Section: Anaesthesia

Original Research Article

THE COMPARISON OF TWO PROGNOSTIC SCORES PRISM IV AND PIM 3 IN A PEDIATRIC INTENSIVE CARE UNIT

Surabhi Chaudhary[1], Neerul Pandita[2], Nitika Agrawal[3]

[1]*Junior Resident, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, India.*
[2]*Associate Professor, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, India.*
[3]*Associate Professor, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, India.*

Received *: 04/12/2024*
Received in revised form *: 01/02/2025*
Accepted *: 16/02/2025*

Corresponding Author:
Dr. Nitika Agrawal,
Associate Professor, Department of Paediatrics, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, India.
Email: drnitika80@rediffmail.com.

DOI: 10.70034/ijmedph.2025.1.236

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 1271-1275

ABSTRACT

Background: Pediatric intensive care units (PICUs) are pivotal in reducing morbidity and mortality among critically ill children through advanced monitoring and treatment. The implementation of various illness scoring systems like PIM 3, PRISM IV, P-MODS, and PELODS helps in assessing disease severity and predicting outcomes. However, the effectiveness of these systems varies, highlighting the need for ongoing evaluation to enhance healthcare delivery in PICUs. **Aim & Objective:** This study aims to evaluate the predictive performance of the PRISM IV and PIM 3 scoring systems in determining mortality rates among patients admitted to a PICU.

Materials and Methods: Conducted as a prospective observational study over 12 months, the study included children aged 1 month to 18 years, excluding those with early discharge or death. The PIM 3 and PRISM IV scores were calculated upon admission. Data was recorded and analyzed using SPSS, focusing on variables such as age, gender, and score outcomes. Statistical significance was considered at $p < 0.05$.

Results: The study revealed age-specific mortality variations, with the highest in children aged 2-5 years. Males exhibited slightly lower mortality than females. Maximum mortality was seen in the haematological cases. PRISM IV (AUC=0.866) and PIM 3 (AUC=0.818) both are good prognostic indicators and no significant difference was found between the two scores. PRISM IV is more sensitive while PIM 3 is more specific to compare the mortality.

Conclusion: The findings of this study affirm the critical role of tailored scoring systems such as PRISM IV and PIM 3 in predicting the mortality in intensive care settings.

Keywords: Pediatric intensive care, critically ill, PRISM IV, PIM 3.

INTRODUCTION

Pediatric intensive care units (PICUs) are essential for tertiary pediatric care, focusing on reducing morbidity and mortality in critically ill children through intensive monitoring and treatment.[1] To enhance healthcare delivery, PICUs must be continuously assessed and updated. Various illness scoring systems, including PIM 3 (Pediatric Index of Mortality 3), PRISM IV (Pediatric Risk of Mortality IV), P-MODS (Pediatric Multiple Organ Dysfunction Score), and PELODS (Pediatric Logistic Organ Dysfunction), are employed to assess disease severity and predict outcomes using physiological variables, laboratory parameters, and clinical conditions.[2] These scoring systems differ in their risk stratification and predictive capabilities, necessitating comparative studies to evaluate their efficacy.

Mortality in PICUs is influenced by factors such as patient demographics, institutional infrastructure, and treatment strategies. Severity scoring systems are designed to predict prognosis, classify patients by disease severity, identify high-risk patients, and

reduce variability in management practices. They facilitate early implementation of evidence-based interventions and improve communication with families regarding patient conditions and prognoses, supporting shared decision-making aligned with patient values.[3] Additionally, these scores help assess the efficacy of PICUs as part of quality improvement programs.

In India, the Pediatric Risk of Mortality IV (PRISM IV) and Pediatric Index of Mortality 3 (PIM 3) scores are commonly used, yet their predictive performance for mortality in developing countries remains underexplored.[4,5] Differences in epidemiology and patient characteristics highlight the need for localized studies to tailor these scores effectively.6 The challenges faced in Indian PICUs, such as resource constraints and healthcare disparities, further emphasize the importance of adapting these scoring systems to improve care quality and outcomes for critically ill children. Research on prognostic scores in Indian contexts can enhance clinical validity and contribute valuable insights to the global body of pediatric critical care knowledge.

Aims and Objectives

- To evaluate the performance of PRISM IV in predicting mortality in patients admitted in a Pediatric Intensive Care Unit.
- To evaluate the performance of PIM 3 in predicting mortality in patients admitted in a Pediatric Intensive Care Unit.

