ECUADORIAN JOURNAL OF PEDIATRICS
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RESEARCH ARTICLE

Sensitivity and Specificity of the SNAP-II And SNAPPE-II Scores as Predictors of Neonatal Mortality in Patients Admitted to the Neonatal Intensive Care Unit.

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Received: Dec 12 2019
Accepted: March 22, 2020
Published: April 30, 2020

Bibliographic letterhead:

Abril M, Medina S, Lalangui A. Sensitivity and Specificity of the SNAP II and SNAPPE II Indices as predictors of Neonatal Mortality in patients admitted to a Neonatal Intensive Care Unit. Rev. Ecuat. Pediatr. 2020;21(1). Article number 5. Pages: 1-8.

ABSTRACT

Introduction: The SNAP-II and SNAPPE-II (extended scoring) neonatal physiological scoring systems play an important role in the prediction of mortality. The objective of the present study was to contrast these scales in patients admitted to a neonatal intensive care unit (NICU) and to carry out a diagnostic test to predict mortality.

Methods: This analytical observational study was carried out in the NICU of the Isidro Ayora Gyneco-Obstetric Hospital, Quito-Ecuador from December 2014 to November 2015. All analyzable cases were included. The variables included gestational age, sex, clinical variables of the SNAP-II and SNAPPE-II scores and mortality. Group 1 (G1) consisted of neonates who died, and Group 2 (G2) consisted of living neonates. Sensitivity (S), Specificity (E), Positive Predictive Value (PPV), Negative Predictive Value (NPV) of each score were calculated.

Results: Two hundred cases were included. Components of the SNAP-II score included the mean arterial pressure, body temperature and PaO2/FiO2, which did not differ between groups. The pH in G1: n = 48 was 7.25 ± 0.16; in G2, n = 152 it was 7.32 ± 0.13 (P = 0.005). Urinary flow in G1 was 1 ± 1.27, and in G2 it was 2.7 ± 2.2 (P <0.001). In SNAPPE-II, the Apgar score at the fifth minute was "small for gestational age," without statistical differences. The SNAP-II score was S: 79.2%, E: 60.5%, PPV: 38.8%, NPV: 90.2%. The SNAPPE-II score was S: 93.8%, E: 45.4%, PPV: 35.2%, NPV: 95.8%.

Conclusion: The SNAPPE-II score is the best predictor of mortality, and its use is recommended when patients are admitted to the NICU.

Keywords:
MESH: Intensive Care Units; Neonatal; Infant; Newborn, Infant mortality.
Free Text: SNAP II, SNAPPE-II

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INTRODUCTION

The World Health Organization (WHO) indicates that the mortality of neonates corresponds to 41% of all deaths of children under five and that newborn mortality has decreased from 4.6 million in 1990 to 3.3 million in 2009. The rate of decline has been faster since 2000.

Three causes are given for three-quarters of neonatal mortality in the world: preterm births (29%), suffocation (23%), and serious infections such as sepsis and pneumonia (25%). If the interventions reached those who needed it, two-thirds or more of those deaths could have been prevented. [1]

Based on the data registered in the National Institute of Statistics and Census for the year 2014, the mortality rate for children under one year in Ecuador was the lowest, (8.35 per thousand live births) since 1990. Furthermore, the data revealed that the main causes of neonatal death in the country were respiratory disorders, perinatal asphyxia, congenital malformations, low birth weight and infections. [2]

There are many situations in which the doctor, nurse, or researcher would like to quantify the morbidity of a neonate in order to explain in casuistic terms the differences found in mortality values compared with results observed in other neonatal intensive care units. This could determine the estimated probability of an outcome specific to a particular child or the need to properly identify newborns at high risk for a particular intervention.[3]

Prognostic models or scales are required that can carry out a correct evaluation of the patient from the time of admission to a neonatal intensive care unit (NICU), predict the probability of death, and assess its evolution during the hospitalization.

Neonatal Acute Physiological Score

Of these scales, the Score for Neonatal Acute Physiology II (SNAP-II) and the Score for Neonatal Acute Physiology/Perinatal Extension (SNAPPE-II) use physiological values. SNAP-II uses blood pressure medium, lower temperature, lower serum pH, multiple seizures, urinary flow (ml/kg per hour) and the PaO2/FiO2 ratio. SNAPPE-II, in addition to these parameters, uses three additional values: the Apgar score at the fifth minute, birth weight and a determination of small for gestational age (Table 1). All of these aremeasured in the first 12 hours of hospital admission, and are used for mortality risk assessment at the time of admission to the neonatal intensive care unit. [4]

Table 1. Comparisons of Neonatal Mortality Scales.

