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ORIGINAL RESEARCH

Comparison of Pediatric Risk of Mortality (PRISM) and Pediatric Logistic Organ Dysfunction (PELOD) scales in pediatric intensive care unit patients: A single-center study.

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Abstract

Introduction: The aim of the present study was to examine diagnostic tests between the PRISM III scale and the PELOD scale to predict mortality in patients admitted to the Intensive Care Unit (PICU) of the Baca Ortiz Pediatric Hospital in the period of June-December 2019.

Methods: In this retrospective observational study, mortality and the variables that make up each of the predictive scales were recorded. Descriptive and inferential statistics were applied along with calculation of the area under the ROC curve. The calibration was calculated using the Hosmer Lemeshow chi2, and the mortality rate was standardized using the statistical package STATA v16.

Results: 150 patients entered the study. 99 patients (66%) were male, and the mean age was 3 years (P25 to P75) with a range from 1 month to 14 years. The most frequent admission pathologies were postoperative disease in 43 patients (28.6%) and respiratory failure in 31 patients (21.6%). Mortality was 12.7%, and the mean hospital stay was 5 days (1 to 60 days). The PRIMS III scale had an area under the curve of 0.80 (95% CI from 0.70 to 0.90), sensitivity of 79%, and specificity of 63% with a PRISM III score of 13 points. The PELOD scale had an area under the curve of 0.7 (95% CI from 0.5 to 0.80), sensitivity of 79%, and specificity of 60% with a PELOD score of 21 points.

Conclusions: The PRISM III scale predicts mortality better than the PELOD scale in this group of pediatric patients in the first 24 hours.

Key words: Child Mortality; Critical Care; Child; Prognosis; Cause of Death.

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Introduction

Children admitted to the pediatric intensive care unit (PICU) are patients with a high risk of mortality, and they may present multiple organ dysfunction syndrome (MODS), which is defined by the presence of two or more affected organ systems (respiratory, cardiovascular, neurological, hematological, renal, hepatic, and gastrointestinal) [1]. In clinical practice, the assessment of severity as well as the clinical instability and prognosis of the patient are vital components to face in the PICU [2]. In this context, scoring systems are useful to predict mortality early, improve the quality of care, strengthen the training of physicians, and also effectively classify patients by establishing early and adequate treatment [3].

Of the existing scoring systems, the Pediatric Mortality Risk Score (PRISM III) and Pediatric Logistic Organ Dysfunction (PELOD) are used to quantify physiological status and can be used to calculate expected mortality risk [4]. The PRISM III score is a system that was developed by including more than 11,000 consecutive admissions in 32 PICUs in the United States. It consists of 14 physiological variables that include vital signs and laboratory results, which are evaluated in the first 24 hours of admission to the PICU. It is currently considered an accepted standard against which other scores are compared because it presents good calibration and discrimination with values of the area under the curve greater than 0.78 [5].

The PELOD scoring system was derived from the MODS criteria and allows for determining the presence of dysfunction and severity of 6 organ systems by assessing 12 variables calculated daily [1]. This scale is considered a surrogate for the probability of death since there is a direct relationship between the number of organ dysfunctions and the mortality rate in children [6]. It is imperative to establish the predictive capacity of these scores to assess whether or not there is a statistically significant difference in the prediction of mortality. The reason is that the predictive value of the scores may not be the same for all populations. This is due to the difference in the pattern of diseases and particular characteristics of each population. Thus, the following research question was established: what differences exist between the PRISM III and PELOD scale in determining mortality in patients admitted to hospital to the Intensive Care Unit of Baca Ortiz Pediatric Hospital in the period of June-December 2019? An observational study of diagnostic tests was designed with the objective of comparing whether the PRISM III scale has a better predictive capacity than the PELOD scale to predict mortality in children admitted to the PICU.

Population and methods

Design of the investigation

This is an observational study of diagnostic tests with a retrospective design.

Venue and study period

The study was carried out in the PICU area of Baca Ortiz Pediatric Hospital of the Ministry of Public Health of Quito, Ecuador, between the dates of June 1, 2019, and December 31, 2019.

Sample size

The sample was a non-probabilistic census-type sample of all possible cases attended at the institution on the specified dates.

Participants

Patients were included if they were from 1 month of age to 14 years, 11 months, and 29 days; were admitted to the PICU; and had all the variables of the PRISM III and PELOD questionnaires available. Cases in which there was a history of oncological diseases were excluded.

