

# **Pediatrics Index of Mortality 2 Scoring (PIM2) In Patients Admitted at Pediatric Intensive Care Unit of Tikur Anbesa Specialized Hospital**

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## **Abstract**

**Introduction** Mortality risk scoring systems have been widely used in modern intensive care unit. It is considered as important measures for quality assessments, controlling for severity of illness in clinical studies and studies of resource utilization and management.

**Objective** The aim of this study was to determine pediatrics index of mortality 2 (pim2) scoring for Pediatric intensive care unit (PICU) admitted to Tikur Anbesa specialized hospital (TASH) patients, and to evaluate its service with the standards.

**Methodology** Descriptive cross sectional study with prospective data collection. All patients admitted to PICU from April, 1-September, 20-2017 were included. Pretested questioner which includes demographics, diagnoses at admission, and duration of intensive care unit stay, PIM2 score and outcome was used. The data was entered and analyzed using SPSS version 20. The ratio of observed to predicted mortality using Standardized mortality ratio (SMR) was calculated for the group of patients by using chi square.

**Results** The study included 82 patients. The main causes of admission surgical (34.1%), neurology (17.1%) and cardiac diseases (13.1%) Patients stay in PICU ranged from (1 – 120) days with a median 4(interquartile range (IQ): 1-120) days. Fourty four (53.66%) needed mechanical ventilator within 1 hour of admission from this 23(52.3%) of them died which contributed 69.7%of the total death. The mean predicted mortality by pim2 was 13.1[95%CI: 15.26-26.86] and the observed mortality was 40.2% making a SMR 3.1.

**Conclusion and recommendation** In our study PIM2 scoring didn't discriminate between died and improved in PICU case mix patients at TASH so it is better to do another scoring system with its validation study.

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## Abbreviations and Acronyms

AUC: Area under the curve

JUSH: Jimma University Specialized hospital

PICU: pediatric intensive care unit

PIM2: pediatric index of mortality 2

PRISM: pediatric risk of mortality

ROC: Receiver operating characteristics curve

SMR: Standardized mortality ratio

SPSS: Statistical package for social science

TASH: Tikur Anbessa Specialized Hospital

## **1. Introduction**

Ever since their appearance in Sweden in 1955, pediatric intensive care units (PICUs) have provided a relevant contribution to the care of severely ill children based on the best use of human resources and high-cost equipment as well as continuous monitoring of patients, thus allowing for early intervention and better therapeutic outcomes, including recovery and prevention or reduction of permanent disabling injuries. Comprehensive care for critically ill children in the pediatric intensive care unit (PICU) is done with the aim of achieving good outcomes.

Severe disease in children is characterized by disruption of homeostatic processes, and can be evaluated by mortality scoring methods. There are several mortality scoring methods which can be used to predict mortality in children, the pediatric risk of mortality (PRISM) and pediatric index of mortality (PIM) are the most preferably used among all. The pediatric index of mortality 2(PIM2) is a key mortality prediction model for children receiving treatment in intensive care units[1]. Normally, the guidelines of providing cares in the PICU are designed upon the possibilities and limitations in each country so that there are many reconstructed criteria extracted through similar studies[2]. In our country there is no any report about use of scoring system to compare the outcome of PICU admission and management. So it is important to do scoring in PICU and see the outcome then compare in international studies. To the top of the knowledge of the researcher, there was no a single study in Ethiopia on scoring method of PICU patients. So this study will help for early detection of severity of the disease and to take action and will help for baseline for future study.



## 2. Literature review

Each new development in critical care treatment over the past 30 years has been implemented to improve the quality of care. Therefore, the extrinsic risks that patients carry should be as low as possible. Ideally, quality of care performance research should give more information about the extrinsic rather than the intrinsic risks. Presently, ICU performance evaluation is becoming increasingly difficult because of the presence of an increasing variety in patient case mix for the different intensive care units. Since the development of prediction mortality models in the early 1980s, physicians have tried to normalize certain ICU populations through the use of severity of illness measurements[3].

Improvement of pediatric critical care service can be achieved by strict quality control to identify groups at high risk of death and provide adequate treatment with rational use of resources [4] There are different severity scoring systems. Among this are PRISM, PRISM3, PIM, PIM2 and PIM3. Different study shows pim2 showed good predicting ability of patient mortality and morbidity at different centers.

