Prospective Observational Study to Develop Paediatric Acute Care Score (PACS) For Early Prediction of Clinical Deterioration in Paediatric Wards Requiring Intensive Care in Children Presenting to Paediatric Emergency Services in A Tertiary Care Hospital

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ABSTRACT

Background: All critical inpatient events are preceded by warning signs like change in vital signs such as tachycardia, tachypnoea, hypotension, acute dyspnoea, and change in level of consciousness for an average of 6–8 hours that can be graded into an Early Warning Score.

Objective: To develop and validate a scoring system for early prediction of clinical deterioration requiring intensive care in not unwell children with Comorbid factors admitted to paediatric wards at presentation to the Paediatric emergency department.

Subjects and Methods: This prospective observational study was done in 13987 children with PACS (derived from the PEWS score and indigenously added co-morbidities). The score was developed in the first stage and then validated in the follow-up study. After training the Emergency and ward Medics, all children at presentation were screened, sick children eliminated, and the scores were repeated at the time of deterioration in children needing intensive care.

Results: There was a significant difference in the scores of children between the deteriorated and non-deteriorated groups (P=0.0001) in the parameters of consciousness, breathing, and circulation. When the co-morbid factors are included, the distribution of the scores in the receiver operator curve (ROC) showed a standard error of 0.0122 and an Area under the curve (AUC) of 0.939 with good predictive power.

Conclusion: The PAC score is an easy and accurate scoring system in identifying the risk of clinical deterioration in children with co-morbid factors in the Paediatric wards. At a score of > 4 at presentation, the score has a sensitivity of 83.7% with a specificity of 93.9%, LR+ of 13.8, and AUC of 0.93 of predicting deterioration needing Intensive care.

Keywords: Clinical Deterioration in Children in Paediatric Wards, PEWS, Comorbidity Scores.

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Introduction

About 7% of the in-patient children have cardiopulmonary arrest during their stay, with only 15-36% of children surviving the arrest.[1-3] The identification of a sick child and immediate intervention can prevent deteriorating to a critical crash event. As children have limited compensatory mechanisms and a very narrow window period for the same, predicting the deterioration in children is an ominous task. This unexpected clinical deterioration can be prevented by a Rapid Response Team (RRT) or early warning scores.

Almost all critical inpatient events were preceded by warning signs like change in vital signs such as tachycardia, tachypnoea, hypotension, acute dyspnoea, and change in level of consciousness for an average of 6–8 hours that can be graded into a score or a Paediatric Early Warning System (PEWS)[4,5] Fever, hypoxia, tachycardia, mental deterioration, and hypotension were remarkably present before the cardiac arrests in the ward. PEWS has been used in many countries as a trigger tool both for PICU admissions and RRT team arrival in varied indigenous versions.[6-45]

When used in the Paediatric Emergency Department (PED) as a trigger, triage, or disposition tool, it has excellent data capture and inter-rater reliability and can be used as a screening tool for the prediction of ICU admission.[46-56] Some studies have validated the score in children with oncological comorbid factors, and no scores account for cardiac, respiratory, and nutritional factors.[57-59] There is a paucity of literature regarding the Indian setting.

Background

Figure 1. Study Flow sheet

The Pediatric Acute Care Score (PACS) was developed from the validated Brighton score Bedside Paediatric Early Warning Score (PEWS), except for the two elements of need for nebulization and post-surgical vomiting. The variables of consciousness, breathing, and circulation formed the main framework in the score. The modified parameters were deciphered by the multidisciplinary team and the commonly seen comorbid factors in our institute. In a Pilot audit done, we found that the children who shifted into intensive care from the wards accounted for about 45% of the ICU admissions. These children were admitted from the emergency in a non-critical clinical state and then deteriorated in the ward. This study was drafted to quantify clinical deterioration as a part of part of making it a clinical Standard of Operation. This was not a QI project but a Protocol derivation study with validation of the score.

Objectives

The objective of this study was to develop a simple scoring system using the clinical vital variables and co-morbidities for sick children who are admitted to paediatric wards through the Paediatric Emergency Service and to determine the early prediction of clinical deterioration requiring intensive care. Our hypothesis was the score would predict deterioration with children referred with Co-morbid factors in our set up of tertiary care.

Methods

I: Design and Score Development:

This is a prospective observational study done in Paediatric Emergency Service (PED) and the Paediatric wards, at Christian Medical College, Vellore. Institutional Review Board (IRB) committee approval was sought before the study was commenced. Consent and assent were taken from all the parents and children as needed.

