Original Article

Validation of Thammasat Pediatric Early Warning Score for Prediction of Pediatric Intensive Care Unit Admission

Chanapai Chaiyakulsil

Abstract

Objectives: The aim is to prospectively validate Thammasat Pediatric Early Warning Scores (TPEWS) in the prediction of unanticipated PICU admission.

Design: Prospective, descriptive, observational study

Methods: All children from 1 month to 15 years old who were admitted to the general pediatric wards were included. Scoring was conducted by nurses every 4 hours. To ensure the good-inter-rater reliability among nurses, the first 20 scorings were performed by two nurses and Cronbach's alpha analysis was performed. Children who were admitted to PICU for elective procedures were excluded. Validity was analyzed using area under the receiver operating characteristics (ROC) curves, sensitivity, specificity, positive and negative predictive value.

Results: A total of 242 children were included for analysis. The mean age was 3.78 ± 7.80 years and 53.3% were male. Initial phase revealed excellent inter-rater reliability (Cronbach's alpha = 0.934). Thirteen children (5.4%) were transferred to PICU. The area under ROC curve for predicting PICU admission was 0.965 (95% CI: 0.927-1). Sensitivity and specificity for PICU admission using a cut-off value of ≥ 4 were 92.3% and 89.1%, respectively. Positive predictive value and negative predictive values were 32.4% and 99.5%, respectively.

Conclusion: TPEWS is a novel, simple scoring system that demonstrates high sensitivity and specificity for categorizing clinical deterioration in patients at risk for PICU admission.

Keywords: Pediatric Early Warning Score, Pediatric intensive care unit, Unanticipated pediatric intensive care unit admission

Received: 5 February 2020 **Revised:** 14 May 2020 **Accepted:** 19 May 2020

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Introduction

Early identification and management of deteriorating patients in the general ward are important for enhancing patient safety as well as minimizing morbidity and mortality. Patients in the general ward can later worsen and require pediatric intensive care unit (PICU) admission. Studies showed that children who were transferred from the general ward to PICU experienced 1.65-2.38 times higher mortality compared to those admitted directly from the emergency department (ED).[1-5] Several pediatric early warning scores (PEWS) such as Brighton Pediatric Early Warning Score[6-7], Bedside Pediatric Early Warning Score[8-9], Bristol Pediatric Early Waring tool[10], and other modified PEWS[11-14] were developed in an attempt to detect deteriorating children to facilitate early intervention.

The drawbacks of the previous score, such as Brighton Pediatric early warning score, is that it was not inclusive of all vital signs parameters. It encompassed only behavioral, cardiovascular (capillary refill and heart rate), respiratory and oxygen support.[6-7] It lacked the scores concerning the body temperature and blood pressure measurement and include oxygen support in the scoring system instead of oxygen saturation. Detection of alterations in body temperature, blood pressure, and oxygen saturation can lead to earlier intervention of the deteriorating patients. Additionally, previous scoring systems, such as Bedside Pediatric Early Warning Score or Bristol Pediatric Early Warning Tool, usually included children with normal baseline saturations which did not take into consideration children with cyanotic heart disease or chronic lung disease. These children would score abnormally high in the previous scoring systems due to lower baseline saturations. Studies were conducted to demonstrate the validity of these scores. Several primary endpoints such as code blue call, PICU transfer, or rapid response team notification were used. Studies resulted in variable sensitivity ranging from 46% to 96%.[6-14] High variability might imply that the previous scoring systems were not sensitive enough to be utilized as screening tools. Moreover, most studies were conducted in a case-control and retrospective nature. Only a few small studies were done prospectively and consisted of a population lower than 100 patients.[15-16] Only one large prospective study was done to date.[9] Only two previous studies were conducted in children with cyanotic heart disease and children with low baseline saturations but both were performed in retrospective nature.[17-18] Thus, the most ideal PEWS would be a simple scoring system that incorporates all vital signs measurements and deviations from standard norms for specific age groups and specific patient groups. The majority of the studies were in Europe, United Kingdom, USA and Canada with no study from Asia.

Currently, in Thailand, there is no published scoring system which incorporates complete vital signs measurement and takes into consideration children with lower baseline saturations in term of prediction of unexpected PICU admissions from the general ward. A new scoring system, Thammasat Pediatric Early Warning Score (TPEWS) was recently developed from the meeting and consensus of all the pediatric intensivists at Thammasat University Hospital to alleviate these concerns. TPEWS was created and has not yet been validated.