Research done from 2005 to 2006 in brazil pediatric ICU from total admission of 276 patients observed mortality was 39% and expected mortality using PIM2 scoring was 38.999% which was a good indicator of mortality rate[5]. A study done in Iran Tehran in 240 patients admitted in PICU there was 36(15%) deaths and expected mortality using PIM2 scoring was 20(8.3%) making SMR 1.8 (1.28-2.46) with the confidence interval of 95%[2]. A research done in Hong Kong involving 540 patients were included in this study, only seven deaths were observed (1.3%). PIM 1 and PIM 2 overestimated the mortality rate by giving a greater mortality rate (PIM1: 13.4, Standardized mortality ratio = 0.52, 95% CI = 0.14 to 0.91; PIM2: 14.2, Standardized mortality ratio=0.49, 95% CI = 0.13 to 0.86) The discrimination of PIM1 and PIM2 were satisfactory as reflected by area under receiver-operator characteristic curve of 0.889 (95% CI: 0.703 to 1.000) and 0.904 (95% CI: 0.738 to 1.000) respectively[6].

A research done in Indonesia 54 children were enrolled, consisting of 33 males and 21 females, with an age distribution of 1 month to 12 years. Most patients were less than 2 years of age (66.7%). Subjects' mean systolic blood pressure was 81.8 (SD 27.1) mmHg. Most subjects had PIM2 total scores  $\leq 5$  (72.2%), followed by scores  $>30$  (13%). Mortality occurred in 8 children (14.8%). The PIM2 discrimination between survival and death is presented on a ROC curve in with The c-index was 0.81 (95%CI 0.59 to 1.03)[1]. A study done in multidisciplinary PICU in Japan between 1 January 2008 and 31 December 2010 total of 2,536 patients 67 (2.6%) died. Discrimination between survival and death

assessed by the area under the receiver operating characteristic curve was 0.92 [95% confidence interval (CI) 0.89–0.96]. The standardized mortality ratio for the whole population was 0.77 (95% CI 0.59–0.96)[7].

Another study done at Al Fayoum University, Egypt During the period of the study 205 patients were admitted to the PICU. Of the 205 patients, 105(51.2%) were males and 100(48.8%) were females. The age of the patients ranged from 1 - 168 months, with a median 14 (interquartile range (IQ): 7-30) months. Patients stay in PICU ranged from 1 - 45 day with a median 6 (IQ 3 - 9) days. Respiratory illnesses such as pneumonia, bronchiolitis and status asthmaticus were the most common diagnoses among admitted patients followed by cardiovascular and neurological diseases. The predicted mortality by PIM2 score ranged from 0.03% - 96.5% with a mean 5.67% (95% CI: 3.43 - 7.91). The observed mortality rate was 8.8% and expected mortality using PIM2 score is 5.86, making the SMR being 1.55. PIM2 scoring system show adequate discriminatory function and well calibrated for the case mix of patients in PICU of Fayoum, Egypt[4].

A study done in ETHIOPIA at Jimma university referral hospital general ICU from 2009 to 2013 age of from birth to 14 years. A total of 170 children were admitted to the ICU of Jimma university referral hospital over the study period. The greater share was taken by males (54.7%), with a male-to-female ratio of 1.2:1. The overall mortality rate was 40%. The majority of the children were in the age range of 10–14 years (38.8%). Of the total number of patients admitted, 34.7% were trauma cases, 45.8% of whom died. The highest percentage 69.5% of trauma patients were admitted for head injuries. Among the trauma cases, burn and poly trauma were the second and third leading causes (15.3%) of admission. Postoperative patients and medical patients accounted for the rest of the admitted cases (28.2% and 27.6% of the cases respectively)[8].

### 3.Objective

#### **3.1.General Objective:**

To calculate Pediatric Index of Mortality 2 in patients admitted to a pediatric intensive care unit

#### **3.2.Specific Objectives:**

1. Asses outcome of our PICU admission based on PIM2 scoring
2. To compare treatment outcome with the standards

### 4.Methodology

#### **4.1.Study Design and Period**

##### **4.1.1 Study area**

The study was conducted at Tikur Anbessa Specialized Hospital (TASH), Pediatrics ICU Addis Ababa, Ethiopia.

##### 4.1.2. Study Period

The study was conducted from April, 1-2017 to September, 20-2017

##### 4.1.3. Study design

The type of study used in this study was health institution based descriptive cross sectional study with prospective data collection.

