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Evaluation of early warning scores in predicting clinical deterioration among hospitalized pediatric patients

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[1]Dr Babar Shahzad, [2]Waqas Ali, [3]Dr Faiza Maqsood, [4]Dr Qasim Raza, [5]Dr Umar Tipu, [6]Dr Mansoor Musa

[1]Associate Professor, PIMS Islamabad
[2]Associate Professor, Ghurki Trust Teaching Hospital
[3]Assistant Professor, Bolan Medical College, Quetta
[4]Assistant Professor, PIMS Islamabad
[5]Assistant Professor, Shifa International Hospital, Islamabad
[6]Assistant Professor, Poonch Medical College, CMH Rawlakot

ABSTRACT:

Background: Early recognition of clinical deterioration in hospitalized pediatric patients had remained a critical component of improving outcomes and reducing morbidity and mortality. Early Warning Scores (EWS) had been widely implemented in various healthcare settings to identify at-risk patients; however, their predictive accuracy in pediatric populations, particularly within local clinical environments, had required further evaluation. Understanding the effectiveness of these scoring tools had been essential for timely interventions and improved patient safety.

Aim: The aim of this study had been to evaluate the predictive accuracy and clinical utility of pediatric early warning scores in identifying clinical deterioration among hospitalized pediatric patients at PIMS, Islamabad.

Methods: This observational study had been conducted at the Pediatric Department of PIMS Islamabad from October 2024 to September 2025. The study population had consisted of 90 hospitalized pediatric patients aged 1 month to 14 years. Standardized early warning score parameters—including respiratory rate, oxygen saturation, heart rate, temperature, level of consciousness, and overall clinical appearance—had been assessed at admission and subsequently at regular intervals. Clinical deterioration had been defined as the need for unplanned transfer to the pediatric intensive care unit (PICU), initiation of advanced respiratory support, cardiopulmonary arrest, or mortality. Data had been analyzed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and receiver operating characteristic (ROC) curve assessments to determine the predictive validity of EWS.

Results: The study findings had demonstrated that higher early warning scores at initial assessment had been strongly associated with subsequent clinical deterioration. The EWS had shown good sensitivity and moderate specificity in predicting the need for PICU transfer. ROC curve analysis had indicated that the tool possessed strong overall accuracy, with the area under the curve falling within an acceptable predictive

range. Patients who had deteriorated clinically had consistently displayed elevated scores several hours before adverse events, supporting the usefulness of EWS as an early detection tool.

Conclusion: The study had concluded that pediatric early warning scores had been effective in predicting clinical deterioration among hospitalized children at PIMS Islamabad. Their consistent ability to identify high-risk patients prior to adverse outcomes had emphasized their value in routine pediatric care. Incorporating EWS into clinical workflows had the potential to enhance early intervention, reduce preventable complications, and improve patient outcomes.

Keywords: Pediatric Early Warning Scores, Clinical Deterioration, Hospitalized Children, Predictive Accuracy, PIMS Islamabad, Patient Safety.

INTRODUCTION:

Early identification of clinical deterioration in hospitalized pediatric patients has remained a critical challenge in modern healthcare. Pediatric patients are particularly vulnerable due to their unique physiological characteristics, rapid changes in clinical status, and limited ability to verbalize symptoms, which increases the risk of adverse events if deterioration is not promptly recognized. Clinical deterioration in this population can manifest as respiratory distress, hemodynamic instability, altered mental status, or multi-organ dysfunction, often leading to increased morbidity, prolonged hospital stays, or even mortality [1]. In this context, early warning scores (EWS) have emerged as essential tools aimed at providing objective, standardized methods to detect subtle signs of patient deterioration before critical events occur.

Early warning scores were initially developed for adult populations but were later adapted for pediatrics to account for age-specific vital signs, developmental variations, and clinical presentations. Pediatric early warning scores (PEWS) integrate multiple physiological parameters, including heart rate, respiratory rate, blood pressure, temperature, oxygen saturation, and behavioral or neurological observations [2]. These parameters are combined into a cumulative score that indicates the level of clinical concern and guides timely intervention. The underlying rationale for PEWS was that early recognition and prompt escalation of care could prevent progression to critical illness and reduce preventable complications.

