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ORIGINAL RESEARCH

Post-Intensive Care Syndrome in Newborns from a Nutritional and Neuromotor Perspective

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Abstract

Premature newborns who need prolonged hospital stays may develop Post-Intensive Care Syndrome, which, as the term itself suggests, is characterized by post-hospital changes that manifest themselves in the physical, cognitive and/or nutritional fields. The advance of care in recent decades has provided greater survival for the newborns, thus allowing initial studies to characterize signs and symptoms which may indicate, in the future, the risk of developing PICS. Given the above, the aim of this study was to characterize and verify the prevalence of signs related to PICs in the neuro psychomotor and nutritional domains in children followed at a public hospital in Belo Horizonte, Minas Gerais, Brazil. To this end, an observational, cross-sectional, prospective study was carried out in the period from October 2016 to June 2017. The sample consisted of 26 children, 77% male, 58% of cesarean delivery and age from 1 to 12 months. The birth took place at 26 to 41 weeks of gestation and these newborns remained hospitalized in the NICU for 6 to 97 days. Birth weight was diagnosed as adequate for 92% of these newborns, considering their prematurity. After hospitalization, the prevalence of adequate weight for these children decreased to 81% and a new nutritional diagnosis of low weight was established. As expected, premature children and children with a nutritional diagnosis of low weight stayed longer in the ICU. Complementarily, our study observed that children with longer hospital stays tend to have an altered motor development. Noteworthy, this is one of the first studies on the subject and demonstrated that there is a tendency for changes in the motor and nutritional performance of children who remain hospitalized in the ICU, bringing the need for future studies with more robust samples and followed for more time.

Keywords

Post-Intensive Care Syndrome, Newborns, Nutrition

Introduction

The term Post-Intensive Care Syndrome has been used to denote effects caused in one or more domains of patients who remain hospitalized in intensive care united (ICU) for prolonged periods [1]. In this sense are describes physical, cognitive and/or mental modifications [2]. Reports indicated that this alteration can last months or years after hospital discharge [2,3]. In the field of mental health occur high propension to development of anxiety, depression, post-traumatic stress disorders; decrease of concentration, besides sign and symptoms to deficient movement, fatigue, and weak musculature [4-6]. However, the nutrition of patients in the ICU, especially neonates, plays an important role in the maintenance and gain of body weight, since weight loss and intense catabolism in some clinical conditions are extremely harmful to the treatment, resulting in longer hospitalization time.

The advance in the quality of care provided to preterm infants in recent decades has provided an increase in the survival of high-risk newborns (NB), making it possible for babies with increasingly lower gestational age to survive [7]. In this way, an increased

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number of children with secondary sequels after birth was observed, with an impact on their life quality and neuro psychomotor development [7-10].

Complications resulting from prematurity may require prolonged periods of hospital stay, causing an increased risk of stress [11,12]. Also, the interruption of the growth organization process due to premature birth compromises sensory development [13]. Thereby, the child kept in the Neonatal Intensive Care Unit (NICU), is exposed to an inhospitable environment with excessive light, noise and a large amount of daily procedures, causing changes in the central nervous system and in the pattern of sleep and wakefulness. way, causing damage to its expected growth and development [14-16]. Changes in the pattern of sleep and wakefulness interfere with the eating pattern and present risks for the development of metabolic diseases in the future [16]. In this way, these elements associated with the specificities of premature newborns may have repercussions in future complications such as the Post-Intensive Care Syndrome - PICS. Thus, investigating the impact of interventions on the growth, development and quality of life of these children became a priority. It is true that rapid detection and intervention are essential in the prevention and reduction of complications associated with PICS, since early rehabilitation in the first year of life changes the prognosis of development of these children [17].

The clinical manifestation of PICS encompasses several cognitive, psychiatric, and physical signs and symptoms that start or worsen after a prolonged hospital stay. Most common are: Weakness, fatigue, weak mobility, difficulty concentrating, anxiety and depressed mood [18,19]. The physical, cognitive, and mental domains are correlated and, as a result, the injury in one of these areas can cause the emergence or worsening of another [20-22]. Likewise, the treatment of one area can help to improve another affected domain, was demonstrated that physical rehabilitation, in addition to improving its function, seems to reduce cognitive impairment and psychiatric morbidity [23]. Although nutrition is important at all stages of life, studies involving PICS and Nutrition are scarce [1].

