Open Access   Original Article

Comparison of Combined Apgar Score and Umbilical Cord Arterial Blood Gas in Prediction of Poor Short Term Outcomes in Neonates

Samira Pournajaf[1], Zahra Akbarian-Rad[1], Nesae Bozorgnezhad[2] , Hemmat Gholinia Ahangar[3], Mohsen Haghshenas[1]*

1. Non-Communicable Pediatric Diseases Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran
2. Clinical Research Development Unit of Rouhani Hospital, Babol University of Medical Sciences, Babol, Iran
3. Health Research Institute, Babol University of Medical Sciences, Babol, Iran

ABSTRACT

Background: The APGAR scoring system, including conventional, expanded, and combined Apgar scores, has been used to evaluate the condition of the newborn in the first minutes of birth. Umbilical cord arterial blood gas analysis (UCABGA) is another method. We compared the combined Apgar score with UCABGA in predicting short-term outcomes in neonates.

Methods: A prospective cohort study was conducted on 363 live births. Neonates with major congenital anomalies, congenital cyanotic heart disease, congenital metabolic disorders, and those who transferred to other hospitals were excluded. Admission, discharge, demographic data, and Apgar scores were recorded in a pre-designed form. After delivery, the umbilical cord was double-clamped, and an arterial blood sample was taken from the clamped part. Statistical analyses were done using SPSS version 22 statistical software, and the receiver operating characteristic (ROC) curve was used to analyze the correlations between variables.

Results: Out of 350 Neonates (204 male and 146 female) with a mean gestational age of 33.37±4.12 weeks, 263 (75.1%) neonates were admitted, and 34 neonates (9.7%) died. Retinopathy of prematurity(ROP) and Intraventricular hemorrhage (IVH) were recognized in 42 (12%) and 54 (15.4%) neonates, respectively, and 37 (10.6%) neonates ventilated mechanically. ROC curves show higher sensitivity and Specificity of 5th minute Combined Apgar score than PH and base deficit in predicting short-term outcomes except for IVH.

Conclusion: The Combined Apgar score at minute 5 is a better predictor than UCABGA in predicting Death, need for admission, retinopathy of prematurity, and need for mechanical ventilation. None are good predictors for IVH.

Keywords: Apgar score, Blood gas, Umbilical cord

Introduction

Assessing the condition of the newborn in the first minutes of birth has always been a challenging issue in neonatal medicine, and several methods have been proposed for it. One of them is the Apgar scoring system, introduced by Virginia Apgar in 1953 and used for this purpose for many years. This method evaluates five factors in newborns: appearance and color, pulse rate,

grimace to stimulation, activity, and respiratory effort. Each factor is given a score of zero to two (1).

In this scoring system, the maximum score is 10, given to neonates with excellent conditions. Of course, a resuscitated neonate can get a good score if he responds well without considering resuscitation interventions. Therefore, the

_ Corresponding author*: Mohsen Haghshenas, Non-Communicable Pediatric Diseases Research Center, Department of Pediatrics, Babol University of Medical Sciences, Babol, Iran. Email: Matia.mojaveri@yahoo.com

American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) suggested using Expanded Apgar (2). This method considers seven types of interventions: Oxygen supplementation, CPAP (continuous positive airway pressure), PPV (positive pressure ventilation), endotracheal intubation, surfactant administration, chest compression, and epinephrine administration. If these interventions are performed after birth for the neonate, a score of zero is given, and if not, a score of one is given, and the neonate with the least intervention is given the highest score, 7.

The combined Apgar score (CA) is the sum of the conventional Apgar score and the Expanded Apgar score, which Mario Rüdiger and his colleagues investigated in several studies and compared with the conventional and expanded Apgar score to predict perinatal mortality, which significantly showed better results with the combined Apgar score (3, 4).

Another method used to evaluate the condition of the neonate in the first moments of life is umbilical cord arterial blood gas analysis (UCABGA), which not all centers have access to. Many studies have confirmed this method, and some have rejected it (5-7).

