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EVALUATION OF CLINICAL AND NEURO-BEHAVIORAL VARIABLES OF PRE-TERM NEWBORNS

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ABSTRACT

Objective: To assess the clinical and neurobehavioral variables for the development of preterm newborns. Method: This was a cross-sectional study with a sample of twenty-one preterm newborns of both genders and mean gestational and chronological ages of 32 weeks (± 1.7) and 27 days (± 15.2), respectively, who were assessed while still in hospital. The medical files were used to collect data on the gestation, delivery, complications developed and on the Neonatal Medical Index (NMI). The newborns were evaluated using the Neurobehavioral Assessment of the Preterm Infant (NAPI) in seven categories: scarf sign, motor development and vigor, popliteal angle, alertness and orientation, irritability, cry quality and percent asleep. The data were analyzed using SPSS® statistical software based on descriptive statistics (frequencies, means and standard deviations), Student's t test for comparison of groups (study sample versus normative NAPI sample) and Spearman's correlation test (clinical variables and NAPI categories). Results: The preterm newborns' performance was statistically significantly different from the normative NAPI group in relation to the variables of scarf sign, motor development and vigor and cry quality. The NMI correlated negatively with scarf sign (r= -0.60). Alert behavioral state during inactivity correlated positively with motor development and vigor (r= 0.59) and with cry quality (r= 0.71). The most frequent maternal complications were genitourinary tract infection (47%) and gestational arterial hypertension (24%), and the neonatal complications were hyaline membrane syndrome (86%), neonatal infection (57%) and hyperbilirubinemia (47%). Conclusion: Neurobehavioral assessment and clinical data are variables that must be considered when working with newborns at risk of delayed development.

Key words: neurobehavior; preterm; clinical characteristics; development.

INTRODUCTION

In the last years, great technological advances have been observed in the health sciences and consequently, in the Newborn Intensive Care Units (NICU). Due to prematurity, several complications have been identified during growth and development of pre-term newborns (PN). However, survival of these newborns has increased, and they can demonstrate inferior neuromotor and sensory development compared to children born at full-term and this has drawn the attention of several researchers[1].

Presently, some assessments such as the Apgar Index and the Neonatal Medical Index (NMI) are used early in the heath care unit to identify the risk potential of newborns. The Apgar score is determined right after birth. It is based on the observation of five items in the 1st and 5th minutes of life: heart rate, respiration, muscle tone, skin color and reflex irritability. The NMI is applied after the newborn is discharged from the hospital, as the index was designed to assess how sick the pre-term newborn was while staying in hospital and to provide a complete inventory of complications faced by the child. Classification varies from 1 to 5, with higher classifications corresponding to greater neonatal risk[2].

PN are forced to interact with a new environment in which they are not totally adapted, and thus they become more susceptible to several neonatal complications[3]. As a consequence of these complications, PN can be submitted to several clinical interventions such as oxygen therapy, orotracheal intubation, phototherapy, surfactant resposition, use of orogastric feeding tubes, body heating, among others[4,5,6].

Some studies emphasize the need for caution to avoid excessive stimulation of newborns, as they do not have structured defense mechanisms. Therefore, environmental stimuli such as excessive light, noise, frequent movement, repeated interruption of sleep cycles and painful manipulations are extremely stressful, and this may cause further complications for growth and development[3].

Additionally, the absence of pleasant stimulation in the first days of life can lead to difficulties in sensory adaptation[3]. Linhares et al.[7] remark that lower weight and lower gestational age (GA) at birth have a great impact on the neurobehavioral development of the PN. The different body systems, especially the nervous system, are not fully developed at birth, and are not adequately exposed to motor and sensory experiences (tactile, heat, taste and others). This may cause difficulties for the newborn to interact with the environment.

Some studies point to the importance of considering intrinsic factors such as complications after birth, an Apgar score lower than seven in the 5th minute and a number of complications in the evaluation of the newborn, since these factors can lead to differences in the development of pre-term newborns compared to full-term newborns[8,9,10].

In order to identify possible delays in the neurobehavioral development of PN and comprehend the process of adaptation and interaction with the environment, Korner et al.[2] developed the Neurobehavioral Assessment of the Pre-term Infant (NAPI). The NAPI assesses the neurological and behavioral development of pre-term newborns. The instrument can be used to assess effects of interventions, describe the behavioral repertoire of the newborns during growth, identify possible delays in development and inform parents on the behavior and developmental progress of their child[2,11,12].

