Original Article

Iran J Pediatr
Dec 2007; Vol 17 (No 4), Pp:325-331

Neonatal Mortality Risk Assessment in a Neonatal Intensive Care Unit (NICU)

Maliheh Kadivar[1*], MD; Setareh Sagheb[1], MD; Fariba Bavafa[1], RN; Lida Moghadam[2], MD, Babak Eshrati[2], MD

1. Department of Pediatrics, Children's Medical Center, Medical Sciences/ University of Tehran, Tehran, IR Iran
2. Department of Static, Faculty of Health & Biostatics, Medical Sciences/ University of Tehran, Tehran, IR Iran

Received: 02/06/07; Revised: 20/08/07; Accepted: 01/11/07

Abstract

Objective: This study aims to assess the utility of a scoring system as predictor of neonatal mortality rate among the neonates admitted within one year to the neonatal intensive care unit (NICU) of the Children's Medical Center in Tehran, Iran.

Material & Methods: Data were gathered from 213 newborns admitted to the NICU from September 2003 to August 2004. In addition to demographic data, Apgar scores at 1 minute and 5 minutes, history and duration of previous hospitalization, initial diagnosis and final diagnosis, and scoring system by using the score for the neonatal acute physiology-perinatal extension II (SNAP-PE II) were carried out within 12 hours after admission to the NICU. All of the parameters were prospectively applied to the admitted newborns. The exclusion criteria were discharge or death in less than 24 hours after NICU admission.

Findings: 198 newborn infants met the inclusion criteria. The mean and standard deviation (SD) of the variables including postnatal age, birth weight, SNAP, and finally Apgar scores at 1 minute and 5 minutes of neonates under this study were 7.6 (0.5) days, 2479.8 (29.4) grams, 21.6 (1.1), 7.47(0.08), and 7.71 (0.06), respectively. Twenty five of the 198 patients died (12.6%). Gestational age (P=0.03), birth weight (P=0.02), Apgar score at 5 minutes (0.001), and SNAP-PE II (P=0.04) were significantly related to the mortality rate. By Analyzing through logistic regression to evaluate the predictive value of these variables in relation to the risk of mortality, it was shown that only SNAP-PE II and Apgar score at 5 minutes could significantly predict the neonatal mortality.

Conclusion: According to this study SNAP-PE II and Apgar score at 5 minutes can be used to predict mortality among the NICU patients. SNAP-PE II score had the best performance in predicting mortality in this study. More studies with larger samples are suggested to evaluate all of the above-mentioned parameters among neonates who are admitted to NICUs countrywide.

Key Words: Outcome, Newborn, Neonatal mortality, Neonatal intensive care unit, SNAP-PE II score, Risk assessment

*** Correspondence author;**
Address: Department of Pediatrics- Division of Neonatology
Children's Medical Center, 62 Gharib Street , 14194 Tehran, IR Iran
E-mail: kadivarm@sina.tums.ac.ir

Introduction

Severity of measurements in neonatal intensive care unit (NIUCs) has traditionally employed birth weight and Apgar scores, as two main factors, for mortality prediction. The relationship between mortality rate and the factors have, however, been insufficiently precise in quality assessment of neonatal intensive care settings. In addition, rapid progress of neonatal care has made the relationship between these factors and mortality rate unstable.[1, 2, 3]

Survival of the newborns who are admitted to the NICUs do not depend exclusively on birth weight and gestational age, but also on other perinatal factors and physiological conditions of the individual infants, in particular severity of their diseases.[3-7] More than one decade ago, the score for the neonatal acute physiology (SNAP), and later the SNAP-perinatal extension (SNAP-PE) scores were proposed to be used in assessing severity, with sufficient precision to allow their application for quality assessment.[8,9] These scores were validated and re-applied in distinct studies in different countries. The SNAP score is based on 34 variables evaluated during the worst moment of the first 24 hours after admission. SNAP-PE adds birth weight, small size for gestational age (SGA), and Apgar score at 5 minutes after birth to SNAP. Because of the difficulty in data collection, the original authors produced simpler version of SNAP-PE scores by reducing the number of evaluated items to six.[9] SNAP-PE II increases the scores attributed to perinatal variables (Table 1). Later the derivation and validation cohorts impressively showed appropriate differentiation in predicting mortality.[2-5, 9]

The aim of this study was to evaluate the performance of SNAP-PE II to predict the neonatal mortality rate in the newborn infants admitted to our NICU in one year.

