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Original Research Article

A Study Quantifying Protein Intake and Compare Growth Parameters in ELBW Infants in the First Two Weeks after Birth using Two Different Methods

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Abstract

Aim: The aim of the present study was to quantify protein intake and compare growth parameters at hospital discharge (as measured by discharge weight and head circumference percentiles) in ELBW infants in the first two weeks after birth using two different methods.

Material & Methods: The present study was conducted at Department of Pediatrics and all ELBW admissions to the NICU were included except those regaining BW in ≤ 3 days, those who were transferred to another facility, or those who died before reaching discharge.

Results: We studied 150 infants with 100 and 50 infants in P1 and P2 periods, respectively. Mean gestational age was lower during Phase 1 (24.86 ±1.34 vs. 25.45 ±1.85 weeks). P value =0.01). However, the birth weights were not different between the two periods. The incidence of SGA at birth was higher during Phase 2. Compared to P1, babies in P2 received 1 g/kg/day more protein till BW was regained. This average daily protein deficit would have resulted in a cumulative protein deficit of 5.1 g/kg if the infant's current weight was used for protein calculations for the duration of 1 week (P2 phase). There were no significant differences in protein and fluid intakes. However, there was a higher caloric intake in P2 compared to P1.

Conclusion: The decision to utilize birth weight as the basis for nutrition calculations in extremely low birth weight (ELBW) infants, rather than their current daily weight until they reach their birth weight, led to notable outcomes. Specifically, this approach resulted in a substantial increase in protein delivery, a significant reduction in the occurrence of failure to thrive, and a decrease in head circumference percentiles at the time of discharge in ELBW infants.

Keywords: Nutrition, Prematurity, Breastfeeding, Fat mass, Fortification.

Introduction

During the 2nd and early 3rd trimester, foetus receive about 4+/- 0.5gr/kg/day of protein. [1] A study from NICHD showed that >90% ELBW (extremely low birth weight) infants were growth restricted by 36 weeks of post-menstrual gestational age (PMA). [2] Postnatal growth failure, which is associated with impaired neurocognitive and renal development, [3,4,5,6] was observed in nearly 100% of very low birth weight infants at the end of the 1990s and still occurs in more than half of these infants. [7] Growth impairment during early infancy can have permanent detrimental effects. [8] Impaired foetal and postnatal growth has been associated with neurodevelopmental delay, ischemic heart disease, impaired glucose tolerance, type-II diabetes mellitus, hypertension, and metabolic syndrome. [9,10] Generally, growth failure is considered when a baby's weight is below the 10th percentile (≤−1.28 Z-score), but with different reference charts and variable postnatal periods having been used. [11] Although length growth deficit is also very common, the vast majority of children gradually catch up between the ages of 2 and 8 years and are within normal height ranges as adults. [12,13] A deficit in fat-free mass (FFM) at discharge has been associated with suboptimal neurological outcomes, and the proportion of fat mass (FM) is known to be higher in premature infants compared to foetuses of the same gestational age (GA). [14,15] Small for gestational age (SGA) infants had poorer weight gain than appropriate for gestational age (AGA) infants [16], and SGA infants remained at a lower body weight until the age of 3–6 years. [17]

Factors such as weight, gestational age, length of hospital stay, presence of respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), and sepsis have been associated with post-discharge growth and development in preterm infants. [18] According to a National Institute of Child Health and Human Development study on VLBW infants, nutritional intake deficits persist to some degree during the hospital stay, and infants with BPD, necrotizing enterocolitis (NEC), or late-onset sepsis demonstrate slower growth. Poor nutritional intake is common in VLBW in the early postnatal months. [19] This prompted the promotion of early aggressive nutrition in this vulnerable population [20]. Protein delivery increases steadily as the foetus grows and gains weight in utero.

A recent studies have shown a direct association between first-week nutritional intakes, especially higher protein intake, with improved neurodevelopment at 18-24 months. [21,22] Based on information from such studies, the use of 3-4gm/kg/day of protein in parenteral nutrition for ELBW infants within the first few days of life has become the standard goal. In the premature infant, growth and weight gain do not always occur in the first few days or weeks after birth. An ELBW infant may lose 10-20% of its birth weight (BW) and may take 2 to 3 weeks to regain its BW. Since fluid and nutrition need and delivery in ELBW infants are calculated based on their body weights, there could be a measurable difference in fluid, nutrition, and protein intake calculations based on birth weight or current weight of the infant, especially in the first two weeks of life. The issue is further complicated by the fact that fluid overload in the early newborn period is associated with negative cardiorespiratory outcomes, and most centers pay close attention to the daily fluctuations in weight when managing fluid balance in these infants. [23]

The aims of the study were to quantify the amount of protein intake and compare growth parameters at hospital discharge (as measured by discharge weight and head circumference percentiles) when using two different methodologies (birth weight versus current daily weight until birth weight is regained) for calculating fluid and protein intake in the first two weeks after birth in ELBW infant.