##### **4.1.4. Source population**

All patients admitted and treated to Tikur Anbesa specialized hospital pediatric intensive care unit

##### 4.1.5. Study population

All Children less than or equal to 18 years admitted to TASH PICU consecutively in the study period was taken

##### **4.1.6. Inclusion criteria**

All children 18 years and below who was admitted to TASH PICU on the study period

##### **4.1.7. Exclusion criteria**

Readmitted patients, who had lethal congenital abnormalities and Patients who died within 2 hours of admission [9].

## 4.2. Sample Size Determination

Single population proportion formula for estimating sample size was used as follows:

$$n_i = \frac{(Z_{\alpha/2})^2 p(1-p)}{W^2}$$

Where:  $n$  = is the minimum sample size required

$p$  = Estimated mortality rate pediatric patients admitted to ICU in Ethiopia

$w$  = Margin of error for sampling

$Z$  - The standard normal value at  $(100\% - \alpha)$  confidence level.

**Assumptions:**  $Z_{\alpha/2} = 95\%$  CI ( $=1.96$ ),  $p=40\%$  (mortality rate of patients at Jimma university hospital),  **$w=0.05$ . Therefore,  $n = Z^2 * P * (1-p)$ ,  $n = (1.96)^2 \times 0.4 \times (1 - 0.4) / (0.05)^2$ ,  $n = 368$**

The estimated sample size based on the above assumption was 368. But because our study population size is less than 10000 Correction formula was used

$$N_f = \frac{n_i}{1 + \frac{n_i}{N}}$$

$N$  = IS number of patients admitted to PICU last year during the same period of the study = 85

$N_f = 74$

Adding 10% for inadequate data recordings

$N_f + 10\%$  became 82

## 4.3. Data Collection

### 4.3.1. Data collection quality assurance

The clinical condition of patients who was admitted to PICU, TASH during the data collection time were collected using a structured form prepared for this purpose by admitting residents, and was rechecked by the investigators. The resident working in the unit was trained about the questionnaire during respective attachment months. Component of pim2 was filled duration of PICU stay age and sex diagnosis and outcome was recorded. The regression equation published with PIM2 scoring system was used to calculate the predicted mortality rate[4]

### 4.3.2. Data collection procedure

The patient's demographic profile and pim2 component was filled by using pretested questionnaire when the admitted physician decided to admit PICU or within 4 hours of admission. Patients died within 4

hours of admission, readmitted patients and those who had lethal congenital anomalies were excluded from the study.

#### 4.3.3. Data Analysis

The data was entered and analyzed using Statistical package for social science (SPSS) version 20. The data was analyzed using descriptive statistics and the statistical significance is tested using Chi square and Hosmer–Lemeshow . Association was checked using binary logistic regression using a PIM2 score and Mortality rate as dependent variable and the independent variables used were Socio demographic data, clinical features& pim2 score variables. The results were presented using counts, percentages, frequency tables, figures. A statistical test was regarded as significant when the p value is <0.05.

### **5. Operational Definitions**

Elective admission=An ICU admission or an operation is considered elective if it could be postponed for more than 6 hour without adverse effect on the patient's outcome.

Standard mortality ratio=if standard mortality ratio becomes less than or equal to one

Discrimination= It is the ability of the model to categorize patients into two outcome groups such as survivors and non-survivors

### **6. Ethical Consideration**

The study proposal was forwarded for approval by the Department of Research and publication committee of department of pediatrics and child health, College of Health Sciences, Addis Ababa University. Moreover, letter of cooperation was written from the Department of Pediatrics and Child Health. Because the study is part of care of patient there was no need of asking informed consent. Subject confidentiality and any special data security requirements were maintained and assured.

## 7. Results

A total of 82 patients admitted in the study period who fulfill the study criteria were included in the analysis. Out of 82 patients 46 (56.1%) were males. Most of the study subjects were in the age range of (1- 60) months 59.8% and remaining are greater than 60 months and less than 1 month were 30.5% and 9.8 % respectively. From this 49(59.2%) patients improved and 33(40.2%) patients died. The median age of the studied patients were 24 months ranging (0.06 - 216.0) months. Median age of survivors and non survivors were 36 months and 7 month respectively and the range being cases (0.06 -216) months and (0.23 -180) months respectively see table1. Most common reasons of admissions in our PICU were surgical (34.1%), neurology (17.1%) and cardiac diseases (13.1%) see figure-1. The median duration of stay and the range was 4 days (1-120) days. The median stay of survivors were 3 days with range of (1-120) days and median duration of non survivors were 5 days with range of (1-42)days. From 82 admitted patients 56(68.3%) patients stayed in PICU between 1 and 10 days and 13 patients each stayed greater than 10 days and less than or equal one day (31.7%)