The objective of this study was to prospectively validate TPEWS in predicting unexpected PICU admissions in children from 1 month to 15 years old who were admitted to the general pediatric ward at Thammasat University Hospital, Thammasat University, Thailand.

Materials and Methods

Study Design

This study was conducted as a prospective, descriptive, observational study. The Ethics Committee of Thammasat University Hospital approved this

research and informed consent and assent were obtained from all parents and children participating in this study.

Scoring System

TPEWS is a physiologic scoring system based on vital signs which include body temperature, respiratory rate and work of breathing, heart rate, blood pressure, pulse pressure, capillary refill, oxygen saturation measurement, and neurological evaluation (Figure 1). The score in each parameter ranges from 0-3 with the highest obtainable score of 24 points. The temperature higher than 39 degrees Celsius received two points. Due to difficulty in obtaining correct capillary refill measurements in unexperienced nursing staffs, this score simplifies capillary refill assessment into 3 categories, which are warm and pink (normal), warm and red (vasodilation; flash capillary refill < 1 second) and cold and pale (vasoconstriction; delayed capillary refill > 3 seconds). Alteration from the baseline saturations were used in children with cyanotic heart disease and chronic lung disease. Blood pressure parameters were categorized into hypotension for age, normal pulse pressure (PP = systolic blood pressure (SBP) – diastolic blood pressure (DBP) = 20-40 mmHg), narrow pulse pressure (PP < 20 mmHg) and wide pulse pressure (PP > 50 mmHg) instead of the raw number of systolic and diastolic pressure. Normal age-specific parameters are based and modified from Pediatric Advanced Life Support 2015.[19] These modifications were done with consensus from all attending pediatric intensivists at Thammasat University Hospital. A higher score indicates higher clinical severity.

Participants

All children aged 1 month to 15 years old who were admitted to the general pediatric ward of Thammasat University Hospital from December 2018 to January 2019 were included. This is a large tertiary care, university hospital which receives approximately 150-300 admissions monthly in the general pediatric ward depending on the time of the year. Children who require PICU admission for elective postoperative care were excluded. Using the probability of expected sensitivity from a previous similar scoring system of 0.8 by McLellan et al[17-18] and a two-tailed alpha error of 0.05 and probability of error of 0.05, a total of 242 participants would suffice in the validation of the score.

PICU admission criteria

Unexpected PICU admission is generally defined as an emergency PICU admission. The decision for admission was made by proxy of illness severity and based upon the discussion between the general pediatrician and PICU attending staff. Both were blinded from the scoring system. General criteria for PICU admission are as follows:

1. Respiratory diseases or problems requiring close monitoring

1.1 Respiratory distress or impending respiratory failure

1.2 Intubated patient

1.3 Need noninvasive respiratory assistance (BIPAP)

1.4 Need frequent nebulization more than every hour

1.5 Need frequent pulmonary toilet (every 1 hour)

2. Cardiovascular diseases or problems that need close monitoring

2.1 Requiring intravenous inotropic, vasodilator or vasopressor medication

3. Patients that need continuous closed monitoring

3.1 Arrhythmias

3.2 Neurology (example: status epilepticus)

3.3 Hematology and oncology (examples: hyperleukocytosis, septic shock)

3.4 Endocrinology and metabolic (examples: diabetic ketoacidosis, metabolic crisis)

3.5 Gastroenterology (examples: severe gastrointestinal bleeding)

Data Collection

This study was divided into two phases. During the implementation phase of the study, TPEWS was introduced to the general ward nurses. They were trained for the scoring system. For the first 20 recordings, at least two blinded nurses performed the scoring simultaneously for each recording in order to calculate the inter-rater reliability using Cronbach's alpha statistics.

After ensuring good interrater reliability (> 0.7), the scoring was conducted by any general ward nurse in charge of the patient during each shift. The scores were recorded into the TPEWS Chart every 4 hours according to routine nursing vital sign measurements to minimize nursing workload and for early detection of deteriorating patients until the patient was discharged or admitted to the PICU. Admission diagnosis, demographic data, length of hospital stay, and length of PICU stay were also collected.

