East African Medical Journal Vol. 88 No. 1 January 2011
CLINICAL RISK INDEX FOR BABIES (CRIB) II SCORE AS A PREDICTOR OF NEONATAL MORTALITY AMONG LOW BIRTH WEIGHT BABIES AT KENYATTA NATIONAL HOSPITAL
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ABSTRACT

***Background*: Neonatal deaths, especially among the Low Birth Weight (LBW) babies, are of major concern in the Newborn Unit (NBU) of Kenyatta National Hospital (KNH). Several instruments have been developed to predict initial mortality risk among the LBW babies. Among them is the scoring system Clinical Risk Index for Babies also known as CRIB II score.**

***Objective*: To evaluate the use of CRIB II score as a tool to predict the risk for neonatal mortality among the LBW babies at KNH.**

***Design*: A prospective cohort study.**

***Setting*: Newborn Unit of Kenyatta National Hospital.**

***Subject*: A total sample of 135 low birth weight babies were followed up from admission till discharge, the 28th day of life or death whichever came first.**

***Results*: One hundred and thirty five newborns were enrolled into the study. Birth weight ranged from 600 – 2500g, with a median of 1600g. Total CRIB II score ranged from 1 – 15, with a median of 5.5. Gestational age ranged from 26 – 38 weeks. Total mortality was 45.9%. Birth weight <1500g, gestational age <30 weeks, base excess <-12mmol/l, temperature at admission >37.5 or <35 (all components of CRIB II) and total CRIB II score of > 4 were all found to be significantly associated with hospital neonatal mortality.**

Using a cut off point of 4, CRIB II score was found to have a sensitivity of 80.6%, specificity of 75.3%, and a predictive value of 77.7% compared to 72.5, 71.2, and 71.8% respectively for birthweight. Gestational age was found to have even lower figures; 56, 75 and 66% for sensitivity, specificity and predictive values respectively.

***Conclusion*: CRIB II score of > 4 was found to have better prediction for mortality among the LBW babies at KNH-NBU compared to the traditionally used predictors and can be used to prioritise care for such neonates for better outcome.**

INTRODUCTION

Infant mortality rates are important public health indicators that are seen as proxy measures of health of the population (1). Neonatal mortality is the major component of infant mortality accounting for approximately 60% of all infant deaths worldwide (2). Infant mortality rate has remained relatively high in the developing as compared to developed countries. In Kenya, infant and child mortality have been shown to remain high with infant mortality rate of 73 per 1000 live births in 1998, 77 per 1000 live births in 2003 and 52 per 1000 live births in 2008 (3,4).

Neonatal mortality however was found to contribute to 40% of all the infant mortality with a neonatal mortality rate of 33 deaths per 1000 live births reported in 2003 and has remained relatively the same with rate of 31 deaths per 1000 live births reported in 2008 (3,4). Half of the neonatal deaths can be attributed to low birth weight, acute perinatal asphyxia, prematurity and perinatal infections (1). The prevalence of low birth weight worldwide is 19% and approximately 9% of all newborns require special or neonatal intensive care (2).

Studies done in Kenya have also shown LBW to be a common problem and a major cause of neonatal mortality (5-9). Birth weight specific neonatal diseases such as intraventricular haemorrhage, severe group-B

streptococcal pneumonia and pulmonary hypoxia have also contributed to poor outcome (2). The highest risk of neonatal mortality occurs among infants who weigh less than 1000g at birth and those less than 30 weeks gestation. As birthweight increases from 500g to 3000g, a logarithmic decrease in neonatal mortality occurs. Low Birthweight is probably the single most important factor in neonatal mortality (10).

Disparities exist in birth weight specific mortality between geographical regions, nations and even between different neonatal units. Due to these disparities, simple scoring methods for mortality risk have been formulated to take into account the other risk factors that contribute to neonatal mortality (11). These tools include clinical risk index for babies (CRIB) II, simplified acute physiology (SAPS), score for neonatal acute physiology (SNAP), and mortality probability model (MPM) (11). Of these tools, CRIB II has been found to be the most accurate tool to determine neonatal viability (12). Moreover, CRIB II score has been found to be accurate predictor than birth weight alone (13).

CRIB II score is a validated measure of initial mortality risk and illness severity within one hour of admission that contains only five variables. It is simple to calculate and non subjective. It is useful in identifying high-risk neonates, auditing of neonatal units and also provides a standardised mortality rate for performance comparison among neonatal units. CRIB II score takes into account the birth weight, gestational age, body temperature, base excess and sex of the baby to determine initial mortality risk.

