Comparison of Performance of the Pediatric Index of Mortality (PIM)-2 and PIM-3 Scores in the Pediatric Intensive Care Unit of a High Complexity Institution

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Abstract

Objective: To determine the performance of each of the available pediatric index of mortality (PIM) scores, by assessing the capability for discrimination and calibration in patients admitted to a pediatric intensive care unit in Bogotá.

Design and setting: We designed a retrospective, observational cohort study, which included all patients aged between a month and 17 years and 364 days, admitted to the pediatric intensive care unit of a high complexity university hospital between April 1, 2016 and December 31, 2018. We analyzed the standardized mortality ratio, discrimination, calibration, and net reclassification index (NRI) for each model.

Results: A total of 722 patients were included, the mortality rate was 3.74%, and for PIM-3, the ratio between expected and observed mortality was 0.66 [confidence interval (CI) 0.40–1.05] for PIM-2 and 1.00 (CI 0.59–1.68) for PIM-3. The Hosmer–Lemeshow (HL) test suggests inadequate calibration for PIM-2 (HL = 13.18, $p = 0.11$) and adequate calibration for PIM-3 (HL = 28.08, $p < 0.01$). The area under the diagnostic performance curves for PIM-2 and PIM-3 were 0.87 (95% CI 0.80–0.94) and 0.89 (95% CI 0.82–0.95), respectively. The NRI was −27.1%. PIM-3 classified survivors better than PIM-2, but inadequately classified nonsurvivors.

Conclusion: Although both models show adequate discrimination ability, PIM-3 shows a better correlation between predicted risk score and observed mortality. Thus, it may be a useful tool for measuring the internal processes of intensive care units in Colombia and for making comparisons between groups of similar characteristics.

Keywords: Mortality, Pediatric intensive care unit, Pediatrics, Risk assessment.

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Introduction

Models that predict mortality risk in children admitted to critical care units are necessary to objectively assess the quality of care provided, and thus design possible improvement initiatives.[1] Two models have been implemented for prediction of mortality risk in pediatric population: the pediatric risk of mortality and the pediatric index of mortality (PIM) in their different versions. These models can be used to compare management standards of intensive care units (ICUs) over time while also allowing for evaluation of the internal processes of a particular ICU, and comparing groups of patients in clinical trials.[1–3]

The PIM scores take into account aspects related to the patient's condition before admission to the ICU are easy to calculate, are not operator dependent, and are inclusive to all patients admitted to the ICU. Both versions of this score are currently used. The PIM-3 score, implemented by Straney et al. (2013), is the most recent. The PIM-3 has two additional variables when compared with PIM-2: Postprocedural recovery, which is divided into three categories; and the "very high-risk diagnosis" variable. Other mathematical adjustments have been performed for physiological variables such as systemic blood pressure, base deficit, and the PaO_2/FiO_2 ratio.[4] During the development of this latest version, the authors concluded that the recalibration of coefficients improved performance. In addition, inclusion of new diagnoses, the reclassification of risk groups, and the modification of some variables, such as the absolute value of systolic blood pressure, allowed better estimation of the mortality risk.[5]

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These scores can be applied in any unit around the world; however, there could be many causes for which a model does not work properly in population other than those in which they were originally developed, such as genetic, socioeconomic, and environmental factors, nutritional conditions and characteristics of healthcare systems.[6] This makes it necessary to determine the performance of scores in specific settings. Although the scores have been validated throughout the world, even in Latin America.[3] In Colombia, we are not aware of the existence of studies that compare the performance between these two versions and the simultaneous use of various models in the country to calculate the risk of mortality,

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which has the disadvantage of underestimating or overestimating it, taking into account the diversity of the characteristics of the patients who enter the pediatric ICUs and surely the demographic differences with the population of the original studies, which makes it difficult to adjust the care models and implement opportunities for improvement.

The aim of the present study is to determine the performance of each of the PIM scores by measuring the capability for discrimination and calibration in patients admitted to a pediatric ICU in Bogotá.