From 82 patients in this study 33 patients died making mortality rate 40.2% and SMR3.1. The mean mortality rate of the studied patients predicted by pim2 scoring was 13.1 %(95%CI:15.26-26.86) . From the 82 patients 44(53.66%) needed mechanical ventilator within 1 hour of admission from this 23(52.3%) of them died which contributed 69.7%of the total death. The probability of mortality by PIM2 for this group of patients was 21.1 making their SMR 2.5.

The pim2 score of 67 patients were <15 from which 20 patients (29%) died. Eight patient ( ) had pim2 score of between 15 and 40 from which 6(75%) died. Seven 7( ) patients had pim2 score >40 from whom all patients (100%) died. The incidence of expected deaths was 13.1% and that of observed death was 40.2%.

Observed and expected mortalities across deciles of risk of non-survival according to the Hosmer– Lemeshow test as shown in: table3 revealed that a good calibration for PIM2 as the differences between observed and expected mortalities across all deciles of mortality risk were statistically insignificant. Standard mortality ratio for each deciles of risk was calculated and revealed that PIM2 predicted mortalities for the whole group of patients were okay in nearly all deciles except 7:table3. However the case mix SMR is 3.1 with the PIM2 performance predicting mortality among non survivors is 42.4 % and for survivors PIM 2 predicted 85.7% of observed results:table4.

## 8. Discussion

Improvement of pediatric critical care service can be achieved by strict quality control to identify groups at high risk of death and provide adequate treatment with rational use of resources[4]. To improve quality and to know the prognosis of patients there are several scoring methods. We used pim2 score in this study because it is preferred from other scoring system.

The study showed high mortality of 40.2%.similarly a high actual mortality rate was reported in Tanta University in Egypt and India 37% and 46.2% respectively. But it is similar to another study one in Ethiopia at Jimma university hospitals(40%) [8-10] ).In contrast our study has a higher mortality compared to in Tehran 15% in Hong Kong 1.3% [2, 11].

This high death rate in studies from developing countries and in our set up may be attributed to admission of critical cases, late referral to the PICU, or due to limited resources[9].

The SMR is valid measure that compare risk adjusted mortality, between different centers, but it may vary according to the case mix and care offered to the patients[4].SMR in our study is 3.1 which is high compared to studies done in Brazil (1), Egypt(1.55),Tehran(1.8) and Hong Kong(0.49).So in our study pim2 scoring under predict mortality risk in our setup because SMR should be near to 1([4, 5, 11, 12]).

Discrimination between survival and death assessed by the area under the receiver operating characteristic curve (ROC) in our study is 0.704 (95%CI 0.356-1.00) compared to study done in multidisciplinary PICU in Japan 0.92 [95% (CI) 0.89–0.96][7] it was low .

Performance of PIM2 was evaluated by assessing discrimination and calibration. Discrimination estimates the probability of concordance between outcomes and predictions. It is the ability of the model to categorize patients into two outcome groups such as survivors and non-survivors. It is assessed by measuring area under the Receiver Operating Characteristics Curve[4]. Observed and expected mortalities across deciles of risk of non-survival according to the Hosmer–Lemeshow test revealed a good calibration for PIM2 as the differences between observed and expected mortalities across all deciles of mortality risk were statistically insignificant;table3. SMR for each deciles of risk was calculated and revealed that PIM2 predicted mortalities for the whole group of patients were okay in nearly all deciles

except row7:table3. However the case mix SMR is 3.1 with the PIM2 performance predicting mortality among non survivors is only 42.4 % and for survivors PIM 2 predicted 85.7% of observed results: table4. So based on above result pim2 didn't predict adequately between the survivor and no survivor in our PICU case mix.

From 44 patients who were on mechanical ventilator 23(52.3% )died covering 69.7% of the total death this might be need o f mechanical ventilator showed severity of disease or delay of early identification of need of mechanical ventilator for the needy patients. In our study The pim2 score of 67 patients were <15 from which 20 patients(29%) died and 8 patients had pim2 score of between 15 and 40 from which 6(75%)died and 7 patients had pim2 score >40 from whom all patients (100%) died so in general from pim2 scoring those who had high probability of mortality scoring by pim2 had high actual mortality rate.

