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Accuracy of Crib-Ii for Predicting Mortality of Preterm Infants Admitted to the NICU

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Abstract

Background: Survival of infants admitted to the NICU does not depend exclusively on birth weight and gestational age, but on other perinatal factors and physiological conditions of individual infants, especially the severity of their illness. Therefore, scoring systems are needed to assess the risk of adverse outcomes for each premature infant. In this study, the accuracy of Crib-II was investigated to predict the mortality of premature babies admitted to the NICU.

Methods: 140 babies admitted to the NICU, meeting the selection criteria (gestational age less than 32 weeks or weight less than 1500 grams) were included in the study. The required data for the Crib-II tool (gender, gestational age, birth weight, initial temperature of the baby, and base excess) were collected and analyzed using SPSS software version 23.

Results: In this study, 45% (63 infants) were female and 55% (77 infants) were male, with a mortality rate of 30.7%. The average gestational age was 30.17±2.14 weeks, the average birth weight was 1856.52±583.18 grams, the average initial rectal temperature was 36.92±0.52 °C, the average base excess was -8.54±7.09 mmol/L, the average Crib-II score was 5.15±4.43, and the area under the roc curve with a cut point of 6.5 was 0.96. Also, the sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio were 96%, 93%, 98%, 95%, 97%, 46.5, and 0.07, respectively.

Conclusion: Based on our observations in this study, the Crib-II index has a high value in predicting the mortality of premature babies. It was able to correctly predict 96% of the deaths of premature babies, which indicates the high value of this index.

Key Words: Crib-Ii, Infant Mortality, Premature Baby.

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1- INTRODUCTION

Birth weight and gestational age are one of the important indicators for evaluating the growth and health of a baby at birth, the birth weight of 2500-4000 grams is in the normal range, and the birth weight of 1500-2500 grams is in the low weight range, and the birth weight less than 1500 grams is in the range of very low birth weight, the normal gestational age is between 38 and 42 weeks, and less than 37 weeks is premature birth (1). Compared to babies whose birth weight is normal (2500 grams or more), the probability of death of babies with low birth weight (less than 2500 grams at birth) is 40 times higher and the probability of death of very low birth weight babies is 200 times higher (2). The cause of prematurity is still not well understood (3); however, multiple maternal, fetal, and placental factors may contribute to preterm birth (4).

Despite recent advances in neonatal intensive care medicine, prematurity remains the leading cause of death in newborns (5). Due to the improvement of prenatal care in recent years, infant mortality has decreased significantly. However, the mortality rate among premature infants is still high (the mortality rate for infants born at 24-29 weeks of gestation was 70-220 per 1,000 live births) (6, 7). It is worth mentioning that the infant mortality rate increases with the decrease in birth weight and gestational age (6).

Birth weight and gestational age are used to predict mortality and other complications, although it is difficult to predict mortality and complications only by these two parameters. The death of premature babies depends on birth weight, gestational age, and other factors. It depends on perinatal factors and the physiological conditions of each baby (8); therefore, scoring systems are needed to assess the risk of adverse outcomes for each premature infant. Neonatal scoring systems estimate the probability of mortality and morbidity of a particular infant and can identify high-risk infants for special interventions (9, 10). Different scoring systems predict the death risk of premature babies, such as SNAP, SNAP-II, SNAPPE-II (10-12), Crib, Crib-II (13-15), each of which has different sensitivity and characteristics (16).

The drawbacks of these scoring systems are the complexity of the large number of variables and the collection of data in the first 24 hours of life (17). Crib II has an advantage over other scoring systems, and that is the way of collecting information in the first hours of life with only 5 variables (gender, weight, gestational age, temperature, base excess) (8).

CRIB-II has not yet been adopted in Iran, so information on its reliability and applicability in local settings is lacking. This study aims to evaluate the CRIB-II in predicting neonatal mortality in Taleghani Arak Hospital, which when combined with physicians' judgment, will lead to a better outcome by prioritizing care for at-risk infants.