II Setting

The study was done for a total of seven months, four months as score development. It was analysed interim and was found to have a very good predictive capacity. It was then validated later for three months. The results of development and validation were analysed together.

All children were enrolled in the study and were assessed by the Registrars, and their demographic details, primary diagnosis, co-morbid factors, and Pediatric Acute Care Score were documented in a standardized Performa at admission.

III: PACS Calculation

PACS Scoring Sheet

The vital signs used for different age groups of children were also provided on the same sheet of paper according to the standard reference ranges based on the values provided by the PALS guidelines. (Fig2).

The variables were given alphabetical nominal and not numerical values to avoid bias. Multiple training sessions were done to familiarize the physicians with the assessment and scoring. This process of the assessment by physicians other than the primary investigator and the process of the scoring were audited frequently by the co-authors. The score was then computed by the investigator to remove the bias on the part of the treating physician.

PEDIATRIC ACUTE CARE SCORE (PACS) STUDY

DEPARTMENT OF PEDIATRICS, CHRISTIAN MEDICAL COLLEGE, VELLORE

1.Name: 2.Age: 3.Gender:Male/female

4.Hospital number: 5.Unit: 6.Date:

7.Priority as per TRIAGE : I / II / III

8.Primary diagnosis:………………………………………………………………………………

9.Time at presentation (T0): ……………….A.M/P.M

10.PACS assessment at T0:

	A	B	C	D
Behaviour	Lethargic or confused or reduced pain response	Irritable and unconsoble or Parents concerned	Sleeping or irritable and consolable	Playing or appropriate
Cardiovascular	Grey or cyanotic & mottled or CRT > 5 Secs or Tachycardia 30 above or bradycardia for age	Grey or Cyanotic or CRT >4 secs OR Tachycardia 20 above normal parameters	Pale or dusky or CRT 3 sec	Pink or CRT 1-2 sec
Respiratory	> 30 above or > 5 below normal with retractions or tracheal tug or grunting or >50 %Fio2 or 8 liters/min O2	>20 above normal or using accessory muscles or 40-49% %Fio2 or >6 lit/min O2	>10above normal parameters Or Using accessory muscles or 30 -39%% Fio2 or >3 lit/min O2	Within normal parameters for age , No recessons

11.Time at which admission was decided (T1):…………………………..A.M/P.M

	A	B	C	D
Behaviour	Lethargic or confused or reduced pain response	Irritable and unconsoble or Parents concerned	Sleeping or irritable and consolable	Playing or appropriate
Cardiovascular	Grey or cyanotic & mottled or CRT > 5 Secs or Tachycardia 30 above or bradycardia for age	Grey or Cyanotic or CRT >4 secs OR Tachycardia 20 above normal parameters	Pale or dusky or CRT 3 sec	Pink or CRT 1-2 sec
Respiratory	> 30 above or > 5 below normal with retractions or tracheal tug or grunting or >50 %Fio2 or 8 liters/min O2	>20 above normal or using accessory muscles or 40-49% %Fio2 or >6 lit/min O2	>10above normal parameters Or Using accessory muscles or 30 -39%% Fio2 or >3 lit/min O2	Within normal parameters for age , No recessons

12.PACS assessment at TD:

