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Evaluating the Pediatric Early Warning Score (PEWS) System for Admitted Patients in the Pediatric Emergency Department

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Abstract

Objectives—The Pediatric Early Warning Score (PEWS) systems were developed to provide a reproducible assessment of a child's clinical status while hospitalized. Most studies investigating the PEWS evaluate its usefulness in the inpatient setting. Limited studies evaluate the effectiveness and integration of PEWS in the pediatric emergency department (ED). The goal of this study was to explore the test characteristics of an ED-assigned PEWS score for intensive care unit (ICU) admission or clinical deterioration in admitted patients.

Methods—This was a prospective 12-month observational study of patients, aged 0 to 21 years, admitted from the ED of an urban, tertiary care children's hospital. ED nurses were instructed in PEWS assignment and electronic medical record (EMR) documentation. Interrater reliability between nurses was evaluated. PEWS scores were measured at initial assessment (P_0) and time of admission (P_1). Patients were stratified into outcome groups: those admitted to the ICU either from the ED or as transfers from the floor and those admitted to the floor only. Clinical deterioration was defined as transfer to the ICU within 6 hours or within 6 to 24 hours of admission. PEWS scores and receiver operating characteristic (ROC) curves were compared for patients admitted to the floor, ICU, and with clinical deterioration.

Results—The authors evaluated 12,306 consecutively admitted patients, with 99% having a PEWS documented in the EMR. Interrater reliability was excellent (intraclass coefficient 0.91). A total of 1,300 (10.6%) patients were admitted to the ICU and 11,066 (89.4%) were admitted to the floor. PEWS scores were higher for patients in the ICU group (P_0 = 2.8, SD ± 2.4; P_1 = 3.2, SD ± 2.4; $p < 0.0001$) versus floor patients (P_0 = 0.7, SD ± 1.2; P_1 = 0.5, SD ± 0.9; $p < 0.0001$). To predict the need for ICU admission, the optimal cutoff points on the ROC are P_0 = 1 and P_1 = 2, with areas under the ROC curve (AUCs) of 0.79 and 0.86, respectively. The likelihood ratios (LRs) for these optimal cutoff points were as follows: P_0 +LR = 2.5 (95% confidence interval [CI] = 2.4 to 2.6, $p < 0.05$), −LR = 0.32 (95% CI = 0.28 to 0.36, $p < 0.05$); and P_1 +LR = 6.2 (95% CI = 5.8 to 6.6, $p < 0.05$), −LR = 0.32 (95% CI = 0.29 to 0.35, $p < 0.05$). For every unit increase in P_0 and P_1, the odds of admission to the ICU were 1.9 times greater (95% CI = 1.8 to 1.9, $p < 0.0001$) and 2.9 times greater (95% CI = 2.7 to 3.1, $p < 0.0001$) than to the floor. There were 89 patients in

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the clinical deterioration group, with 36 (0.3%) patients transferred to the ICU within 6 hours of admission and 53 (0.4%) patients transferred within 6 to 24 hours. In this group, an elevated P_0 and P_1 were statistically associated with an increased risk of transfer with optimal cutoff points similar to above; however, there were poorer AUCs and test characteristics.

Conclusions—A PEWS system was implemented in this pediatric ED with excellent data capture and nurse interrater reliability. The study found that an elevated PEWS is associated with need for ICU admission directly from the ED and as a transfer, but lacks the necessary test characteristics to be used independently in the ED environment.

The early identification of patients at risk of clinical deterioration and matching the severity of illness to the appropriate level of care are integral components of high-quality medical care, as is appropriate resource allocation in the hospital setting. The establishment and implementation of inpatient medical emergency teams (METs) addresses the deterioration of hospitalized patients. Prior studies in adults and children have demonstrated that physiologic changes in patient status can be identified in the hours preceding cardiac arrest.[1-4] The MET concept was designed as a direct response to the impending deterioration of a patient admitted to the hospital, but ideally such patients should be identified as early and accurately as possible. Recent studies have been geared toward early warning scores and their ability to identify at risk patients. For children, the original concept of a Pediatric Early Warning Score (PEWS) system was developed to provide a reproducible assessment of the pediatric patient's status based on physiologic parameters.[5-12] Multiple pediatric scoring systems have been developed worldwide, and Monaghan's PEWS is one of the most simple and flexible systems.[5] It is quickly performed, is not age specific, and has five domains: behavior, cardiovascular status, respiratory status, nebulizer use, and persistent postsurgical vomiting.[5,6,11] Monaghan's PEWS has been validated in retrospective studies of the inpatient floor setting of pediatric hospitals.[12,13]

