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Original Article

Applicability of pediatric risk of mortality score in predicting mortality in pediatric severe cerebral falciparum malaria cases

Alpana S Kondekar[1], Maaz Ahmed[2], Santosh Kondekar[1]

From Department of [1]Pediatrics, [2]Speciality Medical Officer, TN Medical College, Mumbai, Maharashtra, India

Correspondence to: Dr. Alpana S Kondekar, Department of Pediatrics, TN Medical College, Mumbai - 400 008, Maharashtra, India. Phone: +91-8097952226. E-mail: dralpanakondekar@gmail.com

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ABSTRACT

Introduction: Pediatric risk of mortality score (PRISM-3) has been applied in pediatric intensive care settings for varied diagnoses. We planned to study the outcome when PRISM score is applied to a single clinical diagnosis. **Objectives:** To study the applicability of PRISM score in predicting mortality in pediatric severe cerebral malaria cases. **Methodology:** This was a retrospective analysis of severe cerebral malaria cases admitted to the pediatric intensive care unit over 3 years from 2009 to 2012 whose peripheral blood smear was positive for *Plasmodium falciparum*. Cases that presented with single seizure without altered sensorium were excluded. The PRISM scores, predicted mortality and observed mortality, were studied from demographic and clinical data. **Results:** Of the total 38 cases, 22 (57.8%) cases were females and 16 (42.10%) cases were males. There were 4 (10.52%) infants, 15 (39.4%) children from 1 to 5 years age and 19 (50%) cases were above 5 year age. A total of 14 cases, 36.84% had PRISM score ≤10, whereas 16 cases (42.1%) had score 10-20 and 8 cases had scored above 20. Mean predicted mortality was 17.84%, whereas observed mortality was 21.05%. Observed mortality had statistically significant association with PRISM score and predicted mortality rate. **Conclusion:** PRISM score and the expected mortality rate were good indicators in expecting the outcome of severe cerebral malaria cases. PRISM score can be effectively applied in severe cerebral malaria cases in predicting the outcome.

Key words: *Cerebral malaria, Pediatric risk of mortality score, Mortality, Pediatric intensive care unit*

The pediatric risk of the mortality (PRISM-3) score is a system of scoring that enables us to assess not only the severity of illness but also the mortality risk in an objective manner. The sensitivity of PRISM score to predict mortality has been shown to be 89-90.9% by various studies [1,2]. The applicability of PRISM score in predicting mortality in India is now widely reported. It is an important tool to predict the outcome and risks of mortality in the pediatric intensive care unit (PICU) settings [1,2]. The PRISM score as epidemiological criteria may help in decision making for PICU admissions [3,4].

Cerebral malaria is the existence of *Plasmodium falciparum* in blood in an unconscious or convulsing child. During the study period, complicated malaria was a common reason for intensive care, and cerebral malaria was a common presentation of complicated malaria. Cerebral malaria can be fatal if not intervened in time with necessary intensive care support [5]. Case survival depends on early detection of complications and timely prediction of outcome risks [6,7]. The PRISM score components had exactly same parameters that are assessed for the prognosis of cerebral malaria. This prompted us to think of applying PRISM score to cerebral malaria cases to understand the prognostic value.

This case was a unique attempt to study the score in a specific clinical condition rather than studying across all the cases in PICU. A similar study was published by Gerardin et al., 2006 in Africa, who noted surprisingly high mortality out of proportion to PRISM score, which could be due to no proper PICU, inappropriate management done and other complications present [6]. The purpose of this study was to assess the efficacy of PRISM score in predicting mortality among critically ill pediatric cerebral malaria cases in our setup. When applied to a group of severe cerebral malaria cases, PRISM score may help in decision making for PICU admissions and also for vigorous resuscitation attempts to improve the outcome.

METHODOLOGY

This retrospective analytical study was conducted in a tertiary care PICU of a medical college over a period of 3-year from July 2009 to June 2012. All children admitted in PICU with the diagnosis of cerebral malaria, where peripheral blood smear was positive for *P. falciparum*, during the study period were included in the study. Cases that had only single episode of convulsion and normal sensorium on hospitalization were excluded. The cases in which the diagnosis of malaria

was doubtful or peripheral smear was negative for malarial parasites and/or cerebrospinal fluid was tested on admission were excluded. Newborns and children above 12 years were not included in the study. Furthermore, the cases whose PRISM score related parameters were not available on records were excluded.

PRISM score and its parameters in first 24 h of hospitalization were noted from case records of recruited children. The course and outcome of each case were noted. The predicted and observed mortality were studied with respect to demographic and clinical data; and the duration of PICU stay.

