∎ Research Article

Validation of the Turkish version of the pediatric early warning score

Pediatrik erken uyarı skorunun Türkçe versiyonunun geçerlilik ve güvenirlik çalışması

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Abstract

Aim: The pediatric early warning score (PEWS) identifies pediatric patients at risk for clinical deterioration and can helpless-experienced providers get a sense of which patients may need escalation of care. The purpose of the study was to adapt the PEWS into Turkish and evaluate its validity in pediatric patients admitted to the emergency.

Material and Methods: This study was conducted between May and October 2022 on 228 patients aged 17 and under in the pediatric emergency department of a tertiary care hospital. In the pilot phase of the study, scoring of the first 30 patients was performed by three nurses in the emergency department. In the second phase, the validity of the PEWS scale was evaluated. Validity of the scoring system in predicting admission was assessed using area under the receiver operating characteristics (ROC) curve (AUC), sensitivity, and specificity, positive predictive value (PPV) and negative predictive value (NPV).

Results: The mean age of the children was 6.37 ± 4.72 years. Phase I demonstrated good inter-rater reliability (kappa = 0.75). In phase II, 22 patients (9.6%) were admitted to the intensive care unit (ICU) during the study period. AUC for predicting was 0.948 (95% CI: 0.915–0.981). According to ROC curve analysis, a cut-off value for PEWS score was found to be 4 (PEWS >4) for admitted to the ICU. Sensitivity and specificity in predicting ICU admission with the cut-off PEWS ≥ 4 was 86.36% and 90.78%, respectively (PPV, 50%; NPV, 90.48%). The sensitivity and specificity in predicting admission with a cut-off of PEWS ≥ 1 was 100% and 59.22%, respectively (PPV, 20.75%; NPV, 100%).

Conclusion: The Turkish version of PEWS can be helpful in assessing patient status in pediatric emergency department with acceptable validity and can serve as a potentially screening tool for prediction of ICU admission.

Keywords: Children, emergency room, PEWS, reliability, validity

Öz

Amaç: Pediatrik erken uyarı skoru (PEUS), acil serviste veya klinikte çocukların erken dönemde klinik kötüleşme riskini belirleyerek, kliniği kötüleşecek hastaları erken dönemde fark edip, tedavi planını düzenlemek için geliştirilmiş bir ölçektir. Çalışmanın amacı, PEUS'un Türkçe'ye uyarlanması ve acil hastalarda geçerlilik ve güvenilirliğinin değerlendirilmesidir.

Gereç ve Yöntemler: Bu çalışma Mayıs-Ekim 2022 tarihleri arasında, üçüncü basamak bir hastanenin pediatrik acil servisinde 17 yaş ve altı 228 hastada gerçekleştirilmiştir. Çalışmanın pilot aşamasında acil serviste üç hemşire tarafından ilk 30 hastanın skorlaması yapılmıştır. İkinci aşamada, PEUS ölçeğinin geçerliliği değerlendirilmiştir. Skorlamanın kabul edilebilirlik düzeyi, işlem karakteristik (ROC) eğrisi ve ROC eğrisi altında kalan alan (AUC), duyarlılık, özgüllük, pozitif tahmin değeri (PPV) ve negatif tahmin değeri (NPV) kullanılarak değerlendirilmiştir.

Bulgular: Çalışmaya yaş ortalaması 6,37 ± 4,72 yıl olan 129'u (%56,57) erkek, toplam 228 hasta alınmıştır. Faz I, iyi bir gözlemci arası güvenirlik göstermiştir (kappa = 0,75). Faz II'de, çalışma dönemi boyunca 22 (%9,6) hasta yoğun bakım ünitesine (YBÜ) kabul edilmiştir. Tahminleme için AUC değeri 0,948 (95% CI: 0,915-0,981) olarak bulunmuştur. ROC eğrisi analizine göre, YBÜ'ye kabul edilenler için PEUS skoru kesim değeri 4 olarak bulunmuştur (PEUS ≥4). PEUS ≥4 kesim değeriyle YBÜ kabulünü tahmin etmede hassasiyet ve özgüllük değerleri sırasıyla %86,36 ve %90,78 idi (PPV: %50, NPV: %90,48). PEUS ≥1 kesim değeriyle kabulü tahmin etmede hassasiyet ve özgüllük sırasıyla %100 ve %59,22 idi (PPV: %2,75, NPV: %100).