Statistical Analyses

The validity of the score was measured using the area under the receiver operating characteristics (ROC) curves, sensitivity, specificity, positive and negative predictive value (PPV and NPV). Missing values were substituted using the multiple imputation model. In children who were discharged without PICU admission, the highest score within the admission was used for statistical calculation. From the preliminary data of TPEWS, the score at decision of PICU admission and highest score within 24 hours was not significantly different. Thus, the highest score within 24 hours before PICU admission was used for analysis in children who were admitted to the PICU to assimilate the data between children who were admitted and not admitted to the PICU. Cut-off value for unexpected PICU admission with acceptable sensitivity and specificity along with confidence interval was also determined. *P*-value < 0.05 was considered statistically significant. Demographic data were analyzed using mean and percentages as well as Student t-test and ANOVA. All statistical analyses were performed using SPSS version 24 (IBM corporation, Armonk, New York).

Results

Study Population

Initial phase showed excellent inter-rater reliability with Cronbach's alpha of 0.934 (95% confidence interval [CI]: 0.897-0.957). During the study period, 265 children were admitted to the general ward. A total of 23 children were excluded due to extreme age (< 1 month or > 15 years old) and elective PICU admission for postoperative care (Figure 2). Thus, 242 children were included for the final analysis of validation, 53.3% were male with a mean age of 3.78 ± 7.80 years. Approximately 55.4% of children had underlying diseases. A total of 13 participants (5.4%) were admitted to the PICU from the general ward due to clinical deterioration. Patients who were admitted to the PICU were significantly younger than those who were not (1.92 ± 4.12 vs. 3.88 ± 8.02 years old; p-value 0.006). The majority of patients who were admitted to PICU were female (76.9%) and had underlying diseases (84.6%). Fourteen patients (5.8%) were categorized as having lower baseline saturation. Only one of such patients (7.1%) was transferred to the PICU during the study period. Diagnoses were categorized into groups according to systems and were summarized along with patient demographic data in Table 1.

TPEWS validation

The area under the ROC curve for prediction of unexpected PICU admission was 0.965 (95% CI: 0.927-1), which was excellent (Figure 3). Using the cut-off value of ≥ 4, the sensitivity and specificity for prediction of unanticipated PICU admission were 92.3% and 89.1%, respectively. Positive and negative predictive values were 32.4% and 99.5%, correspondingly (Table 2). The average length of hospital stays and PICU stays was 4.3 days and 9.4 days, respectively.

Patients admitted to the PICU scored significantly higher and had longer hospital stay than those who did not (6.4 vs. 1.7 points; *P*-value < 0.001) (19.3 vs. 3.9 days; *P*-value < 0.001) (Table 1).

Discussion

This study is the first prospective, validating study of a scoring system in Thailand which predicts deteriorating children in the general inpatient population. The score encompassed the measurement of all vital parameters. Patient's baseline saturation was considered as a normal parameter instead of 95% and alteration from it was served as abnormal. This study showed that TPEWS was able to illustrate excellent area under the ROC curve, sensitivity, and specificity. In comparison with a large retrospective study by Chapman et al in 2017 in predicting PICU admission using three types of PEWS, TPEWS revealed better area under ROC curve, sensitivity, and comparable specificity (Area under ROC curve: 0.82 – 0.88; sensitivity 69-72% and specificity 75-91%).[12] TPEWS also demonstrated better area under ROC curve, specificity, and comparable sensitivity with similar scoring system of Children's Hospital Cardiac Early Warning Score which taken into account of children with lower baseline saturations (Area under ROC curve: 0.86-0.9; sensitivity 84.2-95.3% and specificity 76.2- 80.9%).[17-18]

This is one of the largest prospective studies (242 patients) in predicting clinical deterioration in hospitalized children using PICU admission as primary endpoints and possibly one of the first studies in Asia. Several prospective studies were conducted in Canada and UK by Parshuram et al (60 patients and 686 patients) and Edwards et al. (16 patients).[8-9, 16] TPEWS revealed better area under the curve and sensitivity with comparable specificity upon comparison with a large prospective, multicenter study by Parshuram et al. in 2011 (686 patients) (Area under ROC curve: 0.87; sensitivity 64% and specificity 91%).[9] Furthermore, TPEWS also demonstrated better PPV and comparable NPV in predicting PICU admission when compared to another prospective study done in the U.S.A by Tucker et al. (PPV 5.8%; NPV 99.8%).[20] The reason for better area under ROC and sensitivity might be because TPEWS includes all vital signs parameters making it more sensitive for earlier recognition of deterioration. Previous studies often utilized Brighton PEWS or bedside PEWS which incorporates mainly neurological status, cardiovascular and respiratory parameters without including body temperature. Moreover, by simplifying blood pressure and capillary refill category, this might make it easier for unexperienced nursing personnel.