Variables

Sociodemographic variables such as age, sex, weight, height, and body mass index were recorded. Mortality was recorded in each case. For the PRISM III score, the following were recorded: systolic blood pressure, body temperature, neurological status, heart rate, pupillary response, blood gas, glucose, potassium, urea, creatinine, blood count, and clotting times. For the PELOD score, the following were recorded: neurological status, heart rate, systolic blood pressure, serum creatinine, PaO_2/FiO_2, $PaCO_2$, use of mechanical ventilation, leukocytes and platelets in blood, TGP, and clotting time.

Data sources and measurements

The statistics department was requested to list patients treated in the PICU during the proposed research period. Through a manual review, a definitive list of cases was finally determined.

Avoidance of bias

An approved protocol was used for this investigation with all methodological filters. The information was always taken by the same main researchers (Natalia Sánchez and Pamela Izquierdo), and the data was curated and validated by the study director. Supervision was carried out by the study director. A single computer was assigned with a password administered only by the principal investigators.

Statistical methods

Descriptive statistics were used to describe the characteristics of the population, and we obtained the mean, maximum, and minimum. Inferential statistics were applied to assess the performance of the PRISM III and PELOD scores by means of a Receiver Operating Characteristic (ROC) analysis. We calculated the area under the curve (AUC) as the gold standard for the observed mortality.

The calibration for the accuracy of the expected risk of death was calculated using the Hosmer Lemeshow chi^2 by comparing the observed versus the predicted mortality. A value > 0.20 indicates a good fit of the model. In addition, the standardized mortality rate (SMR) was calculated, which is defined as the product of the division between the observed mortality and the expected mortality.

The predictive capacity of each of the selected tools was evaluated in terms of their ability to predict any of the outcomes listed previously. We used Harrell's C statistics based on the analysis of the area under the curve of the ROC curves following standard procedures. We also analyzed the calibration of the risk score using the Hosmer-Lemeshow χ^2 test. To validate the predictive force of each death-prediction tool, we used the calculation of the area under the ROC curve.

Ethical criteria

The Bioethics Subcommittee of the Pontificia Universidad Católica del Ecuador approved this research. The data use authorization was granted by the teaching department of Baca Ortiz Pediatric Hospital.

Results

The total sample consisted of 150 patients admitted to the PICU. Of these, 99 patients (66%) were male, with a mean age of 3 years (P25 to P75) and range from 1 month to 14 years (see Fig. 1). The pathologies on admission were postoperative disease in 43 cases (28.6%), respiratory failure in 31 cases (21.6%), head trauma in 21 cases (14.0%), and seizure status in 13 cases (8.6%).

On the PRISM III scale regarding neurological status, 72.9% had a Glasgow score less than 8 points, with altered pupillary response in 15.3%. Among vital signs, 7.8% had blood pressure values below the percentiles for age. There was an alteration of heart rate in 7.3% of patients younger than two years, 8.6% of patients older than two years, 24.6% of patients with tachypnea, and 4.6% of apnea cases. Regarding the gasometric parameters, PaO/FiO_2 was altered in 75.2%, $PaCO_2$ was altered in 19.3%, and bicarbonate was altered in 16.0%. With regard to electrolyte levels, potassium was altered in 19.3%, calcium was altered in 33.3%, and liver function was affected with an INR alteration in 8.0%.

On the PELOD scale with respect to neurological status, 83.9% had a Glasgow score less than 8 (equivalent to the patients studied), with altered pupillary response in 29.3%. Regarding vital signs, 14.6% of the patients evaluated had blood pressure values below the percentile for age. Patients with mechanical ventilation support comprised 82.7%. In addition, for the laboratory values in terms of renal function, creatinine was altered in 10.6%, hematic biometry parameters were altered, leukocytes were altered in 3.2%, platelets were altered in 0.6%, liver function was affected with alteration of the TGO in 4.6%, and the INR was altered in 11.3%.

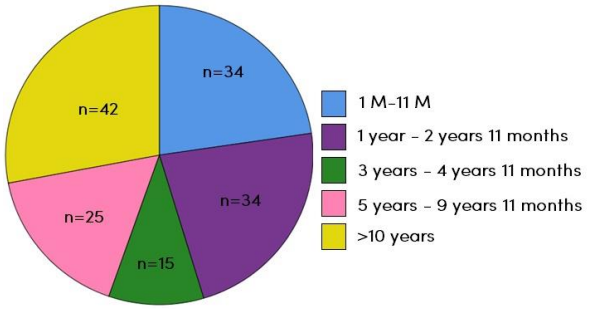

Fig. 1 Percentage of age groups.

