Relationship between the Apgar score and general movements in hospitalized preterm newborns

Relação entre índice de Apgar e general movements *em recém-nascidos prematuros hospitalizados*

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Date of first submission: January 17, 2024
Last received: April 25, 2024
Accpted: August 13, 2024
Associate editor: Ana Paula Cunha Loureiro

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Abstract

Introduction: In Brazil, the Apgar score is the main indicator of immediate risk at birth and general movements (GMs) are the gold standard markers for neuromotor outcomes. However, there are no studies that have investigate direct differences in GM quality in relation to the Apgar score. **Objective:** Assess whether the Apgar score is related to GM quality in hospitalized preterm newborns and compare the presence of risk factors in those at high risk against a low-risk control group. **Methods***:* This is an observational study involving the analysis of medical records. Thirty eligible newborns with a gestational age of 34.80 ± 1.41 weeks, hospitalized in the neonatal intermediate care unit, were divided into a high-risk group (1- and 5-minute Apgar score ≤ 7, birth weight < 2,500 grams) and control group (1- and 5- minute Apgar score > 7, birth weight ≥ 2,500 grams). Prechtl's GM assessment and risk factor analysis were conducted in accordance with the Brazilian National Health System (SUS in Portuguese). **Results:** There were no intergroup differences for GMs, but differences in biological factors were observed, with the high-risk group exhibiting more problems during pregnancy, labor or birth, and severe jaundice. **Conclusion:** The Apgar score was not related to GM quality in the preterm newborns studied. However, there were more gestational and perinatal complications and severe jaundice in the high-risk group, indicating a possible relationship between these risk factors.

Keywords: Early diagnosis. Child development. Preterm newborn. Risk factor.

Resumo

Introdução: *O índice de Apgar é o principal indicador de risco imediato ao nascimento no Brasil, e os* general movements *(GMs) são uns dos marcadores padrão-ouro para desfechos neuromotores. No entanto, não são encontrados estudos que tenham investigado diferenças diretas na qualidade dos GMs em relação ao Apgar.* ***Objetivo:*** *Analisar se o índice de Apgar se relaciona à qualidade dos GMs em recém-nascidos pré-termo hospitalizados e comparar a presença de fatores de risco entre aqueles de maior risco e um grupo controle de me-nor risco.* ***Métodos:*** *Trata-se de um estudo observacional, por análise de prontuários. Foram elegíveis 30 recém-nascidos de 34,80 ± 1,41 semanas gestacionais, hospitalizados em unidade de cuidados intermediários neonatal e divididos em grupo de maior risco (Apgar ≤ 7 no 1º e 5º minuto, peso ao nascer < 2.500 gramas) e grupo controle (Apgar > 7 no 1º e 5º minuto, peso ao nascer ≥ 2.500 gramas). Foram coletados os resultados das avaliações dos GMs pelo método de Prechtl e os fatores de risco segundo o Sistema Único de Saúde.* ***Resultados:*** *Não houve diferenças entre os grupos em relação aos GMs, porém houve diferenças quanto aos fatores biológicos, sendo que no grupo de maior risco houve maior presença de problemas no parto, nascimento ou gravidez e icterícia grave.* ***Conclusão:*** *O índice de Apgar não se relacionou com a qualidade dos GMs nos recém-nascidos pré-termo estudados. Entretanto, houve mais intercorrências gestacionais e perinatais, além de icterícia grave, no grupo de maior risco, indicando possível relação entre esses fatores de risco.*

Palavras-chaves: *Diagnóstico precoce. Desenvolvimento infantil. Recém-nascido prematuro. Fator de risco.*

Introduction

Some newborns (NBs) are born under conditions that increase their chances of unfavorable clinical outcomes. These infants are considered at risk of developmental problems during childhood.[1,2] As such, the Brazilian National Health System (SUS in Portuguese) recommends early identification of risk factors to monitor the development of NBs until the second year of life.[3]

Risk factors can be biological or environmental.[1] Biological risks include prematurity (birth before 37 weeks` gestation); birthweight below 2,500 grams (low birthweight); problems during pregnancy, delivery or at birth; severe jaundice; family history of disability or mental illness; and presence of severe diseases (meningitis, head trauma and seizures). Environmental risks are incomplete or no prenatal care; hospitalization during the neonatal period; kinship between the parents; and high-risk situations (domestic violence, maternal depression, drugs or alcoholism among household members, and suspected sexual abuse).[1,3]

In general, it is well-established in the literature that the lower the gestational age and birthweight, the longer the neonatal hospitalization and the greater the chances of neurological dysfunctions that lead to poor neuromotor outcomes, such as problems in motor performance and cerebral palsy.[4-6] However, the influence of other risk factors on neuromotor outcomes in the neonatal period has been little investigated.