	SNAP-II	SNAPPE-II
Physiological parameters	Mean arterial pressure, temperature, serum Ph, urinary flow, PaO_2/FiO_2.	
Additional parameters		Apgar at 5 birth weight Small for age gestationally

SNAP: Score for Neonatal Acute Physiology. SNAPPE-II Score for Neonatal Acute Physiology/Perinatal Extension.

SNAP-II and SNAPPE-II have been studied widely at the international level, but have not been validated for systematic use at the national level as predictors of mortality at the time of admission of the newborn into the NICU. The countries that exhibit the best results in infant mortality rates in the world show fewer than 7 deaths per 1000 live births, with a neonatal mortality rate below 4 deaths per 1,000 live births.[5]

SNAP-II Index (Score for Neonatal Acute Physiology) and the SNAPPE-II (Score for Neonatal Acute Physiology/Perinatal Extension).

In 2001 Richardson and colleagues published the validation of a score based on the worst results of a series of physiological values, measured in the first 24 hours of admission hospital, which they called SNAP (Score for Neonatal Acute Physiology). Of newborns

from 30 neonatal intensive care units in Canada, California, and New England during the mid-1990s, 26 variables were considered with the objective of validating the SNAP-II scale in 10,819 patients and the SNAPPE-II scale in 14,610 newly born patients. These authors found that SNAPPE-II had excellent discrimination for all patients, regardless of their weight when birth. [4]

The SNAP-II score proved to be a good predictor of mortality in a population of newborns with different pathologies. However, a better discrimination of patient characteristics, added three more variables related to perinatal factors, such as the Apgar test, the weight of very low birth <1500 g and the presence of intrauterine growth restrictions. This score was called SNAPPE-II (that is, the SNAP with perinatal extension) and has shown greater discrimination of risk factors in the very low birth weight preterm population at birth (<1500 g).[4]

The aim of the present study was to compare the SNAP-II versus the SNAPPE-II scales as a predictor of neonatal mortality in newborns of the NICU of the Isidro Ayora Gyneco-Obstetric Hospital (IAGOH). The hypothesis was that the SNAPPE-II scale had higher sensitivity and specificity to predict mortality than the SNAP-II scale.

POPULATION AND METHODS

Study design

An observational and analytical study design was used.

Setting

The study was carried out in the neonatal intensive care unit at the Gyneco-Obstetric Hospital Isidro Ayora in the City of Quito, Ecuador from December 1, 2014 to November 30, 2015. This was considered as a recruitment and exposition period. Tracking of results was completed on February 24, 2016, and the collection of data ended on March 24, 2016.

Participants

Participants included all newborns admitted to the neonatal intensive care unit of the hospital during the study period. Selected patients had completed all data in the clinical history. Also included were newborns who had died in the delivery room or during their immediate hospitalization (before 12 hours of life). Also included were those born with a diagnosis of congenital malformation, elderly or genetic syndrome incompatible with life, and patients with data records that had been taken after 12 hours after the birth. Patients who were transferred from other units were also included. The sample was divided into two groups according to their final outcome when leaving the ICU: Group 1: alive; Group 2: deceased.

Variables

Variables described in each group included demographic, clinical on the severity of the general state with the SNAP-II and SNAPPE-II scales, and mortality.

Data sources/ measurement

Institutional software was used for each variable for registration of medical records as a source of data. Electronic medical records were consulted, and laboratory software was consulted for data extraction. The data were compiled into a spreadsheet for later transfer to the statistical software.

Control of sources of bias

Medical records with incomplete data and data imputation were avoided, lost, or excluded.

Study size

The sample was non-probabilistic, and included all potentially eligible cases from the Gyneco-Obstetric Center.

Quantitative variables

The quantitative variables in scale are presented with means and standard deviations. Nominal quantitative data are presented with frequency and percentages.