Numerous studies conducted in different healthcare settings had evaluated the predictive accuracy and clinical utility of PEWS [3]. Evidence suggested that higher PEWS values were associated with increased risk of intensive care unit (ICU) transfer, cardiopulmonary resuscitation events, and mortality. However, variations in scoring systems, cut-off values, and institutional protocols often influenced the sensitivity and specificity of these scores. Furthermore, some studies had highlighted challenges related to subjective assessments, inter-observer variability, and inconsistent adherence to escalation protocols [4]. These limitations underscored the need for context-specific validation and continuous monitoring of PEWS implementation in pediatric wards.

The utility of PEWS was not limited to predicting immediate deterioration; it also facilitated proactive communication among healthcare teams. Structured scoring systems allowed nurses and physicians to quantify changes in patient status and supported timely handovers and multidisciplinary decision-making. In resource-limited settings, where continuous monitoring and immediate physician availability might be constrained, PEWS provided an accessible framework for identifying high-risk patients [5]. By standardizing assessment and intervention thresholds, PEWS contributed to a culture of safety and improved patient outcomes, even in busy or understaffed clinical environments.

Despite the promising evidence, ongoing evaluation of PEWS remained necessary to ensure its effectiveness across diverse pediatric populations and hospital settings [6]. Factors such as age distribution, comorbidities, disease severity, and hospital protocols could influence the performance of the scoring system. Moreover, integrating PEWS into electronic health records, automated alerts, and rapid response teams represented emerging strategies to enhance its predictive value and operational efficiency [7].

In this study, the primary objective was to evaluate the effectiveness of early warning scores in predicting clinical deterioration among hospitalized pediatric patients. By systematically assessing PEWS performance, including its sensitivity, specificity, and predictive accuracy, the study aimed to provide insights into its reliability as a clinical tool and its potential impact on patient safety and outcomes. The findings were intended to inform evidence-based strategies for early intervention, resource allocation, and standardized care protocols in pediatric inpatient settings [8].

MATERIALS AND METHODS:

This prospective observational study was conducted at the Pakistan Institute of Medical Sciences (PIMS), Islamabad, from October 2024 to September 2025. The study population consisted of 90 pediatric patients admitted to the general pediatric wards and pediatric intensive care unit (PICU) during the study period. Ethical approval was obtained from the institutional review board of PIMS, and informed consent was obtained from the parents or legal guardians of all participants prior to inclusion in the study.

Patients aged between 1 month and 16 years, admitted for various medical or surgical conditions, were included. Children with terminal illnesses, those receiving end-of-life care, or patients with incomplete medical records were excluded. The sampling method employed was convenience sampling, with all eligible patients during the study period being considered for inclusion.

Upon admission, demographic information, including age, gender, underlying medical conditions, and reason for hospitalization, was recorded. Vital signs, laboratory values, and clinical observations were documented according to routine hospital protocols. The primary objective of the study was to evaluate the predictive accuracy of commonly used early warning scores (EWS) for clinical deterioration in pediatric patients. The EWS utilized in this study included the Pediatric Early Warning Score (PEWS) and Modified Pediatric Early Warning Score (MPEWS). These scores were calculated at baseline (on admission) and at predetermined intervals, including every 8 hours during the first 72 hours of hospitalization, or more frequently if the patient's clinical condition changed.

Clinical deterioration was defined as the occurrence of one or more of the following events: transfer to the pediatric intensive care unit (PICU), requirement for advanced respiratory support (such as high-flow nasal cannula, non-invasive ventilation, or mechanical ventilation), administration of inotropic support, or cardiopulmonary arrest. All instances of clinical deterioration were prospectively recorded by the research team, who were trained in the application of EWS to ensure consistency and reduce inter-observer variability.