In addition to risk factors, the use of clinical indicators of neonatal risks is recommended as part of hospital routine, signaling the need for additional care to minimize adverse clinical outcomes.[7,8] The Apgar score is the main indicator of immediate risk at birth in developing countries.[9] It ranges from 0 to 10 and represents signs of anoxia, generally identified 1 and 5 minutes after birth,[8] whereby the lower the score, the greater the risk of death and neurological complications.[10,11] Scores below 7 signal the need for special care, such as a greater possibility of requiring specialized services.[12]

Despite the neurological complications that may be reflected in the Apgar score, its influence on neuromotor outcomes remains little studied. Research suggests that NBs with low scores may still present normal neurological outcomes in the long term.[13,14] However, it is important to investigate the influence of the Apgar score on early neuromotor outcomes.

Among the tools that can be used in a hospital setting for neuromotor assessment, evaluating the quality of general movements (GMs) using Prechtl's method (GMA – General Movement Assessment)[15] is considered a gold standard.[16-18] GMs are part of the spontaneous motor repertoire, emerging at the start of fetal life and remaining until five months after birth. Normal GMs involve the entire body in a sequence of complex and highly variable movements. When GMs lose these characteristics, it may indicate problems in brain function.

In the preterm and term period, the presence of cramped synchronized GMs in particular, characterized by rigid movements where the trunk and limbs contract almost simultaneously and consistently, is a specific

marker for risk of spastic cerebral palsy.[16-18] Additionally, poor repertoire GMs with reduced variability signal the need for more individualized care.[18] Because GMA requires no handling and enables the screening of high-risk NBs,[15] it is ideal for hospitalized preterm infants, especially in locations where highly complex tests are costly and difficult to access.[17]

Some studies suggest associations between the presence of certain risk factors, including a low Apgar score,[19] and changes in GM quality.[19-21] For example, the presence of infections in preterm newborns (PTNBs) with a low 1-minute Apgar score is associated with abnormal GMs when assessed on the 14th day of life, at term, and 12-15 weeks postterm.[21] However, no studies were found that investigate direct differences in GM quality in relation to the Apgar score.

The main objective of the present study was to analyze whether the Apgar score is related to GM quality in hospitalized PTNBs. Additionally, the presence of environmental and biological risk factors was compared between PTNBs at greater risk according to their birthweight and Apgar score, and control PTNBs. Early identification of these relationships makes it easier to monitor development in this population, allowing referral for timely intervention when necessary.

Methods

This is a comparative observational study conducted by collecting data from medical records and a database of PTNBs hospitalized at the Conventional Neonatal Intermediate Care Unit (UCINCo) of Hospital Maria Aparecida Pedrossian (HUMAP) of the Federal University of Mato Grosso do Sul (UFMS), in Campo Grande, Mato Grosso do Sul state (MS), from April 2019 to June 2021. HUMAP is a referral hospital for high-risk pregnancies in the state.

Newborns considered potentially eligible due to preterm birth (< 37 weeks) were selected from the UCINCo database, and 693 cases listed on an Excel spreadsheet. Of these, 15 were selected by filtering, based on the following inclusion criteria in addition to gestational age below 37 weeks: low birthweight (< 2,500 grams), 1- and 5-minute Apgar score ≤ 7, continued hospitalization in UCINCo, and GMA between 35 and 40 weeks corrected age (high-risk group – HRG). The control group (CG) consisted of 15 NBs matched according to the same criteria, but with birthweight ≥ 2,500 grams and 1- and 5-minute Apgar score ≥ 7, indicating less risk. Thus, the final sample contained 30 NBs. Exclusion criteria were NBs with no registered GMA or who died during hospitalization.

