

Original Research Article

INOTROPE SCORE AS PROGNOSTIC INDICATOR IN CHILDREN ADMITTED IN PEDIATRIC INTENSIVE CARE UNIT: PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Critically ill children with fluid-refractory shock admitted to the Paediatric Intensive Care Unit (PICU) often require vasoactive and inotropic support. Objective tools such as the Inotrope Score (IS) and Vasoactive-Inotropic Score (VIS) help quantify cardiovascular support and may serve as reliable prognostic indicators for adverse outcomes. The objective is to evaluate the association between inotrope score and clinical outcomes, including need for mechanical ventilation, length of PICU stay, and mortality, and to identify an optimal cut-off value for mortality prediction.

Materials and Methods: This hospital-based prospective observational study was conducted over two years in the PICU of Kamla Raja Hospital, G.R. Medical College, Gwalior. A total of 176 children aged >1 year admitted with fluid-refractory shock requiring inotropic support were enrolled. Hemodynamic parameters and inotrope scores were recorded at predefined intervals. Associations between mean inotrope score and clinical outcomes were analyzed, and receiver operating characteristic (ROC) curve analysis was used to determine the mortality cut-off.

Results: Of the 176 children, 66.5% succumbed to illness. Higher mean inotrope scores were significantly associated with mortality (28.9 ± 4.1 vs. 23.4 ± 3.6 ; $p < 0.05$), need for mechanical ventilation, oxygen support, and prolonged PICU stay. Logistic regression confirmed the inotrope score as an independent predictor of mortality (OR 1.31, 95% CI 1.19–1.45) and ventilator requirement (OR 1.34, 95% CI 1.22–1.48). An inotrope score cut-off of 25 predicted mortality with 85% sensitivity and specificity (AUC = 0.85).

Conclusion: The inotrope score is a simple, reliable, and effective prognostic marker in children with fluid-refractory shock. Routine use may aid early risk stratification, guide clinical decision-making, and improve outcome prediction in the PICU.

Keywords: Inotrope Score, Vasoactive-Inotropic Score, PICU, Fluid-Refractory Shock, Mortality, Mechanical Ventilation, Prognostic Indicator.

INTRODUCTION

Critically ill children admitted to the Paediatric Intensive Care Unit (PICU) often require prompt diagnostic and therapeutic decisions to optimize recovery and survival. Objective tools that assist clinicians in assessing illness severity, guiding management, predicting outcomes, and counselling families regarding prognosis are therefore essential.

One such tool that has gained importance in paediatric critical care is the Inotrope Score (IS) and its expanded form, the Vasoactive-Inotropic Score (VIS), which quantify the degree of cardiovascular support required by a child.

The Inotrope Score was first introduced by Wernovsky et al.^[1] in 1995 to quantify inotropic support in children undergoing arterial switch operations for congenital heart disease. The original

score included commonly used inotropes such as dopamine, dobutamine, and epinephrine, and was designed to aid interpretation of postoperative cardiac output measurements rather than to function as an illness severity score. Subsequently, Gaies MG et al,^[2] expanded this concept into the Vasoactive-Inotropic Score by incorporating additional vasoactive agents, thereby improving its ability to reflect total hemodynamic support and predict clinical outcomes in critically ill children.

Although the IS and VIS were not originally intended as prognostic tools, multiple studies have validated their usefulness in predicting early clinical outcomes, especially following neonatal and infant cardiac surgery. Studies by Asaran et al,^[3] and Gruenwald CE et al,^[4] demonstrated that higher scores were associated with increased morbidity, prolonged ICU stay, and mortality. Over time, these scores have been increasingly adopted as surrogate markers of illness severity in paediatric cardiac and general critical care.

Sepsis remains one of the most common causes of PICU admission and a leading contributor to paediatric morbidity and mortality worldwide. Septic shock, particularly fluid-refractory shock, is associated with significant cardiovascular dysfunction requiring aggressive vasoactive and inotropic support to restore hemodynamic stability and improve tissue perfusion. Inotropes and vasopressors are cornerstone therapies in this setting; however, clinical practice varies widely across institutions and among clinicians. This variability highlights the need for standardized, objective measures to assess and compare hemodynamic support.