Materials and Methods

Type of Study and Population

We designed a retrospective, observational cohort study, which included all patients aged between a month and 17 years and 364 days, admitted between April 1, 2016 and December 31, 2018 to the pediatric ICU of the Hospital Universitario San Ignacio, in Bogotá, Colombia, a high complexity institution. We excluded patients who were transferred to other institutions, as in these cases, their evolution could not be monitored. The institutional Ethics and Research Committee approved the study.

The following data were systematically registered from electronic health records: age, sex, diagnosis on admission, length of stay, time of mechanical ventilation, if required, presence of chronic disease defined according to Feudtner's classification,[7] (Supplementary Table 1), status at discharge (alive or dead), and the variables necessary to calculate PIM-2 and PIM-3 (Supplementary Tables 2 and 3). We scheduled a review of the database every 2 months; in each period, five medical records were analyzed on a random basis, and the percentage of missing data was evaluated. The percentage of lost data was minimal for clinical and sociodemographic variables (<5% for each variable). As for physiologic variables, we had data for PaO_2 in 25.6% of the cases and data on base excess for 25.9% of the studied subjects. Imputation of missing data was performed according to the instructions disclosed in the original studies for both scales. To calculate PIM-2 and PIM-3, we used the data recorded on admission, and the algorithms were taken from the original studies (Supplementary Tables 2 and 3).[2,5] Mortality was defined as happening before discharge from the pediatric ICU. The sample corresponded to the total number of patients admitted within the prespecified time period, who met admission criteria.

Statistical Analysis

The entire sample was stratified by age according to the classification used in Slater's original work, with modifications in the final category: 1–11, 12–59, 60–119, and 120–215 months.[2] Additionally, patients were classified by diagnosis on admission into seven subgroups: heart disease, trauma, hematological, neurological, respiratory, miscellaneous, postoperative noncardiac, and poisoning; and grouped according to the presence of chronic disease: neurological, cardiovascular, respiratory, renal, gastrointestinal, hematological or immunological, metabolic, congenital defects, and malignancy.

For the evaluation of performance, three fundamental aspects were analyzed: general functioning, discrimination, and calibration.[8]

- General functioning: It was estimated through the standardized mortality ratio (SMR = observed mortality/expected mortality). Confidence intervals (CIs) were calculated using the Cornfield method.
- Discrimination: It measures the ability of the scoring system to differentiate between patients with different outcomes. In this case, we evaluated the area under the diagnostic performance curve (*c*-statistic), which estimates the differential risk among survivors and nonsurvivors.[9]
- Calibration: It measures the correlation between the predicted and the observed prognosis at each risk level, which was initially evaluated within five increasing mortality risk groups, according with the risk groups defined in the original study (0–1%, 1.01–5%, 5.01–14%, 14.01–29%, 29–100%) (1). Additionally, we assessed calibration employing 10 groups of the same size (deciles) using the Hosmer–Lemeshow (HL) goodness-of-fit test.[10]

Finally, the net reclassification index (NRI) was analyzed, which allowed us to assess whether a score with an additional component compared with the previous score improved the ability to correctly classify events.[9,11] Considering that the present study evaluates a non-nested model, which includes externally derived prediction equations, we presented the complete reclassification tables and evaluations of calibration of each model.[12]

Statistical analysis was performed with the STATA 14® statistical package (StataCorp, College Station, TX).

Results

A total of 722 patients were included in the analysis. The population's demographic characteristics are described in Table 1.

A total of 40.44% were infants; the main reason for admission was respiratory etiology, which corresponded to 40.22%. Of the entire population described, 481 patients suffered from chronic diseases, mostly cardiovascular (18.28%), followed by respiratory diseases (16.20%).

The highest percentage of patients (44.91%) had an average stay in ICU between 4 and 14 days. From the total, 270 patients received mechanical ventilation.

For PIM-2, most patients (45.71%) were classified in the first mortality risk group (0–1%), and for PIM-3, the majority (41.41%) corresponded to the second mortality risk group (1.01–5%) (Table 2).