MATERIALS AND METHODS

The study was designed as a prospective observational study conducted over a 12-month period. The subjects included all children aged 1 month to 18 years, with exclusion criteria encompassing patients who left against medical advice within 4 hours, those whose families refused consent for study or treatment, and patients who died within 4 hours of admission. Data collection tools included a case reporting form, the PIM Score-3, and PRISM IV scoring systems. At the time of admission, demographic details were recorded, and clinical and biochemical data related to the PIM-3 and PRISM IV scores were entered within 4 hours. Patients were followed until discharge or death, documenting the duration of hospital stay and diagnosis, with outcomes categorized as survival or death. PIM scores were calculated using the PIM-3 calculator available at espnic.eu, and the PIM score was converted to predicted mortality. PRISM IV scores were calculated using the PRISM IV Calculator – CPCCRN. Data management and statistical analysis were performed using SPSS software version 21, with data entered into MS Excel. Continuous variables were presented as mean and standard deviation, while categorical variables were expressed as percentages. Median was used instead of mean for non-normally distributed variables. The unpaired t-test or Mann-Whitney U test compared means or medians, and the Chi-square or Fisher's exact test assessed associations between categorical variables. Receiver Operating Characteristic (ROC) analysis was employed to determine cutoff values and predictive accuracy of the two scoring tools for mortality prediction, with a Z-test used to compare two area under the curve (AUC) values. Logistic regression analysis identified independent predictors of outcome, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Table 1: Age and Outcome

Age group	Outcome				
	Total	Died		Survival	
	N	N	%	N	%
Up to 1 year	21	5	23.8%	16	76.2%
1 – 2 year	8	1	12.5%	7	87.5%
2 – 5 year	7	4	57.1%	3	42.9%
5 - 10 year	17	6	35.3%	11	64.7%
10 - 15 year	17	4	23.5%	13	76.5%
> 15 year	15	5	33.3%	10	66.7%
Total	85	25	29.4%	60	70.6%

Table 2: Gender and Outcome

Gender	Outcome				
	Total	Died		Survived	
	N	N	%	N	%
Male	61	17	27.9%	44	72.1%
Female	24	8	33.3%	16	66.7%
Total	85	25	29.4%	60	70.6%

Table 3: ROC PIM 3 VS Outcome

Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.818
Standard Error [a]	0.0503
95% Confidence interval [b]	0.720 to 0.894

z statistic	6.332
Significance level P (Area=0.5)	<0.0001

Youden index

Youden index J	0.5200
Associated criterion	>6.9
Sensitivity	72.00
Specificity	80.00

PIM 3	Outcome					Chi square test p value
	Total	Died		Survival		
	N	N	%	N	%	
>6.9	30	18	60.0%	12	40.0%	**<0.001**
</=6.9	55	7	12.7%	48	87.3%	
Total	85	25	29.4%	60	70.6%	

Statistic	Value	95% CI
Sensitivity	72.00%	50.61% to 87.93%
Specificity	80.00%	67.67% to 89.22%
Positive Likelihood Ratio	3.6	2.05 to 6.32
Negative Likelihood Ratio	0.35	0.18 to 0.66
Disease prevalence	29.41%	20.02% to 40.29%
Positive Predictive Value	60.00%	46.09% to 72.46%
Negative Predictive Value	87.27%	78.31% to 92.87%
Accuracy	77.65%	67.31% to 85.97%

Table 4: ROC PRISM IV VS Outcome

Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.866
Standard Error [a]	0.0434
95% Confidence interval [b]	0.775 to 0.930
z statistic	8.449
Significance level P (Area=0.5)	<0.0001

Youden index

Youden index J	0.6300
Associated criterion	>3
Sensitivity	88.00
Specificity	75.00

PRISM IV	Outcome					Chi square test p value
	Total	Died		Survival		
	N	N	%	N	%	
>3	37	22	59.5%	15	40.5%	<0.001
</=3	48	3	6.3%	45	93.8%	
Total	85	25	29.4%	60	70.6%	

Statistic	Value	95% CI
Sensitivity	88.00%	68.78% to 97.45%
Specificity	75.00%	62.14% to 85.28%
Positive Likelihood Ratio	3.52	2.22 to 5.58
Negative Likelihood Ratio	0.16	0.05 to 0.47
Disease prevalence	29.41%	20.02% to 40.29%
Positive Predictive Value	59.46%	48.04% to 69.94%
Negative Predictive Value	93.75%	83.71% to 97.77%
Accuracy	78.82%	68.61% to 86.94%

