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ORIGINAL ARTICLE

Use of CRIB II (Clinical Risk Index for Babies) Score for Prediction of Mortality in Premature Babies Admitted in A Tertiary Care Hospital

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Abstract

Background: *Neonatal mortality accounts for about two-thirds of all infant deaths. The major causes of neonatal mortality are prematurity/low birth weight (LBW) and congenital anomalies. Application of severity scores in this condition may be useful for prognostication. Clinical risk index for babies (CRIB II) score is a tool to predict initial risk of mortality amongst preterm low birth weight babies, the utility of which is scarce in many developing countries.*

Objective: *To assess the ability of the CRIB II score to predict mortality of preterm babies before hospital discharge.*

Methods: *This was a cross-sectional study, carried out at Department of Neonatal Medicine, Dhaka Shishu Hospital from August 2013 to January 2014. Preterm newborns of 28-32 weeks, birth weight between 750-1500 gm and admitted within 12 hours of age were purposively included in this study and babies having lethal congenital malformations were excluded. The demographic data including age, sex, birth weight, temperature and after doing arterial blood gas analysis base excess were recorded in the questionnaire. CRIB II score was determined and recorded. Receiver operating characteristic (ROC) analysis and the area under the receiver operating characteristic curve (AUC) was calculated for the predictive performance of CRIB II score.*

Results: *One hundred and thirty two neonates met the inclusion criteria. Approximately half (51.5%) neonates belonged to age ≤6 hours and more than half (56.1%) neonates were male. The mean gestational age was 29.7±1.6 week with 60.6% were of ≤30 weeks. The CRIB II score was ranged from 2 to 15 with mean 8.7±3.3. Among the enrolled neonates mortality was 37.1%. Mortality was significantly ($p<0.05$) higher in neonates belonged to lower gestational age, birth weight, admission temperature and whose ABG revealed higher base excess. The mean CRIB II score was significantly higher in death group ($p<0.05$) and a progressive increase in mortality was found with increasing CRIB II score level ($p<0.05$). The receiver operating characteristics (ROC) analysis revealed the predictive performance of CRIB II score was very good (AUC=0.88, $p<0.0001$) with a cut off value of CRIB II score ≥9.0 having 87.2% sensitivity and 76.2% specificity. Its predictive performance was also better than gestational age (AUC 0.799) or birth weight (AUC 0.734) alone.*

Conclusion: *This study found the predictive performance of CRIB II score was very good. This would be a tool to assess mortality of hospitalized ≤32 weeks preterm very low birth weight neonates.*

Keywords: *CRIB score, neonatal mortality, very low birth weight.*

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Introduction

Among the health care indicators of a country, neonatal mortality plays an important role as it represents health status of its population as well as the degree of development of a country. It results from a complex chain of determinants such as biological, socioeconomic and health factors. [1] Almost all (99%) of neonatal deaths occur in low and middle-income countries,[2] in Bangladesh neonatal mortality (32/1000 in 2011) accounts for about three-fourth of all infant deaths (deaths before 1 year of age).[3] World-wide prematurity, birth asphyxia and severe neonatal infections are the leading causes of neonatal mortality.[4,5]

Mortality due to prematurity and its complication responsible for roughly 29% of neonatal deaths globally and pre-term birth acts both as a risk factor as well as a direct cause of mortality.[6] For a long time, gestational age and birth weight were important univariate predictors of neonatal mortality.[7] Survival of premature infants depends on birth weight and gestational age but also other perinatal factors and physiological conditions of the individual neonate, in particular disease severity in the first hours of life.[8] If mortality can be predicted in early period of life, more attention can be given to these premature babies for reduction of mortality rate.

