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ORIGINAL ARTICLE

Comparison of PRISM-IV and PIM-III Score in Predicting Mortality in a Pediatric Intensive Care Unit

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ABSTRACT

Objective: To determine the sensitivity, specificity and diagnostic accuracy of PRISM-IV score and PIM-III score in predicting mortality in critically ill children receiving critical care.

Study Design: Cross-sectional validation study.

Place and Duration of Study: Department of Pediatrics, Combined Military Hospital, Lahore, Aug 2022 to Aug 2024.

Material and Methods: We studied 300 children admitted to the pediatric intensive care unit aged between the ages of 1 to 12 years. Patients who were diagnosed as suffering from severe malnutrition, or those suffering from chronic liver disease, nephrotic syndrome or had received blood product transfusions prior to admission to the PICU were excluded. All patients underwent scoring with PRISM-IV and PIM-III systems at the time of admission and were followed up till completion of twenty-eight days, or till the occurrence of mortality. A PRISM-IV score of >10 and a PIM-III score of >4 were considered to be high risk for the occurrence of mortality.

Results: Patient age upon enrollment was 4.0 (IQR: 6.0) years, with a slight female majority of 158 (52.7%). Common indications for admission were pulmonary infections (n=93, 31.0%) acute exacerbations of bronchial asthma (n=73, 24.3%) and non-respiratory infections (n=57, 19.0%). PRISM-IV had a sensitivity of 92.86%, specificity 86.11% and diagnostic accuracy 88.00% in predicting mortality, while PIM-III had a sensitivity, specificity and diagnostic accuracy of 92.86%, 96.76% and 95.67%, respectively, for the same.

Conclusion: PIM-III and PRISM-IV have good diagnostic accuracy in predicting the occurrence of death in pediatric critical care.

Key Words: *Critical illness, Diagnostic accuracy, Intensive care, Mortality, PIM-III, PRISM-IV.*

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INTRODUCTION

In the clinical discipline of pediatric intensive care, the ability to accurately predict mortality is crucial for effective clinical decision-making and resource allocation.[1] Amongst the various prognostic tools for predicting death, two scoring systems, the Pediatric Risk of Mortality (PRISM) and the Pediatric Index of Mortality (PIM), have emerged as indispensable instruments for clinicians worldwide.[2,3] Specifically, the newest iterations of these two systems i.e., the PRISM-IV and PIM-III scores have garnered recent attention with

regards to their robustness in assessing illness severity and mortality risk in pediatric patients.[4,5] A critical examination of their relative efficacy in predicting mortality within pediatric intensive care units (PICUs) is imperative.

The PRISM score, initially developed from data in the mid-1980s, is known for its comprehensive evaluation of physiological parameters, chronic health conditions, and interventions within the first 24 hours of PICU admission.[6,7] Its multifactorial approach encompasses vital signs, laboratory values, and neurological status, providing clinicians with a holistic perspective on a patient's condition.[6,7] Conversely, the PIM score, introduced later, emphasizes the predictive power of physiological variables collected within the initial hour of admission.[8] With a focus on physiological derangements and organ dysfunction, the PIM score offers a more concise yet insightful prediction of mortality risk in pediatric patients.[8] While earlier versions of both scoring systems have been extensively validated and utilized in clinical practice, discrepancies in their predictive accuracies and clinical applications have sparked scholarly debate, and the newest versions of these scores are still undergoing evaluation for validity.[9,10] The comparative evaluation of PRISM-IV and PIM-III scores has, thus, emerged as a pivotal area of research, aiming to elucidate their relative strengths and limitations in diverse clinical contexts.

This research protocol attempted to elucidate the comparative performance of PRISM-III and PIM-II scores in predicting mortality within PICUs, with the aim of assessing the discriminatory power of PRISM-IV and PIM-III scores in distinguishing survivors from non-survivors within PICUs. In addition, we attempted to identify potential strengths and limitations of these scores in specific clinical scenarios, such as trauma, sepsis, and metabolic disorders. By clarifying the comparative performance of PRISM-IV and PIM-III scores in such scenarios, this article endeavors to enrich clinical decision-making, optimize resource allocation, and ultimately enhance outcomes for pediatric patients in intensive care settings.

MATERIAL AND METHODOS

This cross-sectional validation study was conducted from Aug 2022 to Aug 2024 in the Department of Pediatrics, Combined Military Hospital, Lahore on 300 critically ill children receiving intensive care. All our study participants were selected via non-probability consecutive sampling, and parents or guardians gave informed consent for participation. Our research protocol was designed in accordance with the Declaration of Helsinki and our own local institutional ethical guidelines. The sensitivity/specificity sample size calculator was used to calculate the sample size keeping an expected sensitivity of 100%, expected specificity of 81.5%, expected prevalence of 7.9%, a desired precision of 4 and a confidence level of 95%,[11] which were the sensitivity and specificity of PIM-III score in predicting the occurrence of mortality at one month in children admitted to critical care, and occurrence of mortality in this population during this time period, from Chegini et al.[11]

Inclusion Criteria: All children aged between 1 and 12 years admitted to the PICU were included for study.