DISCUSSIONS

In our study, majority of the patients belonged to the infant age group, i.e. 21 patients (24.7%) which is similar with various other studies as done by SM Roy et al in a PICU of a tertiary care hospital in eastern India in which maximum i.e. 34.34 % patients belonged to the infant age group, a study by Ashish Simalti and Pramod Garg done in a PICU of a tertiary care hospital in north India in which they found higher number of patients in the younger age group having 38% patients in both the less than one year and one to 5 year age group.[12,15] Few studies done in Ethiopian hospitals like the study done by Gemechau et al and by Teshager et al showed higher admission rate in infant age group,i.e. 38.7% and 28.1% respectively.[10,16]

As the maximum number of admissions in critical care unit belong to the younger age group, health care system should furthermore emphasize upon the need to target this population and promote services to decrease the inf ant as well as under - 5

morbidity and mortality. Out of the total number of patients, maximum deaths occurred in 2 to 5-year age group, i.e. 57.1%, but is insignificant as the chi square test p value is 0.455. Many of the studies done in the pediatric critical care settings however show that majority of deaths are seen in the younger age group such as in the study by Muthupandi et al,[9]

"Total number of male patients admitted were 61 (71.7%) and female patients were 28.2%. Male to female ratio was 2.5. Male preponderance in PICU admission was also seen in other studies done by Tyagi et al, Teshager et al, Mukhija et al, SM Roy et al, Patki et al, Varma et al,[8,10-14] This can be attributed to male susceptibility to various serious diseases but it could also be because of more likelihood of a male child to be brought to PICU as compared to a female child due to still existing preference to a male child among Indian families.[15]

But higher mortality rate was seen in the female patients, i.e. 33.3 % which was similar as observed in the comparative study done by Muthupandi et al to analyze the PIM 2 and PRISM III scores in the Indian settings in which 66.6% mortality was seen in female patients but it was not shown to be statistically significant.[9]

But in some of the studies a higher mortality rate is seen in males such as in a study done by Rahmatinezad et al to compare the PRISM III and PIM 3 scores showed a higher mortality rate in males (53%) as compared to females (47%) but the gender influence on study outcome was insignificant.[7]

To analyse the effect of gender on outcome, more studies with a larger sample size and analyzing the multiple other associated other factors which might influence the outcome are required. "

As per the ROC analysis of our study, the AUC for PIM - 3 was 0.818 with a standard error of 0.0503, a 95% confidence interval of 0.720 to 0.894 and a p value of < 0.0001. The sensitivity of the PIM - 3 as per the study was 72% with 95% C.I. (50.61% - 87.93%) and specificity was 80% with 95% C.I. (67.67% - 89.22%). The positive likelihood ratio was 3.60 and negative likelihood ratio was 0.35. The positive predictive value was 60% and negative predictive value was 87.27% and the accuracy of PIM - 3 was 77.65 %.

The AUC for PRISM IV was 0.866 with a standard error of 0.0434, a 95% confidence interval of 0.775 to 0.930 and a p value of < 0.0001. The sensitivity of the PRISM - IV as per the study was 88% with 95% C.I. (68.78% - 97.45%) and specificity was 75% with 95% C.I. (62.14 % - 85.28 %). The positive likelihood ratio was 3.52 and negative likelihood ratio was 0.16. The positive predictive value was 59.46 % and negative predictive value was 93.75 % and the accuracy of PIM - 3 was 78.82 %.

As per the analysis, both PRISM IV and PIM - 3 were good prognostic tools to assess mortality in tertiary healthcare centre. Analyzing the comparison done between the scores, difference between the areas was 0.0480 with a standard error of 0.0470 and 95% confidence interval of -0.0442 to 0.140 and p value of 0.3076, signifying that no significant difference was noted in PIM 3 and PRISM IV for predicting mortality. While PIM -3 was more specific to predict the mortality, PRISM IV was more sensitive to predict the mortality.