Given the above, the aim of the study was to characterize and verify the prevalence of signs related to the Post-Intensive Care Syndrome in the physical domain, specifically in the neuro psychomotor and nutritional field in children followed up at the Follow up Clinic of a metropolitan public hospital, located in the city of Belo Horizonte, Minas Gerais, Brazil.

Methods

An observational, cross-sectional, prospective study was carried out from October 2016 to June 2017.

Twenty-six children of both sexes, aged between 1 and 12 months, who remained hospitalized in the Neonatal and Pediatric ICU for a period longer than three days and who, after hospital discharge, started follow-up in the public hospital.

The inclusion criteria used in the research were the inclusion of all children and newborns who started follow-up in the period from October 2016 to June 2017, with a maximum age of 1 year, who remained hospitalized in the ICU for a period equal to or greater than three days, and those whose guardians signed an informed consent form.

The exclusion criteria were children with metabolic diseases that predispose to malnutrition, neuromuscular diseases such as multiple sclerosis and amyotrophic lateral sclerosis, diseases that significantly impair motor development expected for their age, syndromes that limit proven psychological and or cognitive function through reports and/or exams, children over 1-year-old. And those whose guardians did not agree to participate or did not sign an informed consent form.

The collected data from medical records was organized and stored in a database in the Epi InfoTM 7.1.5 software. Normality assumptions were verified by the Shapiro-Wilk test. Continuous variables are presented as mean ± standard deviation. Discrete or non-parametric variables had a measure of central tendency presented as median. Measures of association between nutritional status, motor development and morbidities were given by logistic binary regression, with a variable selection method by best fit of the model's likelihood ratio. The relationship between ICU time, motor development and nutritional status was verified using the Kruskal-Wallis and Mann-Whitney tests.

Statistical analysis was performed using Epi InfoTM 7.1.5 and SPSS Statistics 17.0 software. For all analyses, a critical value of p equal to 5% was assumed to reject the null hypotheses.

The research project was approved by the Research Ethics Committee of the Institution (CAAE: 59166916.6.0000.5129 with report 2.041.481).

Results

The analysis of the results allowed us to characterize the sample, shown in Table 1.

Maternal age ranged from 18 to 44 years, with a median of 29, with 11% of the pregnant women being adolescents (n = 3) and 89% adults (n = 23). When evaluating the frequency of prenatal consultations, 8% (n = 2) of them did not attend consultations; and among those who underwent prenatal care, the number of consultations ranged from: 3 consultations 4% (n = 1), and 4 consultations 4% (n = 1), 15% (n = 4) for 5 consultations, 6 consultations were carried out by 35% (n = 9), 4% (n = 1) pregnant woman had 7 consultations; 19% (n = 5) had 8 consultations and, 8% (n = 2) had 10. And one was unable to inform 4% (n = 1).

Table 1: Sample profile.

Mother profile (N = 26)	**Minimum**	**Maximum**	**Median**
Age, years	18	44	29
Prenatal, number of consultations	0	10	6
Gestational age, weeks	26	41	33
Delivery (type)	**N**	**Percentage (%)**	
Spontaneous vaginal delivery	11	42	
Cesarean birth	15	58	
Sex	**N**	**Percentage (%)**	
Male	20	77	
Female	6	23	
Birth weight (nutritional classification)	**N**	**Percentage (%)**	
Adequate	24	92	
High	2	8	
Hospitalization (days)	**Minimum**	**Maximum**	**Median**
Full time	10	107	45.5
ICU time	6	97	14.5
Mechanical Ventilation	0	33	1

Table 2: Motor assessment using the AIMS × Gestational age performed after admission.

