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The results of early intervention neurodevelopmental therapy in premature infants at the age of four, according to the Bayley's III assessment tool

Theocharopoulou Fani [1], Papadopoulou Ourania [1], Tzitiridou-Chatzopoulou Maria [2], Kallistratos Ilias [1], Xalkia Anna [1], Savvidis Georgios [3,*] and Hristara Alexandra [1]

[1] *Postgraduate Program, Pediatric Physiotherapy, School of Health Sciences, Department of Physiotherapy, International University of Greece, Thessaloniki – Sindos, Greece.*
[2] *Assistant Professor, School of Healthcare sciences, Midwifery Department, University of Western Macedonia, Koila, Greece.*
[3] *PhD Candidate, School of Healthcare sciences, Midwifery Department, University of Western Macedonia, Koila, Greece.*

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Abstract

Introduction: The main goal of modern Neonatology is the survival of premature infants with as few problems as possible. The purpose is to preserve and care for the brain potential of Brain Care (Als H. 2006). Neurodevelopmental Care is provided to infants from birth to the age of three. It concerns infants who have developmental deficits or are at risk of developing neurodevelopmental disorders. The goal of Early Intervention is to promote child health, enhance existing and emerging abilities, minimize developmental delay, address existing or emerging motor, cognitive, and emotional deficits, as well as prevent cognitive, functional, and limited parents and the entire family environment. Purpose: The purpose of this research is to study the necessity and possibilities of early intervention and physiotherapeutic rehabilitation of premature infants, according to the Bayley III assessment scale. A clinical trial demonstrating the effect of Neurodevelopmental Education on premature infants, according to the measurements of the Bayley Scale. Method: This study was designed as a clinical trial between September 2017 and August 2023. It included one hundred premature infants who were recorded and equally divided between premature infants who received simple counseling according to early intervention therapy and not any type of Neurodevelopmental Education (Group A, 25 boys, 25 girls aged 1 month and 15 days) and premature infants who received Neurodevelopmental Education therapy immediately after their discharge from the NICU (Group B, 25 boys, 25 girls aged 1 month and 15 days). Both groups received Early Intervention Neurodevelopmental Care during their stay in the NICU. Therapy will be administered by the researcher and the staff trained by the researcher himself for a period of the last 12 years. The groups were evaluated at the age of 4 years using the Bayley Scale for Infant and Toddler Development, Third Edition (BayleyIII). It should be noted that the Bayley Scales for infant and toddler development will be examined and will serve as the research instrument of the current project. Finally, conclusions will be drawn based on the statistical analysis of the results obtained from the evaluation and comparison of the two groups.

Keywords: Developmental care; Premature infants; Prematurity; Neurodevelopmental Therapy; Early Intervention; Neurodevelopmental Care; Bobath method; Bobath Therapy; NDT method; Bayley III Scale; Bayley's Test

1. Introduction

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*Corresponding author: Tzitiridou Maria

The study by Moreira, Magalhães & Alves (2013) can be seen as a substantial confirmation regarding the long-term vulnerability of preterm infants across a range of indicators related to their developmental stages. This vulnerability of infants is explicitly related to issues of mobility, behavior, and school performance. Therefore, as revealed by the results of Moreira, Magalhães & Alves (2013), a possible long-term follow-up of preterm children is considered pivotal. This can be attributed to the fact that reliability at a crucial period in children's development requires various skills and abilities that may not have been required and are likely to worsen. Thus, according to the findings of Moreira, Magalhães & Alves (2013), preterm infants are considered more vulnerable in terms of improving their motor skills, behavior, and cognitive functioning compared to full-term infants. Such complex functions, whose effects are shown in the long term, can be predicted through the contribution of early parental guidance, interaction from specialized therapists, and interventions among them.

