Caspian Journal of Pediatrics
Babol University of Medical Sciences
e-ISSN: 2383-3106

Diagnostic Value of Combined and Conventional Apgar Scoring System in Identifying Poor Short-Term Outcomes in Infants

Samira Pournajaf [1], Zahra Akbarian-Rad [1], Nesae Bozorgnezhad [2], Hemmat Gholinia Ahangar [3], Mohsen Haghshenas [4 *]

1. Non-Communicable Pediatric Diseases Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, IR Iran.
2. Clinical Research Development Unit of Rouhani Hospital, Babol University of Medical Sciences, Babol, I.R. Iran.
3. Health Research Institute, Babol University of Medical Sciences, Babol, Iran.
4. Clinical Research Development Unit of Amirkola Children's Hospital, Babol University of Medical Sciences, Babol, IR Iran.

* **Corresponding Author:** Dr. Mohsen Haghshenas;
Address: Associate Professor of Neonatology, Non-Communicable Pediatric Diseases Research Center, Department of Pediatrics, Babol University of Medical Sciences, Babol, IR Iran.
Tel: +98 1132346963 **Fax:** +98 1132346963 **E-mail:** matia.mojaveri@yahoo.com

Article Info.

Article type:
Research Article

Received: 4 April 2024
Revised: 14 July 2024
Accepted: 21 Aug. 2024
Published: 27 Aug. 2024

Keywords:
Combined Apgar;
Conventional Apgar;
Infant, Newborn

ABSTRACT

Background and Objective: Clinical assessment of newborns in the first minutes after birth is a challenge in neonatal medicine. The aim of this study was to compare the diagnostic value of the combined and conventional Apgar scoring systems in identifying poor short-term outcomes in newborns.

Methods: This prospective cohort study evaluated 660 newborns at Ayatollah Rouhani Hospital of Babol-Iran (a tertiary referral hospital), from October 2021 to November 2022. After birth, the 5th-minute conventional and combined Apgar scores were recorded. The newborns were followed. The area under the receiver operating characteristic (ROC) curve (AUC) was used to determine the sensitivity and specificity of the Apgar scores to predict short-term outcomes (mechanical ventilation requirement, occurrence of intraventricular hemorrhage, neonatal mortality, and retinopathy of prematurity).

Findings: Out of 660 newborns 373(56.5%) males and 287(43.5%) females), Fifty-seven (8.6%) newborns had IVH, 46(6.97%), were diagnosed with ROP, 40(6.1%) newborns required mechanical ventilation, and 41(6.21%) died. The AUC of combined Apgar for predicting ROP and IVH (82% and 76% respectively) and the AUC of conventional Apgar for predicting death and mechanical ventilation (90% and 85% respectively) was higher than the others.

Conclusion: The conventional Apgar score was better than the combined Apgar score for predicting mechanical ventilation requirement and death. When infants were grouped by gestational age, none of the Apgar scores was a good predictor of ROP. Also, Apgar was only a good predictor of IVH at gestational ages greater than 34 weeks, of which combined Apgar is better than the others.

Cite this Article: Pournajaf S, Akbarian-Rad Z, Bozorgnezhad N, et al. Diagnostic Value of Combined and Conventional Apgar Scoring System in Identifying Poor Short-Term Outcomes in Infants. *Caspian J Pediatrs* March 2024; 10: e6.

[DOI: 10.22088/CJP.BUMS.10.0.6]

Introduction

The Clinical assessment of newborns in the first minutes after birth has always been a challenge in neonatal medicine. One of several methods that have been proposed to address this problem is the Apgar scoring system [1]. This strategy, introduced by Virginia Apgar in 1953, evaluates five components in newborns: skin color, muscle tone, heart rate, grimace to stimulation and respiratory effort. A newborn in good condition receives a top score of 10. Of course, a resuscitated newborn can score high if he or she responds well to resuscitation, regardless of resuscitation interventions. Therefore, the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) suggested using the Expanded Apgar score [2]. In this method, the interventions that are performed to resuscitate the newborn are also considered, and the newborn who undergoes the fewest interventions receives the highest score. In Expanded Apgar (EA), seven types of interventions are considered: oxygen supplementation, CPAP (continuous positive airway pressure), PPV (positive pressure ventilation), endotracheal intubation, surfactant administration, chest compression, and epinephrine administration. If any of these interventions were performed after the birth of the newborn, a score of 0 was assigned to that intervention. Otherwise, a score of 1 was assigned.

