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Research Article

ASSOCIATION OF THE IMPACT OF POSTNATAL NUTRITION ON THE GROWTH OF PRETERM INFANTS <34 WEEKS GESTATIONAL AGE FROM BIRTH TO DISCHARGE

JITENDRA SINGH FAUJDAR[1], KALPANA SINGH[2], RAJVEER SINGH YADAV[1]*, JITENDRA KUMAR GUPTA[1], MUNISH KAKKAR[1], USHA ACHARYA[1], SOURABH SINGH[1]

[1]Department of Paediatrics, MG Medical College and Hospital, Jaipur, Rajasthan, India. [2]Medical Officer, State Government Hospital, Jaipur, Rajasthan, India. Email: drrajveer77@yahho.com

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ABSTRACT

Objectives: The objectives of the study were to measure the actual daily amount of each nutrient (protein, glucose, and fat) energy and fluid as per current ESPGHAN guidelines for preterm infants and to analyze the role of nutrients at different gestational age on growth and weight of preterm infants.

Material and Methods: An observational and prospective cohort study was conducted from January 1, 2018, to December 31, 2018. This study included all preterm infants born <34 weeks gestational age admitted in the neonatal intensive care unit during this period at Mahatma Gandhi Medical College and Hospital. A total of 120 preterm neonates were studied.

Results: There were mean weight, length, and head circumference continues to rise till the study end. Mean energy at birth was also continues to rise till the end.

Conclusion: In the study, proper nutritional supplement as per ESPHAGEN guidelines was used for the development of preterm infant. The study showed that there were statistically significant results with anthropometry parameters with preterm baby growth in all domains.

Keywords: ESPGHAN, Energy, Neonates, Nutrients.

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INTRODUCTION

Preterm infant is defined as an infant born less than 37 weeks gestation. Preterm infants are classified according to their degree of prematurity. Extremely preterm infants are born less than 28 weeks, very preterm are born between 28 and < 32 weeks, and moderate to late preterm are born 32 to < 37 weeks. The number of preterm birth has been increasing in almost all countries, with more than 1 in 10 infants now born preterm worldwide [1]. The World Health Organization (WHO) has recently reported that the infant mortality rate in 2017, 4.1 million (75% of all under-five deaths) occurred within the 1st year of life. Globally, the infant mortality rate has decreased from an estimated rate of 65 deaths per 1000 live births in 1990 to 29 deaths per 1000 live births in 2018. In India, out of 27 million babies born every year (2010 data), 3.5 million babies born are premature. There is a large survival gap of preterm infants between low- and high-income countries. In high-income countries, 90% of infants born before 28 weeks survive compared to only 10% surviving in low-income countries [2].

Subcategories based on gestational age are a useful indicator as lower gestational age at birth is associated with increased mortality, disability, intensity of neonatal care, and cost. Late preterm infants do far better than infants of earlier gestational age although they are likely to experience more complications than term infants [3]. The advancement of neonatal medicine has resulted in increased survival rates of preterm infants [4]. Preterm infants are at particular risk of nutrient deficiencies, both during hospitalization and post-discharge. Infants with shortened gestational length miss out most important *in utero* accretion periods and are more likely to be born growth restricted, leading to greater utilization of nutrient stores for accelerated postnatal growth [5]. Preterm infants are also more likely to have medical problems or developmental delay [6]. The result is that many preterm infants will continue to be at risk of nutrient deficiencies after discharge from the neonatal intensive care unit (NICU). Nutritional support is often still required beyond hospital discharge but is not necessarily available.

Because every preterm is different, individualized planning and approaches are necessary to provide optimal nutritional management of the preterm infant. Such approaches include close monitoring of nutrient intake, feeding tolerance, and growth during hospitalization and growth after hospital discharge. Parents should be educated regarding warning signs of poor feeding/inadequate intake before discharge and early and frequent follow-up in an outpatient clinic should be scheduled until the infant demonstrates consistent, appropriate weight gains in the home environment. Any nutritional strategy implemented should recognize that preterm infants are a vulnerable population, at risk for short- and long-term sequel and that poor nutrition during the period of rapid brain growth (34–40 weeks gestation) may contribute to long-term neurodevelopmental problems.

Evidence-based standardized feeding guidelines have been published by different organizations such as ESPGHAN [7], the WHOCC, AIIMS, New Delhi [8], and American Academy of Pediatrics [9]. These guidelines cover parenteral, enteral, or combined nutrition.

The post-discharge nutrition of preterm infants is an understudied area. A lack of evidence in this area has meant that current recommendations for feeding preterm infants are based on the paucity of evidence available. Keeping this in view, we planned a prospective follow-up study to evaluate nutrient supply and growth outcomes of preterm infants born <34 weeks in response to a standard feeding protocol based on the ESPGHAN guidelines. There is also a lack of evidence on the effects of nutrition during early hospitalization on long-term growth outcomes.