This study had several limitations. Due to the single-center study design in a tertiary university hospital, it might be difficult to generalize the results. Furthermore, different centers have different PICU admission criteria and most decisions for admission were made upon proxy of illness severity which might alter the reproducibility when using in different centers. Since only 14 patients had lower baseline saturations and only one patient was transferred to the PICU during the study period, a larger population might be required to demonstrate the effectiveness of the scoring system in this population.

TPEWS is a novel, simple scoring system that revealed high sensitivity and specificity for categorizing clinical deterioration in patients at risk for PICU admission. This can be implemented as a useful trigger tool for the rapid response team.

Area of future research

The main aim of early detection and management is to reduce morbidity and mortality. Analysis of mortality and morbidity should be compared between historical control before the implementation of the score and after score implementation. Since only one mortality was observed during the study period, long term post-implementation analysis should be performed. An assembly of a rapid response team might be warranted in response to this trigger tool.

Acknowledgment

The author would like to show gratitude to Thammasat University Hospital along with all nursing staff for facilitating data collection and made this study possible. The author would also like to thank Assistant Professor Prapasri Gulalert, Department of Epidemiology, Faculty of Medicine, Thammasat University for statistical assistance.

Compliance with Ethical Standards

Financial disclosure: No financial or nonfinancial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

Potential Conflicts of Interest: The author has no conflicts of interest relevant to this article to disclose.

Contributors' Statements

Dr. Chanapai Chaiyakulsil conceptualized and designed the study, acquired and analyzed the data, drafted the initial manuscript, reviewed and revised the manuscript.

The author approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Appendix

Abbreviations: CI = confidence interval; DBP = diastolic blood pressure; PEWS = Pediatric Early Warning Score; PICU = Pediatric Intensive Care Unit; PP = pulse pressure; ROC = receiver operating characteristics; SBP = systolic blood pressure; TPEWS = Thammasat Pediatric Early Warning Score; PPV = positive predictive value; NPV = Negative predicting value

References

1. El Halal MGS, Barbieri E, Filho RM, Trotta EA, Carvalho PRA. Admission source and mortality in a pediatric intensive care unit. *Indian J Crit Care Med* 2012; 16(2): 81-86.
2. Odetola FO, Rosenberg AL, Davis MM, Clark SJ, Dechert RE, Shanley TP. Do outcomes vary according to the source of admission to the pediatric intensive care unit? *Pediatr Crit Care Med.* 2008; 9:20-25.
3. Escarce J, Kelley MA. Admission source to the medical intensive care unit predicts hospital death independent of APACHE II score. *JAMA.* 1990;264:2389–2394.
4. Knaus WA, Wagner DP, Zimmerman JE, Draper EA. Variations in Mortality and Length of Stay in Intensive *Care Units. Ann Intern Med.* 1993; 118:753–761.
5. Hill AD, Vingilis E, Martin CM, Hartford K, Speechley KN. Interhospital transfer of critically ill patients: Demographic and outcomes comparison with nontransferred intensive care unit patients. *J Crit Care.* 2007; 22:290-295.
6. Monaghan A. Detecting and managing deterioration in children. *Paediatr Nurs*. 2005; 17(1):32-35.
7. Miranda JOF, de Camargo CL, Sobrinho CLN, Portela DS, Monaghan A. Accuracy of a pediatric early warning score in the recognition of clinical deterioration. Rev. *Latino-Am Enfermagem.* 2017;25:e2912.
8. Parshuram CS, Bayliss A, Reimer J, Middaugh K, Blanchard N. Implementing the Bedside Pediatric Early Warning System in a community hospital, a prospective, observational study. *Pediatr Child Health (Oxford).* 2011;16(3):e18–e2.
9. Parshuram CS, Duncan HP, Joffe AR, Farrell CA, Lacroix JR, Middaugh KL, et al. Multicentre validation of the bedside paediatric early warning system score: a severity of illness score to detect evolving critical illness in hospitalised children. *Critical Care.* 2011;15:R184.
10. Haines C, Perrott M, Weir P. Promoting care for acutely ill children – development and evaluation of a paediatric early warning tool. *Intensive Crit Care Nurs.* 2006;22:73-81.