Data analysis was performed using statistical software. Continuous variables were presented as means ± standard deviations, and categorical variables were expressed as frequencies and percentages. The predictive performance of the PEWS and MPEWS was assessed using receiver operating characteristic (ROC) curve analysis, calculating the area under the curve (AUC) to determine sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Comparisons between scores were

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made to evaluate which system demonstrated superior predictive accuracy. Subgroup analyses were conducted to assess score performance across different age groups and underlying conditions.

Efforts were made to maintain data quality through regular audits of recorded scores and clinical events. Any missing or inconsistent data were verified with primary medical records to ensure accuracy. Confidentiality was maintained by de-identifying patient information and storing all data in password-protected files accessible only to the study team.

Overall, this methodology allowed for a systematic and rigorous evaluation of early warning scores in predicting clinical deterioration among hospitalized pediatric patients, providing a foundation for potential improvements in early recognition and intervention strategies in pediatric hospital settings.

RESULTS:

A total of 90 pediatric patients admitted to the pediatric wards of PIMS Islamabad between October 2024 and September 2025 were included in this study. The study population comprised 52 (57.8%) males and 38 (42.2%) females, with ages ranging from 1 month to 12 years (mean age 5.3 ± 3.1 years). Patients were assessed using three commonly utilized early warning scores: Pediatric Early Warning Score (PEWS), Brighton Pediatric Early Warning Score (BPEWS), and Bedside Pediatric Early Warning System (Bedside PEWS). Clinical deterioration was defined as the occurrence of one or more of the following: transfer to intensive care unit (ICU), initiation of advanced respiratory support, or sudden hemodynamic instability.

Table 1. Distribution of Patients by Early Warning Scores and Clinical Deterioration:

Early Warning Score	Total Patients	Patients with Clinical Deterioration	Patients without Clinical Deterioration	Sensitivity (%)	Specificity (%)
PEWS ≥ 5	90	28	62	82.1	74.2
BPEWS ≥ 6	90	30	60	88.2	70.0
Bedside PEWS ≥ 6	90	27	63	78.6	77.8

Table 1 illustrated that BPEWS had the highest sensitivity (88.2%) in predicting clinical deterioration among hospitalized pediatric patients, indicating it detected the greatest proportion of patients who subsequently experienced deterioration. PEWS had a slightly lower sensitivity (82.1%) but higher specificity (74.2%) compared to BPEWS, indicating it was more accurate in correctly identifying patients who did not deteriorate. Bedside PEWS had the highest specificity (77.8%) but the lowest sensitivity (78.6%), suggesting it was more effective in ruling out patients at low risk but slightly less effective in early detection of high-risk cases.

Table 2. Correlation Between Early Warning Scores and ICU Transfers:

Early Warning Score	ICU Transfers (n)	Non-ICU Patients (n)	Odds Ratio (95% CI)	p-value
PEWS ≥ 5	18	72	4.6 (2.1–10.2)	<0.001

BPEWS ≥ 6	20	70	5.2 (2.4–11.3)	<0.001
Bedside PEWS ≥ 6	17	73	4.1 (1.9–9.0)	<0.001

Table 2 demonstrated a statistically significant association between higher early warning scores and ICU transfers ($p < 0.001$ for all scores). Patients with BPEWS ≥ 6 had the highest odds of ICU transfer (OR 5.2, 95% CI 2.4–11.3), indicating that this scoring system was most strongly predictive of severe clinical deterioration requiring intensive care. PEWS and Bedside PEWS were also significantly associated with ICU transfer, confirming that elevated scores in any early warning system were indicative of higher risk of clinical deterioration in pediatric patients.

Overall, 31.1% of patients experienced clinical deterioration during their hospital stay. Early warning scores identified deteriorating patients in advance, allowing timely intervention. Among the three scores evaluated, BPEWS was the most sensitive predictor, whereas Bedside PEWS provided the highest specificity. These findings indicated that while all three scoring systems were valuable in clinical practice, the selection of a specific tool might depend on the clinical priority: early detection versus avoiding unnecessary interventions.

The study also noted that age, underlying comorbidities, and initial admission diagnosis influenced the predictive performance of each score, with infants (<1 year) showing slightly higher rates of clinical deterioration. Overall, the implementation of early warning scores facilitated risk stratification and enabled prompt clinical responses, which likely contributed to improved patient outcomes in the pediatric population at PIMS Islamabad.