13. Co-Morbid factors:

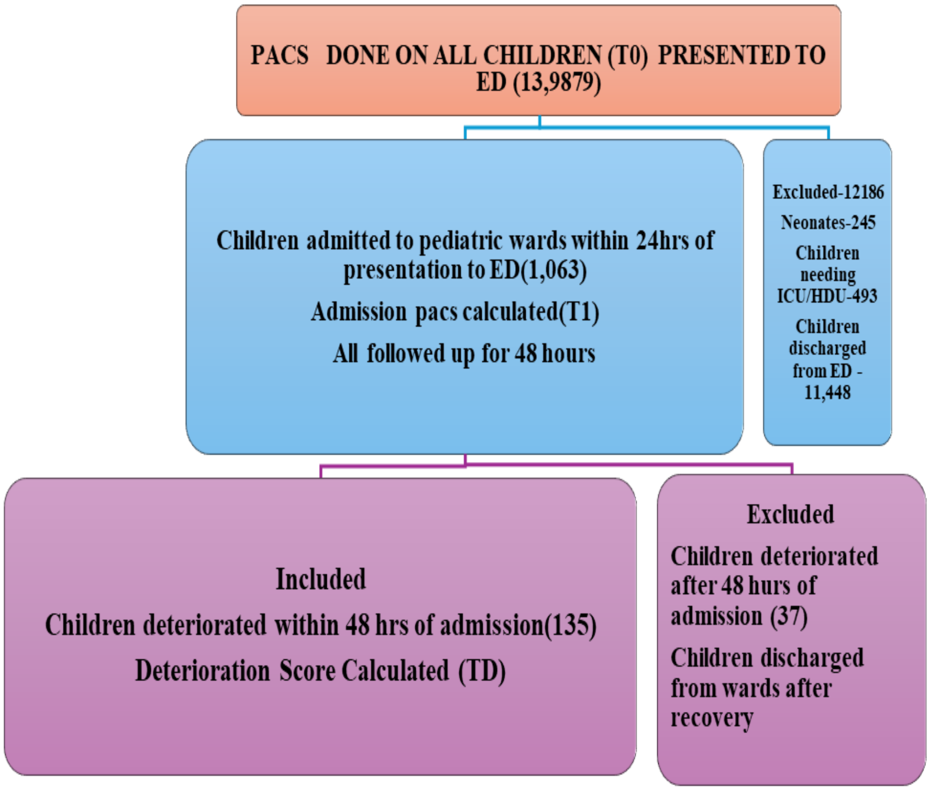
Pathology	A	B
Oncology	**Neutropenic**	**Non-neutropenic**
Chronic pulmonary pathology	**present**	**Absent**
Chronic Cardiac pathology: CHD/Cardiomyopthy	**compensated**	**De-compensated**
Chronic renal pathology	**present**	**absent**
Immunodeficiency state	**present**	**absent**

***reference standard for heart rate and respiratory rate in children:**

Age	Heart rate(per min)	Respiratory rate(per min)
1-12months	100-180	35-40
13 months – 3years	70-110	25-30
4-6 years	70-110	21-23
7-12 years	70-110	19-21
13-19 years	55-90	16-18

IV: PACS timing

Figure 1: Study flow diagram



A total of 13987 patients presented to the PEM during the study period of 7 months. Among them, 1801 children required admission, and 1063 patients who were admitted within 24 hours of presentation to PEM were recruited in our study (Fig. 1)

T0: The score was calculated at the time of presentation to the pediatric emergency triage (T0).

T1: The time at which admission/ decision of admission was taken by the consultant was (T1) the score was recalculated.

TD: The score at deterioration was also measured at the time when the child deteriorated needing a higher level of care than the usual care or needed an admission to critical care.

V Rational for Scoring

In some patients, the decision of admission was made at the time of presentation to the PEM and for them, T0 is the same as T1. In others, the decision of admission was made after the presentation to the PEM based on the clinical status and lab parameters. If the decision of admission was made 24 hours after the presentation to the PEM (i.e., if the difference between the T0 and T1 is more than 24 hours), then the participant was excluded from the study (as the disease process will not be the reason of the deterioration but the monitoring thereof).

Each child was followed up for 48 hours after admission to the paediatric wards. the children admitted to the ward had deteriorated, the score and the time of deterioration (Td) were also noted. The children who were discharged well from the Emergency and the wards were not included in the analysis.

Inclusion criteria

Children with ages between 28 days to 16 years presenting to Paediatric Emergency Service (PEM), who require admission to paediatric wards.

Exclusion criteria

1. Children who require immediate admission to the Paediatric intensive care unit (PICU) at the time of presentation to PEM, according to the treating physician's opinion.
2. If the difference between the time of presentation (T0) and the time at which admission was decided (T1) is more than 24 hours.
3. Children below 28 days of life and completed 15 years and those shifted to Neonates directly from emergency.

Primary Outcome

The primary outcome is "clinical deterioration requiring ICU or HDU care" which is defined as,

1. Cardio-pulmonary arrest
2. Respiratory failure requiring intubation
3. Worsening respiratory distress leading to respiratory support in the form of non-invasive ventilation or high-flow oxygen therapy.
4. Worsening of shock requiring > 10 mcg/kg/min Dopamine and or the addition of a Catecholamine/vasopressin and or increasing lactate level of more than 2 from the baseline / metabolic acidosis.
5. Deterioration of sensorium –i.e. drop in Glasgow Coma Scale (GCS) >/= 2 after admission to the ward.
6. Persistent, uncontrolled seizures after two long-acting anticonvulsants, requiring continuous anticonvulsant infusion.

Sample Size

We have taken the study done by Parushuram et al[27] as our standard for the calculation of Sample Size. A sample of size 78 was required to detect an on-odds ratio of 2.8 times with the PEWS score of 8 and above requiring ICU admission in children with clinical deterioration with 80% power and 5% level of significance.