According to the above, the main objective of the study by Vohr et al. (2012) was interpreted around comparing the scores of 18-22 month-olds regarding the assessment of neurodevelopmental impairment (NDI) in two time periods using the significant evaluation that emerged from the National Institute relating to the Neonatal Research Network on Infant Health and Human Development regarding newborns with significantly low birth weight through the contribution of the Bayley Scale regarding infant development concerning the second edition Bayley II for the reference period years 2006-2007, i.e., Period 1. Therefore, the study by Vohr et al. (2012) proceeded with the above comparison using the subsequent use of the Bayley Scale for the development of infants and toddlers, i.e., the Third Edition called Bayley III with fragmented cognitive and dialectical scores, concerning the years 2008-2011 (period 2).Furthermore, according to the main results of Vohr et al. (2012), whether the Bayley III overestimates cognitive performance or can provide a more substantive assessment of increasing cognitive skills compared to the Bayley II is questionable. Given that the Bayley III has improved psychometric properties, it is expected to have more predictive validity in terms of later childhood outcomes. Nevertheless, the study highlights the need for additional research to fully understand the implications of using the Bayley III for assessing cognitive development in preterm children.

Additionally, according to Elbasan et al. (2017), family physiotherapy with the Neurodevelopmental Treatment (NDT) method is considered dominant. NDT principles may not be sufficient to promote mechanism and cognitive performance in preterm neonates in the primary age range. Other intervention methods may also be considered to support the motor and cognitive improvement of preterm infants.In reference to the aforementioned study by CabraldePaulaMachado et al. (2016), it was found that sensory processing problems occur in prematurity. At the same time, the issue of motor development is positively correlated with the aspect of sensory processing.

Furthermore, the study by Manus, Carle & Poehlmann (2011) has clearly shown that participation in early intervention therapy can be associated with more optimal cognitive trajectories. At the same time, Manus, Carle & Poehlmann (2011) emphasized that for preterm children whose mothers have more support, receiving therapy could prove particularly useful.

The study by Kline et al., (2019) has identified a wide range of maturation strategies related to significantly improved Bayley-III scores for cognitive and language development in preterm infants up to 2 years corrected age. Similarly, the significant contribution of the study by Kline et al., (2019) is related to the use of extensive combinations of these measures in terms of surface area and curvature, while the measures continued to be separately predictive of variance in Bayley-III scores. As clearly inferred from the aforementioned findings of Kline et al., (2019), these cortical measures are promising biomarkers of later disability and may help facilitate precise early stratification probability for neuroprotective trial design when neuroplasticity is maximal. Furthermore, as highlighted by Haugland et al., (2014), an early intervention program does not appear to have a critical impact on cognitive scores (IQ) in preterm children aged 7 to 9 years. The attenuation of intervention impact is congruent with the results of other long-term studies regarding at-risk preterm children. In line with the above, Morsing et al., (2018) emphasized that brain volumes as determined by magnetic resonance imaging in early school age were related to degree of prematurity at birth and less so to restriction of embryonic growth. Regional brain volumes did not differentiate motor and cognitive function beyond that expected for gestational age at onset.

Furthermore, Hutchonetal., (2019) presented a new framework called EISMART. This framework relates to early intervention that is associated with sensory-motor development, in combination with regulation and attention according to relationships and support provided by the therapist. This new intervention aims to identify the key components that could significantly contribute to the field of effective intervention in infants who belong to the high-risk category of a type of typical neurodevelopmental outcome.

