

Neonatal Mortality Risk Assessment using the Snappe-II Score - A Prospective Observational Study

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Abstract: *Background:* The Score for Neonatal Acute Physiology with Perinatal Extension (SNAPPE-II) is a scoring system developed and validated for illness severity and mortality risk scores for newborn intensive care. The values range from 0 to 148 and are proportional to the illness severity, with higher scores indicating higher mortality risks. The effects of perinatal factors, physiologic factors, laboratory parameters and on the mortality in neonates are assessed. *Objectives:* To study SNAPPE-II for evaluating the survival prognosis of newborns admitted to a Neonatal Intensive Care Unit and to assess the best cut-off score in predicting overall mortality. *Study Design:* Prospective observational study. *Participants:* The data was collected from 180 neonates admitted to the NICU fitting the inclusion & exclusion criteria in Tertiary Teaching Hospitals attached to Mahadevappa Rampure Medical College, Kalaburagi. *Results:* Mean SNAPPE II among subjects who died was 55.29 (SD 25.67) and among subjects who recovered was 18.79 (SD 16.01) (p -value<0.001). The best cut-off score was found to be 27. This score has a sensitivity of 87.50%, specificity of 78.85%, Positive Predictive Value of 38.9% and Negative Predictive Value of 97.6% in predicting mortality. *Conclusion:* Higher the SNAPPE II, higher the mortality risk of neonates. SNAPPE-II is better in predicting mortality in babies with duration of NICU stay of <7 days when compared to duration of NICU stay of >7 days. It assists the clinician in identifying and prioritizing a very sick neonate and also helps in counselling the parents.

Keywords: APGAR, Mean Blood Pressure, Small for Gestational Age, Lowest Temperature, ROC Curve

1. Introduction

Every year, 26 lakh babies die worldwide within 28 days of life, an average of 7, 000 neonatal deaths every day. [1]The neonatal period, the first 28 days of life, carries the highest risk of mortality per day than any other period during the childhood. The daily risk of mortality in the first 4 weeks of life is about 30-fold higher than the post neonatal period. [2]

Neonatal intensive care unit (NICU) care has been improved over the past several decades and survival rates are increasing, more advances are still needed to improve the critical care of neonates. Illness severity scores have the potential in help clinicians estimate the risk at the and monitor illness severity throughout the patient's admission. [3]. A score for neonatal acute physiology (SNAP) is been developed by Richardson and colleagues in 1993 to evaluate clinical severity in neonatal intensive care units. It is a physiology-based score that uses 14 routinely available vital signs and laboratory test results. [4]

Only parameters which added significance were retained and SNAP II (second generation) was developed Perinatal factors were added to SNAP II to generate SNAPPE II (SCORE FOR NEONATAL ACUTE PHYSIOLOGY, PERINATAL EXTENSION, VERSION II) which consisted of 9 variables. [5]

The SNAPPE-II values range from 0 to 148 and are proportional to the illness severity, with higher scores indicating higher mortality or morbidity risks. The SNAPPE-II can be used in patients with all birth weight and

gestation age. It is an admission score, the effects of perinatal factors (birth weight, gestational age, APGAR score at 5 minutes), physiologic factors (mean blood pressure, temperature, urine output, presence of multiple seizures) laboratory parameters (arterial blood gas analysis for pH and PaO₂) and on the mortality in neonates. It is applied within first 12 hours of admission and first 48 hours of life. [5]

A prospective, observational study was carried out by Dipak Muktan, Rupa R. Singh, Nisha K. Bhatta et al, 2016on 305 neonates from June 2015 to May 2016 at NICU in a tertiary care hospital of eastern Nepal. SNAPPE-II score was significantly higher among neonates who died compared to those who survived [median 57 (42–64) vs.22 (14–32), $P < 0.001$]. SNAPPE II score had discrimination to predict mortality with area under ROC Curve (AUC): 0.917 (95% CI, 0.854–0.980). The best cut-off score for predicting mortality was 38 with sensitivity 84.4%, specificity 91%, positive predictive value 66.7% and negative predictive value 96.5%. The study also concluded that a score of 38 may be associated with higher mortality. [6]

