Assessing the Efficacy of Pediatric Early Warning Score PEWS for Predicting Clinical Outcomes in Pediatric Emergency Care

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Abstract: *Background: Pediatric Early Warning Score (PEWS) is a simple tool in identifying children who are at risk of clinical deterioration and matching the severity of illness to appropriate level of care thereby allocating resources in the hospital. Objective: To determine the usefulness of Pediatric Early Warning Score in predicting clinical outcome in children brought to emergency and to explore the score characteristics for intensive care unit admission or clinical deterioration in admitted children. Methods: Study design - Prospective observational study. Setting - conducted in emergency room of, Kanchi Kamakoti CHILDS Trust Hospital during October - Nov 2019. Participants - 550 children aged 1 month to 18 years attending Emergency department during the study period. Intervention - Applying PEW Score. Outcome - Treated on Outpatient basis or requiring Hospitalisation including Intensive care. Results: 550 children with a mean age of 4.3 years were assessed. 36 % managed on outpatient basis and 64 % required admission. As the PEW scores increased sensitivity decreased and specificity increased. Optimal cut off point for intensive care and hospitalization obtained from ROC are 5 and 2 respectively. PEW Score 5 is 83.1 % sensitive and 95.8 specific in predicting PICU admission. PEW Score 2 or more is 70.3 % sensitive and 91.8 specific in predicting hospitalisation. After considering Dengue patient parameters (PCV, warning signs) PEWS had 93.8% sensitivity and 86.1% specificity. Discussion: PEW Score was found to be a useful tool in predicting chances of clinical deterioration. As PEW scores increased, chances of getting admission in PICU increased. In the presence of comorbid conditions /associated diseases, chance of predicting the clinical deterioration increased. PEWS score of ≥5 may be used to determine which patients are in critically ill condition requiring treatment in PICU. PEW score is not highly sensitive in predicting hospitalisation.*

Keywords: Warning Signs, Intensive care, Hospitalisation, Dengue.

1. Introduction

Pediatric Early Warning Score (PEWS) is a simple and effective tool in assessing, identifying children who are at risk of clinical deterioration and matching the severity of illness to appropriate level of care. Previous studies in adults and children had revealed that in the hours preceding cardiac arrest physiologic changes in patient status can be identified [1 - 3]. Early warning score at admission correlates both with in hospital mortality (p<0.001) and length of stay (p=0.01) [4]. Multiple Pediatric Warning scoring systems have been developed worldwide, and Monaghan's PEWS [5]in 2005 is one of the most simple and flexible systems. Patient volume burdens placed on health settings that suffer with staff shortages may be addressed by utilizing PEWS systems for risk stratification of clinically deteriorating patients. [6]. There is little existing literature to guide the use of PEWS in RLS and no literature on their use in humanitarian settings. [7]. 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) [8]. Pediatric Early Warning Score (PEWS) consist of 3 domains of physiological variables which can be rapidly assessed and does not include any laboratory blood analysis. It is suitable for rapidly assessing and stratifying even in a busy OP day when a gush of patients attend ER for triage, so that critically ill children are intervened as soon as possible. Other critical illness scores like prognostic scores (PRISM, PIM), descriptive scores (PEMODS, PELODS), SOFA, APACHE II are more time consuming, includes laboratory blood analysis for scoring, more suitable for ICU inpatients. Scores like PRAM, PRIMES, Pulmonary index score, HFSS, were confined to one organ system and cannot be applicable for all the children attending triage. WHO severity of index score ETAT (Emergency Triage And Treatment) score also involves the assessment of number of clinical variables compared to PEW score. Paediatric Early Warning Scores (PEWS) are used in hospitalised patients to detect physiological deterioration and is being used increasingly throughout healthcare systems with a limited evidence especially in emergency department setting [9]. This study is done to evaluate the usefulness of Pews Score in the emergency department in predicting the outcome or identifying the children who are at risk of clinical deterioration.

Aims and Objectives
1) To determine the usefulness of PEWS in predicting outcome* in children brought to emergency.
2) To explore the score characteristics of an Emergency department assigned PEW score for PICU admission or clinical deterioration in admitted children.
   *Outcome mentioned here did not refer to the final outcome of the disease. It refers to the Outcome categories stratified and mentioned in the methodology.

2. Materials and Methods

This is a prospective observational study conducted in emergency department of Kanchi Kamakoti CHILDS Trust Hospital during October to November 2019 withsample size

550. All children presenting in Emergency room aged 1 month to 18 years in during the study period were included and children presenting with cardiac arrest, brought dead and neonates were excluded from the study. Approval from the institutional ethics committee was obtained and children brought to the emergency department who satisfied the inclusion criteria were included in the study. Clinical details, PEWS Table 1) were noted. Past history of associated diseases or comorbid conditions, time of their presentation to the emergency department were also noted. Vitals were compared with standard reference values followed in the hospital which is adapted from PALS. The investigator was documenting PEWS independently and was not involved in management/admission decision and managing team was blinded to the PEW score to eliminate bias.

