

# Evidence Based Care Journal

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Evidence Based Care Journal 2020 10:58 originally published  
online 01 July 2020

**DOI: 10.22038/ebcj.2020.45945.2254**

**Online ISSN: 2008-370X**

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## Clinical Risk Index for Babies (CRIB-II) Scoring System in Prediction of Mortality Risk in Preterm Neonates in the First 24 Hour

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Received: 02/02/2020

Accepted: 19/07/2020

Evidence Based Care Journal, 10 (2): 58-63

### Abstract

**Background:** The scoring systems evaluate neonatal outcomes based on perinatal factors in the Neonatal Intensive Care Unit (NICU).

**Aim:** This study aimed to predict mortality risk in preterm neonates for the first time, using the Clinical Risk Index for Babies (CRIB II).

**Method:** This cross-sectional, descriptive-analytical, longitudinal study was conducted on 344 preterm neonates with the gestational age of 23-32 weeks and birth weight of 500-1500 g in a referral center in Tehran, Iran, from winter 2016 to spring 2017. Some neonatal variables were completed within the first 12 h of life, and the final scores were calculated based on CRIB II. Then, the correlation of these variables with mortality outcome was evaluated using logistic regression. Sensitivity, specificity, and positive and negative values were also calculated via SPSS software (version 23).

**Results:** According to the results, 253 (73.57%) neonates, including 122 girls (48%), survived in the first 24 h after birth. The total CRIB II score in the surviving neonates was  $6.1 \pm 2.6$ . The area under the receiver operating characteristic curve was estimated at 0.84 with the cut-off point of 8.5. In addition, the sensitivity, specificity, positive predictive value, and negative predictive value of the CRIB II system were obtained as 75%, 78%, 55%, and 89.5%, respectively. The results revealed a significant correlation between the CRIB II score and mortality outcome. In this regard, an increase in the CRIB score coincided with a 0.67 increase in the risk of death (OR=1.671,  $P < 0.001$ ).

**Implications for Practice:** Based on the findings of the present study, CRIB II can be concluded to be an appropriate scoring system. Consequently, the result of this tool can be used for routine investigations.

**Keywords:** CRIB II, Mortality risk prediction, Preterm newborn

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## Introduction

The neonatal period (i.e., the first 28 days of neonatal life) is the time during which the newborns are exposed to high risk owing to their transition from intrauterine to extrauterine life. Accordingly, this period of life has a high mortality rate (1, 2). According to the World Health Organization, the neonatal mortality rate is 28 per 1,000 live births in the world and 19 in Iran (3). Preterm birth is a leading cause of mortality among neonates and children under five years of age across the world (4, 5). As a result, morbidity and mortality rates are authentic and important indicators of the educational, social, and health status of a population (6).

Neonates with very low birth weight (i.e., less than 1,500 g) are considered preterm (2). The prevalence of prematurity in Iran is 10%. This condition is considered the leading cause of neonatal morbidity and mortality. In this regard, premature neonates are exposed to the risk of this 40 times higher than their term counterparts (2, 7). The mortality rates of preterm neonates are reportedly 20.6% and 60.7% in the first 24 h and week of life, respectively (8). The risk level for these neonates can be determined based on their clinical condition due to the immaturity of their structural and functional organs. This can help care institutions to better evaluate their therapeutic measures in improving the well-being of these neonates, as well as decreasing morbidity rates (9-11). The probability of neonatal death or survival in the Neonatal Intensive Care Unit (NICU) depends on perinatal factors and physiological conditions at the time of admission, which can be evaluated through scoring systems. Clinical Risk Index for Babies (CRIB) and CRIB II (an updated version of CRIB) are two scoring systems among others (9, 12). The CRIB, which was first developed by the International Neonatal Network in the UK in 1993, is a useful indicator for the evaluation of morbidity and mortality rates in hospitals. In this system, the risk of mortality is evaluated through the data collected during the first 12 h after birth (9). This scoring system was updated to CRIB II in 2003, a simplified scoring system which eliminates the potential problems associated with the use of drug items and related human error cases.

The CRIB II is only applicable to preterm neonates with the birth weight of less than 1,500 g, as well as those with the gestational age of fewer than 31 weeks. This instrument takes into account variables, including birth weight, gestational age, congenital anomalies, minimum and maximum values of  $\text{FiO}_2$ , and base excess (BE), within the first 12 h of life. The measurement of this index is highly simple and time-saving since all the applied variables are already evaluated in the routine investigations of low-birth-weight neonates. Moreover, these variables are not subject to human error (9, 13).