Despite the extensive literature discussing PEWS in the inpatient setting, there are limited published studies evaluating the utility of PEWS systems in the pediatric emergency department (ED). To date, there are two studies evaluating the ability of PEWS systems to predict which patients in the pediatric ED need admission to the intensive care unit (ICU). A recent study from a pediatric hospital in the Netherlands evaluated the validity of multiple PEWS scores. The authors tested the performance of ten different established PEWS in the ED, with the discriminative ability of each PEWS determined to be poor to moderate for predicting hospitalization and moderate to good for predicting ICU admission.[14] A second study by Breslin et al.[15] sought to determine the association between PEWS at time of ED disposition and level of care and included both admitted and discharged patients in the cohort. The authors concluded that PEWS is associated with the level of care at ED disposition, but cannot accurately be used in isolation.

Our study objective was to explore if the PEWS assigned in the ED predicts the need for ICU admission from the ED or clinical deterioration in admitted patients. Most earlier studies investigating the various uses of PEWS in hospitalized patients have had positive findings, implying that a PEWS will help identify those patients who will go on to need intensive care therapies. Despite this trend, we hypothesized that a PEWS obtained in the

ED setting would not reliably identify those patients in need of ICU beds due to various factors specific to the ED and thus would not be an independently effective disposition or treatment tool.

METHODS

Study Design

This was a prospective 12-month observational study of consecutive Emergency Severity Index (ESI) category 2 or 3 patients admitted from the ED to the hospital floor or ICUs (pediatric or cardiac). This study was approved by our institutional review board.

Study Setting and Population

The study hospital is an urban, free-standing, tertiary care children's hospital with over 85,000 ED visits per year, with an average admission rate of 18%. Eligible patients presented to the ED between October 1, 2012, and September 30, 2013. Patients were excluded from the study if they were older than 21 years of age, ESI category 1, admitted to the neonatal ICU, transferred to another facility, or expired while in the ED. The ESI is a well-established algorithm that triages patients based on the predicted need for resources and life-saving interventions.[16] This system has five tiers, with tier 1 being assigned to the patients requiring the most resources. For our study, we opted to include only ESI category 2 and 3 patients, as category 1 patients are from the outset identified as needing extensive resources and more likely to be critically ill, whereas category 4 and 5 are likely to be discharged. In our institution, all admitted patients are upgraded to a minimum of category 3 and thus are captured in this data set.

Study Protocol

Prior to study initiation, all ED registered nurses were trained by one author (DG), using institution-based learning modules. Additionally, clinical scenarios with an emphasis on PEWS assignment were distributed. Education sessions continued throughout the year to capture and educate new nurse hires. Interrater reliability between nurses was evaluated in a subset of five ED nurses prior to study patient enrollment.

The Monaghan PEWS[5] was used as adapted by our hospital (Table 1), and institutional parameters for normal vital signs were the basis for comparison. Our institutional vitals are based on a combination of Pediatric Advanced Life Support and multiple established text-book ranges. For each study patient, PEWS was measured at initial assessment (P_0) and time of admission (P_1) in the ED. Also, as the PEWS was originally designed to be a trended score, the difference between P_0 and P_1 ($P_1 – P_0$) was named P_Δ. This variable was analyzed in comparison to the time elapsed between assignment of P_0 and P_1 ($P_{\Delta\text{-time}}$). The nurses entered these scores into discrete fields of the electronic medical record (EMR). Physicians were not informed of the assigned PEWS, and the scores are located in an area of the EMR outside of the normal workflow for the physicians. Disposition decisions were made without physician knowledge of the patients' PEWS scores. All study data, demographics, clinical characteristics, and diagnoses were documented in the EMR in real time and extracted by the hospital electronic database warehouse to create the study database.