Motor performance	**Premature (N)**	**Median ICU (days)**	**Full term (N)**	**Median ICU (days)**	**Total (N)**	**Median ICU (days)**
Changed	12	18	4	16	16	16
Expected	7	18	3	8	10	13

The analysis of data from the children showed the variation in gestational age, in which 7 children were classified as full-term newborns (27%) and 19 preterm newborns (73%), detailed below 2 children with 26 weeks (8%), 4 with 28 weeks (15%), 2 with 29 (8%), 1 with 30 (4%), 1 with 31 (4%) , 2 with 32 (8%), 2 with 33 (8%), 2 with 34 (8%), 3 with 35 (10%), 1 with 37 (4%), 5 with 39 (19%) and 1 with 41 (4%). Of these children, 42% were born by spontaneous vaginal delivery (n = 11) and 58% by cesarean (n = 15), 20 males and 6 females.

According to the Growth Curves used by the World Health Organization version 2006, the birth weight recorded in the discharge summary was found to be adequate for age (using the growth curves for prematurity when necessary) and 8% above the ideal weight.

The length of stay ranged from 10 to 107 days. The minimum ICU time found was 6 and the maximum 97 days, with a median of 14.5 and an interquartile distance (IQR) of 39 days for the 26 children evaluated, and of these 42% were not submitted to mechanical ventilation (n = 11).

Although 58% of hospitalized children were on mechanical ventilation, no significant differences were found between time on mechanical ventilation and motor development ($p = 0.269$). There was also no difference between body mass index (BMI), classified by adequate or inadequate, and motor development when compared in different lengths of stay ($p > 0.05$) or length of stay and motor development ($p = 0.856$).

When submitting children on the Alberta scale (Table 2), 16 had altered motor performance, (14 with suspicious performance and 2 with abnormal performance), 10 were within the expected pattern for their age. Children who spent a longer period in the ICU tended to have abnormal motor development, with a median of 16 days, while the median length of stay for children with normal development was 13 days.

To nutritional diagnosis, in the case of premature infants, the corrected age and specific curves were used as recommended by The International Fetal and Newborn Growth Consortium for the 21st Century for premature children [24], the classification of BMI by age showed that 81% had an adequate nutritional diagnosis (n = 21), and 19% had an altered diagnosis (n = 5), as follows: 8% classified as thin (n = 2) and 11% were overweight (n = 3).

As expected, we noticed a prolonged stay in the ICU of premature children, with a diagnosis of thinness (median of 52 days) and overweight (median of 18), when compared to children with adequate weight, who had a shorter hospital stay, median of 11 days (Table 3). However, no significant difference was observed in the length of stay according to nutritional diagnosis for any of the groups ($p = 0.956$). There was also no significant difference between length of stay and adequate and

Table 3: Nutritional classification of children treated after hospitalization.

Weight, classification	Sample (N)	Sample Percentage (%)	Median (days of hospitalization)	Premature (N)	Full term (N)
Adequate	21	81	11	12	9
Low weight	2	8	52	2	0
Overweight	3	11	18	3	0

inadequate nutritional diagnosis (diagnosis of thinness or overweight) (p = 0.819). Equally noted for association between grouped nutritional diagnosis and use of mechanical ventilation in the ICU (p = 0.620).

Discussion

This study allowed us to verify the profile of the pregnant woman and the child participating in the study, as well as the impact generated by admission to the Intensive Care Unit. According to our data, there was participation of adolescent mothers in 11%. Although a minority, and very young mothers represent a risk factor with high predictive value for the delay in the motor and cognitive development of premature children [25].

During pregnancy, monitoring the pregnancy makes it possible to predict risks arising from pregnancy until delivery. The Pre-Christmas Humanization Program establishes the minimum number of consultations that must be carried out by pregnant women as 6 [26]. In addition, evidence demonstrates an inverse relationship between the number of prenatal consultations and the chance of perinatal mortality, increasing the number of consultations to be carried out to 8 [27]. The findings of this study are consistent with research carried out with users of the Unified Health System, in Caxias do Sul-RS, verifying an average of 6.2 consultations [28].

There is still no consensus in the literature on the expression “prolonged hospitalization”. Different authors attribute this expression to the time of 3 days [29], 7 days [30], 10 days [31], 14 days [32] or up to one month [33]. In the present study, the length of stay in the ICU was found to be a minimum of 6 and a maximum of 97 days, to be considered a prolonged hospital stay. Under the effects of this hospitalization, we showed that the results point to a tendency towards an atypical motor development in children who remained hospitalized for a prolonged period in the ICUs.

