ORIGINAL ARTICLE

Pediatric Early Warning Score in Predicting Length of Stay in Hospital

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ABSTRACT

Objective: "To determine the predictive accuracy of pediatric early warning score to predict the length of hospital stay in children"

Study Design: Cross sectional study

Study place and duration: Department of Pediatrics, The Children's Hospital, Lahore from June 2022 to August 2022.

Methodology: After meeting inclusion and exclusion criteria 190 children were enrolled. Then child was examined for PEWS and score was noted. Then children were labeled as positive or negative for prolonged hospital stay (as operational definition). Children were managed as per standard protocol. All the children were followed-up in wards or intensive care unit till discharge and total hospital stay was noted.

Results: The mean age of the children was 7.89±4.49 years, 103(54.21%) children were male. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of PEW score of the children was 88.03%, 80.82%, 88.03%, 80.82% & 85.26% children respectively taking actual prolonged hospital stay as gold standard.

Conclusion: From the findings of this study we may conclude that pediatric early warning score is a useful and reliable tool to predict the length of hospital stay in children.

Keywords: Length of Hospital Stay, Pediatric Early Warning Score,

INTRODUCTION

Appropriate resource allocation in the hospital context, early detection of children at risk of clinical deterioration, and matching the severity of disease to the appropriate level of treatment are all essential elements of high-quality medical care.[1, 2] Children and their families have a right to think that they will receive the finest care available at a hospital, and they feel that they are entering a safe haven. Typically, 72.9% of sick children stay in the hospital for more than 24 hours.[3, 4] Few studies have examined the effectiveness of scoring systems in pediatric emergency rooms, and none have examined how well they predict hospital stays and observation unit utilization.[5] To enhance clinical outcomes, clinically worsening events must be identified early and treated quickly. This has been attempted on several occasions, such as when fast reaction teams with early warning scores were introduced.[6]

To identify decline in pediatric wards or emergency rooms, pediatric early warning scores, or PEWS, were created.[7, 8] Although PEWS are commonly utilized in the UK, best practices cannot be improved due to tool heterogeneity and a lack of evidence on their predictive efficacy. Strong validation will be necessary for the planned National PEWS to standardize practice.[9, 10]

Rationale of study is to determine the predictive accuracy of pediatric early warning score to predict the length of hospital stay in children. In routine, children admitted to the hospital are expected to be discharged within 24 hours. But early classification of children at risk according to the severity of the disease illness is important care are integral components of assessing the prognosis of these children. PEWS is a clinical tool that can help to predict he hospital stay and can help to plan the treatment protocols to shorten the hospital stay, as prolonged hospital stay has its own risks. But in routine, children are not. This may be because of lack of local evidence. In Pakistan, the resources of heath care facilities are low, so there is a need to develop prediction tools to get prognosis of patient in initial stages and plan treatment accordingly. Therefore we want to conduct this study to get updated data for local setting and implement a scoring system to improve our practice. Also varied data has been observed in literature showing low sensitivity of PEWS. This will advance our understanding and help us update future guidelines for determining the prognosis and duration of hospitalization for such youngsters.

METHODOLOGY

"This Cross sectional study was carried out in the Department of Pediatrics, The Children's Hospital, Lahore for around 3 months (June 2022 to August 2022). Sample size of 190 cases was estimated by keeping 95% confidence level, percentage of prolonged hospital stay i.e. 72.9%,[11] sensitivity of PEWS i.e. 37% and specificity of PEWS i.e. 88% with 9% margin of error. [12] Children were enrolled after applying Non-Probability, consecutive sampling technique as who passed the following criteria were enrolled only.

Inclusion Criteria: Children of age 1-15 years, both genders, admitted in hospital due to high grade fever (>100⁰F), pneumonia, asthma, bronchiolitis, gastrointestinal illness, acute gastroenteritis, infectious diseases, cardiac disorders, neurologic disorders or renal disorders were enrolled.

Exclusion Criteria: Children with sepsis, severe malnutrition, trauma or head injury or undergoing / underwent major surgery were not included.

