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Original Article

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Nutrition Supply and Growth Post Nutrition Support Team Activity in Neonatal Intensive Care Unit

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ABSTRACT

Purpose: For neonates admitted to the neonatal intensive care unit (NICU), appropriate nutritional assessment and intervention are important for adequate growth. In this study, we aimed to determine whether there were changes in the nutritional supply and growth status of premature infants hospitalized in the NICU after the introduction of the Nutrition support team (NST).
Methods: This study retrospectively analyzed premature infants admitted to the NICU for over 14 days. The average daily calorie, protein, and fat supply at 1 and 2 weeks after birth were compared before and after NST, and growth was evaluated by changes in length, weight, and head circumference z-scores at birth and 28 days after birth.
Results: A total of 79 neonates were included in the present study, with 32 in the pre-NST group and 47 in the post-NST group. The average daily energy supply during the first (p=0.001) and second (p=0.029) weeks postnatal was significantly higher in the post-NST group than in the pre-NST group. Lipid supply for the first week was significantly higher in the post-NST group than in the pre-NST group (p=0.010). The change in the z-score for length was significantly higher in the post-NST group than in the pre-NST group (p=0.049).
Conclusion: Nutrient supply and length z-score change increased significantly at 28 days after birth in the post-NST group. These results suggest that calorie calculators and NST activity can promote adequate growth and development in neonates.

Keywords: Nutritional support; Nutritional status; Growth; Infant, premature; Intensive care units, neonatal

INTRODUCTION

Neonates admitted to the neonatal intensive care unit (NICU) are likely to have inadequate growth [1-3]. This is because oxygen desaturation and stressful stimuli in newborns can reduce energy stores, and furthermore, changes in metabolism reduce nutrient absorption and increase energy expenditure [4,5]. In addition, insufficient nutritional supply due to inappropriate feeding, such as feeding intolerance and difficulty swallowing, can lead to poor growth and decreased neurodevelopment, therefore it is important to assess nutritional requirements and provide appropriate nutrition [6,7].

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Conflict of Interest
The authors have no financial conflicts of interest.

Most strategies to prevent inadequate growth involve provision of adequate nutrition. Nutrition support team (NST) is a multidisciplinary unit composed of nutrition experts who conduct nutritional risk screening, assess nutritional levels, and facilitate effective nutritional management. A previous study reported that intensive nutritional support provided by NST improved the nutritional state and clinical outcomes of neonates, including shortening of NICU stays and reduction in the duration of treatment with antibiotics [8,9]. The European Society for Pediatric Gastroenterology, Hepatology, and Nutrition also recommends the activities of NST to prevent and manage pediatric nutritional disorders [10].

Although the NST plays a significant role in neonatal growth and development, there are few reports available on the impact of NST activities in the NICU. In this study, we aimed to compare short-term nutrition supply and growth status before and after NST implementation in the NICU.

MATERIALS AND METHODS

Study design and study population

This retrospective, single-center study investigated changes in nutrient supply and growth after NST implementation. Patients hospitalized in the NICU for over 14 days, between April 2020 and October 2021, were included in this study. We divided the neonates into two groups based on NST activity from its implementation in October 2020. The neonates admitted between April 2020 and September 2020 were classified as pre-NST, and those admitted between October 2020 and October 2021 were classified as post-NST. Among the neonates included in this analysis, a subset of preterm neonates hospitalized for over 28 days was selected for further analysis of growth changes. A flow chart of the study design is shown in **Fig. 1**.

