

Optimizing Patient Care in the Emergency Department: Insights from Automated Alert Systems and Triage Strategies

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Abstract

Over the past three decades, various scoring systems have emerged in clinical practice, but evidence primarily originates from ward contexts, yielding conflicting data on their impact, including mortality and referrals. Although early intervention benefits emergency department (ED) patients, the effectiveness of early warning systems remains uncertain due to insufficient evidence. This systematic review aims to comprehensively analyze current literature, exploring the integration of automated alerts and novel triage methods in the ED. Thorough database searches (e.g., MEDLINE/PubMed, Cochrane Library) identified relevant articles meeting specific criteria: adults (≥ 18 years), randomized controlled trials, observational, and comparative studies. Inclusion focused on English-language, human-participant studies; exclusions involved pediatric, case, non-English studies, and abstract-only content. Initially, 260 studies underwent screening based on titles and abstracts, with 218 papers excluded. Subsequently, 42 papers underwent full-text assessment, eliminating articles not meeting the criteria. Ultimately, only four studies were deemed suitable for final data collection and inclusion in the review. The integration of technology-assisted decision support, combined triage approaches, and standardized assessment tools shows promise in enhancing patient outcomes and optimizing resource utilization. Nonetheless, the studies' limitations highlight the importance of robust research methods and a considerate implementation process. Advancing emergency care necessitates a harmonious balance between innovation and evidence-based practice to ensure the highest quality of patient well-being.

Keywords: Early warning score, mortality, triage methods, vital signs

Introduction

Physiological scoring systems such as the early warning score (EWS) play a vital role in quantifying the degree of deviation of physiological parameters from their normal values by consolidating them into a single numerical measure. These scores are extensively used in emergency departments (EDs) and general wards to promptly detect critically ill and deteriorating patients, facilitating early intervention and escalation of care [1].

Over the past three decades, several different scoring systems have been developed and implemented in clinical practice [2]. However, most of the supporting evidence comes from the ward setting, leading to conflicting data on the effectiveness of these scores in improving patient care, such as reduced mortality rates or increased referrals/admissions to intensive care facilities.

Despite the benefits of early care for many conditions in the ED [3-5], the benefit of EWS in this setting remains uncertain due to a lack of sufficient evidence. One of the reasons for the limited evidence could be that most EWS were originally developed based on ward data sets, which might not fully capture the unique challenges of the ED environment. ED patients often present with acute and rapidly resolved physiological disturbances (e.g., supraventricular tachycardia), making the application of ward-based scoring systems challenging [6,7]. For example, diseases that are normally mild can suddenly become very aggressive and potentially fatal for patients [8]. Recognizing these patients early in the ED is crucial. Therefore, EWS systems are of great importance in EDs.

In response to these concerns, the UK-based Royal College of Physicians developed the national early warning score (NEWS)



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and its updated version, NEWS2, to enhance the detection of patients at risk for deterioration, thereby triggering timely escalation of care [9,10]. Both NEWS and NEWS2 have demonstrated superior performance over other EWS in predicting mortality and clinical deterioration, leading to widespread adoption in hospitals and EDs in the UK and beyond [11,12].

However, EWS have faced criticism for their failure to consider chronic hypoxia in their scoring systems, particularly in patients with chronic pulmonary diseases. Current scoring systems often trigger similar scores for decreased oxygen saturations (SpO₂) regardless of patient age or disease chronicity, potentially resulting in higher scores for patients with chronic lung conditions. National guidelines for patients with chronic lung disease recommend lower SpO₂ target levels (88-92%) during oxygen therapy, which fall below the trigger thresholds of most EWS, including NEWS [11]. This could lead to an overestimation of physiological disturbance in patients with chronic lung disease.

To address these concerns, the NEWS2 was introduced in 2017, incorporating a new SpO₂ scoring scale specifically tailored to patients with or at risk of chronic lung disease and type II respiratory failure [9]. Some studies have indicated that a NEWS2 score ≥ 5 effectively identifies patients at a higher risk of death, potentially benefiting from intensive care unit (ICU) admission (sensitivity for in-hospital mortality: 84.5%, and for ICU admission: 83.4%) [13].