For analysis, admissions were stratified into two outcome groups: patients admitted to the ICU (initially from the ED or subsequently from the floor) and patients admitted to the floor (with no ICU transfer). Additionally, patients initially admitted to the floor and subsequently transferred to the ICU within 24 hours of admission were analyzed.

Data Analysis

We tested the effects of the initial PEWS and admission PEWS on admission to the ICU (including direct admission to the ICU and transfer to the ICU within 24 hours of admission to the floor). The transfer patients are further analyzed as a subset outcome group and broken down into two outcomes: transfer to ICU within 6 hours of admission to the floor and transfer within 6 to 24 hours of admission to floor. Logistic regression was used for analysis of predictor variables (P_0 or P_1) on above binary outcomes. The validity of PEWS was demonstrated by the receiver operating characteristic (ROC) curves. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the likelihood ratio (LR) for ICU admission were calculated using the optimal cutoff point of each ROC. Interrater reliability was analyzed with the intraclass correlation coefficient (ICC). The Spearman correlation was used to analyze the relationship between P_Δ and $P_{\Delta\text{-time}}$. The outcome of patients with missing data was also evaluated. All tests were conducted in SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Study Population and Data Collection

Over the study period, 85,340 patients were evaluated in the ED, with 13,184 hospital admissions (15.5%). Of those admissions, 878 (6.6%) were excluded by established criteria from the study, yielding 12,306 consecutive patients for data analysis. Of these patients, 11,066 (89.4%) were admitted directly to the floor, with roughly 10% of total patients at some point in their hospitalization being admitted to or transferred to the ICU. Patient enrollment and characteristics are shown in Figure 1 and Table 2.

From the total evaluated, 12,166 (98.9%) patients had at least one PEWS score recorded; 140 (1.1%) patients were missing both P_0 and P_1, 1,163 (9.45%) were missing P_0, and 838 (6.8%) were missing P_1. Patients missing either P_0 or P_1 had significantly higher odds of admission to the ICU during their hospital courses (odds ratio 4.4, $p < 0.0001$). Interrater reliability was determined to be excellent (ICC = 0.91).

Disposition to ICU Versus Floor

Both the P_0 and the P_1 were significantly higher for patients in the ICU group ($P_0 = 2.8$, SD ± 2.4; $P_1 = 3.2$, SD ± 2.4; $p<0.0001$) than for floor patients ($P_0 = 0.7$, SD ± 1.2; $P_1 = 0.5$, SD ± 0.9; $p < 0.0001$). In comparing both P_0 and P_1, there was also a significant overall difference between the four admission groups (direct to ICU, admit to floor with transfer between 0 and 6 hours, transfer between 6 and 24 hours, or admit to floor only; $p < 0.0001$). Pairwise comparisons among the four groups demonstrated a significant difference in PEWS between the patient groups that went to the ICU as opposed to those who stayed on the floor ($p < 0.0001$; Figure 2).

The ROC curves of the PEWS are shown in Figure 3. For every one-unit increase in P_0, the odds of admission to the ICU were 1.9 times greater than admission to the floor (95% confidence interval [CI] = 1.8–1.9, $p < 0.0001$). For every one-unit increase in P_1, the odds of admission to ICU were 2.9 times greater than admission to the floor (95% CI = 2.7 to 3.05, $p < 0.0001$). For the ICU group, the optimal cutoff points based on the ROC were P_0 = 1 and P_1 = 2 (Figure 3; for sensitivity, specificity, PPV, NPV, and LR of these cutoff points see Table 3). As a subanalysis, we did evaluate the effects of season on admission to the ICU. There was no statistically significant correlation.