Exclusion Criteria: Patients who were diagnosed as suffering from severe malnutrition, or those suffering from chronic liver disease, nephrotic syndrome or had received blood product transfusions prior to admission to the PICU were excluded from the study due to the alteration of serum albumin levels.

All study participants underwent a thorough history taking and clinical examination session. All patients underwent scoring with PRISM-IV and PIM-III systems at the time of admission in the PICU.[12,13] All blood sampling was performed by a trained phlebotomist with a minimum of two years' experience in paediatric phlebotomy. All participants were followed up till completion of twenty-eight days since admission to PICU, or till the occurrence of mortality. A PRISM-IV score of >8 and a PIM-III score of >4 were considered to be high risk for the occurrence of mortality,[11] and the same cut-offs were used to predict prolonged PICU admissions, i.e., admissions lasting >7 days.

Data was analyzed using Statistical Package for the Social Sciences (Version 27, IBM Corp; Armonk, USA). Mean and SD was calculated for quantitative variables specifically age, length of hospital stay, PRISM-IV and PIM-III score.

Qualitative variables like gender and indication for admission in intensive care were recorded in terms of frequency and percentage. A 2 x 2 table was constructed to calculate the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of PRISM-IV and PIM-III scores in predicting mortality within one month of admission to intensive care. Receiver operating characteristic (ROC) curves were plotted for both scores.

RESULTS

Our study sample comprised of 300 pediatric patients admitted to the PICU. The median patient age upon enrollment in the study was 4.0 (IQR: 6.0) years, with a slight female majority of 158 (52.7%). The most common indication for admission was pulmonary infections, accounting for 93 (31.0%) cases, followed by acute exacerbations of bronchial asthma and non-respiratory infections which were seen in 73 (24.3%) and 57 (19.0%) cases, respectively. Acute kidney injury (AKI) was seen in 36 (12.0%) patients while acute hepatitis due to any aetiology and metabolic disorders were the primary indications for admission in 26 (8.7%) and 15 (5.0%) cases, respectively. Table 1 shows the patient characteristics at the time of enrollment in the study and admission to the PICU.

Table 1. Patient characteristics on admission to PICU (n=300)

Variable	Male (n=142) {%}	Female (n=158) {%}
Age (years)	4.0 (IQR: 5.0)	4.0 (IQR: 11.0)
		Indication for Admission
Pulmonary Infections	43 (30.3)	50 (31.6)
Acute Asthma Exacerbations	31 (21.8)	42 (26.6)
Non-Pulmonary Infections	27 (19.0)	30 (19.0)
Acute Kidney Injury	18 (12.7)	18 (11.4)
Acute Hepatitis	17 (12.0)	9 (5.7)
Metabolic Disorders	6 (4.2)	9 (5.7)
PRISM-IV	6.00 (IQR: 8.00)	6.00 (IQR: 8.00)
PIM-III	2.00 (IQR: 3.00)	2.00 (IQR: 3.00)
Length of Hospital Stay	7.00 (IQR: 7.00)	7.00 (IQR: 6.00)
Death	42 (29.6)	42 (26.6)

Table 2 displays the 2x2 table for the PRISM-IV and PIM-III scores in predicting the occurrence of death within one month of admission to the PICU, while Table-III shows the test parameters for these scores in making this prediction. PIM-III had a higher diagnostic accuracy of 95.67% in predicting the occurrence of mortality when compared to 88.00% with PRISM-IV.

TABLE- 2: 2x2 Table for PRISM-IV and PIM-III in predicting the occurrence of mortality in PICU

2x2 Table		Mortality		Total
		Yes	No	
Mortality as predicted by PRISM-IV	Yes	True Positive: 78	False Positive: 30	108
	No	False Negative: 6	True Negative: 186	192
Total		84	216	300
Mortality as predicted by PIM-III	Yes	True Positive: 78	False Positive: 7	085
	No	False Negative: 6	True Negative: 209	215
Total		84	216	300

TABLE 3: PRISM-IV/PIM-III test characteristics in predicting mortality

Test	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Diagnostic accuracy (%)
PRISM-IV	92.86	86.11	72.22	96.88	88.00
PIM-III	92.86	96.76	91.76	97.21	95.67

DISCUSSION

This prospective cross-sectional validation study aimed to evaluate the diagnostic accuracy of the PRISM-IV and PIM-III scoring systems in predicting mortality among pediatric patients admitted to a critical care unit. Our sample included 300 patients, with a median age of 4 years and a slight predominance of females. The primary indications for PICU admission were predominantly respiratory-related conditions, particularly pulmonary infections and acute exacerbations of bronchial asthma.