The Inotrope Score and VIS provide a quantitative and reproducible method to assess vasoactive requirements. A strong association between higher VIS values and adverse outcomes, including increased mortality, prolonged mechanical ventilation, and longer ICU stay, has been demonstrated in several studies, including that by Gaies MG et al.^[2] Despite certain limitations—such as the lack of a universally standardized formula incorporating all vasoactive agents—VIS remains a valuable tool for both clinical assessment and research comparison.

In paediatric sepsis research, low mortality rates in fluid-refractory shock often limit the feasibility of using death as a primary outcome measure. Therefore, validated surrogate markers that correlate with clinically meaningful outcomes are crucial. A score that accurately reflects cardiovascular dysfunction and correlates with ICU length of stay, ventilator duration, and overall outcome can aid in early risk stratification, guide therapeutic escalation, and serve as a reliable endpoint in clinical research and quality improvement initiatives.

The present prospective observational study was undertaken to determine the association between the inotrope score and clinical outcomes in children

admitted to the PICU with fluid-refractory shock over a period of 18 months.

Aim: To determine the association between the inotrope score and clinical outcomes in children admitted to the Paediatric Intensive Care Unit (PICU) with fluid-refractory shock.

Primary Objectives

1. To assess the association between the inotrope score and the need for mechanical ventilator support in critically ill children.
2. To evaluate the relationship between the inotrope score and duration of hospital stay.
3. To identify the optimal timing for assessment of the inotrope score in the PICU.

Secondary Objectives

1. To determine the association between the inotrope score and mortality among children admitted to the PICU.
2. To estimate the threshold value of the inotrope score with optimal sensitivity and specificity for predicting adverse outcomes.

MATERIALS AND METHODS

The study was conducted in the Paediatric Intensive Care Unit (PICU), Kamla Raja Hospital, Department of Pediatrics, G.R. Medical College, Gwalior, Madhya Pradesh.

Study Design: Single-centre prospective observational study.

Study Period: 18 months (May 2023 to Oct. 2024).

Study Population: All children admitted to the Paediatric Intensive Care Unit of Kamla Raja Hospital, Department of Pediatrics, G.R. Medical College, Gwalior.

Study Sample: Children aged more than one year admitted to the PICU with fluid-refractory shock or requiring inotrope support. Fluid-refractory shock was defined as persistence of clinical signs of shock despite administration of fluid boluses totaling 60 ml/kg.

Sampling Method: Simple random sampling technique.

Sample Size Calculation: Based on the study by Kumar M et al. (2014)⁵, which reported a mean hospital stay of 13.25 ± 4.24 days as the primary outcome. Using a 5% level of significance and 5% absolute error, the calculated sample size was 176 patients.

Inclusion Criteria:

1. Children aged more than one year admitted to the PICU.
2. Patients requiring inotrope support.
3. Patients with fluid-refractory shock.

Exclusion Criteria:

1. Children aged less than one year.
2. Patients not requiring inotrope support.
3. Patients intubated prior to initiation of inotrope therapy.

4. Children with primary cardiac diseases such as congenital heart disease or rheumatic heart disease.
5. Patients already receiving inotrope support before PICU admission.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Committee of Gajra Raja Medical College, Gwalior, Madhya Pradesh (Approval No. 158/IEC-GRMC/2023). Written informed consent was obtained from parents or legal guardians.

Statistical Analysis: Data was collected, complied and analysed. All data were entered into MS-Excel Software and analysed on open access Zamovi statistical software. Appropriate descriptive and

analytical statistical tests were applied for this. P value less than 0.05 was considered statistically significant.