All the children were enrolled from Pediatrics emergency department. Informed consent was obtained from parents. Demographics were noted. Then child was examined for PEWS and score was noted. Then children were labeled as positive if PEWS score ≥2 or negative for prolonged hospital stay. Children were managed as per standard protocol. All the children were followed-up in wards or intensive care unit till discharge and total hospital stay was noted. Child was discharged when no parenteral feeding or treatment required, oral feed can be taken and behavior is normal and child is conscious. If patient stay in hospital for ≥24 hours due to critical condition, then it was noted. All data is entered is specially designed Performa.

Royal Alexandra Hospital for Sick Children, Brighton Pediatric Early Warning Score. Monaghan (2005)

Data was entered & analyzed by using SPSS version 21. 2x2 table was generated to calculate the sensitivity, specificity, PPV, NPV and diagnostic accuracy of PEWS. Stratification was done for age, gender, weight, diagnosis and duration of illness.

RESULTS

In this study the mean age of the children was 7.89±4.49 years. There were 103(54.21%) male children and 87(45.79%) were female children. The mean weight of the children was 23.18±12.10 kg. The mean duration of illness was 2.96±0.81 days. Table-I

The most common diagnosis of the children was URTI noted in 40(21.05%) children followed by bronchopeneumonia in 28(24.74%), enteric fever in 27(14.21%) children, phanygitis in

20(10.53%) children and rest of children belonged to other diagnosis. Figure-1

The mean PEW score was 1.78±0.87. The prolonged hospital stay on PEW score was noted in 117(61.58%) children. The mean total hospital stay in actual was 3.63±2.51 days, with actual prolonged hospital stay in 117(61.58%) children. Table-II

The sensitivity, specificity, PPV, NPV and diagnostic accuracy of PEW score of the children was 88.03%, 80.82%, 88.03%, 80.82% & 85.26% children respectively taking actual prolonged hospital stay as gold standard. Table-III

Table-1: Pediatric Early Warning Score (PEWS) *Score 2 extra for persistent vomiting following surgery or ¼ hourly nebulizers.[13]

	0	1	2	3
Behavior	Playing / appropriate	Sleeping	Irritable	Lethargic/confused or reduced response to pain
Cardiovascular	Pink or capillary refill 1-2 sec	Pale or capillary refill 3 sec	Gray or capillary refill 4s or tachycardia of ≥20 bpm above normal rate	Gray and mottled or capillary refill ≥5 s or tachycardia ≥30 bpm above normal rate or bradycardia
Respiratory	Within normal parameters, no retractions or tracheal tug	Respiratory rate ≥10 bpm above normal parameters, using accessory muscles or 30%+ FIO2 or 3+ L/min	Respiratory rate ≥20 bpm above normal parameters, retractions, tracheal tug, or 40%+ FIO2 or 6+ L/min	RR 5 bpm below normal rate with retractions and/or grunting, or 50%+ FIO2 or 8+ L/min

Table-2: Basie information of enrolled cases (n = 190)

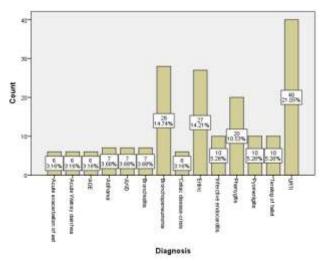|	Mean±SD, F (%)
Age (Years)	7.89 ± 4.49
Gender	
Male	103 (54.2%)
Female	87 (45.8%)
Weight (Kg)	23.18 ± 12.10
Duration of illness (days)	2.96 ± 0.81

Figure-1: Diagnosis of children (n = 190)

In children having age ≤ 7 days the diagnostic accuracy of PEW score of the children was 82.98%, and in children having age >7 days the diagnostic accuracy of PEW score was 87.5% taking actual prolonged hospital stay as gold standard. In male children the diagnostic accuracy of PEW score of the children was 87.38%, and in female children the diagnostic accuracy of PEW score was 82.76% taking actual prolonged hospital stay as gold standard. In children having duration of illness ≤ 2 days the diagnostic accuracy of PEW score of the children was 78.46%, and in children having duration of illness >2 days the diagnostic accuracy of PEW score was 88.8% taking actual prolonged hospital stay as gold standard. In children having weight ≤ 20 kg the diagnostic accuracy of PEW score of the children was 82.8%, and in children having weight >20 kg the diagnostic accuracy of PEW score was 87.63% taking actual prolonged hospital stay as gold standard. In URTI children the diagnostic accuracy of PEW score of the children was 100%, and in other diagnosis children the diagnostic accuracy of PEW score was 81.33% taking actual prolonged hospital stay as gold standard. Table-IV"