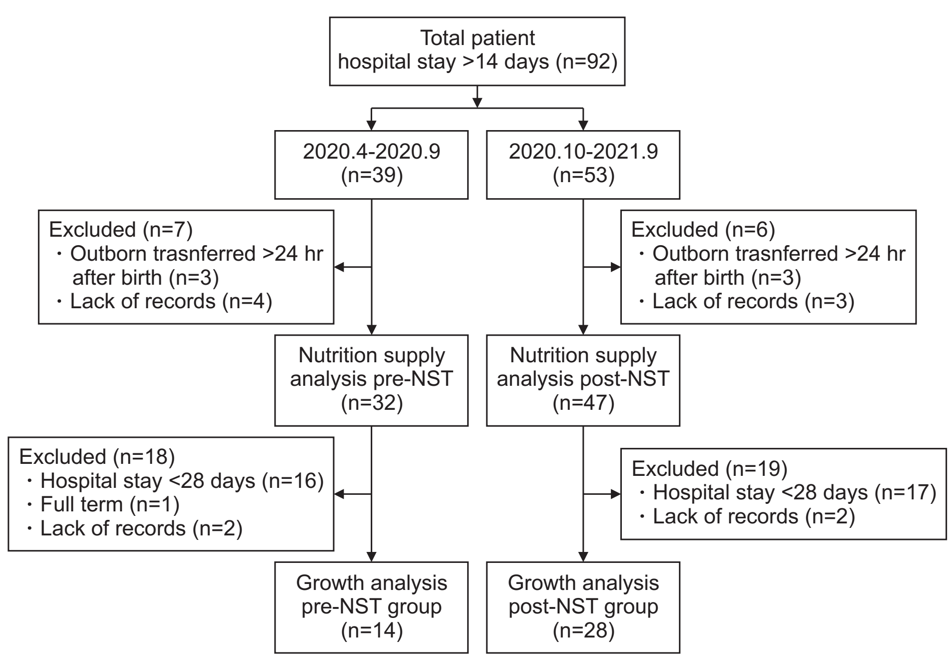

Fig. 1. Flowchart of the study.
NST: nutrition support team.

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Nutrition support team activity

In October 2020, the pediatric NST was formed in our hospital, which included a pediatric gastroenterologist, neonatologists, pharmacist, dietitian, and nurse. Basically, the attending physician (neonatologist) evaluated the nutritional status and intervened to provide nutritional status every day, and once a week, the NST team reevaluated the nutritional supply and growth status for a week and adjusted the amount of each macronutrient and micronutrient supplied. The NST developed a "calorie calculator" to calculate the calories (kcal/kg) (carbohydrates [g/kg], proteins [g/kg], and lipids [g/kg]) and the nonprotein calorie: nitrogen ratio based on the daily records of the input/output volume sheet. The amount of nutritional supply from parenteral and enteral nutrition was calculated separately as well as together. The NST shared the nutrition supply results, and monitored the weight, length, and head circumference of the neonates treated.

Outcome assessment

1. Change in nutrition supply

We collected data on the number of days required to reach full enteral feeding (>100 mL/kg) and the duration of parenteral nutrition. Nutritional supply was evaluated by comparing the average daily intake of calories (kcal/kg/d), proteins (g/kg/d), and lipids (g/kg/d) for the first two weeks postnatally.

2. Change in growth

We used the Lambda-Mu-Sigma method from the Fenton preterm infant growth chart to calculate the z-score [11]. We compared the changes in the z-scores for weight, length, and head circumference from the time of birth to 28 days postnatal.

3. Statistical analysis

The Mann-Whitney U test was used for continuous variables. All statistical analyses were performed using SPSS 25.0 (IBM Co.). Results with p<0.05 were considered statistically significant.

Ethical approval

This study was approved by the Institutional Review Board (IRB) of Kosin University Gospel Hospital, and informed consent was waived owing to the retrospective nature of this study (IRB number 2023-03-021).

RESULTS

Change in nutrition supply

A total of 79 neonates were included in the present study, with 32 in the pre-NST group and 47 in the post-NST group. The baseline demographics in the pre-NST and post-NST groups, such as the gestational age at birth (34.0±3.3 weeks vs. 33.4±2.7 weeks, p=0.337), birth weight (2,131±670 g vs. 2,101±594 g, p=0.745), and the Apgar score at 5 minutes (8.3±1.2 vs. 8.0±1.3, p=0.476), were not significantly different between the two groups (**Table 1**). The small for gestational age percentage was higher in the pre-NST group than in the post-NST group (15.6% vs. 2.1%, p=0.027), and the mean duration of ventilator support was longer in the pre-NST group than in the post-NST group (6.4±15.1 days vs. 1.5±3.3 days, p=0.023).