The combined Apgar score is the sum of the conventional Apgar score and the Expanded Apgar score. The combined Apgar since its introduction, has been studied in several studies and compared with other types of Apgar as well as with umbilical cord blood gas analysis. These studies showed mixed results. [3-7]. The combined Apgar score may be a good predictor of the need for hospitalization but cannot predict the length of stay.

Currently, there is no standard method for assessing newborns in the delivery room. The aim of this study was to compare conventional and combined Apgar scores and determine the cut-off point, sensitivity and specificity of combined Apgar to predict poor short-term outcomes, including the requirement for mechanical ventilation (mech vent), the occurrence of intraventricular hemorrhage (IVH), neonatal mortality and retinopathy of prematurity (ROP).

ROP is a destructive and developmental neurovascular disorder of the retina in newborns which can lead to visual impairment and even blindness. The diagnosis is made during screening by specialized ophthalmologists [8]. IVH is a form of intracranial hemorrhage that commonly occurs in premature newborns weighing less than 1500 g. It is a global health problem with incidence rates typically ranging from 20 to 25% and up to 40% in those more preterm than 25 weeks [9, 10]. It is classified into four categories, grade I, germinal matrix hemorrhage, grade II, intraventricular hemorrhage without ventricular dilation, grade III, intraventricular hemorrhage and with acute ventricular dilation (clot ills >50% of the ventricle), grade IV, intraventricular and parenchymal hemorrhage and intraparenchymal lesion [11].

The purpose of this project was to compare conventional and combined Apgar scores and determine the cut-off point, sensitivity and specificity of combined Apgar for predicting poor short-term outcomes.

Methods

Study design and sample

This prospective cohort study was conducted on the 660 neonates born at Ayatollah Rouhani tertiary Hospital, affiliated with Babol University of Medical Sciences, from October 2021 to November 2022.

Inclusion Criteria were: live birth at term or preterm within the study center. Exclusion criteria subsume congenital cyanotic heart disease, congenital metabolic disorders diagnosed during hospitalization, major anomalies, and newborns sent to another hospital for any reason.

Sample size and sampling

This study, based on the following formula, had to be done on 660 samples.

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

Sense=85%, Prev=30%, d=5%

[DOI: 10.22088/CJP.BUMS.10.0.6]

Data collection

According to a predesigned form, all live newborns received conventional, expanded and combined Apgar scores at the fifth minute after birth. Apgar scores were given to newborns by midwives trained and certified in neonatal resuscitation programs. All interventions performed during resuscitation were fully documented. The expanded and combined Apgar scores were reviewed and corrected by the neonatologist based on the information in the medical records.

The form also includes demographic data, gestational age, gender, birth weight (Bwt), and mode of delivery. If the newborn was admitted to the neonatal intensive care unit (NICU) for any reason, the time of admission, discharge, or death was recorded. If the newborns required mechanical ventilation, it was noted on the checklist.

According to the national guidelines for retinopathy of prematurity, all preterm newborns with GA≤ 32 weeks or Bwt<2000, require ROP examination. These neonates were evaluated for this problem both in hospital and after discharge, by a retinal specialist experienced in the field of neonatology. If the infant had ROP, this was documented. Our judgment criterion for the diagnosis of ROP was the first retinal examination according to the mentioned guidelines at the age of 28 days or more [12].

All preterm newborns (less than 34 weeks], had a cranial ultrasonography during the first week of life by an experienced radiologist to detect IVH. This ultrasound was repeated at 36-40 weeks post-conception. However, if signs of bleeding were observed at the first ultrasound, the next ultrasound would be performed at a shorter interval. The results were recorded based on the medical reports in case of hospitalization and by personal or telephone follow-up by the researcher if they were outpatients.

Discharged infants were followed up until one month of age. Deaths before 28 days of age from any cause other than major anomalies and accidents were recorded. Infants who died during hospitalization at any age (in the neonatal period or later) were recorded as death.

statistics analysis

After data collection, statistical analyses were performed using SPSS statistical software version 22 and analyzed using descriptive indices and chi-square tests, t-tests, ANOVA, and calculation of sensitivity, specificity, and positive and negative predictive values. Receiver operating characteristics (ROC) were used to analyze the correlation between variables and P values < 0.05 were used to evaluate the statistical significance of the association and correlation between variables.