Statistical methods

The averages were compared using the Student's t-test. The percentages were compared with Chi square. Two comparative groups were formed, which obtained an odds ratio for the binomial variables. As a secondary analysis, a logistic regression for mortality based on SNAP-II and SNAPPE-II scores was provided. The statistical package used was SPSS v.22 for Windows.

RESULTS

Participants

Two hundred patients were included in the study. Cases not included in the study are presented in **Figure 1**.

Figure 1. Flowchart of the participants in the study.

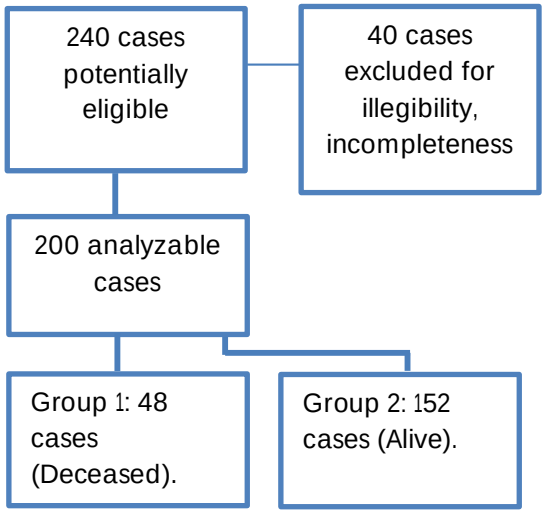

Table 2. Distribution of hospitalized neonates in the Neonatal Intensive Care Unit of the IAGOH according to gestational age at birth.

Gestational Age	Frecuency	Percentage
≤27 GW, 6 days	10	5.0%
28 to 31 GW, 6 days	51	25.5%
32 to 33 GW, 6 days	42	21.0%
34 to 36 GW, 6 days	55	27.5%
37 to 38 GW, 6 days	24	12.0%
39 to 40 GW, 6 days	9	4.5%
41 to 41 GW, 6 days	5	2.5%
> 42 GW	4	2.0%
Total	200	100.0%

GW: Gestation Weeks

Descriptive data

There were 99 females (49.5%) and 101 males (50.5%). The largest group consisted of neonates with gestational ages ranging from 28 weeks to 31 weeks (**Table 2**). There were 48 deceased patients (Group 1) and 152 living patients (Group 2). **Table 3** describes the general characteristics of the group with the SNAP-II score and with the SNAPPE-II score. The characteristics are detailed in **Table 4**.

SNAP II y SNAPPE-II

Table 3 describes the clinical characteristics of SNAP II. The cases present with mean arterial pressure of 20 to 29 mmHg in 14% of the participants and with the presence of multiple seizures in 5.5% of the cases.

Tabla 3. Score SNAP II de los recién nacidos hospitalizados en la Unidad de Cuidados Intensivos Neonatales del IAGOH.

Variables	N=200	%
Mean arterial pressure		
≥ 30 mmHg	170	85%
20- 29 mmHg	28	14%
< 20 mmHg	2	1%
Mean 39.92		
Temperature		
≥35.6°C	186	93%
35- 36.6°C	14	7%
<35°C	0	
Mean 36.55		
Relationship PaO_2/ FiO_2*		
≥ 2.49	5	2.5%
1-2.49	42	21.0%
0.3-0.99	149	74.5%
<0.3	4	2.0%
Mean 0.82		
pH		
≥7.2	169	84.5%
7.1-7.19	18	9.0%
≤7.1	13	6.5%
Mean 7.30		
Urinary flow		
≥1	119	59.5%
0.1-0.9	79	39.5%
< 0.1	2	1.0%
Mean 2.29		
Multiple seizures		
Absent	189	94.5%
Present	11	5.5%

Main results

SNAP II

The analysis groups were formed (Group 1 versus Group 2). There were no statistical differences between mean arterial pressure, temperature, PaO2/FiO2. (**Table 5**).

There were statistical differences between serum pH and urinary flow (Table 5). The presence of multiple seizures was a risk factor for neonatal death 10/48 in the group of deceased (90.0%) vs 1/152 in the living group (9.1%) OR 39.7 (95% CI 4.9-320) P <0.0001.

Table 4. SNAPPE-II score of newborns hospitalized in the neonatal Intensive Care Unit IAGOH.