### **8.1. Limitation of the study**

All pim2 components were not used because of there was no blood gas analysis in our PICU.

### **8.2. Conclusion and recommendation**

In our study PIM2 scoring didn't discriminate between died and improved in PICU case mix patients at Tikur Anbesa specialized hospital Addis Ababa university, Ethiopia so it is better to do another scoring system with its validation study.

But as showed above those who had pim2>30 value had high mortality rate so we can use the scoring method to predict the prognosis of the patient and use for the council of parents or attendants about the condition (prognosis) of the patients.



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Table1: socio demographic and outcome of studied population

: Age, gender, diagnoses on admission, duration of ICU stay and pediatric index of mortality version 2 in all patients							
	Improved (n= 49)		Died (n= 33)		Total (n = 82 )		P value
	N	%	N	%	N	%	
<b>Sex</b>							.816
Male	28	57.1	18	54.5	46	56.1	
Female	21	42.9	15	45.5	36	43.9	
<b>MV</b>							
Yes	21	57.1	23	69.7	44	53.6	
No	28	42.9	10	30.3	38	46.4	
<b>Diagnosis</b>							
Surgical	24	49.0	4	12.1	28	34.1	
Neurology	7	14.3	7	21.2	14	17.1	
Cardiac	4	8.2	7	21.2	11	13.4	
Respiratory	4	8.2	3	9.0	7	8.5	
Hemo-onco	2	4.1	5	15.1	7	8.5	
Renal	2	4.1	2	6.1	4	4.9	
Others	6	12.2	5	15.1	11	13.4	
<b>Age</b>							
Median (IQR)	36.0(0.06 - 216)		7.0 (0.23-180.0)		24.0 (0.06 - 216.0)		0.037
Mean +- sd	54.9 +- 55.2		36.3 +- 50.5		47.4 +- 53.8		
<b>Length of ICU stay</b>							
Median (IQR)	3.0 (1-120)		5.0 (1-42)		4 (1 - 120) )		0.35
Mean +- sd	9.2+-18.7		8.3+-9.3		8.8 +- 15.5		
<b>PIM2 Score</b>							
Median (IQR)	0.8(0.0-38.5)		13.1(0.8-92.2)		2.80 (0.0 - 92.2)		0.01
Mean+-sd	3.23+-7.5		27.98+-26.97		13.2 +- 21.7		
<i>SD = standard deviation,IQR = inter quartile range. DOS:Duration of stay; PMI2: pediatric index of mortality version 2,MV =mechanical ventilator</i>							

**Table2, comparison of studied group according to the predicted mortality probability index of mortality score -2**

Predicted mortality probability (pim2 risk for death%)	Outcome		P value
	Survivors	No survivors	
Range	0.0-38.5	0.8-92.2	0.01
Mean+-SD	3.23+-7.5	27.98+-26.97	