Considering that during the first minute, very few interventions were performed on the newborns, we decided to measure the results based on the combined Apgar score of the 5th minute, since at that time, most necessary interventions for the baby were done and the desired response has been achieved, and both the conventional Apgar and combined Apgar score can be evaluated.

This study was approved by the Ethics Committee of the Babol University of Medical Sciences.

Results

Descriptive statistics

This study was conducted on 660 neonates born at gestational ages (GA) 25-42 weeks (35.07±3.92w). Among them, 373 (56.5%) males and 287(43.5%) females were registered (Table 1).

Out of 660 newborns, 339 (51.36%) newborns were admitted to this tertiary referral hospital and 40(6.1%) newborns were mechanically ventilated. Fifty-seven (8.6%) newborns had IVH, including, 49 in grade I, 4 in grade II, and 2 in grade III and 2 in grade IV. Also, out of all the studied newborns, 46(6.97%) were diagnosed with ROP, including 24 in stage I, 16 in stage II, and 6 in stage III. Forty-one (6.21%) cases died.

Sensitivity and specificity of 5th minute three proposed Apgar scores in predicting short-term outcomes of neonates

Figure 1 illustrates the sensitivity and specificity of the proposed 5th minute Apgar scores in predicting ROP, IVH, mechanical ventilation and death by using a receiver operating characteristic

[DOI: 10.22088/CJP.BUMS.10.0.6]

(ROC) curve (figure 1). The area under the curve (AUC) for conventional, expanded and combined Apgar scores are summarized in Table 2.

The predictive values of the three proposed Apgar scores were compared by calculating the AUC for the occurrence of ROP, IVH, need for mechanical ventilation and death. The AUC was higher for the combined Apgar score than for the others in predicting ROP and IVH. The AUC was higher for the conventional Apgar score than for the others in predicting mechanical ventilation and death. Before classifying newborns according to gestational age for predicting ROP and IVH, we determined a cut-off point for the combined Apgar score. The sensitivity and specificity of the 5th combined Apgar cut-off < 14 in predicting outcomes are shown in Table 3.

We re-examined three proposed Apgar scores in GA subgroups to predict short-term outcomes using the Rock curves (figure 2 and Table 4).

As ROP was only assessed at less than 34 weeks gestation, this outcome was examined separately in this subgroup. As shown in Figure 2, when infants were grouped by gestational age, no Apgar score was a good predictor of ROP. Also, Apgar is only a good predictor of IVH at gestational ages greater than 34 weeks, of which combined Apgar is better than the others.

Table 1. Summary of gestational age and Apgar scores of the studied subgroups

GA	Frequency	Percent	Mean±SD		
			5th conventional Apgar	5th expanded Apgar	5th combined Apgar
<28 w	44	6.7	7.00±1.347	4.57±1.087	11.57±2.028
28-33 w	141	21.4	8.34±1.478	4.96±1.381	13.38±2.466
≥34 w	475	72.0	9.52±1.048	6.29±1.010	15.89±2.610
Total	660	100	9.10±1.385	5.89±1.277	15.07±2.895

Table 2. AUC showing 5th minute of Conventional, Expanded and Combined Apgar scores in predicting short-term outcomes of neonates

Outcomes	Test Result Variable(s)	Area	Std. Error	p-value	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
IVH	Conventional 5	0.710	0.035	0.000	0.642	0.779
	expanded 5	0.736	0.027	0.000	0.684	0.789
	combined 5	0.759	0.027	0.000	0.706	0.811
Mechanical Ventilation	Conventional 5	0.849	0.034	0.000	0.783	0.916
	expanded 5	0.781	0.034	0.000	0.714	0.847
	combined 5	0.839	0.032	0.000	0.778	0.901
ROP	Conventional 5	0.801	0.030	0.000	0.742	0.860
	expanded 5	0.782	0.025	0.000	0.732	0.831
	combined 5	0.824	0.022	0.000	0.782	0.866
Death	Conventional 5	0.904	0.026	0.000	0.854	0.955
	expanded 5	0.817	0.031	0.000	0.756	0.877
	combined 5	0.888	0.026	0.000	0.837	0.939

