Section: Pediatrics

Research

EVALUATE AND COMPARE SNAP II AND SNAPPE II AS PREDICTORS OF NEONATAL MORTALITY IN A NEONATAL INTENSIVE CARE UNIT AT B.P. KOIRALA INSTITUTE OF HEALTH SCIENCES

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Abstract

Background: Prediction of morbidity and mortality minimizes health resources utilization. This study aimed to evaluate and compare Score for Neonatal Acute Physiology II (SNAP II) and Score for Neonatal Acute Physiology with Perinatal Extension II (SNAPPE II) scoring systems as predictors of neonatal mortality rate. **Materials and Methods:** A prospective observational study was conducted in neonatal intensive care unit (NICU), B.P.Koirala institutes of health sciences (BPKIHS), Dharan, Nepal. Data required for the SNAP II and SNAP II PE scores were collected within 24 hours of admission. The relationships between the SNAP II and SNAP PE II scores and neonatal mortality were analyzed. **Result:** 260 neaonates were enrolled meeting the inclusion criteria. Of 260 neonates, 49 (18.84%) expired. A SNAP II score of ≥30 had a sensitivity of 85.4%, and specificity of 87.08 % for predicting mortality, and a SNAP PE II score of ≥40 had a sensitivity of 83.8% and specificity of 89.9% for it. Using logistic regression, it was found that SNAP II (area under the curve [AUC] = 0.912; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.927; 95% CI: 0.984–1). There was no statistically significant difference in predictive value of SNAP II and SNAPPE II methods (P > 0.99). **Conclusion:** SNAP II and SNAP II PE scoring systems are clinically productive utilitarian tools for predicting neonatal mortality of newborn admitted in our NICU. Although, there is no difference between SNAP II and SNAP PE II, SNAP II would be pragmatically convenient for out born babies.

INTRODUCTION

Advances in the neonatal intensive care have significantly increased survival and decreased mortality and morbidity among neonates admitted to the Neonatal Intensive Care Unit (NICU).[1] Costs of stay at NICU are exorbitant and incurs a major chunk of health resources. Detection of critically ill newborn infants offers the possibility of a timely treatment that would have a direct impact on survival and decrease morbidity as well.[2] Outcomes of NICU can be measured through development of mortality risk assessment.[3] Accurate and reliable risk models evaluate medical practices and quality of care. The measurement of severity of illness using scoring systems has gained importance in intensive care. These scoring systems help in predicting mortality and morbidity and thereby can guide us in optimizing the limited healthcare resources available in our country.[4]

The severity score that were used for Severity measurements in neonatal intensive care have traditionally used birth weight and Apgar scores. It was found out that the relationship between mortality and these parameters had been insufficiently precise to use for quality assessment.[5] There are perinatal factors and physiological conditions of the individual infants which precisely determines outcome of severely ill neonates. In 1993, the Score for Neonatal Acute

Physiology (SNAP), the SNAP-Perinatal Extension (SNAPPE) and the Clinical Risk Index for Babies (CRIB) scores were proposed for use in assessing severity with sufficient. There are 34 variables in SNAP score, evaluated during the worst moment of the first 24 hours after admission. SNAP-PE adds to SNAP birth weight, small size for gestational age (SSGA), and low Apgar score at 5 minutes after delivery.[6-8] The Score for Neonatal Acute Physiology, Version II (SNAP-II) is a simplified neonatal illness severity score that measures six empirically weighted, physiology based items during a 12-hour period, including lowest blood pressure, lowest temperature, PO2 / FiO2 ratio, lowest serum pH, seizures, and urine output. SNAP-II scoring ranges from 0 to 115. SNAPPE II system includes 9 physiological and laboratory evaluations regarding the vital functions collected during the first 12 h after delivery. The SNAPPE-II values range from 0 to 162 and are proportional to the illness severity, with higher scores indicating higher mortality or morbidity risks.[9] The benefits of SNAPPE II is experienced only if it is calculated in the first 12 hours following birth as perinatal factors remains unchanged whereas the SNAP II is purely based on physiologic signs of illness which is assessable over time; therefore the SNAP II is also useful for quantifying the severity of illness even later in newborn's life and for out born newborn whose perinatal data is not well documented during referral.[10]

If these scores become the predictor of mortality in NICU in our set up, we may be able to use better score out of SNAP II and SNAPPE II. These scores are used routinely to assess the mortality and morbidity which will help to guide the treatment and also in proper use of resources, cost effectiveness, performance of NICU in quality care and counselling. This will also assist us to compare the effectiveness of treatment outcome among the intensive care units of different centres across country.