Based on interdisciplinary group discussions with parents of high-risk children and a literature search, Hutchonetal., (2019) offered a clinical consensus on current difficulties and issues in early intervention. Therefore, a comprehensive data survey should be included in early intervention programs. These interventions include promoting age-appropriate independent mobility, along with providing support regarding self-regulation and the process of developing positive parent-infant bonds according to the early promotion of communication skills, parental guidance, responsive parenting, and support for parental mental health. At this point, it is considered crucial to mention that these multifaceted programs may need to be evaluated as a whole. According to Hyunetal., (2020), they mentioned that infants born at a moderate to late gestational age may be at risk for borderline cognitive problems and attention problems when they start school. In preterm infants born at intermediate to late gestational age, cognitive and executive abilities that are considered crucial for academic performance need to be carefully evaluated and monitored. Based on the aforementioned findings, Staceyetal., (2020) reported that every year, more than 270,000 infants are born very prematurely in the United States, with 50% of them developing neurological abnormalities. As a direct consequence, this type of abnormality may potentially limit their ability to keep up with their normally developing peers. Therefore, the significant contribution of the study by Staceyetal., (2020) revolves around forming a better understanding of the impact of intense developmental intervention on this population during the first months of life. Novak (2014) does not fail to mention that rehabilitation interventions include child-centered interventions aimed at enhancing the gains in motor and functional skills, such as explanatory interventions related to management therapy, goal-oriented education, movement therapy resulting from restrictions, or alternative home programs or occupational therapy after poisoning. They also encompass a wide range of pharmacological, orthopedic, and therapeutic interventions aimed at promoting secondary prevention and health, such as casting, diazepam, exercise, poisoning, active hip surveillance, and bisphosphonates. Finally, they include a variety of environmental and compensatory interventions, as for example, the field of context-focused therapy can be perceived.

The purpose of this study is to investigate the necessity and potential of early intervention and physiotherapy rehabilitation for premature infants, according to the Bayley III assessment scale. A clinical trial that demonstrates the impact of Neurodevelopmental Facilitation on premature infants, based on the measurements of the Bayley III Scale.

2. Material and methods

This study was designed as a clinical trial conducted between September 2017 and August 2023. It included one hundred preterm infants who were enrolled and equally divided into two groups. The premature infants in Group A received standard counseling according to early intervention therapy and not any type of Neurodevelopmental Therapy (25 boys and 25 girls at the age of 1 month and 15 days). Group B consisted of preterm infants who received Neurodevelopmental Treatment immediately after their discharge from the NICU (25 boys and 25 girls at the age of 1 month and 15 days). Both groups received Early Intervention Neurodevelopmental Treatment during their hospitalization in the NICU. The Treatment will be implemented by the researcher and the staff who have been trained by the same researcher for a period of the past 12 years. The groups were evaluated at the age of 4 years using the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley III). It should be noted that the Bayley Scales for infant and toddler development will be examined and will serve as the research tool of the current study. Finally, appropriate conclusions will be drawn.

2.1. Statistical analysis

For the statistical analysis of the results, the SPSS (Superior Performance Software System) version 20.0 was used, specifically the one-way ANOVA variance analysis and the parametric Tukey's test. The level of statistical significance was set at $p < 0.05$, while the data are presented as means.

3. Results

3.1. Demographic data

The sample of this quantitative research consisted of 100 preterm infants, half of which (50) received simple counseling according to the basic principles of early therapeutic intervention, while the remaining (50) infants outside the counseling process followed a Neurodevelopmental Care Program immediately after their discharge from the NICU. The infants were equally divided into 25 girls and 25 boys in each group. All infants were born prematurely, between 33-37 weeks of gestation, with the majority being at 35 weeks of gestation. None of the participating children showed any form of brain damage or other disorders. Initially, the selection of children who met the research criteria was made, followed by their division into two equal groups (n=25). The first group (Experimental Group) included children who received simple counseling according to the principles of Early Intervention Therapy and not any form of

Neurodevelopmental Therapy. Similarly, the second group (Control Group) included children who received Neurodevelopmental Therapy immediately after their discharge from the NICU.

4. Discussion

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As previously stated, the purpose of this research was to study the effectiveness and significance of early developmental physical therapy care for premature infants, and its impact on children at the age of 4 according to the developmental assessment tool BayleyIII.