11. Lambert V, Matthews A, MacDonell R, Fitzsimons J. Paediatric early warning systems for detecting and responding to clinical deterioration in children: a systematic review. *BMJ Open.* 2017; 7:e014497.
12. Chapman SM, Wray J, Oulton K, Pagel C, Ray S, Peters MJ. 'The Score Matters': wide variations in predictive performance of 18 paediatric track and trigger systems. *Arch Dis Child.* 2017;102 (6): 487-495.
13. Fuijkschot J, Vernhout B, Lemson J, Draaisma JM, Loeffen JL. Validation of Paediatric Early Warning Score: first results and implications of usage. *Eur J Pediatr.* 2015;174(1):15-21.
14. Duncan H, Hutchinson J, Parshuram CS. The pediatric early warning system score: a severity of illness scores to predict urgent medical need in hospitalized children. *J Crit Care.* 2006;21: 271-278.
15. O'Laughlin K, Ruparelia K, Vince T, Drysdale S, Broughton S. The effectiveness of the paediatric early warning tool (PEWT) in identifying children requiring admission to critical care unit. *Arch Dis Child.* 2012;97:A154.
16. Edwards ED, Powell CV, Mason BW, Oliver A. Prospective cohort study to test the predictability of the Cardiff and Vale paediatric early warning system. *Arch Dis Child.* 2009;94(8):602-606.
17. McLellan MC, Connor JA. The Cardiac Children's Hospital Early Warning Score (C-CHEWS). *J Pediatr Nurs.* 2013;28:171-178.
18. McLellan MC, Gauvreau K, Connor JA. Validation of children's hospital early warning scoring system for identifying hospitalized children for arrest or ICU transfer. *Pediatr Crit Care Med.* 2014;15-30.
19. de Caen AR, Berg MD, Chameides L, et al. Pediatric advanced life support 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015; 132 (suppl 2): S526-42.
20. Tucker KM, Brewer TL, Baker RB, Demeritt B, Vossmayer MT. Prospective evaluation of a pediatric inpatient early warning scoring system. *J Spec Pediatr Nurs.* 2009;14(2):79-85.

Table 1 Patients demographic data and diagnoses

Patient Characteristics	Total patients (n = 242)	Non-PICU admitted patients (n = 229)	PICU-admitted patients (n = 13)	Patients with lower baseline saturations (n = 14)
Mean age, years (± SD)	3.78 ± 7.80	3.88 ± 8.02	1.92 ± 4.12**	2.00 ± 4.00
Gender, N (%)				
Male	129 (53.3)	126 (55)	3 (23.1)	10 (71.4) **
Female	113 (46.7)	103 (45)	10 (76.9) **	4 (28.6)
Underlying disease, N (%)				
None	108 (44.6)	106 (46.3)	2 (15.4)	0 (0.0)
Yes	134 (55.4)	123 (53.7)	11 (84.6) **	14 (100.0) **
Oncology	29 (21.6)	29 (23.6)	-	-
Hematology	20 (14.9)	19 (15.4)	1 (9.2)	-
Miscellaneous*	16 (12.0)	15 (12.1)	1 (9.2)	-
Respiratory	15 (11.2)	13 (10.6)	2 (18.1)	5 (35.7)
Cardiovascular	15 (11.2)	13 (10.6)	2 (18.1)	9 (64.3)
Neurologic	10 (7.5)	8 (6.5)	2 (18.1)	-
Renal	8 (6.0)	8 (6.5)	-	-
Gastrointestinal	6 (4.5)	5 (4.1)	1 (9.2)	-
Genetic	5 (3.7)	5 (4.1)	-	-
Endocrine	5 (3.7)	5 (4.1)	-	-
Allergy	5 (3.7)	3 (2.4)	2 (18.1)	-
Diagnosis, N (%)				
Respiratory	58 (24.0)	55 (24.0)	3 (23.0)	8 (57.1)
Gastrointestinal	47 (19.4)	43 (18.8)	4 (30.8)	1 (7.1)
Oncology	29 (12.0)	29 (12.7)	-	-
Febrile illness	27 (11.2)	25 (10.9)	2 (15.4)	-
Miscellaneous*	23 (9.6)	23 (9.9)	-	-
Hematology	18 (7.4)	16 (7.0)	2 (15.4)	-
Cardiovascular	12 (5.0)	10 (4.4)	2 (15.4)	5 (35.7)
Renal	10 (4.1)	10 (4.4)	-	-
Neurologic	10 (4.1)	10 (4.4)	-	-
Surgical	3 (1.2)	3 (1.3)	-	-
Endocrine	3 (1.2)	3 (1.3)	-	-
Allergy	2 (0.8)	2 (0.9)	-	-
Mean length of hospital stay, days (±SD)	4.30 ± 12.94	3.71 ± 8.22	19.33 ± 44.56**	10.36 ± 30.76**
Mean length of PICU stay, days (±SD)	-	-	9.42 ± 26.0	2.50 ± 10.94
Mortality, N (%)	1 (0.4)	0 (0.0)	1 (7.7)	0 (0.0)
Mean highest score, points (±SD)	1.95 ± 3.82	1.70 ± 3.02	6.38 ± 4.12**	1.86 ± 2.56
PICU admission, N (%)	13 (5.4)	0 (0.0)	13 (100.0)	1 (7.1)