Tartışma: PEUS Türkçe versiyonu kabul edilebilir geçerlilikle, pediatrik acil serviste hastanın durumunu değerlendirmeye yardımcı olabilir ve erken klinik veya YBÜ kabulünü tahmin etmek için tarama aracı olarak kullanılabilir.

Anahtar kelimeler: Çocuklar, acil servis, PEWS, güvenilirlik, geçerlilik

Introduction

The numbers of patients presenting to pediatric emergency units are rising continually. The early identification of critical patients in emergency units with limited time and resources and the planning of treatment as quickly as possible are highly important. Hospital-acquired complications and those resulting from inappropriate or delayed diagnosis and treatment can both increase morbidity and mortality rates [1].

Warning signs of clinical deterioration in children may occur during initial presentation to hospital, or suddenly during clinical follow-up. Patients requiring treatment through admission to the ward or intensive care need to be detected early during observation in the emergency unit. However, the detection of patients requiring admission to the ward or intensive care may not be as simple and quick as desired [2]. Several scales using various physiological findings have therefore been developed for use in the decision to admit patients to the ward or intensive care [3]. One such is the Pediatric Early Warning Score (PEWS) scale. PEWS, a scoring system using physiological parameters, was developed for the early detection by healthcare professional of clinical worsening in pediatric patients under observation in the emergency department or on the ward [4]. PEWS has been validated by translation into several languages in order to permit the use of a common tool for assessing the clinical state of emergency pediatric patients in different populations and cultures [5-8].

However, a systematic review of the current literature elicited no Turkish-language version of the PEWS in clinical use. The purpose of this study was therefore to translate PEWS into Turkish and subsequently validate it.

Material and Methods

Study design

After being approved by the local ethics committee of Ondokuz Mayıs University, Faculty of Medicine with the registration number OMUKAEK-2022/188 (dated: 30 April 2022), this observational, prospective study was conducted among pediatric patients under the age of 17. All the children and their parents can understand and read the Turkish language and the parents of the children who were included in the study were fully informed about the study details and written consent was obtained from them before data collection.

Patients

Data were collected for all children who presented to the Samsun University, Samsun Maternity and Children's Training and Research Hospital emergency department between 1 May and 30 October 2022. This is a tertiary care university hospital with a 24-h emergency department. Patients who received home mechanical ventilator support or intubation, traumatic and psychiatric patients, and patients in the neonatal period (<30 day) were excluded from the study. The patients were divided into two groups. Group 1 consisted of patients who were not admitted to intensive care and Group 2 those who were admitted.

PEWS Description

PEWS consists of three dimensions involving behavioral awareness, the cardiovascular system, and the respiratory system. It yields reliable information that allows clinical nurses to evaluate the states of pediatric patients in a rapid, objective, and accurate manner. Each dimension is scored from 0 to 3, and the PEWS score representing the sum of the three dimension scores. Higher scores indicates more severe disease. In addition to these three main parameters, it also involves two further parameters of continuous nebulization for every 15 minutes and persistent vomiting following surgery. A score of 1, for each, is added to the total if these complaints are present. Total PEWS scores thus range from 0-11. A PEWS total score of 0–1 indicates that no treatment is required and that observation should be maintained. A score of 2 indicates that the responsible nurse should be notified to employ PEWS for continuous monitoring, to assess the presence of symptoms such as pain and fever, and to determine fluid balance and urine output. A score of 3 indicates that the patient should be assessed a minimum of every 24 h, observed and evaluated dynamically, and that the specialist nurse should be notified. A score of 4 indicates that evaluation should be performed at least once every 8 h, that the duty physician or resident physician should be notified, and that the patient should be prepared for transfer. Scores higher than 4, an increase >2 points, or a single score of 3 points indicate that the patient should be evaluated every 4 h, that the general inpatient and pediatric intensive care physicians should be notified to arrive within 15 minutes, to cooperate with the rescue procedures, and that the patient should be prepared for transfer [4,9,10].