The total CRIB II score ranges from 0 to 27. The scores have further been classified into four levels as follows:

- Level 1 0 to 5
- Level 2 6 to 10
- Level 3 11 to 15
- Level 4 above 15

The higher the score, the poorer the prognosis, with worst prognosis in level 3 and 4. Previous studies have shown optimal cut off point based on receiver operating characteristic to be at score 4 (14). CRIB II score provides a recalibrated and simplified scoring system that avoids the potential problems of early treatment bias (15).

CRIB II score has been shown to correlate strongly with hospital neonatal mortality, the cost of hospitalisation per day and quite good predictor for days on ventilator and length of hospital stay and that it was a better predictor neonatal viability than APGAR score or any independent variables such as birth weight, gestational age, base excess, and temperature at admission in predicting severity of illness (16). Further, CRIB II score has been used to predict neuro-developmental outcome in ELBW infants. CRIB II score is valid tool of initial risk assessment even in ELBW in predicting hospital outcome (death or major brain lesions) more accurately than birth weight or gestational age alone (16).

Kenyatta National Hospital is yet to adopt the CRIB II score in evaluating the neonatal mortality risk of the neonates admitted into its neonatal unit. The aim of the study was therefore to evaluate the CRIB II tool's applicability in evaluating neonatal mortality in this neonatal care unit.

MATERIAL AND METHODS

This was a prospective longitudinal study where the subject were recruited between December 2004 to April 2005. The study was carried out at the Newborn Unit and Labour ward of Kenyatta National Hospital, a Teaching and Referral Hospital located in Nairobi. All LBW (Birth weight of less than 2500g) babies delivered at KNH during the study period were eligible for the study. All LBW babies admitted to the Newborn unit at KNH between 8am and 8pm were seen within one hour of admission into the Newborn Unit. Consent was obtained at the admission from the mother. For mothers in preterm labor, consent was obtained in advance.

A quick clinical assessment was performed on the neonate to determine the need for emergency resuscitation followed by general physical examination. Baseline data such as respiratory rate, temperature and body weight (taken using a top pan balance-Zy-20 baby scale model and recorded to the nearest 50 grams) were taken on admission. Gestational age assessment was done using the Dubowitz method. Blood for arterial blood gas analysis was obtained using standard procedure for arterial blood withdrawal. The specimen was then labelled and transported to the laboratory immediately. The samples were analysed using an automated electrode (Rapid lab) blood gas analyser. Using the measured parameters PaO2, PaCO2, the value of the base excess was automatically derived by the machine.

CRIB II score was assigned and used to assess the medical viability of the neonates that were admitted at the hospital's neonatal care unit. The babies were then reviewed every morning thereafter until discharge, death or up to 28 days of life, whichever came first. During the follow up, weight gain, mode of feeding and the presence of any other morbidity were noted. The mothers' and babies' notes from maternity and antenatal clinic were also reviewed.

All the data generated from the clinical procedures described earlier was recorded and consolidated into a worksheet. These included maternal demographic data, events surrounding labor, the babies' details – the components of CRIB II score, and the outcome of the baby – alive or dead. The data were later on entered into an Epi Info 6 data sheet and then exported into Statistical Package for Social Sciences (SPSS).

Rigorous analysis of the data was done to derive correlations and other associations. ROC curve was

used to compare the predictive value of birth weight; gestational age and total CRIB II score for hospital neonatal mortality. Pearson chi – square, Fischer exact and Chi-square for linear trends were used as tests of significance. P-values below 0.05 were considered as significant. The outcome in the study was defined as neonatal death or survival to 28 days.

RESULTS

One hundred and thirty five babies were enrolled into the study between December 2004 and April 2005. Seventy one (52.6. %) were male and 64 (47.4%) were female. The birth weights of the study subjects ranged from 600g to 2500g with median weight of 1600g. Maternal age ranged from 16 years to 41 years with a median of 23 years. Maternal parity ranged from 0 to 12 with a median of 1. Most babies (59.3%) were delivered by spontaneous vertex delivery (SVD), 21.1% via Caesarian section and 12.6% via Breech delivery. Breech delivery had the highest mortality rate (88%) followed by SVD (44%) and finally Caesarean deliveries (32%). The table below shows the characteristics of babies admitted at the hospital's Newborn Unit.