Statistical Analysis

Study variables such as age, sex, PRISM score and duration of PICU stay were tested using contingency Chi-square test wherever applicable. Further, the association in terms of odds ratio of observed and predicted mortality was assessed by logistic regression analysis (using SPSS 13). Predicted death rate was calculated by the formula, probability of mortality=$e^{logit}/(1+e^{logit})$.

RESULTS

A total of 42 critically ill children admitted to PICU satisfied the inclusion criteria. Three cases were excluded as the diagnosis of cerebral malaria was questionable. One case had only single seizure without any alteration of sensorium; hence, was excluded. Finally, 38 cases of peripheral smear positive *P. falciparum* cerebral malaria were studied. Total of 9 children were given respiratory support in the form of mechanical ventilation, of which 8 died and 1 survived, with 5 days mechanical ventilation (Fig. 1). Eight children were ventilated as a part of terminal resuscitation had multiorgan dysfunction and died within 12 h of mechanical ventilation.

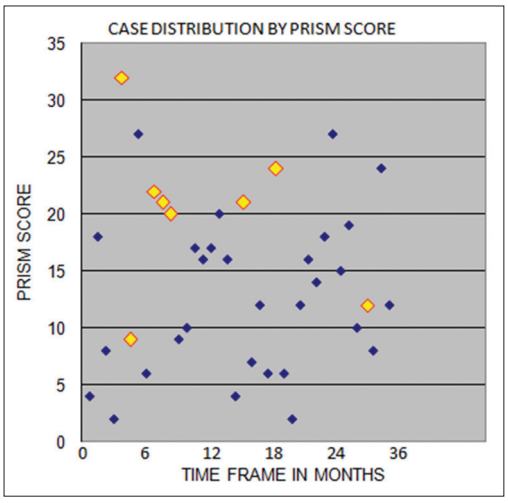

Figure 1: Case distribution by pediatric risk of mortality score (X-axis is months)

Of total 38 cases, 22 cases (57.8%) were females and 16 were males. There were 4 (10.52%) infants, 15 children (39.4%) from 1 to 5 years age and 19 cases (50%) were above 5 year age. Mean age was 5.5 years. The mean duration of PICU stay was 5 days. Table 1 depicts the details about the demographic distribution of survival and mortality. PRISM scores and predictive mortality from it is described across different groups as seen in Table 1. The association of high PRISM score (>20) had high predictive mortality (>50%) and was statistically significant by Chi-square test (Table 1). Logistic regression analysis yielded logit=(0.207 * PRISM−[0.005*(age in months)])−0.433. Predicted death rate was calculated by the formula, probability of mortality=$e^{logit}/(1+e^{logit})$. The expected mortality was calculated for each case and compared with the observed mortality. Mean mortality was 17.84%. Observed mortality was 21.05%.

Logistic regression analysis of scores yielded well-calibrated results for Hosmer–Lemeshow goodness of fit test for survival and mortality across various PRISM subgroups (Table 2). This is also obvious from Fig. 2 when PRISM and predictive mortality is plotted together as a scatter diagram. 14 cases (36.84 %) had PRISM score ≤10, whereas 16 cases (42.1%) had 10-20 and 8 cases had scored above 20. Average PRISM score was 14.28 (Table 1). The 8 deaths accounted for 21.05% observed mortality. Of these, 1 case had PRISM score 32, 1 had a score of 9, and rest all had scores between 15 and 25.

Table 1: Case distribution and their statistical significance for various variables

Variable	Number (%)	Died	Survived	p value
Sex				
Male	16 (42.10)	3	13	0.76
Female	22 (57.80)	5	17	
Age (month)				
Infants	4 (10.52)	1	3	0.72
1-5 years	15 (39.4)	4	11	
>5 years	19 (50)	3	16	
PRISM score				
≤10	14 (36.84)	1	13	0.004*
10-20	16 (42.1)	2	14	
>20	8 (21.05)	5	3	
Predicted mortality (%)				
<10	18 (47.36)	2	16	0.01*
10-20	9 (23.68)	1	8	
20-30	3 (7.89)	0	3	
30-50	5 (13.15)	4	1	
>50	3 (7.81)	1	2	

***Suggests a statistically significant p value.**
PRISM: Pediatric risk of mortality

Table 2: Goodness of fit test

PRISM score	Total number (%)	Deaths		Alive	
		Observed	Expected (%)	Observed	Expected
Score					
≤10	14 (36.84)	1	0.47 (3.4)	13	13.53*
10-20	16 (42.1)	2	6.3 (39.4)	14	9.7
>20	8 (21.05)	5	3.6 (46.2)*	3	4.4