The first stage of this study involved the translation and cultural adaptation of PEWS. A multi-step approach based on the guideline recommended by Guillemin and Beaton was adopted during this process [11,12]. The original version of the PEWS was first translated from English to Turkish by three individuals, including a native English speaker (a university graduate resident in Turkey for the previous three years) and two academics from the university's English Language Department. The resulting Turkish-language version was then back-translated into English by two different English linguistic academics from the university English Language Department. Following those procedures, the most comprehensible form of each question was produced by a three-member committee, including a health professional fluent in English, a Turkish linguist, and an English linguist.

Pilot testing

The pediatric emergency department nurse was first given bedside training sessions, in which the content of PEWS and how the results are evaluated were explained. This study was conducted in two phases. During the pilot phase, two triage nurses were asked to perform blind scoring in each patient for the first 30 patients, and inter-rater reliability was measured using kappa statistics. The Turkish version of the PEWS was thus finalized.

Procedure

In the second phase, the scores were then recorded on the PEWS chart–triage nurse section (Figure 1). Pediatric emergency physicians blinded to the scores were then asked to complete the PEWS chart pediatric doctor section, consisting of diagnosis, underlying diseases, and disposition. Once good inter-rater reliability (>0.70) had been ensured, the scoring was performed by one triage nurse during each shift. Based on a probability of expected sensitivity of 0.70 in the previous study, a sample size of 228 patients was calculated to be sufficient to validate the score [8]. The PEWS was used by a nurse in the pediatric emergency unit for the purpose of evaluating patients' health status.

Patient characteristics, including age, gender, and body mass index (BMI) were recorded.

Statistical analysis

Normality and variance were evaluated using the One-Sample Kolmogorov-Smirnov test for each variable. Quantitative data were presented as means and standard deviation, and qualitative data as frequency and percentage. Comparisons were completed using the Mann-Whitney U test. Categorical variables were analyzed using the Chi-square test. A cut-off value for unexpected intensive care unit admission with acceptable sensitivity and specificity, along with an appropriate confidence interval, was also calculated. The validity of the PEWS score was evaluated using the area under the ROC curves, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). A p values lower than 0.050 were considered statistically significant. Analyses were performed on Statistical Package for Social Sciences (SPSS Inc., Chicago, IL) version 20.0 software.

Results

Two hundred twenty-eight patients, with a mean age of 6.37±4.72, 43% of whom were female, were included in the study. While a significant age difference was observed between the groups, there was no significant difference in terms of gender, BMI, spent in the emergency department, or hour

of admission. The demographic characteristics of the groups are presented in Table 1. The frequency of comorbidities was asthma in two (0.9%), congenital syndromes in three (1.3%), neurological diseases in seven (3.1%), diabetes in four (1.8%), cardiac disease in one (0.4%), and metabolic syndrome in one (0.4%). In terms of complaints during admission, dermatological problems were present in eight patient (3.2%), fever in 45 (19.8%), nausea in six (2.4%), vomiting in 84 (33.6%), abdominal pain in 32 (12.8%), sore throat in 10 (4%), respiratory problems in 29 (11.6%), and seizure in 21 (8.4%). ROC analysis among several cut-off values for PEWS scores is shown in Table 2. ROC curve analysis of the PEWS score revealed an AUC of 0.948 (Figure 2). The cut-off value for the PEWS score at ROC curve analysis was 4 (PEWS >4).

