Open Access Publish Free

http://jept.ir
doi 10.34172/jept.2024.13

Journal of Emergency Practice and Trauma
Volume 9, Issue 2, 2023, p. x-x

Original Article

Severity of organ dysfunction in pediatric intensive care using PELOD-2

Sangeetha Shenoy*, **Shruti Patil**

Department of Pediatrics, Ramaiah Medical College and Hospital, Ramaiah University of Applied Sciences, Bangalore, India

Received: November 5, 2023
Accepted: February 10, 2024
Published online: June 3, 2024

***Corresponding author:**
Sangeetha Shenoy,
Email: sangeethashenoy@yahoo.co.in

Citation: Shenoy S, Patil S. Severity of organ dysfunction in pediatric intensive care using PELOD-2. Journal of Emergency Practice and Trauma 2023; 9(2): x-x. doi: 10.34172/jept.2024.13.

Abstract

Objective: Organ dysfunction is an important factor determining the severity and outcome of critical illness in children. Organ dysfunction scores are based on the number of organs involved and the severity of dysfunction in each. This study aimed to evaluate organ dysfunction using PELOD-2 in critically ill children.

Methods: This prospective observational study included all consecutive critically ill children with organ dysfunction aged one month to 15 years admitted to pediatric intensive care unit of a Ramaiah Medical College Hospital, Bangalore between January 2018 and December 2020. The severity of organ dysfunction was scored using Pediatric logistic organ dysfunction-2 (PELOD-2) and evaluated based on the outcome using SPSS and PASW statistics for Windows version 18.0. The sample size required for the study with 95% confidence level and 10% relative precision was 149 critically ill children. The children were classified based on the presence of single and multiple organ dysfunction. Demographics and laboratory parameters were compared between the two groups using non parametric tests. The factors affecting mortality among children with multiple organ dysfunction were assessed using univariate and multivariate analysis.

Results: Of the 550 children admitted with critical illness during the study period, organ dysfunction was present in 84% of the patients. Of these, 43% had multiple-organ dysfunction. The median (interquartile range) of the patients was 5.5 (1, 11) years with a male-to-female ratio of 1.7:1. The mortality rate was 14.4%. The PELOD-2 score and mortality steadily increased with the number of organs involved. The presence of more than two organ dysfunctions had an odd ratio (OR) of 45.7 for mortality (95% CI: 18.9–110.6, *P* value < 0.001). The area under the receiver operating curve (ROC) for predicting mortality using the number of organs affected was 0.96 (95% CI: 0.94–0.97, *P* value < 0.001). Dysfunction in more than two organs had a sensitivity of 92.5% and a specificity of 91% in predicting mortality. The presence of cardiovascular dysfunction and the need for ventilation were found to be independent predictors of mortality.

Conclusion: The presence of more than two organ dysfunctions in PELOD-2 increased the risk of mortality; the need for ventilation and the presence of cardiovascular dysfunction were independent predictors of mortality.

Keywords: Critical illness, Children, Mortality

Introduction

Organ dysfunction is a common occurrence among children admitted to the pediatric intensive care unit (PICU) (1,2). It is also a significant cause of mortality among critically ill children (1,3). Multiorgan dysfunction (MOD) is the presence of simultaneous dysfunction in two or more organ systems. The incidence of MOD varies from 11 to 27% (2). One Indian study found persistent MOD in 10.6% of admissions, accounting for 49% of mortalities (3). The presence of MOD is often used as a surrogate indicator for morbidity in PICU.

The number and severity of organ dysfunctions in critically ill children have been associated with mortality (4). Thus, scoring systems that describe organ failure are of great importance. Many diagnostic criteria for defining pediatric organ dysfunction have been validated and are currently being used. There are many prognostic scoring systems, like PRISM-3. However, few scores describe organ dysfunction. pSOFA (pediatric sequential organ failure assessment score) and pediatric logistic organ dysfunction (PELOD) are descriptive or outcome scores describing the course of illness after admission into the PICU. However, there is no consensus on the diagnostic criteria for MOD, the organs to be included, and the thresholds to define dysfunction for each organ system. PELOD is a discontinuous score and has been found to have poor calibration (5). In 2013 an updated version, PELOD-2 (6,7), which used a continuous scale, was developed. Daily PELOD-2 was validated in 2015 at specific time points during the hospital stay. Days 1, 2, 5, 8, 12, 16, 18, and the discharge day were identified as the optimal times to score the daily PELOD-2 (8). Deshmukh

et al (3) studied the predictive efficacy of the PELOD-2 measured within 1 hour of admission and found PELOD-2 to have good discrimination, with an area under receiver operating characteristics curve of 0.87 and a *P* value of 0.42 on the Hosmer Lemeshaw goodness of fit test.