* Orthopedics, Rheumatology, Development, ENT, plastic, Urology, Dermatology, Dental

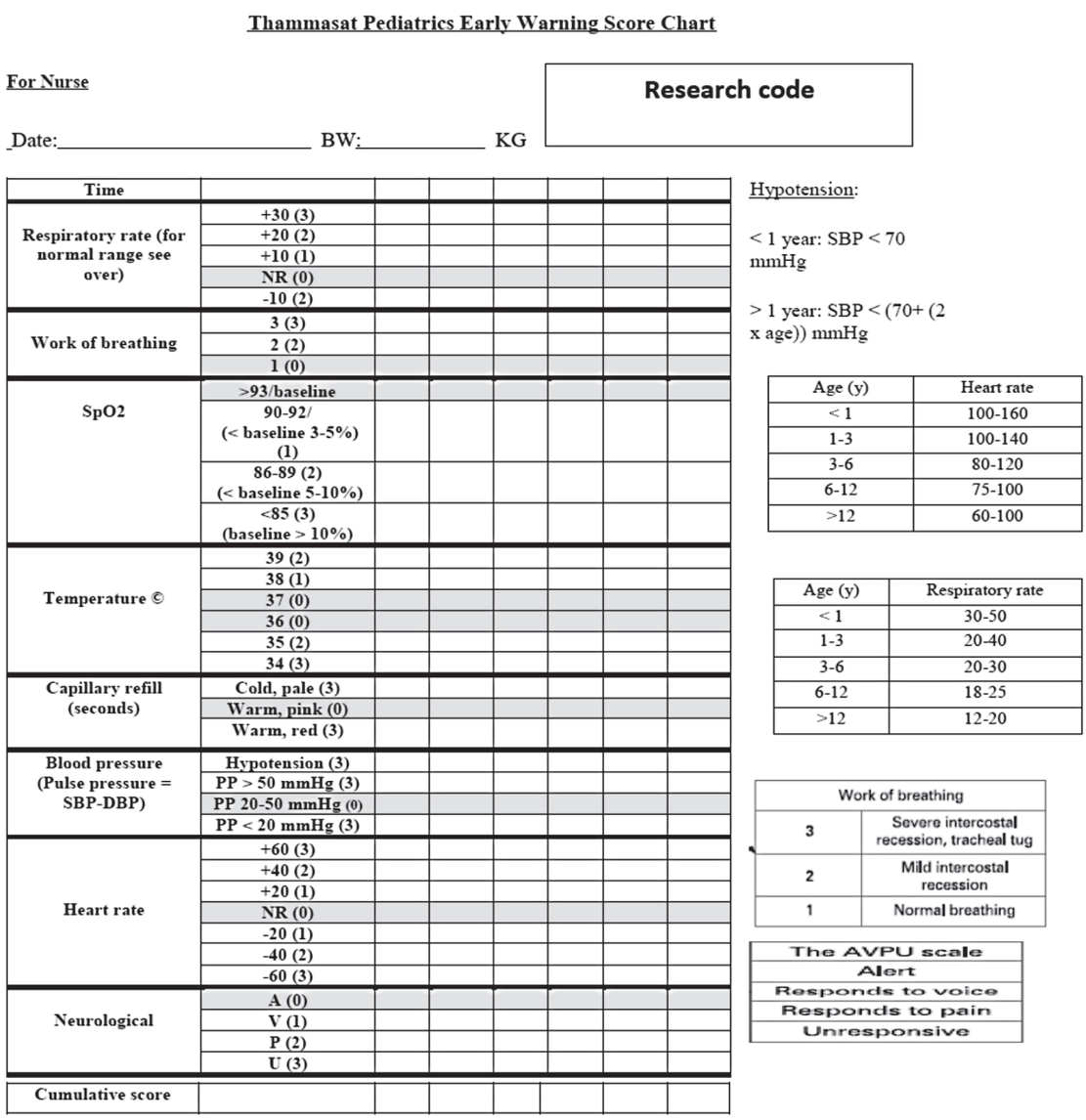
** (*P*-value < 0.05)