Table 3. Sensitivity and specificity of 5th combined Apgar cut off < 14 in predicting outcomes

Outcomes	IVH	Mechanical Ventilation	ROP	Death
Sensitivity	74.1%	87.5%	84.8%	92.7%
Specificity	68.6%	68.2%	68.6%	68.7%

[DOI: 10.22088/CJP.BUMS.10.0.6]

Table 4. AUC showing 5th minute of Conventional, Expanded and Combined Apgar scores in predicting short-term outcomes of neonates in GA subgroups.

Outcomes	Test Result Variable(s)			Area	Std. Error	P-value	Asymptotic 95% Confidence Interval	
							Lower Bound	Upper Bound
IVH	<28w	10	Conventional 5	0.488	0.128	0.911	0.237	0.739
			expanded 5	0.468	0.120	0.758	0.232	0.703
			combined 5	0.509	0.101	0.933	0.311	0.707
	28-33w	37	Conventional 5	0.505	0.054	0.935	0.399	0.610
			expanded 5	0.510	0.052	0.853	0.409	0.612
			combined 5	0.492	0.052	0.881	0.391	0.593
	>33w	11	Conventional 5	0.696	0.088	0.026	0.524	0.868
			expanded 5	0.791	0.061	0.001	0.671	0.910
			combined 5	0.780	0.057	0.001	0.669	0.891
ROP	<34	46	Conventional 5	0.567	0.046	0.172	0.478	0.657
			expanded 5	0.549	0.046	0.324	0.458	0.639
			combined 5	0.562	0.045	0.210	0.474	0.650

