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Comparison of CRIB-II and SNAP-PE-II Scoring Systems in Predicting the Mortality and Morbidity of Very Low Birth Weight Infants

Çok Düşük Doğum Ağırlıklı Bebeklerde CRIB-II ve SNAP-PE-II Skorlama Sistemlerinin Mortalite ve Morbiditeleri Öngörmedeki Etkinliklerinin Karşılaştırılması

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ABSTRACT

Objective: A number of illness severity scores have been established to predict mortality and morbidity in neonatal intensive care units (NICUs). The objective of this study was to compare SNAPPE-II (Scores for Neonatal Acute Physiology- Perinatal Extension-II) and CRIB- II (Clinical Risk Index for Babies-II), the latest versions of European and American scoring systems, in predicting hospital mortality and overall morbidity of surviving infants.

Material and Methods: Very low birthweight infants (VLBW) admitted to the neonatal intensive care unit were identified. CRIB-II and SNAP-PE-II scores were electronically calculated for each patient via the website www.sfar.org. The receiver operating characteristics (ROC) curve was used to check the accuracy of the mortality and morbidity prediction.

Results: A total of 189 VLBW neonates (mean CRIB-II:9.9±3.8; mean SNAP-PE-II: 45.8±25.4) were evaluated. The mean birth weight, gestational age, CRIB-II, SNAP-PE-II scores were associated with mortality. Both CRIB-II and SNAP-PE-II were determined to be discriminatory for mortality, but not predictive enough for morbidity when evaluated with ROC curve analysis.

Conclusion: Both CRIB-II and SNAP-PE-II were found to be eligible in predicting hospital mortality of VLBW patients whereas their value was poor in predicting morbidity. CRIB-II, due to fewer parameters to evaluate, may be the preferred scoring system to predict mortality in NICUs with high patient capacity.

Key Words: Morbidity, Mortality, Newborn, Risk assessment

ÖZET

Amaç: Yenidoğan yoğun bakım ünitelerinde (YYBÜ) hastalığın ciddiyetini değerlendirmek ve mortalite ve morbiditeyi öngörmek için oluşturulmuş pek çok skorlama sistemi mevcuttur. Çalışmanın amacı Amerikan ve Avrupa skorlama sistemlerinin son versiyonları olan SNAP-PE-II (Scores for Neonatal Acute Physiology-Perinatal Extension-II) ve CRIB-II (Clinical Risk Index forBabies-II) skorlama sistemlerinin çok düşük doğum ağırlıklı bebeklerde, hastane mortalitesini ve yaşayan infantlarda morbiditeyi tahmin etmedeki etkinliğinin karşılaştırılmasıdır.

Gereç ve Yöntemler: Yenidoğan Yoğun Bakım ünitesine yatırılan çok düşük doğum ağırlıklı infantlar çalışmaya dahil edildi. Mortalite ihtimali tahminleri CRIB-II ve SNAP-PE-II skorları kullanılarak hesaplandı. Mortalite ve morbidite tahminlerinin doğruluğunun değerlendirilmesi için reciever operating characteristics (ROC) analizi kullanıldı.

Bulgular: Toplam 189 çok düşük doğum ağırlıklı bebek (ortalama CRIB-II: 9.9±3.8; ortalama SNAP-PE-II: 45.8±25.4) çalışmaya dahil edildi. Doğum ağırlığı, gestasyonel yaş, CRIB-II ve SNAPP-II skorları mortalite ile ilişkili saptandı. Hem CRIB-II hem de SNAP-PE-II'nin mortalite için ayrımcılığı iyi saptanırken, ROC analizi ile değerlendirilen morbiditeyi öngörmedeki performansları yetersiz saptandı.

Sonuç: Hem CRIB-II hem de SNAP-PE-II skorları hastane mortalitesi tahmininde iyi iken, morbiditeyi tahmin etmede ikisi de yetersizdir. Daha az veri ile hesaplanan CRIB-II skoru daha pratik olduğundan, hasta sayısı fazla olan yenidoğan yoğun bakım ünitelerinde çok düşük doğum ağırlıklı bebeklerin mortalite ihtimalini değerlendirmede öncelikli tercih olabilir.