In this context, assessment of severity of illness and mortality prediction could be done through the development of probabilistic models predicting mortality risk.[9] Scoring systems for the assessment of severity of neonatal illness were increasingly utilized for mortality prediction and to compare the quality of care at different centers. Implementation of severity scores in this condition may be beneficial for prognostication and evaluation of the effectiveness of therapeutic protocols in the neonatal intensive care units (NICUs).[10] The aim of developing illness severity score were to quantify the clinically obvious fact that infants of the same gestational age and birth weight differ in their risk of dying.[11]

To improve predictability of mortality of these newborns, few scoring systems are available.[12] Four scoring systems for assessment of neonatal mortality risk were introduced during 1993 as follow: the national institutes of health neonatal network model, SNAP (Score for Neonatal acute physiology) SNAP-PE (Score for Neonatal acute physiology-Perinatal Extension) and CRIB (Clinical risk index for babies).[13] But those systems are cumbersome and difficult to use in all situations.

CRIB score was created to predict mortality for infants born at less than 32 week gestation and based upon 6 variables for predicting mortality. But the appropriateness of CRIB score has been questioned because it needs up to 12 hours after admission thus introducing a factor of early treatment bias. It also needs to measure FiO_2 which is not a true physiological measurement because it is determined by the care team.[14]

CRIB II score, an improved version of CRIB, was developed to solve those questions.[15] CRIB II provides a simplified and recalibrated scoring system that avoids the potential problems of early treatment bias. The score is meant to improve predictors for smaller, very premature infants and to exclude variables that could be influenced by care given to the infants.[16,17]

CRIB II score is a rational method for assessing initial mortality risk and illness severity within one hour of admission that has only five variables. It is non-subjective and simple to calculate.[17] It is a beneficial and practical tool for identifying high-risk neonates, auditing of neonatal units and also provides a standardized mortality rate for performance comparison among neonatal units.[16] In a setup of low resource and facility this CRIB II can be used as it is easy and a simplified scoring system. This study was designed to assess the ability of the CRIB II score to predict mortality in preterm babies before hospital discharge.

Materials and Methods

This was a cross-sectional study, carried out in the Department of Neonatal Medicine, Dhaka Shishu Hospital from August 2013 to January 2014. Preterm newborns between 28 weeks to 32 weeks of gestation and birth weight between 750 gm to 1500 gm, admitted within 12 hour of age, was purposively enrolled in this study. Neonates having lethal congenital malformations were excluded from this study. The demographic data including age, sex, birth weight, temperature was recorded in the questionnaire immediate after admission. Gestational age was calculated from the first day of last menstrual period (LMP). New Ballard score was used to assess gestational age of every neonate. Weight was recorded for each baby as soon as after

enrollment by using an electronic scale having a sensitivity of 10 gm. Temperature was recorded by using a digital thermometer. After doing arterial blood gas analysis base excess was recorded in the questionnaire. All these parameters of the baby were assigned according to the CRIB II score. The final CRIB II score was obtained by the arithmetic sum of the individual score assigned. The CRIB II score was divided into 4 subgroups: 0-5, 6-10, 11-15, and >15. The primary outcome measure was mortality before hospital discharge.

Written informed consent was taken from parents before enrolment in the study. The protocol was approved by the Ethical Review Committee of Bangladesh Institute of Child Health.

All statistical analysis was done using SPSS version 20 for windows. The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Unpaired t-test used to compare continuous variables between death and alive neonates. Chi-Square test was used to analyze the categorical variables. Receiver operating characteristic (ROC) curve was constructed and the area under the receiver operating characteristic curve (AUC) was calculated for the predictive performance of CRIB II score. P values <0.05 was considered as statistically significant.

Results

One hundred and thirty two neonates were enrolled in this study. Among the enrolled cases about half (51.5%) neonates belonged to age ≤6 hours. The mean age was 6.8±3.2 hours with ranged from 1 to 12 hours. More than half (56.1%) neonates were male. The mean gestational age was 29.7±1.6 weeks with ranged from 28 to 32 weeks. Almost two third patients belonged to gestational age ≤30 weeks. The mean birth weight was 1153.1±228.6 gm with ranged from 780 gm to 1480 gm. Mean admission temperature was 35.1ºC±1.5ºC with ranged from 32ºC to 38ºC. The ABG revealed mean base excess was – 13.4±7.42 with ranged from –26 to 5 (Table I). Regarding outcome we found that 62.9% (two third) neonates were alive and 37.1% were expired. The mean CRIB II score was 8.7±3.3, ranged from 2 to 15 and almost half (49.2%) neonates had Level II (6-10) score (Table I). There was no significant difference (p >0.05) of age and sex between survived and expired neonates. But mortality was significantly (p<0.05) higher in neonates belonged to lower gestational age, birth weight, admission temperature and whose ABG revealed higher base excess (Table II).