Statistical Methods

The data sheets were scored and entered in Epidata version 3.1. The descriptive statistics used were mean and standard deviation for continuous variables and frequency distribution for categorical data. STATA was used for the thresholds and the Receiver Operative Curve (ROC) along the Area under the Curve (AUC). The individual specificity, sensitivity, positive predictive value, negative predictive value, odds ratio, and likelihood ratio were calculated. The logistic regression analysis and Pearson square test were used to study the relationship between ICU admission and PACS and the time to deteriorate. The demographic variables were compared using the Pearson chi-square test. For the multivariable logistic regression model prediction of deterioration, the study data were divided into two random parts (approximately 70% versus 30%) with the training set (n=391) and the validation set (n=151). In both models, logistic regression was used for predicting deterioration against risk factors age, gender and PACs score, including comorbid conditions. The estimated logistic regression coefficients were then used to validate in the validation data set. The classification summary statistics including sensitivity, specificity, PPV, NPV, correctly classified, AUROC curve, goodness-of-fit test were estimated from the derivation (training) set and validation set. Data used for the prediction model: out of 564, 542 subjects were used for the training set (n=391) and validation set (n=151). The remaining were excluded due to missing in the deterioration (n=16), score (n=4) and gender (n=2). The training (derivation) and validation were selected randomly into 70% versus 30% approximately.

Results

A total of 13987 patients presented to the PEM during the study period of 7 months. Among them, 1801 children required admission and 1063 patients who were admitted within 24 hours of presentation to PEM were recruited in our study (Fig-1, Table 1). Among these 1063 patients who were admitted, 891 (83%) were discharged after recovery. Among the remaining 172(17%) children who deteriorated during hospital stay, 135(80.8%) children deteriorated within 48 hours of admission and 37(19.2%) children deteriorated after 48 hours of admission.

Participants and Vital parameters data

In our data, the mean age of the children in the study was 3.62 and 4.3 years respectively in non-deteriorated and deteriorated children. Female children in both the study groups were around 39.73 and 32.59 percent respectively. There was a significant difference in the scores of children between the deteriorated and non-deteriorated groups (P=0.0001) in parameters of consciousness, breathing, and circulation. The distribution of the scores in the receiver operator curve (ROC) showed a standard error of 0.0122 and an Area under the curve (AUC) of 0.939.

Characteristics	Non deteriorated (n=891)	Deteriorated (n=135).	P value
Age of the child(yrs) Median (IQ Range)	2(1,5)	2(1,7)	0.146
Female sex, n (%)	353(39.3)	45(33.3)	0.163
Ethnicity,n (%)			0.498
Tamil	632(70.9)	90(66.6)	
Andhra	162(18)	25(18.5)	
Bengal/Bangladesh	88(9.9)	19(14.1)	
Other parts of India	9(2.0)	1(0.8)	
Assessment at presentation			
Consciousness, n (%)			0.0001
Playing or appropriate	867(97.3)	83(61.9)	
Sleeping or irritable and consolable	20(2.2)	18(13.3)	
Irritable and unconsolable, parents are concerned	3(0.3)	29(21.5)	
Lethargic or confused or reduced pain response	1(0.1)	5(3.7)	
Breathing, n (%)			
Within normal parameters for age, no recessions	252(28.4)	4(3.0)	0.0001
>10 above normal or using accessory muscles or 30- 39%FiO2 or >3 lit/minO2	395(44.3)	19(14.1)	
>20above normal or using accessory muscles or 40-49%Fio2 or >3lit/min O2.	238(26.7)	43(31.9)	
>30 above normal or with a tracheal tug or >50%Fio2 or 8l/minO2	6(0.7)	70(51.2)	
Circulation, n (%)			0.0003
Pink or CRT 1-2 sec	232(26.0)	3(2.2)	
Pale or dusky or CRT 3 sec	326(36.6)	26(19.3)	
Grey or cyanotic or CRT >4 secs or tachycardia 20 above normal	309(34.7)	49(36.3)	
Grey or cyanotic or CRT > 5 secs or tachycardia 30 above or	24(2.7)	57(42.1)	

bradycardia for age			
Co-morbid factors, n (%)			
Hemato-Oncology **Non-Neutropenic** **Neutropenic**	 140(15) 46(5.2)	 18(13.3) 9(6.7)	
Immunodeficiency **Inactive state** **Active disease**	 13(1.7) 2(0.2)	 5(3.7) 1(0.7)	0.0012
Chronic lung disease **Compensated state** **Needing oxygen at rest**	 2(2.4) 0.0	 2(2.5) 1(0.8)	
Chronic Cardiac disease **Compensated state** **In failure**	 21(2.4) 0.0	 7(5.8) 1(0.8)	
Chronic renal disease **Compensated state** **De-compensated state**	 2(2.3) 1(0.1)	 3(2.9) 1(0.7)	
Malnutrition **Mild and Moderate Malnutrition** **Severe Malnutrition**	 225(26.3) 10(1.1)	 31(23). 12(8.9)	

Malnutrition (IAP grading used for children <5 Yrs., WHO grading for > 5Yrs)

Table 1. Baseline Demographic and clinical characteristics.