In total 27 patients died, which corresponded to a mortality rate of 3.74%. Most of these patients belonged to group V (mortality risk > 29%), according to the PIM-2 model. For the PIM-3 model, most of the patients who died corresponded to group III (mortality risk 5.01–14%) (Table 2).

Table 2 shows the observed and expected mortality in the five risk groups. The SMR for PIM-2 was 0.66 (CI 0.40–1.05), which suggests an overestimation of the risk, and 1.00 (CI 0.59–1.68) for PIM-3, which suggests an adequate calibration of the score. Likewise, the HL test suggests inadequate calibration for PIM-2 (HL = 13.18, $p = 0.11$), but adequate calibration for PIM-3 (HL = 28.08, $p < 0.01$).

The *c*-statistic for PIM-2 was 0.87 (95% CI 0.80–0.94). For PIM-3, the *c*-statistic was 0.89 (95% CI 0.82–0.95) (Fig. 1). Difference between both areas was not significant ($p = 0.24$).

Table 3 displays the complete reclassification tables. Among the patients who died, the percentage correctly reclassified by PIM-3 score in the higher risk categories was 7.4% (two patients). However, 10 patients were incorrectly reclassified in the lower risk categories. Among the patients who survived, the percentage correctly reclassified in the lower risk categories 18.6% (129 patients), while

Table 1: Demographic characteristics of the population

	n = 722
Age, *n* (%)	
1–11 months	292 (40.44)
12–59 months	205 (28.39)
60–119 months	92 (12.74)
120–215 months	133 (18.42)
Males, *n* (%)	419 (58.03)
ICU length of stay (days), *n* (%)	
≤3 (standard)	286 (38.34)
4–14 (average)	335 (44.91)
≥15 (prolonged)	125 (16.76)
Presence of chronic diseases, *n* (%)	481 (66.62)
Cardiovascular	132 (18.28)
Gastrointestinal	34 (4.71)
Genetic	53 (7.34)
Hematological	28 (3.88)
Metabolic	11 (1.52)
Neurological	43 (5.96)
Renal	26 (3.60)
Respiratory	117 (16.20)
Malignant tumor	37 (5.12)
Admission diagnosis, *n* (%)	
Heart disease	116 (16.09)
Noncardiac surgery	94 (13.04)
Hematological	42 (5.83)
Poisoning	21 (2.91)
Neurological	34 (4.72)
Respiratory	290 (40.22)
Trauma	13 (1.80)
Miscellaneous	111 (15.40)
Mortality at discharge, *n* (%)	27 (3.74)
Mechanical ventilation, *n* (%)	270 (37.40)
Mechanical ventilation days	
≤3 (standard)	104 (13.94)
4–8 (average)	103 (13.81)
>8 (prolonged)	539 (72.25)
Heart surgery with bypass	39 (5.40)

111 were incorrectly reclassified in the higher risk categories. The NRI was −27.1%.

Discussion

Continuous improvement processes are a priority for adequate functioning of pediatric ICUs. This requires an objective evaluation of the quality of care in terms of structure, processes, and results. The measurement and interpretation of the latter, especially regarding mortality, is not easy, due to the heterogeneity in the characteristics of the patients, which makes it necessary to adjust the risks of death by the factors that can affect these results.[3] To this end, different mortality risk models have been implemented, which have been designed in developed countries with population characteristics, resources, and organizational flowcharts, which are different from ours.[1,2,5,13]

This study evaluated the performance of each of the available PIM scales, by measuring the discrimination and calibration ability in a patient population admitted to the pediatric ICU of a high complexity university hospital, in Bogotá, Colombia. The results show that both PIM-2 and PIM-3 models have good discrimination ability, although there was no significant difference