Table 1
Characteristics of the neonates admitted to the Newborn Unit

Characteristics	Range	Median
Birthweight (g)	600-2500	1600
Gestational age (weeks)	26 – 38	32
Temperature (0C)	33.4 - 38.4	36.2
Base excess (mmol/l)	- 24 to –2.1	- 8.2
Apgar score (at 5 min)	3 -10	8
Maternal age (years)	16 – 41	23
Maternal parity	0 -12	1

The neonates admitted at the hospitals Newborn Unit were distributed into three levels according to the CRIB II score, with 61% being in level 1, 28% in level 2 and 11% in level 3. There was no neonate graded in level 4 (table 2)

Table 2
Survival of the neonates as per the CRIB II score levels

CRIB II score	N=135	Dead N=62 (%)	Alive N=73 (%)	RR (CI= 95%)	p-value
Level I (0 –5)	82(61)	18(22)	64(73)	1	
Level II (6 –10)	38(28)	30(79)	8(21)	3.6 (2.3- 5.8)	<0.01
Level III (11–15)	15(11)	14(93)	1(7)	4.25 (2.8- 6.5)	<0.01
Level IV (>15)	0(0)				

From the study, it was established that of the neonates who had a CRIB score of less than or equal to four, 18% died whereas those that were greater than 5, 73% died within 28 days (RR=4.1 p= 0.001).

The non-survivors who scored favourably (≤ 5) had a longer duration of hospital stay compared to those who scored unfavourably (>5) who were more sick and therefore died earlier. For the survivors, those who scored unfavourably spent more time in the hospital compared to those who scored favourably. The latter were less sick and therefore got discharged home earlier.

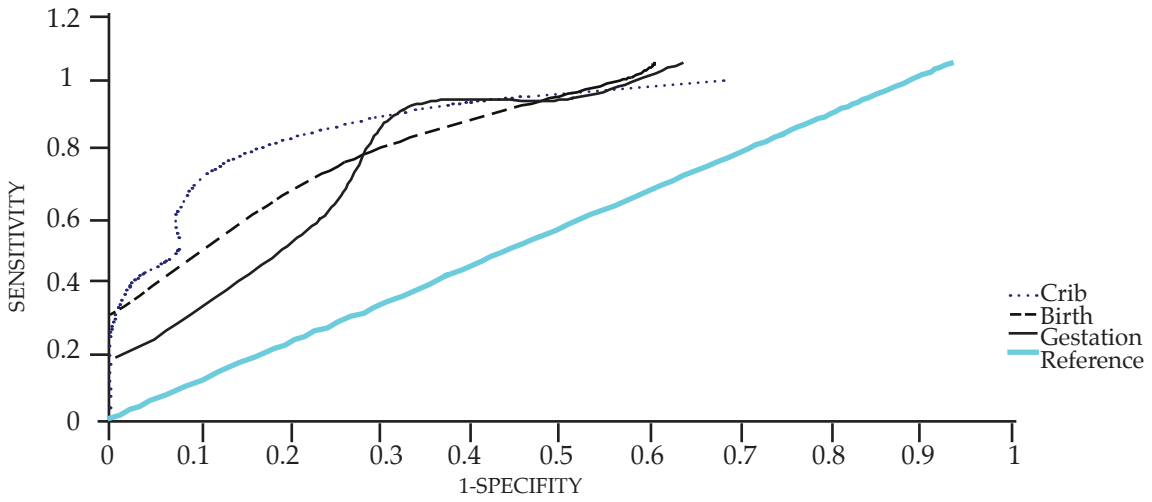
Table 3 assesses the reliability of CRIB II as predictor of survival of low birth weight neonates.

Table 3
Some of the characteristics of CRIB II as a predictor of neonatal mortality

Model	Sensitivity (%)	Specificity (%)	Predictive value (%)	PPV (%)	NPV (%)
Bithweight	72.5	71.2	71.8	68.1	75.3
Gestational age	56.4	75.3	66.6	66.0	67.0
CRIB II (cut off of 4)	80.6	75.3	77.7	83.3	82.1
CRIB II (cut off of 10)	32.3	98.6	68.1	95.2	63.2

CRIB II score is noted to have the highest sensitivity and predictive value at a cut off point of 4. At a cut off of 10 CRIB II seems to have a very high specificity (98.6%) but very low sensitivity (32.3%)

ROC curve for prediction of hospital neonatal mortality by CRIB II score, birthweight and gestational age



Area under the ROC for CRIB II, birth weight and gestational age were 0.692, 0.608 and 0.682 respectively.