Table 1 Demographic and clinical characteristics of the study patients.

Variable	Total sample n=150
Male	99 (66.0%)
Female	51 (34.0%)
Age (years), 50th P (25th to 75th P)	3 (1m a 14a)
1m – 11m	34 (22.7%)
1y – 2y 11m	34 (22.7%)
3y – 4y 11m	15 (10%)
5y – 9y 11m	25 (16.7%)
> 10y	42 (28%)
Respiratory diseases	
Respiratory insufficiency	31 (21.6%)
Foreign body in the airway	4 (2.6%)
Type I lung malformation	1 (0.6%)
Complicated tracheitis	1 (0.6%)
Drowning	1 (0.6%)
Neurological diseases	
Severe head trauma	21 (14.0%)
Convulsive status	13 (8.6%)
Subarachnoid hemorrhage	1 (0.6%)
Uremic encephalopathy	1 (0.6%)
Post-surgical	54 (36.0%)
Other conditions	
Sepsis	9 (6.0)
Burn	5 (3.3)
Diabetic cetoacidosis	3 (2.0)
Nephritic syndrome	1 (0.6)
Nephrotic syndrome	1 (0.6)
Animal bite	1 (0.6)
Hypovolemic shock	1 (0.6)
Necrotizing enterocolitis	1 (0.6)
Exit condition	
Alive	131 (87.3%)
Deceased	19 (12.7%)
Mortality in Men / Women	
Mortality in Men	12 (8%)
Mortality in Women	7 (4.7%
Mortality by pathologies	
Respiratory insufficiency	6 (4%)
Sepsis	5 (3.3%)
Post-surgical	4 (2.6%)
Head trauma	3 (2%)
Necrotizing enterocolitis	1(0.6%)
Days of hospital stay, 50th P (25th to 75th P)	5 (0 a 60)
PRISM III score	
Low < 20 points	136 (90.7%)
Moderate 20 to 29 points	13 (8.7%)
High >30 points	1 (0.7%)
PELOD score, 50th P (25th to 75th P)	21 (11- 31)*

The percentage of deceased patients was 12.7%, with a mean hospital stay of 5 days (p25 and p75: 1 and 60). The results of the PRISM III scale showed that 136 patients (90.7%) presented a low risk of death in the first 24 hours of hospitalization in the intensive care. The results of the PELOD scale showed a mean of 21 points with a P25 and P75 of 11 and 31, respectively (see Table 1 and Table 2).

Table 2 Tertiles of age in PICU patients according to the PRISM III and PELOD scales.

	Tertile 1	Tertile 2	Tertile 3	P
PRISM III	12 (8-19)	11 (9-17)	10 (6-13)	0.0913
PELOD	21 (11-84)	26 (21-88)	21 (1-84)	0.0291*

Tertile 1: 1 month-1.8 years; Tertile 2: 2 -7 years; Tertile 3: 8 -14 years.

Analysis of the area under the curve

In this study, the PRISM III scale showed power of discrimination with good predictive capacity, where the area under the ROC curve was 0.80 (95% CI 0.70 to 0.90). Sensitivity of 79% and specificity of 63% were obtained with a PRISM III score of 13 points. The PELOD scale showed power of discrimination with a low predictive capacity, in which the area under the ROC curve was 0.7 (95% CI from 0.5 to 0.80). A sensitivity of 79% and specificity of 60% were obtained with a PELOD score of 21 points (see Table 3 and 4, Figure 2).

Table 3 Sensitivity, specificity, correct classification, positive and negative likelihood ratio for each score on the PRISM III scale.

