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Original Research

Modified pediatric logistic organ dysfunction scoring system: A feasible tool in pediatric intensive care units

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ABSTRACT

Background: Pediatric logistic organ dysfunction (PELOD) score, which can predict mortality or multiple organ dysfunction syndrome (MODS) outcomes, has been validated for children. It is cumbersome to measure respiratory dysfunction variables included in original PELOD scoring, in ventilator and blood gas analysis limited setups, so all three variables included under respiratory dysfunction (i.e. PaO_2/FiO_2 ratio, $PaCo_2$ and mechanical ventilation) in original PELOD score were replaced by three new variables (i.e., respiratory rate, chest retractions and SpO_2). The present study aims to modify the PELOD score and make it more clinical and feasible to adopt in resource-limited setups rather being dependent on sophisticated facilities. **Aims:** Evaluation of modified PELOD scoring system to determine the prognosis of patients in pediatric intensive care units (PICU). **Method:** The modified PELOD scoring system consists of physical and laboratory variables representing six organ systems namely neurological, cardiovascular, renal, respiratory, hematological, and hepatic system. The score was calculated for the subjects during first 24 h of admission in PICU. Patients were then followed until they were discharged from PICU or deceased. In each organ system, the highest score in any variable accounted was taken as the score for that organ system. The sum total of the 6 scores for each organ system gives modified PELOD score (range 0-71) which was used for looking at the association between modified PELOD score and mortality. **Results:** The risk of mortality varies directly with the modified PELOD score of the patients. In those patients whose modified PELOD score was <10, mortality was 10.4%, whereas in patients whose modified PELOD score was >10, mortality increased significantly to 46.4% (χ^2 = 12.000, P < 0.001). The mean (SD) modified PELOD score was considerably higher in those who died as compared to those who survived (16.25 [8.63] vs. 7.68 [5.55]; P < 0.001). **Conclusion:** The modified PELOD score can be used as a reliable prognostic predictor of mortality among PICU patients.

Keywords: Modified pediatric logistic organ dysfunction score, pediatric intensive care units, prognosis

INTRODUCTION

Estimation of disease severity and probability of death are important elements in determining the prognosis of patients in ICU.[1] The impact of prognostic predictors needs to be communicated to parents clearly to explain the objectives of treatment and to involve them in the decision-making process.[1] It has been a consistent observation that in ICU, mortality correlates with number of failing organ systems and degree of dysfunction within any given organ system.[2] Children in ICU usually present with multiple organ dysfunction syndrome (MODS). Frequency of MODS in the ICU setting ranges from 10% to 90%.[3-6] MODS, the development of progressive physiological dysfunction remote from the site of primary disease, termed as MODS appears to develop in a simultaneous way, not in a sequential manner and much earlier in children.[7] Three MODS scores which can predict mortality or MODS outcomes have been validated for adult patients, but only one MODS score exists for children, the pediatric logistic organ dysfunction (PELOD) score.[3] Variables in the original PELOD score were chosen by the use of Delphi method on the basis of an ideal descriptor of organ dysfunction.[3] The cut-off point of each continuous variable was established by the threshold that was the best overall predictor of death. Severity level and weight of each organ dysfunction were derived from logistic regression rather than opinion.

Acute lower respiratory tract infections (ALRI) are the leading cause of morbidity and mortality among children in

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developing countries, causing about one-third of all deaths in childhood.[8] Hypoxemia is an important risk factor for mortality in children with ALRI.[8] Pulse oximetry is a simple technique to determine the oxygen saturations. However, detection of hypoxemia by use of pulse oximetry alone is not feasible in most situations in developing countries. It is, therefore, important to accurately identify hypoxemic children by use of clinical signs alone. Various clinical signs have been evaluated for their ability to predict hypoxemia like respiratory rate (RR) and chest retractions and when these signs are evaluated alone or in combination, can accurately predict hypoxemia as well as mortality in children with ALRI.[9,10] This was the basis of replacing all three variables included under respiratory dysfunction (PaO_2/FiO_2 ratio, $PaCo_2$, and mechanical ventilation in original PELOD score) with three new variables (RR, chest retractions, and SpO_2) as it is cumbersome to measure respiratory dysfunctions variables included in original PELOD scoring, in ventilators and blood gas analysis limited setups.

The modified PELOD scoring system consists of physical and laboratory variables representing six organ systems namely neurological, hematological, respiratory, cardiovascular, renal and hepatic system. All physical and laboratory variables representing six organ systems included in modified PELOD are same as original PELOD score except variables included in respiratory dysfunction (Appendix 1). The present study aimed to evaluate a modified PELOD scoring system for determining prognosis of patients in pediatric intensive care units (PICU).