The sample of this quantitative study consisted of 100 preterm infants, half of which (50) received basic counseling according to the principles of early therapeutic intervention, while the remaining (50) infants, who were excluded from the counseling process, followed a Neurodevelopmental Care Program immediately after discharge from the NICU. The infants were equally divided into 25 girls and 25 boys in each group. All infants were preterm, born between 33-37 weeks of gestation, with a majority born at 35 weeks. None of the participating children exhibited any form of brain damage or other disorders. Initially, the selection of children who met the research criteria was made, followed by their division into two equal groups (n=25). The first group (Experimental Group) included children who received basic counseling according to the principles of Early Intervention Therapy and not any type of Neurodevelopmental Therapy. Similarly, the second group (Control Group) included children who received Neurodevelopmental Therapy immediately after discharge from the NICU.

In the following year, the evaluation of the children took place privately by myself (K. Fani Theoharopoulou) as a Specialized Neurodevelopmental Physiotherapist and Certified BayleyIII Examiner. Permission was requested from both the parents and the children if they were willing to be evaluated with this specific assessment tool. The evaluation took place between September 2017 and August 2023, after the children had turned 4 years old according to the BayleyIII Developmental Tool. The evaluation of the children took place in two stages. The first evaluation was conducted when the infants were 1 month and 15 days old and the second evaluation took place when the children had reached the age of 4. The evaluation was conducted in my personal private space, under appropriate testing conditions and equipment. The timing of the evaluation was chosen after consultation with the parents, so that the children could be well-rested and there were no third-party presence, except for the mother if deemed necessary, in order to minimize distractions and enable the children to maintain their calmness and focus. The duration of the evaluation did not exceed 2 hours and 30 minutes. The majority of participants completed the tests within a maximum time of 1.5 to 2 hours. The evaluation form included the child's details (Full Name, Gender, Examiner's Full Name, Evaluation Date, Date of Birth, Age, Calculation of Corrected Age for children aged 1 month and 15 days, and their placement in the respective Starting Point of the assessment tool). Subsequently, the execution of the tests commenced, either through instructions or demonstrations, depending on the specific test requirements. The tests are divided into three categories:

A) Cognitive, B) Verbal (Expression and Comprehension), C) Motor (Gross and Fine Motor Skills)

The Bayley III assessment form contains a total of 326 tasks (91 tasks in the cognitive domain, 97 in the verbal domain, and 138 in the motor domain). However, each child starts with the task that corresponds to their age category in order to complete as many tasks as possible. Each task is scored as either 0 or 1, depending on whether the child fully completes it or not. In this specific form, children are assessed based on their ability to perform the task, regardless of the method they use. The assessment process stops when the child fails to complete 5 consecutive tasks. At the end of the assessment process, the total number of successfully completed tasks is summed up for each specific domain. Using ranking and matching tables, we arrive at the final score (composite score), which indicates the child's functioning level and potential in each respective domain. Once the assessment process is completed and the required measurements are taken, the percentage rating for each domain and the overall percentage rating for all participants in each domain and for both age groups are calculated. The data is then categorized and presented in tables, according to the group and age. This is followed by the creation of graphs and statistical analysis using SPSS 20.0, specifically analysis of variance for a single factor (one-way ANOVA) and the parametric Tukey's test. The level of statistical significance was set at $p < 0.05$, and the data is presented as mean values.

5. Conclusion

Prematurity seems to affect the global community and is the single most important cause of death in the first month of life, while also being a factor in over 75% of pediatric deaths in the neonatal period. It is a fact that prematurity is associated with learning and motor difficulties, visual and hearing problems, contributing to about half of the disabilities in children. For this reason, the role of the physiotherapist is invaluable, as the results show significant improvements in various aspects of health. Finally, studies prove the importance of the Bayley III assessment tool, which is widely used in observing and evaluating children with developmental problems, as well as for comparing and determining improvement or lack thereof in a child up to the age of 4 for each corresponding category (cognitive, verbal, motor). The Bayley III can also be used to assess one or two of the categories alone.

Compliance with ethical standards

Disclosure of Conflict of interest

The authors declare no conflict of interest.

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