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CRIB score, birth weight and gestational age in neonatal mortality risk evaluation

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ABSTRACT

Objective

To evaluate the mortality rate of very low birth weight babies born at a Neonatal Intensive Care Unit (NICU) during a specified period of time according to variations in CRIB (Clinical Risk Index for Babies) score, birth weight and gestational age.

Methods

From January 1997 to December 2000, the CRIB score was prospectively applied to all newborn infants admitted to the N ICU of an university hospital, of Londrina, Brazil, with birthweight under 1,500 g and/or less than 31 weeks' gestational age. The exclusion criteria were: death before 12 hours of life, presence of lethal congenital malformations and newborns who had been referred from other hospitals.

Results

Two hundred and eighty-four infants met the inclusion criteria. Mean birth weight was $1,148 \pm 248$ g (median = 1,180), mean gestational age was 30.2 ± 2.4 weeks (median = 30.0) and mean CRIB score was 3.8 ± 4.4 (median = 2.0). The neonatal mortality rate was 23.2%, varying according to mean birthweight <750 g (72.7%), gestational age <29 weeks (57.1%) and CRIB score >10 (79.4%). Receiver Operating Characteristic (ROC) curves were composed for CRIB score, birth weight and gestational age to assess the ability of each to predict hospital mortality and the areas under the curve were respectively 0.88, 0.76 and 0.81. Sensitivity, specificity and predictive values were evaluated and all variables were considered predictors of mortality ($p < 0.0001$). The optimal cut off point based on the ROC curve for the CRIB score was 4 with sensitivity 75.8%, specificity 86.7, positive predictive value 63.3% and negative predictive value 92.2%.

Conclusions

In this study infants with birthweight of less than 750 grams, less than 29 weeks gestational age and CRIB scores above 10 had higher mortality rates. However, a CRIB score higher than 4 proved to be a better predictor of mortality when compared to birthweight and gestational age.

Keywords

Infant, very low birth weight. Neonatal mortality (public health). Risk. Intensive care units, neonatal. Birthweight. Gestational age. CRIB score.

INTRODUCTION

Advances in perinatal medicine and the increasing sophistication of support therapies within neonatal intensive care units (NICUs) have led to a noteworthy reduction in the rates of neonatal mortality among very low birthweight infants. Progress in this field has brought into question the present limits of fetal viability. Mortality risk assessments, utilizing variables that may interfere in mortality rates, have been the object of study in different countries and different neonatology units. During a long time, birthweight and gestational age were significant univariate predictors of neonatal mortality. However, more complete scoring systems for assessing the risk of mortality have been developed recently which aggregate physiological parameters which reflect the initial clinical state of the newborn. Among the scores based on physiological alterations, some are simpler, with few variables and can be rapidly applied; others are more complete, for they contemplate more variables, but take a longer time to be applied. The scoring systems which have been studied in greater depth and which are more frequently utilized on newborns are the Clinical Risk Index for Babies (CRIB) Score and the Score for Neonatal Acute Physiology (SNAP). These scores were validated and re-applied in distinct studies in different countries. 11,12,16

Data from studies undertaken by the International Neonatal Network, in tertiary hospitals in the United Kingdom among newborns weighing less than 1500 g and/or less than 31 weeks gestational age, were analyzed and predictors for mortality were developed and proposed in 1993.¹⁶ Since then,

the CRIB score has been utilized in different neonatal units, 3,4,6,8,13 because it is a simple instrument which is sensitive and can be rapidly applied. It stresses parameters which reflect the physiological conditions of the newborn soon after birth and supercedes the disadvantages of birthweight specific and/or gestational age specific predictors of neonatal mortality. This score may also be employed in the evaluation of the performance of a single NICU throughout a period of time or when comparing the performances of different units.^{2,6,14} The score utilizes six different variables obtained routinely during the first 12 hours of life, namely, birthweight, gestational age, the presence of congenital malformation(s) (excluding inevitably lethal congenital malformations) and the indices of physiological status, that is, minimum and maximum appropriate inspired oxygen concentration and maximum (most acidotic) base excess.¹⁶

In Brazil, different neonatal units have utilized scores based on gravity of the clinical status of the newborn, reinforcing the importance of its application and recommending its use at the moment the infant is admitted to the NICU.^{8,9,13,15} The CRIB score has been utilized since 1997. The objective of the present study is to evaluate the mortality rate of very low birthweight liveborn infants, according to variations in CRIB score, birthweight and gestational age.

METHODS

In a prospective study undertaken during the period from January 1997 to December 2000, the CRIB score was applied to all newborns with a birthweight of <1,500 g and/or gestational age <31 weeks, born at the maternity of a University Hospital in Londrina and admitted to the NICU of this hospital. The latter is a public hospital, which attends patients under a covenant with the national health system the Sistema Unico de Saúde or SUS. Those assisted by this hospital come predominantly from the low social and economic strata of the regional population.