Few studies have evaluated organ dysfunction using the PELOD-2 scoring system in developing countries. This study aimed to describe organ dysfunction in the PICU using PELOD-2 and evaluate risk factors associated with mortality.

Methods

This prospective descriptive study was conducted in the 13-bed PICU of a Ramaiah Medical College Hospital, Bangalore after obtaining institutional ethical clearance (No. MSRMC/EC/2018). This was part of another study comparing the performance and discrimination of PRISM-III and PELOD-2 in critically ill children (9). All consecutive children aged between 1 month and 18 years admitted to the PICU between January 2018 and December 2020 with signs of organ dysfunction were included in the study after written informed consent was obtained from the caregivers. PELOD-2 was scored within the first 24 hours of admission to the PICU. The worst values for the variables that were measured more than once in a 24-hour period were used to calculate the scores. The methodology has been described in detail in a previous study (9). PELOD-2 has variables related to five organ systems: neurologic, renal, respiratory, hematologic, and cardiovascular. An organ can have a maximum of 10 points, and the maximum PELOD-2 score is 33. The patient was then followed up till death or discharge. Demographic details (age and gender), diagnosis, presence of organ dysfunction, PELOD-2 scores at admission, and outcome were noted in a predesigned proforma.

In a study (10), 72% of pediatric intensive care unit patients had multiple organ dysfunctions. Based on results of the above study, for a 95% confidence level and 10% relative precision for the present study, the sample size was estimated to be at least 149 subjects.

Continuous variables were expressed as median (IQR) or mean (SD). Categorical variables were expressed as percentages. A nonparametric test compared the median values between single and MOD groups. Univariate analysis was done to study the factors associated with mortality among patients with MOD. Logistic regression analysis was done to analyze the independent factors affecting mortality. The area under the receiver operating curve (ROC) with a 95% confidence interval (CI) was used to assess the ability of the number of organ dysfunctions to differentiate between survivors and non-survivors. Youden's index was used to determine the cut-off value. Analysis was done using SPSS and PASW statistics for Windows version 18.0. *P* values < 0.05 were taken as significant.

Results

Among the 550 children admitted with critical illness, 464 (84%) had organ failure at admission, of which 199 (43%) had MOD, and 265 (47%) had single organ dysfunction (SOD) (Table 1). The median (IQR) age of the patients was 5.5 (1, 11) years. The male-to-female ratio was 1.7:1, and the overall mortality rate among study subjects was 14.4% (n = 67).

Patients with SOD and MOD were comparable in terms of age and gender. Patients with MOD spent more days in the PICU compared to those with SOD, which was statistically significant (*P* = 0.045). A significantly higher number of patients with MOD were ventilated compared

Table 1. Comparative analysis of study patients with single and multiorgan dysfunction

Variables	Total (N = 464)	SOD (n = 265)	MOD (n = 199)	*P* value
Age (years), Median (IQR)	5.5 (1, 11)	6 (1.6, 12)	4 (1, 11)	0.081[a]
Gender				
Male	291 (62.7)	174 (65.7)	117 (58.8)	0.14[b]
Female	173 (32.3)	91 (34.3)	82 (41.2)	
Length of PICU stay	4 (3,6)	4 (3,5)	5 (3,8)	0.045[a]
Mechanical ventilation	122 (26.3)	7 (2.7)	115 (57.8)	<0.001[b]
Mortality	67 (14.4)	0 (0)	67 (33.7)	<0.001[b]
Neurological dysfunction	98 (21.1)	8 (3)	90 (45.2)	<0.001[b]
Cardiovascular dysfunction	122 (26.3)	3(1.1)	119 (59.8)	<0.001[b]
Hematological dysfunction	270 (58.2)	159 (60)	111(55.8)	0.362[b]
Respiratory dysfunction	129 (27.8)	12 (4.5)	117 (58.8)	<0.001[b]
Renal dysfunction	206 (44.4)	83 (31.3)	123 (61.8)	<0.001[b]
Leucocyte count (x10^3), median (IQR)	9.05 (5.81,14.1)	8.2 (5.4,12.7)	10.7 (6.4,15.5)	0.002[a]
Platelet count (x10^3), median (IQR)	75 (28,323)	60 (26,356)	100 (32,312)	0.238[a]