2- MATERIALS AND METHODS

2-1. Design and population

In this study Cohort type, Premature babies hospitalized in the NICU of Taleghani Arak Hospital with gestational age of less than 32 weeks or weight of less than 1500 grams were included in the study and until discharge from the NICU or in case of death in the NICU were followed- up and the final outcome of the babies (alive/dead) were recorded.

2-2. Procedure

All the infants studied were evaluated based on the Crib-II scoring system and the Crib-II score was determined for each infant, so that the five variables that make up the Crib-II, i.e., sex, birth weight, gestational age, initial temperature of the

infant, and base excess, were assessed as follows.

Gestational age was determined based on the first day of the mother's last menstrual period or an ultrasound performed before the 20th week of pregnancy or the Ballard criteria. Birth weight was measured using a digital scale. Base excess was determined based on arterial blood gas analysis, initial body temperature using a rectal mercury thermometer, and the sex of the baby was determined based on the phenotype of the newborn's reproductive system. All the criteria required in the study were registered and the final score of Crib-II was calculated for them.

2-3. Data analysis

The data was entered and analyzed using SPSS software version 23. The area under the ROC curve was used to evaluate and compare the results of predicting mortality. Accuracy, sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio were calculated using the 2x2 table, considering mortality as the gold standard. In all cases, 0.05 was considered as the level of significance.

3- RESULTS

Based on Table 1, a total of 140 babies were examined in this study, of which (45%) 63 were female and (55%) 77 were male. 97 infants (69.30%) survived and were discharged from the hospital and 43 infants (30.70%) died in the hospital. The average gestational age, average birth weight, average body temperature and average base excess (based on the results of arterial blood gas analysis) in dead infants were significantly lower than those in infants who survived.

Table-1: Mean and standard deviation of variables studied in infants by outcome

Variable	Outcome	Minimum	Maximum	Mean	Standard deviation	P-value
Gestational age (weak)	Alive (97)	28	32	31.21	0.99	0.0001
	Dead (43)	24	32	27.84	2.24	
birth weight (gram)	Alive (97)	1190.00	3000.00	2086.00	455.36	0.0001
	Dead (43)	700.00	2800.00	1338.86	505.60	
Initial temperature (°C)	Alive (97)	36	38	36.95	0.20	0.02
	Dead (43)	35.90	39.50	36.86	0.89	
Base excess (Mmol/l)	Alive (97)	-17.50	1.90	-5.04	3.50	0.0001
	Dead (43)	-29.00	4.20	-16.04	6.80	

Using the ROC curve diagram, the cut-off point of 6.5 with 93% sensitivity and 98% specificity was determined for the Crib-II score, and using the cut-off point, the outcome of death/life of infants was predicted. Crib-II score above 6.5 was considered as a predictor of infant death.

In the ROC curve, the higher the AUC, the better the model has performed in diagnosing diseased and healthy patients (18). Therefore, based on Fig. 1, Crib-II with the area under the curve of 0.96 has performed well in determining the correct prediction of the mortality of premature babies.

The outcome predicted by the Crib-II tool compared to the actual outcome of the newborns was reported in Table 2.

Crib-II score was positive in 42 patients and negative in 98 cases. Among the 42 positive patients, 40 patients died and 2 patients survived.

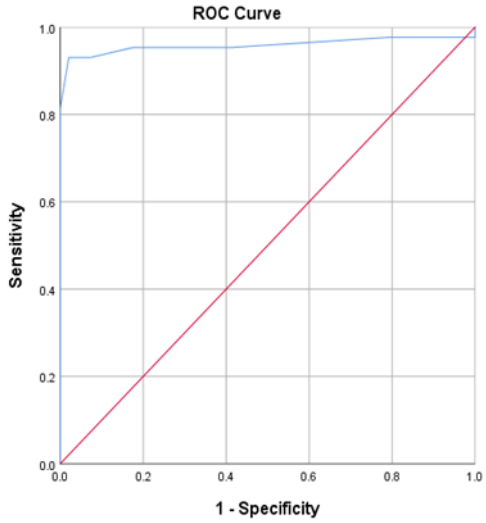

Fig. 1: ROC curve for prediction of mortality by CRIB-II

Table-2: CRIB Score status and mortality

CRIB-II score status	Mortality of Patient		Total
	Yes	No	
Positive	40 (TP)	2 (FP)	42
Negative	3 (FN)	95 (TN)	98
Total	43	97	140