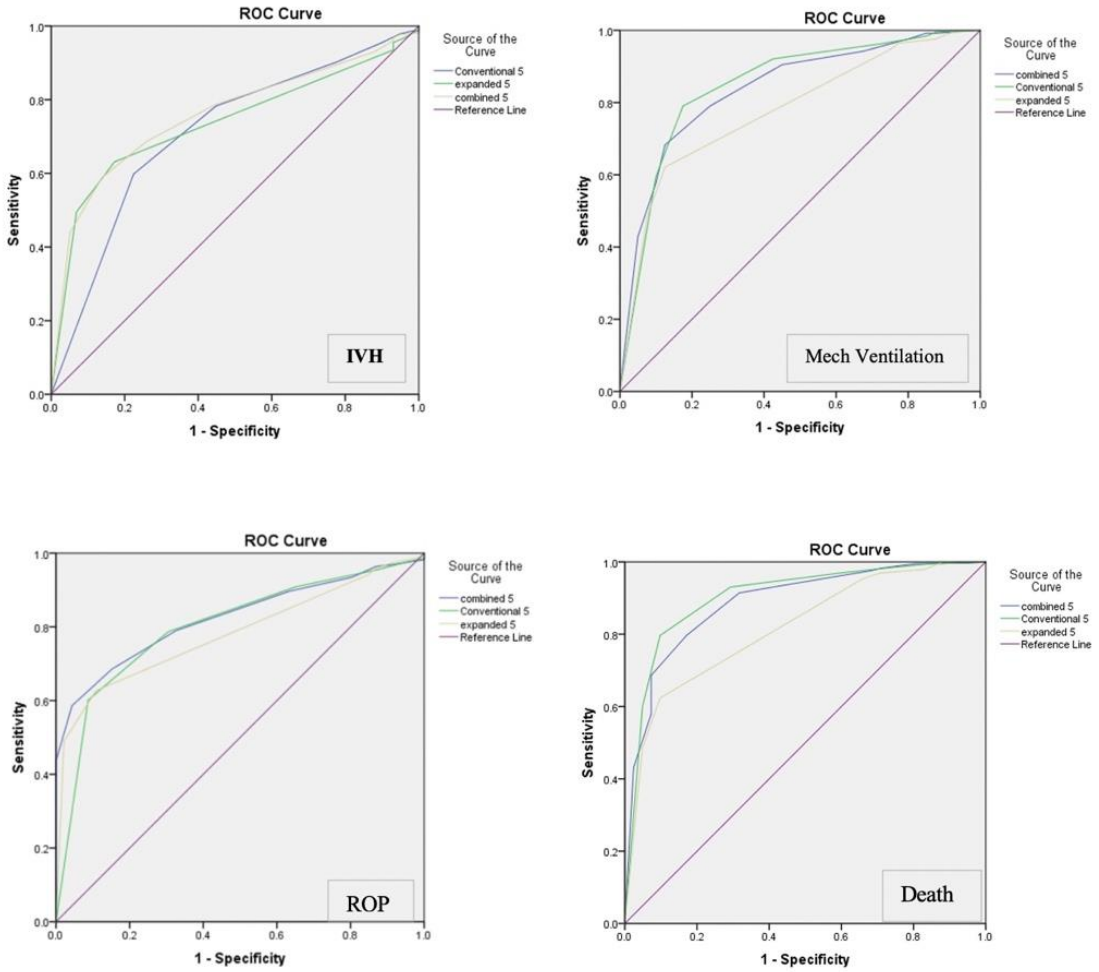

Figure 1. ROC curve showing the sensitivity and Specificity of Conventional, Expanded and Combined Apgar scores in predicting ROP, IVH, mechanical ventilation and death.

[DOI: 10.22088/CJP.BUMS.10.0.6]

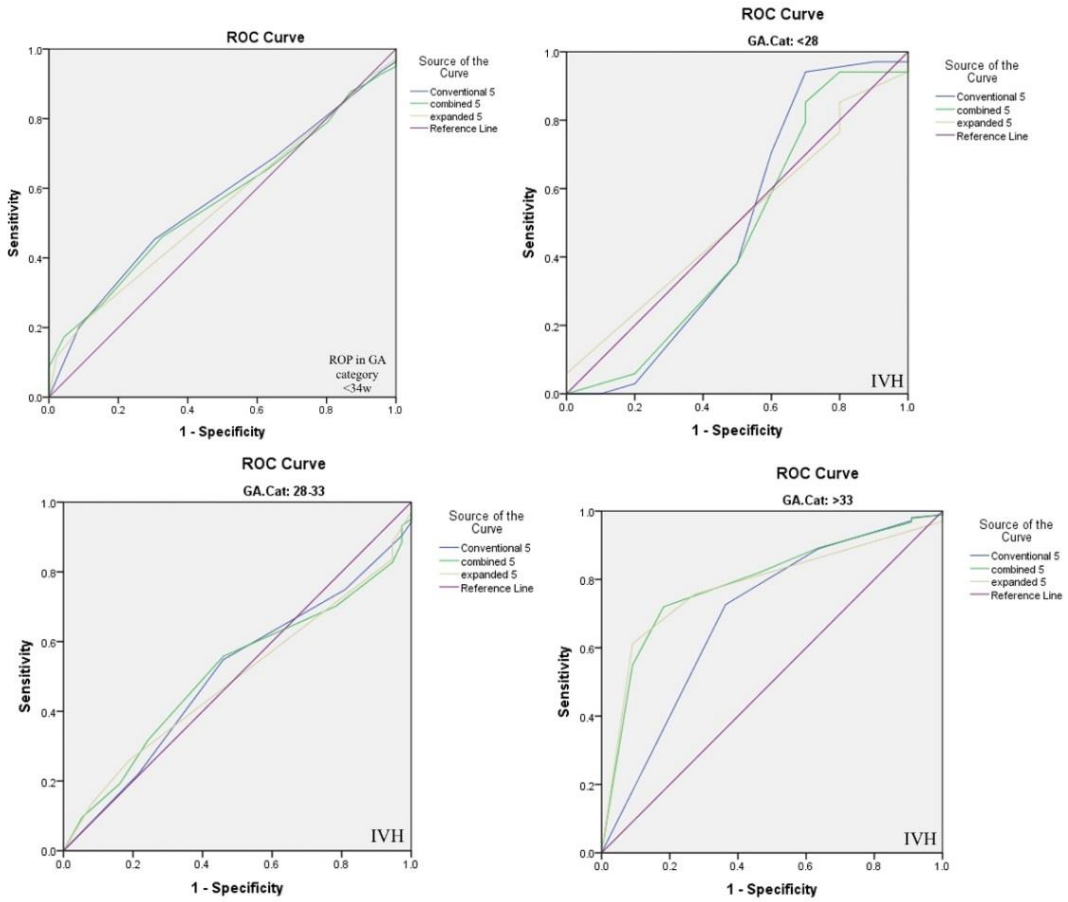

Figure 2. ROC curve showing the sensitivity and Specificity of Conventional, Expanded and Combined Apgar scores in predicting ROP and IVH in GA subgroups