Materials & Methods

The present study was conducted at department of pediatrics , SKMCH, Muzaffarpur, Bihar, India for one year and all ELBW admissions to the NICU were included except those regaining BW in ≤ 3 days, those who were transferred to another facility, or those who died before reaching discharge.

Exclusion criteria

- Those regaining BW in ≤ 3 days, those who were transferred to another facility, or
- Those who died before reaching discharge.

Methodology

Birth weight, current daily weight, caloric intake (Kcal/kg/day), total fluid intake (mL/kg/day), and parenteral protein intake (gm/kg/day) were recorded daily until BW was regained and until discharge. At this center, in P1 CW was exclusively used for calculating fluid, calorie, and protein administration till BW was regained. In P2, BW was exclusively used for all calculations.

Comorbid conditions that may influence an infant's nutritional needs and growth outcomes were studied. CLD (chronic lung disease) was defined as the requirement for oxygen at 36 weeks of corrected gestational age. [24] PDA (patent ductus arteriosus) was defined as the presence of patent ductus arteriosus on an echocardiogram. NEC (necrotizing enterocolitis) was defined as the presence of pneumatosis intestinalis or air in the portal vein on an X-ray or surgical diagnosis at the time of laparotomy. [25] IVH (intraventricular hemorrhage) was defined as the presence of any hemorrhage in the lateral ventricles of the brain on an ultrasound. [26] Gender-specific Fenton growth charts (2013) were used for growth assessment. [27] The length was not analyzed due to intrinsic variability in measurement secondary to lack of standard-length board. This study received institutional review board exemption as part of the quality improvement. Feeding and nutritional practices during the two phases were as follows.

In P1, infants were gavage-fed ≤15ml/kg/day for seven days. Soon after birth, protein-based early parenteral nutrition was initiated with infants being given 2g/kg/day within 24 hours of birth. Fluids are initially started at 80-100 ml/kg/day and advanced as needed based on serum sodium levels. Enteral nutrition is calculated based on formula nutrient composition and average breast milk composition. Protein intake was calculated to provide 3-4 g/kg/day in the first week of life based on the current weight. Subsequently, daily administration of a protein of 3-4g/kg/day, calories of 120-130 kcal/kg/day, and fluids of 135-155 ml/kg/day was targeted based on CW, unless an infant's condition warranted a change. Human milk fortifier was used to fortify the breast milk to 24 cal /oz. Average targeted daily weight gain was 15-20 grams/kg/d. No probiotics were administered.

P2 infants were gavage-fed ≤15ml/kg/day for five days. Soon after birth, protein-based early parenteral nutrition was initiated with infants being given 2g/kg/day within 24 hours of birth. Protein intake was calculated to provide 3-4g/kg/day after 24 hours of age. Subsequently, daily administration of a protein of 3-4g/kg/day, calories of 120- 130 kcal/kg/day, and fluids of 135-155 ml/kg/day was targeted based on BW, unless infant's condition warranted a change. Human milk fortifier was used to fortify the breast milk to 24 cal/oz. Average targeted daily weight gain was 15-20 grams/kg/d. Infants received a daily dose of probiotics (UDO's choice infant's probiotic, Flora Inc., Lynden, Washington, USA). P1 and P2 periods were compared and analyzed for differences in demographics, nutritional intake, comorbid conditions, and growth outcomes.

Statistical Analysis

Statistical analysis was completed using SPSS v.18. Descriptive statistics were summarized using frequencies and means. Wilcoxon Signed-rank test and Chi-square analyses were used to determine associations between variables.

Results

Table 1: Patient characteristics

	P1 (N=100) Count	%	P2 (N=50) Count	%	P value
Female	45	45	26	52	0.36
Gest Age-mean, std dev	24.86	1.34	25.45	1.85	0.01
Birth Wt-mean, std dev	771.89	128.92	746.84	164.76	0.34
Birth Weight <10%	15	15	40	40	<.001
Birth HC <10%	18	18	28	28	0.18
Discharge Weight <10%	76	76	43	43	<.001
Discharge HC <10%	34	34	14	28	0.42

We studied 150 infants with 100 and 50 infants in P1 and P2 periods, respectively. Mean gestational age was lower during Phase 1 (24.86 ±1.34 vs. 25.45 ±1.85 weeks). P value =0.01).

Table 2: Daily nutritional intake before regaining birth weight

	P1		P2		P Value
	Mean	SD	Mean	SD	
Protein Received	2.48	0.46	3.47	0.34	0
Calories Received	64.86	12.8	67.03	13.37	0.07
Fluids Received	134.48	14.66	120.8	13.34	0

However, the birth weights were not different between the two periods. The incidence of SGA at birth was higher during Phase 2.