A prospective validation study done by Sujana Rachuri, Saritha Paul, Jaidev M. D., 2018in a tertiary care hospital, where a total of 116 newborns admitted to the NICU was included. Out of which, 56 (48%) had mild SNAPPE-II score, 44 (38%) had moderate score and 16 (14%) had severe score. Among the 44 babies with moderate score, 12 (27%) died, which was statistically significant ($P < 0.001$). Among 16 babies with severe score, 13 (81%) babies died, which was highly statistically significant ($P < 0.0001$). Urine

outputs, seizures, serum pH in the first 24 hours of life are independent predictors of mortality with significant p value (0.001). They concluded that the SNAPPE-II score recorded in the first 48 hours of life could be a good predictor of mortality in babies admitted to NICU. [7]

A study done by Moumita Samanta et al, 2020 showed that a SNAPPE-II score cut-off of ≥ 20 offered the highest sensitivity of 74.5% with specificity 48.3%, PPV 27.6% and NPV 87.7%. Comparison of mortality proportions between the two subgroups defined by this cut-off returned $p=0.005$ with OR 3.47 (95% 1.40 to 8.64). No significant association was found between SNAPPE-II score and blood culture results; mean scores for culture positive 25.16 (SD 15.6) and negative groups 24.49 (SD 15.6) were comparable ($p=0.920$). The study concluded that at a cut-off value of ≥ 20 in presence of sepsis, SNAPPE-II score offers acceptable indices to predict mortality outcome. Prediction of outcome by SNAPPE-II score is not affected by positive or negative blood culture sepsis. [8]

A pilot study done by Jain and Bansal, 2009 assessed the prediction of mortality using SNAPPE II score in level II NICU in Indian setup. Study with large sample size can be done to predict mortality for each range of score. As the score increased to 40 and above chances of mortality increased and it was maximum with a score of 80 and above. [9]

2. Methods

This Prospective Observational Study was conducted in the neonatal units of Department of Pediatrics of tertiary care teaching institute from 1st March 2021 to 31st August 2022 after obtaining ethical clearance from the Institutional ethical committee. Written and Informed consent was taken from the parent/guardian for participation in the study before enrolment.

Newborns admitted to NICU within 48 hours of birth requiring respiratory support will be included in this study. Newborns who died or were discharged in <24 hours after admission, those with congenital malformations incompatible with life, those neonates who did not require ABG (Arterial blood gas analysis) or catheterisation and those who were home deliveries with unknown APGAR score were excluded in the study.

The SNAPPE-II score was calculated on the basis of recommended physiological and clinical factors, evaluated prospectively within the first 48 hours of admission after stabilization. The Apgar score for the fifth minute of life was established by the physician responsible for the delivery room of each patient. Non-invasive mean blood pressure in (mmHg) was measured with the use of appropriate cuff size in left or right arm via vital sign monitor (BPL Multi parameter monitor). Temperature was measured in axilla using commercially available digital thermometer (35 to 42 °C). Serum pH and PaO₂/FiO₂ was calculated by arterial blood gas analysis (ABG) using blood gas and electrolytes analyser (GEM 3500) available in our hospital attached laboratory. All types of neonatal seizure were included in this score. Birth-weight of inborn neonates was measured by

electronic weighing machine (± 5 g error) without clothing. Birth-weight of out born neonates was recorded from their details mentioned on referral slips. Urine output (ml/kg/hr) was measured using Paediatric urine collecting bag or by catheterization. Modified Ballard score was used to assess the gestational age. WHO growth chart was used for classification as small for gestational age as birth weight <10th percentile for gestational age. Neonates were treated as per hospital protocols and they were discharged from NICU as per standard NICU protocol.