Aims and Objectives
The aims of the study were as follows:
- To measure the actual daily amount of each nutrient (protein, glucose, and fat) energy and fluid as per current ESPGHAN guidelines for preterm infants
- To analyze the role of nutrients at different gestational age on growth and weight of preterm infants
- To observe the growth pattern of preterm on enteral nutrition.

METHODS

The observational, prospective cohort study, present study, was conducted in the NICU of MGUMST, Jaipur, Rajasthan, during January 2018–December 2018. All preterm infants born <34 weeks admitted in the NICU MGMC during a 1-year period.

Inclusion criteria
- All preterm births (<34 weeks) were included in the study.

Exclusion criteria
- Any congenital malformations, metabolic disorders, and conditions requiring surgical interventions
- Whose parents did not give informed consent
- Neonates on total parenteral nutrition (PN).

Due approval was taken from the Institutional Ethical Committee of Mahatma Gandhi Medical College, Jaipur, before undertaking the present study. Informed written consent was taken from the parent/ guardian before starting the study.

All preterm neonates were subjected to detailed clinical examination and gestational age was assessed by the last menstrual period and Ballard scoring system. Anthropometric parameters (weight, length, and head circumference [HC]) were recorded with standardized technique (detailed method is explained in the materials and method section) from birth to discharge. Length and HC were measured weekly and weight was measured daily and plotted over preterm FENTON growth charts and gestational age calculated by Ballard scoring system. Data related to the actual daily nutrient requirement were calculated as per ESPGHAN guidelines. This was applied uniformly to all preterms focusing on the achievement of optimum growth in preterm infant.

Weight was recorded with weighing scale (subtract the weight of the towel).

Length of neonatal was measured by "Harpenden's infantometer."

HC was measured using a non-stretchable tape.

Growth charts
We used FENTON growth charts because it is a simple and effective way to monitor the growth. Serial plotting of weight, length, and HC on FENTON growth charts is compared with a reference standard. It helps us in early identification of growth faltering in infants.

Dexolac special care infant formula
Dexolac is powdered milk substitute. It is specially designed for the preterm neonates for overall growth and development.
1. Strictly advised washing of hands thoroughly before preparing of feeds
2. We sterilize the feeding bowl and spoon by boiling in water for 10 min
3. Boiled drinking water for 5 min and leave it till lukewarm
4. We poured 30 ml of lukewarm water in bowl and mix it with 1 scoop of Dexolac special care. In same proportion, amount of lukewarm water and scoops of Dexolac special care added.

Statistical analysis
The data were coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means, and standard deviations. The repeated measures analysis of variance (for quantitative data within three groups) was used for quantitative data comparison of all clinical indicators. Level of significance was set at $p \leq 0.05$.

OBSERVATION AND RESULTS

Mean gestational age in the present study was 31.17±1.22 weeks with minimum and maximum gestational age of 30 and 33 weeks, respectively.

In the study, 58.3% male child (MCH) while 41.7% female child (FCH) in our study. Male and female ratio 1.4:1. Mean birth weight of babies was 1.18 with minimum and maximum BW of 0.96 kg and 1.5 kg, respectively.

Mean length of stay in hospital was 3.57±1.08 with minimum and maximum stay of 1 week and 5 weeks, respectively. About 33.3% newborn was stay in hospital at least 3–4 weeks.

Mean score of full eternal nutrient was 7.79±1.83 with minimum and maximum value of 6 and 15, respectively.

According to weight, mean score was continuously increasing from birth to follow-up at 5 weeks which showed statistically significant results.

According to length, mean score was continuously increasing from birth to follow-up at 5 weeks which showed statistically significant results.

According to HCs, mean score was continuously increasing from birth to follow-up at 5 weeks which showed statistically significant results.

Mean protein requirement according to weight was continuously increasing from birth up to 5 weeks which showed statistically significant.

Mean fat requirement according to weight was continuously increasing from birth up to 5 weeks which showed statistically significant results.

Mean calorie requirement according to weight was continuously increasing from birth up to 5 weeks which showed statistically significant results.

DISCUSSION

The nutritional care for preterm newborns remains a challenge in clinical practice. Despite international feeding guidelines, in which it is recognized that human milk is the best source of nutrition for preterm infants [10], their implementation varies widely even for those born at 33–<37 weeks' gestation [11], who constitute 8–9% of all births, represent the vast majority of preterm infants [12], and remain at higher risk than their term counterparts.

In addition, there is no international consensus regarding how the growth of preterm infants should be monitored or what constitutes the ideal pattern of growth, including the period after they have reached term. This situation is even more unclear for those born very preterm (i.e., <32 weeks' gestation) [13], who are at the highest risk but only represent 10% of all preterm births.