RESULTS

The present hospital-based prospective observational study was conducted in the Paediatric Intensive Care Unit of Kamla Raja Hospital, Department of Paediatrics, Gajra Raja Medical College, Gwalior, over two years. The study included 176 children aged >1 year admitted with fluid-refractory shock requiring inotropic support.

Table 1: Sociodemographic Profile of Study Participants (n = 176)

Variable	Category	Number	Percentage (%)
Gender	Male	84	47.7
	Female	92	52.3
Age Group (years)	1–5	68	38.6
	6–10	88	50.0
	>10	20	11.4
Residence	Rural	100	56.8
	Urban	76	43.2
Socioeconomic Status	Lower	74	42.0
	Upper Lower	35	19.9
	Lower Middle	32	18.2
	Upper Middle	27	15.3
	Upper Class	8	4.6

Among the 176 children studied, females (52.3%) slightly outnumbered males. Half of the participants belonged to the 6–10 years age group. A majority were from rural areas (56.8%) and lower

socioeconomic strata, indicating higher representation of economically disadvantaged children in PICU admissions with fluid-refractory shock.

Table 2: Clinical Characteristics, Supportive Interventions, and Outcomes of Study Participants (n = 176)

Variable	Category	Number	Percentage (%)
Presenting Symptoms*	Vomiting	85	48.3
	Loose stools	93	52.8
	Cough / difficulty breathing	81	46.0
	Reduced food intake / refusal	84	47.7
	Seizure / abnormal movements	96	54.5
	Other symptoms	54	30.7
Glasgow Coma Score at Admission	3–8	84	47.7
	9–12	63	35.8
	>12	29	16.5
Pupillary Reaction	Reactive	127	72.15
	Non-reactive	49	27.85
Ventilator Support	Required	57	32.4
	Not required	119	67.6
Duration of Ventilation (n=57)	<24 hours	24	42.1
	24–72 hours	16	28.1
	>72 hours	17	29.8
Oxygen Support	Required	92	52.27
	Not required	84	47.73
Duration of Oxygen Support (n=92)	<24 hours	28	30.43
	24–72 hours	34	36.96
	>72 hours	30	32.61
Cardiopulmonary Resuscitation	Required	47	26.7
	Not required	129	73.3
Cardiac Arrest	Yes	38	21.5
	No	138	78.4
Length of PICU Stay	<24 hours	29	16.5
	24–72 hours	97	55.1
	>72 hours	50	28.4

Table 3: Trends in Hemodynamic Parameters, Oxygenation, Shock Index, and Inotrope Score Over Time (n = 176)

Time Point	Heart Rate (beats/min) Mean $\pm$ SD	SBP (mmHg) Mean $\pm$ SD	DBP (mmHg) Mean $\pm$ SD	Oxygen Saturation (%) Mean $\pm$ SD	Shock Index Mean $\pm$ SD	Inotrope Score Mean $\pm$ SD
Admission	152 $\pm$ 12.8	65 $\pm$ 8.9	49 $\pm$ 6.8	75 $\pm$ 8	2.4 $\pm$ 0.7	—
6 Hours	150 $\pm$ 13.4	68 $\pm$ 7.7	50 $\pm$ 8.9	78 $\pm$ 9	2.3 $\pm$ 0.9	16 $\pm$ 3.7
12 Hours	149 $\pm$ 11.7	71 $\pm$ 9.5	50 $\pm$ 11.4	80 $\pm$ 7	2.1 $\pm$ 0.7	22 $\pm$ 5.9
24 Hours	148 $\pm$ 11.6	76 $\pm$ 9.1	53 $\pm$ 10.6	83 $\pm$ 9	1.9 $\pm$ 0.8	29 $\pm$ 7.4
48 Hours	146 $\pm$ 15.9	81 $\pm$ 10.8	59 $\pm$ 9.7	89 $\pm$ 11	1.7 $\pm$ 0.8	45 $\pm$ 12

