Original Article

Pews vs Empirical Triage: A Comparison Between Two Triage Systems in A Pediatric Hospital

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Abstract

Introduction: The Emergency Department (ED) serves as the primary point of access for a vast majority of patients seeking medical care. This seems to be a worldwide problem which results in waiting times for patients with serious diseases. Serious illnesses, or life-threatening conditions, need to be identified quickly, minutes after patients' arrival. In response to this challenge, pediatric triage systems have been developed and used in order to ensure the rapid identification of patients with severe conditions and their immediate transfer to the definitive treatment site.

Aim: The purpose of our study was to compare the patient triage method we use in our hospital with a corresponding international tool and to investigate the possibilities of complementing each other of the two systems.

Results: A total of 261 children who presented at the Emergency Department of our Hospital with symptoms compatible with pediatric diseases were included. At arrival of the children at the triage station they were evaluated, by a nurse and a medical doctor, using both the currentsystem and the system "PEWS".

Conclusions: Our analysis reveals that both PEWS scores and the "current situation" wield significant influence over the variations in "incident outcome".

Keywords: Triage system, pediatric, warning signs

Introduction

The Emergency Department (ED) serves as the primary point of access for a vast majority of patients seeking medical care. The volume of care in the ED cannot be predicted, and most patients who come to the ED will not be admitted and treated immediately which is a fact that poses a risk to patient safety. This seems to be a worldwide problem which results in waiting times for patients with serious diseases. Serious illnesses, or life-threatening conditions, need to be identified quickly, minutes after patients' arrival. In such cases, delay in care, referral to the appropriate place of care, and treatment initiation may result in increased morbidity and mortality(Simon et al., 2022). Pediatric patients in particular, with their unique physiology and vulnerability, are in great need of well-structured and specialized monitoring systems that can detect subtle signs of clinical deterioration (Monaghan, 2005).

In response to this challenge, pediatric triage systems have been developed and used in order to ensure the rapid identification of patients with severe conditions and their immediate transfer to the definitive treatment site. The primary objective of triage is to ensure priority treatment for patients that require urgent emergency care and accurately predict the type of care they need. After a rapid assessment of signs and symptoms, critically ill patients are prioritized to the ED for immediate care, whereas patients with more stable conditions may experience longer waiting time or be referred for outpatient follow-up(VanVeen et al., 2009. Hardern, 1999).Triage in a pediatric emergency service is a task that is both challenging and complex. Children bring some challenges to the triage systems, since they may exhibit a variation of vital signs depending on their age group and may also present non-specific clinical symptoms(Magalhães-Barbosa et al., 2023).There is no standardized tool for pediatric patients that is used routinely, as one of the difficulties in establishing such a tool is the variation in clinical parameters in different age groups. An additional concern is that a critically ill child may initially appear stable but then rapidly deteriorate(Subbe et al., 2006).

Key instruments of pediatric triage for alert and rapid recognition of severity are the Pediatric Observation Priority Score (POPS), Pediatric Early Warning Score (PEWS), and Pediatric Assessment Triangle (PAT). These classification systems are based on the rapid assessment of a set of physiological parameters that, if altered, indicate a need for prompt medical evaluation.

These are considered valuable tools to identify patients in need of immediate care and recognize the clinical deterioration of patients under observation or inpatients. The PEWS assesses patient behavior along with cardiovascular and respiratory status parameters, each given a score between 0 and 3, with additional points for persistent vomiting and the need for continuous nebulization. The PEWS is not age-specific and provides a 13-point scale of clinical severity that is used to identify patients at risk of clinical deterioration and in need of intensive care(Bonafide et al., 2013). This score serves as an indicator of the child's condition, and is offering an extra tool to the healthcare providers to initiate appropriate interventions based on the severity of the score(Duncan, 2006).

