Original Article

Neonatal mortality risk assessment using SNAPPE-2 score in a neonatal intensive care unit in moderate-to-late preterm Newborns

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ABSTRACT

Background: In 1993, Richardson *et al*. introduced the score for neonatal acute physiology (SNAP), a 34-parameter system predicting mortality and morbidity in neonates. To enhance simplicity, it was later refined to nine parameters and renamed SNAP-II. Additionally, a perinatal extension known as SNAP Perinatal Extension, Version II (SNAPPE-II) was developed for broader applicability. **Objectives:** To determine the validity of SNAPPE-II in predicting the outcome in terms of mortality in premature babies of gestational age between 32 and 36 weeks in a tertiary care neonatal intensive care unit (NICU) of Cheluvamba Hospital, Mysore, Karnataka. **Materials and Methods:** The diagnostic study was conducted in the NICU of a tertiary care center in Mysore, India. The sample size of 138 subjects was calculated using a formula, and simple random sampling was used. The study included newborns with gestational ages between 32 and 36 weeks, and data was collected within 48 h of birth as per the proforma. The study assessed the correlation between the SNAPPE II score and mortality rate in babies admitted to the NICU. Data were analyzed using various statistical methods. **Results:** This study finds that the SNAPPE-II score has a moderate ability to distinguish between those newborns who will end up with mortality and those who will survive, as indicated by an area under ROC curve of 0.724, and has moderate diagnostic accuracy as indicated by a Youden index of 0.3974. The associated criterion for the SNAPPE-II score is >57, indicating newborns are more likely to have mortality. **Conclusion:** The SNAPPE-II score can be used to predict neonatal mortality rates in moderate-to-late preterm babies of gestational age between 32 and 36 weeks.

Key words: Mortality, neonatal intensive care units, preterm, score for neonatal acute physiology perinatal extension, version II

Neonatal intensive care units (NICU) have improved over the past several decades, and survival rates are increasing. More advances are still needed to improve the critical care practices of neonates [1]. Routinely available markers of risk, such as birth weight, gestational age, and sex, do not adequately capture dimensions of illness severity and do not explain such a variation. In pediatric ICUs and NICUs, this problem has been addressed using prognostication scoring systems [2]. Disease severity scores have the potential to help neonatologists estimate the risk and monitor illness severity throughout the patient's admission so that appropriate action can be taken. A score for neonatal acute physiology (SNAP) was developed in 1993 to evaluate clinical severity in the NICU. It uses 34 routinely available vital signs and laboratory test results. As this was cumbersome to use, in 1998, was validated a second-generation SNAP score, SNAP II. This score was made simpler by reducing the number of items to six and the duration for the first 12 h of admission to minimize the effects of early treatments. Only parameters that added significance to monitoring were retained in this score. Later, three more perinatal factors were added to SNAP II, namely, birth weight, Apgar scores, and small gestational age, to generate SNAP Perinatal Extension, Version II (SNAPPE II), which consists of nine variables [1,2].

Thus, Richardson *et al*. developed the SNAPPE-II scoring system, a modified and simpler version of the SNAP score. Only nine criteria are recorded in this score: average/mean blood pressure, PO_2/FiO_2, lowest temperature (°C), serum pH, multiple seizures, urine output, birth weight, APGAR score, and gestational age. The present study was conducted to assess the validity of the SNAPPE-II score as a predictor of neonatal mortality in preterm newborns of gestational age between 32 and 36 weeks in the NICU in the tertiary care center at Cheluvamba Hospital, Mysore.

MATERIALS AND METHODS

The prospective study was conducted in the NICU of a prominent tertiary care center in Mysore, India. This specialized unit caters to the critical care needs of newborns, particularly those with

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gestational ages between 32 and 36 weeks. The study enrolled a total of 138 newborns with a gestational age between 32 and 36 weeks. The sample size was determined based on a meticulous calculation to ensure statistical power and reliability in assessing the correlation between the SNAPPE II score and mortality rates.

To maintain the homogeneity of the study cohort, inclusion criteria comprised newborns with gestational ages between 32 and 36 weeks. Exclusion criteria included infants with congenital anomalies or other pre-existing conditions that might significantly impact the study outcomes. Data collection was initiated within 48 h of birth using a meticulously designed proforma. The proforma included parameters such as mean blood pressure, PaO_2/FiO_2 ratio, lowest temperature, serum pH, number of seizures, urine output, birth weight, APGAR score, and gestational age.

Prior approval was obtained from the institutional ethics committee. Informed consent was obtained from the parents or legal guardians of the participating newborns. The study objectives, procedures, potential risks, and benefits were thoroughly explained to the parents, and their voluntary consent was documented before the inclusion of their infants in the study.

Quantitative data obtained from the study were analyzed using appropriate statistical measures, including mean, percentage, and proportion. Furthermore, diagnostic test performance metrics such as net sensitivity, net specificity, positive predictive value (PPV), and negative predictive value (NPV) were employed to assess the correlation between the SNAPPE II score and mortality rates in the NICU.