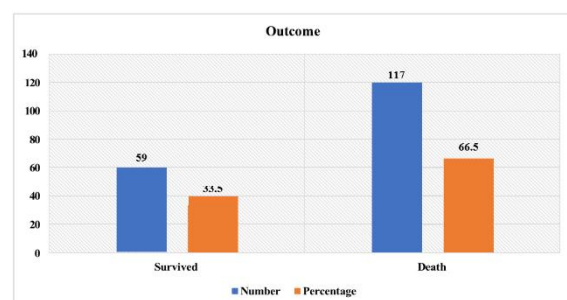
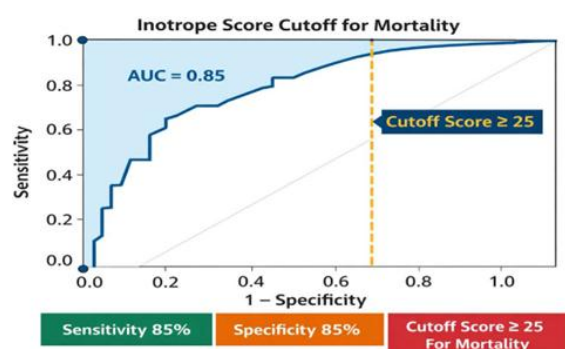
[Table 3] show Over the 48-hour observation period, children demonstrated progressive hemodynamic stabilization, evidenced by a gradual decline in heart rate, improvement in systolic and diastolic blood

pressures, rising oxygen saturation, and a decreasing shock index. Conversely, the mean inotrope score increased steadily.

Table 4: Association of Mean Inotrope Score with Clinical Outcomes and Mortality (n = 176)

Outcome Variable	Category	n	Mean Inotrope Score $\pm$ SD	Test Statistic	P value
Mortality	Survived	59	23.4 $\pm$ 3.6	t = -8.74	<0.05
	Death	117	28.9 $\pm$ 4.1		
Ventilator Support	No	119	25.3 $\pm$ 3.6	t = -9.63	<0.05
	Yes	57	31.2 $\pm$ 4.2		
Oxygen Support	No	84	26.3 $\pm$ 3.9	t = -2.86	0.005
	Yes	92	28.2 $\pm$ 4.8		
Length of PICU Stay	$\leq$ 72 hours	126	23.3 $\pm$ 2.7	t = -13.85	<0.05
	> 72 hours	50	30.2 $\pm$ 3.6		

[Table 4] show the Children with higher mean inotrope scores had significantly greater mortality, increased need for ventilator and oxygen support, and longer PICU stay show the statistical significance (p < 0.05) indicates that these associations were unlikely due to chance.

**Figure 1: Showing Outcomes of Study Participants (n = 176)****Figure 2: ROC curve of inotrope score as cut off for mortality**

DISCUSSION

In this study, the gender distribution of children with fluid-refractory shock was nearly equal, with a slight

female predominance. The majority of cases (50%) were in the 6–10 years age group, indicating that school-aged children were most commonly affected. These findings are broadly consistent with previous studies by Kumar et al,^[5] McIntosh et al,^[6] and Mondal et al,^[7] though the age distribution varies slightly across populations.

Cardiopulmonary resuscitation (CPR) was required in 26.7% of patients, and cardiac arrest occurred in 21.5%, reflecting the high severity of illness in this cohort. Comparable rates have been reported internationally: Musick et al,^[8] (23%), Dauhan et al,^[9] (29.3%), and McIntosh et al,^[6] (19%), all of which were associated with high mortality.

In the present study, 32.4% of children with fluid-refractory shock required mechanical ventilation, with 29.8% needing support for more than 72 hours, reflecting the significant burden of respiratory failure and systemic compromise in this population. Prolonged ventilation increases the risk of complications such as ventilator-associated pneumonia, longer ICU stay, and higher mortality. These findings align with previous studies: Pudjiadi et al,^[10] (2021, Indonesia) reported 38.2% ventilated patients, McIntosh et al.⁶, (2017, USA) observed 34.6%, and Mukthar et al,^[11] (Sri Lanka) found 41.9% requiring ventilation, all showing a strong association with increased illness severity and mortality. Dauhan et al,^[9] (2021, Indonesia) noted higher mortality among patients ventilated for >72 hours.