TP: True Positive / FP: False Positive / TN: True Negative / FN: False negative

Among the 98 patients whose Crib-II scores were negative, 95 patients survived and 3 patients died. Of the 43 patients who died, 40 patients had a positive Crib-II score and 3 patients had a negative Crib-II score. With these interpretations, based on Table 3, Crib-II in our study has a sensitivity of 93%, a specificity of 98%, a positive predictive value of 95%, a negative predictive value of 97%, a positive likelihood ratio of 46.5, and a negative likelihood ratio of 0.07. It also has a diagnostic accuracy of 96%.

Table-3: The diagnostic accuracy of crib-II score

Diagnostic Accuracy	Formula	Percentage/ Value
Accuracy	(TP + TN) / pop	96%
Sensitivity	TP / (TP + FN)	93%
Specificity	TN / (FP + TN)	98%
Positive predictive value	TP / (TP + FP)	95%
Negative predictive value	TN / (FN + TN)	97%
Positive likelihood ratio	Sensitivity/(1- Specificity)	45.6
Negative likelihood ratio	(1- Sensitivity)/ Specificity	0.07

4- DISCUSSION

Several groups of infants are high-risk. These include infants below the 10th percentile, infants with intrauterine growth restriction, gestational age below 37 weeks, large-for-gestational-age infants, small-for-gestational-age infants, infants with sepsis, and children of mothers with

Eclampsia, Chorioamnionitis, or Diabetes (19-21). Infant mortality is an important parameter in measuring the efficiency of some health systems of the country. Likewise, if with some neonatal scoring systems, even at admission, we can categorize some infants as having a high chance of death, this can help us in providing and allocating more specialized care to these infants and ultimately may reduce morbidity and mortality. There are several scoring systems to assess the severity of disease, its outcome, and neonatal mortality (10). These scoring systems should have features such as easy to use; all parameters be filled easily, if it will be having more invasive parameters then its applicability will be affected. In addition to these, the next important parameter is its ability to predict mortality and morbidities. Currently, good predictive values of Crib-II have been found in the neonatal intensive care unit (14, 22). That's why we used the Crib-II scoring system.

In a study to investigate the accuracy of Crib-II for predicting mortality of Severely-ill Preterm Neonates, 200 infants who met the selection criteria (gestational age 26 to 34 weeks and admitted to the neonatal intensive care unit during the first 12 hours of life) were examined. They stated that Crib-II has a sensitivity of 77.7%, a specificity of 65.4%, a positive predictive value of 64.8%, and a negative predictive value of 78.2% (23). Also in 2022, Sadia Qasim et al. conducted a study on 240 premature babies born before the 32nd week of pregnancy with a birth weight of 600 to 1500 grams to target the predictive power of the Crib-II in premature babies and found that the Crib-II has sensitivity, specificity, positive predictive value, and negative predictive value of 92.68%, 94.94%, 90.48%, and 96.15%, respectively (24). Abdul Rehman and Muhammad Haroon Hamid in a study entitled the accuracy of the Crib-II score in predicting mortality in very premature babies included 145 premature babies and stated that the Crib-II has an area under the receiver operating characteristic curve of 0.84, the accuracy was 84.14%. The sensitivity in their findings was 84.91%, specificity was 83.70%, positive predictive value was 75%, and negative predictive value was 90.58% (25).

Although in the mentioned studies as well as our study, Crib-II has a high value in predicting the mortality of premature babies, there are studies who have evaluated the Crib-II index at a lower level than other indices. In the study by Baumer et al., from 1991 to 2006, 1485 infants were examined. In this study, based on AUC, Crib (82%), Gestational age (71%), and Crib-II (69%) of infant death cases were predicted. Despite there being no significant difference between the indicators, Crib-II had a lower value than other indicators. Although no specific reason has been given to justify these observations, the authors have considered it necessary to conduct more studies (26).