However, despite being an updated version of NEWS, some studies have reported lower success rates for NEWS2 in discriminating adverse outcomes, such as inpatient mortality, unanticipated ICU admission, or cardiac arrest within the first 24 hours of admission, when compared to NEWS [14].

Given these uncertainties, this systematic review aims to comprehensively assess and synthesize the current body of literature surrounding the integration of automated alert systems and innovative triage strategies in EDs.

Methods

This systematic review adheres to the recommendations provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines [15]. The primary objective of this review is to comprehensively analyze and consolidate existing literature on the incorporation of automated alert systems and inventive triage strategies within the ED. To achieve this goal, the study question was framed using the population, exposure (intervention), control group, and outcome framework, ensuring a predetermined and well-defined methodology for the investigation [16].

Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including MEDLINE/PubMed, PubMed Central, Google Scholar, and the Cochrane Library, to identify relevant articles for this study. The search terms encompassed EWSs “in conjunction with terms related to the” ED acute medical unit in adult populations. Additionally, extensive searches were performed in reference lists and relevant journals to ensure the inclusion of all pertinent papers. Two independent reviewers executed the search and selected articles for further assessment. Furthermore, the references of the initially retrieved papers were manually examined to uncover any additional research that might have been overlooked during the initial search.

Inclusion and Exclusion Criteria

We included studies that met the following inclusion criteria: adult patients aged 18 years and above, randomized controlled trials, observational studies, and comparative studies. Only studies involving human participants and published in the English language were considered for inclusion.

However, the review excluded studies that fell under the following criteria: pediatric populations, individual case studies, studies presented in the form of letters, responses to letters or comments, articles published in languages other than English, and studies with only abstracts available and lacking full-text content.

Risk-of-Bias Assessment

In this systematic review, we utilized the “risk of bias in non-randomised studies-of interventions (ROBINS-I)” tool to assess the ROBINS included in our analysis [17]. Two independent reviewers conducted the evaluation of each study, and any discrepancies were resolved through discussion or consultation with a third reviewer when necessary.

For each included study, the reviewers assessed bias across the various domains outlined in the ROBINS-I tool. They carefully examined the study design, participant selection methods, intervention classification, deviations from intended interventions, outcome measurement procedures, and potential selective reporting of results. Each domain was evaluated to determine the level of bias in the study.

Following the assessments, an overall judgment of the risk of bias for each study was assigned based on the findings from individual domains.

Results

Following the initial search across PubMed, Google Scholar, and the Cochrane Library, a substantial pool of 2,937 studies was identified. However, an automated screening tool flagged 2,615 studies as ineligible based on predefined criteria.

A total of 260 studies underwent the initial title and the abstract screening process, and of these, 218 papers were excluded from further consideration. The remaining 42 papers underwent full-text evaluation, where articles that did not align with the topic or meet the exclusion criteria were removed. Only 4 studies emerged as suitable candidates for the final data collection and inclusion in the review (Figure 1, Table 1) [18-21].

Discussion

The synthesis of the reviewed studies offers a comprehensive exploration into the intricate landscape of optimizing patient care within the ED by integrating automated alert systems and innovative triage strategies. These studies collectively unravel multifaceted insights that underscore the potential benefits, operational challenges, and ethical considerations associated with these transformative approaches. By delving into the intricacies of patient assessment, monitoring, and timely interventions, these studies contribute to the evolving paradigm of emergency care.

In the midst of the hectic and unpredictable clinical atmosphere of the ED, an automated EWS becomes a vital ally and safety net, providing crucial assistance to patients in these dynamic and bustling healthcare hubs [22-25].

Writing a clinical trial varies with respect to the audience it is intended for [26]. This consideration is essential in ensuring effective communication and tailored dissemination of study results to different stakeholders.

In Alam et al. [18] study, correlations between NEWS and patient outcomes were significant across various time points, encompassing 30-day mortality, hospital admission, and length of stay. Although bearing a moderate level of bias and operational challenges, the study’s findings indicate that NEWS holds potential value in the ED-distinct from its role as a triage system-by offering continuous monitoring throughout patients’ ED and hospital stay. While the study design is commendable, limitations in sample size and operational aspects warrant consideration.