Our results revealed that both PRISM-IV and PIM-III scores were effective in predicting mortality within one month of PICU admission, with PIM-III demonstrating slightly superior diagnostic accuracy. Specifically, the PIM-III score had a diagnostic accuracy of 95.67%, compared to 88.00% for the PRISM-IV score. Similarly, Arslan et al reported high diagnostic accuracies for both PRISM-IV and PIM-III in predicting the occurrence of death in children in the PICU, with figures of 92.3% and 89.6%, respectively.[14] Leal et al studied the diagnostic accuracy of PRISM-IV in children with oncological diseases and found that it carried a diagnostic accuracy of 89.0% in predicting death in this population subset.[15] Chegini et al also reported that PIM-III score was associated with a high diagnostic accuracy for predicting mortality in this setting (93.9%) which was consistent with our study, but reported the PRISM-IV was associated with a low diagnostic accuracy (66.0%), a result that was converse to ours.[11] Thus, it can be inferred with reliable precision, from this group of studies, that both PIM-III and PRISM-IV have good diagnostic accuracy in predicting the occurrence of death in pediatric patients in the critical care setting, with the minor variation seen likely attributable to the differences in population characteristics as well as differing institutional practices. One aspect to note here is that PIM-III appears to have a higher diagnostic accuracy when compared to PRISM-IV, in this setting, which was not only observed in our study, but in others as well.[11]

In the current study, both PRISM-IV and PIM-III scores performed well with regards to sensitivity, indicating that both are adept at identifying patients who are at risk of mortality, ensuring that high-risk patients are appropriately monitored and managed. However, the slightly improved specificity of the PIM-III score suggests that it may better discriminate between those who will and will not succumb to their critical illness, which is crucial for optimizing patient outcomes. The slightly higher specificity and positive predictive value of the PIM-III score are critical in a clinical setting, as they indicate a lower rate of false positives, as was seen in our study. This is particularly important in critical care where resources are limited and the consequences of misallocation can be severe. Previous studies on the subject have reported that PIM-III score has, if not superior, then comparable sensitivity and specificity to PRISM-IV score,[11,14] with the sole exception of Shen et al, who reported that the PIM-III had slightly less discriminatory power in their meta-analysis on the subject.[16] We believe this difference may have arisen due the way in the which the latter study conducted its meta-analysis: the study compared PIM-III with pooled studies looking at both PRISM-III and PRISM-IV score, which may not proved an accurate comparison. Moreover, while there was minimal heterogeneity among the studies looking at the PRISM-III/IV scoring systems, the heterogeneity was high in those looking at PIM-III, which may have greatly affected the results of this study.

Lastly, our study also highlighted the common causes of PICU admissions and their associated mortality rates. Pulmonary infections and sepsis, the leading cause of admission, were also associated with a significant proportion of the mortality cases. Our findings are in agreement with other studies on the subject where respiratory illness and other organ infections account for a significant proportion of indications for children requiring admission in the PICU.[17-19] This underscores the need for targeted interventions and enhanced management protocols for respiratory illnesses in pediatric critical care settings, as well as interventions in the community to prevent the occurrence of such diseases.

Limitations: Our findings suggest that the PIM-III score is more reliable for identifying patients at high risk of mortality, thereby potentially improving the allocation of intensive care resources and guiding clinical decision-making. However, Despite the robust findings, our study has several

limitations that must be acknowledged. First, the study was conducted in a single center, which may limit the generalizability of our results. The patient population and healthcare practices in our institution may differ from those in other settings, potentially influencing the applicability of our findings elsewhere. Second, we did not stratify the results based on the severity of underlying conditions or comorbidities, which could impact the predictive accuracy of the scoring systems. Third, the follow-up period was limited to one month post-admission, and longer-term outcomes were not assessed. Finally, the study did not account for potential changes in clinical management or interventions that may have occurred during the PICU stay, which could affect patient outcomes and the performance of the predictive scores.

CONCLUSION

Both PRISM-IV and PIM-III scores are valuable tools for predicting mortality in the paediatric critical care setting, with PIM-III demonstrating superior diagnostic accuracy. The higher specificity and positive predictive value of the PIM-III score make it particularly useful for clinical decision-making, helping to identify patients at true risk of mortality more effectively. These findings support the integration of the PIM-III scoring system into routine clinical practice to enhance the management of critically ill pediatric patients. Future studies should aim to validate these findings in multi-center settings and explore the utility of these scores in predicting long-term outcomes. Additionally, further research should investigate the impact of integrating these scoring systems into clinical workflows and their potential to improve patient outcomes and resource allocation in pediatric intensive care units in Pakistan.

Conflict of interest: None

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