Criteria for exclusion from this study were: newborns that died in the first twelve hours of life, those who presented inevitably lethal congenital malformations, and those who were born at other hospitals and referred to this hospital afterwards.

After they were dismissed from the NICU, the newborns remained interned in the same hospital until they recuperated or until they died. None of the newborns were discharged from the hospital before they had completed 28 days of life and, in the present study, only neonatal deaths were included, that is, only those deaths which occurred up to 28 days of life.

The CRIB score was calculated on the basis of an established number of points and are presented on Table 1, according to the proposal made by the International Neonatal Network.¹⁶

Table 1 – CRIB score.*

Factor	Score
<i>Birthweight (g)</i>	
>1350	0
851-1350	1
701-850	4
≤700	7
<i>Gestational age (wk)</i>	
>24	0
≤24	1
Congenital malformation **	
None	0
Not acutely life-threatening	1

Acutely life-threatening	3
Maximum base excess in first 12h	
>7.0	0
-7 to -9.9	1
-10 to -14.9	2
≤15.0	4
Minimum appropriate FiO ₂ in first 12h	
<0.40	0
0.41-0.80	2
0.81-0.90	3
0.91-1.00	4
Maximum appropriate FiO ₂ in the first 12h	
<0.40	0
0.41-0.80	1
0.81-0.90	3
0.91-1.00	5

*CRIB – “Clinical Risk Index for Babies”.

**Excluding inevitable lethal malformations.

FiO₂:- Fraction of inspired oxygen.

Newborns who did not require respiratory support and gasometrical control received scores equal to zero in the FiO₂ factors, maximum and minimum, and maximum base excess. Newborns were distributed according to the scores they received. There being four score groups: those who received from 0 to 5 points, those who received from 6 to 10 points, those who received from 11 to 15 points and those who received more than 15 points. Gestational age was calculated on the basis of the date of the last menstruation, when the mother could provide this information with precision or with the aid of data obtained through the ultrasound, if the latter had been performed before the 20th week of gestation, conferred by the modified Ballard method for small premature infants.¹ All newborns were observed until they were discharged or until their death, and the data was registered by one of the neonatologist authors, on a form which is utilized in this sector of the hospital. All deaths which occurred up to 28 days of life were considered neonatal deaths.

The quantitative variables were evaluated according to mean and standard deviation, median, and maximum and minimum scores. In order to compare the children who survived with those that died, the t Student test was applied when gestational age was evaluated, once homogeneity of variances were detected by the Bartlett test. The Wilcoxon test was applied when birthweight and CRIB score were evaluated. Associations of the categorized variables with neonatal death were evaluated utilizing the Chi –square test. The discriminatory power and cut-off points for mortality through the CRIB score, birthweight and gestational age were evaluated by means of the Receiver Operator Characteristic (ROC) curve. The predictive accuracy of the CRIB score for mortality was compared to both birthweight and gestational age and evaluated according to values of sensitivity, specificity, positive and negative predictive values, relative risk and respective 95% confidence intervals. Statistics tests were carried out at the 5% significance level. Analysis of the ROC curve was undertaken utilizing the Medcalc program (statistical software – v.5), being constructed on the Excel program and the Epi Info program (v.604d) was utilized for all other forms of analyses. This research project was approved by the Ethics Committee of the University Hospital of Londrina.

RESULTS

During the study period, 284 newborns fulfilled the criteria for inclusion. Eleven newborns were excluded, one of which suffered from lethal congenital malformations (renal agenesis with hydropsy) and 10 died in less than ten hours after birth due to extreme prematurity and asphyxia. Twelve liveborn infants died more than 28 days after birth. The cohort analyzed presented mean birthweight of 1148 ± 248 g, with a median weight of 1180 g and variation of 530 to 1,500 g. Mean gestational age was 30.2 ± 2.4 weeks, with median of 30, varying from 24 to 39 weeks. The need for intubation in the delivery room occurred among 79 newborns (27.8%), 15 (5.3%) presented 5 minute Apgar scores <5, and 174 were born by means of cesarean sections. The mean CRIB score was 3.8 ± 4.4 , with a median of 2.0, varying from zero to 19. Among the newborns included in this study, 66 infants died (23, 2%).

The rate of mortality was higher among newborns weighing less than 750 g, with less than 29 weeks gestational age and CRIB scores higher than 10 (See Table 2). The variables analyzed above presented a significant association with mortality ($p > 0.0001$).

Table 2 – Rate of survivals and deaths according to CRIB score, birthweight, and gestational age.