The concept of leveraging technology-driven solutions, as observed in studies examining automated alert systems, introduces a promising avenue for proactive patient management. The integration of an automated decision support system coupled with the NEWS, as demonstrated in Howard et al. [21] showcases tangible improvements in patient outcomes, such as reduced adjusted hospital mortality and length of stay. This finding aligns with emerging evidence that underscores the role of EWSs in identifying patients at risk of decompensation. However, the presence of moderate bias in the study warrants a measured interpretation of the results and prompts a critical assessment of potential confounders that may influence the observed outcomes.

Triage is a crucial step in emergency care, evaluating the urgency of a patient’s clinical state. Various triage scales facilitate this evaluation [27-31]. Although generally displaying moderate to good validity [32], these scales may encounter challenges in terms of interrater reliability [27]. Additionally, while effective for prioritization, they might not serve as continuous monitoring tools in the ED [33]. This drawback could potentially result in undetected patient deterioration, especially during extended waiting periods.

The interplay between different triage strategies, notably the combination of the manchester triage system and the EWS, in McCabe et al. [19] study elucidates the potential to address the challenges posed by overcrowded EDs. While the study suggests positive effects on patient categorization and waiting times, the underlying operational complexities and the presence of serious bias necessitate caution in extrapolating the findings. This study underscores the intricate balance between appropriate prioritization, efficient resource utilization, and the need for a experienced clinical staff.

Direct comparisons between traditional triage scales and EWSs, as conducted in the Schinkel et al. [20] study, highlight the potential superiority of EWS in recognizing patients in need of urgent care. The robust performance of the modified