After birth, the umbilical cord is clamped in two areas at a distance of 10 to 20 cm, and a blood sample is taken from the clamped area. Although ACOG and AAP suggest that umbilical cord arterial blood gas analysis should be done for all high-risk newborns and those with a low first-minute Apgar score (8), in some centers, this sampling is done after all deliveries (9).

In some centers, sampling is not done for many eligible neonates due to economic issues and lack of facilities.

Although arterial blood gas analysis can reflect metabolic conditions and fetal distress following hypoxic events, it may not be a good predictor of hypoxic-ischemic damage (10-12).

Although various Apgar scores and umbilical cord arterial blood gases have been studied to predict various complications in infants, none of them have been recognized as the gold standard, and several studies have shown different results.

In this study, we decided to compare the new combined Apgar scoring system with the analysis of newborns' umbilical cord arterial blood gases to predict poor short-term outcomes. Although several studies have compared different types of Apgar scoring systems or reviewed Umbilical Cord Arterial Blood Gas Analysis (UABGA) to predict complications and short-term or long-term

consequences of newborns, few studies have investigated and compared these two methods with each other.

The main purpose of this project is to compare the combined Apgar scoring system with umbilical cord arterial blood gas analysis in predicting short-term outcomes in neonates, including the need for newborn admission, intraventricular hemorrhage (IVH), retinopathy of prematurity (ROP), the need for mechanical ventilation, and death.

Methods

Type of study and the research community

This prospective cohort study was conducted on 350 neonates with available sampling born in Ayatollah Rouhani Hospital, affiliated with the Babol University of Medical Science, a referral hospital with high-risk mother-fetal pairs, between October 2021 and November 2022.

Inclusion and exclusion criteria

The Inclusion Criteria were alive, term, or preterm births within the study center. The exclusion criteria subsumed major congenital anomalies, congenital cyanotic heart disease, a congenital metabolic disorder diagnosed during hospitalization, and neonates who were transferred to another hospital for any reason.

Data collection

According to the pre-designed form, all live births were given a conventional, expanded, and combined Apgar score at minute 5 of birth. The Apgar score was given to the neonate by a trained midwife or pediatrics specialist who is certified in a neonatal resuscitation program. All the interventions that were done for the neonate in the first moments of birth were recorded in the medical report. The expanded and combined Apgar score was reviewed again and corrected by a neonatologist using recorded data.

After delivery, the umbilical cord was double clamped, at a distance of 25-30 cm, by a midwife who was only responsible for taking care of the neonate. The same midwife took an arterial blood sample from the clamped part of the umbilical cord, using a heparinized syringe for arterial blood gas analysis, which was performed by a blood gas analyzer (GEM, Germany). The results are recorded in the form.

Demographic data (such as gender, gestational age, and birth weight) were recorded in medical reports; admission and discharge data were

recorded if the neonate needed to be hospitalized before being discharged from the hospital with the mother.

The duration of mechanical ventilation was recorded on the checklist for intubated neonates. According to the national guidelines, neonates who needed to be screened for retinopathy of prematurity were visited by a retinal specialist experienced in newborns both during their stay in the Neonatal Intensive Care Unit (NICU) and after they were discharged from the hospital. If they had retinopathy of prematurity in the first exam, it was recorded in the form.

Brain ultrasonography was done for all neonates with a gestational age of less than 34 weeks in the first week of life to rule out intraventricular hemorrhage by an experienced radiologist and repeated at 36-40 weeks of post-conceptional age. However, if, in the initial ultrasonography, evidence of bleeding was observed, the next ultrasonography was performed at shorter intervals.

All infants who died after discharge before the age of 28 days and also all infants who died during hospitalization at any age before discharge were recorded under the title of death in the form.

Sample size and data analysis

This study, based on the formula for determining the sample size, required 350 samples.

$$n \geq \frac{z_{1-\alpha/2}^2 \; \text{sense}(1-\text{sense})}{d^2 \times \text{prev}}$$

Sense=88%
Prev=50%
d=5%

After data collection, statistical analyses were done using SPSS version 22 statistical software and analyzed with descriptive indices and chi-square tests, T-tests, ANOVA, and calculation of sensitivity, specificity, positive and negative predictive value, and receiver operating characteristic (ROC) curves were used to analyze the correlations between variables. Moreover, a P value < 0.05 was used to evaluate the statistical significance of the associations and correlations between variables.