Johnston et al.[11] report a study using the NAPI to evaluate 103 PNs admitted to the NICU. The objective of the study was to determine the efficacy of the saccharose to decrease pain of the newborns during painful procedures. The neonates were randomly assigned to intervention and control groups. Newborns allocated to the intervention group received a saccharose solution and newborns allocated to the control group received sterile water before each invasive procedure over seven days. Results demonstrated that 0,1ml of saccharose at 24% administered in repeated doses was efficacious in reducing the pain score during painful procedures. Regarding possible adverse effects of the saccharose, the authors observed that a high number of saccharose doses predicted low neurobehavioral development scores for the NAPI areas of motor development, vigor, alertness and orientation in newborns with post-conceptional ages between 36 and 40 weeks. A high number of saccharose doses also predicted high Neuro-Biological Risk Scores (NBRS) in newborns at two weeks of post-gestational age.

Brandon et al.[12] used the NAPI to assess the neurobehavioral development and the sleep-alertness cycle of pre-term newborns during the administration of caffeine doses and manipulation of environmental light. The authors assessed clinical risk according to the NBRS, length of hospital stay and utilization of mechanical ventilation. Researchers observed that the administration of caffeine was associated with low scores in the dimensions of alertness and orientation, motor development and vigor, irritability, vigor and crying, popliteal angle and the scarf sign. The greater neonatal risk was associated with a high percent of quiet sleep and active sleep and low scores in the dimensions of alertness, and visual and auditory orientation of the infants during examination. The popliteal angle was significantly lower for 32 week old newborns exposed to environmental light.

In light of such evidence, the objective of the present study was to assess clinical and neurobehavioral variables related to the early development of pre-term newborns. An additional objective was to compare the results of the neurobehavioral assessment of infants included in the study sample to the normative data available for the Neurobehavioral Assessment of the Pre-term Infant (NAPI).

MATERIALS AND METHODS

Participants

A cross-sectional study was conducted with a convenience sample of 21 pre-term newborns of both sexes. Chronological age varied between 4 and 59 days (27; ± 15.2) and gestational age varied between 29 and 35 weeks (32; ± 1.7). Weight at birth varied between 1005 and 2205 grams (1512 ± 287). All newborns were assessed in the Neonatal Unit of Moderate Risk of the Mother-Child Hospital of Goiânia (GO) between January and February 2005.

Inclusion criteria for the newborns were: GA < 37 weeks, weight at birth < 2500g, consent of the parents and the physician responsible for the infant. Newborns should also have been clinically stable and should have been fed 90 min. before the assessment. Newborns that did not fulfill the above criteria were excluded from the study along with infants with congenital malformations, cardiopulmonary conditions, associated neurological pathologies, meningitis, history of maternal drug abuse or signs of seizures. Initially, 43 pre-term newborns were identified during the data collection period, however, only 21 fulfilled the inclusion criteria.

Instruments

The Anamnesis Form and the NAPI Assessment Form were used for this study. The Anamnesis Form was used to collect data regarding gestation (gestation, maternal health problems, use of medication, gestational age), delivery (type, duration, fetal suffering, weight at birth) and post-natal period (length of hospital stay, 1st and 5th minute Apgar scores, complications and correspondent clinical procedures, Neonatal Medical Index –NMI).

The NAPI Assessment Form[2] was used to register the behavior of the child. The NAPI assesses the pre-term newborn at the post-conceptional ages of 32 to 40 weeks in seven categories: scarf sign, motor development and vigor, popliteal angle, alertness and orientation, irritability, vigor and crying, and percent sleep ratings. The test contains 41 items. The behavioral state of the newborn is assessed with 14 items[13]. Such states are classified in 1 (quiet sleep), 2 (active sleep), 3 (sleepiness), 4 (inactive alertness), 5 (active alertness), and 6 (crying). Other instruments used in the study included a mattress on which to position the newborn for examination on a examination table at the Moderate Risk Neonatal Unit, a chair where the examiner sat to administer the alertness and orientation items, a chronometer, the newborn's blanket and the NAPi Kit (two head supports and a red rattle).

To register and store the data, the following equipment and software were used: digital camcorder Sony HC-40, Pinacle Studio Video Capture software, mini-DV tapes and CD-ROMs.

Procedures

After the study was approved by the Ethics Committee for Human and Animal Research of the General Hospital of Goiânia (protocol number 73/04) the newborns were selected to compose the study sample. Hospital registers were checked for filling in the Anamnesis Form. After that, the person legally responsible for the child received an invitation to the study as well as instructions regarding participation and signed the Free and Informed Consent Form.