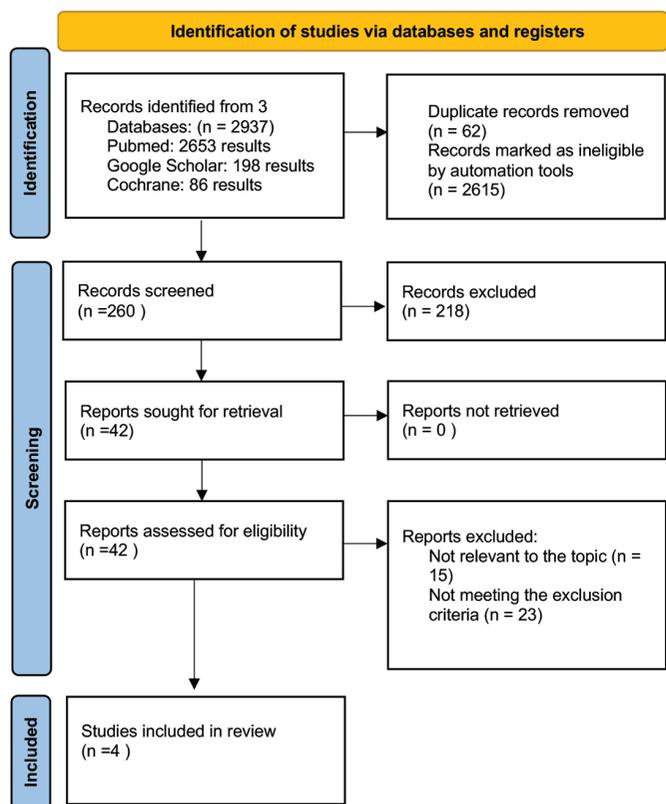


Figure 1. PRISMA diagram

PRISMA: Preferred reporting items for systematic reviews and meta-analyses

Table 1. Individual studies and their outcomes				
Author	Aims	Study design, setting, and sample	Main results	Conclusions
Alam et al. [18]	To explore the performance of the NEWS in an ED with regard to predicting adverse outcomes	Study design: prospective observational. Patients: ED attendees with ESI 2 and 3 (excluding resuscitation room). Intervention: NEWS recorded at T0, T1, and T2 (arrival, 1 hour after arrival, transfer to ward/ICU). Outcomes: hospital admission, ICU admission, length of stay, 30-day mortality	Complete data was able to be collected for 274 patients on arrival at the ED. NEWS was significantly correlated with patient outcomes, including 30 day mortality, hospital admission, and length of stay at all-time points	The NEWS measured at different time points was a good predictor of patient outcomes and can be of additional value in the ED to longitudinally monitor patients throughout their stay in the ED and in the hospital
McCabe et al. [19]	To determine the effect of the EWS in conjunction with the MTS on the accuracy of the MTS and waiting times for patients in the ED	A retrospective cohort chart review of all adult patients who presented to the ED in one large hospital in Ireland (n=10,048) at three time points between 1 st September 2015-30 th September 2016; 3 months prior to EWS introduction, implementation month and 9 months post implementation	Patients were significantly more likely to be categorised as an MTS category 2 (rather than 3-5) after the EWS was introduced (p<0.001). Waiting times between triage and clinician review (p<0.05) increased as did total time in the ED (p>0.001). A similar finding was observed for patients with an MTS of 3-5	Although positive in terms of patient outcomes, the effective and sustained combined use of the MTS and EWS requires increased bed capacity and experienced clinical staff to ensure that the ED journey time reduced rather than increased
Schinkel et al. [20]	To compare the ability of currently used triage scales and EWS scores to recognise patients in need of urgent care in the ED	A retrospective, single-centre study on all patients who presented to the ED of a Dutch level 1 trauma centre, between 1 September 2018 and 24 June 2020 and for whom a NTS score as well as a MEWS was recorded. The performance of these scores was assessed using surrogate markers	MEWS score had a significantly better AUC than the NTS for predicting the need for hospital admission (0.65 vs. 0.60; p<0.001) or 30-day all-cause mortality (0.70 vs 0.60; p<0.001). Furthermore, when non-urgent MEWS scores co-occur with urgent NTS scores, the MEWS score seems to more accurately capture the urgency level that is warranted	EWSs could potentially be used to replace the current emergency triage systems
Howard et al. [21]	To study the effectiveness of a early warning score based decision support system to detect and intervene on clinical decompensation in the ED by evaluating reductions in hospital mortality and LOS	If and when a vital sign(s) deviation occurred to the point that an overall NEWS score of "5" was reached, an electronic text alert was sent the pagers of both the charge nurse and ED physician, prompting the performance of a rapid clinical assessment	The control group consisted of 11 150 admissions (across a period of 12 months) and the intervention group consisted of 8.363 admissions (across a period of 9 months). The reduction in O/E LOS was significant, and although the reduction in adjusted O/E mortality did not quite reach a p value of 0.05 (p=0.09) the effect size was large (d=0.87) indicating a substantial difference	Using an automated decision support surveillance and alert system to trigger alerts for ED patients reduced both adjusted hospital mortality and hospital length of stay

NEWS: National early warning score, ED: Emergency department, ICU: Intensive care unit, MTS: Manchester triage system, NTS: Netherlands triage system, MEWS: Modified early warning score, AUC: Area under the curve, LOS: Length of stay

EWS in predicting the need for hospital admission and 30-day all-cause mortality challenges the conventional reliance on patient complaints as the basis for triage decisions. This study contributes to the growing body of literature advocating for standardized assessment tools that can enhance the accuracy and efficiency of patient prioritization. However, the

presence of serious bias underscores the importance of future investigations with rigorous designs and methodological robustness.

Among these insightful findings, it is imperative to acknowledge the limitations that underpin the studies. Operational

challenges, inherent biases, and relatively low patient numbers underscore the complexities of conducting research in a dynamic and fast-paced ED environment. While these studies provide valuable glimpses into the potential benefits of integrated approaches, they also emphasize the need for comprehensive evaluation and contextual understanding.

In conclusion, the amalgamation of these studies paints a nuanced portrait of optimizing patient care within the ED by merging automated alert systems and innovative triage strategies. The integration of technology-assisted decision support, combined triage methodologies, and standardized assessment tools holds promise for enhancing patient outcomes and streamlining resource allocation. However, the studies' limitations underscore the necessity of robust research methodologies and a thoughtful approach to implementation. The evolution of emergency care necessitates a concerted effort to balance innovation with evidence-based practice while striving to ensure the highest quality of care for patients in their most vulnerable moments.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: B.H.A., S.A., Design: B.H.A., S.A., Data Collection or Processing: B.H.A., S.A., Analysis or Interpretation: B.H.A., S.A., Literature Search: B.H.A., S.A., Writing: B.H.A., S.A.

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