The study was approved by the UFMS Research Ethics Committee (CAAE no. 53934421.6.0000.0021), with no need for written informed consent since the parents/guardian had given written permission for images to be taken by the hospital while the infants were hospitalized. Initially, the following information was collected from the medical records and database: date of birth, gestational age, birthweight, Apgar score, GMA results, and risk factors at birth.

The risk factors considered were those cited in the Brazilian Ministry of Health/SUS Child Health Guide,[3] namely: Incomplete or no prenatal care; problems during pregnancy, delivery or birth (pre/perinatal); prematurity; birthweight below 2,500 grams; severe jaundice; hospitalization during the neonatal period; severe diseases such as meningitis, head trauma and seizures; kinship between the parents; family history of disability or mental illness; and environmental factors such as domestic violence, maternal depression, drugs or alcoholism among household members, and suspected sexual abuse.

GMAs registered in the medical records were performed by a UCINCo physiotherapist certified in Prechtl's method[15] and took place between admission of the NB to UCINCo and discharge. To that end, the NBs were filmed and the resulting footage subsequently stored in the Neonatology Department database. According to instructions for Prechtl's method,[15] filming was performed with a cell phone and lasted 1 to 3 minutes. The NBs remained in the supine position wearing only a diaper, and any objects/toys/pacifiers were removed to ensure greater freedom during movement. No interference, including verbal, from the rater and/or mother was permitted during filming.

The videos were filmed after 72 hours of life, between 35 and 40 postmenstrual weeks, comprising the preterm and term GM period. In this phase, GMs are described as smooth fluid movements of the neck, trunk, upper and lower limbs in different sequences, whose quality can be categorized as: a) normal; b) poor repertoire, when the NB shows no variety in amplitude or speed, making movement predictable; c) cramped synchronized, when movements are more limited, occurring in blocks with

no fluidity; and d) chaotic, when movements are confused with no variety in amplitude or speed, and no fluidity, considered high risk for neurodevelopment.[15]

For the purpose of reliability in the present study, all filming was supervised, and GMs were assessed by two certified independent raters. Disagreements were discussed until 100% agreement was reached between the three raters, and the original assessments registered in the medical records. The average Kappa value reported for interrater reliability in global GMA is 0.88.[15] The assessments were carried out with the raters blinded to group allocation.

Statistical analysis was performed using SPPS 23.0 software, in line with assumptions of normality (Shapiro-Wilk) and homogeneity (Levene). First, descriptive analysis was conducted using raw frequencies and proportions for categorical variables (classification of GM quality, presence/absence of risk factors) and means and standard deviations for continuous variables (neonatal data). The t-test for independent samples was applied to compare neonatal data between groups and characterize the sample. To compare the proportions of GM quality categories (normal, poor repertoire, cramped synchronized, chaotic) in the preterm and preterm periods and the presence/absence of risk factors at birth between groups (HRG x CG), the chi-squared test was used, and Fischer's exact test when appropriate.

Additionally, Fischer's exact test was applied to assess the relationship between the Apgar score and preterm and term GM quality regardless of group. The Apgar score was categorized based on scores obtained at 1 and 5 minutes (0 - 2 = critically low; 3 - 5 = very low; 6 - 7 = moderately low; 8 - 10 = high). Significance was set at 5% for all analyses.

Results

Table 1 presents the sample characteristics. The gestational age of the NBs was 34.80 ± 1.41 weeks (minimum of 32 and maximum of 36 weeks and 6 days). The HRG obtained lower birthweights and 1- and 5-minute Apgar scores than those of the CG, in accordance with the inclusion criteria.

General movements

The GM quality categories identified were normal, poor repertoire and cramped synchronized. No chaotic GMs were observed. No intergroup differences were observed for GM quality [$X^2_{(2)}$ = 2.14; p = 0.44], but cramped synchronized GMs only occurred in the HRG (Table 2).

