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Original Article

Utilization of SNAP II and SNAPPE II Scores for Predicting the Mortality Rate Among a Cohort of Iranian Newborns

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Abstract

Background: The present study was conducted to determine the utility of 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, and to compare the predictive value of these two methods.

Methods: In this prospective study data were gathered from infants admitted to the neonatal intensive care unit (NICU) of Imam Hossein Medical Center, Tehran, Iran, from March 2015 to December 2015. In addition to demographic data, Apgar score at 5 minutes after birth, initial and final diagnosis, SNAP II, and SNAPPE II were recorded within 24 hours after admission to the NICU.

Results: One hundred ninety-one newborn infants entered into the study. Birth weight (2555 ± 722 g in survival group versus 1588 ± 860 g in expired group, $P<0.001$), and Apgar score more than 7 at 5 minutes after birth (99.4% in survival group versus 57.1% in expired group, $P<0.001$) were significantly related to the mortality rate. By analyzing the data using logistic regression, it was found that 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) had better value for predicting the patients' survival compared to Apgar score at 5 minutes after birth (AUC = 0.711; 95% CI: 0.568–0.855). There was no statistically significant difference in predictive value of SNAP II and SNAPPE II methods ($P>0.99$).

Conclusion: According to our findings SNAP II and SNAPPE II are useful tools in predicting the mortality rate among Iranian neonates admitted to NICU. Although there was no significant difference between SNAP II and SNAPPE II, both methods had a much better predictive value compared to Apgar score at 5 minutes after birth.

Keywords: Mortality, Newborn, Neonatal intensive care unit, Risk assessment, SNAP II, SNAPPE II

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Introduction

Although neonatal intensive care unit (NICU) care has improved over the past several decades and survival rates are increasing, more advances are still needed to improve the critical care of neonates.[1] Researchers have tried to decrease the risk of mortality and morbidity in critically ill neonates. Considerable efforts have been put to find the best method to estimate the severity of different illnesses among these patients.[1] Illness severity scores have the potential to help clinicians estimate the risk at birth, and monitor illness severity throughout the patients' admission.[1] The original Score for Neonatal Acute Physiology (SNAP) was developed by Richardson et al, in 1993.[2] The SNAP could help the physicians to quantify the illness severity; however, it is time consuming, requiring about 30 measurements and up to 15 minutes to evaluate the parameters.[2,3]

Severity of illness is associated with mortality rate; however, there are also perinatal risk factors such as birth weight, small for gestational age, and the five minute Apgar score that influence the mortality, independent of illness severity.[4] These perinatal parameters were added to the SNAP, forming the Score for Neonatal Acute Physiology with Perinatal Extensions (SNAPPE) to have physiologic instability and perinatal mortality risk in one instrument.[4]

The SNAP scoring system was too time consuming to perform, so a simpler format of the initial SNAP score called SNAP II was devised, which included only six items.[3] The parameters in this new scoring system were blood pressure, body temperature, PO2/FIO2, serum pH, multiple seizures, and urine output.[3]

The SNAP II is a summative rating scale and its highest possible score is 115.[1] SNAPPE II adds 3 more parameters to SNAP II including birth weight, small for gestational age, and the 5 minutes Apgar score; and its highest possible score is 162.[1,3] Higher SNAP II or SNAPPE II scores indicate that the neonate is more severely ill. It should be noted that the SNAP II was designed to measure the mortality risk based on physiologic instability, whereas the SNAPPE II was designed to measure the mortality risk by combining physiologic and perinatal factors.[4]

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Since perinatal factors will not change over time, the SNAPPE II is beneficial if only it is calculated in the first 12 hours following birth. But the SNAP II is based on physiologic signs of illness which can be assessed over time; therefore the SNAP II is also useful for measuring the severity of illness later in neonate's life.[1]

SNAP II is one of the most common instruments used to measure neonatal illness severity, and has been used internationally in many different countries including Iran.[5-11] The present study was conducted to determine the usefulness of SNAP II and SNAPPE II scores in predicting the outcome, in terms of mortality in NICU of Imam Hossein Medical Center, Tehran, Iran. Also this study compared these 2 different methods regarding their predictive value.

Patients and Methods

This prospective, observational study was carried out on 191 newborns less than 24 hours of age admitted to Imam Hossein Medical Center NICU, Tehran, Iran, from March 2015 to December 2015. Patients who were discharged against medical advice, or died in less than 24 hours after NICU admission were excluded from the study. The neonates admitted were first stabilized and resuscitated, and then the variables for SNAP II and SNAPPE II were collected prospectively, by doctors as well as trained nurses within the first 12 hours of admission. Variables other than those used to calculate SNAP II and SNAPPE II scores were Apgar scores at 5 minutes after birth, initial diagnosis and patients' mortality outcomes.