Several studies try to evaluate the efficacy of PEWS in predicting hospital admissions as well as the outcome.Bradman et al. assessed whether the PEWS could accurately identify children, aged 0–16 years, at risk for admission or requiring discharge in EDand found limited predictive value(Bradman, 2008). Seiger et al. evaluated children under 16 years of age in an ED in the Netherlands for 3 years using the PEWS. The prediction of ICU stay was moderate to good and the prediction of admission was poor to moderate. The sensitivity and specificity varied widely(Seiger, 2013).Gold et al. assessed the outcomes of 12,306 patients under 21 years of age who were evaluated by nurses using the PEWS; they reported excellent inter-evaluator reliability (coefficient: 0.91). The study showed that high scores in the ED were associated with the need for ICU admission. However, as a single tool, it did not have sufficient ability to determine hospital discharge or predict deterioration(Gold, 2014).

Methods and materials

A perspective study was performed at Children's Hospital of Athens "Agia Sofia" between February 2023 until April 2023. 261 children, 0-16 years old, were included. Children who presented at the Emergency Department of the Hospital with symptoms compatible with pediatric diseases were included, whereas children with strictly surgical problems were excluded. The recording of the data was anonymous, while the measurements made on the children were not invasive but part of the routine procedure in the emergency room. Therefore, we conducted an observational study, with the result that parental consent is not needed. However, approval was requested and given by the scientific council of the Hospital.

For the meaning of our study, we used an already existing tool, the Pediatric Early Warning Score (PEWS) (Akre et al, 2010). This tool was translated in Greek. The translation of PEWS into Greek was carried out by 2 (two) bilingual translators / doctors, who took into account language differences as well as medical terminology. Pediatric residents then used the PEWS tool in clinical practice and confirmed the understanding of the translation as well as its ease of use. No corrections requested. This tool counts the patient's vital signs and records physical examination findings during the initial patient observation. For the convenience of the medical staff, we designed a complementary table with the reference range of vital signs' measurements by different age. The latter table included five age groups (0-3 months, 4-11 months, 1- 4 years, 5-11 years and 12 and above years of age). (Figures 1 and 2).At arrival of the children at the triage station they were evaluated, by a nurse and a medical doctor, using both the currentsystem and the "under study" system (PEWS).

Data of every patient were recorded, including gender, age, presenting symptom and vitals. In the current system we were recorded temperature, oxygen saturation, heart rate and if necessary arterial pressure and glucose, while in the "under study" system, temperature, capillary refill time, heart rate, respiratory rate, oxygen supply and behavior. According to the current system of triage evaluation, the seriousness of each case was based on the judgment of the triage doctor and nurse, with the vitals' measurements taken into consideration. On the other hand, according to PEWS, a score was calculated which on a standardized scale would determine the prioritization of each case. More precisely, score ≤2 was considered as low risk, score 3-4 medium risk and ≥5 high risk. (Figure 3). All collected data were transferred to excel cages, while anonymity of the patients was preserved, with regard to GDPR. For data analysiswasusedregression analysis, a widely used statistical technique in research that helps model the relationship between a dependent variable and one or more independent variables. In our study, we applied this method to, firstly, examine the association between patients outcome in the hospital and their first incoming clinical presentation. Secondly, we investigated how patients' outcome relates to the Pediatric Early Warning Score (PEWS). Lastly, we explored the correlation between the case's clinical presentation and both the current hospital triage and evaluation system as well as the PEWS. The aim of this analysis is to determine the extent to which the PEWS index serves as a valuable and essential tool for predicting patients' outcome, both independently and in conjunction with the existing hospital case triage and evaluation system.