Pim2, pediatric index of mortality-2

**Table 3 contingency table for hosmer and lemeshow test across risk groups**

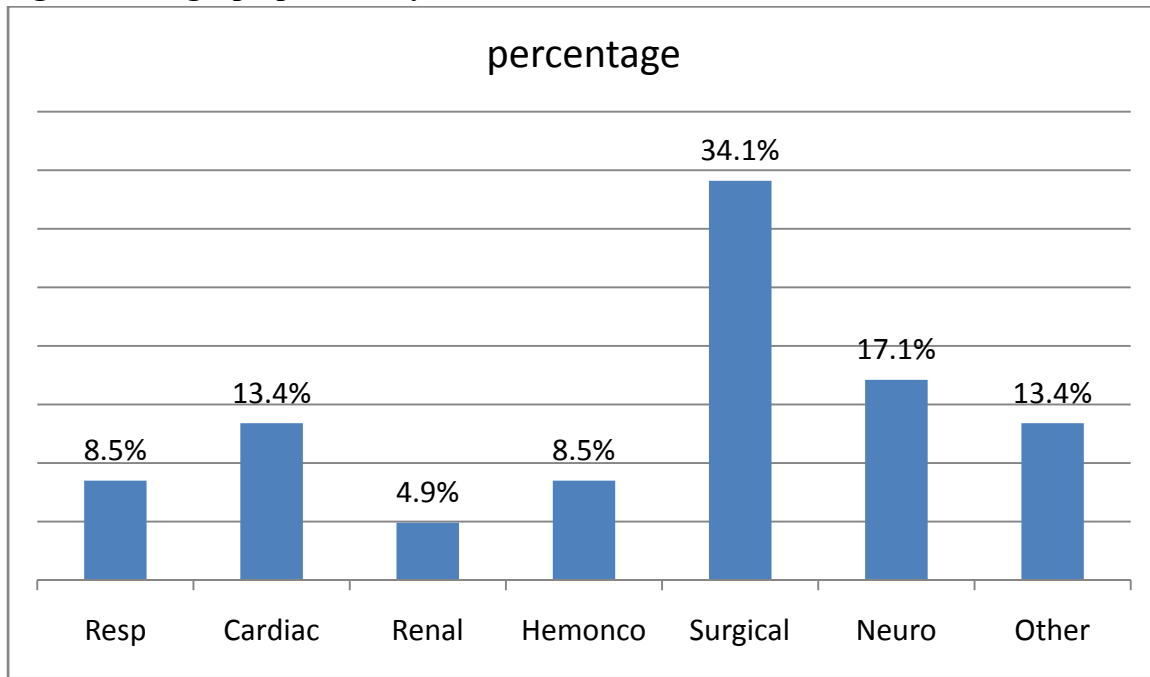
Risk group	Survivors		No survivors		SMR
	observed	Expected	Observed	expected	
1	6	7.020	3	1.980	1.52
2	7	6.043	1	1.957	.51
3	4	5.087	3	1.913	1.6
4	5	5.936	4	3.064	1.3
5	6	5.009	2	2.991	0.67
6	7	5.151	2	3.849	0.52
7	7	4.249	1	3.751	0.27
8	3	3.832	5	4.168	1.2
9	1	3.875	8	5.125	1.56
10	3	2.798	4	4.202	0.952

SMR=standard mortality ratio

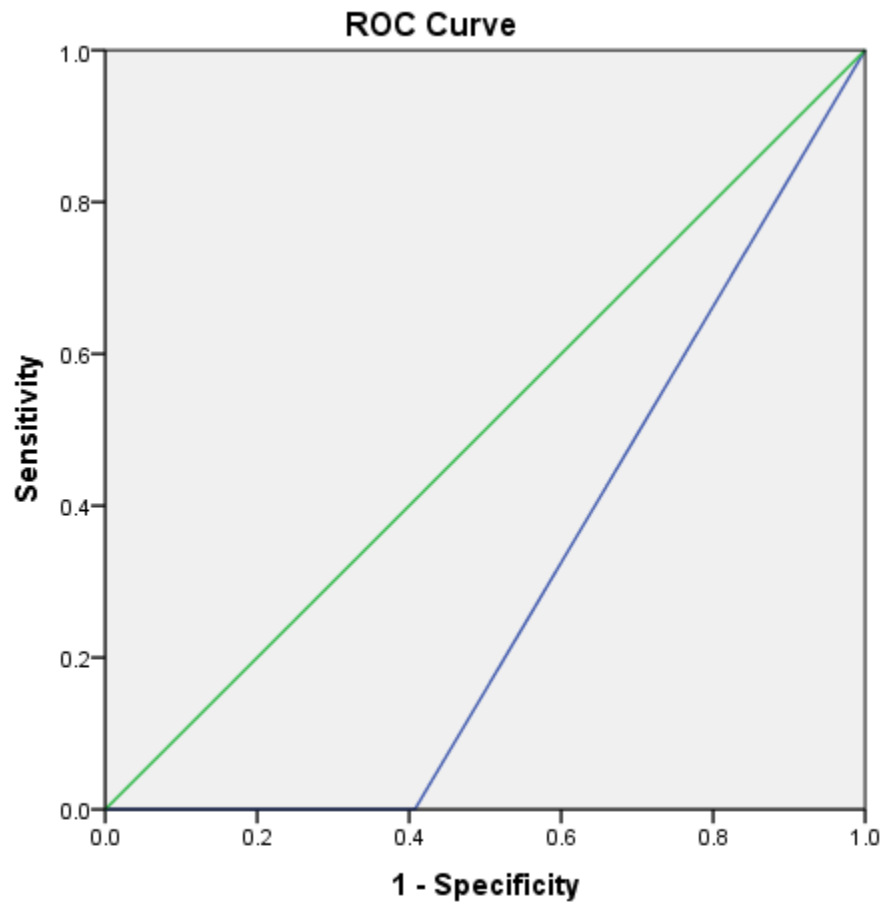
**Table 4 :Predicting ability of pim2 for survivors and no survivors**

Observed	Predicted		
	Outcome		Percentage
	Improved	Died	
Improved	42	7	85.7
Died	19	14	42.4
Overall survival			68.3

**Figure.1 Bar graph patients by case distribution**



**Fig2 ROC curve**



Diagonal segments are produced by ties.



