(REVIEW ARTICLE)

A Scoping Review of Electronic Triage Systems in Emergency Departments

Anthony Vincent Razzano *

Department of Business Administration and Economics, Worcester State University, Worcester, Massachusetts, United States.

Abstract

Background: Emergency departments (EDs) face significant challenges, including overcrowding and long wait times, which negatively impact patient outcomes and operational efficiency. The integration of triage technologies aims to address these issues by improving patient flow, reducing wait times, and enhancing the accuracy of triage decisions.

Methodology: This scoping review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews checklist, utilizing a systematic search of literature on PubMed. The search focused on free full-text accessible articles published in 2023, using keywords "emergency department," "triage system," and "overcrowding." A total of 13 articles were initially identified, with 3 being selected for in-depth review based on relevance and quality. The review focuses on the following population, intervention, comparison, and outcome (PICO) question: "Within hospital emergency departments, how does the implementation of triage technologies compare to traditional triage practices impact efficiency, patient outcomes, and resource allocation?"

Conclusion: The review found that triage technologies, such as the Electronic Canadian Triage and Acuity Scale and Visual Triage Systems, have significantly improved patient flow and reduced wait times in ED settings. Despite challenges such as the need for cultural adaptations and comprehensive training, the studies highlight the potential of these technologies to enhance ED operations. Future research should focus on refining triage algorithms, ensuring consistent training, and expanding the implementation of successful triage systems to diverse regions. Addressing these challenges will further optimize the effectiveness of triage technologies, leading to better patient outcomes and more efficient ED operations.

Keywords: Emergency department; Triage system; Overcrowding

1. Introduction

Emergency departments (EDs) are designed to provide immediate care for patients with acute illnesses or injuries within hospitals. The complex nature of EDs creates obstacles for hospitals to optimize operations and efficiently service patients with immediate care needs. Overcrowding and long lengths of stay are prominent indicators of poor performance in EDs, with reports of patients in Italy waiting up to 12 hours for treatment.[1] Many patients treated in the ED are quickly readmitted, indicating lower quality of care. For example, high readmission rate for acute aortic syndromes highlights the need to improve initial examinations during ED initial visits.[2] Patients seeking immediate treatment within ED settings often do not fully understand their condition, which requires additional time and resources for clinicians to accurately diagnose.[3] Ensuring proper readiness to combat the complex and limited resources of ED settings can improve health equity among different populations. Racial and ethnic disparities in adolescents' mortality exist for acute medical emergencies, and enhancing ED readiness in hospitals could reduce these disparities threefold.[4]

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* Corresponding author: Anthony Vincent Razzano

The limited resources and complex nature of ED settings cause long wait times, which lead to overcrowding. Overcrowding has long been a significant issue affecting global healthcare, particularly in EDs, and the COVID-19 pandemic has exacerbated this already critical problem.[5] Overcrowding in the ED results from various factors, contributing to increased patient volume, higher mortality and morbidity rates, reduced timeliness of critical care services, and potential exceeding of optimal capacity levels. Overcrowding can negatively impact the ED environment for both patients and staff. Delirious older patients experience exacerbated symptoms due to prolonged ED wait times, leading to compromised care quality and heightened readmission rates.[6-7] Additionally, overcrowding leads inadequate treatment plans, longer hospital stays, and extended durations in critical care units, with various indicators utilized in literature to measure congestion levels.[8] Hospitals that consistently explore strategies to enhance the structural efficiency of EDs can reduce overcrowding, optimize resource allocation, and improve patient outcomes.[9]

Health system technologies play an important role in ED operations. Emergency medicine is increasingly adopting digital health technologies, including those leveraging electronic health record (EHR) systems, medical imaging software, and telehealth systems.[10] In complex ED environments, ongoing patient triage is necessary to prioritize and direct patients to suitable locations and providers based on their evolving conditions. Hospitals leverage triage systems to effectively assess, classify, and communicate patient condition for effective resource allocation and documentation. Effective triage decision-making in the emergency room is critical as it significantly impacts clinical outcomes, yet establishing a consistent standard to categorize patients remains challenging.[11] Advancements to electronic triage systems are influenced by standards, such as the Electronic Canadian Triage and Acuity Scale (E-CTAS), which categorizes patients into five levels to manage patient flow and prioritize patient access to healthcare services.[12] Implementing triage systems in different ED settings requires cultural adaptation, staff training, and validation to ensure effectiveness and reliability.[13] Properly implemented ED triage systems improve patient flow and decreases wasted time and energy of staff.[14] Hospitals must critically assess their current ED triage systems to ensure that capabilities and functionalities are adequately meeting the needs of staff to effectively categorize, communicate, and place patients in appropriate settings.

The intent of this scoping review is to explore the current state of ED triage systems in operations. The review aims to address the following population, intervention, comparison, and outcome (PICO) question: "Within hospital emergency departments, how does the implementation of triage technologies compare to traditional triage practices impact efficiency, patient outcomes, and resource allocation?" The scoping review systematically assesses existing literature related to ED triage systems to address the PICO question and identify the benefits, challenges, and recommendations of ED triage technologies.