Material & Methods

In a prospective study undertaken during the period from 1st September 2003 to 28th August 2004, the SNAP-PE II score was applied to all newborns admitted to the NICU of the Children's Medical Center which is a tertiary care unit affiliated to Tehran University of Medical Sciences in Tehran, Iran. Different variables such as age (days), sex, gestational age (weeks), birth weight, type of referral center, previous and duration of hospitalization, initial diagnosis, and ultimate diagnosis, Apgar scores at 1 and 5 minutes were also registered in each case.

A criterion for exclusion from this study was the newborns that died or were discharged in less than 24 hours after admission to our NICU. The SNAPII-PE score was calculated on the basis of an established number of factors which are presented in table 1.

The clinical data relevant to this survey was the physiologic information required for the SNAP score [mean blood pressure, heart rate, respiratory rate and temperature, reports of blood gas analysis, blood chemistries and complete blood counts, urine output, presence of seizures, base excess and minimum and maximum fraction of inspired oxygen (FIO_2 values)].

Fifteen patients who were discharged or died during the first 24 hours of hospitalization in the NICU were excluded from this study. Newborns were distributed according to their age (5 groups: less than 1 day old, 1-3 days old, 4-7 days old, 8-14 days old, and 15-30 days old), sex (male or female), gestational age (4 groups on the basis of the date of the last menstruation or data obtained through the ultrasound: less than 30 weeks, 30-34 weeks, 35-37 weeks and more than 37 weeks), birth weight (4 groups: less than 1500 grams, 1500-1999 grams, 2000-2499 grams and 2500 grams or more), referral center (2 groups: the hospital itself (either the neonatal nursery level II or the emergency ward; and other hospitals), duration of previous admission, and duration of hospitalization if referred from other medical centers (4 groups: less than 1 day, 1-3 days, 4-7 days and 8 days or more), initial diagnosis (8 groups: respiratory, cardiac, hematological, infectious, surgical, metabolic, neurological and miscellaneous), and final diagnosis (8 groups: the same as primary diagnosis), and the SNAP-II PE score (6 groups: 0-9 points, 10-19 points, 20-29 points, 30-39 points, 40-49 points, 50 points or more), the Apgar score at 1 and 5 minutes (3 groups: 7 points or more, 4-6 points, 3 points or

Table 1- Score for the neonatal acute physiology perinatal extension (SNAP II–PE) Scoring system [9]

Factor		Score
BP (mmHg)	> = 30	0
	20- 29	9
	20	19
Temperature (^{o} C)	> = 35.6	0
	35.0 – 35.5	8
	< 35	15
PaO_2/FlO_2	> = 2.50	0
	1.00- 2.49	5
	0.30- 0.99	16
	<0.30	28
Serum PH	> = 7.20	0
	7.10 – 7.19	7
	<7.10	16
Seizure	None/single	0
	Multiple	19
Urine output (ml/Kg/hr)	>= 0.91	0
	0.10 – 0.90	5
	< 0.10	18
Birth weight (gm)	>= 1000	0
	750 – 999	10
	< 750	17
Small for gestational age	No	0
	Yes	8
Apgar score at 5 minutes	7- 10	0
	< 7	18
Total score	Group 1	0-9
	Group 2	10-19
	Group 3	20-29
	Group 4	30-39
	Group 5	40=<

less) and the final outcome (2 groups: discharge or death).