## ANNEX I: Questionnaires

This is questioner of PIM2 to perform at pediatric intensive care TASH

Please the fellow residents fill the following data carefully. Thank you your cooperation

1. Age of patient----- MRN -----
2. Date of admission -----
3. Admission diagnosis -----
4. GCS
  - A. 15
  - B. b/n 9 and 14
  - C. <9
5. Sex
  - A. female
  - B. male
6. Systolic blood pressure in mmHg during admission
  - A. Normal
  - B. Shock
  - C. Cardiac arrest
  - D. Unknown
7. Pupillary reactions to bright light
  - A. >3 mm and both fixed
  - B. Abnormal finding due to drugs, toxins or local eye injury
  - C. Other or normal
  - D. Unknown
8. PaO<sub>2</sub>, mmHg or FIO<sub>2</sub> at the time of PaO<sub>2</sub> if oxygen via ETT or headbox
  - A. Write the value in number
  - B. Unknown
9. Base excess in arterial or capillary blood
  - A. Write value in number
  - B. Unknown
10. Need Mechanical ventilation at any time during the first hour in ICU

- A. Yes
  - B. No
11. . Elective admission to ICU(operational definition )
- A. Yes
  - B. No
12. Recovery from surgery or a procedure is the main reason for ICU admission
- A. Yes
  - B. No
13. Admitted following cardiac bypass
- A. Yes
  - B. No
14. High risk diagnosis Record the number in brackets. If in doubt record 0.
- A. (0)None
  - B. (1)Cardiac arrest preceding ICU admission7
  - C. (2)Severe combined immune deficiency
  - D. (3)Leukaemia or lymphoma after first induction
  - E. (4)Spontaneous cerebral haemorrhage
  - F. (5) Cardiomyopathy or myocarditis
  - G. (6)Hypoplastic left heart syndrome
  - H. (7)HIV infection
  - I. (8)Liver failure is the main reason for ICU admission
  - J. (9)Neuro-degenerative disorder
15. Low risk diagnosis. Record the number in brackets.If in doubt record 0
- A. (0) None
  - B. (1)Asthma is the main reason for ICU admission
  - C. (2)Bronchiolitis is the main reason for ICU admission
  - D. (3)Croup is the main reason for ICU admission
  - E. (4)Obstructive sleep apnoea is the main reason for ICU admission
  - F. (5) Diabetic keto-acidosis is the main reason for ICU admission
16. Days stay in the PICU
17. Probability of mortality by PIM2 score
18. Outcome- A, died                      B, improved

## Annex II: description of the score

PIM2 is calculated from the information collected at the time a child is admitted to ICU. Because PIM2 describes how ill the child was at the time you started intensive care, the observations to be recorded are those made at or about the time of first face-to-face (not telephone) contact between the patient and a doctor from your intensive care unit (or a doctor from a specialist paediatric transport team). Use the first value of each variable measured within the period from the time of first contact to 1 h after arrival in ICU. The first contact may be in ICU, in emergency department, a ward in the hospital, or in another hospital (e.g. on a retrieval). If information is missing (e.g. base excess is not measured) record zero, except for systolic blood pressure, which should be recorded as 120. Include all children admitted to ICU (consecutive admissions).