Table I
Demographic data of studied neonates (N=132)

Variables	Number	Percentage
Age (hrs)		
≤6	68	51.5
>6	64	48.5
Range, Mean±SD	1-12	6.8±3.2
Sex		
Male	74	56.1
Female	58	43.9
Gestational age (weeks)		
≤30	80	60.6
>30	52	39.4
Range, Mean ± SD	28-32	29.7±1.6
Weight (gm)		
Range, Mean ± SD	780-1480	1153.1±228.6
Temperature (ºC)		
Range, Mean ± SD	32-38	35.1 ± 1.5
Base Excess		
Range, Mean ± SD	5-(–26)	–13.4 ± 7.42
Outcome		
Alive	83	62.9
Death	49	37.1
CRIB II score		
Range, Mean ± SD	2-15	8.7±3.3
CRIB score levels		
Level I (1 - 5)	26	19.7
Level II (6 - 10)	65	49.2
Level III (11 - 15)	41	31.1
Level IV (> 15)	0	0.0

Table II

Comparison between general information with outcome (N=132)

Variables	Death n (%)	Alive n (%)	p value
Age (hrs)			
≤6	29 (22.0)	39 (29.5)	0.175*
>6	20 (15.1)	44 (33.4)	
Range	2-11	1-12	
Mean±SD	6.6±3.1	6.8±3.2	0.726#
Sex			
Male	30 (22.7)	44 (33.3)	0.358*
Female	19 (14.4)	39 (29.6)	
Gestational age (weeks)			
≤30	37 (28)	43 (32.6)	0.007*
>30	12 (9.1)	40 (30.3)	
Range	28-32	28-32	
Mean ± SD	30.2±1.5	29.4±1.6	0.005#
Weight (gm)			
Range	780-1480	780-1480	
Mean ± SD	1097.0±231.0	1248.3±194.6	0.0001#
Temperature (°C)			
Range	32-37	34-38	
Mean ± SD	34.8±1.5	35.8±1.5	0.008#
Base Excess			
Range	– 26 - (+5)	– 22.3 - (–1)	
Mean ± SD	– 16.1±6.95	– 8.82±5.8	0.006#

* Chi-square test; # Unpaired t test

Comparison of CRIB II score with outcome of the study patients, it was found that a progressive increase in mortality with increasing CRIB II score level; mortality was 8(6.1%), 19(14.3%), 22 (16.7%) and 0(0%) in level I, II, III of CRIB II score respectively and it was statistically significant (p <0.05). The mean CRIB II score was significantly higher in expired group (p<0.05) (Table III). ROC curve analysis revealed that the most suitable cut-off points of CRIB II score in predicting mortality was ≥9 and there was significantly higher mortality (p <0.05) in this group (Table IV).

Table III

Comparison between CRIB II score with outcome (N=132)

CRIB II score	Outcome				p value
	Death (n=49)		Alive (n=83)		
	n	%	n	%	
Level I (1-5)	8	6.1	18	13.6	
Level II (6-10)	19	14.3	46	34.9	0.03*
Level III (11-15)	22	16.7	19	14.4	
Level IV (>15)	0	0.0	0	0.0	
Mean±SD	8.1±4.1		6.0±3.9		0.001#
Range (min, max)	2, 15		4, 15		

*Chi-square test; #Unpaired 't' test

Table IV
Comparison between best cutoff level of CRIB II score with outcome (N=132)

CRIB II score	Outcome				p value
	Death		Alive		
	n	%	n	%	
< 9	19	15	50	37.9	0.017*
≥9	30	22.1	33	25	

* *Chi-square test*

The receiver operating characteristics (ROC) analysis showed that the predictive performance of CRIB II score was very good (AUC=0.88, p<0.0001) with a cut off value of CRIB II score ≥9.0 having 87.2% sensitivity and 76.2% specificity. Its predictive performance was also better than gestational age (AUC 0.799) or birth weight (AUC 0.734) alone (Fig.-1, Table V).