The aim of this study is to evaluate and compare risk scores as predictors of neonatal mortality in a Neonatal Intensive Care Unit (NICU).

MATERIALS AND METHODS

We enrolled 260 newborns of less than 24 hours of age NICU of B.P. Koirala institute of Health sciences(BPKIHS), Dharan, a tertiary care centre in eastern part of Nepal from July 2019 to May 2020 in this prospective observational study. Neonates who were transferred out of NICU or expired before 24 hour of stay, with congenital malformations not compatible with life, those newborn who did not require Arterial blood gas analysis (ABG) or catheterization, out born (either home or hospital) deliveries with no documentation of perinatal factors like weight, APGAR score and those left against medical advice (LAMA) were excluded from this study.

Parental informed consent was taken prior to this study then participants were enrolled consecutively. Institutional review committee (IRC) on the hospital approved this study.

The neonates admitted were first stabilized and resuscitated, and then the physiological variables for SNAP II and SNAPPE II were collected prospectively, by doctors as well as trained nurses within the first 12 hours of admission. The SNAP II score consists of six items: the lowest mean arterial pressure (MAP); the worst ratio of partial pressure of oxygen (PaO2) to fraction of inspired oxygen (FiO2); lowest temperature (in °F); lowest serum pH; occurrence of multiple seizures; and urine output (<1mL/kg/hr). The SNAP PE II score included the six physiological variables of the SNAP II score with the addition of points for birth weight, low APGAR score, and small for gestational age to create a nine-factor score.

Non-invasive mean blood pressure in (mmHg) was measured with the use of appropriate cuff size in either left or right arm via vital sign monitor (EPMTM SERIES, MINDRAY, CHINA). Temperature was measured in axilla using commercially available digital thermometer (35 to 42 °C) keeping thermometer for 3 min in axilla. Serum pH and PaO2/FiO2 was calculated by arterial blood gas analysis (ABG) using blood gas and electrolytes analyser ABL 800 basic (Radiometer, Denmark) available in our NICU. Neonatal seizures of all forms were documented in this score. Admission weight in NICU for both inborn and out born neonates was measured by electronic weighing machine (EBSA-20 BABY SCALE, CHINA) (±5 g error) without clothing. Birthweight of both inborn and outborn babies were matched from the documents at birth. Urine output (ml/kg/hr) was measured using Pediatric urine collecting bag or by catheterization. New Ballard score was used to assess the gestational age.

Intergrowth-21st growth chart was used for classification as small for gestational age as birthweight < 10th percentile for gestational age.[11,12] Management of newborn were done as per in house NICU protocol.

For available data, we used mean, standard deviation, median and range. Chi-square, Fisher exact test, t test and Mann-Whitney test were used to compare survivors and non-survivors groups. To assess power of scores to predict mortality, Receiver Operating Characteristics (ROC) curve was used. We compared the predictive value of SNAP II and SNAPPE II scores by using multiple logistic regression methodaximum sensitivity and optimal specificity in combination was taken as to determine optimal cut off score to predict mortality. Positive predictive values (PPV) and negative predictive values (NPV) were calculated for different cut-off scores. All statistical analysis was performed by SPSS software version 20.0 (IBM Corp., Armonk,

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NY). P value less than 0.05 was considered statistically significant.

RESULTS

A total of 295 neonates were admitted to the NICU of B.P.Koirala institutes of health sciences (BPKIHS) during the study period.27 of them were excluded as per exclusion criteria. 268 neonates that fulfilled the inclusion criteria and were enrolled in the study; and 8 out of enrolled new born went LAMA (left against medical advice). [Figure 1] represents the patient enrolment. The demographic data like gender, birth weight, place of delivery, mode of delivery, gestational age and various diseases were recorded and analysed. The characteristics of the neonates are summarized in [Table 1].