CONCLUSION

Age and gender significantly influence outcomes in the Pediatric Intensive Care Unit (PICU), with mortality rates varying across age groups. The highest mortality was observed in children aged 2–5 years (57.1%), while the lowest was in those aged 1–2 years (12.5%). Gender analysis revealed that males had a slightly lower mortality rate (27.9%) compared to females (33.3%). The Pediatric Index of Mortality 3 (PIM 3) proved to be a robust predictive tool, with an area under the ROC curve (AUC) of 0.818, demonstrating high sensitivity (72%) and specificity (80%). Notably, children with a PIM score greater than 6.9 showed a significantly higher mortality rate (60%) compared to those with a score of 6.9 or less (12.7%). Similarly, the PRISM IV scoring system showed excellent predictive capability with an AUC of 0.866 and even higher sensitivity (88%) and specificity (75%) than PIM 3. Children with a PRISM score above 3 had a mortality rate of 59.5%, which was significantly higher than those with lower scores (6.3%). Both scoring systems are statistically significant predictors of outcomes, underscoring their clinical utility in anticipating patient trajectories in the PICU effectively.

REFERENCES

1. Lemeshow S, Le Gall JR. Modelling the severity and illness of ICU patients: a systems update. J Am Med Association. 2008. (272: 1049 -1055)
2. Pollack MM, Patel KM, Ruttiman UE. PRISM III: an updated pediatric risk of mortality score. Critical care medicine. 1988 (16: 1110 -1116)
3. Seneff M, Knaus WA. Predicting patient outcome from intensive care: a guide to APACHE, MPM, SAPS, PRISM, and other prognostic scoring systems. Journal Intensive Care Med. 1990 (5: 33-52)
4. Pollack MM, Holubkov R, Funai T, Berger JT, Clark AE, Meert K et al. Simultaneous prediction of new morbidity, mortality, and survival without new morbidity from pediatric intensive care: a new paradigm for outcomes assessment. Critical Care Medicine. 2015 (43: 1699 –1709)
5. Lee OJ, Jung M, Kim M, Yang H, Cho J. Validation of the pediatric index of mortality 3 in a single pediatric intensive care unit in Korea. J Korean Med Science. 2017 (32: 365-370)
6. Qureshi AU, Ali AS, Ahmad TM. Comparison of three prognostic scores (PRISM, PELOD and PIM 2) at pediatric intensive care unit under Pakistani circumstances. Journal of Ayub Mediczl College, Abbotabad. 2017 (19: 49 -53).
7. Rahmatinejad Z, Rahmatinejad F, Sezavar M, Tohidinezhad F, Abu-Hanna A, Eslami S. Internal validation and evaluation of the predictive performance of models based on the PRISM-3 (Pediatric Risk of Mortality) and PIM-3 (Pediatric Index of Mortality) scoring systems for predicting mortality in Pediatric Intensive Care Units (PICUs). BMC Pediatr. 2022; 22:1-7.
8. Tyagi P. Comparison of PRISM III, PIM-2 and PIM-3 in predicting mortality in a pediatric intensive care unit. J Pediatr Intensive Care. 2018; 7:201-6.

9. Muthupandi V, Dianagrace R, Narayanan E, Sathya J. Comparison of PRISM III and PIM II Score in Predicting Mortality in Paediatric Intensive Care Unit: An Observational Study. J Clin Diagn Res. 2022; 16:2.
10. Teshager NW, Amare AT, Tamirat KS. Incidence and predictors of mortality among children admitted to the pediatric intensive care unit at the University of Gondar comprehensive specialised hospital, northwest Ethiopia: a prospective observational cohort study. BMJ Open. 2020; 10:367.
11. Mukhija G, Chandra S, Prasad PL. Clinical profile of patients admitted to the PICU of a tertiary care teaching hospital. J Paediatr Res. 2017; 4:127-9.
12. Roy SM, Basu S, Roy BC, Datta S. Clinical profile and outcome of patients admitted to Pediatric Intensive Care Unit of a Tertiary Care Teaching Hospital in Eastern India. JMSCR. 2018; 6:171-7.
13. Patki VK, Raina S, Antin JV. Comparison of severity scoring systems in a pediatric intensive care unit in India: a single-center prospective, observational cohort study. J Pediatr Intensive Care. 2017;6(2):98-102.
14. Varma A, Damke S, Mesharm R, Vaha J, Kher A, Vagha K. Prediction of mortality by pediatric risk of mortality (PRISM III) score in a tertiary care rural hospital in India. Int J Contemp Pediatr. 2017; 2:322-7.
15. Kumar SA, Garg P. Clinical profile and validity of PRISM III among children admitted in a PICU over one year. Ann Pediatr Child Health. 2020;8(2):1173.
16. Gemechu Edae, Atnafu Mekonnen, Melaku Getachew, Tigist Bacha. Treatment outcome in pediatric intensive care unit, Tertiary Hospital, Addis Ababa, Ethiopia. Ethiop J Health Sci. 2022;32(3):497.