Table 1 - Means and standard deviations of newborn characteristics in each group

Characteristic	HRG	CG	t	p
Gestational age (weeks)	33.87 ± 1.32	35.80 ± 0.60	5.02	0.07
Age at GMA (weeks)	37.51 ± 1.88	37.61 ± 0.92	0.18	0.86
Birthweight (grams)	1678.00 ± 552.21	2870.33 ± 301.47	7.34	< 0.01
1-minute Apgar	3.13 ± 1.68	8.13 ± 0.83	6.79	< 0.01
5-minute Apgar	6.06 ± 1.79	9.00 ± 0.65	9.79	< 0.01

Note: HRG = high-risk group (n = 15); CG = control group (n = 15); t = student t-test value for independent samples; significant at p < 0.05.

Table 2 - Intergroup comparison of GMs quality by GMA in raw frequencies (f) and proportions (%)

GMA	HRG		CG	
	f	%	f	%
Cramped-syncronized	2	100	0	0.0
Normal	3	37.5	5	62.5
Poor repertoire	10	50.0	10	50.0

Note: HRG = high-risk group (n = 15); CG = control group (n = 15); GMs = general movements; GMA = Prechtl's qualitative assessment of general movements.[15]

Risk factors

Although the risk factors consisted of ten topics from the Brazilian Ministry of Health's Child Health Guide,[3] three were not found in any of the groups studied (incomplete or no prenatal care, kinship between the parents, and family history of disability or mental illness), and three formed part of the inclusion criteria of one or both groups (prematurity, birthweight below 2,500 grams and hospitalization during the neonatal period). Thus, four risk factors were analyzed, namely environmental factors; problems during pregnancy, delivery or

birth (pre/perinatal); severe jaundice; and severe diseases such as meningitis, head trauma and seizures. There was no intergroup difference for the presence of environmental risk factors [$X^2_{(1)}$ = 2.16; p = 0.33] and severe diseases [$X^2_{(1)}$ = 0.16; p = 1.00], but intergroup differences were observed for the presence of pre/perinatal problems [$X^2_{(1)}$ = 8.57; p = 0.00] and severe jaundice [$X^2_{(1)}$ = 5.00; p = 0.03], with a larger proportion of these risk factors present in the HRG when compared to the CG (Table 3).

Apgar score and general movements

GM quality categories were not associated with the 1-minute [$X^2_{(6)}$ = 7.10; p = 0.25] or 5-minute Apgar score categories [$X^2_{(6)}$ = 5.88; p = 0.85] (Table 4).

Table 3 - Intergroup comparison of the presence of risk factors in frequencies (f, count) and proportions (%)

Risk factor	High-risk group (n = 15)		Control group (n = 15)	
	f	%	f	%
Environmental factors	4	80.0	1	20.0
Pre/perinatal problems	11	78.6	3	21.4
Severe jaundice	9	75.0	3	25.0
Severe diseases	5	55.6	4	44.4

Table 4 - Frequencies of the GM categories in relation to Apgar score categories (n = 30)

GMA	Apgar							
	Critically low (0 - 2)		Very low (3 - 5)		Moderately low (6 - 7)		High (8 - 10)	
	1st minute	5th minute	1st minute	5th minute	1st minute	5th minute	1st minute	5th minute
Normal	0	0	2	0	1	3	5	0
Poor repertoire	6	1	5	1	4	9	6	10
Cramped-synchronized	1	0	0	0	0	1	0	5

Note: GMA = general movements assessment by Prechtl's method.[15]

Discussion

The present study investigated whether the Apgar score is related to GM quality in the neonatal period in hospitalized PTNBs. In regard to GM quality, most of the NBs exhibited poor repertoire GMs. This is consistent with other studies, which reported that many PTNBs, especially extremely preterm infants, exhibit poor repertoire GMs in the first days of life.[22,23] These studies also indicate that some NBs normalize within a few weeks,[22] and others at an age equivalent to term or later.[22,24] As such, the results obtained here may be transitory. Interestingly, cramped synchronized GMs were only observed in the HRG (low birthweight and Apgar scores). These GMs are considered one of the most important early markers of a compromised central nervous sys-tem.[15] However, statistical analysis demonstrated that 1- and 5-minute Apgar scores were not related to GM quality. These findings are similar to those of Wu et al.,[25] who reported that perinatal complications, such as jaundice, low 5-minute Apgar score, and sepsis/infec-tions, among others, were not associated with altered GMs at a corrected age of 2, 3 and 4 months. Mallmann et al.[26] studied hospitalized PTNBs and term infants and found a relationship between abnormal GMs and risk factors such as preterm birth, low birthweight, and hospital stay greater than 30 days (the last two more prevalent in PTNBs).