Variables	N=200	%
APGAR at the fifth minute		
≥ 7	171	85.5%
≤ 7	29	14.5%
Mean 7.91		
Birth weight (gr)		
≥ 1000	175	87.5%
750-999	21	10.5%
≤ 750	4	2.0%
Mean 1804.9		
Small for GA		
No	147	73.5%
Yes	53	26.5%

GA: Gestacional Age

Table 5. Predictors of mortality.

Variables	Group 1 (n=48)	Group 2 (n=152)	*P*
MAP*(mmHg)	37.9 ±12.4	40.6 ±11.3	0.17
T°C*	36.5 ±0.8	36.6 ±0.6	0.62
PaO2/FiO2*	0.76 ± 0.79	0.84 ± 0.52	0.38
pH*	7.25 ±0.16	7.32 ± 0.13	0.005*
UF*	1 ±1.27	2.7 ± 2.2	<0.0001*

MAP: Mean Arterial Tension. T°C: temperature en ° C. UF: Urinary Flow *Mean and Standard Deviation.

SNAPPE-II

Neither the Apgar nor the small gestational age showed significant differences statistically. The Apgar at the fifth minute in Group 1 was 7.6 ± 1.6, and in Group 2, it was 8.01 ± 1.2 P = 0.062. Small for the gestational age in Group 1 was 16/48 (30.2%), and in Group 2, it was 37/152 (24%) X^2 = 1.66, P = 0.436.

Sensitivity and specificity

The area under the curve of both scales was similar; SNAP-II showed 0.74 (74%), and SNAPPE-II 0.75 (75%) (Figure 2).

In evaluating the predictive capacity indicators for SNAP-II, a cut-off point (20) with a sensitivity of 79.2%, specificity of 60.5%, positive predictive value of 38.8%, negative predictive value of 90.2%, likelihood ratio (LR) of (+) 2, likelihood ratio (LR) (-) 0.3 was selected. For SNAPPE-II the cut-off point was 20 coinciding with SNAP-II, using a sensitivity of 93.8%, specificity of 45.4%, positive predictive value of 35.2%, negative predictive value of 95.8%, likelihood ratio (LR) of (+) 1.71, and likelihood ratio (LR) of (-) 0.14.

Other analyses

At the predictive level, it can be seen that the SNAPPE-II scale had a better prediction for mortality, obtaining statistical significance with P <0.05 (P = 0.08) within the model built between the two independent variables in an equation of logistic regression between SNAP-II and SNAPPE-II and the neonatal mortality as a dependent variable (**Table 6**).

Figure 2. COR curve sensitivity and 1-Specificity of the SNAP-II and SNAPPE-II scales.

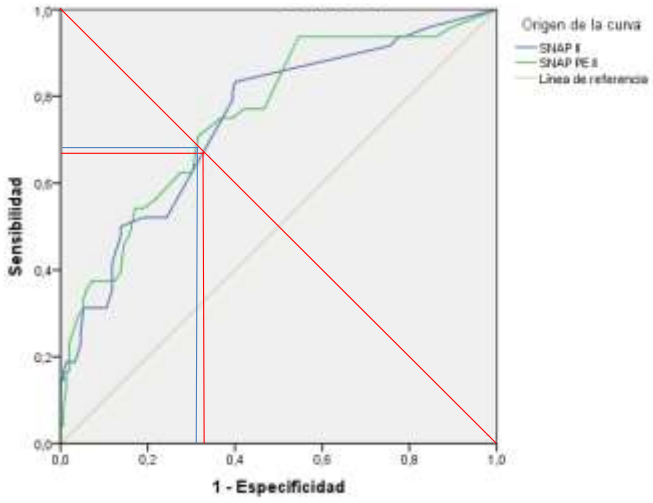

Table 6. Logistic regression for mortality prognosis with the SNAP-II and SNAPPE-II scales.

Variables in the equation	B	Standard error	X^2 Wald	gl	*P*	Exp(B)
SNAP II	0.733	0.48	2.3	1	0.126	2.08
SNAP-PE II	1.946	0.73	7.1	1	0.008	7.00
Constant	-2.222	0.72	9.5	1	0.002	0.12

DISCUSSION

In the present study it was found that the areas under the curve for both scales were similar, SNAP-II with 0.74 and SNAPPE-II with 0.75. These values are similar to the studies carried out in Canada, California, and New England and analyzed by Richardson et al. in 2001. They reported that SNAPPE-II had excellent discrimination for all patients with an area under the COR curve of 0.91 regardless of their weight at birth. [6]

The similarity between the curves of the two scores is equivalent to those reported by other authors, such as the prospective study carried out in Vermont, United States, by Zupancic, et al. In 2006, the areas under the ROC curve for the two scores, regardless of birth weight, were 0.86 for SNAP-II and 0.89 for SNAPPE-II. Therefore, it can be concluded that the two scores are useful tools for predicting mortality [7].