Table-3: PEW score (n = 190)

N	Mean±SD, F (%)
PEW Score	1.78 ± 0.87
Prolonged hospital stay predicted on PEW score	117 (61.6%)
Actual hospital stay (days)	3.63 ± 2.51
Actual prolonged hospital stay	117 (61.6%)

Table-4: Accuracy of PEW for predicting prolonged hospital stay

Prolonged Hospital Stay		Prolonged Hospital Stay		Total
		Yes	No	
PEW score	Yes	103	14	117
	No	14	59	73
Total		117	73	190

Sensitivity = 88.03%, Specificity = 80.82%, PPV = 88.03%, NPV = 80.82% & Diagnostic Accuracy = 85.26%.

Table-5: Accuracy of PEW for predicting prolonged hospital stay in different groups

	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Age ≤7 years	88.89%	70.97%	86.15%	75.86%	82.98%
Age >7 years	87.04%	88.10%	90.38%	84.09%	87.50%
Male	87.50%	87.18%	91.80%	80.95%	87.38%
Female	88.68%	73.53%	83.93%	80.65%	82.76%
Duration ≤2 days	82.50%	72%	82.50%	72%	78.46%
Duration >2 days	90.91%	85.42%	90.91%	85.42%	88.80%
Weight ≤20 kg	88.71%	70.97%	85.94%	75.86%	82.80%
Weight >20 kg	87.27%	88.10%	90.57%	84.09%	87.63%
URTI	100%	100%	100%	100%	100%
Other	86.92%	67.44%	86.92%	67.44%	81.33%

DISCUSSION

In this study the sensitivity, specificity, PPV, NPV and diagnostic accuracy of PEW score of the children was 88.03%, 80.82%, 88.03%, 80.82% & 85.26% children respectively taking actual prolonged hospital stay as gold standard.

For kids admitted to hospital wards, the PEWS score is the initial indicator of sickness severity. The PEWS score might distinguish between "well" children who needed regular ward-based care and ill children who later need urgent medical attention at the initial assessment. A technique used in healthcare settings

to evaluate young children's clinical deterioration is the young Early Warning Score (PEWS). It is primarily designed to identify children who may require escalated care or interventions. While the PEWS can be helpful in identifying high-risk children, its predictive accuracy for determining the length of hospital stay in children may vary.[14-17]

Obeid M Shafi et al., found that there was a modest correlation between PEWS and hospital stay. Compared to children who needed prolonged inpatient care, children who had brief stays (both ≤24 and ≤36 hours) had a statistically significant decreased PEWS. Although more prospective studies in facilities with observation units would better characterize its ability to suggest admission to an observation unit compared to the wards, the PEWS is a helpful tool to predict hospital stay and assist emergency department physicians in determining disposition.[18]

Heather Duncan et al., said that focus groups with nursing experts were used to create the severity of disease score for youngsters admitted to hospitals. Children who experienced a code blue event can be distinguished from those who did not using the PEWS score. The sensitivity and specificity were 78% and 95%, respectively, for a threshold score of 5.[19]

One study by Juliana de Oliveira Freitas Miranda et al led them to conclude that the Brighton Pediatric Early Warning Score for the Brazilian setting performed well and was deemed reliable for identifying the children's clinical deterioration warning symptoms. The Brighton PEWS for Brazil had a positive post-test probability of 80%, sensitivity of 73.9%, specificity of 95.5%, PPV of 73.3%, NPV of 94.7%, and area under the Receiver Operating Characteristic Curve of 91.9%.[20]

It has been observed in a study, conducted in USA that the PEWS ≥2 has Sensitivity: 44%, and Specificity: 80% for prolonged hospital stay.[11] Bradman et al., further showed that PEWS ≥ 2 had a poor sensitivity of 37% and a specificity of 88%, indicating that the PEWS determined at the time of emergency triage had little usefulness.[12]

