

Outcome of Children In Pediatric Intensive Care Unit By Using Pediatric Index of Mortality (Pim-Ii) Score

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ABSTRACT

Objective: To determine the outcome and associated factors of using the pediatric intensive care pediatric index of mortality (PIM-II) score in a pediatric intensive care unit for predicting mortality.

Study Design: Cross-sectional study

Place and Duration of Study: Pak Emirates Military Hospital, Rawalpindi, Pakistan from August 2019 to November 2020.

Methodology: All children age 1 month to 12 years of either gender admitted in PICU were consecutively enrolled. PIM-II scoring system was used to predict mortality in PICU. Patient follow was maintained throughout the entire hospital stay, including PICU admission to record patient outcome. It was then categorized as either “discharged” or “death.”

Results: Of 105 patients, the median PIM-II score was 26 (20-41). There were 26 (24.8%) patients predicted death rate of <20%, 51 (48.6%) patients with 20-40% predicted death rate, and 28 (26.7%) patients with >40% predicted death rate. The observed mortality was reported in 36 (34.3%) patients. The odds of mortality were 99% lower among patients with predicted death rate of <20% (adjusted OR=0.01, 95% CI 0.01-0.05) and in between 20% to 40% predicted death rate (adjusted OR=0.01, 95% CI 0.01-0.05) as compared to >40% predicted death rate. The area under the curve of PIM-II was found to be 0.88 (95% CI 0.79-0.97).

Conclusion: The PIM-II score predicted accurately in most of the patients admitted in PICU and could be recommended as a valuable tool for anticipating prognosis in pediatric patients.

Keywords: Children, Pediatric index of mortality (PIM-II) score, Pediatric outcome

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INTRODUCTION

Pediatric Intensive care units (PICU) are rapidly emerging as critical resources in the practical treatment of pediatric critical and emergency care. PICU facilities have also been noticed¹ for their role in resource limited countries, where they can significantly reduce mortality. However, it is estimated that even now, 33% of all pediatric patients die within the first 24 hours of hospitalization.¹

Any pediatrician or care-givers assessment of a critically ill patient's mortality is qualitative and therefore fallible. This highlighted a need for a quantitative method to assess patients admitted to the PICU. Clinical scoring indexes first became available for intensive care setting in the 1980s and since then have become an essential part of patient management. One such scoring index is the Pediatric Index of Mortality (PIM) comprises of eight variables which originated from Europe.² It has since been modified and validated across the world and the current version in use is known as the PIM-II.³ This score is used to

assess the probability of death using physiological and clinical data of the patient at the time of admission to the PICU. The data is noted immediately after the admission which comprises of key variables including blood pressure, mechanical ventilation, pupillary reaction, admission status, cardiac status and reason of admission.³

The PIM-II score is derived from various coefficients validated by Muthupandi *et al*⁴ which make up questions and observations during the first interaction between the patient and a clinician from the ICU team.⁵⁻⁶

Since most of the work done with PIM-II is in the west, there is a dearth of data available in South Asia and in Pakistan. However, the few studies in local literature show promising signs. Sajid M *et al*, studied these scores and found promising results.⁷ There have been other studies done across Pakistan including Mirza *et al* and Tabish *et al*, assessing outcomes on the basis of various clinical scales. However, none has focused specifically on PIM-II.⁸⁻⁹

We believe there is a need to determine whether PIM-II can be an effective tool in our setup, as a tertiary care center in Pakistan. The PIM-II can help

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identify children with better chances of survival making it vital for parental counselling. It can also be put in place at PICU facilities to decrease the mortality among patients with high predicted death rate at the time of admission, by helping guide and streamline resource allocation and effective interventions. These practices have a positive impact on the performance of PICU.

METHODOLOGY

This cross-sectional study was conducted at Pak Emirates Military Hospital, Rawalpindi from August 2019 to November 2020. Ethical approval was obtained from Pak Emirates Military Hospital prior conducting of the study (IRB approval no: A/28EC/155). Moreover, signed informed consent was also obtained from all parents/guardians of all study participants after explaining the pros and cons of the study.

All children aged 1 month to 12 years of either gender admitted in PICU were consecutively enrolled. While patients who were discharged or who died within 12 hours of ICU admission, left against medical advice (LAMA) within 12 hours of admission, neonates in the neonatal ICU, and patients admitted in a state of continuous cardiopulmonary resuscitation who did not achieve stable vital signs for at least 2 hours were excluded.