Statistical Analysis

To present data, we used mean, standard deviation, median and range. To compare the groups, we used chi-square and Fisher exact test, *t* test and Mann-Whitney test. To assess the prediction ability of scores, we used area under the curve (AUC). To compare the predictive value of SNAP II and SNAPPE II scores we used multiple logistic regression method. All statistical analysis was performed by SPSS software version 22 (IBM Corp., Armonk, NY). *P* values less than 0.05 were considered statistically significant.

Results

The mean age of participants at admittance was 1.5 ± 3.9 hours. There was a statistically significant difference between the mean age at admittance ($P = 0.037$), and gestational age ($P < 0.001$) of patients who survived and those who expired (Table 1). The mean birth weight of patients was 2445 ± 798 g, witch was statistically higher among patients who survived compared to those who expired ($P < 0.001$) (Table 1). Sex, hospital stay and initial diagnosis did not show a statistically significant correlation with survival (Table 1). Nineteen out of 191 patients who entered the study expired, which corresponds to a mortality rate of 9.9%.

Table 2 shows different variables used in calculating the SNAPII and SNAPPE II scores, as well as Apgar score at five minutes after birth, and their relationship with patients' survival. As it can be seen, all variables showed a significant relationship with patients' survival except for occurrence of seizure.

Table 3 shows the relationship between survival and SNAP II and SNAPPE II tests final scores among patients. As it can be seen in this table, both scores show a strong correlation with patients' survival ($P < 0.001$).

Figure 1 and Table 4 show the area under the curve for SNAPII and SNAPPE II methods as well as Apgar at 5 minutes after birth. These three methods can be

Table 1. Demographic Findings of Patients and Their Correlation With Survival

Variable		Statistics	Total	Survived	Expired	*P*
Gestational Age	Week	Mean ± SD	35.5 ± 3.5	36.1 ± 2.9	30.7 ± 4.6	<0.001[a]
		Median (range)	36 (23.41)	36 (28.41)	29 (23.38)	
Age at acceptance	Hours	Mean ± SD	1.5 ± 3.9	1.6 ± 4.1	0.6 ± 2.4	0.037[b]
		Median (range)	0 (0.23)	0 (0.23)	0 (0.11)	
Sex	Male	n (%)	89 (48.1)	82 (50)	7 (33.3)	0.136[c]
	Female	n (%)	96 (51.9)	82 (50)	14 (66.7)	
Birth weight	Grams	Mean ± SD	2445 ± 798	2555 ± 722	1588 ± 860	<0.001[b]
		Median (range)	2600 (700,4200)	2700 (800,4200)	1250 (700.3400)	
Admission Duration	Days	Mean ± SD	0.6 ± 2.4	0.7 ± 2.5	0.1 ± 0.4	0.12[b]
		Median (range)	0 (0.20)	0 (0.20)	0 (0.1)	
Initial diagnosis	Respiratory	n (%)	130 (70.3)	112 (68.3)	18 (85.7)	0.321[d]
	Cardiac	n (%)	37 (20)	36 (22)	1 (4.8)	
	Surgical	n (%)	1 (0.5)	1 (0.6)	0 (0)	
	Hematological	n (%)	3 (1.6)	3 (1.8)	0 (0)	
	Metabolic	n (%)	8 (4.3)	7 (4.3)	1 (4.8)	
	Neurological	n (%)	3 (1.6)	3 (1.8)	0 (0)	
	Miscellaneous	n (%)	3 (1.6)	2 (1.2)	1 (4.8)	

[a] Based on *t* test; [b] Based on Mann-Whitney test; [c] Based on chi-square test; [d] Based on Fisher exact test.

Table 2. Variables Used in Calculating SNAP II and SNAPPE II Scores and Their Relationship With Patients' Survival