Transfer Patients and P_Δ

The ROC curves of the PEWS in this population subset are shown in Figure 3. For every one-unit increase in P_0 and P_1, the odds of ICU transfer within 6 hours of admission to floor were increased by 1.6 times (95% CI = 1.4 to 1.9, $p < 0.0001$) and two times (95% CI = 1.6 to 2.4, $p < 0.0001$), respectively. The optimal cutoff points based on the ROC for this group were P_0 = 1 and P_1 = 1. For every one-unit increase in P_0 and P_1 the odds of transferring to the ICU within 6 to 24 hours of admission to the floor were increased by 1.4 times (95% CI = 1.2 to 1.7, $p < 0.0001$) and 1.7 times (95% CI = 1.4 to 2.01, $p < 0.0001$), respectively. The optimal cutoff points for this group were P_0 = 2 and P_1 = 1.

The P_Δ was calculated for 10,445 patients (85%). The mean P_Δ over the course of the ED visit and after all ED interventions was negligible (mean ± SD 0.07 ± 1.4). The mean (±SD) $P_{\Delta\text{-time}}$ was 3.7 (±1.8) hours. The correlation between P_Δ and $P_{\Delta\text{-time}}$ was weak (Spearman correlation 0.02).

DISCUSSION

In our study, we found that elevated PEWS scores are statistically associated with the need for ICU care. Additionally, we found that the PEWS system can be implemented in a busy ED and embedded into the EMR, with excellent nurse interrater reliability. This is important, as previous studies used study personnel in some form to assign the PEWS and did not have ED nurses assigning PEWS to their patients. Having all ED nurses score their patients is a more accurate reflection of how PEWS would be used in the clinical environment.

The area under the ROC curve (AUC) for both P_0 and P_1 in the ICU group reflect good expected performance, but the optimal cutoff scores for each were P_0 = 1 and P_1 = 2 (+LR = 2.5, −LR = 0.32; and +LR = 6.2, −LR = 0.32; Figure 3).[17] Given these test characteristics, to admit these patients using the optimal PEWS cut points alone would result in an inappropriate two-to fourfold increase in ICU admission rate. It would also incorrectly predict admission to the floor instead of the ICU in roughly 25% of patients (Table 3). Additionally, with such low PEWS scores serving as optimal cutoff points, this demonstrates a skewed distribution in which it is difficult to differentiate the critically ill patients from controls. Notably, the P_1 demonstrated higher discriminant ability for ICU admission with improved sensitivity, specificity, and +LR, compared to P_0.

During the 12-month study period, 12,306 patients were admitted, of whom only 89 (0.7%) were transferred from the floor to the ICU. The optimal cutoff points were similar to the ICU group, with decreased sensitivity and specificity compared to the ICU group (Figure 3). Presumably, this small percentage of transfer patients reflects appropriate initial disposition to the floor by the ED physician. The average change in PEWS after ED interventions (P_{Δ}) was zero, and there was no correlation between P_{Δ} and $P_{\Delta\text{-time}}$. This implies that PEWS scores are not significantly affected by medical interventions or length of stay in the ED.

Our results are in agreement with recent publications by Seiger et al.[14] and Breslin et al.[15] The study by Seiger et al. from the Netherlands evaluated 10 different PEWS and their ability to predict admission to the hospital or ICU.[14] Correspondingly, the authors found PEWS to be moderate to good at predicting admission to the ICU (AUC of 0.79 for the Monaghan's PEWS). The optimal cutoff level on the ROC was a PEWS score of 1. Our populations had similar admission rates to the hospital and ICU, as well as overall numbers of subjects. The authors addressed missing data with a multiple imputation model that imputes a value drawn from an estimate of the distribution of the variable to create a complete database.[14] Our findings suggest that patients with missing data were more likely to go to the ICU, in contradistinction to their findings. A novelty of our current study is the demonstrated ability to embed and record the PEWS in the EMR in real time. In aggregate, the finding in a different country and hospital system demonstrates reproducibility of the signal of an ED-implemented PEWS.