Prematurity itself, which was a controlled risk factor between groups in the present study, may be the main risk factor for changes in GM quality. Zahed-Cheikh et al.,[27] investigated GM quality in extremely preterm infants

TNBs and found that worse classifications were directly related to younger gestational age and postnatal morbidities, such as chronic lung disease and nosocomial infections. Porro et al.[28] highlighted the importance of evaluating neonatal factors along with GM trajectories over time to identify NBs at risk of neurodevelopmental changes, especially those with poor repertoire GMs in the neonatal period.

The present study used risk factors listed by the Brazilian Ministry of Health.[3] Three of these factors, namely prematurity, birthweight below 2,500 grams, and hospitalization during the neonatal period were used as inclusion criteria for one or both groups studied. Interestingly, some of the seven remaining factors were not present, such as incomplete or no prenatal care. Previous studies indicate that this is an important factor in prolonged hospitalization and death,[29,30] and its absence may therefore have favored the outcomes found in our study. The NBs were also clinically stable, which may have contributed to the results.

With respect to the risk factors present, there were no intergroup differences for environmental factors related to domestic violence, maternal depression, drugs or alcoholism among household members, and suspected sexual abuse. On the other hand, there was a higher percentage of problems during pregnancy, delivery or birth and severe jaundice in the HRG when compared to controls. This suggests that the presence of environmental risks may be independent of birthweight and Apgar scores, but when these are low, they may be linked to a greater prevalence of other biological risk factors.

These findings are consistent with those of Silva et al.,[29] who observed an association between maternal complications and/or problems during delivery, low birthweight, extreme prematurity, 1- and 5-minute Apgar score below 7 and the presence of clinical complications in PTNBs. These factors were correlated with greater risk of hospitalization and in-hospital death. As such, the association between low Apgar score and birthweight and other biological risk factors increases the risk of prolonged hospitalization and death.[29,30] Moura et al.[30] found that NBs hospitalized in a neonatal unit exhibited less favorable characteristics, such as greater Wainstock of low birthweight and prematurity when compared to nonhospitalized infants. On the other hand, Wainstock and Sheiner[11] reported an association between low Apgar scores and subsequent hospitalization for neurological morbidities in term NBs, but not in PTNBs.

Finally, it is important to recommend caution when interpreting the findings of the present study. This is because its external validity is limited, since it does not have a representative sample of hospitalized preterm infants. Additionally, only one GMA was performed, making it impossible to determine whether the outcomes performed were only transitory. However, it should be noted that the final sample consisted solely of NBs that met the inclusion criteria from a list of almost 700 NBs admitted to a referral hospital, which indicates a small sample consisting of a very specific target population.

This study improves knowledge on the characteristics of GMs in hospitalized newborns and which risk factors require greater attention during hospitalization in a neonatal unit. To our knowledge, this is the first study to compare two groups based on the Apgar score. Future research should involve prospective cohorts that follow the trajectory of GMs to investigate whether the results obtained in the neonatal period change.

Conclusion

In conclusion, 1- and 5-minute Apgar scores did not affect preterm and term GM quality in hospitalized clinically stable PTNBs. However, low birthweight and Apgar scores were associated with a greater presence of biological risk factors, characterized by problems during pregnancy, delivery or birth, and severe jaundice in these newborns.

Acknowledgments

The authors are grateful to the Coordination for the Improvement of Higher Education Personnel (CAPES)/ Federal University of Mato Grosso do Sul (UFMS/MEC) for the funding provided - Code 001.

Authors' contributions

DASM was responsible for study conception and, along with MONR and LYH, structuring the manuscripts. The data were collected by MONR and LYH, and analyzed and interpreted by MONR, LYH, PRA and DASM. LYH drafted the manuscript, which was then revised by the remaining authors. All the authors approved the final version.

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