Results

A prospective observation study was conducted, including 261 children, of whom 116 were girls (44.5%) and 145 were boys (55.5%). The average age was 7.5 years old, with an age range from 14 daysold to 16 years old. (Table 1)

A regression analysis was conducted to assess the relationship between the existing patient assessment system that was recorded until now just upon the arrival of the ill child, including the criteria for patient prioritization (vital signs, presenting symptoms)-"current situation"-and the final outcome (need for resuscitation, admission to a ward, or ICU admission) variable- "incident outcome" variable. (Figure 4, Table 2)

It was found that the "current situation" variable has a moderate explanatory power in understanding the variations in the "incident outcome" (Table 2). R-squared (R^2) value of

0.31 suggests that about 31% of the variability in the "incident outcome" can be attributed to the "current situation. Additionally, the significance F value was extremely low (8.3155e-23), signifying that the regression model is statistically significant. This means that the observed connection between the "current situation" and "incident outcome" is unlikely to be due to random chance. Finally, the coefficient of -0.5426 represents the slope of the regression line. This negative coefficient signifies that, on average, as the "current situation" variable increases (indicating a less serious incident), the "incident outcome" variable tends to decrease, suggesting less severe outcomes. This implies that milder initial conditions are associated with less severe incidents or outcomes.

Interpretation: There is a noteworthy role of the existing patient assessment system that was recorded until now influencing the final outcome, with less serious initial situations typically leading to less severe outcomes (Figure 4).

Moreover, a regression analysis was conducted to assess the relationship between PEWS and the final outcome of our patients ("incident outcome”).

It was found that the "PEWS" variable accounts for about 21% of the variability in the "incident outcome” (Table 3). The R-squared value of 0.21 indicates that approximately 21% of the variation in the "incident outcome" variable can be explained by the "PEWS" variable. Additionally, the significance F-value of 1.0999E-14 (a very small value) indicates that the regression model as a whole is statistically significant. This means that there is strong evidence to suggest that the “PEWS" variable has a significant impact on the "incident outcome”. Finally, the coefficient of 0.4035 represents the slope of the regression line. It indicates the average change in the "incident outcome" variable associated with a one-unit change in the "PEWS" variable. Since the coefficient is positive, it suggests that as the "PEWS" variable increases, the "incident outcome" variable tends to increase as well.

Interpretation: The analysis highlights that PEWS scores have a statistically significant impact on the final outcomes of patients. However, it's important to note that PEWS alone does not account for all the variability in patient outcomes, indicating that other factors may also play a role in determining these outcomes (Figure 5).

Moreover, a regression analysis was conducted with three variables: "current situation", "PEWS", and "incident outcome.”

It was found that the R-squared value of 0.36 indicates that approximately 36% of the variation in the "incident outcome" variable can be explained by the combination of the PEWS and "current situation" variables (Table 4). In other words, these two independent variables jointly account for about 36% of the variability in the "incident outcome". Additionally, the significance F-value of 4.7975E-26 (a very small value) suggests that the regression model as a whole is statistically significant. This means that there is strong evidence to suggest that at least one of the independent variables (PEWS and "current situation") is related to the "incident outcome”. Finally, the coefficient of 0.2261 for PEWS means that, holding "current situation" constant, a one-unit increase in the "t-PEWS" variable is associated with an average increase of approximately 0.226 units in the "incident outcome". This suggests a positive relationship between "t-PEWS" and "incident outcome". The coefficient of -0.431467301068072 for "current situation" means that, holding "t-PEWS" constant, a one-unit increase in the "current situation" variable is associated with an average decrease of approximately 0.431 units in the "incident outcome". This suggests a negative relationship between "current situation" and "incident outcome”.

Interpretation: Our analysis reveals that both PEWS scores and the "current situation" wield significant influence over the variations in "incident outcome". The higher the PEWS the more severe clinical outcomes, whereas less severe initial conditions ("current situation") tend to correlate with more severe incident outcomes. These findings emphasize the critical role of evaluating both the patient's initial condition and PEWS scores to effectively predict and manage clinical outcomes.