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Table 1. Baseline characteristics of patients before and after nutritional support team implementation

	Pre-NST (n=32)	Post-NST (n=47)	*p*-value
Male	14 (43.8)	29 (61.7)	0.118
Hospital day (d)	37.4±23.4	38.8±22.7	0.487
Gestational age (wk)	34.0±3.3	33.4±2.7	0.337
Birth weight (g)	2,131±670	2,101±594	0.745
Small gestational age (yr)	5 (15.6)	1 (2.1)	0.027
Apgar score (at 5 min)	8.3±1.2	8.0±1.3	0.476
Patent ductus arteriosus	8 (25.0)	7 (14.9)	0.264
Respiratory distress syndrome	14 (43.8)	12 (25.6)	0.093
Bronchopulmonary dysplasia	5 (15.6)	8 (17.0)	0.870
Sepsis	11 (34.4)	10 (21.3)	0.199
Necrotizing enterocolitis	0 (0)	0 (0)	>0.999
Cesarian section	25 (78.1)	35 (74.5)	0.711
Prenatal steroid use	16 (50.0)	31 (66.0)	0.159
Gestational diabetes	2 (6.3)	7 (14.9)	0.238
Ventilator day (d)	6.4±15.1	1.5±3.3	0.023

Values are presented as number (%) or mean±standard deviation.
NST: nutrition support team.

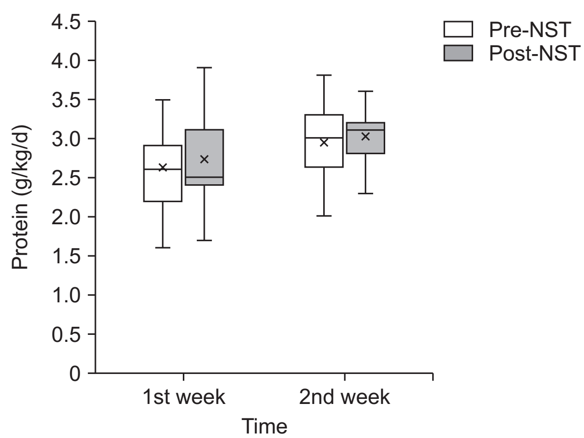

Fig. 2. Comparison of protein supply in the pre-NST and post-NST groups.
NST: nutrition support team.

Our analyses showed that the number of days required to reach full enteral feeding, the duration of parenteral nutrition, and protein supply did not vary significantly between the two groups (**Table 1**, **Fig. 2**). However, the average daily energy supply during the first (73.0±18.7 kcal/kg/d vs. 81.1±8.8 kcal/kg/d, p=0.001) and second (104.3±15.8 kcal/kg/d vs. 110.9±11.2 kcal/kg/d, p=0.029) weeks postnatal was significantly higher in the post-NST group than in the pre-NST group (**Table 2**, **Fig. 3**). Overall, infants in the post-NST group received intensive nutrition, whereby lipid supply for the first week was significantly higher in the post-NST group than in the pre-NST group (2.4±1.5 g/kg/d vs. 3.2±1.2 g/kg/d, p=0.010) (**Table 2**, **Fig. 4**).

Changes in growth

A total of 42 preterm neonates were included for further evaluation of their growth; 14 in the pre-NST group and 28 in the post-NST group. The baseline for weight, length, and head circumference z-scores at birth did not differ between the two groups (**Table 3**, **Fig. 5**). However, the change in the z-score for length was significantly higher in the post-NST group than in the pre-NST group (−0.57±0.45 vs. −0.22±0.57, p=0.049). There was no statistically significant difference in z-score changes for weight (−0.65±0.65 vs. −0.57±0.50, p=0.843) and head circumference (−0.66±0.55 vs. −0.33±0.54, p=0.076) between the two groups.

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Table 2. Comparison of the change in nutrition supply in the pre-NST and post-NST groups

	Pre-NST (n=32)	Post-NST (n=47)	*p*-value
Duration to reach full enteral nutrition from birth (d)	11.6±10.7	9.1±7.4	0.471
Parenteral nutrition duration (d)	12.5±12.7	9.3±7.4	0.258
1st week			
Energy (kcal/kg/d)	73.0±18.7	81.1±8.8	0.001
Protein (g/kg/d)	2.6±0.6	2.7±0.6	0.568
Lipid (g/kg/d)	2.4±1.5	3.2±1.2	0.010
2nd week			
Energy (kcal/kg/d)	104.3±15.8	110.9±11.2	0.029
Protein (g/kg/d)	3.0±0.5	3.0±0.4	0.710
Lipid (g/kg/d)	5.0±1.4	5.5±0.9	0.089

Values are presented as mean±standard deviation.
NST: nutrition support team.