RESULTS

The mean gestational age for both deceased and surviving newborns was 33 weeks, with a standard deviation of 1 week. The overall mean gestational age was 33±1 weeks (p=0.456).

At 1 minute, the mean APGAR score for surviving newborns was 7 (SD=2), while for those who did not survive, it was 5 (SD=1) (p=0.036). The overall mean APGAR score at 1 minute was 6 (SD=2). Similarly, at 5 min, the mean APGAR score for surviving newborns was 8 (SD=2), and for those who did not survive, it was 4 (SD=2) (p=0.021). The overall mean APGAR score at 5 min was 7 (SD=2).

The difference in the mean birth weight of alive newborns (1.975±0.47 kg) and expired newborns (1.457±1.862 kg) was not significant (p=0.265). However, the mean lowest serum pH and mean urine output between the two groups were significantly different (p=0.001) as shown in Table 1.

The study found that 74 newborns who were alive (67.30%) did not have multiple seizures, while 36 (32.70%) had multiple seizures. Twenty of the newborns who died (71.40%) did not have multiple seizures, while 8 (28.60%) had multiple seizures (p = 0.956).

As shown in Table 3, the mean blood pressure and P/F ratio between the two groups of newborns were significantly different (p=0.001). In this study, out of 110 alive newborns, 84 (76.40%) were not substantial gainful activity (SGA), while 26 (23.60%) were SGA. Similarly, out of 28 expired newborns, 17 (60.70%) were not SGA, while 11 (39.30%) were SGA. There was no significant difference in the proportion of SGA between the two groups (p=0.563) (Table 2).

As shown in Table 4, the mean total SNAPPE II scores for alive and expired newborns were significantly different (p=0.001). Newborns who had a higher mean total SNAPPE II score were more likely to die than those who had a lower mean total SNAPPE II score.

The area under the ROC curve (AUC) for the SNAP-PE II score in this study was 0.724, which indicates that the score has a moderate ability to distinguish between those who will die and those who will survive. The standard error of the AUC is 0.0541, and the 95% confidence interval for the AUC ranges from 0.641 to 0.796. The z-statistic is 4.131, and the significance level (p-value) for the AUC is <0.0001, which indicates that the results are statistically significant (Figure 1).

The Youden index (J) is a measure of the diagnostic accuracy of the test, and its value of 0.3974 indicates moderate diagnostic accuracy. The associated criterion for the SNAPPE II score is >57, which means that newborns with a score >57 are more likely to die. The sensitivity of the test is 64.29%, which means the proportion of newborns who died had a score greater than 57, and the specificity of the test is 75.45%, which means the proportion of newborns who survived had a score <57.

DISCUSSION

The objective of this study was to assess the mortality risk of preterm newborns of gestational age between 32 and 36 weeks

Table 1: Comparison of gestational age, APGAR score, birth weight, serum pH, temperature, urine output between dead and alive

Parameters	Outcome						p-value
	Alive		Death		Total		
	Mean	SD	Mean	SD	Mean	SD	
Gestational age	33	1	33	0.9	33	1	0.456
APGAR 1’	7	2	5	1	6	2	0.036
APGAR 5’	8	2	4	2	7	2	0.021
Birth weight	1.975	0.47	1.457	1.862	1.87	0.95	0.265
Lowest serum pH	7.79	6.24	7.22	0.56	7.67	5.58	0.001
Temperature (°C)	36.87	0.46	35.92	1.57	36.68	0.9	0.164
Urine output (mL/kg/h)	1.23	0.51	1.08	0.6	1.19	0.53	0.001

using the SNAPPE-II score in a NICU. The present study found that there was no statistically significant difference in mortality rates between males and females (p=0.365) or in gestational age between live and expired newborns (p=0.456). APGAR scores at 1 and 5 min were found to be statistically significant indicators of mortality, with p=0.036 and 0.021, respectively. Other factors such as birth weight, lowest serum pH, temperature, and urine output were also found to have statistically significant differences between the groups of preterm newborns who were alive and those who died, with p=0.265, 0.001, 0.164, and 0.001, respectively.

Furthermore, the study found that the SNAPPE-II score has moderate diagnostic ability, with an AUC of 0.724, a Youden index of 0.3974, and an associated criterion of >57 on the SNAPPE-II scores. This indicates that newborns with a score >57 SNAPPE-II score are more likely to die, and the sensitivity and specificity of the test were 64.29% and 75.45%, respectively. According to the study conducted by Ali *et al*. [3], the AUC was 0.82, indicating a strong association between the severity of the score and the neonatal mortality rate. According to a cohort study carried out by Aryana *et al*., [4] the score of SNAPPE-II is a good predictor of mortality in NICU newborns, with an AUC of 0.92 and a strong relationship between the score and mortality rate. As per the study conducted by Ashrafzadeh *et al*., [5] the cutoff point was 27.5 and the Youden index was 0.64, according to Youden's approach, with an AUC of 0.88, which was comparable to our study.