2. Materials and methods

Scoping reviews, providing a comprehensive perspective, are becoming crucial in handling the growing research corpus in rapidly advancing fields, with a notable increase in their use in healthcare literature.[15] This scoping review is guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA) checklist. The review systematically searches existing literature available on PubMed. The scholarly database of PubMed serves as a vital resource for research by offering extensive access to a vast array of life science, peer-reviewed, and vetted journals.[16]

The search strategy for this scoping review included a systematic literature review of literature on PubMed. The search inquiry included free full-text accessible articles in the English language, published in the year 2023. The search terms included "emergency department," "triage system," and "overcrowding." The search inquiry returned 13 articles, all of which were deemed eligible for evidence selection. After review of the title and abstract of each article, results were subsequently narrowed to 5 articles that appeared most relevant. Upon thorough examination of the full text of these 5 articles, results were further distilled to 3 articles that contained the most pertinent information for the study. These 3 articles were then chosen as the primary evidence for the research.
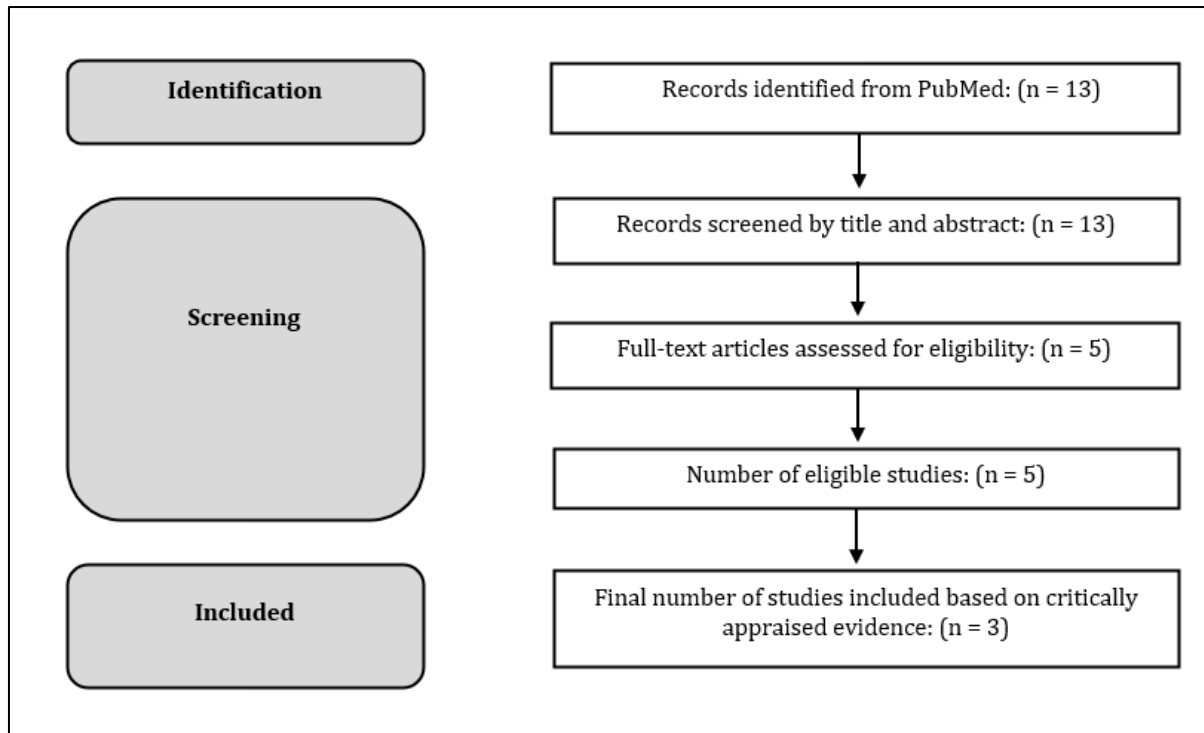
Figure 1 PRISMA Flow Diagram

3. Result

This scoping review employs a simple data charting process to extract and present information derived from the studies. Key aspects of each study, including its scope, design, population, and statistical relevance, are presented in Table 1. The scope refers to the overarching intent or objective of the study, while the design encapsulates the chosen research method or framework employed in the study.[17] The population denotes the group of individuals who participated in the study. The statistical relevance signifies the measurability and applicability of the study's findings to the research topic.