Table 1: Snappe II Parameters with Score Points

Parameters with Range	Score Points
MEAN BLOOD PRESSURE (mmHg)	
>30	0
20-29	9
<20	19
LOWEST TEMPERATURE (Degree Celsius)	
>35.6	0
35-35.6	8
<35.0	15
PaO₂/ FiO₂ ratio	
>250	0
100-249	5
30-100	16
<30	28
LOWEST SERUM pH	
>7.2	0
7.1-7.19	7
<7.1	16
MULTIPLE SEIZURES	
NO	0
YES	5
URINE OUTPUT (ml/kg/hr)	
>0.9	0
0.1-0.9	5
<0.1	18
BIRTH WEIGHT	
>999 g	0
750 – 999 g	10
<750 g	17
SMALL FOR GESTATIONAL AGE	
>3 rd percentile	0
<3 rd percentile	12
APGAR score at 5 minutes	
>7	0
<7	18

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software.

Graphical representation of data: MS Excel and MS word were used to obtain various types of graphs such as bar diagram, Pie diagram and ROC Curve.

Validity of Screening test was plotted by ROC Curve sensitivity, specificity at best showing cut-off. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

3. Results

A total of 180 newborns who fulfilled the inclusion criteria were included in this study. Among which, 106 (58.9%)

were male and 74 (41.1%) were female. 30% of the study population had Multiple Seizures of varying semiology. 75% of the babies were having APGAR Score of >7; whereas, 25% of them had APGAR Score of <7. The Mean Blood Pressure was found to be 36.23 (SD 13.19) mmHg; Mean Lowest Temperature was 36.40 (SD 0.76) degrees Celsius; Mean Urine Output was 1.72 (SD 0.79) ml/kg/hr; Mean P/F

Ratio was 178.63 (SD 71.07); Mean Lowest PH was 7.29 (SD 0.14); Mean Birth Weight was 2.29 (SD 0.77) Kgs.