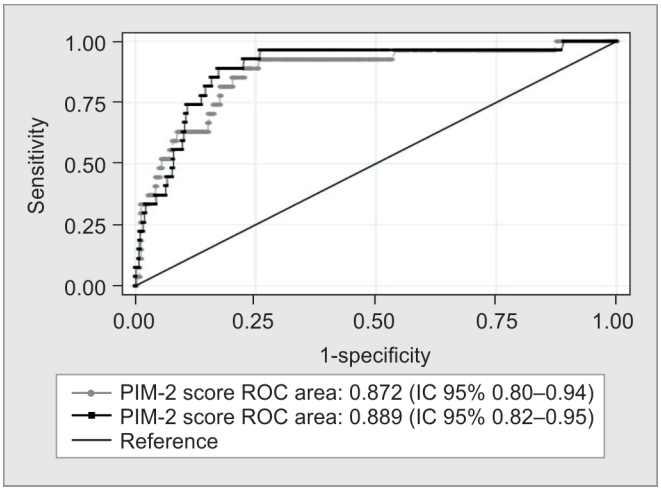

Fig. 1: Area under the diagnostic performance curve (c-statistic) for PIM-2 and PIM-3

Table 2: Calibration of PIM-2 and PIM-3 scores observed vs expected events of mortality

*PIM-2 score**									
Lower limit	*Upper limit*	*Class mark*	*n*	*% of total*	*Expected events*	*Observed events*	*Expected proportion*	*Observed proportion*	*SD*
0	1	0.5	330	45.71	1.68	2	0.51	0.6	0.30
1.01	5	3	221	30.61	5.52	2	2.5	0.9	1.35
5.01	14	9.5	78	10.80	6.01	6	7.7	7.7	2.54
14.01	29	21.5	61	8.45	12.51	7	20.5	11.5	4.11
29.01	100	64.5	32	4.43	15.04	10	47.8	31.25	15.93
*PIM-3 score***									
Lower limit	*Upper limit*	*Class mark*	*n*	*% of total*	*Expected events*	*Observed events*	*Expected proportion*	*Observed proportion*	*SD*
0	1	0.5	281	38.92	0.87	1	0.31	0.36	0.22
1.01	5	3	299	41.41	6.67	3	2.23	1.00	1.10
5.01	14	9.5	98	13.57	7.91	13	8.07	13.26	2.54
14.01	29	21.5	33	4.57	6,11	5	18.53	15.15	4.29
29.01	100	64.5	11	1.52	5.39	5	48.96	45.45	25.96

*Hosmer–Lemeshow = 13.18, $p = 0.11$.
**Hosmer–Lemeshow = 28.08, $p < 0.01$.

Table 3: Reclassification tables and net reclassification index (NRI)

	Surviving patients						*Mortality events*					
PIM-2\PIM-3	*0–1%*	*1.01–5%*	*5.01–14%*	*14.01–29%*	*>29%*	*Total*	*0–1%*	*1.01–5%*	*5.01–14%*	*14.01–29%*	*>29%*	*Total*
0–1%	236	91	1	0	0	328	1	**1**	**0**	**0**	**0**	2
1.01–5%	39	162	18	0	0	219	0	1	**1**	**0**	**0**	2
5.01–14%	2	35	33	2	0	72	0	1	5	**0**	**0**	6
14.01–29%	3	*8*	*26*	17	0	54	0	0	4	3	**0**	7
>29%	*0*	*0*	*7*	*9*	6	22	0	0	3	2	5	10
Total	280	296	85	28	6	695	1	3	13	5	5	27

Among the patients who died, patients correctly reclassified in the higher risk categories by PIM-3 were 2 divided by the total number of patients who died ($n = 27$), which is equivalent to 7.4% (Bold squares). However, 10 patients were incorrectly reclassified in the lower risk categories (37%). Among the patients who survived, those correctly reclassified in the lower risk categories were 129 divided by the total number of patients who survived (695), which is equivalent to 18.6% (Italic squares), while 111 were incorrectly reclassified in the higher risk categories (16.1%). The NRI is the sum of the percentages of patients reclassified in surviving and nonsurviving groups: (7.4–37.0%)+(18.6–16.1%)=−29.6%+2.45%=−27.1%

when comparing both scores. However, PIM-2 overestimated the risk of mortality, while PIM-3 showed a better correlation between predicted and observed events of mortality. Regarding the NRI, with the addition of variables, PIM-3 classified survivors better, which did not happen with those who were deceased (Table 3).