DISCUSSION

There is an emergency cases there is a need to define urgent, emergent and life threatening conditions to the primary care physician. The CRIB II score is a measure of illness severity (initial risk) based on clinical and laboratory abnormalities found at admission (13).

During the study we verified that CRIB II score was easy to apply as most of its components form part of the routine care of preterm babies in our newborn unit except for base excess estimation. No subjective parameters are used hence it can easily be reproduced even in inexperienced hands. However, it is worth noting that its application is limited to facilities where arterial blood gas analysis is possible. In Kenya, its application may be limited to referral hospitals. A simpler score system is necessary for the health facilities where arterial blood gas analysis is not routinely done.

This study had several limitations that could have contributed to different results compared to previous studies. The study considered all babies less than 2500g since this group was found to have high mortality in our setting (53%). In the study originating the CRIB II score, only babies less than 1500g were included (15). This may have affected accuracy levels of CRIB II score as shown by the lower ROC values compared to previous studies (13, 14,18).

Due to logistical reasons, it was not possible to cover the Newborn Unit for 24 hours hence an important group of babies born at night may have been left out. This may also have affected the accuracy of the results. A large group of babies born by emergency Caesarean section was also left out because their mothers were not in a position to give an informed consent within one hour of admission to the Newborn unit.

In this study the mean CRIB II score at admission was 5.5 (Range 1 –15). Overall mortality was found to be 45.9%. Survivors had a mean CRIB II score of 3.7, while non-survivors had a mean CRIB score of 7.7. This study compares well with a study by Lucia in 2002 which found a mean CRIB II score of 4, range of 0 –19 (17). However no babies had a CRIB II score of more than 15 in this study. This could be due to the fact that babies in this category were too sick and died before arrival into the newborn unit or ended up in the hospital general intensive care unit instead of the newborn unit. It is worth noting that the earlier studies though were done in a neonatal intensive care setting, they compare well to this study, which was done in a largely level III setting at KNH.

The quantitative expression of CRIB II score as a mortality predictor was assessed using the area under ROC curve. CRIB II score was confirmed to positively predict mortality and to have a better performance than birthweight and gestational age independently. Area under ROC curve for CRIB II, birthweight and gestational age were found to be 0.692, 0.608 and 0.682 respectively. However, the accuracy was found

to be lower than the study that originated it (0.900 for CRIB II) (13). Other validating studies also found lower ROC values for example Jukka found a value of 0.89 (12). This differences can be explained by the limitations mentioned earlier.

Sensitivity, specificity and predictive value were calculated for CRIB II score at two different cut off points and compared to those of birth weight and gestational age as predictors of hospital neonatal mortality. CRIB II score with cut off point of 4 was found to be most sensitive (80.6%) with the best predictive value (77.7%) compared to birthweight and gestational age. However its specificity was equal to that of gestational age alone. This compares well to a study by Brito which found a sensitivity of 79.4% (14).

The results of the comparative analysis between the four levels of CRIB II score for hospital mortality are comparable with those proposed in the original study (13). That is the higher the score, the higher the mortality rate. Similar results were published in several other studies (18, 19,20).

In this study no baby was admitted with a score above (15). Level III was found to have very high mortality (93.3%), which was not comparable to the original study, which had mortality of less than 80% in this category (13). This shows that we need to put more effort to improve the outcome of this specific group.

Based on the study, it is noted that CRIB II score is a better predictor of neonatal mortality compared to birthweight and gestational age independently. It is also found to be applicable and therefore should replace the traditional models as the predictor of neonatal outcome. This is in agreement with other studies (14,17,20,21).

The sensitivity, specificity and predictive value of CRIB II score were found to be better than any of the traditional models independently. The area under the receiver- operating characteristic (ROC) curve for predicting death was greater for CRIB II score than for birthweight or gestational age alone. CRIB II cut off point of 4 was found to be optimal for predicting mortality. CRIB II score is a better predictor of hospital neonatal mortality among LBW babies at KNH than birthweight and gestational age independently. Based on these findings, we recommend that CRIB II score be included in the routine assessment of newborns admitted at the newborn unit of Kenyatta National Hospital.

ACKNOWLEDGEMENTS

To the department of paediatrics and child health, University of Nairobi, Members of staff of Kenyatta National Hospital Newborn Unit and finally the director of Kenyatta National Hospital for allowing us to publish this findings.

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