Anahtar Sözcükler: Morbidite, Mortalite, Yenidoğan, Risk değerlendirme

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INTRODUCTION

The early recognition of patients with increased risk of mortality and morbidity in Neonatal Intensive Care Units (NICUs) may result in improved patient care. Many scoring systems have been established to predict the prognosis of sick neonates, to plan medical interventions of patient care and to inform the families about the possible outcomes. It also helps to compare different patient groups of NICUs for clinical purposes (1, 2).

Assessment of disease severity in NICUs has traditionally used birth weight and Apgar scores but they lack the ability to capture dimensions of illness severity and explain possible variations between NICUs. In 1993, the Score for Neonatal Acute Physiology (SNAP), the SNAP-Perinatal Extension (SNAP- PE) and the Clinical Risk Index for Babies (CRIB) scores were proposed for clinical use (3-5). The clinical validity of CRIB and SNAPPE has previously been reported and both scores have been revised (6-10). In 2001, an updated and simplified version of SNAPPE, called SNAPPE-II, was reported, consisting of only 9 parameters in the first 12 hours instead of the original 34 collected in the first 24 hours (11). In 2003, an update of CRIB was declared, using only five parameters available up to one hour from admission; as CRIB- II (12). However, the value of scoring systems in the prediction of death differs between countries, and even interinstitutional variations are observed due to varied distribution of gestational ages (13).

The aim of this study was to compare the two scoring systems, SNAPPE-II and CRIB- II, for predicting mortality in very low birth weight (VLBW) neonates and to evaluate the performance of these scoring systems in predicting morbidities of surviving infants at a tertiary neonatal intensive care unit in Turkey.

PATIENTS and METHODS

Study Group

This prospective cohort study was conducted at the NICU of Tepecik Training and Research Hospital in İzmir, a tertiary care center serving the Aegean Region of Turkey, after local ethics committee approval. All preterm newborns with <32 weeks of gestation and < 1500 g birth weight (VLBW), admitted to the NICU at within the first 12 hours of age, were eligible for inclusion during the one-year period. Infants with major congenital anomalies or congenital metabolic disorders, <23 weeks of gestation and <500 g birth weight, and admitted to the NICU after the first 12 hours of age were excluded from the study.

Data Collection

The data about perinatal and antenatal properties including multiple gestation, gestational age, birthweight, gender, delivery type, Apgar Scores at the 1st and 5th minutes, antenatal steroid therapy, and duration of hospitalization were recorded. Gestational age was calculated from the first day of the last menstrual period (LMP) or from obstetric ultrasonography if LMP was not known. In cases where both the LMP and obstetric ultrasonography were missing, the Expanded New Ballard score was used to assess gestational age (14). SNAP-PE II and CRIB-II were calculated electronically on the website www.sfar.org as soon as the patient was stabilized on admission (15). SNAPPE-II included nine items: birth weight, mean blood pressure, lowest temperature (rectal), P02 (mmHg) / FIO2 (%) ratio, lowest pH, multiple seizures, urine output (mL/kg/h), 5th minute Apgar score, and being small for gestational age (SGA).

CRIB-II was calculated with five items: gender, gestation (week), birthweight (g), temperature on admission (rectal), and base excess. The data were collected in the defined time period of the scoring systems.

The infants diagnosed with necrotizing enterocolitis (NEC) according to the Bell's stage II or III, bronchopulmonary dysplasia (BPD), and intracranial hemorrhage (ICH) were recorded, after the diagnosis was established by the same neonatologist. All infants were screened for retinopathy of prematurity (ROP) at postnatal 30th day with binocular indirect fundoscopy by the same ophtalmologists, and followed-up according to initial findings and risk factors. SNAP-PE II and CRIB- II were evaluated to predict both the mortality risk and morbidity in the study group based on NEC, BPD, ICH and ROP in the surviving infants.