In our study, we found inadequate calibration due to overestimation of mortality risk. This finding, despite the fact we have a high percentage of patients with chronic diseases (66.62% of the total population), can be explained by some characteristics of our unit: the availability of highly qualified human resources, highly complex technological support, timely and efficient intervention in the emergency room, the implementation of palliative care in the pediatric service, and the application of end-of-life protocols that prevent the admission of patients with decreased recovery potential.

The PIM scores have been validated in different settings around the world, showing a good discriminatory ability but important differences in calibration. An Argentinian multicenter study published in 2018 showed adequate discrimination of PIM-2, with a receiver operating characteristic (ROC) curve of 0.83 (95% CI 0.82–0.85) but with higher observed mortality than that predicted by the score, especially in the adolescent group as such,[14] risk of mortality was underestimated, this is different from our findings. The study by Wolfler et al. was the first to compare the two models, and showed a better discrimination ability for PIM-3, with an ROC curve of 0.88 and adequate calibration with an SMR of 0.98,[13] although the population characteristics were different from ours.

The Korean study published in 2017[15] showed an observed mortality rate of 8.47% and a predicted mortality of 6.57%, with acceptable calibration and discrimination abilities for general population (*c*-statistic = 0.76), but unacceptable discrimination (*c*-index = 0.66) for the hematooncological subgroup. Furthermore, the study conducted by Czaja et al. displayed poor performance in pediatric cardiac surgery patients. As such, PIM-2 could not be recommended for quality measurements in this patient group.[16] Unfortunately, the number of mortality events did not allow us to evaluate the performance of PIM scores within specific subgroups. New studies are required to evaluate calibration and discrimination abilities in cardiovascular surgery and hematooncologic patients.

The evaluation of the NRI in our population suggested that PIM-3 score did not classify nonsurvivors better than the PIM-2 score, in fact the proportion of nonsurvivors that were incorrectly reclassified to a category of lower risk was relatively high (29.6%); this can be related with the modification of PIM-3 variables, including patients with diagnosis of necrotizing enterocolitis and bone marrow transplant recipients in different risk categories. In our study, these patients were poorly represented because we have a neonatal unit that is independent from the pediatric unit, which reduces the possibility of admission due to enterocolitis, and because our transplant service exclusively admits patients over the age of 18. However, the PIM-3 score correctly reclassified a larger number of survivors to a lower risk category. The SMR and the standardized length of stay ratio have become standards for benchmarking ICU performance and quality,[6,17] in such a way that the best calibration obtained with the PIM-3 can be translated into an advantage over the PIM-2 in terms of performance comparison among the hospitals that offer care to the pediatric population in critical condition.[17]

This is the first study comparing the performance of the PIM-2 and PIM-3 models in a Colombian population, which has

demographic characteristics that differ significantly from those of the population where the original studies were conducted (Australia and Britain), which in turn included all patients admitted to the ICU of a high complexity university hospital for a period of two-and-a-half-years.

One of the main limitations of our study is that the results correspond to a single-center population, with a low mortality rate, which does not represent what can happen in other places, but the results could be specifically extrapolated to high-complexity hospitals. On the contrary, it was not possible to perform an adequate subgroup evaluation by age, diagnosis on admission (especially for the cardiovascular group), and presence of chronic disease, as most validation studies reported in the literature have done; this makes it necessary to include other centers, increase the number of events, and perform a better analysis between subgroups.

Conclusion

This study compares the performance of the PIM-2 and PIM-3 scores in a Colombian population. Both models show adequate discrimination capability, but the PIM-3 shows a better correlation between the predicted score and the observed mortality. Although larger validation studies are required in our population, PIM-3 can be a good tool for measuring the internal processes of ICUs in Colombia and for making comparisons between groups of similar characteristics.

Compliance with Ethical Standards

This research was approved by the IRB at Hospital Universitario San Ignacio and Pontificia Universidad Javeriana with code of approval FM-CIE-0134-19 on March 29, 2019.