The goal of nutrition management of very low birth weight (VLBW) infants is to achieve postnatal growth velocity that mimics intrauterine growth rates of the developing fetus. However, postnatal growth failure (GF), as defined by discharge weights below the 10^{th} percentile for corrected gestational age, has been reported at rates as high as 97% for VLBW infants [14]. GF is associated with long-term impairments in cognitive development and neurological outcomes [15], and promoting accelerated weight gain in preterm infants after a period of slow growth to "catch up" on standardized growth curves is associated with later risk for visceral adiposity, insulin resistance, and hypertension [16]. Thus, optimizing growth velocity to maintain intrauterine growth patterns and to avoid the need for catch-up growth is an integral component of the nutrition management of preterm infants.

Nutrition factors such as energy and protein deficit prolonged time on PN and delayed enteral feeds are independent predictors of GF, as are medical conditions such as low birth weight, chronic lung disease, corticosteroid exposure, and sepsis [17]. Although nutrition practices vary across NICUs, the nutrition course of all preterm infants involves phases of PN, enteral feeds, and the transitional period in between. PN is administered early to provide the initial nutrient requirement for growth [18].

PN helps to provide adequate amount of nutrients and improvement in growth and neurodevelopmental outcomes. It is started because of limitations to start enteral nutritional support due to immature gastrointestinal tract (GIT) [19]. Human milk is considered to be standard diet for infants, however, it should be fortified to meet requirements [20]. The American association paediatrics (AAP) and WHO recommendations suggest that if mother milk is not available, pasteurized donor breast milk should be provided as first alternative.

Studies have documented that necrotizing enterocolitis and bronchopulmonary dysplasia were significantly reduced in infants receiving human milk compared to infants who receive formula milk [21]. These effects are more prominent in premature neonates. Hence, the present study was planned to analyze the impact of postnatal nutrition on the growth of preterm infants <34 week gestational age from birth to discharge in a tertiary care NICU.

Mean gestational age in the present study was 31.17±1.22 weeks with minimum and maximum gestational age of 30 and 33, respectively, in the present study. Kwok *et al.* [22] in their study titled "multicenter prospective observational study of feeding practices in 30–33 weeks preterm infants" reported similar gestational age. They reported that the median (interquartile range) gestational age was 32+3 (31+1–33+0) weeks among the study subjects. Sanghvi *et al.* also revealed mean age of 31.8 weeks among the study subjects in their study [23].

In the present study, out of 120 born babies, 41.7% were female and 58.3% were male.

Miller *et al.* found 52% of the babies as males and rest as females [24].

In the present study, subject's mean length of stay was 3.58±1.08. BW among the study subjects was 1.19±0.14 in the present study. Sanghvi *et al.* in their study reported that mean duration of stay (days) in hospital among the study subjects was 15±5.26 [23]. Nangia *et al.* in their study found that mean duration of stay (days) in hospital among the study subjects was 14 [25].

In the present study, mean day required to reach adequate fluid, electrolyte, and nutrition was 7.79±1.84 days with minimum and maximum days of 6 and 15, respectively. Sanghvi *et al.*in their study also revealed that mean time to regain birth weight in the study group was 5.52±2.94 days [23]. Nangia *et al.* in their study stated that days to regaining birth weight were 13.2±0.7 [25]. The difference in time to regain birth weight though pleasant is difficult to explain. Whether a greater intake of even 40 kcal/kg in the study group in the initial days is crucial or whether oral intake of fluid causes better fluid retention remains to be proven.

When mean weight was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Mathew *et al.* in their study revealed that mean birth weight±SD was 1226.76±191 [26]. Mean time (±SD) to reach full volume feeds was 8.66±2.6 days. Average time to regain birth weight was 14.2 days (2 weeks), with range from 12 to 17.6 days. A serial reduction in time to regain birth weights was observed with increasing gestational age. Maximum mean time to regain birth weight was in 28-week gestational age (17 days) and minimum time noted in 33-week gestational age. A study from Chandigarh showed a growth velocity ranging from 15 g/kg/day to 19.2 g/kg/day in 29–30 weeks and 33 weeks of gestation, respectively [27]. Growth charts by Saluja *et al.* showed a growth velocity of 15.18±1.7 g/kg/d [28], as compared to 16.24±2.37 g/kg/d in our study, despite using human milk fortifier (HMF) in the former study. Kumar *et al.* also mentioned using HMF/preterm formula in extreme situations such as inadequate weight gain or insufficient breast milk [27].

When mean length was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Sanghvi *et al.*in their study found that mean length at discharge was 41.52±2.78 cm [23]. Visuthranukul *et al.* in their study showed that birth length was 33.7 cm which increases to 45 cm at discharge [29].