Table 2 TPEWS prediction ability

Score	Sensitivity (%) [95% CI]	Specificity (%) [95% CI]	Positive predictive value (%) [95% CI]	Negative predictive value (%) [95% CI]
≥1	100 [71.7- 100]	31.4 [25.6 – 37.9]	7.6 [4.3 -13.0]	100 [93.6-100]
≥2	100 [71.7- 100]	51.5 [44.9 – 58.1]	10.5 [5.9 – 17.6]	100 [96.1-100]
≥3	100 [71.2- 100]	64.2 [57.6 – 70.3]	13.7 [7.8 – 22.6]	100 [96.8 -100]
≥4	92.3 [62.1 – 99.6]	89.1 [84.1 – 92.7]	32.4 [24.3 – 41.7]	99.5 [96.7 – 99.9]
≥5	76.9 [46.0 – 93.8]	96.5 [93.0 – 98.4]	55.5 [31.3 – 77.6]	98.6 [95.8 – 99.6]
≥6	61.5 [32.3 – 84.9]	98.7 [95.9 – 99.7]	72.7 [39.3 – 92.7]	97.8 [94.7 – 99.2]

CI: Confidence interval

Figure legends



Thammasat Pediatrics Early Warning Score Chart

For Nurse

Research code

Date:_____ BW:_____ KG

Time							
Respiratory rate (for normal range see over)	+30 (3)						
	+20 (2)						
	+10 (1)						
	NR (0)						
	-10 (2)						
Work of breathing	3 (3)						
	2 (2)						
	1 (0)						
SpO2	>93/baseline						
	90-92/ (< baseline 3-5%) (1)						
	86-89 (2) (< baseline 5-10%)						
	<85 (3) (baseline > 10%)						
Temperature ©	39 (2)						
	38 (1)						
	37 (0)						
	36 (0)						
	35 (2)						
	34 (3)						
Capillary refill (seconds)	Cold, pale (3)						
	Warm, pink (0)						
	Warm, red (3)						
Blood pressure (Pulse pressure = SBP-DBP)	Hypotension (3)						
	PP > 50 mmHg (3)						
	PP 20-50 mmHg (0)						
	PP < 20 mmHg (3)						
Heart rate	+60 (3)						
	+40 (2)						
	+20 (1)						
	NR (0)						
	-20 (1)						
	-40 (2)						
	-60 (3)						
Neurological	A (0)						
	V (1)						
	P (2)						
	U (3)						
Cumulative score							

Hypotension:

< 1 year: SBP < 70 mmHg

> 1 year: SBP < (70+ (2 x age)) mmHg

Age (y)	Heart rate
< 1	100-160
1-3	100-140
3-6	80-120
6-12	75-100
>12	60-100

Age (y)	Respiratory rate
< 1	30-50
1-3	20-40
3-6	20-30
6-12	18-25
>12	12-20

Work of breathing	
3	Severe intercostal recession, tracheal tug
2	Mild intercostal recession
1	Normal breathing

The AVPU scale
Alert
Responds to voice
Responds to pain
Unresponsive

Figure 1 Thammasat Pediatric Early Warning Score (TPEWS).

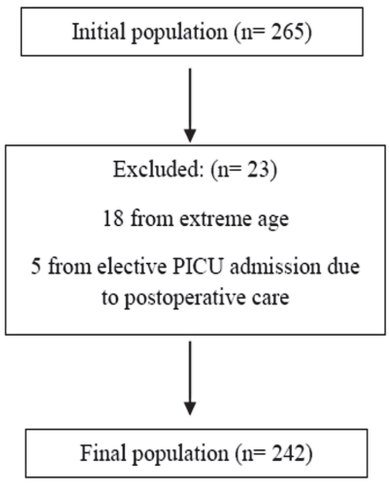


Figure 2 Population flow chart.