The study by Breslin et al. evaluated the association between a single PEWS at time of ED disposition and level of care and whether this system could predict the need for admission.[15] The study had a small convenience sample of 383 patients admitted to the floor and ICU, as well as those who were discharged to home. A study team collected data and assigned PEWS at the time of disposition, with moderate agreement between scorers (ICC = 0.67). They found that an increase in PEWS was associated with increased risk of needing ICU admission and that a PEWS of 1 had the highest discriminant ability to predict admission, while a PEWS of 3 or higher predicted the need for an ICU bed. Analysis of patients with respiratory complaints only found that the PEWS in this population had increased sensitivity and specificity with regard to predicting admission compared to the study group. Overall, the authors concluded that the PEWS does not provide adequate sensitivity and specificity to be used in isolation.[15] Of note, this study was published after our data collection and analysis was completed.

Additional other studies have investigated the PEWS in the general ED setting. A small case-control study by Edgell et al.[7] devised a novel scoring system for pediatric patient assessment in the ED of a large tertiary referral hospital in England and retrospectively assigned this score to the study patients to determine if it correlated with admission to the ICU. Using a trigger score of 3 or higher, their scoring system was able to identify patients needing pediatric ICU admission with good sensitivity and specificity.[7] Adshead and Thomson[18] discussed the implementation of PEWS to determine if the score could help adult trained nurses to accurately assess children's needs and interventions; this study did not attempt to validate PEWS in this setting. The Monaghan PEWS has also been investigated as a potential admission tool.[15,19,20] In 2008, Bradman and Maconochie[19] evaluated whether PEWS can be used as a tool to identify from triage children who would require hospital admission. They found that PEWS is of limited value in predicting admission as a triage tool in the undifferentiated patient with a lower likelihood of admission in a patient scoring less than 2, although this finding was not statistically significant.[19] A subsequent study by Bradman et al.[20] in 2012 further evaluated PEWS as a triage tool and compared its accuracy with the pediatric risk of admission score (PRISA) and triage nurses. The triages nurses were found to be best at predicting the need for patient admission, followed by the PEWS, then the PRISA score.

In studies involving PEWS, the overarching conclusion is that an elevated score is associated with sicker patients at higher risk of needing ICU care.[11,13-15] This is logically to be expected, as PEWS is based in part on physiologic data and it is known that abnormalities in vital signs often accompany critical illness.[21-25] Notably, a recent study on the effects of mandating MET activation on the hospital floor based solely on PEWS score demonstrated an increase in METs, with an overall decrease in interventions and ICU transfers and no significant change in “code blue” calls.[26] Our results concur with previous studies in demonstrating that a patient with a higher PEWS is more likely to need an ICU bed. Yet, the more clinically relevant question asks whether there is an actual cutoff PEWS score determined in the ED that can reliably predict the need for ICU admission with acceptable test characteristics. We found that the PEWS alone lacks sufficient statistical strength to optimally capture those patients at risk of deterioration from the ED and if used in isolation will result in the incorrect disposition of a significant cohort of patients (Table 3). The PEWS system is not particularly sensitive as it has a broad scoring range (0 to 13) with low scores frequently seen in patients who clinically needed admission to the hospital or ICU (Figure 2). The ED is a dynamic environment with patients frequently having alterations in physiologic parameters due to the acuity of illness or injury, medication, pain, fear, and anxiety. Such factors would result in elevated PEWS scores that do not reflect actual illness. Additionally, these undifferentiated patients are in the ED for a relatively limited time. Previous studies demonstrated increased performance of the PEWS over the prolonged periods of observation intrinsic to the inpatient floor.[5,6,10,13,27] These reasons and others likely contribute to the lack of sensitivity of the present PEWS in the ED. It should be noted that these scoring systems were designed for the inpatient setting as an alert to practitioners that a patient with an elevated score may need more frequent evaluation. In Monaghan’s original study,[5] the cutoff score was determined to be 4, and those patients required quick assessment on the floor with 96% requiring medical intervention. Of those patients who received intervention, 83% stayed on the regular floor, while 17% deteriorated and needed intensive care therapies.[5] Using Monaghan’s cutoff score of 4 at the time of admission in our study population would result in an unnecessary twofold increase in admission to the ICU (Figure 3).