Statistical Methods

Statistical analyses were performed using SPSS software version 18 and Medcalc software version 12. The univariate analysis to identify variables associated with patient outcome (survive/ death) during the NICU stay was investigated by Chi-square, Fisher exact, Student t and Mann-Whitney U tests, where appropriate. Point biserial correlation was used to investigate the association between mortality and scoring systems. For the multivariate analysis, the possible factors identified with univariate analysis were further entered into the logistic regression model to determine any other factor affecting patient outcome. The Hosmer-Lemeshow goodness of fit test was used to assess model fit. A 5% type-1 error level was used to infer statistical significance. The patients were divided into two groups as survivors and non-survivors and then analyzed. The capacity of CRIB-II and SNAP-PE-II scores in predicting mortality and morbidity were analyzed using the Receiver Operating Characteristics (ROC) curve analysis (16). When a significant criterion value was observed with the highest Youden index, the sensitivity, specificity, positive and negative predictive values were presented. Comparison of ROC curves were obtained by the method of De Long et al. (17). Acceptable discrimination of ROC analysis was represented by an area under the curve (AUC) value of 0.70-0.79, and good discrimination by an AUC value ≥0.80.

RESULTS

A total of 189 VLBW infants (mean gestational age: 28.2±2.2 weeks; mean birth weight: 1064±262 g; male/female: 107/82) were included in this prospective cohort study. Antenatal risk factors such as multiple birth and in vitro fertilization were present in 62.5% of the study group. The mortality rate in the study group was 50.7%. The most common morbidity in surviving neonates was ROP (n=40; 43%), followed by ICH (n=14; 15.1%), BPD (n=2; 2.2%) and NEC (n=2; 2.2%). The basic characteristics of the infants and accompanying risk factors are presented in Table I.

The mean CRIB-II score was 9.9±3.8 and the mean SNAP-PE-II score was 45.8±25.4 in overall patients. CRIB-II scores were calculated as 12.1±3.6 and 7.5±2.4 while SNAP-PE-II scores were calculated as 30.8±15.5 and 60.2±24.7 in survivors and non-survivors, respectively. The difference between survivors and non-survivors was statistically significant (p<0.001). The mean birth weight (1196.6±215 g/935.6±254 g) and gestational age (29.1±1.6 week/26.9±2.1 week) were also different between the two groups (p<0.001) (Table II). Higher scores of CRIB-II, SNAP-PE-II were found to be associated with increased risk of mortality (r=0.58) when evaluated with the point biserial correlation model. Birth weight (r=0.48, p< 0.001) and gestational age (r=0.5 p< 0.001) were also found to be associated with increased risk of mortality on univariate analysis, but the logistic regression model did not show significant risk with gestational age (OR=0.84; 95% CI=0.6-1.18; p=0.33) or birth weight (OR=1.002; 95% CI=0.999-1.002; p=0.21).

The ROC curves for CRIB-II and SNAP-PE-II are presented in Figure 1. The sensitivity, specificity, positive predictive value and negative predictive value of CRIB-II and SNAP-PE-II in predicting hospital mortality are also summarized in Figure 1. The area under the ROC curve of CRIB-II for mortality was 0.83 (95% CI=0.77-0.88) with the best discriminatory cut-off value 9 and the AUC value was statistically significant (p<0.01). The cut-off value of the ROC curve of SNAP-PE-II for mortality was 43; the AUC value was 0.85 (95% CI=0.79-0.89) and statistically significant (p<0.01). Both CRIB-II and SNAP-PE-II were found to be discriminatory and no significant difference was present between the ROC curves of these scoring systems when evaluated with the method of DeLong et al. (p=0.69). Hosmer-Lemeshow test was performed to test the difference between observed and expected outcomes to calibrate. Both CRIB-II (p=0.81; $\chi 2$=3.6) and SNAP-PE-II (p=0.1; $\chi 2$=11.7) were found to be well calibrated in the multivariate model. The AUC values for CRIB-II and SNAP-PE-II to predict the overall morbidity of survivors were 0.60 (95% CI=0.48-0.71) and 0.56 (95% CI=0.44-0.68), respectively, lacking an accurate statistically significant discriminant value (p>0.05).