All those patients who were readmitted in PICU during the same hospital stay were considered as new patient. This was done due to the reason that all new admission in PICU is because of the new reason and opportunity for an outcome. Detailed clinical and laboratory examination was performed.

Sample size was calculated using PIM-II sensitivity of 98.2%, specificity of 65.6%, 46.2% observed mortality rate in previous study,¹⁰ 95% level of confidence, and margin of error 4%. The estimated sample size came out to be 105, while non-probability consecutive sampling technique was used to enroll participants.

PIM-II scoring system was used to predict mortality in PICU. A total of 10 predictor variables were assessed for the purpose of PIM-II scoring these include elective admission, recovery after procedure, high-risk or low-risk diagnosis, cardiac bypass, pupils irresponsive to bright light, mechanical ventilation required with the first hour of ICU stay, systolic blood pressure, arterial or capillary blood base excess, and $\text{FiO}_2 \times 100 / \text{PaO}_2$. First value of each variable was observed between first contact to within an hour of

arrival at the ICU facility. The detailed method for reporting PIM-II is illustrated in table 1.

This information along with other predictor variables like age, gender, reason of admission in PICU, length of stay in PICU, Glasgow coma scale, presence of shock, and mortality were noted.

A diagnosis of shock was comprised on observation of tachycardia, poor end organ perfusion categorized as defined by poor peripheral pulses with normal central pulses, observation of prolonged capillary refill or flash refill, altered mental state, decreased temperature at extremities, and decreased urine output.

The follow-up was done till the disposition of patients from PICU. The duration of stay in the PICU along with outcome such as discharge or death were noted. For the purpose of prediction of mortality, an online calculator for calculation of PIM-II was used (www.sfar.org/scores2/pim22.html).^{4,11}

Statistical Package for Social Sciences (SPSS) version 24 was used for the purpose of statistical analysis. Median and interquartile range was computed for the quantitative variables like age, length of stay, GCS level, and predicted mortality rate via PIM-II score. Frequency and percentages were calculated for qualitative variables like gender, reason of admission, length of stay, shock, and observed mortality. Chi-square test was applied to see the association of outcome variable (observed mortality) with predicted mortality rate and other baseline and clinical characteristics. Bivariate logistic regression was also applied. The p-value of ≤ 0.05 considered as significant.

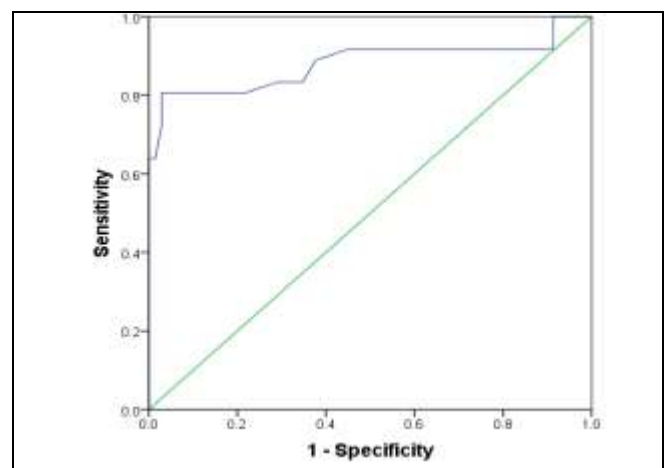


Figure-1: Area under the curve of Pediatric Index Mortality-II Score

RESULTS

Of 105 patients, the median age of the patients was 5.0 years (with age range of 3-9 years). There were 65(61.9%) females and 40(38.1%) males. The median length of stay in PICU was 5.0 days (with range of 4-6 days). The reason of admission in majority of the patients was neurological disease, i.e., 43(41%) patients followed by cardiovascular disease in 27(25.7%), renal disease in 15(14.3%), gastrointestinal disease in 11(10.5%), whereas any form of the infection was the reason of admission in 4(8.6%) patients.

The median GCS level of the patients was 7(5-11). There were 54(51.4%) patients with <9 GCS level whereas 51 (32.4%) with >9 GCS level. Shock was reported in 74(70.5%) patients.

The findings of the PIM-II score showed that the median score was found to be 26 (with range of 20-41). There were 26(24.8%) patients with predicted death rate of <20%, 51(48.6%) patients with 20-40% predicted death rate, and 28(26.7%) patients with >40% predicted death rate. While the final outcome showed mortality was reported in 36(34.3%) patients.