Notwithstanding the above findings, the continued investigation of alternative uses for the PEWS in the ED setting may be warranted. Bonafide et al.[28] published a qualitative evaluation of the PEWS and its perceived effects on patient safety. They found that despite the marginal performance of PEWS when applied to data sets, clinicians who recently experienced failures of PEWS still considered the system valuable. The authors suggested combining the PEWS with clinician judgment to create a better system for recognition of clinical deterioration.[28] Similarly, in a survey of 254 general EDs in the United Kingdom, a majority of practitioners support the use of early warning systems in the ED, despite the evidence that such scores lack sufficient sensitivity to be used as risk assessment tools.[29] Another more recent study from Britain confirms a significant increase in the use of PEWS since 2005, particularly in tertiary centers that have MET teams available, and recommends a coordinated national evaluation of implementation and standardization of the system to establish effectiveness.[30] In light of such studies, the decision to implement such a tool in the ED may be undertaken as one of many clinical considerations the emergency physician balances or as a starting point for inpatient PEWS monitoring.

LIMITATIONS

We depended on the accuracy of nursing staff assigning the PEWS for all statistical analysis. It is possible that the scores were not entirely accurate, as study personnel did not manually recheck every score for the entire study population. However, we did determine excellent interrater reliability (ICC = 0.91), from which we can extrapolate that our nurses were able to reliably assign the correct PEWS. Missing data were found in only a small subset of our patients, and we found that unlike other studies, there were more missing data points for patients admitted to the ICU compared to the floor. This is intuitively logical, as sicker patients require more nursing care, which may limit the ability to assign a PEWS score. This was a single institution site, potentially limiting generalizability. Additionally, we defined clinical deterioration as transfer from the floor to the ICU and severity of illness as related to direct admission to the ICU from the ED. Both of these outcomes serve as proxies for patient outcomes and therefore may not reflect actual physiologic need. Variation in practice regarding the definition of need for ICU admission may affect corroboration of our findings. We also excluded triage category 1, 4, or 5 patients, as these patients were intrinsically at less risk for incorrect disposition. Lastly, there are different PEWS systems that could be evaluated. The Monaghan PEWS was chosen as it has been validated in the hospital setting, can be assigned quickly and accurately by busy ED nurses, and is the system already used hospital-wide at our institution.

CONCLUSIONS

The Pediatric Early Warning Score system can be implemented in a busy, dynamic ED with excellent data capture. Patients with elevated scores are statistically more likely to be admitted directly to the intensive care unit or transferred to the intensive care unit from the floor. However, while there may be compelling reasons to consider using the Pediatric Early Warning Score in the ED, alone the tool lacks sufficient test characteristics to determine disposition or predict deterioration on the floor. Using the optimal cutoff score to predict disposition from the ED would result in a two- to fourfold increase in intensive care unit admission rate, as well as incorrectly place roughly 25% of intensive care unit patients on the floor. Future studies evaluating the Pediatric Early Warning Score in concert with other variables may discover more robust findings. A modified early warning score for the pediatric ED setting may be more sensitive, but no such score has been developed at this time.

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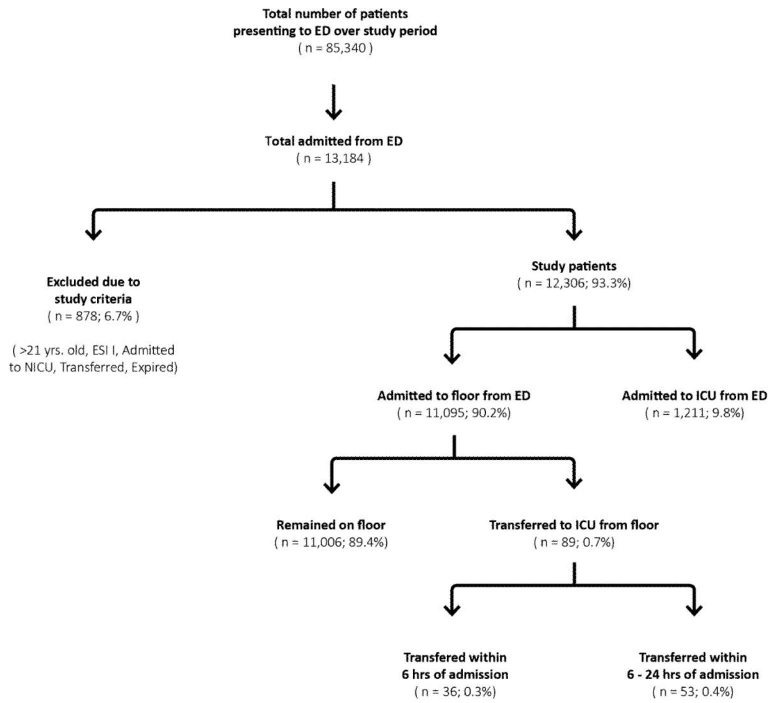