PEDIATRIC EARLY WARNING SCORE (PEWS)				
Behavior	Playing /appropriate	0		
	Sleeping	+1		
	Irritable	+2		
	Lethargic/confused or reduced responsed to pain	+3		
Cardiovascular	Pink OR capillary refill 1-2 seconds	0		
	Pale OR capillary refill 3 seconds	+1		
	Gray OR capillary refill 4 seconds OR tachycardia of 20 bpm above normal	+2		
	Gray and mottled OR capillary refill ≥5 seconds OR tachycardia of 30 bpm above normal OR bradycardia	+3		
Respiratory	Within normal parameters, no retractions	0		
	>10 above normal parameters using accessory muscles OR 30+%FiO2 or 3+L/min	+1		
	>20 above normal parameters and retractions OR 40+ %FiO2 or 6+ L/min	+2		
	Five below normal parameters with retractions and grunting OR 50% FiO2 or 8+ L/min	+3		
Quarter hourly nebulizers (every 15 minutes)	No	0	Yes	+1
Persistent vomiting following surgery	No	0	Yes	+1

Figure 1. The pediatric early warning score developed by Monaghan (4).
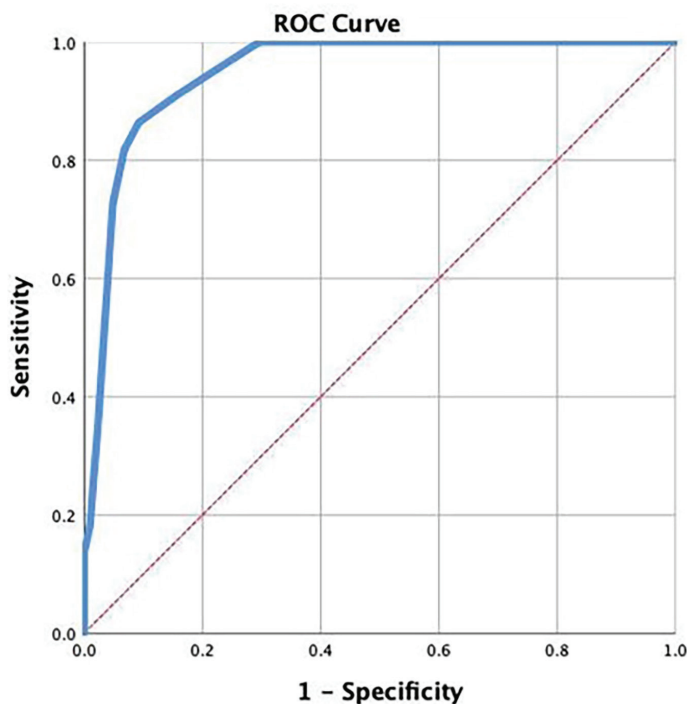
Figure 2. Receiver operating characteristic (ROC) curve of the Turkish version of PEWS(AUC = 0.948, p <0.05; CI = 0.915 – 0.981)

Discussion

The present study investigated the validation of the Turkish-language version of PEWS, one of the most widely and effectively used questionnaires for evaluating pediatric patients in the emergency department [13]. Our search of the literature showed that the scale had previously been adapted in numerous other countries, but not in Turkey. According to the results of the present study, PEWS exhibits acceptable levels of validity, reliability, and clinical feasibility in Turkish children.

Analysis for intensive care unit admission in this study showed that an AUC of 0.948 for all patients indicated excellent predictive ability. The equivalent value in Chaiyakulsil and Pandee's study was 0.97, and both values are high [5]. Using a cut-off value of ≥3, the sensitivity and specificity of PEWS were 90.91% and 84.47%, respectively. These values were superior to those of the original pilot study by Egdell et al. (AUC: 0.86, sensitivity 70%, specificity 90%), than in extensive studies in Rwanda by Rosman et al. (AUC: 0.77, sensitivity 96%, specificity 87.3%), and Chaiyakulsil and Pandee's study from Thailand (AUC: 0.97, sensitivity 100%, specificity 95%) [5,7,14].