Ethical approval

The Ethics Committee of the Babol University of Medical Sciences approved this study. (Ethics code: IR.MUBABOL.HRI.REC.1400.215)

Results
Descriptive statistics

Based on the formula, 363 neonates were included in the study. Thirteen neonates were excluded due to exclusion criteria. This study was conducted on 350 neonates (204 boys and 146 girls) with a mean gestational age of 33.37±4.12 weeks (25-41 weeks). Out of them, 262 (74.9%) were preterm (GA<37 weeks), and 88 neonates (25.1%) were term (GA≥37 weeks).

In the 5th minute of life, conventional, expanded, and combined Apgar was evaluated, and the results are summarized in Table 1.

Out of 350 neonates, 263 (75.1%) neonates were admitted to the NICU, and 34 neonates (9.7%) died. Surfactant therapy was done for 158 neonates (60% of admitted neonates) in the first hour of life, and 42 neonates (12%) were diagnosed with ROP. IVH was recognized in 54 neonates (15.4%), and 37 neonates (10.6%) underwent mechanical ventilation for respiratory support, and the longest was 12 days. The lowest PH was 6.80, and the highest was 7.45, with an average of 7.26±0.10. The highest base deficit (Bd) was 26, and the average was 6.63.

We tried to determine the sensitivity and specificity of combined Apgar in predicting poor short-term outcomes in neonates and compared it with umbilical arterial blood gas.

Comparison of combined Apgar and UCABGA in predicting outcomes

Figure 1 illustrates the sensitivity and specificity of the 5thminute Combined Apgar score (A), PH (B), and Bd (C) in predicting the need for admission, mechanical ventilation, and ROP by using receiver operating characteristic (ROC) curves. The area under the curves (AUC) for the 5thminute Combined Apgar score, PH, and Bd has been shown in Table 1. Based on the comparison of the above curves, it can be concluded that combined Apgar is a better predictor for the probability of hospitalization of newborns, mechanical ventilation, and ROP than PH and Bd.
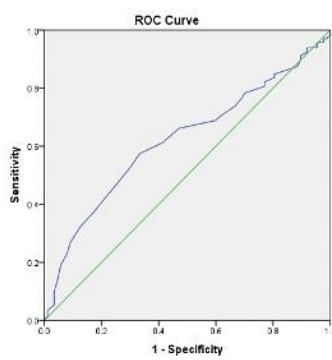
Table 1. Mean, minimum and maximum of three types of Apgar score

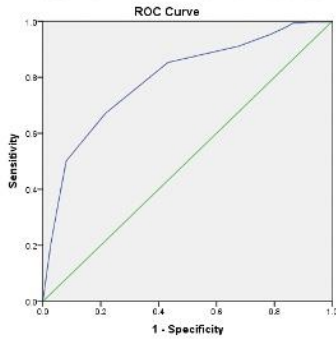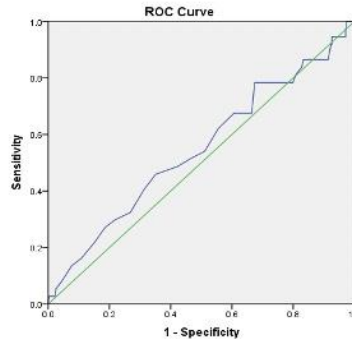| 5th minute Apgar	Mean	Standard deviation	minimum	maximum
Conventional	9.00	1.52	1	10
Expanded	5.42	1.22	0	7
Combined	14.07	2.46	3	17