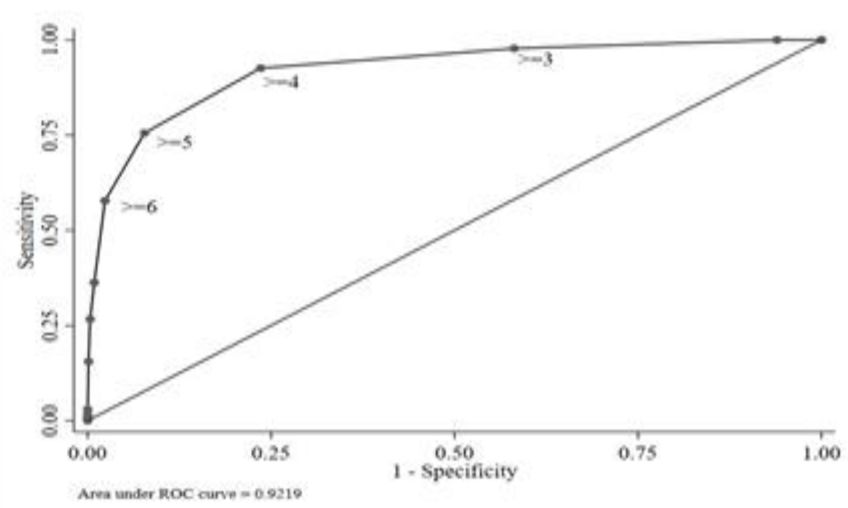


Figure 3: Logistic regression and AUROC curve.

In children with Heamot-oncological comorbidity, the main vital that was significantly affected was breathing (P=0.00). In children with Immunodeficiency, there were no significantly affected vitals that increased the score. In children with Chronic Lung disease, the vitals of consciousness had a significant difference (P = 0.002). The children with mild respiratory morbidity did not have the respiratory vitals affected. In children with Chronic cardiac disease, the vitals of consciousness, breathing, and Circulation were not as significant as in the case of children with Chronic renal disease.

Comorbidity	Vitals not affected n (%)	Vitals Affected		P value
		Mild n (%)	Moderate n (%)	
Hemato-Oncology(n=213) Consciousness	198(93.0)	8(4.0)	7(3.0)	0.11
Breathing	81(38)	78(36.6)	54(24.4)	0.48
Circulation	14(6.6)	48(22.5)	151(70.9)	0.002
Immunodeficiency state(n=20) Consciousness	17(85.0)	1(5.0)	2(10.0)	0.07
Breathing	2(10.0)	9(45.0)	9(45.0)	0.15
Circulation	4(20.0)	11(55.0)	1(5.0)	0.005
Chronic lung disease(n=24) Consciousness	22(91.6)	1(4.2)	1(4.2)	0.001
Breathing	1(4.2)	12(50.0)	11(45.8)	0.05
Circulation	6(25)	10(41.6)	8(33.3)	0.35
Chronic Cardiac disease (n=29) Consciousness	24(82.8)	3(10.3)	2(6.9)	0.90
Breathing	3(10.3)	13(44.8)	13(44.8)	0.53
Circulation	7(24.1)	11(37.9)	11(37.9)	0.43
Chronic renal disease (n=25) Consciousness	22(88.0)	2(8.0)	1(4.0)	0.87
Breathing	5(20.0)	12(48.0)	8(32.0)	0.72
Circulation	4(16.0)	14(56.0)	7(28.0)	0.70
Malnutrition (n=278) Consciousness	252(90.5)	9(3.2)	17(6.1)	0.01
Breathing	29(10.4)	109(39.2)	140(50.4)	0.06
Circulation	95(34.2)	92(33.1)	91(32.7)	0.000

Table 2: Clinical Characters of children with comorbid factors.