The comparison of mortality with baseline and clinical characteristics showed a significant association of mortality with predicted death rate ($p<0.001$), reason of admission ($p<0.001$), shock (p -value 0.003), and GCS level ($p<0.001$). (Table-I)

Table-I: Comparison Of Mortality With Demographic And Clinical Characteristics (n=105)

Clinical Characteristics (n= 105)		Mortality		
	Total	Yes (n=36)	No (n=69)	p
Predicted death rate				
<20	26	3(11.5)	23(88.5)	<0.001
20-40	51	7(13.7)	44(86.3)	
>40	28	26(92.9)	2(7.1)	
Age, years				
≤5	54	20(37)	34(63)	0.541
>5	51	16(31.4)	35(68.6)	
Gender				
Male	40	16(40)	24(60)	0.333
Female	65	20(30.8)	45(69.2)	
Reason of admission				
Neurological Disorder	43	8(18.6)	35(81.4)	<0.001
Cardiovascular Disease	27	3(11.1)	24(88.9)	
Renal Disease	15	10(66.7)	5(33.3)	
GI Disease	11	8(72.7)	3(27.3)	
Infection of any kind	9	7(77.8)	2(22.2)	
Length of stay, days				
≤5	71	20(28.2)	51(71.8)	0.056
>5	34	16(47.1)	18(52.9)	
Shock				
Yes	74	32(43.2)	42(56.8)	0.003

The findings of the regression analysis revealed that after adjusting for other covariates, the odds of mortality were 99% lower among patients with predicted death rate of <20% (adjusted OR=0.01, 95% CI 0.01-0.05) and in between 20% to 40% predicted death rate (adjusted OR=0.01, 95% CI 0.01-0.05) as compared to >40% predicted death rate. The odds of mortality were 97% lower among patients with neurological disorder as reason of admission (adjusted OR=0.03, 95% CI 0.01-1.75), 98% lower among patients with cardiovascular disease as reason of admission (adjusted OR=0.02, 95% CI 0.01-0.83), 98% lower among patients with renal disease as reason of admission (adjusted OR=0.02, 95% CI 0.01-1.24), while 26% lower among patients with gastrointestinal disease as reason of admission (adjusted OR=0.74, 95% CI 0.01-59.86) as compared to the patients with infections as reason of admission. Moreover, the odds of mortality was 98% lower among patients with >9 GCS as compared to the patients with ≤9 GCS level (adjusted OR=0.02, 95% CI 0.01-1.24). (Table-II)

Table-II: Regression Analysis of The Factors Associated Mortality (n=105)

	OR (95% CI)	<i>p</i> -value	Adjusted OR (95% CI)	<i>p</i> -value
Predicted Death Rate				
<20	0.010 (0.01-0.06)	<0.001	0.01 (0.01-0.05)	<0.001
20-40	0.012 (0.01-0.06)	<0.001	0.01 (0.01-0.05)	<0.001
>40	Ref			
Reason of admission				
Neurological Disorder	0.06 (0.01-0.37)	0.002	0.03 (0.01-1.75)	0.090
Cardiovascular Disease	0.03 (0.01-0.25)	0.001	0.02 (0.01-0.83)	0.040
Renal Disease	0.57 (0.09-3.83)	0.564	0.02 (0.01-1.24)	0.063
GI Disease	0.76 (0.09-5.95)	0.796	0.74 (0.01-59.86)	0.892
Infection	Ref		Ref	
Shock				
Yes	5.14 (1.63-16.18)	0.005	1.63 (0.03-77.17)	0.804
No	Ref		Ref	
GCS				
>9	0.04 (0.01-0.14)	<0.001	0.02 (0.01-0.37)	0.009
≤9	Ref		Ref	

CI: Confidence Interval, GCS: Glasgow Come Scale, GI: Gastrointestinal Disease, OR: odds ratio, aOR: adjusted odds ratio, Ref: reference category

The area under the curve of PIM-II was found to be 0.88 (95% CI 0.79-0.97). (Figure-1) Somewhat similar findings of area under curve were found when compared with the baseline and clinical characteristics of the patients. (Table-III)

DISCUSSION

This study aimed at evaluating patient outcomes using the PIM-II scale. Our study found a significant association between the death rate predicted by the scale and patient mortality. This was in-line with current studies which also found the PIM-II scale to be an adequate indicator of patient mortality when calibrated to individual study settings.¹² Similarly, Ekinci F et al found that the score maintained its

validity once the population was stratified according to the PIM-II score.¹³

Table-III: Findings of The Area Under The Curve Across All Patients And Different Sub-Groups (n=105)