In a study to investigate the value of crib-II in predicting the mortality rate of premature babies compared to their birth weight and gestational age, 97 babies were examined and the area under the rock curve for birth weight, gestational age and crib-II was almost equal and the results of this study show that crib-II has no more power than gestational age and birth weight in predicting the death rate of premature babies (27).

Also, Masoumeh Mohkam et al., in their study of published in 2010, comparing newborn scoring systems (Crib, Crib II, Snap, Snap II and Snap-pe) state that Crib-II has the lowest accuracy amongst the tools (67.1% compared to Snap (92.8%) and Crib (84.4%)) (16). While Gagliardi et al., in their study comparing Crib, Crib-II, and SNAPPE-II by measuring the area under the receiver operating characteristic curve (AUC) state that Crib and Crib-II are

better discriminated than SNAPPE-II (AUC 0.90 and 0.91 against 0.84)(28).

In the study carried out by us, the Crib-II scoring system was used to predict the mortality of premature babies hospitalized in intensive care with a gestational age less than 32 weeks or birth weight less than 1500 grams.

The strength of the present study was that all the variables examined in this scoring system are routinely measured in all infants included in the study, and we did not need any further intervention for this study.

5- CONCLUSION

Based on our observations in this study, the Crib-II index has a high value in predicting the mortality of premature babies. It was able to correctly predict 96% of the mortality of premature babies, which indicates the high value of this index. Because predicting the mortality of premature babies (gestational age less than 32 weeks or weight less than 1500 grams) is of great importance in carrying out therapeutic interventions, Crib-II is a reliable tool in predicting the mortality of newborns and stratifying them in prioritizing therapeutic interventions, especially in low-income areas.

6- CONFLICT OF INTEREST

There is no conflict of interest involved.

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8- REFERENCES

1. Cutland CL, Lackritz EM, Mallett-Moore T, Bardají A, Chandrasekaran R, Lahariya C, et al. Low birth weight: Case definition & guidelines for data collection, analysis, and presentation of maternal immunization safety data. Vaccine. 2017 Dec 12;35(48Part A):6492.

2. Waldemar A. Prematurity and Intrauterine Growth Restriction. Robert M Kliegman, Stanton. Nelson textbook of pediatrics. Philadelphia: Saunders; 2011.

3. Bettiol H, Barbieri MA, da Silva AA. Epidemiology of preterm birth: current trends. Revista brasileira de ginecologia e obstetricia: revista da Federacao Brasileira das Sociedades de Ginecologia e Obstetricia. 2010 Feb;32(2):57-60.

4. Villar J, Papageorghiou AT, Knight HE, Gravett MG, Iams J, Waller SA, et al. The preterm birth syndrome: a prototype phenotypic classification. American journal of obstetrics and gynecology. 2012; 206(2):119-23.

5. Goldenberg RL, Culhane JF, Iams JD, Romero R. Epidemiology and causes of preterm birth. The lancet. 2008; 371(9606):75-84.

6. Helenius K, Sjörs G, Shah PS, Modi N, Reichman B, Morisaki N, et al. Survival in very preterm infants: an international comparison of 10 national neonatal networks. Pediatrics. 2017 Dec 1;140(6).

7. Patel RM, Kandefer S, Walsh MC, Bell EF, Carlo WA, Laptook AR, et al. Causes and timing of death in extremely premature infants from 2000 through 2011. New england journal of medicine. 2015 Jan 22;372(4):331-40.

8. Reid S, Bajuk B, Lui K, Sullivan EA, NSW, ACT Neonatal Intensive Care Units Audit Group P. Comparing CRIB-II and SNAPPE-II as mortality predictors for very preterm infants. Journal of pediatrics and child health. 2015; 51(5):524-8.

9. Dorling JS, Field DJ, Manktelow B. Neonatal disease severity scoring systems. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2005 Jan 1;90(1):F11-6.