Among the 260 neonates completing the study admitted, Among the 260 neonates, there were 164 (63.07%) males and 96 (36.92%) the male to female ratio was 1.7:1. mean birth weight was 2388.88 ± 758.22 grams. 35.38% of new born were outborn. 21.2% were Low Birth Weight (LBW) and 18.8% were Very Low Birth Weight (VLBW). Only 3.1% was extremely low birth weight and rest had normal birth weight. 49 out of 260 patients who entered the study expired, which corresponds to a mortality rate of 18.84 % and 211(81.16%) were discharged. Average stay at NICU was 5 days. Median SNAP II score with IQR for term neonates was 14 (0-83) and preterm neonate was 13 (0-31). Median SNAP II score with IQR for expired neonates was 46 (17-83) and discharged neonate was 12 (0-83). SNAP II score has positive correlation with mortality. Score of 20-29 had 4.34%, score of 30-39 had 36.73% and score of > 40 had 100 % mortality. Median SNAPPE II score for term neonates was 12 (0-148) and preterm neonate was 14 (0-150). Median SNAPPE II score with IQR for expired neonates was 64 (16-148) and discharged neonate was 12 (0-148).

[Table 2] summarizes predictive scores for both SNAP and SNAPPE-II.

[Table 3] shows different variables used in calculating the SNAPII and SNAPPE II scores their relationship with patients' survival. As it can be seen, all variables showed a significant relationship with patients' survival except for occurrence of seizure.

Relationship between survival and SNAP II and SNAPPE II tests final scores among patients has been shown through Table 4. As it can be seen in this table, both scores show a strong correlation with patients' survival ($P < 0.001$).

[Figure 1] the area under the curve for SNAP II (area under the curve [AUC] = 0.912; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.927; 95% CI: 0.984–1) have a very strong predictive value of the patients' survival, with no statistically significant difference between two methods.

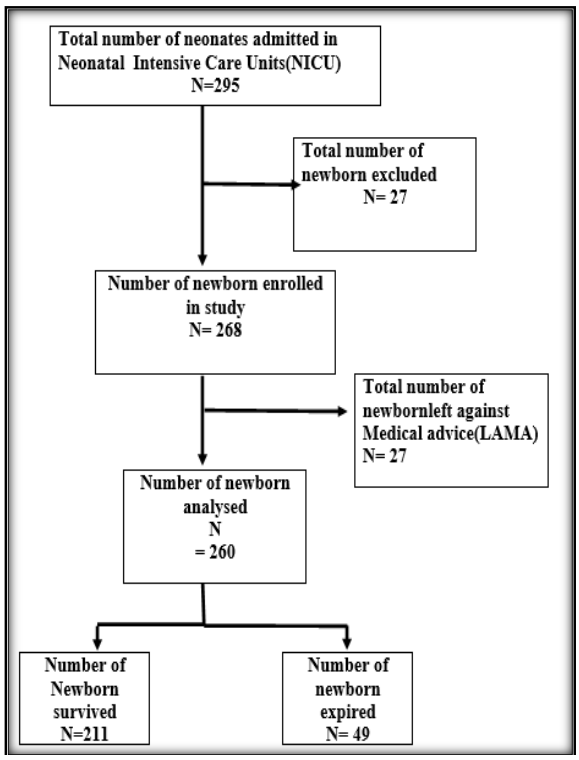

Figure 1: Flow diagram showing the number of newborn babies admitted to the NICU and their outcomes

[Figure 2]

ROC curve comparing SNAP II & SNAPPE for mortality prediction:

ROC curve for both SNAP II and SNAPPE II have been compared with their significant mortality predictive values.

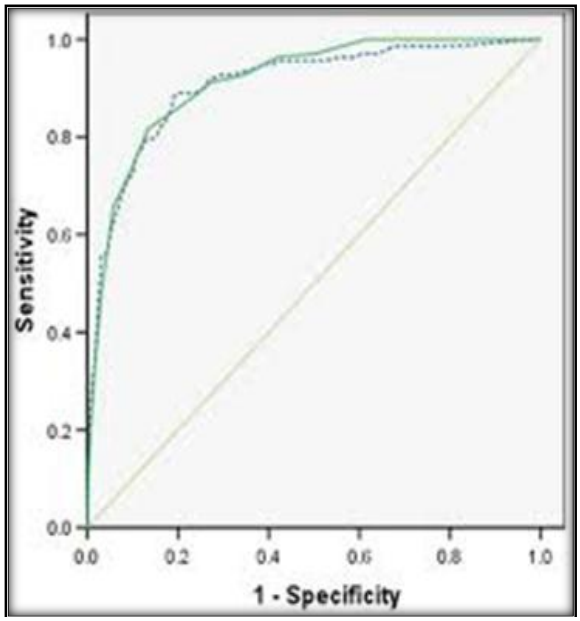

Figure 2: Area under the curve for SNAP II and SNAPPE II tests showing the predictive value of these 2 methods for predicting patients' survival. SNAP II (AUC = 0.912; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.927; 95% CI: 0.984–1)