	AUC	95% CI	p
Total	0.881	0.79-0.97	<0.001
Age, years			
≤5	0.889	0.78-0.99	<0.001
>5	0.87	0.72-1.00	<0.001
Gender			
Male	0.915	0.79-1.00	<0.001
Female	0.853	0.73-0.97	<0.001
Reason of admission			
Neurological Disorder	0.911	0.79-1.00	<0.001
Cardiovascular Disease	0.951	0.86-1.00	0.012
Renal Disease	0.901	0.71-1.00	0.014
GI Disease	0.750	0.45-1.00	0.221
Infection	0.750	0.43-1.00	0.306
Length of stay, days			
≤5	0.906	0.81-1.00	<0.001
>5	0.861	0.71-1.00	<0.001
Shock			
Yes	0.854	0.74-0.96	<0.001
No	0.954	0.88-1.00	0.004
GCS			
≤12	0.885	0.79-0.98	<0.001
>12	0.976	0.93-1.00	0.006

AUC: Area Under the Curve, CI: Confidence Interval, p: p-value

Analysis of study data showed a significant relation between mortality and reason for admission. A majority of patients were admitted for management of neurological disease, followed by cardiovascular disease, then renal disease and gastrointestinal disease in 11(10.5%), whereas infection was the least common reason. Seifu *et al*¹⁴ also found neurological and cardiovascular disease to be the most and second most common cause of admission respectively. Similarly, a significant association was seen between mortality and both shock and the GCS level of patients, a finding supported by Ebrahim MM *et al*.¹⁵

The area under the curve for PIM-II was found to be 0.88. Somewhat similar findings of area under curve were found when compared with the baseline and clinical characteristics of the patients. This is a measure of the sensitivity and specificity of the scale with respect to the study population. Teshager *et al*.¹⁶ from Ethiopia reported good validity of PIM-II among cohort of 313 children, and concluded that this was a well calibrated test for their particular population. Sengupta *et al*¹⁶ from India reported that among 138

PICU patients, respiratory illnesses were the predominant diagnosis (46.4%), with an overall mortality of 20.3%. PRISM III demonstrated the highest discriminative ability (AUC 0.984), followed by PELOD (0.872) and PIM 2 (0.836), with good calibration across all scores.¹⁷ The area under the curve is a reflection of the differentiation between patient death and survival by the PIM-II score. It is reasonable to say that in this instance PIM-II score was an adequate predictor of mortality and the findings are similar to the results by Mazhar MB *et al* from Pakistan showed that PIM-II demonstrated moderate discriminatory ability for mortality prediction, with 54.3% sensitivity, 83.3% specificity, and an AUROC of 0.75 (95% CI: 0.67-0.84; p<0.001). However, poor calibration was observed (Hosmer-Lemeshow p=0.027), indicating a need for recalibration to reflect local population characteristics.¹⁸ However, on the other end of the spectrum, there are studies that have concluded that the PIM-II score is a poor discriminator of study outcomes. The likely reason suggested paucity of resources, and differences in patient clinical profile and the quality of care as compared to the center where the score was developed.¹⁹

Demographically, the mean age of within our sample population was 5 years, with 61.9% of females and 38.1% males. This is similar to multiple studies done in Pakistan and in other international study samples.^{5,6,13,14,19} It is important to note that contrary to other scoring scales employed in PICU settings, such as PRISM which is supposed to be calculated using observations within 24 hours of PICU admission,⁷ PIM-II score is ideally done within an hour of patient admission, which leads to early identification of severity of illness and stratification of children for necessary intervention, in a situation where time is of the essence. This made our study particularly streamlined. In addition our wide variance in the study sample is reflective of the community our hospital system serves.

One of the limitations of this method of predicating mortality is that they are population sensitive. It is recommended that a pilot study be initiated before they are used broadly in the PICU. A larger study, spanning multiple centers will help improve on our research. Another fact to consider was that the pattern of disease referral and the quality and standard of treatment facilities available is singular to our particular setup and geographical location and

may not be applicable to other areas, without stratification.

CONCLUSION

The PIM-II score predicted accurately in most of the patients admitted in PICU and could be recommended as a valuable tool for anticipating prognosis in pediatric patients admitted to a tertiary PICU facility within a resource constrained set up in Pakistan. As the PIM-II score can be done at earliest part of patient management, this will be very useful in counseling of parents and making strategic management choices in patient care.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SS & QM: Data acquisition, data analysis, critical review, approval of the final version to be published.

KK & SJ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AJ: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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