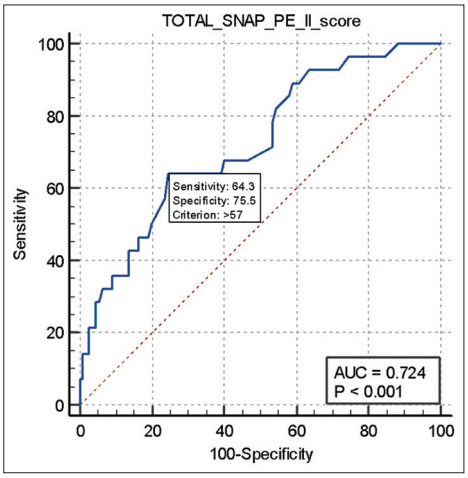

Figure 1: Area under ROC curve

Table 2: Comparison of multiple seizures among dead and alive

Multiple seizures	Outcome						p-value
	Alive		Death		Total		
	Count	%	Count	%	Count	%	
No	74	67.30	20	71.40	94	68.10	0.956
Yes	36	32.70	8	28.60	44	31.90	

The neonatal mortality rate in the present study was 20.29% according to the SNAPPE-II scoring system. Neonatal mortality rate, as per the study conducted by Ashrafzadeh *et al*. [5] was 26.4% by the SNAPPE-II scoring system. A higher score increases the likelihood of death. As per the study conducted by Harsha and Archana, [2] SNAPPE-II showed a good correlation with outcome in terms of mortality, irrespective of gestational age. In their study, a SNAPPE-II score of 37 and above was associated with higher mortality. In a study conducted by Ramirez *et al*., [6] scores of 40 and above, a study done by Ucar *et al*., [7] scores of 33 and above, a study done by Babaei *et al*. [8] scores above, and a 40 were associated with higher mortality.

According to the results of the above study, the mean total SNAPPE-II score was 16.94 in the surviving infants and 51.60 in the deceased ones. In another study conducted in Karnataka by Patil *et al*., [1] it was observed that the mean SNAPPE II score among the study population was 23.66 (SD 21.48). Among the expired, the mean score was found to be the highest. Among the improved, the mean score was found to be the lowest. There was a significant difference in mean SNAPPE II between died and survived patients, suggesting that a higher SNAPPE-II is associated with a higher risk of mortality. Besides, in the study conducted in Thailand by Nakwan *et al*., [9] it was reported that the mean total SNAPPE-II score was 23.5 and 36.5 for the survived and deceased neonates, respectively, suggesting that a higher score is associated with mortality.

In similar studies, variables that had significant relationships with mortality outcome included one- and five-minute APGAR scores and gestational age, which were the most important factors in predicting mortality, respectively. [8] Another study conducted by Ramirez *et al*. [6] also found that the overall SNAPPE-II score, perinatal asphyxia, and congenital malformations were significantly correlated with neonatal death.

In the current study, the sensitivity of the SNAPPE-II system was 64.29%, the specificity was 75.45%, and the cutoff point was 57. Another study conducted by Patil *et al*. [1] calculated that the sensitivity of SNAPPE-II had a predictive cutoff score of 27, with a sensitivity of 87.5% and a specificity 78.85%, which was comparable to our study. As per the study conducted by Muktan *et al*., [10] the higher the score of SNAPPE-II, the higher the mortality risk for neonates. A SNAPPE-II score of ≥38 was the best way to predict mortality, with a sensitivity of 84.4%, a specificity of 91%, a PPV of 66.7%, and an NPV of 96.5%.

Because the SNAPPE-II does not include gestational age as an item in the scoring, the study also could not calculate the correlation between gestational age and the final score due to limited data availability. It is suggested that this issue should be considered in future studies [5]. Overall, this study suggests that

Table 3: Comparison of mean blood pressure and PaO_2/FIO_2 (P/F) ratio among dead and alive

Parameters	Alive		Death		Total		p-value
	Mean	SD	Mean	SD	Mean	SD	
Mean blood pressure (mm-Hg)	40.73	10.16	31.73	11.41	38.91	11.00	0.001
PaO_2/FIO_2 ratio	2.22	0.96	1.18	0.95	2.01	1.04	0.001

Table 4: Total SNAPPE -II score among dead and alive

Total SNAPPE II score	Outcome						p-value
	Alive		Death		Total		
	Mean	SD	Mean	SD	Mean	SD	
Score	48	16	64	20	51	18	0.001

SNAPPE II: Score for neonatal acute physiology perinatal extension, version II

the SNAPPE-II score can be used as a useful tool in assessing the mortality risk of preterm newborns in a NICU. In addition, other factors such as APGAR scores, birth weight, lowest serum pH, temperature, and urine output were found to have a statistically significant correlation with neonatal mortality.

The study was conducted in a single center, which may limit the generalizability of the results to other settings. The study had a relatively small sample size of 138 newborns, which may limit the statistical power of the analysis. Also, this study excluded newborns with congenital anomalies, which may limit the applicability of the findings to this population.

CONCLUSION

The final score obtained from the SNAPPE-II scoring system is the predictor of neonatal death, which shows a higher mean value compared with other studies and may indicate that the higher the score, the higher the mortality.

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