Figure 1.

Patient enrollment. ESI = Emergency Severity Index; ICU = intensive care unit; NICU = neonatal intensive care unit.

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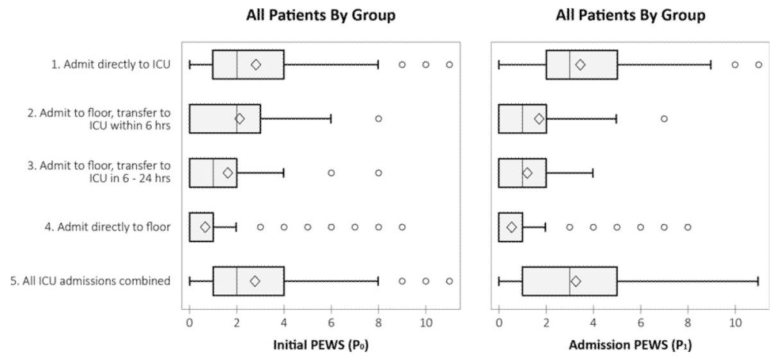

Figure 2.

PEWS Score in Patient Outcome Groups. The bottom and top edges of the box indicate the IQR. The line inside the box indicates the median value; the diamond symbol represents the mean. The whiskers that extend from each box indicate the range of values that are outside of the IQR. Any points that are a distance of more than 1.5 × IQR from the box are considered to be out liers. These points are indicated by circles. ICU = intensive care unit; IQR = interquartile range; PEWS = Pediatric Early Warning System.

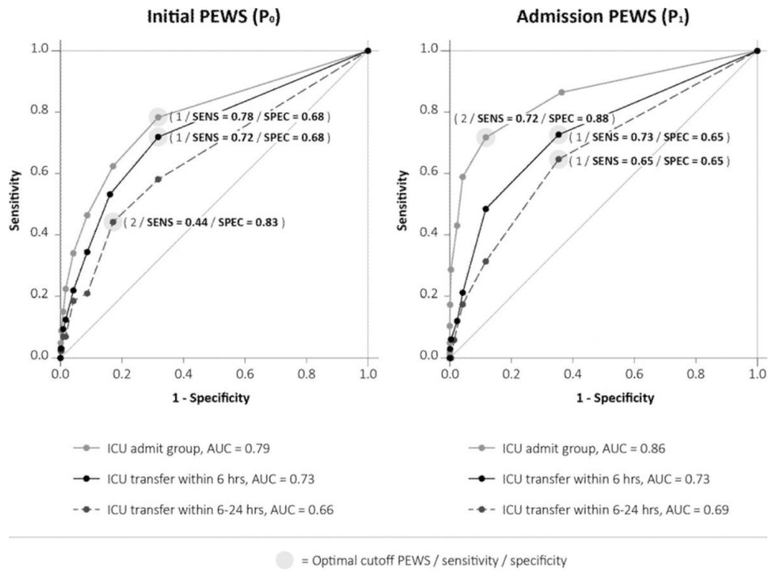

Figure 3.

Receiver operating characteristic curves for patient outcome groups using the PEWS. AUC = area under the curve; PEWS = pediatric early warning system; SPEC = specificity; SENS = sensitivity.