Discussion

In this study, we evaluated the sensitivity and specificity of three proposed Apgar scores in predicting adverse short-term outcomes in newborns. Although the results were almost similar, the conventional Apgar score was a better predictor for mechanical ventilation requirement and death, and the combined Apgar score had more sensitivity and specificity in predicting IVH and ROP. After classifying newborns according to the gestational age, it was found that the combined Apgar score was not a good predictor of the occurrence of ROP and could only predict IVH in the gestational age group above 33 weeks.

In this study, we proposed the combined Apgar score of 14 as the cut-off point. In a prospective study from 2012 to 2014, Dalili et al. evaluated 464 hospitalized newborns and found different cut-off points from those in our study. They compared the four types of Apgar scores and concluded that only a low 5th-minute combined Apgar score could independently predict the occurrence of HIE (Hypoxic Ischemic Encephalopathy) and IVH in asphyxiated neonates, but could not predict the severity of HIE or IVH. Based on the results of this study, cut-off points were proposed for the 5th minute Combined Apgar (less than 10), and Expanded Apgar scoring systems (less than 4) to assess birth asphyxia and adverse neonatal outcomes [13].

In our study, more newborns, both hospitalized and non-hospitalized, were evaluated and newborns with HIE were not separated from others. while in the above study, they introduced the cutoff points for asphyxiated newborns.

In a retrospective cross-sectional study, 84 asphyxiated newborns admitted to a NICU in India were included. The conventional Apgar and combined Apgar scores, convulsion, use of anticonvulsants, requirement of mechanical

[DOI: 10.22088/CJP.BUMS.10.0.6]

ventilation and length of hospital stay were noted. They found that low combined Apgar scores were superior to the conventional Apgar scores in predicting early neonatal mortality, but found no difference in predicting convulsion and mechanical ventilation. They identified a score of 10 as the cut-off point for a combined Apgar score [14]. In our study, although the difference between Apgar types was not very significant, unlike the above study, in predicting death, conventional Apgar was better than combined Apgar, and vice versa in predicting mechanical ventilation. Perhaps differences between the research communities and the number of newborns explain this difference.

In another study conducted by Dalili et al and very similar to our study, two types of Apgar scores, combined and conventional, were compared. A low 5th-minute Combined-Apgar score was significantly associated with the requirement for mechanical ventilation, IVH, and neonatal mortality. Additionally, using ROC curves, the area under the curve of the combined Apgar was higher than that of the conventional Apgar in predicting neonatal mortality and the measured morbidities among all admitted newborns and their gestational age subgroups [15]. Perhaps one of the differences between our study and the above study was the number of neonates. additionally, unlike the study above, some of our newborns did not require hospitalization.

It appears that different studies [6, 13-16] show different results about combined Apgar's predictive value for different outcomes. In addition, this issue is also influenced by other factors such as gestational age, weight, neurological status, etc. Therefore, making a decision based only on Apgar alone cannot be of much help and other factors should also be considered. Although the combined Apgar score pays more attention to therapeutic interventions than the conventional and provides a more accurate assessment of the newborn's condition, it still cannot replace the conventional Apgar score to detect newborn outcomes.

Considering that no surfactant was administered to any of our newborns during resuscitation, it is suggested that the score of surfactant administration be removed from the Apgar score. In addition, to obtain more complete information, more studies should be conducted on larger statistical populations.

Limitations

In this study, we did not consider factors such as delivery method (cesarean section or normal vaginal delivery), medications used in cesarean section or painless delivery, etc.

Conclusion

The conventional Apgar score is a better predictor of mechanical ventilation requirement and death, and the combined Apgar score had more sensitivity and specificity in predicting IVH and ROP. When infants were grouped by gestational age, no Apgar score was a good predictor of ROP. Also, Apgar may be a good predictor of IVH only at gestational ages greater than 34 weeks, of which combined Apgar is better than the others.