Despite the significant number of preterm and low-birth-weight newborns admitted to NICUs, an accurate tool has not yet been used to seriously estimate the rate of mortality in this population. This underscores the need for the prediction of mortality risk in preterm neonates with low gestational age or low birth weight and planning of clinical measures and follow-ups accordingly. With this background in mind, the present study was aimed to predict mortality risk in preterm neonates with the birth weight of less than 1,500 g admitted to the NICU using the CRIB II scoring system. In order to do so, it was important to examine the psychometric properties of this scoring system first.

## Methods

This cross-sectional, descriptive-analytical, longitudinal study was carried out on preterm newborns with the gestational age of 23-32 weeks and birth weights of 500-1,500 g. These newborns were admitted to the NICU of Vali-e Asr Hospital, Tehran, Iran, during their first 12 h of birth, from the winter of 2016 to the spring of 2017. The sampling was carried out through the available sampling technique (14).

The formula of the sample size was based on the prevalence of death in premature newborns and the sensitivity of the CRIB II system according to a previous similar study (15). The prevalence and sensitivity were obtained according to a study performed by Babaei and Jafrasteh (15). Given that the prevalence of premature neonate mortality is reported to be 25%, there should be at least 50 neonatal deaths and 150 live births in the samples. Therefore, the sample size was calculated to be 196; however, 200 samples were considered in this study. In order to enhance the accuracy of the study, the number of samples increased to 344 neonates. The inclusion criteria were: 1) birth weight of 500-1,500 g, 2) gestational age of 23-32 weeks, and 3) hospitalization within the first 12 h after birth. On the other hand, the newborns with severe congenital anomalies as well as those who were discharged from the hospital due to their parents' consent were excluded from the study.

In this study, the CRIB II was calculated based on the scores of the items related to neonatal gender, birth weight (measured by the SECCA digital weight scaling instrument), gestational age (estimated according to the last day of maternal menstruation, registered in her obstetrical file), temperature, base excess, and congenital anomalies. The overall CRIB II scores were calculated based on the score ranges defined by Parry et al. (16). In this research, to determine the validity of the questionnaire, the face validity was evaluated based on the opinion of 5 experts (i.e., three neonatologists, two professors of the School of Nursing and Midwifery, and two nurses working in the NICU), in terms of ambiguous points and inappropriate terms translated into Persian. Moreover, predictive validity was evaluated by determining the association of birth weight, intrauterine age, gender, and hyper or hypothermia with the prognosis of premature neonatal death in the NICU.

The neonates involved in the present study were evaluated and observed in the first 24 h after birth. The validity of the scores was evaluated and recorded according to the outcome (i.e., death). The sensitivity, specificity, and cut-off point of the CRIB II were calculated, in addition to the positive and negative predictive values and positive likelihood ratio.

After the collection of the necessary information, the data entry and analysis were carried out using SPSS software (version 23). The data were analyzed according to the aims of the study by the Chi-square test and independent t-test. In addition, the beta-coefficient and odds ratio were derived from linear logistic regression tests. A p-value less than 0.05 was considered statistically significant. The receiver operating characteristics (ROC) curve analysis was conducted in order to estimate the cut-off point.

Before the study, the approval of the ethics committee was gained under IR.SBMU.PHNM.1395.682. In addition, verbal and written consent was obtained from the parents of the involved neonates.

## Results

This study was conducted on 344 neonates, including 181 (53%) boys and 163 (47%) girls, for whom the CRIB II scoring system was completed. Out of this population, 253 cases survived within the first 24 h of life, while 91 subjects passed away. A total of 131 (52%) surviving neonates were boys and the rest were girls. Therefore, based on the results of the Chi-square test, there was no significant difference between the girls and boys regarding the survival or mortality rate ( $P=0.66$ ).