Need to admission

Mechanical ventilation

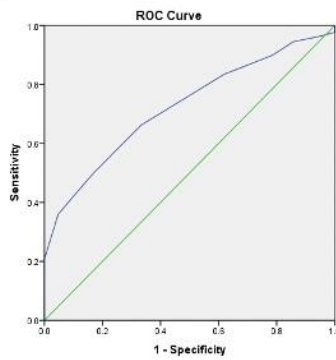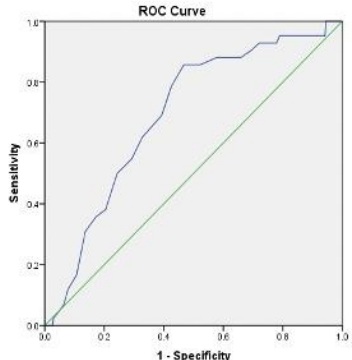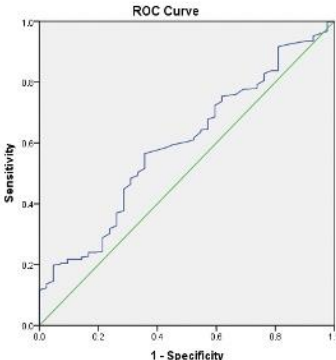## ROP
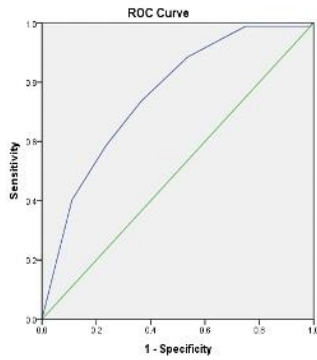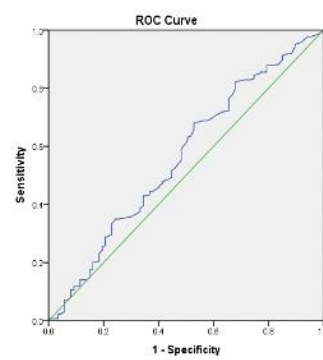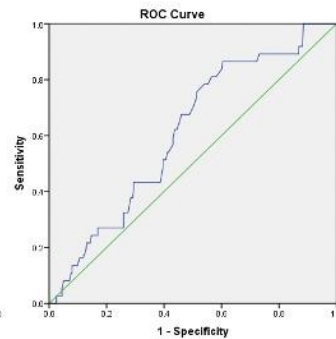
Figure 1. ROC curve showing the sensitivity and Specificity of 5th minute Combined Apgar score (A), PH (B), Bd (C), in predicting the need for admission, mechanical ventilation, and ROP

Table 2. Area under the curves (AUC) showing 5th minute combined Apgar, PH, and Bd in predicting short-term outcomes of neonates