Table 2: Gender distribution

	Count	%	
Sex	Female	74	41.1%
	Male	106	58.9%
	Total	180	100.0%

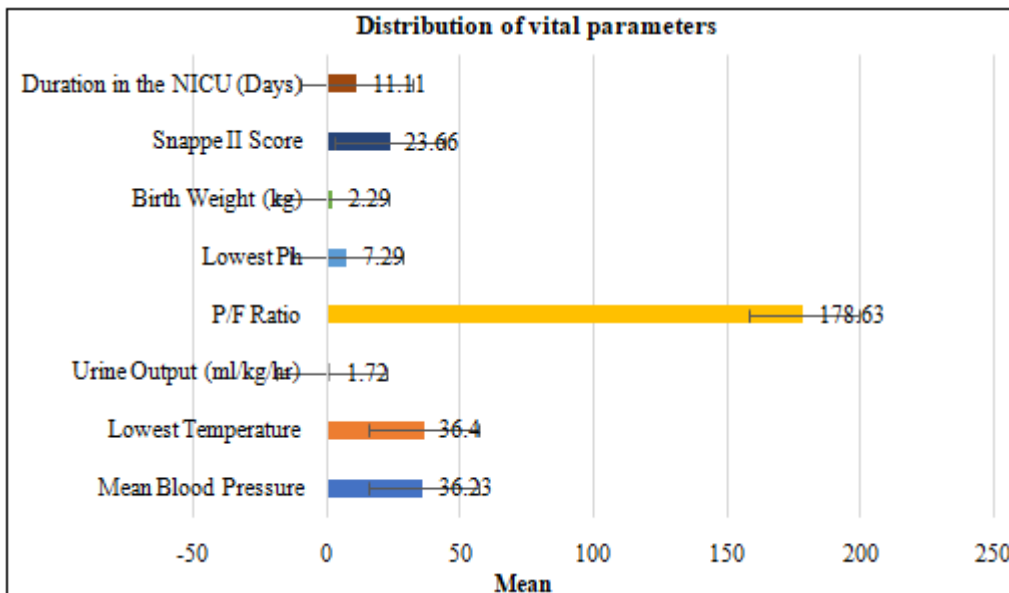


Figure 1: Bar diagram showing Distribution of vital parameters

During our study period, it was observed that 24 (13.3%) of the babies expired, whereas 156 (86.7%) survived and discharged. Mean SNAPPE II Score among subjects who succumbed to death was 55.29 (SD 25.67) and among subjects who recovered was 18.79 (SD 16.01) (p<0.001). There was significant difference in mean SNAPPE II Score between died and survived subjects. Mean Duration in the NICU among subjects who succumbed to death was 6.67 (SD 4.95) and among subjects who recovered was 11.79 (SD 7.69) days (p < 0.002). There was significant difference in mean Duration in the NICU between died and survived subjects.

Best cut off for SNAPPE II Score is 27 as given by Youden index J. A Score of 27 had sensitivity of 87.50%, specificity of 78.85% (Figure 1), Positive predictive value (PPV) of 38.9% and Negative predictive value (NPV) of 97.6% in predicting mortality.

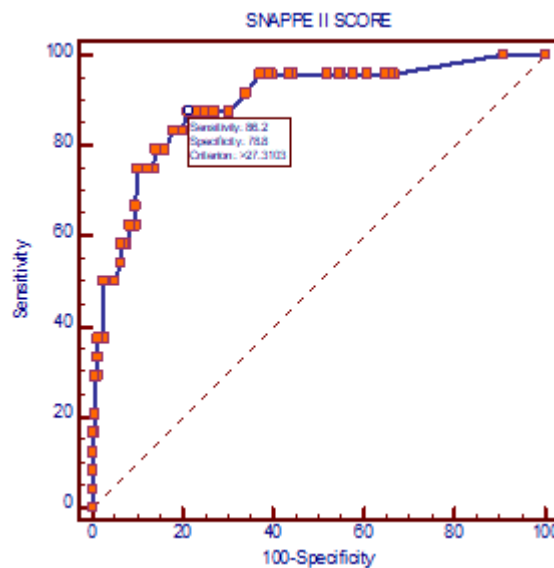


Figure 1: ROC curve diagram showing SNAPPE II Score in prediction of Mortality

In the study among subjects with SNAPPE II score <30, 3.1% (4) of the babies expired; Among subjects with a score of 30 to 60, 27.5% (11) of them expired and among subjects with a score of >60, 81.18% (9) of them expired. Hence, with an increase in SNAPPE II, there was an increase in mortality.

For a NICU stay of <7 days, a Score of 33 had sensitivity of 80.00%, specificity of 95.83%, PPV of 85.7% and NPV of 93.9% in predicting mortality. And for a NICU stay of >7 days a Score of 33 had sensitivity of 88.89%, specificity of

75.00%, PPV of 22.9% and NPV of 98.8% in predicting mortality.

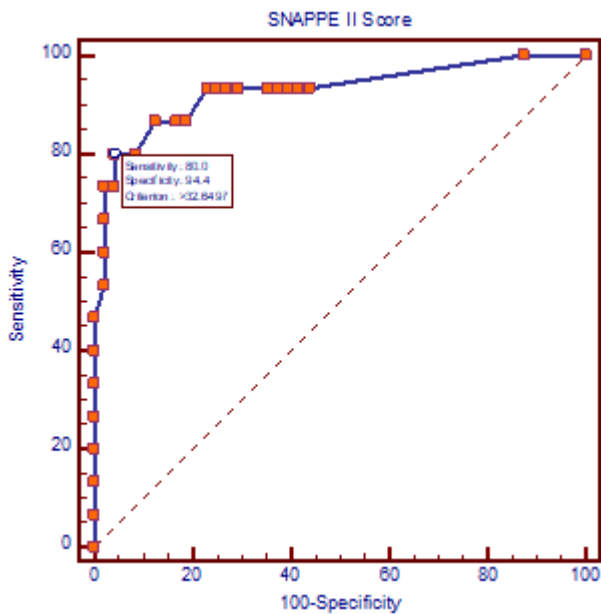


Figure 2: ROC curve diagram showing SNAPPE II Score in predicting mortality among subjects with NICU Stay <7 days