MATERIALS AND METHODS

This prospective study was carried out in a tertiary care hospital in north India over a period of 1 year (from September 2011 to August 2012). Institutional Ethical Committee approval was obtained (Reference ID 109-116/BIO/MC/ETHICS dated 30/11/11). All sick children admitted in PICU were considered for inclusion. 109 children were recruited for the study, but 10 were dropped who met exclusion criteria. Subjects excluded from the study were those who stayed in PICU for <4 h, who were admitted in a state of continuous cardiopulmonary resuscitation without achieving stable vital signs for at least 2 h, who for any reason did not undergo sufficient diagnostic laboratory tests in accordance with modified PELOD score and those who were discharged from PICU on request (of parents or legal guardian). Written and informed consent was obtained from the parents prior to study. After the recruitment in the study, patients were followed until they were discharged from PICU or deceased. The modified PELOD score was calculated for the subjects during the first 24 h of admission in PICU. In each organ system, the highest score in any variable accounted was taken as the score for the organ system. For example, for a patient with a heart rate of 200 beats/min (10 points), systolic blood pressure 30 mm Hg (20 points), the score for the cardiovascular system was 20 points. The sum total of the 6 scores for each organ system gives modified PELOD score (range 0-71) which was used for looking at the association between modified PELOD score and mortality.

RESULTS

About 90% of recruited children (65 males, 34 females) were included in the study. Children aged between 5 and 9 years accounted for 40.4% of the subjects. In this study, acute lower respiratory infections (20%), cerebral malaria (18%), hepatic encephalopathy (14%), central nervous system (CNS) infections (13%), and severe sepsis/septic shock (10%) constituted most of study subjects. At the end of the follow-up, 36 children (36.36%) died. The distribution of modified PELOD scores among subjects is shown in Table 1. The risk of mortality varies directly with the modified PELOD score of the patients (Figure 1). In those patients whose modified PELOD score was <10, mortality was 10.4%, whereas in patients whose modified PELOD score was ≥10, mortality increased significantly to 46.4% (χ^2 = 12.000, P < 0.001) (Figure 2). The mean (standard deviation) modified PELOD score was considerably higher in those who died as compared to those who survived (16.25 [8.63] vs. 7.68 [5.55]; P < 0.001). Incidence of MODS was 89%. The mortality rate with at least one organ dysfunctions was 10.34%, increasing to 35% for 2 organ dysfunction

Table 1: Distribution of modified PELOD scores among survivors and non-survivors

Modified PELOD score	Frequency (number of patients)	Survivors	Non-survivors
1	11	11	0
2	14	12	2
3	5	4	1
10	14	11	3
11	19	14	5
12	13	6	7
13	3	1	2
20	8	3	5
21	5	1	4
22	2	0	2
30	2	0	2
31	2	0	2
41	1	0	1
Total	99	63	36

PELOD: Pediatric logistic organ dysfunction

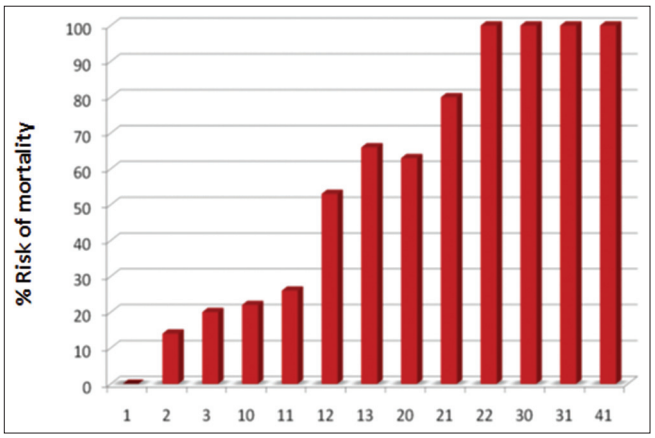

Figure 1: Modified pediatric logistic organ dysfunction score and risk of mortality

and 100% for all six organ dysfunction in our study. The study also revealed that the risk of mortality is inversely proportional to the length of stay in PICU (Table 2). The mean length of stay was considerably higher in patients who survived as compared to those who expired (Table 3).

DISCUSSION

The risk of mortality varies directly with modified PELOD score of patients. It was also observed that mean (standard deviation [SD]) of modified PELOD score of non-survivors was significantly higher than those of survivors ($P < 0.001$). The validation study (Leteutre *et al.*) of PELOD score found that the mean PELOD scores of non-survivors was 31 and those of survivors was 9.4 ($P = 0.0001$).[3] The mean (SD) of PELOD scores observed among survivors was 13.5 (8.5) while this value among non-survivors was 22.2 (10.1) in a study conducted by Metta *et al.*[11] Honna *et al.* found that PELOD score was significantly higher in "died" group (mean 28.2, SD 12.5) than in "improved" group (mean 11.5, SD 9.3).[12]

The apparently varying mean modified PELOD scores in non-survivors in our study and the other validation studies of PELOD score could be explained by the different population of patients in various PICUs and the utilization frequency of facilities.[13] In this study, Acute lower respiratory infections, cerebral malaria, hepatic encephalopathy, CNS infection, and severe sepsis/septic shock constituted most of the study subjects, which is similar to other Indian study.[6] This differs from other study (Leteutre *et al.*) where neurological and cardiovascular emergencies ranked at first and second place.[3]

