A study on the prediction of illness related mortality of critically ill children by applying paediatric risk mortality III score in paediatric medical intensive care unit patients

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Abstract

Background: Prognostic scoring systems are increasingly used to predict risk of mortality by assessing severity of illness on the day of admission. Paediatric risk mortality III (PRISM III) score is commonly used among paediatric critical care units.

Objectives: To assess the severity of illness using PRISM III score in all paediatric medical intensive care unit (MICU) admissions within the first 24 hours and to find the relationship between PRISM III score and the mortality rate.

Method: This was a prospective study conducted at MICU, Sirimavo Bandaranaike Specialized Children Hospital, Peradeniya, from July 2016 to April 2017. PRISM III score of each patient was calculated from abnormal physical and laboratory variables according to scoring system on admission day and the patients followed up for their outcome.

Results: The sample size was 105 with 51 males and 54 females. There were 23 deaths and 82 discharges from MICU. There was significant positive correlation with death and provision of mandatory ventilation or usage of any number of inotropes. The average PRISM III score among the sample was 8.1. The PRISM III scores among the deaths and survivals were 14.6 and 6.3 respectively.

Conclusions: PRISM III score is a good predictor of mortality and it is a good indicator of severity of illness on the day of admission.

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Introduction

The paediatric intensive care unit (PICU) scoring system started as a Clinical Classification Scoring System to divide patients for routine ward care from those for intensive care[1,2]. This was followed by the Therapeutic Intervention Scoring System[3] and the Paediatric Logistic Organ Dysfunction scoring system[4]. These systems have validation problems[5]. Currently, only the PRISM score has been tested for its potential to facilitate decision making in critically ill paediatric patients[1,2,6].

PRISM score was developed from the Physiologic Stability Index[1,6]. It utilizes a set of commonly measured predetermined physiological variables and their ranges to quantify status of illness[7]. This was validated in PICU settings by Pollack *et al.*[4]. This score was used to assess mortality risk in patients undergoing bone-marrow transplant[8], liver transplant[9] and in diabetic ketoacidosis[10]. Some studies compare benefit of PRISM score over other mortality scores[11]. PRISM III score evaluates the severity of illness according to physiological determinants detected on clinical examination and laboratory investigations on the first day of admission[6]. Accuracy and reliability of PRISM score is unlikely to be influenced by other factors[12]. Maulen Radovan *et al.* in 1996 showed that PRISM score is an efficient method and it objectively predicts the outcome and risk of mortality[13].

Sri Lankan studies on deaths among ICU patients are few. A study on paediatric workload in multidisciplinary tertiary care indicated that the mortality rate in PICU was 10-15%[14]. Another study in the medical intensive care unit (MICU) Lady Ridgeway Hospital in 2005 had a death rate of 25%[15]. In comparison, mortality rates in western countries are less than 4%[16]. Use of PRISM III score will be helpful in reducing the mortality and the morbidity among critically ill. Our study targeted the PRISM III scoring system to evaluate patients admitting to a paediatric tertiary intensive care unit. Similar studies had been performed in various countries in order to assess mortality risk, to predict outcome and to assess quality control among institutions[6,17]. However, no such studies had been conducted in Sri Lanka up to date.

Objectives

To assess severity of illness on admission by using PRISM III score in all paediatric MICU admissions in the first 24 hours and to assess the relationship between PRISM III score and the mortality rate.

Method

A prospective study was conducted at MICU, Sirimavo Bandaranaike Specialized Children Hospital (SBSCH), Peradeniya, from July 2016 to April 2017. Data was collected after getting written consent from parents (or guardians). All patients had routine clinical assessments and basic investigations according to MICU protocol[18,19]. All parents were informed about the research appropriately. Details on admission day were plotted separately in the data collection tool including age, gender, duration of hospital stay, ventilatory requirement, vasoactive drug therapy, along with physical and laboratory variables in respect to PRISM III score. All patients were followed up to record their outcome. PRISM III score of each patient was calculated on admission day according to the scoring system (Table 1)[1,2,7].