Pre-term newborns were assessed according to the item sequence determined in the test manual. The newborn was carefully moved from the incubator and all handling was performed over the mattress on the exam table. Before initiating items that required handling, the newborn should not have been actively moving, stretching or yawning. The newborn was undressed and two supports were used to maintain the head at midline during testing of the scarf sign, motor development and vigor and popliteal angle items. After that, the child was dressed and covered with a blanket to test the items related to alertness and orientation. During this part of assessment, the examiner sat with the child on his lap and used a red rattle to test visual and auditory inanimate items. For the animated visual and auditory items, the examiner used his voice and his face at 30 cm from the face of the child. At the end of examination, the newborn was placed in the incubator and his behavioral state was registered. The total assessment time was 20 to 25 minutes, and the whole procedure was video-recorded by a second examiner for later scoring.

The analysis of videos of the newborns was performed after determination of the inter-examiner reliability. A reliability index of 90% was obtained. According to instructions contained in the NAPI manual, the raw score of each newborn was converted to a 0-100 scale score for all seven assessed domains. The post-conception age of the PN (30 to 40 weeks) was used for comparison with normative values. Final scoring of the 21 newborns were analyzed with the software SPSS®. Initially, the Student t test ($p \leq 0.05$) was used to compare mean NAPI scores of the newborns assessed in the present study with normative NAPI data. The Student t test tests the null hypothesis of an absence of difference between means.

To analyze the behavioral states, the 14 registered items were divided into four phases: 1st phase (items 1, 3, 5, 7 and 10), 2nd phase (items 13,16, 20, and 22), 3rd phase (items 25 and 27), and 4th phase (items 34, 39 and 41). The evolution of behavioral states during assessment was calculated according to the frequency of states presented by the newborns for the items of each phase.

After that, the Spearman correlation test was performed between clinical variables (gestation, delivery and post-natal), the predominant behavioral states during assessment and the seven NAPI categories (scarf sign, motor development and vigor, popliteal angle, alertness and orientation, irritability, vigor and crying, and percent sleep ratings) Data registered in the Anamnesis Form were organized descriptively for calculations of means, frequency and standard deviations.

RESULTS

Figure 1 presents results of the neurobehavioral assessment of the pre-term newborns of the studied sample compared to the normative NAPI sample.

Figure 1 demonstrates that standard-deviation values obtained for the present sample were superior to the standard deviations of the normative values. It is also possible to observe that normative means were superior to the means obtained in this study. These differences indicate that the newborns assessed in this study demonstrated neurobehavioral development delays for the variables scarf sign, motor development and vigor, popliteal angle and crying.

Results of the t test ($p \leq 0.05$) allowed rejection of the null hypothesis (no differences between sample and normative means) for the domains scarf sign, motor development and vigor, popliteal angle and crying. Therefore, test results indicated statistically significant differences between means. The data suggest that the behavior of the newborns who composed the study sample was inferior to the performance of the normative group. In the domains alertness and orientation, irritability and percent sleep ratings the null hypothesis of no difference between means could not be rejected, therefore the means are considered to be statistically comparable ($p > 0.05$). These results demonstrate that the behavior of the newborns assessed in the study was similar to the behavior of the normative group.

The behavioral state of the newborns demonstrated variability during the NAPI assessment. In the first phase of the assessment, the means of the behavioral states were 2.3 (± 1.58), 4.7 (± 1.18) in the 2nd phase, 4.8 (± 0.96) in the 3rd phase and 3.4 (± 1.23) in the 4th phase. Considering the

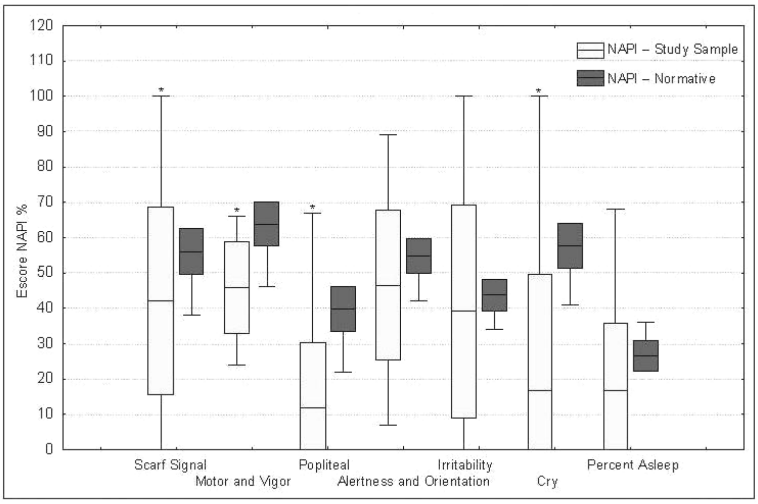

Figure 1. Comparison between the results obtained by infants of the study sample and NAPI normative data in the variables scarf signal, motor development and vigor, popliteal angle, alertness and orientation, irritability, cry and percent asleep.

four phases, the mean of the behavioral states was 3.8 (±1.19), indicating that inactive alertness was the predominant state.