The mean CRIB II scores for the surviving and non-surviving neonates are shown in Table 1. Based on the results, the mean was significantly higher in the surviving group than in their non-surviving counterparts. In the ROC curve analysis (Figure 1), the area under the ROC curve was calculated as

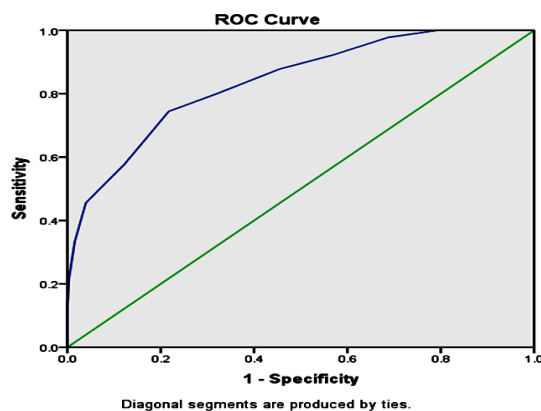
**Table 1. Mean of Clinical Risk Index for Babies II in surviving and non-surviving neonates in the first 24 h after birth**

CRIB score	Number	Mean±SD*	P-value**
Survivors	253	6.1±2.6	0.001
Non-survivors	91	10.2±3014	

CRIB: Clinical Risk Index for Babies

\*Standard Deviation

\*\*t-test



**Figure 1. Receiver operating characteristics curve for the prediction of neonatal mortality by Clinical Risk Index for Babies II scoring system**

**Table 2. Area under receiver operating characteristics curve and the efficacy of Clinical Risk Index for Babies II**

AUC*	SD**	P-value	CI***	
			Upper	Lower
0.84	0.02	<0.001	0.79	0.88

\* Area under the curve

\*\*Standard Deviation

\*\*\*Confidence Interval

**Table 3. Sensitivity and specificity of Clinical Risk Index for Babies II scoring system based on Youden's index**

CRIB II cut-off point	SD	Specificity	Youden's Index	Sensitivity
8.50	0.74	0.78	0.53	0.75

**Table 4. Association of some neonatal variables with death odds in neonates**

	OR	P-value	95% CI	
			Lower	Upper
Gender	0.92	0.73	0.56	1.48
GA	1.09	0.81	0.61	1.84
Temperature	2.70	0.35	0.44	9.60
BE	0.89	0.20	0.74	1.06
Weight	0.99	0.001	0.00	0.99
CRIB II	1.67	0.001	0.51	1.88

GA: gestational age

BA: Base Excess

0.840 (Table 2). According to the analysis, the efficacy of the CRIB II scoring system was at an adequate level ( $P < 0.001$ ).

Based on the Youden's index, the CRIB II cut-off point was 8.5 (Table 3). Youden's index indicates the optimal sensitivity and specificity cut-off points. Furthermore, the positive and negative predictive values of the CRIB system were estimated at 54.9% and 89.6%, respectively. Therefore, it could be concluded that 55% of the neonates did not survive, while 90% of them survived according to the evaluated scores. With regard to the predictive values of CRIB II, the positive and negative likelihood ratios were obtained as 3.43 and 0.32, respectively.

Logistic regression was utilized to evaluate the association of neonatal mortality with the given variables. The results revealed a significant association between birth weight and mortality outcome. In this respect, the odds of death in neonates increased with a decrease in neonatal weight ( $OR = 0.996$ ,  $P < 0.001$ ). However, neonatal mortality showed no significant correlation with neonatal gender ( $OR = 0.92$ ,  $P = 0.70$ ), gestational age ( $OR = 1.96$ ,  $P = 0.81$ ), body temperature ( $OR = 0.20$ ,  $P = 0.35$ ), and base excess ( $OR = 0.89$ ,  $P = 0.30$ ). However, a significant correlation was observed between the CRIB score and mortality outcome. In this regard, an increase in the CRIB score coincided with a 0.67 increase in the rate of death ( $OR = 1.67$ ,  $P < 0.001$ ; Table 4).

## Discussion

The results of the present study were indicative of an elevation in the risk of preterm neonatal mortality in the first 24 h after birth with the increase in the mean CRIB score. In this study, the mean scores of CRIB were obtained as 6.12 and 10.28 for the surviving and non-surviving neonates, respectively. However, in other studies, these scores were reported as 4.5-6.8 and 5.8-9.8, respectively (15, 17). This difference indicates that at-risk neonates with higher CRIB II scores were kept alive in this research environment.