Figure 1. Pediatric Early Warning Score by age

0-3 months	SCORE 0	1	2	3
Respiratory	RR= 30-60/min Without respiratory difficulties	RR≥60 Using accessory muscles O_2≥3lt/min	RR≥70 Interocostal retractions, tracheal tug O_2≥6lt/min	RR≤25 Retraction, grunting O_2≥8lt/min
Cardiovascular	Pink Capillary refill time ≤2sec	Pale Capillary refill time =3sec	Grey Capillary refill time =4sec Heart rate ≥180σφ	Grey /Mottled Capillary refill time ≥5sec Tachycardia ≥190bpm Bradycardia ≤100bpm
Behaviour	Appropriate/playing	Sleeping	Irritable	Lethargic/confused Reduced response to pain

4-11 months	SCORE 0	1	2	3
Respiratory	RR= 25-45/min Without respiratory difficulties	RR≥55 Using accessory muscles O_2≥3lt/min	RR≥65 Interocostal retractions, tracheal tug O_2≥6lt/min	RR≤15 Retraction, grunting O_2≥8lt/min
Cardiovascular	Pink Capillary refill time ≤2sec	Pale Capillary refill time =3sec	Grey Capillary refill time =4sec Heart rate ≥180bpm	Grey /Mottled Capillary refill time ≥5sec Tachycardia ≥190bpm Bradycardia ≤100bpm
Behaviour	Appropriate/playing	Sleeping	Irritable	Lethargic/confused Reduced response to pain

1-4 years	SCORE 0	1	2	3
Respiratory	RR= 15-35/min Without respiratory difficulties	RR≥45 Using accessory muscles O_2≥3lt/min	RR≥55 Interocostal retractions, tracheal tug O_2≥6lt/min	RR≤10 Retraction, grunting O_2≥8lt/min
Cardiovascular	Pink Capillary refill time ≤2sec	Pale Capillary refill time =3sec	Grey Capillary refill time =4sec Heart rate ≥160bpm	Grey /Mottled Capillary refill time ≥5sec Tachycardia ≥170bpm Bradycardia ≤90bpm
Behaviour	Appropriate/playing	Sleeping	Irritable	Lethargic/confused Reduced response to pain

Figure 2. Pediatric Early Warning Score by age

5-11 years	SCORE 0	1	2	3
Respiratory	RR= 15-30/min Without respiratory difficulties	RR≥40 Using accessory muscles O_2≥3lt/min	RR≥50 Interocostal retractions, tracheal tug O_2≥6lt/min	RR≤10 Retraction, grunting O_2≥8lt/min
Cardiovascular	Pink Capillary refill time ≤2sec	Pale Capillary refill time =3sec	Grey Capillary refill time =4sec Heart rate ≥150bpm	Grey /Mottled Capillary refill time ≥5sec Tachycardia ≥160bpm Bradycardia ≤80bpm
Behaviour	Appropriate/playing	Sleeping	Irritable	Lethargic/confused Reduced response to pain

12+ years	SCORE 0	1	2	3
Respiratory	RR= 15-25/min Without respiratory difficulties	RR≥35 Using accessory muscles O_2≥3lt/min	RR≥45 Interocostal retractions, tracheal tug O_2≥6lt/min	RR≤10 Retraction, grunting O_2≥8lt/min
Cardiovascular	Pink Capillary refill time ≤2sec	Pale Capillary refill time =3sec	Grey Capillary refill time =4sec Heart rate ≥130bpm	Grey /Mottled Capillary refill time ≥5sec Tachycardia ≥140bpm Bradycardia ≤70bpm
Behaviour	Appropriate/playing	Sleeping	Irritable	Lethargic/confused Reduced response to pain

Figure 3. Risk classification

PEWS ≤ 2	Low risk	Wait and reassess PEWS (30'-60')
PEWS 3-4	Medium risk	Be alert and reassess PEWS (until 30') and medical assessment soon (until 60')
PEWS ≥ 5	High risk	Immediate intervention