Variable		Total	Survive	Expire	*P*
Mean blood pressure (mm Hg)	>30	168 (90.8)	162 (98.8)	6 (28.6)	<0.001[a]
	20–29	14 (7.6)	2 (1.2)	12 (57.1)	
	<20	3 (1.6)	0 (0)	3 (14.3)	
Po2/Fio2 ratio	>2.5	81 (43.8)	81 (49.4)	0 (0)	<0.001[a]
	1–2.4	83 (44.9)	81 (49.4)	2 (9.5)	
	0.33–0.999	19 (10.3)	2 (1.2)	17 (81)	
	<0.33	2 (1.1)	0 (0)	2 (9.5)	
Lowest temperature	> 35.6	172 (93)	162 (98.8)	10 (47.6)	<0.001[a]
	35–35.5	13 (7)	2 (1.2)	11 (52.4)	
	< 35	0 (0)	0 (0)	0 (0)	
Lowest serum pH	> 7.2	36 (19.5)	36 (22)	0 (0)	<0.001[a]
	7.1–7.19	132 (71.4)	128 (78)	4 (19)	
	< 7.1	17 (9.2)	0 (0)	17 (81)	
Multiple seizures	None/single	175 (94.6)	156 (95.1)	19 (90.5)	0.302[b]
	Multiple	10 (5.4)	8 (4.9)	2 (9.5)	
Urine output (mL/kg/h)	> 0.91	164 (88.6)	160 (97.6)	4 (19)	<0.001[a]
	0.1–0.9	20 (10.8)	4 (2.4)	16 (76.2)	
	< 0.1	1 (0.5)	0 (0)	1 (4.8)	
Birth weight (g)	>1000	178 (96.2)	163 (99.4)	15 (71.4)	<0.001[a]
	750–999	5 (2.7)	1 (0.6)	4 (19)	
	<750	2 (1.1)	0 (0)	2 (9.5)	
Small for gestational age	NO	173 (93.5)	154 (93.9)	19 (90.5)	0.625[b]
	Yes	12 (6.5)	10 (6.1)	2 (9.5)	
Apgar at 5 min after birth	>7	175 (94.6)	163 (99.4)	12 (57.1)	<0.001[a]
	4–7	10 (5.4)	1 (0.6)	9 (42.9)	
	<4	0 (0)	0 (0)	0 (0)	

[a] Based on Mann-Whitney test; [b] Based on Fisher exact test.

Table 3. The Relationship Between Patients' Survival and SNAP II and SNAPPE II Tests Final Scores Among Patients

Variable		Total	Survived	Expired	*P* [a]
SNAP II	Mean	14 ± 15	9 ± 6	49 ± 15	<0.001
	Median (range)	12 (0–83)	7 (0–31)	46 (17–83)	
	≤9	87 (45.8)	87 (100)	0 (0)	
	19–20	72 (37.9)	71 (98.6)	1 (1.4)	
	20–29	10 (5.3)	9 (90)	1 (10)	
	30–39	4 (2.1)	2 (50)	2 (50)	
	40+	17 (8.9)	0 (0)	17 (100)	
SNAPPE II	Mean	22 ± 31	15 ± 25	69 ± 33	<0.001
	Median (range)	12 (0–150)	12 (0–127)	64 (17–150)	
	≤ 9	82 (43.2)	82 (100)	0 (0)	
	19–20	67 (35.3)	66 (98.5)	1 (1.5)	
	20–29	10 (5.3)	9 (90)	1 (10)	
	30–39	2 (1.1)	2 (100)	0 (0)	
	40–49	4 (2.1)	0 (0)	4 (100)	
	50+	25 (13.2)	10 (40)	15 (60)	

[a] Based on Mann-Whitney test.

used for predicting patients' survival. The data suggest that both SNAP II (AUC = 0.992; 95% CI: 0.98–1) and SNAPPE II (AUC = 0.994; 95% CI: 0.984–1) have a very strong predictive value of the patients' survival, with no statistically significant difference between two methods. Both methods have a higher predictive power than the Apgar score at 5 minutes after birth (AUC = 0.711; 95% CI: 0.568–0.855).

Discussion

Estimating the severity of illness is a key factor when caring for critically ill neonates. SNAP II and SNAPPE II methods are two scoring tools proposed for assessing the severity of illness among neonates.

In the present study, the neonatal mortality rate among the neonates admitted to our neonatal intensive care unit was 9.9%. In a similar report from Iran by Hoseini et al, out

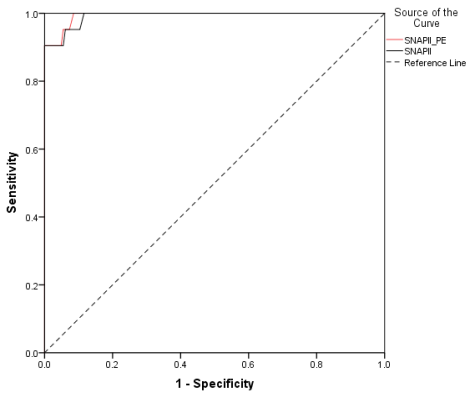

Figure 1. The area under the curve for SNAP II and SNAPPE II tests showing the predictive value of these 2 methods for predicting patients' survival.