Descriptive data of the Outcome (Table 3)

The most common cause for the deterioration within 48 hours of admission (n=135) was worsening of shock requiring >10mcg of Dopamine or the addition of catecholamine or an increase in the lactate level of more than 2 from the baseline (n=70) (51.8%). The incidence of worsening of respiratory distress requiring intubation was found in 23(17%). The incidence of children who had worsening respiratory distress needing Non-Invasive ventilation or high-flow oxygen therapy was 27 (20%). The other causes for deterioration were cardiopulmonary arrest (n=11, 8%), worsening of sensorium (n=3, 2%), and Persistent, uncontrolled seizures (n=1, 0.75%).

	Vitals not affected	Vitas Affected		
		Mild n (%)	Moderate/Severe n (%)	
CARDIO RESPIRATORY ARREST (n=11)				
Consciousness	6(54.6)	0	5(45.5)	
Breathing	0	4(36.4)	2(63.6)	
Circulation	0	2(18.2)	9(81.9)	
Haemato-Oncology	9(81.8)	1(9.1)	1(9.1)	
Immunodeficiency state	10(90.9)	1(9.1)	0	
Chronic lung disease	11(100)	0	0	
Chronic Cardiac disease	8(72.8)	3(27.3)	0	
Chronic renal disease	11(100)	0	0	
Malnutrition (IAP <5 Yrs., WHO > 5Yrs)	7(63.6)	2(18.2)	2(18.2)	
RESPIRATORY FAILURE REQUIRING INTUBATION(n=23)				
Consciousness	10(43.5)	4(17.4)	9(39.1)	
Breathing	1(4.35)	3(13.0)	19(82.6)	
Circulation	0	3(13.0)	20(86.7)	
Haemato-Oncology	18(78.3)	3(13.0)	2(8.7)	
Immunodeficiency state	23(100)	0	0	
Chronic lung disease	23(100)	0	0	
Chronic Cardiac disease	22(95.7)	0	1(4.4)	
Chronic renal disease	22(95.7)	0	1(4.4)	
Malnutrition (IAP <5 Yrs., WHO > 5Yrs	18(78.3)	4(17.4)	1(4.4)	
WORSENING RESPIRATORY DISTRESS LEADING TO RESPIRATORY SUPPORT IN THE FORM OF NON-INVASIVE VENTILATION OR HIGH FLOW OXYGEN THERAPY(n=27)				
Consciousness	16(59.3)	4(14.9)	7(25.9)	
Breathing	1(3.7)	3(11.1)	23(41.9)	
Circulation	0	3(11.1)	25(88.9)	
Haemato-Oncology	22(81.5)	3(11.1)	2(7.4)	
Immunodeficiency state	27(100)	0	0	
Chronic lung disease	26(96.3)	0	1(3.7)	
Chronic Cardiac disease	27(100)	0	0	
Chronic renal disease	26(96.3)	0	1(3.7)	
Malnutrition (IAP <5 Yrs., WHO > 5Yrs)	14(51.9)	10(37.0)	3(11.1)	
WORSENING SHOCK REQUIRING >10MCG/KG/MIN DOPAMINE AND OR OF A CATECHOLAMINE /VASOPRESSIN AND OR INCREASING LACTATE LEVEL OF MORE THAN 2 FROM THE BASELINE METABOLIC ACIDOSIS (n=70)				
Consciousness	50(71.4)	8(11.4)	12(17.2)	
Breathing	2(2.9)	8(11.4)	60(85.1)	
Circulation	3(4.3)	18(25.7)	49(70.3)	
Haemato-Oncology	56(80)	10(14.3)	4(5.7)	
Immunodeficiency state	66(94.3)	3(4.3)	1(1.4)	
Chronic lung disease	68(97.1)	2(2.9)	0	
Chronic Cardiac disease	66(94.3)	3(4.3)	1(1.4)	
Chronic renal disease	68(97.1)	2(2.9)	0	
Malnutrition (IAP <5 Yrs., WHO >5Yrs)	52(74.3)	13(18.6)	5 (7.1)	

DETERIORATION OF SENSORIUM –DROP IN GLASGOW COMA SCALE (GCS)>/+2 SINCE ADMISSION TO THE WARD(n=3)				
Consciousness	1(33.3)	2(66.7)	0	
Breathing	0	1(33.3)	1(66.7)	
Circulation	0	0	3(100)	
Haemato-Oncology	3(100)	0	-	
Immunodeficiency state	3(100)	0	-	
Chronic lung disease	3(100)	0	-	
Chronic Cardiac disease	3(100)	0	-	
Chronic renal disease	3(100)	0	0	
Malnutrition (IAP <5 Yrs., WHO > 5Yrs	0	2(66.7)	1(33.3)	
PERSISTENT UNCONTROLLED SEIZURES AFTER TWO LONG ACTING ANTICONVULSANTS REQUIRING CONTINUOUS ANTICONVULSANT INFUSION (n=1)				
Consciousness	0	0	1(100)	
Breathing	0	0	1(100)	
Circulation	0	0	1(100)	
Haemato-Oncology	0	1(100)	0	
Immunodeficiency state	1(100)	0	0	
Chronic lung disease	1(100)	0	0	
Chronic Cardiac disease	1(100)	0	0	
Chronic renal disease	0	0	1(100)	
Malnutrition (IAP <5 Yrs., WHO >5Yrs)	1(100)	0	0	

Table 3. Outcome analysis of deterioration.