Score	Sensitivity	Specificity	Correct classification	LR+	LR-
≥0	100.00%	0.00%	12.67%	1.000	
≥1	100.00%	3.82%	16.00%	1.040	<0.01
≥2	100.00%	5.34%	17.33%	1.057	<0.01
≥3	100.00%	6.87%	18.67%	1.074	<0.01
≥4	100.00%	10.69%	22.00%	1.120	<0.01
≥5	100.00%	14.50%	25.33%	1.170	<0.01
≥6	100.00%	16.03%	26.67%	1.191	<0.01
≥7	100.00%	22.14%	32.00%	1.284	<0.01
≥8	100.00%	26.72%	36.00%	1.365	<0.01
≥9	100.00%	31.30%	40.00%	1.456	<0.01
≥10	94.74%	43.51%	50.00%	1.677	0.1210
≥11	94.74%	53.44%	58.67%	2.035	0.099
≥12	89.47%	60.31%	64.00%	2.254	0.175
≥13	78.95%	63.36%	65.33%	2.155	0.332
≥14	68.42%	70.99%	70.67%	2.359	0.445
≥15	68.42%	74.05%	73.33%	2.636	0.427
≥16	63.16%	77.10%	75.33%	2.758	0.478
≥17	63.16%	80.15%	78.00%	3.182	0.460
≥18	63.16%	83.21%	80.67%	3.760	0.443
≥19	52.63%	90.08%	85.33%	5.304	0.526
≥20	31.58%	91.60%	84.00%	3.761	0.747
≥21	26.32%	95.42%	86.67%	5.746	0.772
≥23	26.32%	97.71%	88.67%	11.491	0.754
≥24	21.05%	99.24%	89.33%	27.578	0.796
≥25	21.05%	100.00%	90.00%		0.790
≥27	10.53%	100.00%	88.67%		0.895
≥31	5.26%	100.00%	88.00%		0.947
≥31	0.00%	100.00%	87.33%		1.000

LR: Likelihood ratio

Table 4 Sensitivity, specificity, correct classification, positive and negative likelihood ratio for each score on the PELOD scale.

Score	Sensitivity	Specificity	Correct classification	LR+	LR-
≥0	100.00%	0.00%	12.67%	1.000	-
≥1	100.00%	7.63%	19.33%	1.083	<0.01
≥2	100.00%	12.98%	24.00%	1.149	<0.01
≥10	94.74%	19.08%	28.67%	1.171	0.276
≥11	94.74%	23.66%	32.67%	1.241	0.222
≥12	89.47%	27.48%	35.33%	1.234	0.383
≥13	84.21%	29.77%	36.67%	1.199	0.530
≥21	78.95%	59.54%	36.00%	1.124	0.707
≥22	73.68%	63.36%	61.33%	1.821	0.442
≥30	63.16%	64.12%	63.33%	1.724	0.582
≥31	63.16%	86.26%	64.00%	1.760	0.575
≥32	42.11%	91.60%	80.67%	3.064	0.671
≥33	36.84%	91.60%	84.67%	4.388	0.690
≥41	31.58%	91.60%	84.00%	3.761	0.747
≥42	26.32%	96.95%	88.00%	8.618	0.760
≥43	15.79%	98.47%	88.00%	10.342	0.855
≥51	15.79%	99.24%	88.67%	20.684	0.849

LR: Likelihood ratio

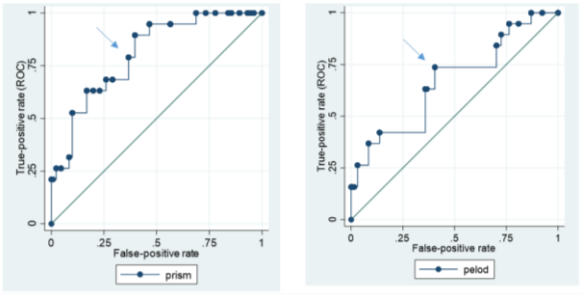

Fig. 2 Comparison of the AUC ROC of the PRISM vs. PELOD Scale

Figure 2 shows the area under the ROC curve and illustrates the sensitivity and specificity of each of the possible cutoff points of a diagnostic test with a measurement scale that is continuous. The scoring area of PRISM III score is shown by the arrow in the first image and is 0.8 (95% CI from 0.70 to 0.90). For the PELOD score, the arrow shows that the ROC is 0.7 with a sensitivity of 74% and specificity of 60%. LR + for the PRISM III scale is 17%, and LR- is 2.5%. For the PELOD scale, LR + is 5%, and LR- is 3%.

Discussion

Main findings

The predictive capacity of the PRIMS III score was significantly better compared to the PELOD in the population of pediatric patients treated at Baca Ortiz Pediatric Hospital in the period from June 2019 to December 2019. The cutoff point to predict mortality in the PRISM III scale was 13 points with a high predictive index. Comparatively, a study carried out in Egypt determined the predictive value with a different cutoff point of 26 points [1].