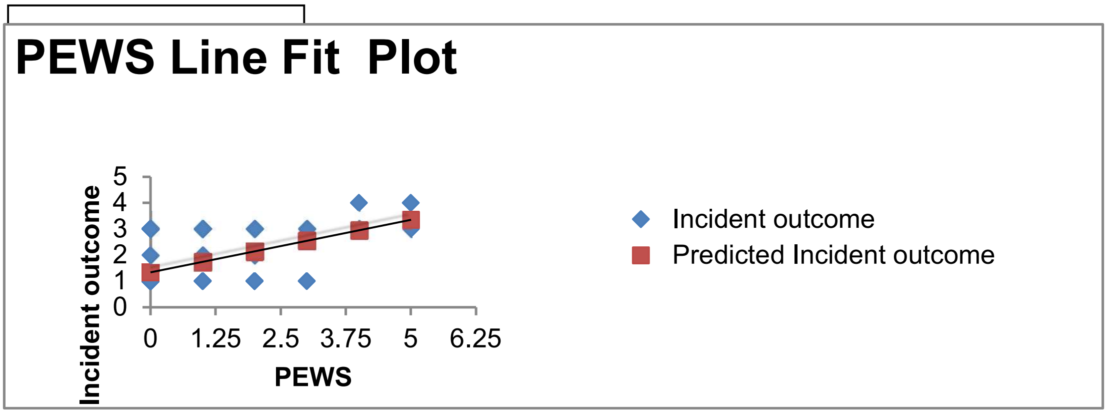

Figure 5. Current sitiuaton

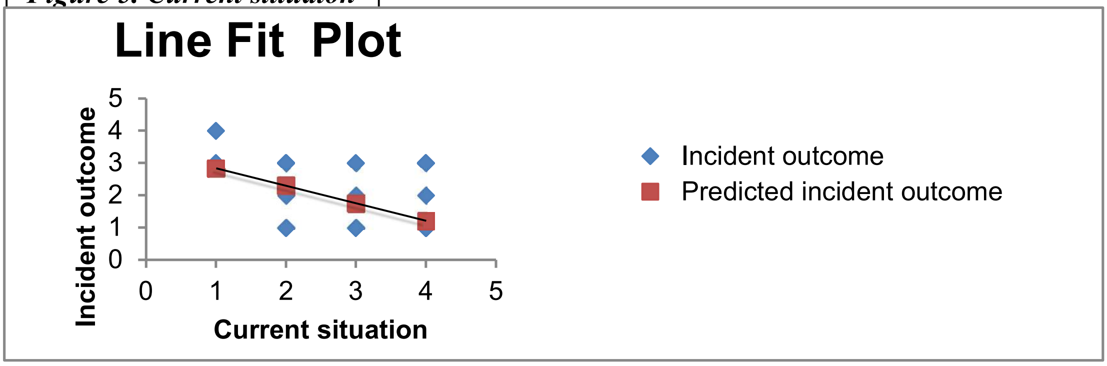

Table 1: Demographic variables

		N	*%*	*Outcome*
Variable				
Gender	Female	116	45,5	
	Male	145	55,5	
Age	0-11 months old	29	11,1	
	5-11 years old	97	37,2	
	>12 years old	135	51,7	
Symptoms	Upper respiratory symptoms	54	20,7	
	GI symptoms	55	21	
	Fever	91	34,9	
	Other reasons	61	23,4	
Current situation score	Emergency (Score 1)	8	3,1	6 Hospitalisation /2 ICU
	High risk (Score 2)	47	18	16 exits/ 28 Hospitalisation/ 3 hourly stay
	Medium risk (Score 3)	23	8,8	17 exits/ 5 Hospitalisation/ 1 hourly stay
	Normal risk (Score 4)	183	70,1	160 exits/ 20 Hospitalisation/ 3 hourly stay