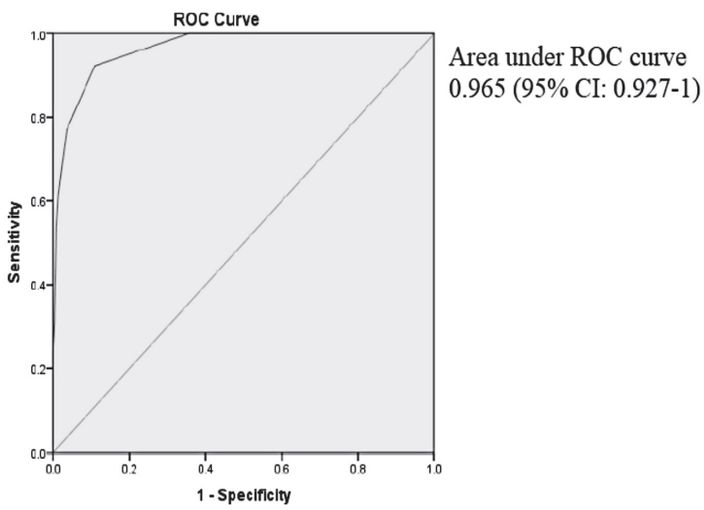


Figure 3 ROC Curve predicting unexpected PICU admission.

บทคัดย่อ

การตรวจสอบรับรอง Thammasat Pediatric Early Warning Scores ในการประเมินความเสี่ยงที่จะได้รับการเข้าดูแลในหอผู้ป่วยกุมารเวชบำบัดวิกฤต

ชนะภัย ไชยกุลศิลป์

ภาควิชากุมารเวชศาสตร์ โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ มหาวิทยาลัยธรรมศาสตร์

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วัตถุประสงค์: เพื่อตรวจสอบรับรอง Thammasat Pediatric Early Warning Scores (TPEWS) ในการตรวจวัดความเสี่ยงผู้ป่วยในหอผู้ป่วยกุมารเวชศาสตร์ทั่วไปที่จะได้รับการย้ายไปดูแลในหอผู้ป่วยกุมารเวชบำบัดวิกฤตโดยไม่

คาดคิดรูปแบบการวิจัย: การศึกษาไปข้างหน้าเชิงพรรณนา

วิธีการศึกษา: ผู้ป่วยอายุ 1 เดือนถึง 15 ปี ทุกรายที่เข้ารับการรักษาที่หอผู้ป่วยกุมารเวชศาสตร์ทั่วไป จะได้รับการตรวจวัดคะแนนความเสี่ยงทุก 4 ชั่วโมง โดยพยาบาลประจำหอผู้ป่วย ในการวัดความคะแนนความเสี่ยงใน 20 ครั้งแรก จะใช้พยาบาลสองคนเพื่อประเมินค่าความเที่ยงระหว่างผู้สังเกต ความสามารถของคะแนนจะถูกวัดโดยการใช้ ความตรงเชิงเกณฑ์ประเมินจากการสร้างพื้นที่ใต้กราฟ receiver operating characteristics (ROC) คะแนนจุดตัดความไวและความจำเพาะ รวมถึงค่าทำนายผลบวกและค่าทำนายผลลบ

ผลการศึกษา: มีผู้ป่วยที่ผ่านเกณฑ์การคัดเข้าและออกทั้งหมด 242 ราย โดยมีอายุเฉลี่ยที่ 3.78 ± 7.80 ปี และเป็นเพศชาย ร้อยละ 53.3 พบว่ามีค่าความเที่ยงระหว่างผู้สังเกตสูง (Cronbach's alpha = 0.934) ผู้ป่วย 13 ราย (ร้อยละ 5.4) ได้รับการย้ายไปดูแลต่อในหอผู้ป่วยกุมารเวชบำบัดวิกฤต ในแง่ความสามารถของคะแนนพบว่ามีพื้นที่ใต้กราฟ ROC เท่ากับ 0.965 (95% CI: 0.927-1) และเมื่อใช้จุดตัดคะแนนมากกว่าเท่ากับ 4 คะแนน พบว่ามีความไวร้อยละ 92.3 และ ความจำเพาะร้อยละ 89.1 มีค่าทำนายผลบวกและผลลบร้อยละ 32.4 และ 99.5 ตามลำดับ

สรุป: พบว่า TPEWS เป็นคะแนนที่มีค่าความไวรวมถึงค่าความจำเพาะสูงในการประเมินผู้ป่วยที่มีความเสี่ยงที่จะได้รับการเข้าดูแลในหอผู้ป่วยกุมารเวชบำบัดวิกฤต

คำสำคัญ: คะแนนประเมินความเสี่ยงในเด็ก, หอผู้ป่วยกุมารเวชบำบัดวิกฤต, การย้ายไปหอผู้ป่วยกุมารเวชบำบัดวิกฤตโดยไม่คาดคิด