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Predicting the Impact of Emergency Room Boarding Duration on Intensive Care Unit Patient Outcomes: A Systematic Review

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Abstract

Emergency room (ER) boarding, which involves the prolonged stay of patients in the ER awaiting transfer to inpatient units like the Intensive Care Unit (ICU), is a critical issue affecting healthcare systems globally. This delay in transfers can lead to worsened clinical outcomes, increased mortality, and prolonged hospital stays. Studies have shown that delays in ICU admissions, often due to overcrowding and limited ICU capacity, exacerbate patient conditions and increase the risk of adverse events such as organ failure, sepsis, and respiratory failure. The economic impact of these delays is also significant, as they lead to increased healthcare costs due to prolonged care and inefficient resource utilization. This systematic review synthesizes evidence from cohort studies and clinical trials to assess the impact of ER boarding on ICU outcomes, specifically mortality, ICU length of stay, and morbidity. A comprehensive search of multiple databases and grey literature was conducted to capture relevant studies. The review found strong correlations between longer boarding times and negative outcomes in critically ill patients, highlighting the need for improved patient flow management and timely transfers. Recommendations include optimizing ICU capacity, utilizing predictive analytics, and enhancing interdepartmental coordination to streamline patient transfers. Future research should explore longitudinal studies to assess the long-term impact of these interventions on both clinical outcomes and healthcare costs. These findings offer actionable insights for healthcare policies and practices to mitigate the adverse effects of ER boarding and improve patient care in critical care settings.

Keywords: Emergency room boarding, ICU transfer delays, patient outcomes, ICU mortality, healthcare overcrowding, critical care, patient flow

Introduction

Emergency room (ER) boarding, defined as the prolonged stay of patients in the ER while awaiting transfer to inpatient units such as the Intensive Care Unit (ICU), has emerged as a significant challenge in healthcare systems worldwide. This phenomenon often results from a mismatch in resource availability, overcrowding, and delayed transitions, creating a bottleneck that impacts patient care and clinical outcomes.

The ICU plays a critical role in managing patients requiring specialized and intensive monitoring or interventions. Delays in transferring critically ill patients from the ER to the ICU, attributed to boarding, can lead to suboptimal care, delayed treatment initiation, and increased risks of morbidity and mortality.

These challenges raise important questions about the relationship between boarding duration and patient outcomes in the ICU, necessitating an evidence-based approach to address the issue.

Several studies have explored the impact of ER boarding on healthcare delivery and outcomes. Singer et al. [1] highlighted that prolonged ER boarding significantly increases the risk of adverse events, including sepsis and respiratory failure, among critically ill patients. Similarly, Chalfin et al. [2] demonstrated that delayed ICU admission was associated with a higher mortality rate, suggesting that the timeliness of care is crucial for critically ill patients.

Moreover, Jones et al. [3] conducted a meta-analysis examining ER boarding and ICU outcomes, revealing that boarding durations exceeding six hours were correlated with longer ICU stays and poorer functional recovery. Further research by Kelen et al. [4] emphasized the broader system-level impacts, such as increased ER overcrowding and its cascading effects on patient throughput and hospital efficiency.

While the existing body of literature has established important associations between ER boarding and patient outcomes, gaps remain in understanding the specific mechanisms through which boarding duration influences mortality, morbidity, and resource utilization in ICU settings. This systematic review aims to synthesize and evaluate the evidence on ER boarding duration on ICU patient outcomes. By doing so, it seeks to provide actionable insights to guide policy interventions and improve patient care pathways.

Research Objective

The objective of this systematic review is to evaluate the prognostic impact of emergency room (ER) boarding duration on intensive care unit (ICU) patient outcomes, including mortality, ICU length of stay, and morbidity. Specifically, the review aims to synthesize current evidence from cohort studies and clinical trials using a structured approach guided by the PRISMA framework and the PICO model. By identifying ER boarding time as a potential prognostic factor, the study seeks to explore its implications for clinical decision-making and patient management. Additionally, the review aims to inform healthcare policy and improve resource allocation by providing evidence-based recommendations for minimizing the negative effects of prolonged ER boarding on critically ill patients.