All newborns were observed till either they were discharged from NICU or died. The study site had a staff registered nurse assigned as a facilitator to help with data collection, and a staff physician (neonatologist) who was also the principal investigator.

A simple descriptive analysis was used for study groups and subgroups; mean, and standard deviation. Univariate comparisons between variables were made with the use of student's test for continuous variables and with Pearson chi square test or Fisher's exact test for discrete variables. Association of all variables with neonatal death was evaluated utilizing the chi-square test. After distinguishing the significantly related variables with the neonatal death, the power of these variables to predict the neonatal mortality was evaluated by means of logistic regression. Statistical analyses were performed using microcomputer software (SPSS release

11.5, SPSS, Inc, Chicago, III). *P* values less than 0.05 were considered as statistically significant. All *P* values were two-tailed.

Findings

During 12 months of this study, 213 babies were admitted to the NICU. Of these, 15 were excluded due to death or discharge from this ward in the first 24 hours of admission (7.0%).
When all patients were evaluated, mean and standard deviation (SD) age was 7.6 (0.5) days, and 119 (60.1%) of them were male. The mean (SD) gestational age was 35.8 (0.2) weeks, mean (SD) birth weight was 2479.8 (29.4) grams, mean (SD) SNAP-PE II score was 21.6 (1.1), mean (SD) Apgar scores at 1 minute were 7.47 (0.08) and 7.71 (0.06) at 5 minutes respectively. By applying Chi-square test the following variables were found to be significantly related to neonatal death: the gestational age (*P*=0.03), the birth weight (*P*=0.02), Apgar scores at 5 minutes (*P*=0.001), and SNAP-PE II (*P*=0.04).

By analyzing through the logistic regression to evaluate the predictive value of these factors for mortality, it was revealed that only SNAP and Apgar at 5 minutes could significantly predict newborn mortality. The relations between SNAP scores and 5 minute Apgar with respect to the outcome is shown in table 2.

Total mortality rate obtained in this study was 12.6%, and the mortality rates in the subgroups were also assessed. The mortality rate in the neonates with gestational age below 30 weeks was 14.3%. It was 19.4% among the newborn infants with birth weight below 2500 grams. Among the newborns who died, 42.1% had Apgar score below 7 at 5 minutes. Finally, mortality in the infants with SNAP-PE II score more than 19 points was 19.4%.

Table 2- Relations between SNAP scores and outcome of newborns admitted to the NICU

SNAP Scores Groups*		Outcome		Total
		Discharge	Death	
0-9	Count	122	15	137
	% within SNAP score	89.1%	10.9%	100.0%
10-19	Count	26	4	30
	% within SNAP score	86.7%	13.3%	100.0%
20-29	Count	13	1	14
	% within SNAP score	92.9%	7.1%	100.0%
30-39	Count	10	2	12
	% within SNAP score	83.3%	16.7%	100.0%
40-49	Count	1	0	1
	% within SNAP score	100.0%	.0%	100.0%
50 & more	Count	1	3	4
	% within SNAP score	25.0%	75.0%	100.0%
Total	Count	173	25	198
	% within SNAP score	87.4%	12.6%	100.0%

** Pearson Chi square tests revealed significant values for SNAP scores regarding neonatal outcome, which regression analysis detected these two variables were the only relevant variables to the outcome.*

Table 2- Relations between 5-minute Apgar and outcome of newborns admitted to the NICU

SNAP Scores Groups*		Outcome		Total
		Discharge	Death	
7>=	Count	156	7	163
	% within SNAP score	95.7%	4.3%	100.0%
4-6	Count	17	18	35
	% within SNAP score	48.6%	51.4%	100.0%
=<3	Count	0	0	0
	% within SNAP score	0%	0%	0%
Total	Count	173	25	198
	% within SNAP score	87.4%	12.6%	100.0%

** Pearson Chi square tests revealed significant values for 5-min Apgar regarding neonatal outcome, which regression analysis detected these two variables were the only relevant variables to the outcome.*