Table I. The clinical characteristics of the study group.

Clinical characteristic	Result
Number of cases, n	189
APGAR Score (1st min)‡	3 (0-7)
APGAR Score (5th min)‡	4 (0-10)
Birth weight (g)*	1064±262
Gestational age (weeks)*	28±2.2
Gender (Male/Female)	107/82
Type of delivery, n (normal/cesarean section)	75/114
Multiple birth, n (%)	52 (27.5)
SGA†, n (%)	39 (20.6)
Premature rupture of membranes, n (%)	53 (28)
Antenatal steroid, n (%)	32 (16.9)
Duration of hospitalization, (day)‡	22 (1-107)
Mortality, n (%)	96 (50.7)

*‡Data are presented as median (min-max), * Data are presented as mean + standard deviation, † Small for gestational age.*

DISCUSSION

In the current study, both CRIB-II and SNAP-PE-II were found to be eligible in predicting hospital mortality but poor in predicting morbidity of VLBW patients. Survival of very low birthweight (VLBW) neonates depends on birth weight and gestational age, together with other perinatal factors and physiological status of the individuals, and in particular disease severity in the first hours of life (18). Illness severity scores have thus been developed with the aim of identifying the clinically obvious fact that infants of the same birth weight and gestational age differ in their risk of mortality (19). In the literature, there are some reports evaluating the discriminatory values of neonatal scoring systems in predicting hospital mortality. De Felice et al. (20) reported that CRIB and CRIB-II scores have similar accuracy values in predicting in-hospital neonatal mortality in a group of VLBW infants. Moreover, Rautonen et al. (21) reported that

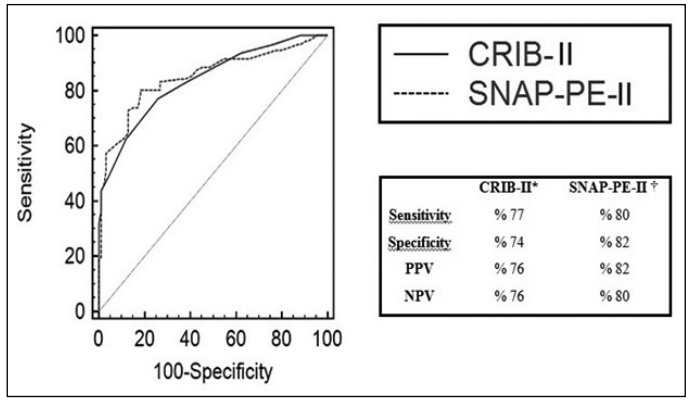

Figure 1: The ROC curve, sensitivity, specificity, PPV and NPV of CRIB-II and SNAP-PE-II in predicting mortality.
*Cut-off value: 9 *Area under the curve = 0.839
†Cut-off value:43† Area under the curve = 0.851

Table II: Clinical characteristics of the survivors and non-survivors in the study group.

Clinical characteristics	Survivors (n=93)	Non-survivors (n=96)	p
Birth weight (g)*	1196.6±215	935.6±254	<0.001
Gestational age (weeks)*	29.1±1.6	26.9±2.1	<0.001
Gender (Male/Female)	45/48	62/34	0.02
Type of delivery (normal/cesarean section)	29/64	46/50	0.02
Multiple birth, n (%)	27/66	25/71	0.50
Premature rupture of membranes	24/69	29/67	0.50
SGA‡, n (%)	17 (18.2)	22 (22.9)	0.43
Antenatal steroid, n (%)	19 (20.4)	13 (13.5)	0.20
Duration of hospitalization (day)†	42 (14-105)	4.5 (1-107)	<0.001
CRIB-II$^{\delta}$ Score*	12.1±3.6	7.5±2.4	<0.001
SNAP-PE-II§ Score*	30.8±15.5	60.2±24.7	<0.001

** Data are presented as mean + standard deviation, ‡ Small for gestational age, † Data are presented as median (min-max), δ Clinical Risk Index for Babies, § Score for Neonatal Acute Physiology Perinatal Extension.*

CRIB scores were significantly better for assessing mortality risk than SNAP and SNAP-PE. The high mortality rate in our study may be due to low antenatal steroid use rate and other perinatal risk factors. In another report, all neonatal mortality scores including SNAP, SNAP-II, SNAP-PE, SNAP-PE-II and CRIB scores had better performance and were superior to birthweight as measures of in-hospital mortality with no statistically significant differences between the areas obtained for all scores evaluated (22).