In Emergency Room of KKCTH Categories of patients who come to the emergency room (ER) of the hospital includes (a) Parents who think that their children needs emergency care and rush ER even for minor ailments. Hemodynamically stable child with labs suggesting dengue fever, enteric fever, simple febrile seizures and get treated as OP or getting directly admitted in ward after triaging. (b) Referral patients from outside hospital brought by parents and ambulance. (c) Patients who are brought with major illness with hemodynamic instability, respiratory distress, hypoxia, altered sensorium, convulsions etc. (d) Patients sent from OP in our hospital for nebulization, hypoxia, hemodynamic instability, dengue patients with increased packed cell volume who require fluid resuscitation and get admitted in ER.

Outcome categories were stratified as Children treated as OP - A) Managed as OP B) Observation in ER and managed as OP C) Children who received nebulization and treated as OP Children who required hospitalization - D) Direct ward admission without necessity for ER stabilization E) Children who needed stabilization in ER and transferred to ward F) Children who needed stabilization in ER and required Pediatric Intensive Care Unit care. This group also includes the ones who deteriorated and transferred to PICU from ward.

Children who were treated as Outpatient basis were followed up using their phone numbers recorded in the hospital for the next 48 hours whether they return again with the PEW score warranting admission or remain well.

Table 1: MONAGHAN PEWS Score

DOMAINS	0	1	2	3	TOTAL SCORE
Behaviour	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	Grey or capillary refill 4 seconds *or* tachycardia of 20 above normal rate	Grey & mottled appearance or capillary refill time 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 %FiO₂ or> 3 L/min	>20 above normal parameters OR retractions OR >40% FiO₂ or >6 L/min	Five below-normal parameters with retractions and grunting *or* 50% FiO₂ or >8 L/min	
				Total PEWS	

- Score by starting with the most severe parameters first.
- Score 2 extra for every 15-minute nebs (includes continuous nebs) or persistent post-op vomiting.
- Use "litres/minute" to score a regular nasal cannula.
- Use "FiO2 " to score a high-flow nasal cannula

3. Results

550 children triaged in Emergency department were assessed by PEWS. Most common age group was 1 – 5 years (47 %) followed by infants (23%). Least common were adolescents (12%). Mean and median age were 4.3 and 3 years respectively. Males were predominantly seen (57.8 %).196 (36%) children were managed as OP and 354 (64%) children required hospitalisation. [Table 2].

Table 2: Consolidation of PEWS Score VS Outcome

PEW Score	Outcome of Patients						Total
	OP	Observed & treated as OP	Nebulised & treated as OP	Direct ward admission	Stabilised in ER & ward transfer	PICU transfer	
0	103	12	0	24*	0	0	139
1	39	26	0	71*	9*	1**	146
2	0	0	1	28	33*	1+1**	64
3	0	0	7	1	45	1+3**	57
4	0	0	8	0	46	6*	60
5	0	0	0	0	19	15*	34
6	0	0	0	0	1	21	22
7	0	0	0	0	0	20	20
8	0	0	0	0	0	6	6
9	0	0	0	0	0	2	2
TOTAL	142	38	16	124	153	77	550

*patients with dengue fever are included in this category. ** children deteriorated and transferred to PICU.

5 Patients admitted in ward later deteriorated and transferred to PICU. Twoof them had bronchiolitis with PEWS 2, one had infantile dengue with PEWS 1. Two had pneumonia of which one was a known case of cystic fibrosis and another was a known Chronic granulomatous disease patient. As the PEW score increased the chance of getting admitted in PICU also increased. Two Patients with lower PEW Score of 2 and 3 respectively who was transferred to PICU were with diagnosis of Guillain Barre syndrome. One patient who got initial PEWS 1 and got admitted in ward later deteriorated and transferred to PICU found to be having Dengue fever. Associated diseases/comorbid conditions were also considered which constitutes 143 patients. Neurological comorbidity was predominant with 30.8 % of total patients followed by 25.9% of respiratory comorbidity. Least commonly seen was Congenital heart disease (CHD) and 100 % of the patients associated with CHD required emergency stabilization. There was statistically significant correlation between age and the outcome of the patients ($P<0.05$). There is significant relationship between other State patients and Tamilnadu patients in terms of the outcome obtained.88 % of other state patients required admission and in that 30 % of the patients needed PICU care.51 out of the 77 children (66.2%) who required PICU admission came after 4 pm ($P<0.05$). Patients who required stabilization in ER were predominantly seen after 4 pm where hospital staff is lesser compared to before 4pm. The sensitivity and the specificity of PEW scores were negatively related to each other. As the PEW scores increased sensitivity decreased and specificity increased. Receiver operator characteristics (ROC) curve for patients requiring PICU admission was obtained (Fig 1).
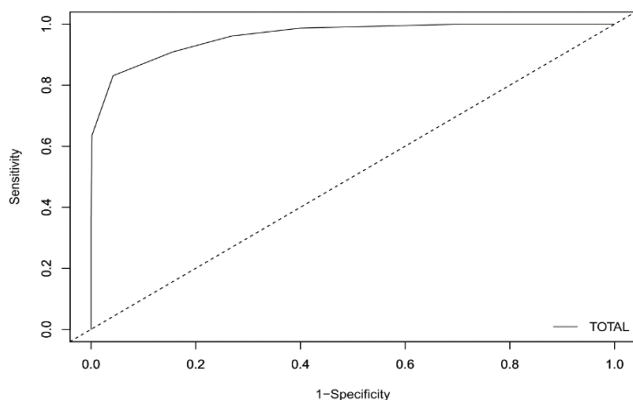