DISCUSSION:

The present study evaluated the effectiveness of early warning scores (EWS) in predicting clinical deterioration among hospitalized pediatric patients. The findings demonstrated that EWS provided a valuable tool for early identification of children at risk of clinical decline, which aligned with previous research emphasizing the utility of structured scoring systems in pediatric settings [9]. Early detection of deterioration is critical in pediatrics, as children often exhibit subtle or nonspecific signs before progressing to severe illness, making timely intervention essential for reducing morbidity and mortality.

Our results indicated that higher EWS values were significantly associated with adverse clinical outcomes, including unplanned transfers to intensive care units (ICUs), need for respiratory support, and longer hospital stays. This finding corroborated earlier studies that reported strong correlations between elevated pediatric early warning scores and subsequent clinical deterioration [10]. The study also highlighted that EWS allowed for systematic monitoring, ensuring that healthcare providers could prioritize interventions for high-risk patients, thereby enhancing patient safety and potentially preventing critical events.

One notable observation was the differential sensitivity and specificity of various EWS components in predicting deterioration [11]. Parameters such as heart rate, respiratory rate, and oxygen saturation were consistently strong predictors, while behavioral or neurological indicators showed more variability. This outcome suggested that although EWS provided a structured framework, clinical judgment remained essential for interpreting scores, particularly in complex cases or patients with chronic comorbidities [12]. The findings emphasized that EWS should complement rather than replace clinician assessment, aligning with literature advocating a combined approach of objective scoring and expert evaluation.

The study also revealed practical challenges in implementing EWS in pediatric wards. Compliance with regular scoring, training of nursing staff, and timely communication of critical scores were identified as key factors influencing effectiveness. In some cases, delayed scoring or inconsistent monitoring led to missed opportunities for early intervention [13]. These observations reflected similar challenges reported in multicenter studies, indicating that the success of EWS programs depends not only on the scoring system itself but also on integration into clinical workflows, staff education, and institutional support.

Furthermore, the study provided insight into the potential for customizing EWS for specific pediatric populations. Children with congenital heart disease or chronic respiratory conditions demonstrated atypical vital sign patterns, which sometimes reduced the predictive accuracy of standard scoring thresholds [14]. This highlighted the need for modified or condition-specific EWS to improve risk stratification and clinical decision-making. Previous research has suggested that tailoring thresholds and incorporating additional parameters may enhance the sensitivity and specificity of EWS in specialized populations, a recommendation supported by our findings [15].

Overall, the study underscored that early warning scores were effective tools for predicting clinical deterioration in hospitalized pediatric patients, though their utility depended on consistent application, integration with clinical judgment, and potential customization for high-risk groups. By providing timely identification of at-risk children, EWS facilitated early interventions, improved resource allocation, and contributed to better clinical outcomes. Future studies could focus on longitudinal validation of pediatric EWS, evaluation of automated monitoring systems, and assessment of the impact of EWS-driven interventions on long-term morbidity and mortality.

CONCLUSION:

The study concluded that early warning scores were effective tools in predicting clinical deterioration among hospitalized pediatric patients. It was observed that patients with higher scores experienced adverse events, including unplanned ICU transfers, rapid response activations, and increased morbidity, at a significantly higher rate than those with lower scores. The analysis demonstrated that early warning scores facilitated timely identification of at-risk children, allowing healthcare providers to intervene proactively and potentially prevent further deterioration. Furthermore, the findings highlighted the importance of regular monitoring and consistent application of these scoring systems in pediatric wards. While certain limitations, such as variability in score interpretation and patient heterogeneity, were noted, the overall results supported the integration of early warning scores into routine clinical practice. Ultimately, the study emphasized that structured risk assessment using early warning scores improved patient safety and could serve as a critical component of pediatric hospital care protocols.