Outcome (according to current score)	Exit	193	73,9	
	Hospitalisation	59	22,6	
	Hourly stay	7	2,7	
	ICU/NICU	2	0,8	
PEWS	0-2	248	95	192 exits/ 49 Hospitalisation/ 7 hourly stay
	3-4	9	3,5	2 exits/ 6 Hospitalisation/ 1 ICU/NICU
	>=5	4	1,5	3 Hospitalisation/ 1 ICU/NICU
Outcome (according to PEWS)	Exit	194	74,3	
	Hospitalisation	58	22,2	
	Hourly stay	7	2,7	
	ICU/NICU	2	0,7	

Table 2: Regression Analysis for the relationship between a dependent variable"incident

Regression statistics								
Multiple R	0.558482836							
R Square	0.311903078							
Adjusted R Square	0.309246333							
Standard Error	0.720226972							
Observations	261							
ANOVA								
	df	**SS**	**MS**	**F**	**Significance F**			
Regression	1	60.89877724	60.89877724	117.400463	8.31552E-23			
Residual	259	134.3502649	0.518726892					
Total	260	195.2490421						

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.379274573	0.17890901	18.88823025	1.27421E-50	3.026973113	3.731576033	3.026973113	3.731576033
CURRENT CITUATION	-0.54262531	0.050080096	-10.83514942	8.31552E-23	-0.641241319	-0.44400932	-0.641241319	-0.44400932

Table 3: Regression Analysis for the relationship between a dependent variable"incident outcome" and independent variable"score t-Pews".

Regression statistics								
Multiple R	0.454134955							
R Square	0.206238558							
Adjusted R Square	0.203173842							
Standard Error	0.773552107							
Observations	261							

ANOVA								
	df	**SS**	**MS**	**F**	**Significance F**			
Regression	1	40.26788084	40.26788084	67.29450889	1.10E-14			
Residual	259	154.9811613	0.598382862					
Total	260	195.2490421						
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	1.334944537	0.052028296	25.65804832	4.37704E-73	1.232492209	1.437396866	1.232492209	1.437396866
SCORE t-PEWS	0.403513664	0.04918905	8020332304	1.09991E-14	0.306652282	0.500375047	0.306652282	0.500375047

Table 4: Regression Analysis for the relationship between a dependent variable"incident outcome" and independent variables"current situation" and "score t-Pews".

Regression statistics								
Multiple R	0.60299419							
R Square	0.363601993							
Adjusted R Square	0.358668675							
Standard Error	0.693983282							
Observations	261							
ANOVA								
	df	**SS**	**MS**	**F**	**Significance F**			
Regression	2	70.99294088	35.49647044	73.70333754	4.80E-26			
Residual	258	124.2561013	0.481612796					
Total	260	195.2490421						
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**

Intercept	2.901109076	0.201562052	14.39313132	7.03508E-35	2.504192805	3.298025	2.504192805	3.298025
CURRENT CITUATION	-0.431467301	0.054019496	07.987251538	4.58772E-14	-0.537842567	-0.32509	-0.537842567	-0.32509
SCORE t-PEWS	0.226162074	0.049400758	4.578109351	7.30191E-06	0.128882032	0323442	0.128882032	0323442

Discussion

In the challenging domain of pediatric emergency care, precise patient assessment is a cornerstone for delivering timely and effective treatment. This review delves into the intricate relationship between the current patient assessment system and the Pediatric Early Warning Score (PEWS) within the context of pediatric care, drawing from a comprehensive study conducted at the Pediatric Emergency Department of "Agia Sophia" Children's Hospital. Our primary aim is to provide a thorough analysis of how these assessment tools impact patient outcomes, offering valuable insights into their effective use and implications for pediatric emergency care.

The Existing Patient Assessment System: We initiate our examination with a deep dive into the existing patient assessment system's pivotal role in shaping patient outcomes. The robust connection between assessment system scores and patient outcomes, as evidenced by an R-squared value of 0.31, underscores the significance of these initial assessments. These assessments, primarily reliant on vital signs and presenting symptoms, prove invaluable for predicting patient acuity upon arrival.