Figure 1: ROC of present study for PICU admission

There was a good area under the curve of 0.96 (0.94 – 0.98) which reflects good expected performance. Optimal cut off point for PICU admission was 5. PEW Score 5 is 83.1 % sensitive and 95.8 specific in predicting PICU admission. There was a good Positive predictive value of 0.76 (0.67 - 0.86). and negative predictive value of 0.97 (0.95 – 0.98). ROC curve for patients requiring hospitalisation was obtained. there was moderate to good area under the curve of 0.87 (0.84 – 0.90) which reflects good expected performance. Optimal cut off point for hospitalisation was 2. (Fig 2)
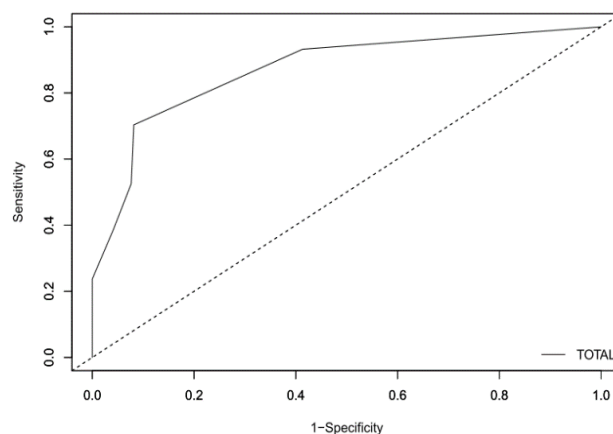

Figure 2: ROC of present study for hospitalisation

PEW Score 2 or more is 70.3 % sensitive and 91.8 specific in predicting hospitalisation. After considering Dengue patient parameters (PCV, warning signs) along with PEW Score ROC obtained for predicting PICU admission showed Area under curve was 0.94 (0.87 - 1.0) with a cut off 4. It had 93.8% sensitivity and 86.1% specificity. Hence considering Dengue parameters (PCV and warning signs) the sensitivity of the PEWS increases to 93.8 %.

4. Discussion

A prospective observational study was conducted in Pediatric ER of KKCTH, Chennai in which 550 children attending emergency were studied. Median age in our study was 3 years. There was significant correlation between Age and the outcome of the patients. This may be attributed to lower PEW scores in older age groups due to their

compensatory mechanisms. Proportion of males getting sicker and attending the emergency department was higher than females. Male: female ratio of 1.36: 1 as seen by Ramtekeet al (2018) [10].64 % children attending ER needed inpatient care in contrary to the observation by Breslin et al with 38 % admissions, lillitos et al (2014) [11] with 11 % admissions. The reason may be this centre being a referral centre, patients inside as well as outside Tamil Nadu come to the emergency department for triaging. Most commonly observed PEWS was 1 (26.5 %) as seen by Lenny elita et al (2016) [12]88 % of other state patients required admission and in that 30 % of the patients needed PICU care. This may be attributed to the reason that only the sick ones are referred by the local pediatricians for further clinical management. Among the comorbid conditions or disease associated (N=143 patients) Neurological comorbidity was predominant with 30.8 %followed by 25.9% of respiratory comorbidity. Least commonly seen was congenital heart disease but all of them required emergency room admission and stabilization. Patients with infectious disease were predominantly seen in emergency (39.2 %). PEW cutoff score for PICU admission obtained by ROC was 5. For predicting the need for intensive care, PEW Score 5 was 83.1 % and 95.8 % specific. Except for patients presenting with hemodynamic instability the deciding factor in dengue patients for hospitalisation were usually PCV and the presence of warning signs which does not figure out in PEW score. Hence separate ROC curve obtained for Dengue patients. Hence considering Dengue fever the sensitivity of PEWS in predicting PICU care increases to 93.8 %. Sensitivity and specificity for hospitalization obtained in our study is 70% and 91.8% respectively. Positive and likelihood ratio for predicting PICU admission was 19.65 (12.6 - 30.5) and negative likelihood ratio of 0.18 (0.11 - 0.29) which are good values.

Contributors: Gem Raghav Prashanth R, Janani Sankar: Concept and design.
Gem Raghav Prashanth R: data acquisition,
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