Table 1

Pediatric Early Warning Score[5] as Adapted for use at Nationwide Children's Hospital in Columbus, Ohio

Components	Score 0	1	2	3
Behavior	Playing/ appropriate	Sleeping	Irritable	Lethargic/confused or reduced response to pain
Cardiovascular	Pink or capillary refill 1–2 seconds	Pale or capillary refill 3 seconds	Gray or capillary refill 4 seconds *or* tachycardia of 20 above normal rate	Gray and mottled or capillary refill 5 seconds or above or tachycardia of 30 above normal rate *or* bradycardia
Respiratory	Within normal parameters, no retractions	>10 above normal parameters using accessory muscles *or* 30+ %FiO_2 or 3+ L/min	>20 above normal parameters and retractions *or* 40+ % FiO_2 or 6+ L/min	Five below-normal parameters with retractions and grunting *or* 50% FiO_2 or 8+ L/min

Score 2 extra for quarter hourly nebulizers or persistent vomiting following surgery.

FiO_2 = fraction of inspired oxygen

Table 2

Characteristics of Study Patients

Patient Characteristics	Total	Floor Group	ICU Group	p-value
Sex (*N* = 12,306)				0.099
Female	5,614 (45.6)	5,049 (89.9)	565 (10.1)	
Male	6,692 (54.4)	5,957 (89.1)	735 (10.9)	
Age (*n* = 12,251)*				<0.0001
0–3 months	1,447 (11.8)	1,292 (89.3)	155 (10.7)	
3–12 months	1,367 (11.2)	1,202 (87.9)	165 (12.1)	
12–47 months	2,761 (22.5)	2,369 (85.8)	392 (14.2)	
4–12 years	3,376 (27.6)	3,035 (89.9)	341 (10.1)	
13–21 years	3,300 (26.9)	3,060 (92.7)	240 (7.3)	
ESI triage category(*n* = 12,305)†				<0.0001
II	6,757 (54.9)	5,537 (81.9)	1,220 (18.1)	
III	5,548 (45.1)	5,469 (98.6)	79 (1.4)	

All data are reported as *n* (%).

*Frequency missing = 55 (age not documented by nurse).

†Frequency missing = 1 (triage category not documented by nurse).

Table 3

Test Characteristics of the PEWS

	Test	Actually Admitted to ICU	Actually Admitted to Floor	Total	Value (95% CI)
A)	$P_0 = 1$				SENS = 0.78% (0.76–0.81)
	Predicted to admit to ICU	858	3,192	4,050	SPEC = 0.68% (0.67–0.69)
	Predicted to admit to floor	238	6,855	7,093	PPV = 0.21 (0.19–0.22)
	Total	1,096	10,047	11,143	NPV = 0.97 (0.96–0.97) +LR = 2.5 (2.4–2.6)
	Note: 1,163 (9.5%) were missing initial PEWS				−LR = 0.32 (0.28–0.36)
B)	$P_1 = 2$				SENS = 0.72% (0.69–0.75)
	Predicted to admit to ICU	676	1,229	1,905	SPEC = 0.88% (0.88–0.89)
	Predicted to admit to floor	266	9,297	9,563	PPV = 0.36 (0.33–0.38)
	Total	942	10,526	11,468	NPV = 0.98 (0.97–0.98) +LR = 6.2 (5.8–6.6)
	Note: 838 (6.1%) were missing admission PEWS				−LR = 0.32 (0.29–0.35)
C)	$P_1 = 4$				SENS = 0.43% (0.39–0.46)
	Predicted to admit to ICU	406	144	550	SPEC = 0.98% (0.98–0.99)
	Predicted to admit to floor	536	10,382	10,918	PPV = 0.74 (0.69–0.77)
	Total	942	10,526	11,468	NPV = 0.95 (0.94–0.96) +LR = 31.5 (26.4–37.6)
	Note: 838 (6.1%) were missing admission PEWS				−LR = 0.58 (0.55–0.61)

+LR = positive likelihood ratio; −LR = negative likelihood ratio; NPV = negative predictive value; PPV = positive predictive value; SPEC = specificity; SENS = sensitivity.