Correlation analyses between clinical and neurobehavioral variables demonstrated that the NMI (Neonatal Medical Index) was negatively associated with the scarf sign (*r*= -60). Such an inverse correlation indicates that greater clinical risk is associated with the decreased scarf sign. In the studied sample, 15 infants (72%) had NMI scores ≥ 3. The behavioral state of inactive alertness was positively correlated with motor development and vigor (*r*= 0.59) and quality of crying (*r*= 0.71). Correlations between those variables indicated that higher frequencies of alertness states are associated with higher scores for motor development and vigor as well as crying quality.

The studied sample demonstrated several neonatal and maternal complications. Among the maternal complications, the following frequency counts were observed: genitourinary tract infection (47%), pregnancy-associated hypertension (24%), oligoamnios (14%), premature placental abruption (9%) and anemia (5%). Twenty-eight% of the mothers did not show any complications. Regarding neonatal complications, the following frequencies were observed: hyaline membrane syndrome (86%), neonatal infection (57%), hyperbilirubinemia (47%), acute respiratory failure (38%), umbilical cord torsion (14%), neonatal anoxia (9%), birth injury (9%), bronchopulmonary dysphasia (9%) and anemia (5%). The mean length of hospital stay of the newborns was 26 days (± 15), with a range from 11 and 69 days.

DISCUSSION

This study analyzed important neurobehavioral and clinical variables related to the initial development of pre-term newborns. When results of the sample were compared to normative NAPI data, it was observed that the performance of pre-term newborns indicated a neurobehavioral development delay for the items: scarf sign, motor development and vigor, popliteal angle and crying quality. These findings may have resulted from the fact that the sample was small compared to the normative group and from the high variability of behavioral states among PN, which demonstrated difficulties of self-regulation during assessment. Additionally, differences between groups could be attributed to neonatal complications of the newborns in this study. Such complications may have influenced the quality of responses observed during the examination. Length of hospital stay was another factor that may have influenced these results. The mean length of hospital stay was 26 days, which could have caused the newborns to show higher reactivity to environmental stimuli and a lower tolerance to handling during assessment.

Wolf et al.[14] assessed neurobehavioral variables and the developmental profile of very low birth weight pre-term infants at the ages of three and six months compared to infants born at term. The author used the Neonatal Behavioral Assessment Scale and the Infant Behavioral Assessment and observed that almost all pre-term infants demonstrated adequate motor quality in regard to age. However, self-regulation problems such as increased irritability and fewer attachment behaviors were observed in the comparison to infants born at term. There is a trend, nevertheless, for these differences to decrease during development.

Regarding development of the behavioral states during the NAPI assessment, the majority of the PN in the present study demonstrated varied behavioral states when test items were administered. In the beginning of assessment, most newborns were in an active sleep state and during examination there were oscillation in the behavioral states. During the second and third phases, most newborns were inactively alert.

At the end of examination the predominant state was sleepiness. These results may be related to the neurological immaturity of each newborn to regulate or stabilize sleep and alertness states while staying in the Neonatal Intensive Care Unit. In general, factors such as use of medications that may depress the autonomic nervous system, difficulties to define differences between day and night hours, and low maturity of the reticular system to maintain alertness levels may have contributed to the results observed for these newborns. The predominant state demonstrated by the sample during the whole assessment was inactive alertness.

Results corroborate findings of Figueiredo et al.[15] who tested the effects of a sensory stimulation program in seven pre-term newborns in the NICU and observed that during handling the newborns alternated between behavioral states. Most of the newborns, however, remained in active or inactive alertness. A study by Ariagno et al.[16] investigated NAPI behavioral patterns in newborns who received individualized treatment of the NICU (adequate positioning, decrease of noise and illumination levels, parental involvement). The results demonstrate that the newborns submitted to interventions, spent more time in alert states and demonstrated signs of greater motor maturity compared to control group newborns.