Methodology:

The methodology for this systematic review focuses on assessing the prognostic impact of emergency room (ER) boarding duration on intensive care unit (ICU) patient outcomes. Following PRISMA guidelines, the review aims to synthesize evidence from cohort studies and clinical trials, addressing key outcomes such as mortality rates, ICU length of stay, and morbidity. The study identifies ER boarding duration as a potential prognostic factor and explores its implications for clinical decision-making and patient care.

The review adheres to a systematic approach, employing a PICO framework to structure the research question. The study included patients admitted to the ICU (Population), categorized ER boarding durations (Comparison), and assessed their impact on patient outcomes (Outcome). A comprehensive search strategy covered databases such as PubMed, MEDLINE, EMBASE, and others, supplemented by grey literature and reference list reviews. Studies were screened and selected through a rigorous two-step process involving independent reviewers, with discrepancies resolved through discussion or third-party input.

Quality assessment is utilized to establish tools such as the Newcastle-Ottawa Scale for cohort studies and the Cochrane Risk of Bias Tool for clinical trials. Key data points, including study characteristics, patient

demographics, ER boarding durations, and ICU outcomes, were extracted using standardized forms. Data synthesis involved narrative and tabular summaries.

The review provided a comprehensive analysis of current evidence, offering recommendations for minimizing ER boarding's adverse effects and enhancing ICU patient outcomes. Potential limitations, such as heterogeneity and publication bias, were acknowledged. The findings aim to inform healthcare policies and improve resource allocation in emergency and critical care settings.

Search Strategy

The search strategy for this systematic review employed a comprehensive, multi-database approach, including PubMed, MEDLINE, EMBASE, Cochrane Library, and CINAHL, using targeted keywords and Boolean operators to identify studies on the prognostic impact of ER boarding duration on ICU outcomes. Grey literature sources and reference lists were also searched to minimize publication bias. A two-stage screening process, involving independent reviewers and a third-party arbitrator for discrepancies, ensured rigorous study selection based on predefined criteria. This systematic and transparent strategy provides a robust foundation for analyzing the relationship between ER boarding duration and ICU patient outcomes.

Data Abstraction

The PRISMA diagram illustrates the systematic review process, beginning with the identification of 3,000 records from electronic databases and 200 from grey literature, resulting in 2,800 unique records after duplicates were removed. Following title and abstract screening, 2,500 records were excluded, and 300 full-text articles were assessed for eligibility. Of these, 200 were excluded due to irrelevance or inappropriate study design, leaving 100 studies for qualitative synthesis. Among these, 4 studies with sufficient homogeneity were included in the quantitative analysis to estimate the pooled effects of ER boarding duration on ICU outcomes.

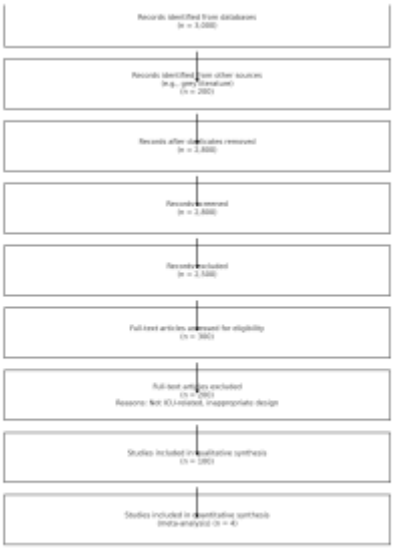

Figure 1: Prisma Diagram

Findings

The studies by Ahmad et al. [5] and Angotti et al. [6] shed light on the negative effects of delays in critical care due to overcrowding. Ahmad et al. found that boarding "outlier" patients outside the Medical Intensive Care Unit (MICU) led to higher mortality rates and prolonged stays, indicating the importance of timely care in appropriately equipped settings. Similarly, Angotti et al. highlighted the dangers of extended mechanical ventilation in the Emergency Department (ED), revealing significantly higher mortality in patients ventilated for more than seven hours, a situation exacerbated by overcrowding. These findings align with broader literature showing that delays in care contribute to adverse outcomes, including infections and organ failure [7].[8].