In the present study, the area under the curve (AUC) was 84%. In another study performed by Babaei et al., the AUC was reported as 85%, which is in line with the results of the present study (15). In similar studies, the AUCs of 91%, 92%, and 96% were reported (16, 18, 19). In a study by De Felice et al., the sampling population included neonates with a birth weight of less than 1,500 g or gestational age of fewer than 31 weeks. In the mentioned study, the CRIB final scoring, gestational

age, and birth weight were evaluated for mortality prediction in neonates. The AUC was reported as 92%, which was indicative of the accuracy and predictive power of this tool (20).

In the present research, the sensitivity and specificity of CRIB II were obtained as 75% and 78%, respectively, with a cut-off point of 8.5. Accordingly, the tool successfully exhibited a prediction accuracy of 75%. In other studies, sensitivity and specificity were reported as 82% and 50% for a cut-off point of 13 and 94.9% and 82.4% for a cut-off point of 11, respectively (18, 19, 21). This cut-off point was obtained as 6.5 and 7 by Babaei et al. and Fouladinejad et al., respectively (15, 22). Although none of these studies calculated sensitivity and specificity, sensitivity is an indicator of true positive rate, whereas specificity is an indicator of true negative rate.

The results of the present study showed that the CRIB II scoring system had a positive predictive value of 55% and a negative predictive value of 89.6%. Khosravi et al. reported positive and negative predictive values of 65% and 72% for CRIB II, respectively (21). In other words, 65% of the cases did not survive despite high CRIB scores, while 72% of them survived in spite of obtaining low scores. Positive and negative predictive values determine false-positive and false-negative cases or the accuracy of the utilized tool without human interpretation and intervention.

In this study, neonate variables, such as weight and overall CRIB II, were significantly associated with neonatal mortality in the first 24 h after birth. However, neonatal mortality showed no significant correlation with body temperature, base excess, and gestational age. The results of some studies have shown that vital variables, such as *first- and fifth-minute APGAR* scores, gestational age, duration of hospitalization (15), birth weight (i.e., less than 1,500 g), and respiratory distress syndrome (22) are correlated with the outcome of neonatal mortality. In this regard, it can be said that the prospective nature of the study and the incomplete recording of some information may be the cause of the difference between the findings of this research and those of similar studies. In this research, there was a small number of premature newborns in a tertiary and referral center which means that the obtained results should not be extended throughout the country.

### Implications for Practice

The sensitivity and specificity of the CRIB scoring system, as well as its cut-off point, were found to be acceptable based on the results of the present study and similar studies. Moreover, a better cut-off point was obtained in this study, compared with those in other studies. Therefore, this scoring system can be regarded as a useful tool for the prediction of mortality in neonates at the risk of death. Furthermore, the measurement of this index during the first 12 h after birth is highly simple and time-saving; consequently, its result can be used in routine investigations.

It seems crucial to perform further studies with a larger sample size and in different hospitals at various levels of care all over Iran to determine the accuracy and precision of the tool and determine a more accurate score limit for the prediction of the mortality outcome in neonates.

### Acknowledgments

This article is a part of a thesis entitled “Mortality prediction risk in preterm newborns based on CRIB II Scoring System” submitted in partial fulfillment of the requirement for a degree of master of science in neonatal intensive care nursing. The approval of the ethics committee was obtained under IR.SBMU.PHNM.1395.682. The authors would like to thank the authorities at Vali-e Asr Hospital, Tehran, Iran, as well as the hospital staff.

### Conflicts of Interest

None declared.

### References

1. Fazli SM, Mohamadzadeh A, Salari M, Karbandi S. Comparing the effect of non-nutritive sucking and abdominal massage on feeding tolerance in preterm newborns. *Evid Based Care*. 2017;7(1):53-9.
2. Kliegman RM, Behrman RE, Jenson HB, Stanton BM. *Nelson textbook of pediatrics e-book*. 8<sup>th</sup> ed. Amsterdam, Netherlands: Elsevier Health Sciences; 2019.
3. Safer MP. *Neonatal and perinatal mortalit*. Geneva: World Health Organization; 2007.
4. Blencowe H, Cousens S, Oestergaard MZ, Chou D, Moller AB, Narwal R, et al. National, regional,