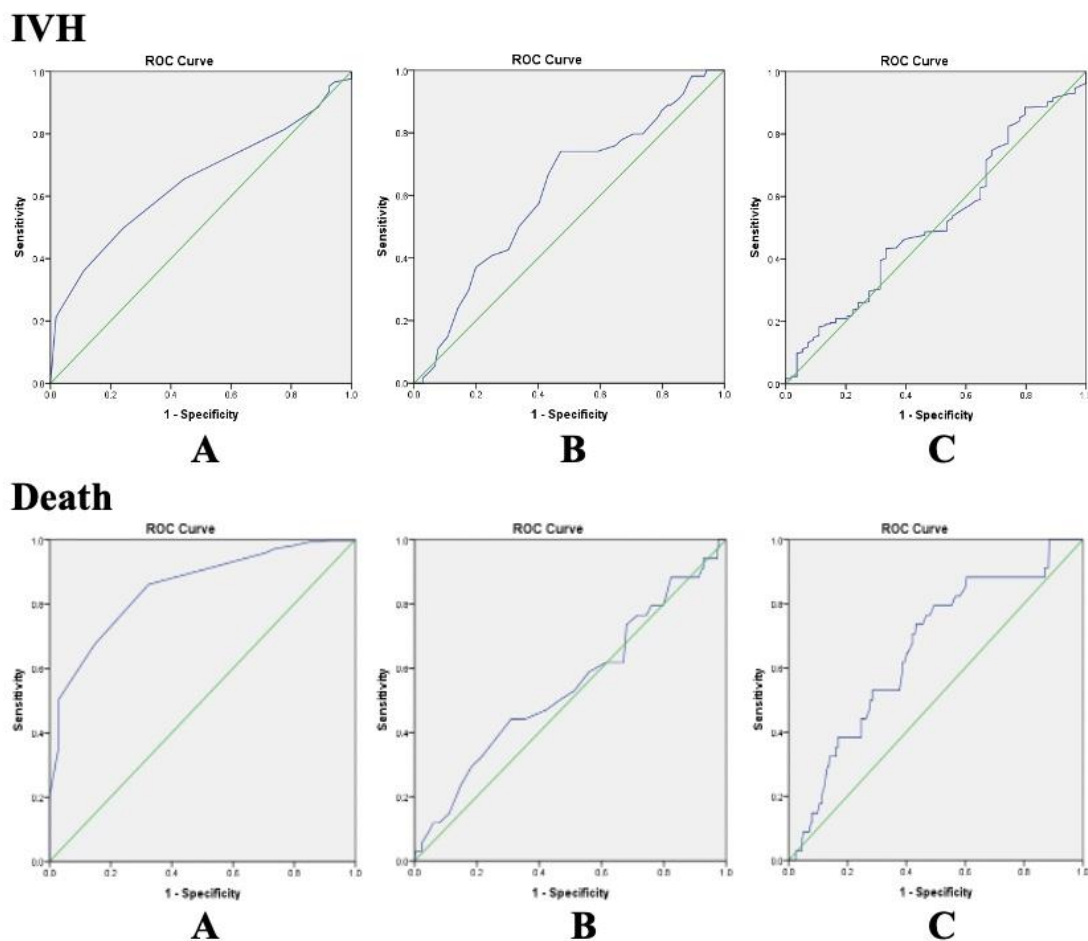|	5th minute Combined Apgar		PH		Bd	
	AUC	P-value	AUC	P-value	AUC	P-value
Need to admission	75.6%	<0.001	62%	0.001	56.3%	0.08
Mechanical ventilation	79.4%	<0.001	54.7%	0.352	61%	0.028
ROP	72.2%	<0.001	69.2%	<0.001	59.3%	0.05
IVH	64.6%	0.001	61.3%	0.008	52.3%	0.598
Death	85.1%	<0.001	54.3%	0.409	65.6%	0.003

IVH

Death

Figure 2. ROC curve showing the sensitivity and Specificity of 5th minute Combined Apgar score (A), PH (B), Bd (C), in predicting IVH and death

Figure 2 clarifies the sensitivity and specificity of the 5th minute Combined Apgar score (A), PH (B), and Bd (C) in predicting IVH and death using ROC curves. Table 1 shows the AUC for the 5th minute Combined Apgar score, PH, and Bd in predicting IVH and death. Although combined Apgar is a better predictor of death than PH and Bd, it cannot predict IVH well.

Discussion

In this study, we concluded that CA has higher sensitivity and specificity compared to UCABGA for predicting short-term outcomes. Few studies have been done in Iran comparing these two methods.

An observational retrospective study was carried out by Marta Mlodawska et al. in the Department of Obstetrics and Gynecology of the Provincial Combined Hospital in Kielce from 01.01.2018 to 30.06.2019. They correlated gasometrical parameters with the Apgar scores of neonates (13). They concluded that there is a low but significant correlation between the clinical condition of a newborn after birth with most of the acid-base parameters from umbilical vein blood and using the Apgar score (but not acid-base parameters) determines the degree of invasiveness of respiratory support activities for newborns after birth. Although different levels of respiratory support were investigated in their study and mechanical ventilation was considered in our study, almost similar results were observed. Although their desired Apgar score was conventional, like combined, Apgar was preferable to the umbilical vein blood gas.

Amrit Ghimire et al. carried out a cross-sectional study from November 1, 2010, to July 30, 2011. Newborns with a 5th minute Apgar score of less than seven were included in the study. UCABGA was done, and Neonates were followed up every six hours for at least 48 hours for HIE, according to Sarnat staging. They concluded that

cord blood PH was a better predictor than Apgar in asphyxiated neonates (14). In our study, we examined outcomes other than asphyxia and HIE and reached a different conclusion.