Table 3: Nutritional intake after regaining birth weight to the time of discharge

Parameter	Period	Mean	Std. Dev	P value
Protein g/kg/day	Phase 1	3.26	0.34	0.138
	Phase 2	3.39	0.38	
Calories kg/day	Phase 1	111.19	6.44	0.032
	Phase 2	114.6	6.04	
Fluids cc/kg/day	Phase 1	144.06	10.36	0.119
	Phase 2	138.52	8.2	

Compared to P1, babies in P2 received 1 g/kg/day more protein till BW was regained. This average daily protein deficit would have resulted in a cumulative protein deficit of 5.1 g/kg if the infant's current weight was used for protein calculations for the duration of 1 week (P2 phase).

Table 4: Morbidity before hospital discharge between the two periods of study

	P1		P2		P Value
	N	%	N	%	
CLD	36	36	48	48	0.15
PDA	63	63	45	45	0.07
IVH	18	18	26	26	0.25
NEC	10	10	5	5	0.314

There were no significant differences in protein and fluid intakes. However, there was a higher caloric intake in P2 compared to P1.

Discussion

Postnatal growth failure, which is associated with impaired neurocognitive and renal development [28-31], was observed in nearly 100% of very low birth weight infants at the end of the 1990s and still occurs in more than half of these infants. [32] The goal of nutrition for premature infants is to duplicate the in-utero growth rate and body composition of a foetus of the same gestational age. [33] However, achieving this weight gain goal is difficult and, consequently, preterm infants are frequently significantly underweight at the time of hospital discharge. [34] Recently, the Vermont Oxford Network, which evaluates the postnatal growth of preterm infants, defined postnatal growth failure (PGF) as a discharge weight that is lower than the 10th percentile for postmenstrual age. Among infants registered in this Network, the prevalence rate of PGF is 50.3%. [35] Kelleher reported that birth weight was significantly lower in low-birth-weight children with failure to thrive than in those without failure to thrive. [36] As well, small for gestational age (SGA) infants had poorer weight gain than appropriate for gestational age (AGA) infants [37] and SGA infants remained at a lower body weight until the age of 3–6 years. [38]

We studied 150 infants with 100 and 50 infants in P1 and P2 periods, respectively. Mean gestational age was lower during Phase 1 (24.86 ±1.34 vs. 25.45 ±1.85 weeks). P value =0.01). However, the birth weights were not different between the two periods. The incidence of SGA at birth was higher during Phase 2. Compared to P1, babies in P2 received 1 g/kg/day more protein till BW was regained. This average daily protein deficit would have resulted in a cumulative protein deficit of 5.1 g/kg if the infant's current weight was used for protein calculations for the duration of 1 week (P2 phase). There were no significant differences in protein and fluid intakes. However, there was a higher caloric intake in P2 compared to P1. When using CW for nutritional calculations, we found that there was an average of a 2 gm/kg deficit of protein in the first week of life with some infants losing up to a 6.9 gm/kg during P1. It is possible that this protein deficit may not have been adequately compensated for, which led to significantly poorer weight and head circumference growth during P1 compared to P2. This may have an impact on future neurodevelopmental outcomes in these infants. Our findings may be corroborated by a recent study that showed that, for each gram/kg increase in protein delivery in the first week, there was an increase of 8.2 points in MDI (mental development index). [39] Another study has shown that higher protein and calorie intake reduced postnatal head growth failure in preterm infants of <29 weeks' gestation. [40] Thus, using BW for protein calculations (till BW is regained) may be a simple, but effective, strategy to avoid significant protein deficits and consequent postnatal growth restriction. It is also important to consider when the additional protein is provided, as that may also be critical to avoid a fall in growth percentile. A study involving 560 children showed that growth during early infancy (0-4 months) predicted IQ at nine years of age. [41]

Another aspect of neonatal physiology that impacts this issue is that a fetus in utero receives increasing amounts of protein every day, which accounts for its continuously increasing growth with advancing gestation. In contrast, soon after birth, this increasing protein transfer is not accounted for in the infant's nutrition, and the infant loses weight and may become catabolic. It may take up to a week or longer to regain BW and reverse the catabolic changes. During this period, even in the best circumstances, the infant would receive significantly less protein and other nutrients than it would have in utero. Therefore, there is a need for an additional allowance of nutritional requirements for catch-up growth. [42]

Conclusion

The decision to utilize birth weight as the basis for nutrition calculations in extremely low birth weight (ELBW) infants, rather than their current daily weight until they reach their birth weight, led to notable outcomes. Specifically, this approach resulted in a substantial increase in protein delivery, a significant reduction in the occurrence of failure to thrive, and a decrease in head circumference percentiles at the time of discharge in ELBW infants. In order to validate the aforementioned result, it is essential to substantiate the findings of this retrospective investigation conducted at a single facility with historical controls by conducting a larger-scale multicenter study with a cohort of very low birth weight (ELBW) children.

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