Acknowledgments

We are grateful to the Clinical Research Development Unit of Amirkola Children's Hospital, the Research Council and Non communicable Pediatric Diseases Research Center, Health Research Institute of Babol University of Medical Sciences and Neonatal and NICU ward for their support and cooperation with study.

Funding

This study was supported by a research grant and Fellow of Neonatology thesis of Dr. Samira Pournajaf from the Non-Communicable Pediatric Diseases Research Center of Babol University of Medical Sciences (Grant Number: 140013709).

Ethical Approval

This study obtained ethics committee approval (Ethics code: IR.MUBABOL.HRI.REC.1400.215).

Conflict of interest

There is no conflict of interest.

[DOI: 10.22088/CJP.BUMS.10.0.6]

References

1. Apgar V. A proposal for a new method of evaluation of the newborn infant. Anesth Analg 2015; 120(5): 1056-9.
2. Pediatrics AAo. American College of Obstetricians and Gynecologists; Committee on Obstetric Practice. The Apgar score. Adv Neonatal Care 2006; 6(4): 220-3.
3. Rüdiger M, Wauer RR, Schmidt K, Küster H. The Apgar score. Pediatrics 2006; 118(3): 1314-5.
4. Rüdiger M, Braun N, Gurth H, Bergert R, Dinger J. Preterm resuscitation I: clinical approaches to improve management in delivery room. Early human development 2011; 87(11): 749-53.
5. Rüdiger M, Aguar M. Newborn assessment in the delivery room. Neoreviews 2012; 13(6): 336-42.
6. Pournajaf S, Akbarian Z, Ahangar HG, Bozorgnezhad N, Mojaveri MH. Assessing the Effectiveness of the Combined Apgar Scoring System in Predicting the Short-Term Outcomes of Newborns. Journal of Comprehensive Pediatrics 2024; 15(1).
7. Pournajaf S, Akbarian Z, Ahangar HG, Bozorgnezhad N, Mojaveri MH. Comparison of combined Apgar score and umbilical cord arterial blood gas in prediction of poor short term outcomes in neonates. Iranian journal of neonatology 2024; 15(3).
8. Dammann O, Hartnett ME, Stahl A. Retinopathy of prematurity. Dev Med Child Neurol. 2023 ;65(5): 625-631.
9. Puerta-Martínez, A.G., López-Garrido, et al. Risk factors associated with intraventricular hemorrhage in very-low-birth-weight premature infants. Childs Nerv Syst 2024; 40(6): 1743–1750.
10. Egesa WI, Odoch S, Odong RJ, et al. Germinal Matrix-Intraventricular Hemorrhage: A Tale of Preterm Infants. Int J Pediatr 2021; 2021: 6622598.
11. Volpe JJ, Inder TE, Darras BT, et al. Volpe's neurology of the newborn. 6th ed. Philadelphia Elsevier 2017.
12. Roohipoor R, Karkhaneh R, Farahani A, et al. Retinopathy of prematurity screening criteria in Iran: new screening guidelines. Arch Dis Child Fetal Neonatal Ed 2016; 101(4): 288-93.
13. Dalili H, Nili F, Sheikh M, Hardani AK, Shariat M, Nayeri F. Comparison of the four proposed Apgar scoring systems in the assessment of birth asphyxia and adverse early neurologic outcomes. PloS one. 2015; 10(3): 0122116.
14. Muduli JK, Mitra M, Banerjee A. Comparison of Conventional and Combined APGAR score in Predicting Adverse Early Neurologic Outcomes in Term and Near Term Babies with Birth Asphyxia. Annals of Int Med Den Res 2019; 5(5): e5-7.
15. Dalili H, Sheikh M, Hardani AK, Nili F, Shariat M, Nayeri F. Comparison of the combined versus conventional Apgar scores in predicting adverse neonatal outcomes. PloS one 2016;11(2): 0149464.
16. Hardani AK, Nili F, Shariat M, Nayeri F, Dalili H. Conventional versus combined apgar scores in neonatal asphyxia:a prospective study. Tehran Univ Med J 2015; 72 (10): 717-722.

[DOI: 10.22088/CJP.BUMS.10.0.6]