Regarding the PELOD scale, in the present study, the cutoff point of 21 points presented a low predictive capacity of the area under the ROC curve of 0.7. The mortality evidenced in this study was 12.7%, in contrast to the previously mentioned study with a mortality of 25% [1]. In Latin America, a study was carried out that compared the effectiveness in prediction between various scales at Hospital Universitario de Neiva in Colombia in 2014 [7]. For the predictive capacity of PRISM, PELOD, lactate, CRP, and white blood cells in patients admitted to the PICU, an analysis was carried out on 60 patients and yielded a mortality of 10%. It was evidenced that the PRISM and PELOD scales demonstrated precision in the prognosis of mortality compared to the present study, where the PRISM III scale was the one that proved to be highly predictive.

In Ecuador, there was a study in 2016 that compared the mortality risk index between the PRISM score and the serum level of lactic acid in children from one month to 14 years old at Baca Ortiz Hospital [8]. 76.5% of the patients were admitted to the PICU with a PRISM below 20 points. 20.6% of the patients had between 20 and 29 points, and 2.9% had a score higher than 30 points, unlike the present study. We found that 90.7% of patients are at low risk, 8.7% are at moderate risk, and 0.7% are at high risk. This shows that the initial management has had a significant improvement during this period of time. Regarding the mortality reported by age in this study, patients under 1 year of age had 4.6% higher mortality, similar to international reports, where it was established that age under 12 months is a risk factor for death [9].

Implications for clinical practice

The PRISM III scale has a greater predictive capacity for mortality within the first 24 hours of hospitalization in pediatric intensive care, unlike the PELOD scale, which did not obtain an adequate likelihood ratio to be applied on the first day of hospitalization. This has been observed by other similar investigations [1, 8]. The

two scales use clinical and laboratory parameters that are generally present in the daily management protocol of the PICUs, so the ordering of the data around the PRISM III scale should be established as a norm and recorded in the clinical history.

Implications for public health

The present findings emphasize the need to strengthen pediatric care in public hospitals in Ecuador. Establishing the standardization of the measurement of the PRISM III scale will not only establish the systematic prognosis of the patients, but will also be able to establish real statistics for intensive care units with the monitoring of global mortality in this scenario. The present study represents a window of opportunities for further research regarding the predictive capacity of assessment scales and pediatric risk since there is a large amount of evidence that supports that risk assessment is a medical process that generates timely interventions and thus efficiencies in terms of health [10].

Strengths of this study

This was a census-type study in which the entire possible population of a third-level national reference center was included. The number of patients included in the study was more than 100 cases, which determines greater statistical strength.

Limitations of this study

Among the limitations of the present study, data was not available for some variables, such as sociodemographic information, since there were shortcomings at the time of recording the patients' medical records. Although the social, demographic, or economic information of the patients is useful for finding differences in social, economic, and educational terms (the social determinants of health), we speculate that the population is similar to that of other pediatric hospitals a national level. Another limitation was the source and the retrospective design of the study. More studies in the future should include a prospective assessment with sociodemographic data and a field period greater than 1 year, which would allow us to observe the fluctuation of the mortality rate due to different factors.

Conclusions

This study demonstrated that the PRISM III scale has a better predictive capacity for mortality compared to the PELOD scale in the first 24 hours of admission for patients in the PICU.

Abbreviations

AUC: area under the curve. MODS: multiple organ dysfunction syndrom. PICU: pediatric intensive care unit. PRISM: Pediatric Risk of Mortality. PELOD: Pediatric Logistic Organ Dysfunction. ROC: Receiver Operating Characteristic.

Acknowledgments

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Authors' contributions

Pamela Estefanía Izquierdo Calahorrano: Data preservation, Formal analysis, Fund acquisition, Research, Resources, Software, Writing - original draft, Writing: review and editing.
Natalia Marisell Sánchez Sánchez: Data preservation, Formal analysis, Fund acquisition, Research, Resources, Software, Writing - original draft, Writing: review and editing.
Jenny Marisela Martinez Mena: Conceptualization, Project Management, Supervision, Validation, Visualization.
Ivan Guillermo Dueñas Espín: Methodology, Validation.
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Availability of data and materials

The data sets generated and / or analyzed during the current study are not publicly available due to the confidentiality of the participants, but are available through the corresponding author upon reasonable academic request.

Ethical statements

Protection of people

The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee and in accordance with the World Medical Association and the Singapore Declaration.

Data confidentiality
The authors declare that they have followed the protocols of their work center on the publication of patient data without identification.

Publication consent
It is not required for retrospective studies, the protocol was approved and the institution does not require it for a study of medical records as a primary source.

Conflicts of interest
The authors declare not to have any interest conflicts.

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