Table 1: *PRISM III scoring system*

Variable	PRISM III score		
1. *Blood pressure* (systolic in mmHg)	*Score =3*	*Score =7*	
Neonate	40-55	<40	
Infant	45-65	<45	
Child	55-75	<55	
Adolescent	65-85	<65	
2. *Temperature* ($<33^0$C or $>40^0$C)	*Score =3*		
3. *Mental status*	*Score =5* Stupor/coma GCS<8		
4. *Heart rate*	*Score =5*	*Score =4*	
Neonate	215-225	>225	
Infant	215-225	.>225	
Child	185-205	>205	
Adolescent	145-155	>155	
5. *Pupillary reflexes*	*Score =7* One fixed	*Score =11* Both fixed	
6. *pH*	*Score =2* 7.0-7.28	*Score =6* <7.0	
7. *PaCO₂* (mmHg)	*Score =1* 50-75	*Score =3* >75	
8. *Bicarbonate* (mmol/L)	*Score =4* >34		
9. *PaO₂* (mmHg)	*Score =3* 42-49	*Score =6* <42	
10. *Glucose* (mmol/L)	*Score =2* >11		
11. *Serum potassium* (mmol/L)	*Score =3* >6.9		
12. *Blood urea nitrogen* (mg/dl)	*Score =3*		
Neonates	>11.9		
All other ages	>14.9)		
13. *Creatinine* (mg/dl)	*Score =2*		
Neonate	>0.85		
Infant	>0.90		
Child	>0.90		
Adolescent	>01.3		
14. *White cell count* (cells/cu mm)	*Score =4* <3,000		
15. *Platelet count* (x 10^3 cells/cu mm)	*Score =2* 100-200	*Score =4* 50-99	*Score =5* <50
16. *Prothrombin time (PT) or partial thromboplastin time (PTT)* (seconds)	*Score =3*		
Neonates	PT>22 or PTT>85		
All other ages	PT>22 or PTT>57		

All collected data were tabulated for analysis using STATA sheet. PRISM III value of each patient was calculated. Data were analysed using appropriate statistical analysis. PRISM III median was found. Chi- square test was used to analyse the categorical variables. Logistic regression analysis was used to find the odd's ratio and probability values (*p* value). Univariate linear regression analysis was used to study the association between PRISM III score value and risk factors.

Results
Of the total sample of 105 children admitted to MICU, 51 (48.6%) were male and 54 (51.4%) were female. Their median age was 37.5 (29.6 - 45.5) months. The average length of hospital stay was 287 (177-361) hours. Fifty four (51.4%) had diseases related to respiratory system, 28 (26.7%) had diseases associated with the central nervous system, 20 (19.2%) had diseases associated with the cardiovascular system, 09 (8.6%) had diseases associated with the gastrointestinal system and 03 (2.9%) had diseases associated with the genitourinary system. The rest (shock, sepsis and dengue cases) account for 26.7% of the total. Thirty nine (37.1%) admissions required mandatory ventilation, 24 (22.9%) required noninvasive positive airway pressure and 42 (40%) required no ventilation. Inotrope drugs were used among 26.7% of patients, 7.6%, 5.7% and 13.3% being given one, two and more inotropes respectively. Twenty three children died and 82 survived among the sample. The association between death and variables with their *p* values are given in Table 2.

Table 2: *The association between death and variables with its P value*

Variable	Total	Deaths	Survivors	*p* value
Sex				
Male	51	08 (15.7%)	43 (84.3%)	0.134
Female	54	15 (27.8%)	39 (72.2%)	
Age				
<12 months	50	16 (32.0%)	34 (68.0%)	
12-60 months	26	04 (15.4%)	22 (84.6%)	0.053
>60 months	29	03 (10.3%)	26 (89.7%)	
Intensive care unit stay (in hours)				
less than 72	45	08 (17.8%)	37 (82.2%)	
72 to 168	22	05 (22.7%)	17 (77.3%)	0.641
more than 168	38	10 (26.3%)	28 (73.7%)	
Inotropes (vasoactive drugs)				
Not given	77 (73.3%)	03 (03.9%)	74 (96.1%)	0.000
Given	28 (26.7%)	20 (71.4%)	08 (28.6%)	
Use of ventilation				
No ventilation	42	0 (0%)	04 (100.0%)	
Continuous positive airway pressure	24	02 (08.3%)	22 (91.7%)	0.000
Mandatory	39	21 (53.8%)	18 (46.2%)	

Table 3 shows the analysis of the main underlying system involvement in the sample population and the related death percentage. Table 4 shows the analysis of the average PRISM III score for sample, deaths and survivals.