Discussion

The study of illness severity and mortality risk measurement among the newborns admitted to the neonatal intensive care units is attaining an increasing level of importance. Although severity of illness is a familiar medical concept, it is sometimes difficult to assess. In the context of intensive care, a rational way to define and quantify severity of illness, is through the development of models predicting mortality risk.[9,10] Scoring systems involve using appropriately weighted demographic, physiological, and clinical data collected on the infant to calculate a score that quantifies its mortality and morbidity. The illness severity scores were thus developed with the aim of quantifying the clinically obvious fact that infants of the same gestational age and birth weight maintain greater mortality risk.[10-12]

The desirable properties of neonatal scores have been described as ease of use, applicability in the early course of hospitalization, ability to predict mortality categories of the neonates, and usefulness for all groups of neonatal infants.[12-16] However, these properties are difficult, perhaps impossible to achieve completely.

Mortality rate in this study (12.6%) was comparable to other studies (8.9% & 23.2%, 29.6%).[1,5,6] The factors associated with late neonatal mortality were mostly birth weight and gestation only in various studies. Mortality rate in infants born either before 30 weeks of gestational age or with very low birth weight is reported widely (11-60%).[1,6,12] In our study the mortality rate of this group of gestation was 14.3% which is consistent with other studies.[6,17] But mortality rate variability among NICUs may be explained by differences in population and resources.[10]

The effect of a variety of issues such as newborn's sex, age, referral center, the history and duration of previous hospitalization, the initial diagnosis and the ultimate diagnosis, for predicting mortality- which has been assessed in this study and found to be statistically not essential - had not been considered significant in the same studies.[7,10,13,14,17] Factors affecting the mortality of sick newborns admitted to intensive care units revealed the importance of the severity of illness scoring systems comparing to birth weight, and gestational age in prediction of the neonatal mortality rate.[7]

The current study evaluated the result of several variables including; birth weight, gestational age, SNAP-PE II, Apgar scores, in relation to the neonatal mortality in the NICU. Among them, only the SNAP-PE II and the Apgar score at 5 minutes were found significant for predicting the newborn mortality. Birth weight, age at admission to the NICU, sex and duration of stay in the NICU had no significant influence on mortality in several studies.[7-9,14]

More over, multivariate analysis revealed that the severity of illness among these neonates was the most important predictors of mortality.[8,10,14]

Measurement of the severity of illness is a research area of growing importance in neonatal intensive care in different countries. Among the admitted neonates in the intensive care units of several countries such as Brazil, India, Saudi Arabia, Turkey, Zimbabwe, and Taiwan numerous variables like birth weight, gestational age, CRIB score SNAP, SNAP-PE, and SNAP-PE II, were used to define risk factor of death as primary outcome measures.[17-24] However, the mortality of sick newborns admitted to these wards were unacceptably high and call for future quality and resource utilization efforts comparing to neonatal care in the intensive care units of the developed countries.[24] In addition, SNAP-PE II had the best performance in this regard.[1,2] The results of these studies emphasize the importance of regionalization of perinatal and neonatal care, organization of neonatal transport system, presence of trained personnel in the neonatal wards, and existence of modern instruments and new drugs in the further improvement of the outcome of sick newborns in tertiary care settings of these countries.[22,24]

Conclusion

Considering widespread use of birth weight, gestational age - along with scoring system - to predict mortality in NICU's all over the world, it seems necessary to evaluate all of these factors in more tertiary care settings in the country. As the number of variables considered in SNAP-PE II is small and relatively fast and easy to obtain, it is a reliable predictor of newborn in-hospital mortality. But re-assessing other factors' predictive power for neonatal mortality is necessary too. Based on these results, we recommend its inclusion in the routine of neonatal units.

Acknowledgment

The study was made possible by the passionate support of the nursing of the NICU personnel's of the Children's Medical Center. We thank them for their great help.

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