In our study, both CRIB-II and SNAP-PE-II are determined to be discriminative to predict mortality with AUC values >0.80. Gagliardi et al. (23) compared CRIB, CRIB-II and SNAP-PE-II and reported that CRIB and CRIB-II had greater discriminatory ability than SNAPPE-II (AUC values for CRIB, CRIB-II and SNAP-PE-II as 0.90, 0.91, 0.84, respectively). These high levels of AUC for CRIB-II may be due to large sample size of their study. Recently, the AUC value for CRIB-II was reported as 0.9 and validated as a good predictive instrument for mortality in preterm infants ≤32 weeks gestation (24). In our study, the AUC value for SNAP-PE-II (0.85) was greater than CRIB-II (0.83), but the difference was not significant statistically (p=0.69). In fact, the discriminative value obtained in this current study for SNAP-PE-II was similar, but lower for CRIB-II when compared with the available literature. This may be related with the fact that SNAP-PE-II consists of more objective laboratory variables and CRIB-II includes gestational age that may sometimes present subjectivity depending on the LMP or ultrasonographic evaluation or the New Ballard score.

In neonatal care, most scores are designed to adjust for risk of death particularly in preterm babies as survival rate has been chosen as the most important outcome for comparison (25). Furthermore, Eriksson et al. (26) reported that all indices predicted the early outcome better than the outcome at the 4-y follow-up and severity of illness indices could therefore be used as instruments to follow and improve neonatal intensive care, but unfortunately seem to have little value in long-term follow-up. In fact, there are only a few studies evaluating the value of CRIB-II and SNAP-PE-II in predicting morbidity in VLBW infants.

Fortes et al. (27) revealed a positive association between high SNAP-PE-II scores and the development of severe ROP, but reported no assessment of risk for the disease. The SNAPPE-II score has been reported to be a good predictor of mortality in perforated NEC (28). More recently, the ELGAN Study revealed that SNAP-II and SNAP-PE-II convey information about cerebral lesions, low Bayley scores and small head circumference but not cerebral palsy (29). To our knowledge, this current study is one of the few reports to evaluate the discriminatory value of neonatal scoring systems in predicting the overall morbidity. The AUC values for CRIB-II and SNAP-PE-II to predict the overall morbidity of survivors are 0.60 (95% CI=0.48-0.71) and 0.56 (95% CI=0.44-0.68), respectively. Our results suggest that the value of both CRIB-II and SNAP-PE-II in predicting the overall morbidity is poor. It is speculated that neonatal morbidities such as BPD, ROP and ICH are not only associated with perinatal events, but also related to neonatal intensive care practice. Indeed, CRIB-II was recently reported to predict the mortality but did not perform better than gestational age or birthweight in predicting functional disability (30).

The limitations of this study are the relative small numbers and the fact that it was conducted in only one NICU, preventing the comparison of multi-center outcomes. Therefore it may not be representative of the remainder of the country. Further confirmation of these results is required to evaluate whether CRIB-II and SNAP-PE-II models are institution-independent. Further work is needed in relation to the use of scoring systems for comparisons of later health status. A recent review of the

literature points out that scoring systems have to include a description of the population at risk (birth defects, etc.) and care environment such as medical technology or specific personnel to lead to an improvement in care (31).

CONCLUSION

Both CRIB-II and SNAP-PE-II, the latest versions of the European and American scoring systems predicting the mortality in newborns, were determined to be discriminatory for mortality, but not predictive enough for morbidity. As there was no statistically significant difference between CRIB-II and SNAP-PE-II in predicting hospital mortality, we recommend the use of CRIB-II, including fewer parameters and therefore making it more practical, in NICUs with high patient numbers.

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