In the results of the two studies described above, the areas under the ROC curve were higher than those reported in the present study, which can be explained by the large sample size.

The present study concurs with the conclusions of the previously cited authors who affirm that both SNAP-II and SNAPPE-II are good predictors of mortality risk in newborns admitted to the NICU, since they are simple, precise, and applicable to any population type.

In a 2001 study conducted in Brazil, Silveira, et al. determined that the best cut-off point of the ROC curve for SNAP-II was 12. The present study uses 20,

and the cut-off point of the ROC curve for SNAPPE-II is 24. The parameters for SNAPPE-II in this study used 24 as a cut-off point, a sensitivity of 35.9% and a specificity of 88.6%, PPV 77.08%, and NPV 56.58%. (8) By comparison, our study of SNAPPE-II used a cut-off point of 20, a sensitivity of 93.8%, specificity of 45.4%, PPV 35.2%, and NPV 95.8%.

In a study carried out in Lima, Peru in 2003, Delgado et al. reported that a SNAP-II score greater than 10 was related to an increased risk of mortality (twice that of the group that survived). This work also found that the higher the score, the longer the hospital stay. Although the study analysis was not exhaustive, it is one of the few available with realities similar to ours where the potential usefulness of these scales was demonstrated. [9]

In a study carried out in Porto Alegre, Brazil in 2003, Schlabendorff et al. determined that birth weight was the indicator with the lowest attributes to predict neonatal mortality. The authors of this study highlighted that their results were similar to those reported by other authors in which the areas under the COR curve for birth weight did not have statistically significant evidence. Our findings confirm that weight assessment is not an indicator of mortality. Schlabendorff et al. also reported that the SNAPPE-II scale achieved the highest scores within the assessment of neonates during admission to the NICU to predict neonatal mortality, which is equal to the highest scores obtained on the SNAPPE-II scale in the development of the present study. [10]

Based on the findings of the present study and those of other international studies, it can be concluded that the SNAPPE-II scale has a better prediction for mortality and its use is recommended in the admission of newborns to the NICU, as it is more accessible, faster, and easier to perform.

CONCLUSION

Based on the results obtained in this research, it is determined that the SNAPPE-II scale is superior to SNAP-II as a predictor of mortality. However, we consider that their differences are minimal and that either of the two scales can be used since they present similar results and contribute to intensive care units in perinatal care.

ARTICLE ADMINISTRATIVE INFORMATION

Abbreviations
ROC: Receiver Operating Characteristic Curve
SNAP: Score for Neonatal Acute Physiology
SNAPPE-II: score for Neonatal Acute Physiology/Perinatal Extension.

Acknowledgements
Not Applicable.

Authors' contributions
MBAS, SLMP, ALLC worked equally in shaping the research idea. SLMP and ALLC performed the bibliographic review, data collection and writing of the document. MBAS performed the critical analysis of the article. SLMP made the editorial corrections. All authors read and approved the final version of the manuscript.

Funding
The work was supported by the authors.

Availability of data and materials
Data are available depending on the nature and objectives of the request.

ETHICAL STATEMENTS

Ethics approval and consent to participate
The protocol was approved by the Institutional Teaching Committee.

Consent for publication
The authors have the authorization for the publication of the data by the tutors of the patients.

Protection of people:
The authors have applied the components of the Singapore Declaration.

Confidentiality of the data:
The authors have technically concealed the identification data of each patient for the analysis and publication process.

Competing interests
The authors declare that they have no competing interests.

Originality of the article

The Ecuadorian Journal of Pediatrics guarantees that the article is original and without redundancy. The anti-plagiarism system of our journal reported less than 3 % similarity. The analysis is available a: https://secure.urkund.com/view/76853792-490804-474731

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DOI: Digital Object Identifier
PMID: PubMed Identifier.
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