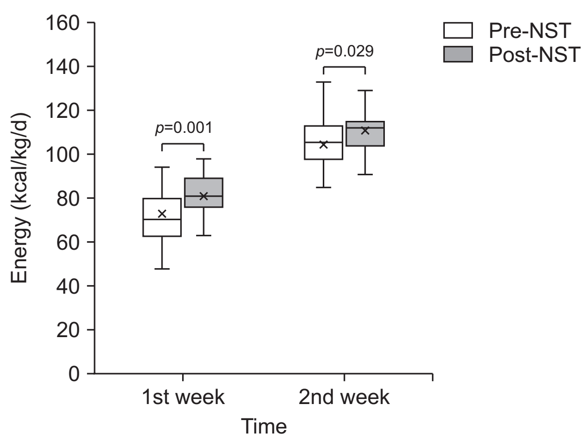

Fig. 3. Comparison of energy supply in the pre-NST and post-NST groups.
NST: nutrition support team.

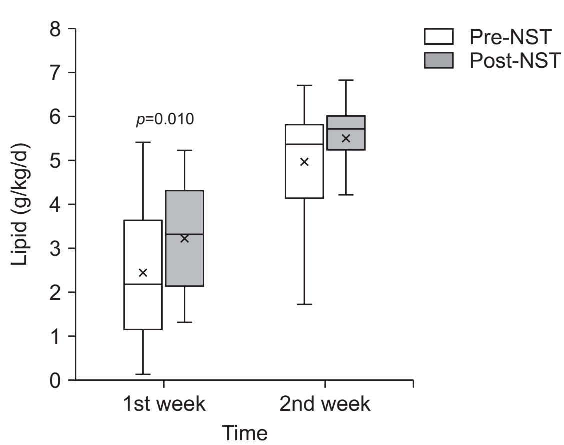

Fig. 4. Comparison of lipid supply in the pre-NST and post-NST groups.
NST: nutrition support team.

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Table 3. Comparison of the changes in growth in the pre-NST and post-NST groups

	Pre-NST (n=14)	Post-NST (n=28)	*p*-value
At birth			
Weight z-score	−0.29±0.83	−0.22±0.69	0.535
Length z-score	−0.24±0.87	−0.15±0.67	0.885
Head circumference z-score	−0.11±0.83	−0.16±0.62	0.802
At postnatal day 28			
Weight z-score	−0.94±0.63	−0.80±0.60	0.438
Length z-score	−0.81±0.85	−0.37±0.65	0.101
Head circumference z-score	−0.77±0.82	−0.50±0.69	0.113
Change of weight z-score	−0.65±0.65	−0.57±0.50	0.843
Change of length z-score	−0.57±0.45	−0.22±0.57	0.049
Change of head circumference z-score	−0.66±0.55	−0.33±0.54	0.076

Values are presented as mean±standard deviation.
NST: nutrition support team.

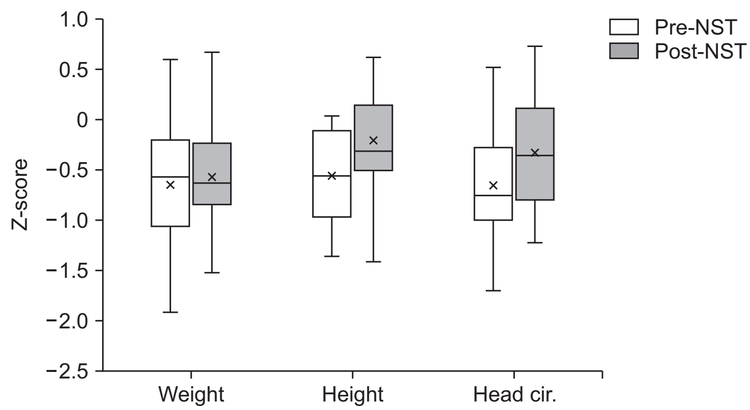

Fig. 5. Comparison of z-score on weight, length, and head circumference in pre- and post-NST groups.
cir.: circumference, NST: nutrition support team.