Significant associations were observed between clinical variables and the neurobehavioral assessment of the newborns. Results demonstrated that newborns with more clinical complications assessed by the NMI demonstrated greater delays in the scarf sign. Similarly, Korner et al.[2] observed that newborns with higher NMI scores demonstrated delayed neuromotor development. The observed correlations between the predominant behavioral state and the domain of motor development and vigor revealed that infants that spend more time in inactive alertness demonstrate higher scores for motor development and vigor. The correlations between predominant behavior and crying revealed that these two variables are directly related, with both scores increasing concomitantly. Therefore, the results indicate that neurobehavioral states are closely related with newborn performance.

It is important to emphasize that the sample of the present study was composed of pre-term newborns that had some developmental risk factors such as low weight (<2500g) and neonatal complications. Therefore, these factors can also have a later influence on the development of the newborn and some authors relate these variables to pre-term birth[9,10,17,18,19].

Magalhães et al.[10] assessed the global development of children at school age, including those with greater number of neonatal complications in association with prematurity and low weight. Performance of children with these characteristics was inferior to that expected for their age, suggesting that the association of risk factors can make the child more vulnerable to developmental problems. The authors also observed that all children with performance lower than normal lived with families with low socioeconomic conditions.

Weiss et al.[17] assessed the temperament of PN with low birth weight during the first two weeks of life. They used the Revised Infant Temperament Questionnaire, which assesses activity levels, approach-withdrawal, adaptability, intensity of emotions and body expression, mood, attention span and persistence in tasks, distractibility and sensory thresholds. The authors also examined the perinatal risk factors of 152 newborns. Their most important findings revealed distractibility and delays in adaptation abilities. Eighty percent of the newborns were classified as newborns with difficult temperaments and gestational age and weight at birth did not significantly influence the temperament of the newborns in the sample. Factors that most importantly accounted for temperament results were ethnic, cultural and socioeconomic variability.

Pedersen et al.[18] reported that pre-term children with low weight at birth showed differences in motor development and functions compared to full term children. They suggested that children born pre-term have more risk factors and should be referred to a follow-up program.

Haddad[19] studied pre-term infants classified into three groups: healthy, sick and neurologically affected. The author reported that differences between groups in regard to environment exploration variables were not as pronounced as the differences observed between pre-term and full-term newborns. PN needed more time to complete tasks of social attention and orientation. However, healthy pre-term newborns with few perinatal complications had better performance scores in the *Neonatal Behavioral Assessment Scale* (NBAS) between 29 and 34 weeks of gestational age. This finding, according to the literature, is related to better prognosis for these infants and lower risk for developmental deficits.

Analysis of the clinical and neonatal variables of the present study revealed that the sample was composed of newborns with low weight at birth with complications such as hyaline membrane syndrome and neonatal infection. These complications can aggravate the health status of the PN and affect the neuromotor and sensory development.

Halpern et al.[20] assessed 1.363 12 month-old infants using the Denver II test and observed the prevalence of suspected developmental delay was fourfold higher in the group of infants born with less than 2.000g. Pre-term infants had a 60% higher chance of having suspected developmental delays.

Shankaran et al.[12] assessed the neurobehavioral development of 246 PN born with extremely low weight (<1.000g) and 1st minute Apgar equal or lower than 3. The newborns were assessed at 18 and 22 months of adjusted age, using the Mental and Psychomotor Developmental Index (MDI and PDI, respectively) of the Bayley Scales. Forty-six percent of the infants had MDI scores lower than 70 and 36% of the infants had PDI scores lower than 70. These low scores indicate delayed performance in comparison to typically developing children.

All studies used standardized instruments to assess the development of newborns during the first year of life. Results demonstrate that clinical and neurobehavioral aspects are important factors for the detection of neuromotor delays in PN. Therefore, earlier detection of neurobehavioral development delays may increase the chances of efficient interventions to promote adequate development. The present study has some methodological limitations due to the small sample size and its cross-sectional design. Therefore, results reflect characteristics of the studied sample and findings should be generalized with caution.

CONCLUSIONS

The comparison between the data of the present study and NAPI normative values indicated delays in some test items in the studied sample. Scores of the domains of alertness and orientation, irritability and percent sleep ratings were not different from normative values. The neurobehavioral status of the newborns in the present study demonstrated variability during the NAPI assessment. However, the predominant behavioral state among the newborns was inactive alertness. This behavioral state may facilitate interactions of the infant with the environment, improve performance during assessments and increase the effects of interventions with this kind of sample.

Future studies should assess larger samples to in order to obtain more homogeneous data. Additionally, studies with longitudinal designs should be undertaken in order to document developmental trajectories of pre-term newborns and identify long term effects of clinical and neurobehavioral variables.

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