Table 1 Study Comparison

Scope	Type of study	Population	Statistical relevance
Evaluate the use of kiosks to improve triage efficiency in EDs [18]	Literature review	Nine articles on the introduction of kiosks in EDs	EDs using kiosks were associated with an almost 57% shorter waiting time compared to those without kiosks
The study examines the impact of transitioning from a 4-level triage (4LT) system to a 5-level triage (5LT) system in an emergency department, focusing on patient waiting times, the frequency of under-triage and over-triage, and overall ED efficiency [19]	Retrospective observational study	Two groups: the 5LT group with 307,198 patients who accessed the ED from November 30, 2015, to December 31, 2020, and the 4LT group with 116,060 patients who accessed the ED from January 1, 2014, to November 30, 2015	During the 5LT period, there was a statistically significant increase in older patients (p < 0.001), with a significant decrease in patients arriving by personal transport (39.1% vs. 20.8%, p < 0.001) and an increase in those arriving by ambulance (27.6% vs. 37.2%, p < 0.001)
Assesses the satisfaction and perceived effectiveness of the Visual Triage System (VTS)	Cross-sectional, observational study using an	127 healthcare workers from two hospitals in Riyadh, including ED nurses	Utilizing a 5-point scale system to prioritize patients in the ED, enhancing timely and

among healthcare workers in EDs of two major hospitals in Riyadh during the COVID-19 pandemic [20]	online self-administered questionnaire	(53.5%), and ED physicians (15%)	accurate decision-making in alignment with the core purpose of triage in medical settings

4. Discussion

The first article, a literature review, critically assessed the effectiveness of kiosks in enhancing triage efficiency within ED settings.[18] Six out of nine studies reported positive outcomes, such as reduced pre-triage times, while three studies highlighted challenges of low uptake.[18] Strengths of the study include a comprehensive review of multiple sources and a focus on measurable outcomes like waiting times. Weaknesses involve the variability in study quality and inconsistent metrics across studies.[18] Opportunities lie in further research and broader implementation of kiosks, with recommendations for integrating kiosks to support but not replace nurse-led triage processes to improve patient flow and outcomes.

The second, a retrospective observational study, evaluated the implementation of a 5-level triage (5LT) system compared to a 4-level triage (4LT) system in an ED, evaluating its effect on patient management and efficiency.[19] The 5LT system demonstrated improvements in managing waiting times and triage accuracy, with significant reductions in under-triage and over-triage incidents.[19] Strengths of the study include its large cohort size and real-world data collection, although its retrospective design and monocentric nature limit generalizability. Opportunities for further research include developing models to address increased overcrowding and refining artificial intelligence triage algorithms for better integration into nursing routines.[19] The study recommends various EDs to consider adopting the 5LT model, supported by ongoing research to optimize triage responses and reduce wait times amidst increasing crowding.

The third, a cross-sectional and observational study, evaluated the effectiveness and satisfaction levels of the Visual Triage System (VTS) from the perspectives of healthcare workers in two prominent hospitals in Riyadh during the COVID-19 pandemic.[20] The study utilized a cross-sectional design, employing an online self-administered questionnaire distributed to 127 healthcare workers, predominantly ED nurses, inpatient specialists, and ED physicians. Key findings include a high level of satisfaction with the VTS and its perceived effectiveness in managing patient triage during the pandemic.[20] Strengths of the study include the comprehensive demographic representation and direct feedback from frontline workers, which provide valuable insights into the system's performance. Weaknesses involve potential response bias and the limited geographic scope. Opportunities highlighted by the study suggest expanding the VTS to other regions and continuous system improvements based on user feedback.[20] Recommendations include ongoing training for healthcare workers, regular updates to the VTS, and further research to explore long-term impacts on patient outcomes.

The three articles highlight several key themes and patterns in the implementation and evaluation of triage technologies in ED settings. [18-20] Across the studies, the importance of triage systems in improving patient flow and outcomes is evident. The adoption of digital triage systems, such as the E-CTAS and the VTS, has shown to enhance efficiency, reduce waiting times, and improve triage accuracy. [18-20] For instance, the transition from a 4-level to a 5-level triage system significantly improved the management of patient wait times and reduced incidents of under-triage and over-triage. Similarly, the use of kiosks demonstrated a 57% reduction in waiting times, underscoring the positive impact of technology on ED operations.[18]

Several challenges in ED triage systems persist. The need for cultural adaptation and rigorous training, particularly in diverse regions like Brazil, highlights the complexity of implementing a one-size-fits-all solution.[20] The studies also indicate that while technology can streamline processes, it cannot completely replace the critical role of healthcare professionals.[18-20] Furthermore, ensuring consistent and comprehensive training, addressing potential biases, and expanding the scope of studies are necessary to optimize the effectiveness of these technologies.

Future recommendations emphasize the need for ongoing research to refine triage algorithms and integrate them seamlessly into healthcare routines. [18-20] Expanding the implementation of successful triage systems like E-CTAS and VTS to other regions, accompanied by robust validation studies, is crucial. Additionally, continuous feedback loops involving healthcare workers can drive iterative improvements in these systems. [18-20] Addressing the identified challenges through targeted training programs, culturally sensitive adaptations, and comprehensive evaluations will enhance the overall impact of triage technologies in emergency departments, ultimately leading to better patient outcomes and more efficient ED operations.

5. Conclusion

The integration of triage technologies in EDs has shown significant promise in improving patient flow, reducing wait times, and enhancing triage accuracy.[18-20] Despite the challenges of variability in implementation and the need for cultural adaptations, the positive outcomes from studies highlight the potential for these technologies to transform ED operations.[18-20] Ongoing research, targeted training, and continuous system improvements are essential to fully realize the benefits and ensure the effective deployment of triage systems across diverse healthcare settings.

Compliance with ethical standards

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