resistance patterns between community-acquired and hospital-acquired strains. Hospital-acquired strains exhibit a higher prevalence of resistance, attributed to factors such as prolonged antibiotic use and inadequate infection control measures. Mechanisms of resistance, including the production of carbapenemases and alterations in membrane permeability, are more common in hospital-acquired strains. The findings highlight the need for targeted surveillance and tailored infection control strategies in healthcare settings to address this growing threat. Recommendations for future research include exploring novel therapeutic approaches and improving resistance monitoring frameworks.

Keywords: Carbapenem resistance, *Acinetobacter baumannii*, Community-acquired infections, Hospital-acquired infections, Meta-analysis, Resistance mechanisms.

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Introduction

Carbapenem-resistant *Acinetobacter baumannii* (CRAB) has emerged as a critical concern in both community and hospital settings, posing significant challenges for treatment and infection control. *A. baumannii* is known for its ability to acquire and spread antibiotic resistance genes, particularly those conferring resistance to carbapenems, which are often considered drugs of last resort (Bergogne-Bérézin et al., 2015; Lee et al., 2019). Carbapenem resistance in *A. baumannii* can be attributed to several mechanisms, including the production of carbapenemases such as OXA-type β -lactamases and metallo- β -lactamases (Canton et al., 2008; Yoon et al., 2020).

The prevalence and patterns of carbapenem resistance can differ significantly between community-acquired and hospital-acquired infections. Hospital-acquired strains often exhibit higher levels of resistance due to the selective pressure exerted by broad-spectrum antibiotics and the prevalence of complex resistance mechanisms (Tzouveleakis et al., 2012; Doi et al., 2017). In contrast, community-acquired strains might present different resistance patterns, potentially influenced by environmental factors and less intense selective pressure (Nair et al., 2018; Hsu et al., 2021).

A meta-analysis of carbapenem resistance in *A. baumannii* is crucial to elucidate these differences and to inform strategies for

controlling and treating infections in diverse settings. By synthesizing data from multiple studies, this review aims to provide a comprehensive comparison of resistance patterns between community-acquired and hospital-acquired *A. baumannii* strains. Understanding these patterns can enhance our approach to surveillance, infection control, and treatment strategies for CRAB.

Methodology

To conduct this meta-analysis, a comprehensive search strategy was employed to gather relevant studies on carbapenem resistance in *Acinetobacter baumannii*. Multiple electronic databases, including PubMed, Scopus, and Web of Science, were systematically searched using terms related to carbapenem resistance, *Acinetobacter baumannii*, and both community-acquired and hospital-acquired infections. Studies included in the analysis were selected based on predetermined inclusion criteria, which involved a focus on carbapenem resistance and providing comparative data between community-acquired and hospital-acquired strains. Exclusion criteria ruled out studies that did not provide clear epidemiological data or lacked relevant comparative information. Data extraction was carried out by multiple reviewers to ensure accuracy and consistency, and the quality of the studies was assessed using established tools such as the Newcastle-Ottawa Scale and the Cochrane Risk of Bias tool. Statistical analyses involved calculating pooled estimates of resistance prevalence and

examining heterogeneity across studies, with meta-analyses conducted where appropriate.

Results

The results revealed a significant prevalence of carbapenem resistance in *Acinetobacter baumannii*, with varying levels of resistance observed between community-acquired and hospital-acquired strains. Community-acquired strains demonstrated a lower prevalence of resistance compared to hospital-acquired strains, which showed higher resistance rates and a broader spectrum of resistance mechanisms. The analysis identified several key mechanisms contributing to carbapenem resistance, including the production of carbapenemases and alterations in membrane permeability. These findings underscore the importance of distinguishing between resistance patterns in different settings to inform targeted infection control measures.

Discussion

The analysis of carbapenem resistance in *Acinetobacter baumannii* from community-acquired versus hospital-acquired settings reveals a stark contrast in resistance patterns, which has been corroborated by several recent studies. The data from this meta-analysis show that hospital-acquired strains exhibit significantly higher resistance rates compared to community-acquired strains. This observation aligns with recent research highlighting that healthcare environments are conducive to the development and propagation of resistant strains due to factors such as increased use of broad-spectrum antibiotics and high patient turnover (Kumar et al., 2020; Zhang et al., 2021).

In a recent study by Patel et al. (2023), hospital-acquired *A. baumannii* strains demonstrated high levels of carbapenem resistance, with a significant proportion of isolates harboring carbapenemase genes, particularly OXA-type and VIM-type carbapenemases. This study complements the findings of our meta-analysis by underscoring the role of specific resistance mechanisms in hospital settings. The study also found that the prevalence of carbapenemase-producing strains was notably higher in intensive care units, supporting the notion that high-density patient environments are critical factors for the emergence of resistant strains (Patel et al., 2023).

Conversely, community-acquired strains, as reported by Sharma et al. (2022), showed a relatively lower prevalence of carbapenem resistance. This lower resistance rate could be attributed to less frequent exposure to carbapenems in the community setting, where antibiotic use is generally more regulated and controlled compared to hospital environments. Sharma et al. (2022) observed that community-acquired *A. baumannii* strains often lacked the genetic determinants for high-level resistance, a finding that echoes our meta-analysis results.

Another recent investigation by Lee et al. (2024) compared resistance patterns across different geographical regions, highlighting a significant regional variability in carbapenem resistance rates. Their study found that hospital-acquired strains from regions with high antibiotic usage had greater resistance profiles, further supporting our meta-analysis conclusions. Lee et al. (2024) also noted that the implementation of stringent infection control practices in hospitals significantly reduced the prevalence of resistant strains, emphasizing the importance of hospital-based interventions.

The contrast between community-acquired and hospital-acquired strains highlights the critical need for differentiated public health strategies. In community settings, where resistance rates are lower, maintaining prudent antibiotic use and strengthening community health education can be effective. In contrast, hospital settings require more intensive measures, such as regular screening for carbapenem-resistant *A. baumannii*, rigorous infection control protocols, and stewardship programs to curb the spread of resistant strains.

Additionally, the limitations of the meta-analysis must be considered. Variability in study design, reporting practices, and geographical factors can influence the results. For instance, some studies included in the meta-analysis may have used different methodologies for resistance testing, which can affect the comparability of data. Addressing these limitations in future research by standardizing testing methods and expanding geographic coverage will enhance the robustness of findings and inform more effective strategies for combating carbapenem resistance.

Conclusion

This meta-analysis provides a comprehensive overview of carbapenem resistance in *Acinetobacter baumannii*, revealing significant differences between community-acquired and hospital-acquired strains. The findings underscore the need for targeted public health strategies to address the growing challenge of antibiotic resistance. Recommendations include enhancing surveillance systems, implementing stricter infection control measures, and conducting further research to explore the underlying mechanisms of resistance. Addressing these issues is crucial for improving patient outcomes and controlling the spread of resistant infections.

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