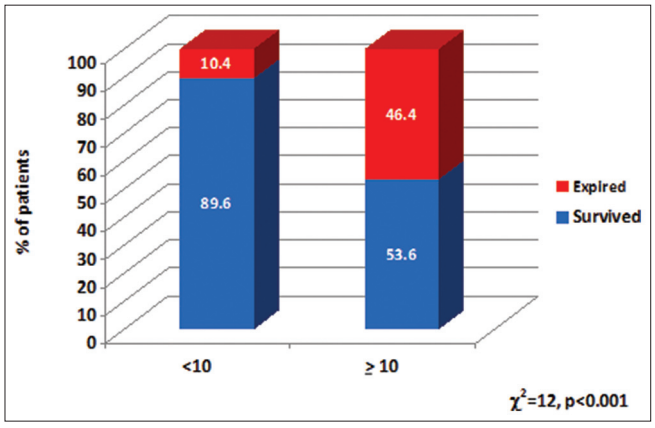

Figure 2: Modified pediatric logistic organ dysfunction score and outcome

Table 2: Distribution according to length of stay and outcome

Length of stay (In hours)	Outcome		Total
	Survived	Expired	
≤48	19 (47.5)	21 (52.5)	40
>48	44 (74.57)	15 (25.43)	59
Total	63	36	99

Table 3: Mean of length of stay according to the outcome

	Outcome		*P* value
	Survived	Expired	
Mean length of stay±SD	3.68±1.72	2.22±1.49	<.001

SD: Standard deviation

About 89% children in the present study had MODS. The relationship between number of organ dysfunction and mortality in our study was linear. The mortality rate with at least one organ dysfunctions was 10.34%, increasing to 35% for 2 organ dysfunction and 100% for all six organ dysfunction in our study. The higher frequency of MODS seen in our study is due to the limited number of beds in our ICU, and only the sickest children were admitted.[12,14,15] Marshall *et al.* found that about 25% of the children admitted to PICU had MODS.[14] Incidence of MODS was 75% in a study conducted by Hona *et al.*[12] while it was 70.3% in the study conducted by Hendra *et al.*[15] Thukral *et al.* found it as high as 90%.[4]

We found that the risk of mortality is inversely proportional to the length of stay in PICU. The mean length of stay was considerably higher in patients who survived as compared to those who expired. To the best of our knowledge, no study to date has compared the risk of mortality with length of stay in PICU.

Our study reveals that modified PELOD score is statistically strong enough to prognosticate risk of mortality in PICU. Thus, modified PELOD score can be used as a reliable prognostic predictor of mortality among PICU patients.

CONCLUSION

Modified PELOD score can be used as a prognostic predictor of mortality among PICU patients. It has a direct correlation with mortality, as the Modified PELOD score increases, the chances of mortality increases proportionately.

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PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

The authors Ajay Gaur, Ravi Ambey and Anoop Sharma declare that they have no competing interests.

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ETHICS COMMITTEE APPROVAL

Medical Ethics Committee, Gajra Raja Medical College and approval reference number is 109-116/BIO/MC/ETHICS dated 30/11/11.

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APPENDIX

Appendix 1: Modified PELOD scoring system

Organ dysfunction and variable	Points assigned			
	0	1	10	20
Neurological				
GCS	12-15	7-11	4-6	3
Pupillary reaction	Both reactive	NA	Both fixed	NA
Hematological				
WBC ($\times 10^9$/L)	≥4.5	1.5-4.4	<1.5	NA
Platelet ($\times 10^9$/L)	≥35	<35	NA	NA
Hepatic				
Aspartate transaminase (IU/L)	<950	>950	NA	NA
Prothrombin time (or INR)	≤60 (≤1.4)	>60 (> 1.4)	NA	NA
Respiratory				
RR				
<3 months	<60	60-80	>80	NA
3-12 months	< 50	50-70	>70	NA
>12 months	<40	40-60	>60	NA
Chest retraction	No retreaction/Subcostal/intercostal	NA	Lower chest retraction	NA
SpO_2	≥90%	NA	<90%	NA
Renal				
Creatinine (mg/dl)				
1 month-1 year	<0.622	NA	>0.622	NA
1-12 year	<1.131	NA	>1.131	NA
>12 year	< 1.583	NA	>1.583	NA
Cardiovascular				
HR (beats/min)				
<12 year	<195	NA	>195	NA
>12 year	<150	NA	>150	NA
SBP (mmHg)				
1 month-1 year	>75	NA	35-75	<35
1-12 year	>85	NA	45-85	<45
>12 year	>95	NA	55-95	<55

GCS: Glasgow Coma scale, WBC: White blood cell RR: Respiratory rate, HR: Heart rate, SBP: Systolic blood pressure