SOD, Single organ dysfunction; MOD, Multiorgan dysfunction; IQR: interquartile range; PICU: pediatric intensive care unit.
[a] Mann-Whitney test; [b] Chi-square test; *P*-value less than 0.05 is taken as significant.

to those with SOD. Sixty-seven (33.7%) patients died in the MOD group, whereas there was no mortality in the SOD group. Hematologic failure was the most common dysfunction in the SOD group. Renal dysfunction was the most common organ involvement in the MOD group. The total leucocyte count was significantly higher in the MOD group compared to the SOD group.

Among the 199 patients with MOD, 100 (18.2%), 48 (8.7%), 39 (7.1%), and 12 (2.2%) patients had 2, 3, 4, and 5 organs involved, respectively. Mortality steadily increased with the increase in the number of organs involved (Table 2). The presence of more than two organ dysfunctions had an odds ratio (OR) of 45.7 for mortality (95%CI: 18.9–110.6, *P* value < 0.001). The area under the receiver operating curve (ROC) for predicting mortality using the number of organs affected was 0.96 (95%CI: 0.94–0.97, *P* value < 0.001). Dysfunction in more than two organs had a sensitivity of 92.5% and a specificity of 91% in predicting mortality.

The factors affecting mortality were analyzed among children with MOD. In univariate analysis, the presence of neurological, hematological, and cardiovascular dysfunction and the use of ventilatory support were significantly associated with mortality. In logistic regression, cardiovascular dysfunction and the need for ventilation were independent predictors of mortality (Table 3). Ventilated patients and those with cardiological dysfunction were 96 and 36 times more likely to die, respectively.

Table 2. Correlation of PELOD-2 score and mortality with number of organ dysfunction

Number of organ dysfunction	No. of patients No. (%)	PELOD-2 score Mean (SD)	Mortality No. (%)
1	265 (57.1)	2 (0.5)	0 (0)
2	100 (21.5)	4.4 (1.8)	5 (5)
3	48 (10.3)	8.9 (3.2)	21 (43.8)
4	39 (8.4)	12.1 (4.4)	31 (79.5)
5	12 (2.6)	15.4 (3.6)	10 (83.3)

SD, standard deviation.

Discussion

MOD is a common occurrence as well as a leading cause of mortality among critically ill children admitted to the PICU. Outcome scoring systems are based on the number of organs involved as well the severity of involvement of each organ system. In this study, the PELOD-2 scoring system was used to describe critically ill children with organ dysfunction.

MOD was present in 43% of patients in this study. A study by Thukral et al (11) observed MOD in 91% of patients, of whom 45% showed association with sepsis. They attributed the former finding to the hospital's limited bed capacity and referral nature. An Egyptian study by El Hamshary et al (10) reported MOD in 72% of the patients.

A larger number of patients with MOD required mechanical ventilation, and they had higher mortality compared to those with SOD in our study. Neurological, cardiovascular, renal, and respiratory dysfunction was significantly higher in the MOD group. There was also a statistically significant difference in the total leucocyte count, which was higher in the MOD group. El Hamshary

Table 3. Univariate and multivariate analysis of factors affecting mortality among critically ill patients with MOD