PACS scores as a detection tool, survival (Table 4. Figure 3,4)

Among those children who had a score of 4, 42% deteriorated within 48 hours of admission, while 78.6% of children with a score of 5 deteriorated within 48 hours of admission. All 42% of children with a score of > 6 deteriorated within 48 hours of admission. The Likelihood Ratio of a patient deteriorating above the score of 4 is 13 times and increases to 65 times if the score is 5. The AUC which measures the test accuracy, suggests that the PAC score is an effective scoring system and at a cut-off score of > 4 (the Positive predictive Value rate was 67.7 % and the Negative Predictive rate was 97.4%) the chance of identifying the children who might deteriorate within 48 hours of admission is high and it is statistically significant. Though scores of > 5 or > 6 are very specific in identifying the severity of illness, they are less reliable for screening the patient.

Classification summary	Training set (n=391)	Validation set (n=151)
Sensitivity	69.4%	72.4%
Specificity	97.8%	96.7%
Positive predicted value (PPV)	87.7%	84.0%
Negative predicted value (NPV)	93.4%	93.7%
Correctly classified	92.6%	92.1%
AUROC curve	0.963	0.947
Goodness-of-fit† for logistic regression (p-value)	0.952	0.443

†Hosmer- Lemeshow goodness-of-fit. Logistic regression analysis was used for predicting deterioration against factors including age, gender and PACs score including comorbid conditions.

Table 4: Classification summary statistics for training and validation of logistic regression.

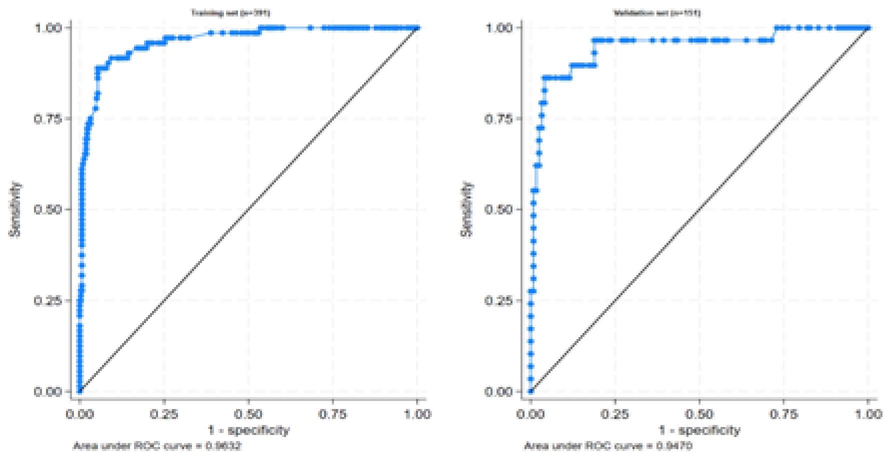


Figure 4: Classification summary statistics for training and validation of logistic regression.

Discussion

Early warning scores have to be used for the detection of sick children as per PALS guidelines. When used in Paediatric Emergency Services (PES) as a trigger, triage, or disposition tool it has excellent data capture and inter-rater reliability and can be used as a screening tool for the prediction of ICU admission.[46-56] Though there are many scoring systems for assessing the severity of illness and predicting morbidity (PIMS, SNAP etc) in children needing Intensive care, there is a paucity of literature in the Indian setting. Previously published studies did not study co-morbid factors.

Key Results

In our data, the mean age of the children in the study was 3.62 and 4.3 years respectively in non-deteriorated and deteriorated children. Female children in both the study groups were around 39.73 and 32.59 percent respectively., in contrast with other studies done where the mean age was infancy or less than 1 year.[21-24]

The interpretation of the Comorbid factors on the score value

Children were not unwell (compensated state of Co morbidity) at the presentation but deteriorated during their stay in the ward. The major predictive Comorbid factor was malnutrition, where both Consciousness and breathing were significantly affected. (P values were 0.001 and 0.000). The addition of the co-morbid factors resulted in higher scores than when the child had clinical symptoms without co-morbidity. There was no significant P value for the prediction of the deterioration in this cohort. To prove the objective, Hosmer- Lemeshow goodness-of-fit by logistic regression analysis (Fig 4) done was significant for predicting deterioration against factors including age, gender and PACs score including comorbid conditions.