Variable	Survivors		Deaths		Total
	N=21 8	%	N=6 6	%	
CRIB*					
0-5	196	90.7	20	9.3	216
6-10	15	44.1	19	55.9	34
11-15	7	26.9	19	73.1	26
>15	-	-	8	100.0	8
Birthweight (g)**					
<750	6	27.3	16	72.7	22
750-999	32	56.1	25	43.9	57
1000-1500	180	87.8	25	12.2	205
Gestational age (wk)***					
22-28	30	42.9	40	57.1	70
29-39	187	87.9	26	12.2	214

*CRIB: $\chi^2 = 106.6$ with 3 g.l. and value of $p < 0.0001$

**Birthweight: $\chi^2 = 57,81$ with 2 g.l. and value of $p < 0.0001$

***Gestational age: $\chi^2 = 59,49$ with 1 g.l. and value of $p < 0.0001$

The weight of the newborns that died in this study varied from 530 to 1495g, being the average weight 953.6 ± 273.2 g and the median weight 907.5 g. Those who survived weighed from 610 to 1,500 g, being the average weight 1207.4 ± 206.7 g and 1,237 median weight. These average weights presented significant statistical differences ($p < 0.0001$).

Gestational age of newborns who died varied significantly from those who survived ($p < 0,0001$), being that the age of those that died varied from 24 to 33 weeks, with an average of 28 weeks and one day \pm two weeks and three days, and a median of 28 weeks. The newborns who survived presented gestational ages varying from 26 to 39 weeks, with an average of 30 weeks and six days + two weeks and one day, and a median of 31 weeks.

The CRIB score of the newborns that died varied from zero to 19, presenting an average score of 9.0 ± 5.0 and a median of 9.5. The score of those that survived varied from zero to thirteen, with an average of 2.3 ± 2.7 and a median score of 1.0. The difference between these scores was highly significant ($p < 0.0001$).

Evaluating the ROC curve of the variables (Figure), for the CRIB score, the cutting off point which presented the greatest accuracy (area of 0.882 ± 0.028) was four.

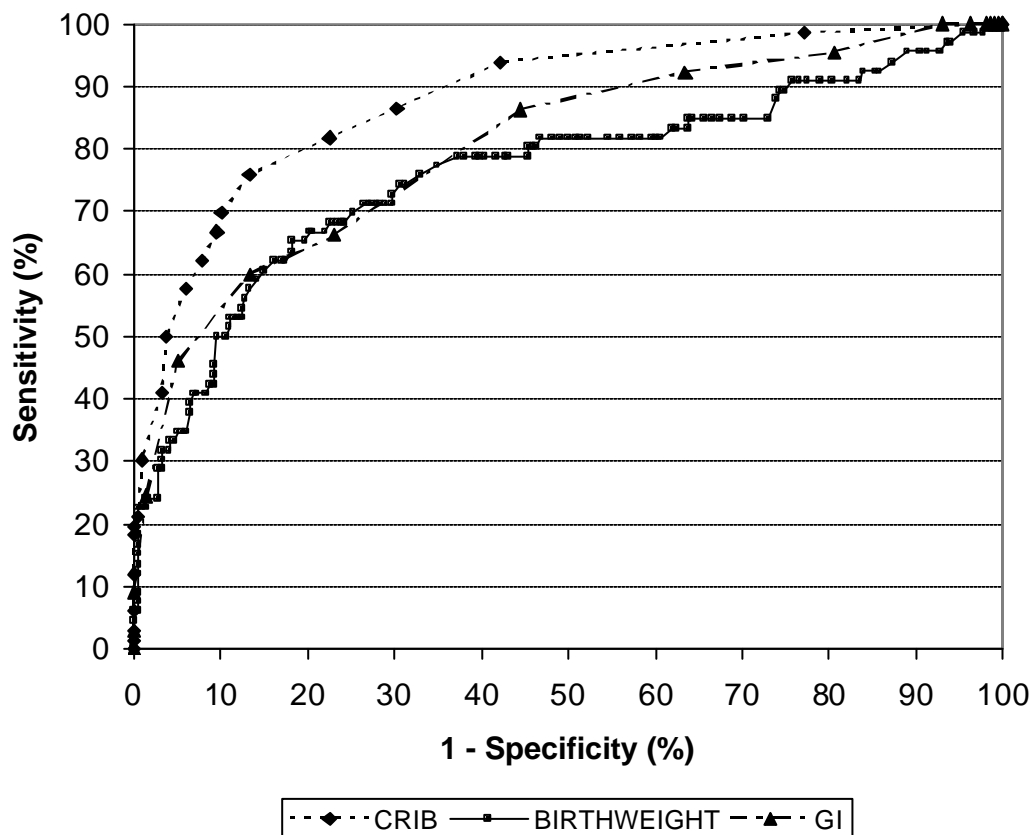


Figure - ROC (Receiver Operator Characteristic) curves for prediction of mortality in hospital by CRIB (Cinical Risk Index for Babies) score, birthweight and gestational age.