DISCUSSION

In the present study, we assessed whether the short-term growth of neonates is associated with NST activities and the development and application of a calorie calculator in the NICU. Although aggressive nutrition early in life improves growth and developmental outcomes, there are many barriers to optimizing neonatal nutrition [12-15]. Premature infants often rely on parenteral nutrition due to immature intestinal structure and function, which interfere with enteral nutrition and increase the risk of necrotizing enteritis. However, providing adequate parenteral nutrition is difficult as parenteral nutrition is often limited by multiple factors, such as infusion of drugs, maintenance of vascular access, and restriction of fluids [16,17]. Therefore, NST activities are important to overcome the energy demand and supply gap in the NICU to provide adequate nutrition [8,18].

A calorie calculator was developed concurrently with NST implementation in the present study. Although it is vital to calculate nutrient intake accurately, it is difficult to determine the calories and component ratios of macronutrients. In particular, during the transition from parenteral nutrition to complete enteral nutrition, the amount of enteral and parenteral nutrition is frequently changed according to the tolerability of enteral nutrition. Therefore, there may be discrepancies between planned and actual consumption. The calorie calculator converts the volume of each ingredient to its weight, enabling the analysis of dosages and proportions of nutrients. Additionally, physicians can adjust the composition of parenteral nutrition and additional calorie supplements according to the calculation [19].

The goal of nutritional supply for low birth weight infants is 90 to 120 kcal of calories per day and 3 to 3.5 g/kg/d of protein requirement, and when administering intravenous lipids, it starts at 1 g/kg/d from the first day and then gradually increases to 3–4 g/kg/d [20,21]. We found that NST intervention significantly increased total energy supply in the first and second weeks after birth. There was no difference in the amount of protein supply before or after the NST intervention, because protein was being administered aggressively postnatally even before the NST intervention. However, lipid supply was significantly higher in the post-NST group because NST shortened the withdrawal period with close monitoring of serum triglyceride concentrations and actively encouraged increased lipid supply. Moreover, when preterm infants reached full enteral feeding, the NST recommended changing the strength of formula milk from 14% to 16%. As a result, after the NST intervention, we were able to actively provide the total nutritional supply according to the required amount.

Several studies have reported that well-nourished premature infants have higher rates of catch-up growth during the first year of life, including greater increases in head circumference [22-24]. In this study, only the change in z-score for length from birth was significantly higher at 28 days of age. Although there was no statistical difference, weight and head circumference were found to increase overall after NST intervention, showing similar results to previous studies.

In addition to growth, another significant difference following NST intervention was ventilator duration. The ventilator period was found to be statistically shorter after NST intervention. Malnutrition may inhibit lung maturation and weaken muscle strength, prolonging the period of mechanical ventilation [25]. It is possible that adequate nutritional support shortened the duration of ventilator days, but it is difficult to generalize because this study was very short-term and small-scale. Adequate nutrition likely played an adjunctive role in preventing malnutrition and inducing lung maturation.

We demonstrated that NST intervention significantly increased nutrition supply and improved short-term linear growth in preterm infants. Monitoring growth status and nutritional intake can guide physicians to improve proper nutrition. In previous studies, the daily energy intake was assessed during the first week after birth, whereas our study was conducted for 2 weeks [9,26]. These data demonstrate the significant role of NST even after reaching full enteral feeding. Lastly, because growth changes were evaluated only for hospitalized preterm infants, it was possible to control for variables that may occur after discharge.

However, this study has some limitations. It was conducted retrospectively at a single center, and the sample size was small. Moreover, premature and term neonates were included without distinction, despite the difference in their nutritional requirements. Lastly, the growth evaluation was performed for only a short period. Therefore, additional long-term studies with large sample sizes are necessary to validate our results.

In conclusion, following the inauguration of the NST, there was a significant increase in nutrient supply and in the z-score for length at 28 days after birth. Although large-scale, long-term follow-up studies are needed, NST activities, including the use of calorie calculators, can contribute to adequate growth in neonates.

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