The quality of documentation and the interrater reliability of the score varied greatly, with some studies only reaching 67% agreement, according to Trubey and colleagues' systematic assessment of the validity and efficacy of pediatric early warning systems. Although there isn't a clear assessment of the difference in accuracy between higher and lower PEWS scores.[21]

Lillitos et al. A PEWS cut-off of three or higher was suggested in their study for hospital admission and serious illness investigation (specificity: 93%, sensitivity: 32%). A lower cut-off with PEWS of 2 or above in the same research yielded a lowered specificity (68%) and nearly double the sensitivity (62%) for hospital admission. Additionally, according to the authors, a low PEWS does not rule out serious disease or the need for hospitalization.[22]

Sam T Romaine et al[9] revealed that while the majority of the seven PEWS showed moderate discrimination for hospital stay (range AUC 0.69–0.75), all seven showed excellent discrimination for critical care admission (range area under the receiver operating characteristic curves (AUC) 0.91–0.95) and sepsis-related mortality (range AUC 0.95–0.99). Bedside PEWS (AUC 0.90; 95% CI 0.86 to 0.93) and National PEWS (AUC 0.90; 0.87–0.93) were the most discriminative in critical care admission threshold studies, both at a threshold of ≥6.

CONCLUSION

From the findings of this study we may conclude that pediatric early warning (PEW) score is a useful and reliable tool to predict the length of hospital stay in children. Now in future, we will implement use of PEW score for prediction of hospital stay and will plan the treatment protocols to shorten the hospital stay, as prolonged hospital stay has its own risks, especially in low resource areas around the country. This will help to improve our knowledge and to update guidelines in future for detection of prognosis and length of hospital stay in such children.

Conflict of Interest: None.