The negative coefficient of -0.5426 emphasizes that less severe initial conditions tend to result in less severe patient outcomes, highlighting the importance of swift and effective assessments in guiding patient care. This observation aligns with the chart's data, where individuals with higher current situation scores, indicating a "Normal risk," had a higher rate of exits, suggesting that an initial assessment of low acuity often leads to favorable outcomes.

The Pediatric Early Warning Score (PEWS):

Our exploration extends to the Pediatric Early Warning Score (PEWS), a standardized tool designed to evaluate a patient's clinical status over time. The study underscores that PEWS plays a significant role in patient outcomes, supported by an R-squared value of 0.21 and a positive coefficient of 0.4035. This reaffirms PEWS as an objective measure for assessing a patient's condition throughout their stay in the pediatric emergency department. These numbers corroborate that as PEWS scores rise, indicating worsening clinical status, there is a corresponding increase in hospitalizations and ICU/NICU stays, signifying its effectiveness in identifying high-risk patients who require specialized care.

The Holistic Approach to Pediatric Care: It's imperative to recognize that neither the existing patient assessment system nor PEWS in isolation can account for all the variability in patient outcomes. This complexity of pediatric patient care is further highlighted by variables such as comorbidities, interventions, and the dynamics of critical care environments, all of which play significant roles. Consequently, our findings underscore the necessity of using these assessment tools in conjunction with other clinical evaluations to achieve a comprehensive understanding of a patient's condition. This holistic approach is crucial in addressing the intricacies of pediatric emergency care.

Implications for Pediatric Emergency Care: In conclusion, this study provides significant insights into the effective utilization of patient assessment tools and their influence on pediatric patient outcomes. It underscores the significance of both initial assessments and ongoing monitoring using tools like PEWS. Healthcare providers are encouraged to identify high-risk patients early and continually reassess all patients to adapt care plans promptly.

These findings have the potential to revolutionize the approach to pediatric patient care in emergency departments. By combining established assessment systems with objective scoring tools, healthcare providers can enhance the accuracy of patient triage, resulting in more timely and effective care provision for critically ill children. Future research should further explore the integration of these assessment tools into clinical practice and comprehensively assess their impact on patient outcomes. This research is pivotal in improving the quality of care provided to pediatric patients in emergency settings.

Conclusion: Pediatric Early Warning Score (PEWS) plays a pivotal role in pediatric healthcare, aiding frontline medical professionals in recognizing and responding to deteriorating young patients promptly. Its introduction aimed to enhance communication within healthcare systems, serving as an invaluable tool for predicting incident outcomes in pediatric cases. While PEWS complements clinical judgment, its significance lies in serving as an early warning system. Pediatric triage, with its challenges rooted in age-related vital sign variations and non-specific symptoms, underscores the indispensability of specialized tools like PEWS. As healthcare professionals navigate the intricacies of pediatric emergency care, the continual development of assessment tools like PEWS remains essential for the well-being of young patients. Our analysis reinforces the importance of the initial patient assessment, showcasing its substantial relationship with patient outcomes. Furthermore, it highlights PEWS' significant influence on patient outcomes, even though other contributing factors may play a role. Combining the existing patient assessment system and PEWS provides valuable insights, explaining a significant portion of variability in patients' outcome. Higher PEWS scores correlate with more severe clinical outcomes, while less severe initial conditions suggest more severe incident outcomes. These findings underscore the necessity of integrating PEWS into clinical practice, particularly in critical cases requiring swift intervention. Beyond statistical analysis, this study emphasizes the importance of comprehensive patient evaluations and encourages further exploration of factors affecting pediatric clinical outcomes. As the medical community continues to navigate pediatric emergency medicine's complexities, a holistic approach considering both initial patient condition and PEWS scores is paramount for providing timely and effective care, ultimately safeguarding young patients in critical situations.

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