***Hosmer–Lemeshow test=Well calibrated. PRISM: Pediatric risk of mortality**

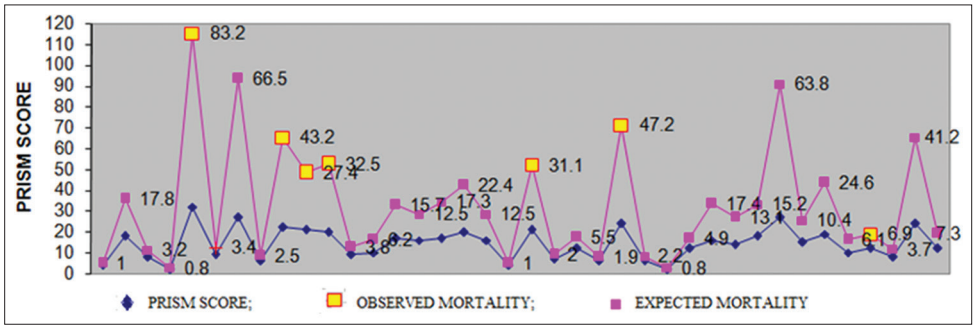

Figure 2: Distribution of pediatric risk of mortality score across predicted and observed mortality

DISCUSSION

The critical danger signs and investigations of cerebral malaria are overlapping with PRISM score parameters, thus in a way, PRISM score may help us grade cerebral malaria [1,5,6]. Prediction of mortality using a scoring system-like PRISM score is very important as the clinical presentations, manifestations, and response of each patient to therapy differ in different clinical diagnoses [1,3,4,8-10]. Even for a single clinical diagnosis, individual judgment of survival or mortality may be highly subjective without a scoring system [11]. We chose PRISM score as its calibration is better than Pediatric Index of Mortality in Indian setting [12-15]. Mortality prediction by PRISM score surely can help in policy making for critically ill children, and hence, for severe cerebral malaria cases [6]. The specific score repercussions in predictive mortality in individual disease group-like cerebral malaria are not yet studied except a study from Africa that studied PRISM score in falciparum malaria with 311 cases [6].

In our study, the PRISM score and mortality was independent of age and sex as was also seen by other researchers [14]. The predicted mortality in severe cerebral malaria cases was proportionate to the PRISM score so was the observed mortality except in 2 individual cases. The case that died at PRISM score 9, was a 7-year-old boy who died of severe anemia and acute respiratory distress syndrome following pulmonary hemorrhage. The other case that died at PRISM score of 12, had expected mortality 6.9%, no clear cause was available to suggest this death with low PRISM score. A 2-year-old female child survived despite PRISM score of 27 and predicted mortality 66.5%

Most cases that died had PRISM score more than 20, and the predicted mortality was more than 30%. The predicted mean mortality was 17.84% which is close to the observed mortality of 21.05%. However, as shown in Fig. 2, there is the difference in the observed and expected mortality in three subgroups. The disparity between observed and expected mortality scores in smaller groups needs further studies to support the statistical correlation due to inadequate sample size. The predicted mean mortality was in contrast with the previous study from Africa that recorded mortality out of proportion to score blaming to poor care and resource-poor settings [6].

The logistic regression analysis confirmed the predictability of survival and mortality from PRISM score by goodness of fit test. This is in unison with other researchers [3,4,6]. PRISM score is recommended for group prognostication of PICU patients and not for individual cases. In resource-poor settings, estimating PRISM score for each case in PICU may not be practical. This was the very reason; we decided to apply to a specific disease group with high morbidity. Hence, instead of applying PRISM score based predictions to all patients in PICU, individualizing it for a specific group of diagnoses may help implement the judicious use of resources in resource-poor critical care setting. This, in addition, is likely to help the intensivist in decision making while giving life support without waiting for further complications that may be life-threatening.

The African study with similar objectives could not prove association of PRISM score with mortality, but this study did prove the statistical significance in individual disease group. Our study may give a message that there may be a need for judicious application of PRISM score to a high-risk group/ disease group. This may help in saving resources and also will

help improve specific disease mortality by early interventions if high score noted in a relatively stable child. Limitations of our study were that the sample size was small and involving only a single center to study the efficacy of PRISM scores. A prospective comparative study with other disease groups may be needed to affirm the same.

CONCLUSIONS

PRISM score and the expected mortality rate were good indicators in expecting the outcome of severe cerebral malaria cases. Most deaths were associated with high PRISM score on admission. It is recommended to calculate PRISM score for all cases of severe cerebral malaria cases on admission that may help understand the clinical and biochemical severity. This may help in the clinical judgment of individual disease group so that preventive strategies can be planned to improve the PRISM score soon after admission and thus improving the outcome.

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