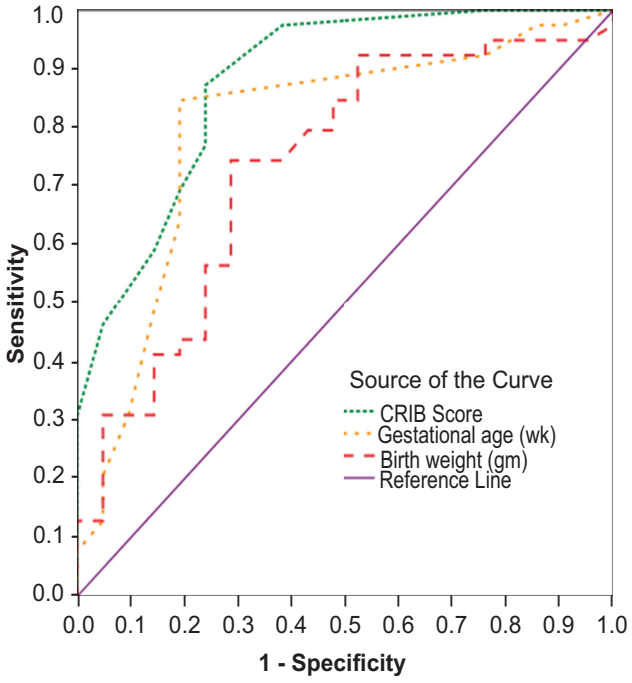

Fig.-1 *ROC curve of mortality in hospital by CRIB II score, gestational age and birth weight*

Table V
Predictive abilities of CRIB II score, gestational age and birth weight

	Cut off value	Sensitivity	Specificity	AUC	95% Confidence interval (CI)		p value
					Lower bound	Upper bound	
CRIB II Score	≥ 9.0	87.2	76.2	0.88	0.787	0.972	<0.0001
Gestational age (wk)	≤30.0	84.6	81.0	0.799	0.672	0.926	<0.0001
Birth weight (gm)	≤1032.0	79.5	57.1	0.734	0.599	0.87	<0.005

Discussion

In the present study, it was observed that more than half (51.5%) neonates belonged to age ≤6 hours and all recruited within 12 hours of age. EZZ-Eldin et al[12] enrolled 113 neonates, during their first 24 hours of birth. In this study, among the enrolled neonates 56.1% were male. Similarly, EZZ-Eldin et al,[12] Marete et al[16] and Mohkam et al[13] found 51.3%, 53% and 52.6% were male respectively. In this study, we observed that 60.6% neonates belonged to ≤30 weeks of gestation with mean 29.7±1.6 weeks and ranged from 28-32 weeks. When comparing our results with those of EZZ-Eldin et al[12] and Fernandez-Carrocera et al[18] we found that the range of gestational age was similar to their findings (28-32 weeks). Similar observations regarding the gestational age were also reported by Brito et al,[7] Marete et al[16] and Rastogi et al.[15] This study observed that the mean weight was 1153.1±228.6 gm with ranged from 780 to 1480 gm. Similarly, EZZ-Eldin et al[12] and Rastogi et al[15] found the birth weight were 1134.5±202 gm and 1228±398 grams respectively. Comparable birth weight was also reported by Sundaram et al[10], Brito et al[7] and Sarquis et al.[19] This study found that mean admission temperature was 35.1±1.5°C with ranged from 32 to 38°C. Similarly, EZZ-Eldin et al[12] found the temperature ranged from 31°C-37°C with mean

34.6±1.4ºC, Marete et al[16] observed the temperature ranged from 33.4ºC-38.40ºC and Fernandez-Carrocera et al[18] found the temperature was <36ºC, which were comparable with the current study. In this study, mean base excess was –13.4±7.42 with ranged from –26 to 5. EZZ-Eldin et al[12] and Marete et al[16] found the base excess ranged from –24 to –2.1 (mmol/l), which coincide with our finding.