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Table 1: Baseline characteristics of the Newborn

Baseline characteristics	Category	frequency	Percentage
Sex	Male	164	63.07
	Female	96	36.92
Gestational age	Term	171	65.7
	Preterm	89	34.2
Birth weight	<1000 g	12	4.6
	1000 to 1500 g	37	14.2
	1500 to 2500g	79	30.36
	>2500g	131	50.75
Place of delivery	In born	168	64.64
	Out born	92	35.38
Mode of delivery	SVD	168	64.64
	LSCS	87	33.46
	Vacuum	5	1.92
Primary diagnosis	Sepsis	95	36.53
	Birth Asphyxia	83	31.92
	Prematurity	61	24.46
	MAS	13	5.0
	Other	8	3.07

Table 2: Comparison of SNAP II and SNAPPE II in predicting the outcome

Variable		Total	Survived	Expired	P-value
SNAP II	Median (range)	14(0–83)	12(0–31)	46(17–83)	<0.001
	<20	71(27.3)	69(97.1)	2(2.8)	
	20–29	117(45.0)	111(94.8)	6(5.1)	
	30–39	52(20.0)	31(59.6)	21(40.3)	
	>40	20(7.6)	0(0)	20(100)	
SNAPPE II	Median (range)	12(0–150)	12(0–148)	64(16–148)	<0.001
	≤ 20	70(26.9)	68(97.0)	2(2.8)	
	20-29	116(44.6)	110(94.8)	6(5.1)	
	30–39	44(16.9)	31(70.4)	13(29.5)	
	40–49	24(9.2)	2(8.3)	22(91.6)	
	>50	6(2.3)	0(0)	6(100)	

Both scores show a strong correlation with patients' survival ($P < 0.001$). SNAP II score more than 30 is consistent with increasesd mortality whereas SNAPPE II score more than 40 increased odds of mortality

Table 3: Variables Used in Calculating SNAP II and SNAPPE II Scores and Their Relationship with Patients' Survival a, Based on Mann-Whitney test; b Based on Fisher exact test.

Variable		Total	Survive	Expire	P-Value
	>30	220 (88.8)	206 (97.6)	14 (28.6)	
Mean blood pressure (mm Hg)	20–29	31(11.9)	5 (1.2)	26(57.1)	<0.001(a)
	<20	9 (3.5)	0 (0)	9 (14.3)	
	>2.5	114 (43.8)	111 (54.4)	3 (6.0)	
Po2/Fio2 ratio	1–2.4	116 (44.9)	106 (49.4)	10 (9.5)	<0.001(a)
	0.33–0.999	27 (10.3)	4(1.2)	23 (81)	
	<0.33	3 (1.1)	0 (0)	3(9.5)	
	> 35.6	232 (93)	209(98.8)	23(47.6)	
Lowest temperature	35–35.5	28 (7)	2 (1.2)	26 (52.4)	<0.001(a)
	< 35	0 (0)	0 (0)	0 (0)	
	> 7.2	51 (19.5)	51 (24.)	0 (0)	
Lowest serum pH	7.1–7.19	186 (71.4)	165 (78)	26 (53.0)	<0.001(a)
	< 7.1	23(9.2)	0 (0)	23 (46.9)	
Multiple seizures	None/single	246(94.6)	201(95.1)	45(91.8)	0.302(b)
	Multiple	14(5.4)	10(4.7)	4(9.1)	
	> 0.91	231(88.6)	206(97.6)	25(51.0)	
Urine output (mL/kg/h)	0.1–0.9	28(10.8)	4(2.4)	23(48.9)	<0.001(a)
	< 0.1	1(0.5)	0(0)	1 (2.0)	
	>1000	250(96.2)	209(99.4)	41 (71.4)	
Birth weight (g)	750–999	7(2.7)	2(0.6)	5 (19)	<0.001(a)
	<750	3(1.1)	0(0)	3(9.5)	
Small for gestational age	NO	244(93.5)	199(93.9)	45(90.5)	0.625(b)
	Yes	16(6.5)	12(6.1)	4(9.5)	
	>7	246(94.6)	210 (99.4)	36(73.46)	
Apgar at 5 min after birth	4–7	14(5.4)	1(0.6)	13(26.59)	<0.001a
	<4	0 (0)	0 (0)	0 (0)	

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DISCUSSION

Assessing the gravity of sickness is a key cue while critically ill newborn is being cared. There are various measures proposed to assess the illness severity among sick newborn, SNAP II and SNAPPE II methods are two scoring tools among them dedicated for the same purpose.