4. Discussion

A total of 812 babies were admitted in two NICUs of our set up during the study period. Out of which, 180 babies were included in the study. When all study subjects were evaluated, we observed that were 58.9% were males, 40% babies were preterm, 54.4% babies were term and 5.6% babies were post term. 19.5% of the babies were SGA. 76.7% neonates were inborn whereas 23.4% were out born. 55% babies were born out of NVD, out of which 5% were instrumental deliveries. 45% neonates were born by LSCS. 73.3% of the babies were born with clear liquor, whereas 26.6% were born with meconium-stained liquor. Out of 180 neonates taken in the study, 82.2% improved, whereas 13.3% succumbed and the rest (4.4%) were discharged against medical advice.

The minimum and maximum score recorded were 0/148 and 106/148 respectively. When the study population was divided into 3 groups of SNAPPE-II (<30; 30-60; >60), it was found that the risk of mortality was the highest when the SNAPPE-II was >60; moderate when the score was 30-60 and lowest when the score was <30.

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 highest. Among the improved, the mean score was found to be lowest. There was 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, thus validating this study. These values were close to the study conducted by Reid S, Bajuk B, Lui K et al where the mean SNAPPE-II among expired and improved subjects were 61.9 and 19.45 respectively. [10]

Higher the SNAPPE II score, higher is the mortality rate. We had a predictive cut-off score of 27, with a sensitivity 87.5% and a specificity 78.85%; Negative predictive value of 97.6% and positive predictive value of 38.9%. The predictive cut off for our study was close to the studies conducted by Dammann O, Shah B, Naples M et al & A M, Etika R, Harianto A, et al. [11, 12]

According Harsha SS and Archana BR, the mean length of stay was found to increase from score of 11-40 but this was not statistically significant. Mean length of hospital stay for children with score of more than 40 was found to decrease suggesting that these neonates were sick at admission and succumbed to disease early. Mean duration of hospital stay was 10.24 (SD 8.056) days. [13] In our study, mean Duration in the NICU was observed to be 11.11 (SD 7.57) days. We also found out that the SNAPPE II score at a cut-off of 33, is better in predicting mortality in babies whose duration of NICU stay was <7 days (when compared to >7 days). There was significant difference in mean Duration in the NICU between died and survived subjects.

In this study, the individual parameters of the SNAPPE II (Figure 4) were compared among the expired and improved. The Mean BP, Lowest Temperature, P/F Ratio, Lowest pH, Multiple seizures, APGAR at 5min, Birth Weight showed significant association with mortality (p value < 0.001). An increase in the score was associated with an increase in mortality. Whereas, the Urine output (p value 0.096) and SGA (p value 0.196) parameters showed no individual association with the mortality.

Since our study was conducted in the neonatal units of a single institution, preventing the comparison of multicentric outcomes, it may not represent the remaining part of the country, which became the major limitation to our study.

5. Conclusion

The current study evaluated the usefulness of SNAPPE II in predicting mortality in terms of comparing the mean SNAPPE II scores in the expired and the survived babies found out that SNAPPE II was higher among expired babies compared to survived babies. A mean score of 27 was associated with higher mortality. SNAPPE II is better in predicting mortality in babies with duration of NICU stay of <7 days when compared to duration of NICU stay of >7 days. It is a good predictor of neonatal mortality. It assists the clinician in identifying a very sick neonate and prioritizing the treatment. It also helps in counselling the parents of such neonates, regarding the severity of illness and the probable treatment cost involved.

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