In this study of 176 children, nearly one-third required mechanical ventilation, and slightly over half required oxygen therapy, with a substantial proportion needing support for more than 24 hours. The most common PICU stay was 24–72 hours, though over a quarter of children stayed >72 hours.

Higher inotrope scores (VIS) were significantly associated with increased need for ventilatory and oxygen support, as well as longer ICU stays, suggesting that VIS is a reliable marker of illness severity. These findings are consistent with previous studies: high VIS predicted prolonged ICU stay and ventilator duration (Gaies MG et al.², Davidson et al.¹² Sanil & Aggarwal),¹³ and correlated with length of hospital stay (Kumar et al.⁵ Garcia et al).¹⁴ In this study, 66.5% of children with fluid-refractory shock died, reflecting the severity of illness. Survivors had a significantly lower mean inotrope score (23.4 ± 3.6) compared to non-survivors (28.9 ± 4.1 , $p < 0.05$), indicating that higher scores strongly predict mortality. Logistic regression showed that elevated inotrope scores independently predicted both increased mortality (OR 1.31, 95% CI 1.19–1.45, $p < 0.001$) and greater need for ventilatory support (OR 1.34, 95% CI 1.22–1.48, $p < 0.0001$). These findings are consistent with previous research: Gaies MG et al.² reported high VIS associated with significantly higher mortality (OR 13.2, 95% CI 3.7–47.6), Shahin et al.¹⁵ observed higher mortality in inotrope-treated cardiac surgery patients (OR 14.7, 95% CI 2.0–111.1), and Garcia et al.¹⁴ showed maximum VIS at 48 hours was strongly linked to adverse outcomes (OR 1.35, 95% CI 1.12–1.64). Similarly, studies by Kallekkattu,¹⁶ Dauhan et al.,⁹ Sousa,¹⁷ Haque,¹⁸ and Shukla,¹⁹ confirmed that elevated inotrope or VIS scores reliably predict PICU mortality, supporting its use as an early prognostic indicator in critically ill children.

In this study, an inotrope score (VIS) cut-off of 25 predicted mortality with 85% sensitivity and specificity (AUC = 0.85), indicating good discriminative ability. Similar studies have reported comparable findings: Garcia et al.¹⁴ (AUC 0.76), Musick et al.⁸ (AUC 0.788–0.879), Kallekkattu et al.¹⁶ (AUC 0.80–0.88), and Dauhan et al.⁹ (AUC 0.797). These results support the utility of VIS as a reliable early predictor of mortality in critically ill children, particularly in cardiovascular and sepsis populations.

CONCLUSION

This prospective observational study highlights the critical prognostic value of the inotrope score in children admitted to the PICU with fluid-refractory shock. The study population predominantly comprised children from rural and lower socioeconomic backgrounds, reflecting the vulnerability of these groups to severe illness requiring intensive care. A high proportion of patients presented with severe neurological compromise and required significant respiratory and cardiovascular support, underscoring the critical nature of their condition.

Over the initial 48 hours of management, children demonstrated gradual hemodynamic stabilization with improvement in heart rate, blood pressure,

oxygen saturation, and shock index; however, this was accompanied by a progressive rise in inotrope score, indicating increasing pharmacological cardiovascular support. Importantly, higher mean inotrope scores were significantly associated with adverse outcomes, including increased mortality, greater need for mechanical ventilation and oxygen therapy, and prolonged PICU stay.

Recommendation:

1. The inotrope score should be routinely used in PICU children with fluid-refractory shock for early risk assessment.
2. An inotrope score ≥ 25 can help identify patients at high risk of mortality and prolonged PICU stay.
3. Rising inotrope scores should prompt early escalation of care and closer monitoring.
4. Incorporating inotrope score-based assessment into PICU protocols may improve outcome prediction and resource utilization.

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