Table 3: *Underlying system involvement & related deaths*

| System involved	No. of patients	No. of deaths	% of deaths
Gastrointestinal tract	09	01	11.1
Cardiovascular system	20	06	30.0
Respiratory system	54	12	22.2
Genitourinary tract	03	02	66.7
Central nervous system	28	06	21.4
Others	28	06	21.4

Table 4: *PRISM comparison between patients who died and survived*

PRISM III score	Number	Mean	Standard deviation	Standard error of mean
Total	105	8.10	7.297	0.712
Deaths	23	14.57	10.378	2.164
Survivors	82	06.29	04.893	0.540

Independent sample t-test   p<0.001

The relationship between the variables in the PRISM III score system and death were analysed through the multivariate linear regression method which emphasised that all the factors were equally valid.

The relationship between PRISM III scores on admission and observed survivals and deaths is shown in Figure 1.
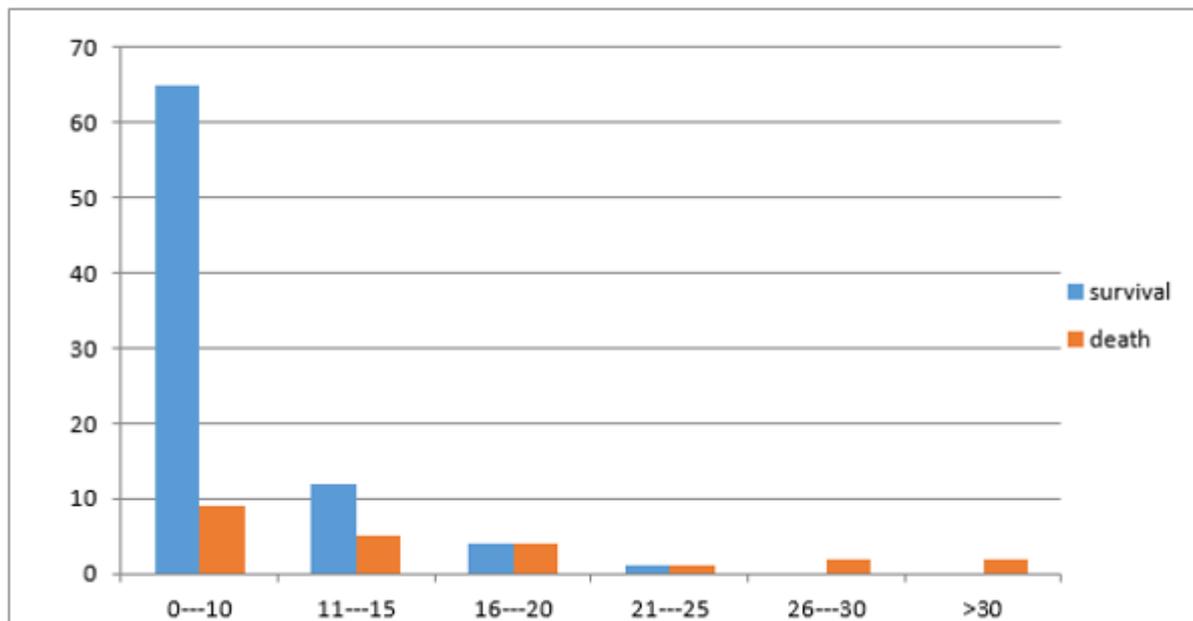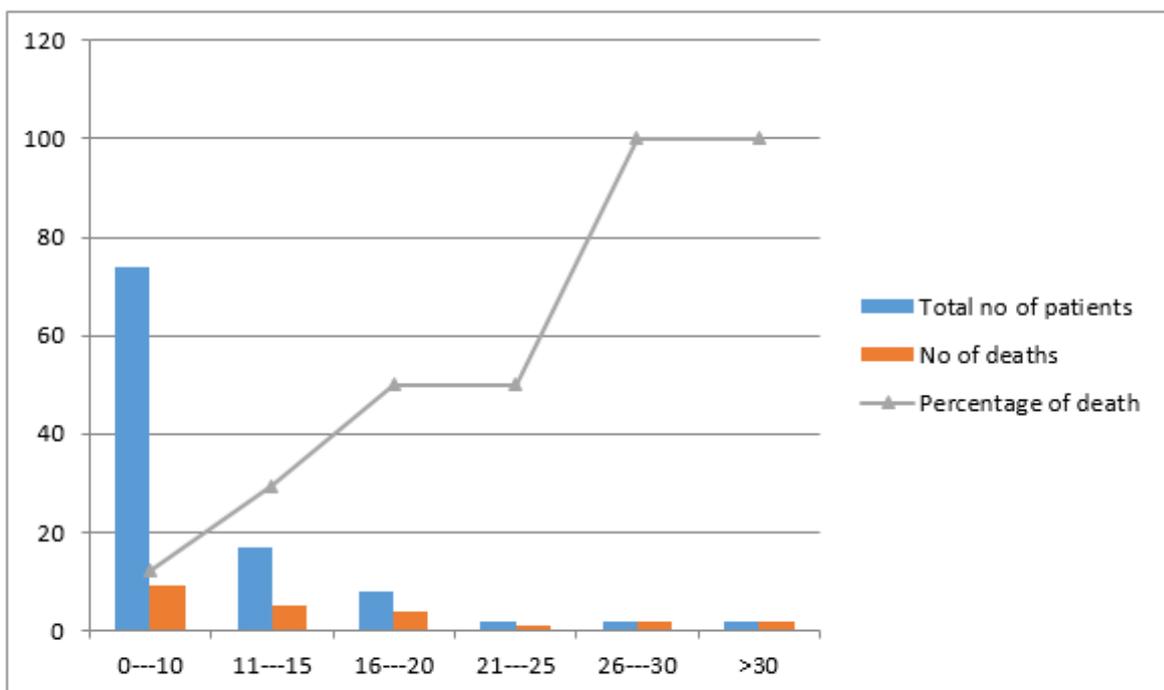