Among 260 neonates enrolled in this study, the demographic data like gender, birth weight, place of delivery, mode of delivery, gestational age and various diseases were analysed and found to be similar to study done by Shrestha D et al,[13] in kathmandu, Nepal, and niranjan et al 2016,[14] in tertiary neonatal unit of a teaching hospital, Indira Gandhi Institute of Child Health, Bangalore from January 2008 to August 2009.

Neonatal sepsis (36.53%) was the commonest cause of admission of neonates to NICU which is more than one third of total neonates admitted to NICU followed by birth asphyxia (31.92%).Similarly, In a study conducted in AIIMS by vasudevan et al 2006, India from 2000-2002, neonatal sepsis was the commonest cause of admission consisting of 51% followed by birth asphyxia (11.2 %).[15] Admission of neonate with birth asphyxia has been increasing in our NICU which is comparable to sepsis (36.53 % vs. 31.92%). Prevalence of sepsis and asphyxia were similar to a retrospective study done by shah GS et.al.in 2013 at BPKIHS.[16] This finding is in contrast to national data of Nepal where neonatal sepsis and birth asphyxia were 47.7% & 16.4%,[17] respectively but in our study neonatal sepsis was only 36.53% and birth asphyxia was higher 31.92%. This is because, being a tertiary care hospital, all pregnant women with complications are referred to us from all periphery District Hospital. Prevalence of sepsis ranged from 30-37.12% documented by various studies in Nepal.[18-20] Among the neonates with sepsis, 10 were diagnosed as pneumonia and 24 as meningitis. In our NICU, most of the neonates admitted are inborn (64.61%). Among these newborn 49(18.84%) expired. This is similar to earlier study at our center where mortality rate was 17.6%. The similar rate mortality was also observed by Shrestha D (23%),[13] niranjan et al, (15.7%),[14] kadivar et al (12.6%).[21] However the studies have documented mortality rate among the newborn in NICU ranging from 8.9-35%.

In present study, both the SNAP II and SNAPPE II scores have performed well in terms of predicting mortality. They may differ by edge from feasibility point of view. In our study, SNAP II (AUC= 0.912; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.927; 95% CI: 0.984–1) methods had very strong value for predicting the patients' survival, but no statistically significant difference between 2 methods was observed which is similar to various studies. D. Shrestha et al,[13] studied and compared SNAP II and SNAPPE II in one of the government tertiary care centres in Kathmandu, Nepal. They concluded that SNAP II and SNAP PE II scoring of neonates can be used to predict prognosis of neonates in resource-limited NICUs in Nepal. Area under Curves (AUC) for SNAP II and SNAPPE II are 0.82 (95% CI: 0.73–0.90, p<0.001) and 0.78 (95% CI 0.70–0.86, p<0.001) respectively. It shows slightly higher discrimination for SNAP II but is statistically insignificant.

In a study by Mitra Radfar et al,[9] included 199 newborn infants. SNAP II (area under the curve AUC = 0.992; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.994; 95% CI: 0.984–1) was found which is similar to our study. There was no statistically significant difference in predictive value of SNAP II and SNAPPE II methods (P > 0.99). Similarly observations were also made by Richardson et al,[10] Gagliardi et al,[22] and Pollack et al,[23] where the SNAP II and SNAPPE II methods both showed strong value in predicting the mortality rate with AUC over 0.9, 0.86 and 0.82 respectively. The results of the present study, shows a strong predicting value for both SNAP II and SNAPPE II methods in predicting the mortality rate among severely ill neonates.

Our results for SNAP II and SNAPPE II are similar to the findings from other populations. Illness severity scores could help the clinicians estimate the risk at birth and monitor illness severity throughout the patients' admission, which will increase the chance of patients' survival.[24] This shows that NICU of our hospital has good critical care facility similar to that of India and other developing countries.

CONCLUSION

In conclusion, according to our findings SNAP II and SNAPPE II are useful tools in predicting the mortality rate among neonates admitted to NICU. There was no significant difference between SNAP II and SNAPPE II. SNAPPE II score includes perinatal components like gestational age, small for gestation age status and APGAR score which does not change over time. SNAP II contains physiological factor which changes over time with illness might perform better from feasibility point of view in our settings.

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