REFERENCES

1. Gawronski, O., Latour, J. M., Cecchetti, C., Iula, A., Ravà, L., Ciofi degli Atti, M. L., ... & Parshuram, C. S. (2022). Escalation of care in children at high risk of clinical deterioration in a tertiary care children's hospital using the Bedside Pediatric Early Warning System. BMC pediatrics, 22(1), 530.
2. Agarwal D, Alam S, Mazahir R, Singh RR, Maini B. Utility of Pediatric Early Warning Sign Score in Predicting Outcome of PICU Admissions at a Suburban Tertiary Care Hospital. J Pediatr Intens Care 2022;Online:http:/doi.org/10.1055/s-0042-1759730.
3. Killien EY, Keller MR, Watson RS, Hartman ME. Epidemiology of intensive care admissions for children in the US from 2001 to 2019. JAMA pediatrics 2023;177(5):506-15. http:/doi.org/10.1001/jamapediatrics.2023.0184.
4. Heneghan JA, Rogerson C, Goodman DM, Hall M, Kohne JG, Kane JM. Epidemiology of Pediatric Critical Care Admissions in 43 United States Children's Hospitals, 2014–2019*. Pediatr Crit Care Med 2022;23(7):484-92. http:/doi.org/10.1097/PCC.0000000000002956.
5. Shafi OM, Rondon JDD, Gulati G. Can the Pediatric Early Warning Score (PEWS) Predict Hospital Length of Stay? Cureus 2020;12(11).
6. Park SJ, Cho K-J, Kwon O, Park H, Lee Y, Shim WH, et al. Development and validation of a deep-learning-based pediatric early warning system: a single-center study. biomedical journal 2022;45(1):155-68.
7. Lampin ME, Duhamel A, Behal H, Recher M, Leclerc F, Leteurtre S. Use of paediatric early warning scores in intermediate care units. Archives of disease in childhood 2020;105(2):173-9.
8. Romaine, S. T., Sefton, G., Lim, E., Nijman, R. G., Bernatoniene, J., Clark, S., ... & Carrol, E. D. (2021). Performance of seven different paediatric early warning scores to predict critical care admission in febrile children presenting to the emergency department: a retrospective cohort study. BMJ open, 11(5), e044091.
9. Romaine ST, Sefton G, Lim E, Nijman RG, Bernatoniene J, Clark S, et al. Performance of seven different paediatric early warning scores to predict critical care admission in febrile children presenting to the emergency department: a retrospective cohort study. BMJ open 2021;11(5):e044091.
10. Romaine, S. T., Sefton, G., Lim, E., Nijman, R. G., Bernatoniene, J., Clark, S., ... & Carrol, E. D. (2021). Performance of seven different paediatric early warning scores to predict critical care admission in febrile children presenting to the emergency department: a retrospective cohort study. BMJ open, 11(5), e044091.
11. Ibiebele I, Algert CS, Bowen JR, Roberts CL. Pediatric admissions that include intensive care: a population-based study. BMC Health Serv Res 2018;18(1):264. https://doi.org/10.1186/s12913-018-3041-x.
12. Bradman K, Borland M, Pascoe E. Predicting patient disposition in a paediatric emergency department. J Paediatr Child Health 2014;50(10):E39-E44. https://doi.org/10.1111/jpc.12011.
13. Soeteman M, Lekkerkerker CW, Kappen TH, Tissing WJ, Nieuwenhuis EE, Wösten-van Asperen RM. The predictive performance and impact of pediatric early warning systems in hospitalized pediatric oncology patients—a systematic review. Pediatr Blood Canc 2022;69(5):e29636. https://doi.org/10.1002/pbc.
14. Simon Junior H, Schvartsman C, Sukys GdA, Farhat SCL. Pediatric emergency triage systems. Rev Paul Pediatr 2022;41:e2021038. https://doi.org/10.1590/1984-0462/2023/41/.
15. Kowalski RL, Lee L, Spaeder MC, Moorman JR, Keim-Malpass J. Accuracy and monitoring of pediatric early warning score (PEWS) scores prior to emergent pediatric intensive care unit (ICU) transfer: retrospective analysis. JMIR Pediatr Parent 2021;4(1):e25991. http:/doi.org/10.2196/.
16. Romaine ST, Sefton G, Lim E, Nijman RG, Bernatoniene J, Clark S, et al. Performance of seven different paediatric early warning scores to predict critical care admission in febrile children presenting to the emergency department: a retrospective cohort study. BMJ open 2021;11(5):e044091. http:/doi.org/10.1136/bmjopen-2020-.
17. Cheng Y, Zhang X, Zhang J, Lu G. The application of pediatric early warning score (PEWS) in emergency observation room. J Pediatr Nurs 2022;66:1-5. https://doi.org/10.1016/j.pedn.2022.05.011.
18. Shafi OM, Rondon JDD, Gulati G. Can the Pediatric Early Warning Score (PEWS) Predict Hospital Length of Stay? Cureus 2020;12(11):e11339. http:/doi.org/10.7759/cureus.
19. Duncan H, Hutchison J, Parshuram CS. The Pediatric Early Warning System score: a severity of illness score to predict urgent medical need in hospitalized children. J Crit Care 2006;21(3):271-8. https://doi.org/10.1016/j.jcrc.2006.06.007.
20. Miranda JdOF, Camargo CLd, Nascimento CL, Portela DS, Monaghan A. Accuracy of a pediatric early warning score in the

recognition of clinical deterioration. Rev Latin Am Enferm 2017;25:e2912. https://doi.org/10.1590/18-8345.1733.2912.

21. Trubey R, Huang C, Lugg-Widger FV, Hood K, Allen D, Edwards D, et al. Validity and effectiveness of paediatric early warning systems and track and trigger tools for identifying and reducing clinical deterioration in hospitalised children: a systematic review. Br Med J Open 2019;9(5):e022105. https://doi.org/10.1136/bmjopen-2018-.

22. Lillitos PJ, Hadley G, Maconochie I. Can paediatric early warning scores (PEWS) be used to guide the need for hospital admission and predict significant illness in children presenting to the emergency department? An assessment of PEWS diagnostic accuracy using sensitivity and specificity. Emerg Med J 2016;33(5):329-37. https://doi.org/10.1136/emermed-2014-204355.

This article may be cited as: Shah SBH, Kokab H, Jeelani MR: Pediatric Early Warning Score in Predicting Length of Stay in Hospital. Pak J Med Health Sci, 2023;17(11):351-354.