Variable		Univariate analysis				Multivariate analysis
		Non-survivors No. (%)	Survivors No. (%)	RR (95% CI)	*P* value	RR (95% CI)
Age (y)	>10	17 (32.1)	36 (67.9)	1	0.063	
	5–10	8 (22.9)	27 (77.1)	0.7 (0.4–1.5)		
	1–5	14 (27.5)	37 (72.5)	0.9 (0.5–1.6)		
	<1	28 (46.7)	32 (53.3)	1.5 (0.9–2.3)		
Gender	Female	23 (27.4)	61 (72.6)	1	0.109	
	Male	44 (38.3)	71 (61.7)	0.7 (0.5–1.1)		
Renal dysfunction	No	44 (35.8)	79 (64.2)	1	0.424	
	Yes	23 (30.3)	53 (69.7)	1.2 (0.8–1.8)		
Neurological dysfunction	No	46 (51.1)	44 (48.9)	1	<0.001	2.6 (0.6–11.9)
	Yes	21 (19.3)	88 (80.7)	2.7 (1.7–4.1)		
Cardiological dysfunction	No	62 (52.1)	57 (47.9)	1	<0.001	35.5 (6.8-184.2)
	Yes	5 (6.2)	75 (93.8)	8.3 (3.5–19.8)		
Hematological dysfunction	No	38 (43.2)	50 (56.8)	1	0.011	1.4 (0.3–6.4)
	Yes	29 (26.1)	82 (73.9)	0.6 (0.4–0.9)		
Mechanical ventilation	No	1 (1.2)	83 (98.8)	1	<0.001	96.6 (11.4-819)
	Yes	66 (57.4)	49 (42.6)	48.2 (6.8–340)		

RR: relative risk; CI: confidence interval.
P values less than 0.05 are considered significant.

et al (10), who compared 237 patients with organ dysfunction, observed that metabolic and renal failure were significantly more prevalent in the MOD group. They also reported a higher ventilator requirement and higher mortality in the MOD group compared to the SOD group. However, they did not find any difference in the leucocyte count. The studies did not find any difference in the gender and median age among the two groups.

The mortality rate in this study was 14.4% compared to 33.5 % (11) and 39.7 % (10) in two other studies. This was probably because of the higher proportion of patients with SOD in our study. In our study, the number of non-survivors increased as the number of organ dysfunctions increased, and the mortality rate in patients with five-organ involvement was 83%. Thukral et al (11), who studied the effectiveness of PELOD in predicting mortality in PICU, observed a mortality of 6.25% in single-organ involvement, which increased to 100% when all six organs were involved. Leteurtre et al (6) also reported that 59% of patients who died had five involved organs. Among pediatric burn patients (12), the involvement of five organs led to a mean PELOD-2 score of 16.8, with a mortality of 59%. Children commonly experience simultaneous involvement of multiple organs, unlike adults, who have sequential involvement of organs. The involvement also happens much quicker in children, with most children presenting with or developing multiorgan involvement within 24 hours of admission. The involvement of multiple organs and also the severity of organ dysfunction have been associated with mortality.

In analyzing the factors affecting mortality in the MOD group, the requirement of ventilator support and cardiovascular dysfunction were the two factors found to be independent predictors of mortality. Need for vasoactive drugs, ventilation, parenteral nutrition, nosocomial infection, MODS at admission, and length of hospital stay were the factors associated with mortality in a study by Costa et al (13) The risk for ventilation and neurological failure were independent predictors of mortality in another study by El Hamshary et al (10). Logistic regression associated respiratory dysfunction with the highest risk of mortality in another study by Typpo et al (14)

The present study has some limitations. Firstly, it is a single-center study based in a tertiary care hospital. Hence, selection bias is possible, and the study population may not be truly representative of the cases in the general population. This might affect the generalizability of the findings. Further multicentric studies involving a larger number of patients are required. The PELOD-2 score can be used as a surrogate marker of mortality. However, it is basically a descriptive score designed to describe the number and severity of organ dysfunctions.

The presence of more than two organ involvements, especially when one is cardiovascular dysfunction, and the requirement of mechanical ventilation at admission should alert the clinician to the potentially unfavorable outcome of the disease. Further multicenter and comparative research involving PELOD-2 and other descriptive scores is required to reach a consensus about the gold standard score.

Conclusion

MOD with more than two organs involved increases mortality risk. Among patients with MOD, the presence of cardiovascular dysfunction and mechanical ventilation are independent predictors of mortality.

Authors' Contribution

Conceptualization: Sangeetha Shenoy and Shruti Patil
Data curation: Sangeetha Shenoy.
Formal analysis: Sangeetha Shenoy.
Investigation: Sangeetha Shenoy and Shruti Patil.
Methodology: Sangeetha Shenoy and Shruti Patil.
Project administration: Shruti Patil.
Supervision: Shruti Patil.
Validation: Sangeetha Shenoy, Shruti Patil.
Visualization: Sangeetha Shenoy and Shruti Patil.
Writing–original draft: Sangeetha Shenoy.
Writing–review & editing: Sangeetha Shenoy and Shruti Patil.