Contributorship Statement

Alba Deyanira Quiñonez López and César Augusto Zuluaga, created the research question, Alba Deyanira Quiñonez López, Daniela Patino-Hernandez, and César Augusto Zuluaga collected data. Alba Deyanira Quiñonez López, Daniela Patino-Hernandez, and Oscar Mauricio Muñoz-Velandia conducted the data analysis. Alba Deyanira Quiñonez López, Daniela Patino-Hernandez, César Augusto Zuluaga, Ángel Alberto García, and Oscar Mauricio Muñoz-Velandia analyzed results, wrote a reviewed the manuscript, and may be held accountable for all aspects of this work.

What is Already Known in this Topic

- The pediatric index of mortality (PIM)- 2 and 3 are useful tools for measuring the quality of internal processes in ICUs.
- PIM-2 and PIM-3 have an adequate discrimination ability.

What this Study Adds?

- PIM-3 displays a better correlation between the predicted risk score and observed mortality.
- PIM-3 can be especially useful in reference centers with very high-risk patients.

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Supplementary Table 1: Categories of complex chronic conditions (7)

Categories	*Subcategories*
Neuromuscular	Brain or spinal cord malformations
	Mental retardation
	Central nervous system degeneration and disease
	Child brain paralysis
	Muscular dystrophies and myopathies
Cardiovascular	Malformations of the heart and the great vessels
	Cardiomyopathies
	Conduction disorders
	Dysrhythmias
Respiratory	Respiratory malformations
	Chronic respiratory disease
	Cystic fibrosis
Renal	Congenital anomalies
	Chronic renal failure
Gastrointestinal	Congenital anomalies
	Chronic liver disease and cirrhosis
	Inflammatory bowel disease
Hematological or Immunological	Sickle cell disease
	Hereditary anemia
	Hereditary immunodeficiency
Metabolic	Acquired immunodeficiency
	Amino acid metabolism
	Carbohydrate metabolism
	Lipid metabolism
	Storage disorders
	Other metabolic disorders
Congenital defects	Chromosomal abnormalities
	Bone and joint abnormalities
	Diaphragm and abdominal wall
	Other congenital anomalies
Malignancy	Malignant neoplasms

Supplementary Table 2: Variables included in PIM-2 score (2)

PIM-2 Data collection form		
Pediatric intensive care unit		
Hospital universitario San Ignacio		
Name:	*MR:*	*Age:*
Systolic pressure (mm Hg)	Unknown = 120 Write 0 if the patient is in cardiac arrest, and 30 if he/she is in shock or his/her blood pressure is so low that it cannot be measured.	
Pupillary response to light	>3 mm and fixed = 1; unknown/other = 0 It is used as a brain function index, do not register a finding as abnormal if it is due to drugs, toxins or local lesion	
PaO_2, mm Hg	Unknown = 0 Concomitant to FiO_2 (not with mask)	
FiO_2	Unknown = 0 At the same time as PaO_2 if oxygen is with ETT or Hood chamber. Expressed from 0 to 1 (no percentage), e.g., 0.60	
Base excess in arterial or capillary blood	Unknown = 0	
Mechanical respiratory assistance during the first hour of admission to the PICU	Yes = 1; No = 0. Includes nasal or mask CPAP and in BiPAP	
Elective admission to the PICU for monitoring, procedure, revision of mechanical ventilation, postoperative elective surgery	Yes = 1; No = 0. It is considered elective when it can be postponed for more than 6 hours without causing adverse effects	
Hospitalization for recovery from surgery or procedure as the main reason for admission to the PICU.	Yes = 1; No = 0	
Admission after cardiac bypass	Yes = 1; No = 0	
Diagnosis of a known high risk of any of the following pathologies:	1. Cardiac arrest or Cardiorespiratory arrest prior to admission to the ICU, 2. Severe combined immunodeficiency, 3. Leukemia or lymphoma after first induction, 4. Spontaneous cerebral hemorrhage, 5. Cardiomyopathy or myocarditis, 6. Hypoplastic left heart syndrome, 7. HIV infection, 8. Hepatic failure as the main reason for admission, 9. Neurovegetative disorder	
Diagnosis of low risk as the main cause of admission.	Yes = 1 No = 0 In case of doubt = 0 1. Asthma 2. Bronchiolitis 3. Croup 4. Obstructive sleep apnea 5. Diabetic ketoacidosis	