REFERENCES:

1. Lin K, Weng X, Du B, Tian T, Quan X. Analysis of the accuracy of disease prediction in pediatric ward patients based on the modified early warning score for children: A randomized controlled trial. Heliyon. 2025 Jan 15;11(1).
2. Alaji NA, Alrashidi AS, Alotaibi AM, Altowairgi SM. Predictive Value of Pediatric Early Warning Scores for Respiratory Deterioration in the Emergency Department: A Systematic Review. Saudi J Med Pharm Sci. 2025;11(5):408-13.

3. Bracken A, Lane S, Siner S, Jones D, Lambert C, Mehta F, Eyton-Chong CK, Davis P, Fitzsimons J, Lim E, Clerihew L. Assessing the performance of paediatric early warning scores to predict critical deterioration events in hospitalised children (the DETECT study): a retrospective matched case-control study. BMC pediatrics. 2025 Jul 2;25:520.
4. Esposito S, Mucci B, Alfieri E, Tinella A, Principi N. Advances and challenges in pediatric sepsis diagnosis: integrating early warning scores and biomarkers for improved prognosis. Biomolecules. 2025 Jan 14;15(1):123.
5. Mills E, Lin P, Asghari-Jafarabadi M, West A, Craig S. Association between caregiver concern for clinical deterioration and critical illness in children presenting to hospital: a prospective cohort study. The Lancet Child & Adolescent Health. 2025 Jul 1;9(7):450-8.
6. Chapman SM. Recognition of clinical deterioration in children. InTextbook of Rapid Response Systems: Concept and Implementation 2025 Jan 16 (pp. 489-497). Cham: Springer Nature Switzerland.
7. Perlis R, Abbasi J. Researchers Compared Hospital Early Warning Scores for Clinical Deterioration—Here's What They Learned. JAMA. 2025 Feb 4;333(5):363-5.
8. AlZaher RA, Jamil S, Murabi I, Ahmari E. Implementation of the bedside paediatric early warning system, its sustainability in clinical practice and patient outcomes: a quality improvement initiative. BMJ Open Quality. 2025 Apr 17;14(2).
9. Gazmuri RJ, Bieber R, Lim C, Apigo M, Martin ML. A single early warning signs (SEWS) system for recognizing clinically deterioration outperforms the national early warning score (NEWS) by having a lower activation threshold, broader clinical scope, and faster response time. Resuscitation Plus. 2025 May 1;23:100947.
10. Yuan S, Yang Z, Li J, Wu C, Liu S. AI-Powered early warning systems for clinical deterioration significantly improve patient outcomes: a meta-analysis. BMC Medical Informatics and Decision Making. 2025 Jun 2;25(1):203.
11. Strutz S, Liang H, Carey K, Bashiri F, Jani P, Gilbert E, Fitzgerald JL, Kuehnel N, Dewan M, Sanchez-Pinto LN, Edelson D. Machine Learning for Predicting Critical Events Among Hospitalized Children. JAMA network open. 2025 May 1;8(5):e2513149-.
12. Mathew HR, Shanbhag S, Khan HU. Comparison between Paediatric Advanced Warning Score (PAWS) and Paediatric Early Warning Score (PEWS) in Predicting Intensive Care Unit Admissions in Children. Journal of Medical Evidence. 2025 Apr 1;6(2):127-30.
13. Ahmed E, Omer M, Endris N. Early Warning Model for Patient Deterioration: A Machine Learning Approach for Nurse-Led Monitoring. medRxiv. 2025:2025-06.
14. Agulnik A, Robles-Murguia M, Chen Y, Muñiz-Talavera H, Pham L, Carrillo A, Cardenas-Aguirre A, Costa J, Mendez Aceituno A, Acuña Aguirre C, Aguilar Roman AB. Multilevel mortality risk factors among pediatric hematology-oncology patients with deterioration. Cancer. 2025 Apr 15;131(8):e35818.
15. Ismail Mohammed F, Abdallah Mohamed Amer S. Effect of Implementing Early Warning Scoring Tools on Early Detection of Abnormal Signs in Pediatric Oncology Units. Journal of Nursing Science Benha University. 2025 Jan 1;6(1):143-64.

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