A prospective cross-sectional, analytic study performed by Ahmadpour-kacho et al. on 96 mother-fetal pairs between 2004 and 2005 at Shahid Yahyanejad Hospital, affiliated with Babol University of Medical Sciences. Mothers who came to the hospital with labor pain were divided into high-risk and low-risk if they had any perinatal risk factors. Apgar score at 1 and 5 minutes after birth was taken, and a UCABGA was done immediately after birth in both groups. There was no significant correlation between the 1st and 5th minutes of Apgar score and umbilical cord pH in the low-risk group. However, there was a significant correlation between the 1st and 5th minutes Apgar score and the umbilical cord pH in the high-risk group (15). In our study, with a sample size about four times theirs, independent of newborn perinatal risk factors, the predictive value of PH, Bd, and combined Apgar for short-term outcomes was investigated separately. The predictive value of these three was not similar, but the relationship between them was not investigated.

Performing UCABGA was not available for all infants in our center, which limited our study. However, this motivated us to continue this study and find a suitable alternative method instead of UCABGA. We suggest continuing this study in other centers.

Conclusion

In this study, we found that the 5th minute combined Apgar score is a better predictor than cord arterial blood gas in predicting Death, need for admission, retinopathy of prematurity, and need for mechanical ventilation, and none are good predictors for IVH.

Acknowledgments

Conflicts of interest

The authors declare that there is no conflict of interest.

References

1. Apgar V. A proposal for a new method of evaluation of the newborn infant. Curr Res Anesth Analg. 1953;32(4):260-267.
2. American Academy of Pediatrics. American college of obstetricians and gynecologists; Committee on obstetric practice. The apgar score. Adv Neonatal Care. 2006;6:220-223.
3. Rüdiger M, Aguar M. Newborn assessment in the delivery room. Neoreviews. 2012;13(6):e336-e342.
4. Rüdiger M, Braun N, Aranda J, Aguar M, Bergert R, Bystricka A, et al. Neonatal assessment in the delivery room–trial to evaluate a specified type of apgar (TEST-Apgar). BMC pediatrics. 2015;15(1):18.
5. Lee JH, Jung J, Park H, Kim S-y, Choi S-J, Oh S-y, et al. Umbilical cord arterial blood gas analysis in term singleton pregnancies: a retrospective analysis over 11 years. Obstet Gynecol Sci. 2020;63(3):293-304.
6. Ferreira CS, Melo Â, Fachada AH, Solheiro H, Martins NN. Umbilical cord blood gas analysis, obstetric performance and perinatal outcome. Rev Bras Ginecol Obstet. 2018;40(12):740-748.
7. Ruth VJ, Raivio KO. Perinatal brain damage: predictive value of metabolic acidosis and the Apgar score. BMJ. 1988;297(6640):24-27.
8. ACoOa G. Executive summary: neonatal encephalopathy and neurologic outcome. Obstetrics & Gynecology. 2014;123(4):896-901.
9. Armstrong L, Stenson BJ. Use of umbilical cord blood gas analysis in the assessment of the newborn. Arch Dis Child Fetal Neonatal Ed. 2007;92(6):F430-434.
10. Fee SC, Malee K, Deddish R, Minogue JP, Socol ML. Severe acidosis and subsequent neurologic status. Am J Obstet Gynecol. 1990;162(3):802-806.
11. Lavrijsen SW, Uiterwaal CS, Stigter RH, de Vries LS, Visser GH, Groenendaal F. Severe umbilical cord acidemia and neurological outcome in preterm and full-term neonates. Biol Neonate. 2005;88(1):27-34.
12. Hafström M, Ehnberg S, Blad S, Norén H, Renman C, Rosén KG, et al. Developmental outcome at 6.5 years after acidosis in term newborns: a population-based study. Pediatrics. 2012;129(6):e1501-1507.
13. Mlodawska M, Mlodawski J. Relationship between Apgar score and umbilical cord blood acid-base balance in full-term and late preterm newborns born in medium and severe conditions. Ginekol Pol. 2021.
14. Ghimire A, Shrestha L, Shrestha M. Analysis of umbilical cord blood gas in term and near term asphyxiated newborn babies. JPAHS. 2017;4(2):3-8.
15. Ahmadpour-Kacho M, Asnafi N, Javadian M, Hajiahmadi M, Taleghani N. Correlation between umbilical cord pH and Apgar score in high-risk pregnancy. Iran J Pediatr. 2010;20(4):401-406.