For birthweight, the cutting off point was at 1.005g and for gestational age, it was 28 weeks. When these cutting off points are examined, the CRIB score presented the best performance with a 75.8% (CI95%: 63.6-85.5%) sensitivity, specificity equal to 86.7% (CI95%:81.5-90.9%), positive predictive value of 63.3 (CI95%: 51.6-73.6) and negative predictive value of CI95%: 87.4-95.3%

Table 3 – Cut-off point, area ± Standard error under the ROC curve, relative risk, specificity, positive predictive value (+), negative predictive value (-) and respective 95% confidence intervals for the CRIB score, birthweight (grams) and gestational age (weeks).

Statistics	Variables		
	CRIB Score	Birthweight (grams)	Gestational Age (weeks)
Ponto de corte	>4	≤1005	≤28
Área ± erro padrão (C. I. 95%)	0.882±0.028 (0.839-0.917)	0.763±0.030 (0.709-0.811)	0.805±0.027 (0.754-0.850)
Sensibility (C. I. 95%)	75.8 (63.6-85.5)	65.2 (52.4-76.5)	60.0 (47.1-72.0)
Specificity (C. I. 95%)	86.7 (81.5-90.9)	81.7 (75.9-86.6)	86.6 (81.3-90.8)
Predictive value + (C. I. 95%)	63.3 (51.6-73.6)	51.8 (40.6-62.8)	57.1 (44.8-68.7)
Predictive value - (C. I. 95%)	92.2 (87.4-95.3)	88.6 (83.1-92.5)	87.9 (82.5-91.8)

ROC – "Receiver Operator Characteristics"

DISCUSSION

Mortality among very low birthweight infants is still very high in Brazil, particularly among those weighing less than 750 grams and with less than 29 weeks gestational age. Interpretation of mortality rates should take into consideration the clinical conditions of the newborn, the quality of attention received, resources available and modifications in therapeutic approaches utilized at the time of birth, which differ from country to country and among NICUs within the same country. The general mortality of newborns with less than 1,500 g, in the NICU studied was 23.2%, being quite different according to variations in weight and gestational age (Table 2), with differences of 72.7% for those who weighed less than 750 g and 12.2% for those weighing from 1,000 to 1,500 g.

These results are comparable to those in other NICUs in Brazil.^{8,9,13} It is known that the physiological response to development of the organs and systems changes from week to week and that gestational age has a significant influence on the initial clinical state and mortality of newborns. In the present study, the mortality of newborns with less than 29 weeks of gestational age (57.4%) was significantly greater in relation to those infants with gestational ages greater or equal to 29 weeks (12.2%).

In the present study, the CRIB score was utilized to evaluate the risk of mortality among newborns with less than 1,500 g, due to the fact that it can be rapidly obtained using available physiological variables routinely obtained and thus discarding the need for extra time in order to apply this score. The initial clinical state of the newborn is a reflex of previous obstetric events and those which occur during labour, as well as the care delivered to the newborn at birth and during the first few hours of life.

The higher the score, the greater the risk of mortality. When the distribution of CRIB scores among newborns that died (median of 9.5 varying from zero to 11) are compared to those that survived (median 1.0 varying from zero to one), a statistical difference ($p < 0,001$) was found.

The average CRIB score within the cohort studied was 3.8 ± 4.4 , with a median of 2.0, which is similar to the results of a national study undergone during the same period among a population with the same characteristics.¹³ Among those newborns included in this study that had scores varying from 11 to 15, 73.1% died, and among those whose scores were higher than 15, the rate of mortality was 100% (Table 2), results similar to other studies.^{4-6,8,10,13}

Analysis of the predictive accuracy of birthweight, gestational age and CRIB score in relation to the risk of mortality, undergone by building a ROC curve, within the current study, determined that the CRIB scores greater than 4 present the best characteristics as a diagnostic test when compared to birthweight $< 1,005$ g and gestational age < 28 weeks. As in previous studies, the present investigation has demonstrated that the CRIB score is more accurate, with an area under the ROC curve of 0.88 (CI 95%: 0.84-0.92), differing significantly from birthweight, which has an area of 0.76 (CI 95%: 0.71-0.81). However, gestational age, with an area of 0.81 under the ROC curve (CI 95%: 0.75-0.85), did not present significant differences.

The results obtained indicate that the CRIB score is an appropriate means of evaluating performance of perinatal care based on the outcome of mortality, considering the initial clinical state of the very low birthweight newborns that were studied. However, it is important to evaluate the quality of life among newborn survivors, since morbidity and complications in the perinatal period may cause important sequels. An analysis of the results of this type of study in a NICU also makes it possible to establish comparisons among different periods of time and with other services, to evaluate costs and benefits and modify procedures so as to improve patterns of performance.

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