In the nutritional scope, the monitoring of weight and nutritional status must be carried out. Was found that the process of weight loss, regardless of the usual weight, is considered by itself a form of malnutrition, even if, after the bodily changes, the individual remains within the standards considered normal [34]. Complementarily, it was demonstrated that malnutrition is related to longer hospital stays, clinical complications of the patient, higher hospital costs, in addition to a greater chance of developing PICS [14,35].

Premature babies need large amounts of nutrients, mimetizing the growth they would present inside the uterus. At the same time, they have great enzymatic immaturity, which often prevents success in meeting nutritional demand. Still, many are unable to feed orally, needing tubes for enteral nutrition with the gastric route as preferred, being post-pyloric in some exceptions. In the case of extremely low birth weight preterm infants, parenteral nutrition is usually the first choice due to the immaturity of the gastrointestinal tract (GIT), which makes the use of enteral therapy difficult. The transition to the oral route must be carried out as soon as possible, giving preference to the breast [36].

The nutrition of preterm newborns aims to meet the needs, promoting adequate growth and development, avoiding as much as possible undesirable effects, such as: Metabolic acidosis, patent ductus arteriosus, necrotizing enterocolitis, hypercholesterolemia, hyperuremia and hyperammonemia, among others [37].

Although motor performance was within expectations, this information does not rule out the possibility of these children presenting changes in one or more domains, requiring follow-up programs for early detection and intervention. We must also keep in mind that change in motor performance is one of the earliest manifestations of pervasive developmental disorder [38,39]. Preterm and underweight children are more likely to develop motor deficits [40], however, not all preterms will necessarily present delays in motor development, and the prognosis will depend on biological and environmental factors [14,41]. Environments that will harm this child's biopsychosocial may interfere with expected development [14,42]. Interestingly, the present study presents the same trend identified in the literature, which demonstrates that preterm newborns had altered motor performance in a greater proportion compared to full-term newborns [43-45].

Prematurity can be considered a biological risk factor for changes in expected motor performance, but it is not isolated, as the large number of manipulations combined with continuous environmental stimuli can cause neurological damage in the low weight newborn secondary to external aggressions [46,47].

The environment in which these infants are inserted can interfere with motricity and the development of body image, these changes can be promoted by the prolonged length of stay in the ICU receiving inadequate stimulus [48]. It must be considered that during hospitalization, the patient can receive about

134 manipulations in 1 day, with a range of 50 to 150 potentially painful procedures throughout the shift [49,50]. Additionally, the stress these patients are subjected to daily were associated with cognitive and neurobehavioral problems [7,51].

Considering that these patients are not prepared to respond in an organized way to countless painful stimuli, they may present motor impairment [49,50], Which can be aggravated by the use of sedation, limiting the movements of this newborn [46]. Thus, the hospital, for these babies, becomes an inhospitable environment where they will be subjected to different routines, noise, often invasive procedures, pain, fear, feeling of abandonment, anxiety [52], lack of adequate stimuli [53], factors that will contribute to the construction of an unpleasant experience [54]. The environment can act beneficially to the NB, enabling exploration and interaction with the environment and/or it can act in a harmful way, restricting learning possibilities, thus delaying their motor acquisitions [55,56].

The impact of PICS on public health is extremely important due to the neuropsychological and functional changes that occur in these patients [57-59].

The concern with these patients who stay for long periods in Intensive Care Units goes beyond the current moment, it persists for long periods as their hospitalization can generate important effects with regard to their development, growth and family interaction [60].

Conclusion

The present study showed that there is a tendency for changes in the motor and nutritional performance of children who remained hospitalized in the ICU, and, therefore, there is a need to carry out studies that verify the impacts of hospitalization in Intensive Care Units.

It is also worth emphasizing the need for more studies on the syndrome in children, with a larger sample size, longer follow-up time for these children after discharged from hospital.

Declaration of Interest

None.

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