- and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet*. 2012;379(9832):2162-72.
5. Salimi M, Masoumpoor A, Shirinabadi Farahani A, Shakeri N, Alaei Karharoudy F, Shiri H. Auditing nursing care related to weaning neonates from mechanical ventilation in neonatal intensive care units. *J Hayat*. 2016;22(2):159-74.
  6. Menezes AM, Barros FC, Horta BL, Matijasevich A, Bertoldi AD, Oliveira PD, et al. Stillbirth, newborn and infant mortality: trends and inequalities in four population-based birth cohorts in Pelotas, Brazil, 1982–2015. *Int J Epidemiol*. 2019;48(Suppl 1):i54-62.
  7. Shariat M, Dalili H, Farrokhzad N, Kavyani Z, Sahebi L, Habibelahi A, et al. Determination of predictive power of CRIB-II and SNAPPE-II in mortality risk of low gestational age or birth weight neonates admitted to NICU. *Iran J Neonatol*. 2020;In Press.
  8. Zeinalzadeh AH, Khodaei R, Heidarzadeh M, Mirnia K. Causes of neonatal mortality in the neonatal intensive care unit of Taleghani Hospital. *Iran J Neonatol*. 2017;8(3):58-61.
  9. Patrick SW, Schumacher RE, Davis MM. Methods of mortality risk adjustment in the NICU: a 20-year review. *Pediatrics*. 2013;131(Suppl 1):S68-74.
  10. Ghaffari Saravi V, Khani S, Kosarian M, Zaeriaqamshady H. Predictive value of SNAP-PE, SNAP, CRIB indices for prediction of disease severity and determination of death in infants admitted to NICU. *J Mazandaran Univ Med Sci*. 2009;19(73):1-9.
  11. Ashrafzadeh M, Shirinabadi Farahani A, Rassouli M, Shariat M, Nasiri M, Faridpor F. The prediction of mortality risk in preterm infants hospitalized in the neonatal intensive care unit using SNAPPE-II score system. *J Compr Ped*. 2019;10(3):e85983.
  12. Richardson DK, Corcoran JD, Escobar GJ, Lee SK. SNAP-II and SNAPPE-II: simplified newborn illness severity and mortality risk scores. *J Pediatr*. 2001;138(1):92-100.
  13. Lee SM, Lee MH, Chang YS. The clinical risk index for babies II for prediction of time-dependent mortality and short-term morbidities in very low birth weight infants. *Neonatology*. 2019;116(3):244-51.
  14. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med*. 2013;35(2):121-6.
  15. Babaei H, Jafrasteh A. The evaluation of CRIB II scoring system in predicting mortality in preterm newborns. *Yafteh*. 2015;16(4):27-35.
  16. Parry G, Tucker J, Tarnow-Mordi W, Group UNSSC. CRIB II: an update of the clinical risk index for babies score. *Lancet*. 2003;361(9371):1789-91.
  17. Mohkam M, Afjeii A, Payandeh P, Zadkarami M, Kazemian M, Fakhraii H, et al. A comparison of CRIB, CRIB II, SNAP, SNAPII and SNAP-PE scores for prediction of mortality in critically ill neonates. *Med J Islam Repub Iran*. 2011;24(4):193-9.
  18. Gagliardi L, Cavazza A, Brunelli A, Battaglioli M, Merazzi D, Tandoi F, et al. Assessing mortality risk in very low birthweight infants: a comparison of CRIB, CRIB-II, and SNAPPE-II. *Arch Dis Child Fetal Neonatal Ed*. 2004;89(5):F419-22.
  19. Ezz-Eldin ZM, Hamid TA, Youssef MR, Nabil HE. Clinical risk index for babies (CRIB II) scoring system in prediction of mortality in premature babies. *J Clin Diagn Res*. 2015;9(6):SC08-11.
  20. De Felice C, Del Vecchio A, Latini G. Evaluating illness severity for very low birth weight infants: CRIB or CRIB-II? *J Maternal Fetal Neonatal Med*. 2005;7(4):257-60.
  21. Khosravi N, Khosravi N. Evaluation of clinical risk factors clinical risk index for babies in predicting survival of extremely low birth weight infants. *Razi J Med Sci*. 2014;21(125):104-9.
  22. Fouladinejad M, Behnampour N, Zanjani AP, Gharib MH, Kamrani MA. The evaluation of predicting mortality risk of premature infants with very low birthweight by CRIB score. *J Gorgan Univ Med Sci*. 2009;10(4):40-89.