Interpretation of the Comorbid factors for the outcome

In children with malnutrition, the burden of shock and worsening of respiratory distress were the major coexisting factors, whereas the children who had a sudden cardiopulmonary arrest, had Heamato oncological and immunological disorders as the additional co-morbidity.

The cause for deterioration was mostly the worsening of shock (51%) followed by respiratory distress worsening - requiring intubation in 20% and requiring high-flow oxygen therapy in 17%.

This is the same as in case of the studies done by both Monaghan and Bradman in the Emergency Department where PEWS was overestimating an undifferentiated patient admission into the ICU and could not be used as a triage tool. The addition of the co-morbid factors which could predict the model of deterioration outcome, can thus be used for triage as well as a treatment protocol and the change in the scores in each period can thus be used as a trigger for the CART team.

Limitations

- The scoring system was kept easy to handle and modified for our setting and not compared prospectively with already validated scores (PIMS, etc) used universally. The score cut-off was later Quasi–compared for deterioration towards the outcome.
- The scores are in implementation in our daily practice in the institute, and the data for the prevention of the outcome which is being prospectively collected has to be finalized for the complete picture of the usefulness of the study.
- We would need more numbers in the cohort with comorbidity burden for a significant P value for deterioration and had to derive the value with training and test model of Logistic Regression.

Comparison of Pacs with Other Scores

Akre6 used an outcome measure for code blue and found that the sensitivity of PEWS was 85.5% (the patient's having had a critical score within 24 hours before the event). In a study done by Duncan[7], the ability of the score to discriminate between case and control was assessed by logistic regression using the maximum score for the 24 hours studied. At a threshold score of 5, the sensitivity and specificity were 78% and 95%, respectively. Another prospective study done at Children's Hospitals of Minnesota8 showed that at least 87% of the events in children could be identified by using a PEWS score of more than 4(with a sensitivity of 84.2%).

Tucker et al[15] in a prospective study described both sensitivity and specificity of PEWS for detecting clinical deterioration that results in unplanned transfer to the PICU as 93% and 84.2% respectively at a score of 4. In the study done by Vandenberg et al[22], at a score of 8, the sensitivity and specificity of identifying the sick children were 82% and 93%, respectively.

PAC Score: The sensitivity and specificity of our study were 83% and 93%. Moreover, the AUC of the PAC score is 0.92 which is like other scoring systems like PEWS, Bedside PEWS, Modified Brighton, etc, suggesting that the PAC score is an accurate test tool in estimating the risk of deterioration of sick children within 48 hours of admission.

Comparison of score cut off different studies

Author	Score	Cut off score	Endpoint	ROC AUC	Sensitivity	Specificity	PPV	NPV
Duncan	PEWS	5	Code blue	90%	78%	95%	4.2%	-
Parashuram	Bedside PEWS	8	Code blue	91%	82%	93%	9	-
Akre	Modified Brighton	4	RRT call	90%	78%	95%	4.2%	

Edwards	Melbourne criteria	1	PICU admission	79%	68.3%	83.2%	3.6%	99.7%
McLellan	C-CHEWS	3 5	PICU admission	92% 67.2%	95.3% 93.6%	76.2% 72.9%	50.8 91.7	98.4% 91
EJ James PVS Pande	PACS	4	Clinical deterioration	92%	92.6%	76.4%	37.3%	98.6

Conclusion

- The PAC score is an easy and accurate scoring system in identifying the risk of clinical deterioration in the Paediatric wards and has proven to be a predictive tool for this deterioration as early as at presentation in the Emergency department.
- At a score of > 4, the score has a sensitivity of 83.7% with a specificity of 93.9%, LR+ of 13.8, and AUC of 0.93. Hence, children with PAC score of > 4 at the time of admission have more risk of deterioration within 48 hours of admission.
- PACS score increase the situational awareness in the team and predicts a deterioration model and thus changes in the scores in a given period can thus be used as a trigger for the CART team.
- If there was an increase in the PACS at admission due to the presence of the coexisting co-morbidity, the Hosmer-Lemeshow goodness-of-fit by logistic regression analysis was significant for predicting deterioration. Hence adding an extra score for the existing co-morbidity–whether compensated, chronic, systemic, or genetic acknowledges the need for care and further monitoring in these children.

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