Table 1: Weight of infant at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	1.16±0.11	0.96	1.35	0.001 (S)
Week 1	1.08±0.13	0.90	1.28	
Week 2	1.203±0.11	1.00	1.40	
Week 3	1.27±0.28	0.00	1.45	
Week 4	1.42±0.08	1.25	1.51	
Week 5	1.44±0.03	1.41	1.51	

Table 2: Length of infant at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	37.96±1.73	34.80	41.00	0.001 (S)
Week 1	38.809±1.81	35.50	41.80	
Week 2	39.81±1.87	36.00	42.80	
Week 3	40.73±1.88	36.70	43.40	
Week 4	41.58±2.05	37.20	44.20	
Week 5	42.33±2.08	38.00	44.90	

Table 3: Head circumferences of infant at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	27.79±1.08	26.00	30.00	0.001 (S)
Week 1	28.43±1.11	26.50	30.60	
Week 2	29.16±1.06	27.30	31.30	
Week 3	29.86±1.12	28.00	32.00	
Week 4	30.73±1.37	28.50	33.40	
Week 5	31.62±1.51	29.00	34.60	

Table 4: Dose of protein of enteral feeding at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	1.87±0.28	1.60	2.90	0.001 (S)
Week 1	3.59±0.91	1.40	4.42	
Week 2	4.106±0.89	1.80	5.00	
Week 3	4.504±0.97	2.00	5.40	
Week 4	5.27±0.97	3.10	6.50	
Week 5	6.27±0.93	4.50	7.60	

Table 5: Dose of fat of enteral feeding at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	3.72±0.35	3.20	4.32	0.001 (S)
Week 1	7.24±1.61	2.80	8.84	
Week 2	8.17±1.66	3.60	10.00	
Week 3	8.9±1.8	4.00	10.80	
Week 4	9.88±1.98	5.10	12.30	

Table 6: Total calories (energy) requirement at different time intervals

Time	Mean±SD	Minimum	Maximum	p-value
Birth	73.98±7.47	64.00	86.00	0.001 (S)
Week 1	149.27±38.106	56.00	184.00	
Week 2	168.62±36.57	74.00	203.00	
Week 3	183.82±38.81	82.00	217.00	
Week 4	197.308±40.13	90.00	232.00	
Week 5	205.73±41.208	95.00	240.00	

When mean HC was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Sanghvi *et al*. in their study found that mean HC at discharge was 31 cm [23]. Visuthranukul *et al*. in their study showed that HC was 24.9 cm which increases to 32.8 cm at discharge [29].

When mean protein eternal was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Miller *et al*. in their study reported that from the parenteral to transitional phase, there were progressive decreases in both protein and protein/energy ratios as enteral feeds progressed by 10 mL/kg/d, reaching a nadir of 2.1±0.5 g/kg and 2.3±0.2 g/100 kcal, respectively ($p<0.05$) [24]. Adjusted energy intakes remained comparable until PN was discontinued. With the discontinuation of PN, protein and energy intakes progressively increased as enteral feeds were advanced to goal ($p<0.05$). Enteral feeds volume during the PN portion of the transitional phase negatively correlated with total protein intake ($r=-0.69$; $p<0.0001$). Visuthranukul *et al*. [31] in their study revealed that mean protein at visit 1 (g/day) was 52.4 g which increased to 63.9 g at the second visit [29].

When mean fat was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Visuthranukul *et al*. in their study revealed that mean fat at visit 1 (g/day) was 47.8 g which increased to 53.4 g at the second visit [29].

When mean energy was compared statistically at different time intervals among the study subjects, it was found to be statistically significant. Visuthranukul *et al*. in their study revealed that mean energy at visit 1 (kcal/day) was 1251 which increased to 1396 at the second visit [29].

Our study has some limitations. It is a single-center study. We could not control for and ensure similar calorie intake by the two groups as the proportion of expressed breast milk and formula differed, but at discharge, all of the infants were on exclusive breastfeeding. We excluded unstable sick neonates, those who required positive pressure respiratory support and extremely LBW infants since these neonates may not be appropriate candidates for such feeding protocols.

CONCLUSION

Preterm birth is a medical emergency and early nutrition after birth is crucial for physical and neurodevelopment of baby. Preterm births are risk for nutritional compromise because of poor nutritional stores as well as physical (immaturity of GIT) and developmental characteristics (lack of suck, swallow, and breathe reflex).

In the study, proper nutritional supplement as per ESPHAGEN guidelines was used for the development of preterm infant. The study showed that there were statistically significant results with anthropometry parameters with preterm baby growth in all domains. All health professionals should acknowledge that preterm nutrition may be an emergency and need to improve their knowledge on when and how to achieve optimal feeds in them. There is a dare need through both clinical practice and research, to reduce nutritional deficits in these vulnerable neonates.

AUTHORS' CONTRIBUTIONS

I would like to express my heartiest gratitude to the participants, who gave willingness to participate in the study.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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Self.

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