The following equation was used to calculate the risk of mortality in the PIM-2 score
PIM-2 = {0.01395 × [absolute. (TAS-120)]} + (3.0791 × pupillary reaction) + [0.2888 × (100 × FiO_2/PaO_2)] + {0.104 × [abs. (Base excess)]} + (1.3352 × Mechanical ventilation in the first hour) –(0.9282 × elective admission) – (1.0244 × recovery from surgery or procedure) + (0.7507 × recovery from cardiovascular surgery with pump) + (1.6829 × high-risk diagnosis) – (1.577 × low-risk diagnosis) – 4.8841
Probability of death = exp. (*r*)/(1 + exp. (*r*) (2)

Supplementary Table 3: Variables included in PIM-3 score (5)

PIM-3 Data collection form		
Pediatric intensive care unit		
Hospital Universitario San Ignacio		
Name:	*HC:*	*Age:*
Systolic pressure (mmHg)	Unknown = 120 Write 0 if the patient is in cardiac arrest, and 30 if he/she is in shock or his/her blood pressure is so low that it cannot be measured.	
Pupillary response to light	> 3 mm and fixed = 1; unknown/other = 0 It is used as a brain function index, do not register a finding as abnormal if it is due to drugs, toxins or local lesion	
PaO_2, mm Hg	Unknown = 0 Concomitant to FiO_2 (not with mask)	
FiO_2	Unknown = 0 At the same time as PaO_2 if oxygen is with ETT or Hood chamber. Expressed from 0 to 1 (no percentage) e.g. 0.60	
Base excess in arterial or capillary blood	Unknown = 0	
Mechanical respiratory assistance during the first hour of admission to the PICU	Yes = 1; No = 0. Includes nasal or mask CPAP and in BiPAP	
Elective admission to the PICU for monitoring, procedure, revision of mechanical ventilation, postoperative elective surgery	Yes = 1; No = 0. It is considered elective when it can be postponed for more than 6 hours without causing adverse effects	
Hospitalization for recovery from surgery or procedure as the main reason for admission to the PICU.	No = 0; Yes, recovery after cardiac bypass = 1; Yes, recovery after cardiac procedure other than bypass surgery = 2; Yes, recovery after noncardiac procedure = 3	
Admission after cardiac bypass	Yes = 1; No = 0	
Diagnosis of a known high risk	Spontaneous cerebral hemorrhage (1). Cardiomyopathy or myocarditis(2), Hypoplastic left heart syndrome (3), Neurovegetative disorder (4), Necrotizing enterocolitis as the main reason for admission to PICU (5)	
Diagnosis of a known very high risk	Cardiorespiratory arrest prior to admission to the ICU(1), Severe combined immunodeficiency(2), Leukemia or lymphoma after first induction (3), Bone marrow transplant recipient (4), Hepatic failure as the main reason for admission(5)	
Low-risk diagnosis as the main reason for admission.	Yes = 1 No = 0 In case of doubt = 0 1. Asthma 2. Bronchiolitis 3. Croup 4 Obstructive sleep apnea 5 Diabetic ketoacidosis 6. Seizure syndrome	

The following equation was used to calculate the risk of mortality in the PIM-3 Score

PIM-3 = (3.8233 × pupillary reaction) + (−0.5378 × elective admission) + (0.9763 × mechanical ventilation) + {0.067 × [absolute (base excess)]} + (−0.0431 × TAS) + [0.1716 × ($TAS^{2/}$1.000)] + {0.4214 × [(FiO_2 × 100)/PaO_2]} − (1.2246 × procedure with pump) − (0.8762 × cardiac procedure without pump) − (1.5164 × noncardiac procedure) + (1.6225 × very high-risk diagnosis) + (1.0725 × high-risk diagnosis) − (2.1766 × low-risk diagnosis) − 1.7928

Probability of death = $e^{Logit}/(1 + e^{Logit})$ (5)