Early warning scores for deterioration in adult patients were described as far back as the late 1990s, but PEWS was not published by Monaghan until 2005 [4]. Monaghan derived that scale from an adult tool and employed a 3 x 3 scoring matrix measuring the child's behavior, and cardiovascular and respiratory status. Further weighting was added for continuous nebulizers or persistent post-operative vomiting. By 2013, the majority of hospitals in the UK were reported to be using PEWS [15]. According to Agulnik et al., PEWS is used in almost all Spanish-speaking countries [8]. Despite being used for many years in several countries, PEWS has not been validated for Turkey. This renders the present study particularly valuable.

There are a number of limitations to this study. In particular, the research was performed at a single center, and it is therefore unclear whether the PEWS score's predictive ability is capable of direct generalization to other hospitals with their own distinct patient populations and health personnel. PEWS scores in this study were calculated by triage nurses. Another limitation of this study is the relatively small sample size.

Conclusion

The Turkish-language version of the PEWS questionnaire is a reliable, comprehensible, and valid instrument for assessing clinical deterioration in children presenting to the emergency department or hospitalized [Appendix]. The answerability and reliability of the questionnaire can be enhanced with further studies.

Table 1. Demographic characteristics of patients

Variables	Total (n = 228)	Group 1 (n = 206)	Group 2 (n = 22)	p*
Age (years, mean±SD)	6.37±4.72	6.55±4.72	4.63±4.5	0.043
Gender (female, [n, %])	99, 43.4%	87, 42.2%	12, 54.5%	0.029
BMI (kg/m2, mean±SD)	19.75±9.37	19.8±9.71	19.23±5.34	0.793
Spent in the ED (min, mean±SD)	122.25±104.11	125.77±107.09	89.36±62.96	0.059
Admission hour (n, %)				
08:00-16:00	90 (39.5%)	82 (39.8%)	8 (36.4%)	
16:00-24:00	74 (32.5%)	66 (32%)	8 (36.4%)	
00:00-08:00	64 (28.1%)	58 (28.2%)	6 (27.3%)	0.914

* Chi-square or Mann-Whitney U test.
BMI, Body mass index; Min, minute; ED, Emergency department; SD, Standart deviation.

Table 2. Pediatric early warning score prediction ability by score

Score	Sensitivity (%) [95% CI]	Specificity (%) [95% CI]	PPV (%) [95% CI]	NPV (%) [95% CI]
≥1	100 [84.56 – 100]	59.22 [52.18 – 66]	20.75 [18.18 – 23.59]	100
≥2	100 [84.56 – 100]	70.39 [63.65 – 76.53]	26.51 [22.61 – 30.8]	73.25 [67 – 78.87]
≥	90.91 [70.84 – 98.88]	84.47 [78.78 ¬– 89.13]	38.46 [30.69 – 46.87]	98.86 [79.79 – 89.45]
≥4	86.36 [65.09 – 97.09]	90.78 [85.97 – 94.36]	50 [38.71 – 61.29]	98.42 [95.61 – 99.44]
≥5	81.82 [59.72 – 94.81]	93.2 [88.86 – 96.23]	56.25 [42.77 – 68.87]	97.96 [95.18 – 95.25]
≥6	72.73 [49.78 – 89.27]	95.15 [91.25 – 97.65]	61.54 [45.35 – 75.52]	97.03 [94.29 – 98.48]

PPV, positive predictive value; NPV, negative predictive value; CI, confidence interval; PEWS, pediatric early warning score.

Conflict of interest

All authors declare that they do not have any conflicts of interest.

Disclosure Statement

The authors have no relevant financial or non-financial interests to disclose.

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