Competing Interests

None.

Ethical Approval

Obtained from the Institutional Ethics Committee of Ramaiah Medical College, Bangalore, India (No. MSRMC/EC/2018).

Funding

None.

References

1. Watson RS, Crow SS, Hartman ME, Lacroix J, Odetola FO. Epidemiology and outcomes of pediatric multiple organ dysfunction syndrome. Pediatr Crit Care Med. 2017;18(3 Suppl 1):S4-16. doi: 10.1097/pcc.0000000000001047.
2. Khilnani P, Sarma D, Zimmerman J. Epidemiology and peculiarities of pediatric multiple organ dysfunction syndrome in New Delhi, India. Intensive Care Med. 2006;32(11):1856-62. doi: 10.1007/s00134-006-0373-5.
3. Deshmukh T, Varma A, Damke S, Meshram R. Predictive efficacy of pediatric logistic organ dysfunction-2 score in pediatric intensive care unit of rural hospital. Indian J Crit Care Med. 2020;24(8):701-4. doi: 10.5005/jp-journals-10071-23528 .
4. Leclerc F, Leteurtre S, Duhamel A, Grandbastien B, Proulx F, Martinot A, et al. Cumulative influence of organ dysfunctions and septic state on mortality of critically ill children. Am J Respir Crit Care Med. 2005;171(4):348-53. doi: 10.1164/rccm.200405-630OC.
5. Garcia PC, Eulmesekian P, Branco RG, Perez A, Sffogia A, Olivero L, et al. External validation of the paediatric logistic organ dysfunction score. Intensive Care Med. 2010;36(1):116-22. doi: 10.1007/s00134-009-1489-1.
6. Leteurtre S, Duhamel A, Salleron J, Grandbastien B, Lacroix J, Leclerc F. PELOD-2: an update of the pediatric logistic organ dysfunction score. Crit Care Med. 2013;41(7):1761-73. doi: 10.1097/CCM.0b013e31828a2bbd.
7. Leteurtre S, Duhamel A, Deken V, Lacroix J, Leclerc F.

Daily estimation of the severity of organ dysfunctions in critically ill children by using the PELOD-2 score. Crit Care. 2015;19(1):324. doi: 10.1186/s13054-015-1054-y.

8. Leteurtre S, Duhamel A, Grandbastien B, Proulx F, Cotting J, Gottesman R, et al. Daily estimation of the severity of multiple organ dysfunction syndrome in critically ill children. CMAJ. 2010;182(11):1181-7. doi: 10.1503/cmaj.081715.
9. Shenoy S, Patil S, Karunakar BP, Mangalgi S, Samaga V. Comparison between paediatric risk of mortality III and paediatric logistic organ dysfunction-2 as mortality predictor in paediatric intensive care. Sri Lanka J Child Health. 2023;52(1):45-51.
10. El Hamshary AA, El Sherbini SA, Elgebaly HF, Amin SA. Prevalence of multiple organ dysfunction in the pediatric intensive care unit: pediatric risk of mortality III versus pediatric logistic organ dysfunction scores for mortality prediction. Rev Bras Ter Intensiva. 2017;29(2):206-12. doi: 10.5935/0103-507x.20170029.
11. Thukral A, Kohli U, Lodha R, Kabra SK, Kabra NK. Validation of the PELOD score for multiple organ dysfunction in children. Indian Pediatr. 2007;44(9):683-6.
12. Dewi W, Christie CD, Wardhana A, Fadhilah R, Pardede SO. Pediatric logistic organ dysfunction-2 (PELOD-2) score as a model for predicting mortality in pediatric burn injury. Ann Burns Fire Disasters. 2019;32(2):135-42.
13. Costa GA, Delgado AF, Ferraro A, Okay TS. Application of the pediatric risk of mortality (PRISM) score and determination of mortality risk factors in a tertiary pediatric intensive care unit. Clinics (Sao Paulo). 2010;65(11):1087-92. doi: 10.1590/s1807-59322010001100005.
14. Typpo KV, Petersen NJ, Hallman DM, Markovitz BP, Mariscalco MM. Day 1 multiple organ dysfunction syndrome is associated with poor functional outcome and mortality in the pediatric intensive care unit. Pediatr Crit Care Med. 2009;10(5):562-70. doi: 10.1097/PCC.0b013e3181a64be1.