Table 4. The area under the curve for SNAP II and SNAPPE II methods, as well as Apgar score at 5 minutes after birth, showing the predictive value of these three methods

Test Result Variable(s)	Area	Asymptotic 95% CI	
		Lower Bound	Upper Bound
SNAPPE II	0.994	0.984	1.000
SNAP II	0.992	0.980	1.000
Apgar 5	0.711	0.568	0.855

of 3667 neonates admitted to the NICU, 375 (10.23%) died before they were discharged.[12] Also in another study by Kadivar et al, 25 (12.6%) out of 198 neonates admitted to NICU expired.[9] These results show that the mortality rate among patients in our study is in line with the mortality rate in similar studies performed in Iran. Our findings indicated a statistically significant correlation between the mean age of patients, the gestational age, and the mean birth weight, and patients' survival. Similar to our findings, Kadivar et al, reported a relationship between gestational age and birth weight with mortality rate.[9] Also in a study by Sankaran et al, the gestational age showed a correlation with the mortality rate among neonates hospitalized in NICU.[13]

In our study, both SNAP II (AUC = 0.992) and SNAPPE II (AUC = 0.994) methods had very strong value for predicting the patients' survival, but no statistically significant difference between 2 methods was observed. In a study by Mesquita Ramirez et al on newborns less than 6 days old admitted to NICU, the AUC for SNAP II and SNAPPE II methods for predicting the mortality rate was 0.78 (95% CI: 0.70–0.86) and 0.76 (95% CI: 0.67–0.85) respectively, which indicated a less strong predictive value compared to our study. However, their study did not find any significant difference between these 2 methods in predicting the survival rate.[14] In another study by Harsha et al, the AUC for SNAPPE II method in predicting the mortality rate among 248 newborns admitted to NICU within 48 hours of birth was 0.849 (95% CI: 0.79–0.97), which is in more agreement with our findings.[15] It should be noted that in the study by Harsha et al, the mean age of participants (under 48 hours) was less than the study by Mesquita Ramirez et al, (under 6 days) and more similar to the results of our study (under 24 hours), which might explain the similarity between the results of our study and the results in Harsha et al study. Mesquita Ramirez et al, had previously indicated that SNAP II and SNAPPE II methods might have better predictive value as predictors of mortality in the group of newborns having the lowest postnatal age at admission.[14] In another study by Richardson et al, the SNAP II and SNAPPE II methods both showed strong value in predicting the mortality rate with AUC over 0.9.[3] Also the AUC for SNAP II was reported 0.86 by Gagliardi et al,[16] and 0.82 by Pollack et al.[17] All of these findings are in line with our results regarding high predictive value of SNAP II and SNAPPE II methods.

In the present study, Apgar at 5 minutes after birth showed a lower value in predicting the mortality compared to SNAPII and SNAPPE II methods with an AUC of 0.711 (95%CI: 0.568–0.855). Similar to our results, Rudiger et al, reported an AUC of 0.74 (95%CI: 0.70 to 0.77) for 5 minutes after birth Apgar score in predicting the survival in preterm infants below 32 completed weeks of gestation.[18]

A limitation of our study is the relatively low number of participants, which suggests the need for further studies with a bigger sample size and also decreases the reliability of the mortality rate.

It should be noted that there is a limited number of studies evaluating the use of these predicting methods in Iranian population of critically ill neonates. 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 Iranian severely ill neonates. Our results are in line with 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.[1] SNAP II and SNAPPE II methods have been devised to predict the patients' outcome more reliably than the Apgar score. Previous studies and also our study indicate that they might have a better predictive value than Apgar score. These scores are easy to calculate and have a very low cost. Using them in NICU settings can improve the care for critically ill neonates, and also predicting their survival.

In conclusion, according to our findings SNAP II and SNAPPE II are useful tools in predicting the mortality rate among Iranian neonates admitted to NICU. There was no significant difference between SNAP II and SNAPPE II, and both methods had a much better

predicting value compared to Apgar score at 5 minutes after birth.

Authors' Contribution

MR: Initial idea of research, implementation, data gathering, writing the manuscript. MH: Implementation, data gathering, writing the manuscript, final corrections. MF: Data gathering, writing the manuscript, statistical analysis. RM: Initial idea of research, data gathering, writing the manuscript, statistical analysis.

Conflict of Interest Disclosures

The authors have no conflicts of interest.

Ethical Statement

This study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences, and informed consent was taken from parents prior to the study.

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