Preterm birth is the major direct cause of neonatal death, responsible for about 35% of the world.[4] This study enrolled 28-32 week preterm neonates and we found 37.1% of them were expired. Heljic et al[5] reported similar outcome pattern of preterm infants in their study. On the other hand, Draper et al[20] had highlighted the variation across Europe in outcomes of very preterm infants. Premature births are outnumbered by males with higher susceptibility of mortalitity.[21] In this study though male is more than female but we found no difference of gender between survived and dead neonates.

The present study observed that the mean CRIB II score was 8.7±3.3 with ranged from 2 to 15. Marete et al[16] found mean CRIB II score 12.9±8.1 with ranged from 0 to 27, similarly Sarquis et al[19] reported mean CRIB scores 14.3±7.9 with ranged from 0 to 27. Both the study found higher mean CRIB II score than that of the current study. In this study, we found significantly higher CRIB II score in the expired group (8.1±4.1 vs 6.0±3.9, p 0.001). EZZ-Eldin et al[12] reported that CRIB II score was significantly higher in non-survivors (14.1 ± 2.1) than survivors (7.7 ± 2.9), which support our finding. Mohkam et al[13] found the mean CRIB score in death neonates was 8.43±4.66 and in survived neonates was 2.57±3.66 ($p<0.05$), which was closely resembled with the present study.

Comparative analysis between the four levels of CRIB II score, present study found hospital mortality showed a progressive increase with increasing CRIB II score level; mortality was 8(6.1%), 19(14.3%), 22 (16.7%) in level I, II, III of CRIB II score respectively. Our findings coincide with the study findings of Marete et al[16] and Sarquis et al.[19] Though EZZ-Eldin et al[12] reported similar objervations but they found 9 neonates graded in level IV with 100% mortality, Marete et al[16] and this study found no neonate graded in level IV.

This present study use CRIB II score as a tool to predict neonatal mortality, quantified by using area under ROC curve, observed that CRIB II score predict morality positively and showed better performance than gestational age and birth weight (AUC 0.88, 0.799, 0.734), which means that CRIB II score was the best discriminate parameter for neonatal mortality. This finding is in agreement with other studies.[7,12,16,18,22] However, the accuracy was found to be lower than the study that originated it (0.91 for CRIB II).[14] This study found CRIB II score had sensitivity 87.2%, specificity 76.2% and cut off value ≥9.0. Similar finding was reported by Marete et al[16] with a cutoff value of 4 and they also showed lower sensitivity (32%) by using a cutoff point of 10. EZZ-Eldin et al[12] showed higher sensitivity and specificity and a higher cutoff point of CRIB II score than this study findings. In this study, sensitivity and specificity of CRIB II score was higher than that of gestational age (84.6% and 81.0%) and birth weight (79.5% and 57.1%). Similar findings were reported by EZZ-Eldin et al[12] and Marete et al.[16] From this study and other reports[12,16,18,22] the sensitivity, specificity and AUC for CRIB II score were found to be better than any of the traditional models separately and the area under the ROC curve for predicting death was greater for CRIB II score than for birth weight or gestational age alone. It was reported that CRIB II score had greater ability to predict mortality in comparison to CRIB and SNAPPE-II.[11]

Conclusion

This study found progressive increase in mortality with increasing CRIB II score. This study also found the predictive performance of CRIB II score was very good and its predictive performance was better than birth weight or gestational age. So, CRIB II score would be a tool in predicting neonatal mortality before hospital discharge.

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