10. Garg B, Sharma D, Farahbakhsh N. Assessment of sickness severity of illness in neonates: review of various neonatal illness scoring systems. The Journal of Maternal-Fetal & Neonatal Medicine. 2018 May 19;31(10):1373-80.

11. Richardson DK, Tamow-Mordi WO, Escobar GJ. Neonatal risk scoring systems: can they predict mortality and morbidity?. Clinics in perinatology. 1998 Sep 1;25(3):591-608.

12. Richardson DK, Corcoran JD, Escobar GJ, Lee SK. SNAP-II and SNAPPE-II: simplified newborn illness severity and mortality risk scores. The Journal of pediatrics. 2001 Jan 1;138(1):92-100.

13. McLeod JS, Menon A, Matusko N, Weiner GM, Gadepalli SK, Barks J, et al. Comparing mortality risk models in VLBW and preterm infants: systematic review and meta-analysis. Journal of Perinatology. 2020 May;40(5):695-703.

14. Parry G, Tucker J, Tarnow-Mordi W. CRIB II: an update of the clinical risk index for babies score. The Lancet. 2003 May 24;361(9371):1789-91.

15. Manktelow BN, Draper ES, Field DJ. Predicting neonatal mortality among very preterm infants: a comparison of three versions of the CRIB score. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2010 Jan 1;95(1):F9-13.

16. 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. 2011.

17. Harsha SS, Archana BR. SNAPPE-II (score for neonatal acute physiology with perinatal extension-II) in predicting mortality and morbidity in NICU. Journal of clinical and diagnostic research: JCDR. 2015 Oct;9(10):SC10.

18. Narkhede S. Understanding auc-roc curve. Towards data science. 2018 Jun 26;26(1):220-7.

19. Burstein R, Henry NJ, Collison ML, Marczak LB, Sligar A, Watson S, et al. Mapping 123 million neonatal, infant and child deaths between 2000 and 2017. Nature. 2019 Oct 17;574(7778):353-8.

20. Howell EA, Janevic T, Hebert PL, Egorova NN, Balbierz A, Zeitlin J. Differences in morbidity and mortality rates in black, white, and Hispanic very preterm infants among New York City hospitals. JAMA pediatrics. 2018 Mar 1;172(3):269-77.

21. Stomnaroska O. Neonatal hypoglycaemia in children with high and normal risk: incidence, etiology, therapeutics and prognosis. Doctotal thesis, Medical Faculty Skopje, University Sts Cyril and Methodius. 2017.

22. Guenther K, Vach W, Kachel W, Bruder I, Hentschel R. Auditing neonatal intensive care: is PREM a good alternative to CRIB for mortality risk adjustment in premature infants?. Neonatology. 2015 Sep 1;108(3):172-8.

23. Akbar N, Sarwar S, Sajid M, Hayat M, Hassan A, Wasim A. The accuracy of clinical risk index for babies (CRIB-II) for predicting mortality of severely-ill preterm neonates. Annals of Punjab Medical College. 2020 Mar 31;14(1):54-7.

24. Qasim S, Zahid S, Islam A, Anwar M, Siddique S, Rafique A. Clinical Risk Index Score (CRIB II) as a Predictor of Neonatal Mortality among Premature Babies. Pakistan Journal of Medical & Health Sciences. 2022 Sep 4;16(08):70-.

25. Rehman A, Hamid MH. Accuracy of CRIB II Score in Predicting the Neonatal Mortality in very Preterm Babies. Pakistan Journal of Medical & Health Sciences. 2022 Apr 18;16(03):564-.

26. Baumer JH, Wright D, Mill T. Illness severity measured by CRIB score: a product of changes in perinatal care?. Archives of Disease in Childhood-Fetal and Neonatal Edition. 1997 Nov 1;77(3):F211-5.

27. Khanna R, Taneja V, Singh SK, Kumar N, Sreenivas V, Puliyel JM. The clinical risk index of babies (CRIB) score in India. The Indian Journal of Pediatrics. 2002 Nov;69:957-60.

28. 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. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2004 Sep 1;89(5):F419-22.