1. Systolic blood pressure, mmHg (unknown=120)
2. Pupillary reactions to bright light (>3 mm and both fixed=1, other or unknown=0)
3. PaO<sub>2</sub>, mmHg (unknown=0)FIO<sub>2</sub> at the time of PaO<sub>2</sub> if oxygen via ETT or headbox (unknown=0)
4. Base excess in arterial or capillary blood, mmol/l (unknown=0)
5. Mechanical ventilation at any time during the first hour in ICU (no=0, yes=1)
6. Elective admission to ICU (no=0, yes=1)
7. Recovery from surgery or a procedure is the main reason for ICU admission (no=0, yes=1)
8. Admitted following cardiac bypass (no=0, yes=1)
9. High risk diagnosis. Record the number in brackets.If in doubt record 0.
  - [0] None
  - [1] Cardiac arrest preceding ICU admission<sup>7</sup>
  - [2] Severe combined immune deficiency
  - [3] Leukaemia or lymphoma after first induction
  - [4] Spontaneous cerebral haemorrhage<sup>8</sup>
  - [5] Cardiomyopathy or myocarditis
  - [6] Hypoplastic left heart syndrome<sup>9</sup>
  - [7] HIV infection
  - [8] Liver failure is the main reason for ICU admission
  - [9] Neuro-degenerative disorder
10. Low risk diagnosis. Record the number in brackets.If in doubt record 0.
  - [0] None
  - [1] Asthma is the main reason for ICU admission
  - [2] Bronchiolitis is the main reason for ICU admission
  - [3] Croup is the main reason for ICU admission
  - [4] Obstructive sleep apnoea is the main reason for ICU admission
  - [5] Diabetic keto-acidosis is the main reason for ICU admission



### **Annex III: coding rules.**

These rules must be followed carefully

For PIM2 to perform reliably:

1. Record SBP as 0 if the patient is in cardiac arrest, record 30 if the patient is shocked and the blood pressure is so low that it cannot be measured or 120 if normal or unknown .
2. Pupillary reactions to bright light are used as an index of brain function. Do not record an abnormal finding if this is due to drugs, toxins or local eye injury.
3. Mechanical ventilation includes mask or nasal CPAP or BiPAP or negative pressure ventilation.
4. Elective admission. Include admission after elective surgery or admission for an elective procedure (e.g. insertion of a central line), or elective monitoring, or review of home ventilation. An ICU admission or an operation is considered elective if it could be postponed for more than 6 hour without adverse effect.
5. Recovery from surgery or procedure includes a radiology procedure or cardiac catheter. Do not include patients admitted from the operating theatre where recovery from surgery is not the main reason for ICU admission (e.g. a patient with a head injury who is admitted from theatre after insertion of an ICP monitor; in this patient the main reason for ICU admission is the head injury).
6. Cardiac bypass. These patients must also be coded as recovery from surgery.
7. Cardiac arrest preceding ICU admission includes both in-hospital and out-of-hospital arrests. Requires either documented absent pulse or the requirement for external cardiac compression. Do not include past history of cardiac arrest.
8. Cerebral haemorrhage must be spontaneous (e.g. from aneurysm or AV malformation). Do not include traumatic cerebral haemorrhage or intracranial haemorrhage that is not intracerebral (e.g. subdural haemorrhage).
9. Hypoplastic left heart syndrome. Any age, but include only cases where a Norwood procedure or equivalent is or was required in the neonatal period to sustain life.
10. Liver failure acute or chronic must be the main reason for ICU admission. Include patients admitted for recovery following liver transplantation for acute or chronic liver failure.
11. Neuro-degenerative disorder. Requires a history of progressive loss of milestones or a diagnosis where this will inevitably occur.
12. Bronchiolitis. Include children who present either with respiratory distress or central apnoea where the clinical diagnosis is bronchiolitis.
13. Obstructive sleep apnoea. Include patients admitted following adenoidectomy and/or tonsillectomy in whom obstructive sleep apnoea is the main reason for ICU admission (and code as recovery from surgery).

**Annex IV: PIM2 calculator**

<b>Variables (<a href="#">help</a>)</b>	<b>Values (1 if Yes, 0 otherwise)</b>	<b>Beta</b>
<b>Elective admission</b>		<input type="text"/>
<b>Recovery post procedure</b>		<input type="text"/>
<b>Cardiac bypass</b>		<input type="text"/>
<b>High risk diagnosis</b>		<input type="text"/>
<b>Low risk diagnosis</b>		<input type="text"/>
<b>No response of pupils to bright light (&gt; 3 mm and both fixed)</b>		<input type="text"/>
<b>Mechanical ventilation (at any time during first hour in ICU)</b>		<input type="text"/>
<b>Systolic Blood Pressure (mmHg)</b>	<input type="text"/>	<input type="text"/>
<b>Base Excess (mmHg) (arterial or capillary blood)</b>	<input type="text"/>	<input type="text"/>
<b>FiO2*100/ PaO2 (mmHg)</b>	<input type="text"/>	<input type="text"/>
<b>Predicted</b>	<b>Death</b>	<b>Rate</b>
<hr/>		
<input type="text"/>		