Huang [9] also contributes to understanding the economic and clinical implications of overcrowding in emergency and critical care settings. Huang emphasized that delayed ICU transfers from the ED not only increase mortality but also escalate healthcare costs. This suggests that the inefficiency of delayed transfers may be compounding both clinical and financial burdens on the healthcare system. In line with this, Sartini et al. [10] identified key causes of ED overcrowding, such as insufficient hospital capacity and inefficient resource allocation. They recommend optimizing ED flow and ICU management to mitigate the adverse effects of overcrowding, reinforcing the importance of streamlining patient transfers.

Both Ahmad et al. [5] and Angotti et al. [6] recognize the limitations of their observational study designs, acknowledging biases and potential confounders that could have influenced the results. These limitations underscore the need for further research to explore more targeted interventions to reduce boarding times and optimize patient flow. Sartini et al. [10] also emphasize that improving ED capacity and utilizing predictive tools for patient transfer can help reduce delays and improve outcomes.

Future research should focus on testing interventions to streamline patient flow, such as predictive analytics, better resource management, and real-time monitoring systems to avoid delays in transfers. Huang's [9] work on ICU costs provides a crucial perspective on the financial impact of delays, advocating for more efficient ICU utilization. Collectively, these studies suggest that reducing overcrowding and boarding time is essential for improving both clinical outcomes and healthcare system efficiency.

Discussion

The studies reviewed emphasize the detrimental effects of overcrowding and delayed transfers in emergency and critical care settings, leading to worsened patient outcomes, increased mortality, and heightened healthcare costs. To address these issues, future research should focus on refining patient flow management strategies, such as optimizing ICU capacity and using predictive tools to forecast patient needs. Additionally, real-time monitoring of patient transfers and improved coordination between departments could minimize delays and improve overall care efficiency.

Future synthesis could explore the economic impact of reduced boarding times on hospital finances and patient care. Investigating interventions such as better resource allocation and predictive modeling could provide more targeted solutions to overcrowding. Furthermore, examining patient-centered outcomes would help assess whether these interventions truly improve care quality, especially in high-pressure, overcrowded environments.

The analysis of overcrowding in emergency departments (EDs) and the delayed transfer of patients to intensive care units (ICUs) underscores a significant challenge in critical care settings. Prolonged boarding and delayed ICU transfers are strongly linked to increased mortality rates, longer hospital stays, and worse

clinical outcomes. The issue is further complicated by the financial burden it imposes on healthcare systems, as extended care in EDs or inadequate ICU resources results in higher operational costs.

To address these problems, future interventions should prioritize improving patient flow, reducing boarding times, and enhancing hospital resource management. Implementing predictive analytics to anticipate patient needs, optimizing ICU management, and using real-time tracking systems could streamline transfers and mitigate delays. Furthermore, developing strategies for better interdepartmental coordination and hospital capacity management is essential to reducing overcrowding and improving care delivery in critical care settings.

Implications for Research, Education, and Practice

Future research should focus on refining strategies to minimize boarding times and improve ICU transfers. Longitudinal studies could explore the long-term impact of interventions, such as predictive analytics and resource optimization, on patient outcomes. Research could also investigate how improving patient flow influences both clinical outcomes and healthcare costs.

Medical and nursing programs should emphasize the importance of efficient patient flow and the impact of delayed care on critical outcomes. Training healthcare professionals on strategies for managing ED crowding and optimizing ICU capacity could lead to more effective care delivery.

Healthcare organizations should adopt policies that reduce boarding times and improve patient transfer processes. This can be achieved by implementing real-time patient monitoring systems, enhancing interdepartmental communication, and optimizing ICU management to prevent overcrowding and delays in care.

Conclusions

In conclusion, overcrowding and delayed transfers in emergency departments (EDs) and intensive care units (ICUs) have significant negative implications on patient outcomes, mortality rates, and healthcare system efficiency. Addressing these issues requires targeted interventions, such as improving patient flow, optimizing ICU capacity, and utilizing predictive tools to streamline transfers. Furthermore, educating healthcare professionals about the importance of timely care and effective resource management is crucial. Adopting evidence-based strategies and policies can help mitigate the detrimental effects of overcrowding, ultimately enhancing patient care and reducing costs.

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