X-axis PRISM III score; Y-axis Number of Patients

Figure 1: *Observed survivals and deaths in relation to PRISM III scores on admission*

Figure 2 clearly shows the number of admissions and deaths belonging to the respective PRISM III score categories and the relationship between the PRISM III score and the percentage of observed deaths.

X-axis PRISM III score; Y-axis Number of Patients

Figure 2: *Relationship between PRISM III score and percentage of deaths*

Discussion

Multiple prognostic and mortality scoring systems have been developed during last few decades. We used the PRISM III scoring system to assess the severity of the illness on admission. Our study was conducted at SBSCH which is a multispecialty tertiary care hospital. Most of the admissions to MICU are medical cases. We had a limited population because the functional bed strength at MICU is only four. However, we managed to collect data from 105 admissions over 7-8 months. During data collection a few admissions were rejected due to lack of consent and missing investigation reports.

In our study we found that age is not a risk factor for the prediction of mortality. Similar results were found by Tan et al. in 1998[27]. Our study found that there was no significant association between death rate and gender of the patient or duration of ICU stay. Similar to our finding, a study by Williams et al. in an adult ICU showed that the duration of hospital stay was not an independent risk factor for mortality[20]. However, in contrast, a study by Graziela de Araujo Costa et al. showed that an additional day of hospitalization increases the death rate by approximately 2%[7] and another study by Aragao et al. denoted that male patients had a higher risk of death[21].

Our study found a positive relationship between deaths and usage of mechanical ventilation and vasoactive drugs. Thirty nine (37%) admissions required mandatory ventilation and the death rate among them was 53.9% ($p<0.001$). All the patients who were not ventilated survived. Usage of vasoactive drugs was noted among 26.7% of patients of whom 71.4% died ($p<0.001$). Similar findings were observed in other studies as well[21-24]. The major systems which contributed to the high mortality rate in our study were genitourinary and cardiovascular being responsible for 66.7% and 30% of deaths respectively. Our study did not show any significant relationship with risk of death and underlying disease condition which was similar to a study by Tan et al (1998)[22].

In our study the main objective was to find the relationship between PRISM III score and death probability. We found the average PRISM III Score value of our sample was 8.10. The average PRISM III scores among deaths and survivals were 14.6 and 6.3 respectively. There was a significant correlation between increasing survival and decreasing PRISM III score values. ($P<0.001$), which means that higher PRISM III scores on admission correlated significantly with a higher risk of mortality. Several studies have similar findings[8,14,36-38].

The PRISM III score would be a good indicator of the severity of illness and it would be a good predictor of outcome on the day of admission as it correlates positively with the mortality of MICU admissions. PRISM III score can also be used as an objective criterion for the selection of ICU admissions in countries like Sri Lanka where facilities are limited. Furthermore it can be used as a tool to assess the quality of care given at an institute and therefore can be utilize in quality control studies in the view of policy formulation.

Conclusions

PRISM III score is a good predictor of mortality and it is a good indicator of severity of illness on the day of admission.

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