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ORIGINAL ARTICLE

Effect of hospital nutrition program on growth of very low birth weight preterm babies.

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ABSTRACT… Objective: To determine the effect of hospital nutrition program on growth of very low birth weight (VLBW) and extremely low birth weight (ELBW) babies. **Study Design:** Cross-sectional study. **Setting:** Neonatal Intensive Care Unit (NICU) of Recep Tayyep Erdogan Hospital, Muzaffargarh, Pakistan. **Period:** February 2024 to July 2024. **Methods:** Inclusion criteria were preterm newborns weighing below 1500 grams, admitted in NICU and who received total parenteral nutrition (TPN). VLBW was labeled as birth weight between 1000-1499 grams, while ELBW as birth weight <1000 grams. Hospital nutrition program included TPN plus orogastric feed or nasogastric feeding plus micronutrients. Effect of hospital nutrition program was described as effective if the baby at the time of discharge added 17-20 g/kg/day according to ESPHGAN recommendation. **Results:** In a total of 131 newborns, 69 (52.7%) were boys. The mean gestational age, and birth weight were 29.68±1.87 weeks, and 1024.50±144.23 grams, respectively. The mean net daily weight gain at the time of discharge was 12.77±3.63 grams. The effective hospital nutrition program was noted in 23 (17.6%) babies. Effectiveness of hospital nutrition program was significantly associated with higher birth weight (1094.78±114.41 vs. 1009.54±145.93 grams, p=0.010), very low birth weight versus extremely low birth weight (87.0% vs. 13.0%, p<0.001), head circumference ≥30 cm (87.0% vs. 53.7%, p=0.003), and gestational age > 28 weeks (87.0% vs. 57.4%, p=0.008). **Conclusion:** The hospital nutrition program had limited effectiveness, with only 17.6% of VLBW and ELBW infants achieving the recommended weight gain by discharge.

Key words: Extremely Low Birth Weight, Hospital Nutrition Program, Orogastric Feed, Total Parenteral Nutrition, Very Low Birth Weight.

INTRODUCTION

It is estimated that more than 20.5 million babies (15-20% of all births) are born annually with low birth weight (LBW) while more than 90% of these belong to low and middle income countries.[1] LBW babies account for 80% of global neonatal mortality and out of these, 2/3rd are preterm.[2] Surviving preterm and LBW babies are at increased risk for morbidities like stunting, ill-health and adult-onset chronic conditions including cardiovascular diseases.[3] Economical burden inflicted by LBW on healthcare systems around the world is also significant.[4] Nutrition among these infants aims to mimic normal fetal growth to promote development.[5]

"American Academy of Pediatrics Committee on Nutrition" highlighted that very preterm infants often struggle to achieve growth rates comparable to those of normal fetuses at the same postmenstrual age, despite receiving adequate nutrition.[6] These infants frequently experience a weight loss of up to 10% after birth, with half of this loss due to extracellular water and the rest due to inadequate lean mass and fat accretion.[7] The time required to regain birth weight can be extended, and these babies typically need additional growth to catch up. Early nutritional deficits can have enduring effects on development, cognition, behavior, and physical growth. Consequently, proactive and intensive nutritional management is essential to address and prevent postnatal growth challenges.[8] A study from Saudi Arabia analyzing the effect of

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hospital nutrition support on growth velocity found that extremely low birth weight neonates showed the highest growth velocity which was about 10.2 g/kg/d, while the growth velocity for low birth weight and very low birth weight were found to be 8.7 and 8.7 g/kg/d, respectively.[9] A study by Hu et al reported that only 32% very low birth weight infants had appropriate growth at the time of discharge following hospital nutrition program.[10]

Whatever literature is available regarding the effectiveness of hospital nutrition program, the evidence has shown that currently adopted approaches have shown variation in outcomes. Different compositions and approaches exist regarding the use of hospital nutrition. To the best of our knowledge, there is paucity of local literature regarding the use and effectiveness of hospital nutrition program among VLBW and ELBW infants so the present study was planned. The findings of this study were thought to provide useful insights about the effectiveness of hospital nutrition program among VLBW and ELBW from Pakistan. The objective of this research was to determine the effect of hospital nutrition program on growth of VLBW and ELBW babies.

METHODS

This cross-sectional study was conducted at the NICU of Recep Tayyep Erdogan Hospital, Muzaffargarh, Pakistan, from February 2024 to July 2024. Considering the effectiveness of parenteral nutritional therapy as 32%[16] with 95% confidence interval and 8% margin of error, the sample size was calculated to be 131. The sample size was calculated using formula: n = z2 * p * (1 - p) / e2. Non-probability convenient sampling technique was adopted. Inclusion criteria were preterm newborns weighing below 1500 grams, admitted in NICU and who received total parenteral nutrition (TPN). Exclusion criteria were babies with birth asphyxia, severe congenital malformations or those who underwent or planned for any kinds of surgery. Parents or guardians of all study participants were briefed about the objectives of this study, and written consents were obtained for this study. Approval from Institutional Ethical Committee was acquired (Number: IHHN_IRB_2023_09_012, dated: 20th May, 2024).

At the time of enrollment in NICU, gender, age, birth weight, height, head circumference, gestational age, and mode of delivery were noted. Newborn with gestational age<37 weeks (estimated according to dating scan that is performed at around 10 weeks) were labeled as preterm. Very low birth weight was defined as baby born with birth weight between 1000 grams to 1499 grams. Extremely low birth weight was definded as birth weight <1000 grams. Hospital nutrition program included TPN plus orogastric feed or nasogastric feeding plus micronutrients. TPN was started on 1st day of life as 60 ml per kg per day and then on daily basis, it was incremented by 20 ml per kg per day, and reaching up to 180 ml per kg in preterm babies. TPN was composed of aminovel (aminoacid), dextrose water, neurobion, calcium, potassium (added after 2 days), and normal saline. Along with TPN, orogastric feeding and buccal colostrum (placing expressed breast milk in buccal cavity of baby) were also commenced. Orogastic feeding was started at 20 ml per kg at day first and then increasing daily at rate of 30 ml per kg per day once full feed volume of 180 ml per kg per day was achieved.[12] Combined volume of TPN and orogastric feeding were kept in such a balance that it was not more than the required volume by baby according to day of life. Gradually tapering of TPN was done and TPN was stopped once orogastric feed was 70% of target feed. Day of life when first enteral feed was started and the day when full enteral feeding was achieved were noted. Once baby was taking feed volume of 150 ml per kg per day, human milk fortifier to breast milk was added and started adding micronutrients. Micronutrients were provided in the form of Vitamin D drop, Vitamin E, tablet folic acid and B complex drops. Weight of the baby was measured on daily bases with digital weighing machine of LAICA Cod PS3001W1 and recorded any weight changes. At the time of discharge, final weight of the babies was noted. Discharge criteria from NICU was if no comorbidities present along with anyone of these: i) baby reach at corrected gestational age (37 weeks); ii) body weight reaches 1500 grams; iii)

baby receiving normal oral feed. Effect of hospital nutrition program was described as effective if the baby at the time of discharge added 17-20 g/kg/day according to ESPHGAN recommendation.[11] Or, it was described as ineffective if the baby at the time of discharge will gain less than 17-20 g/kg/day.

Data were analyzed using "IBM-SPSS Statistics", version 26.0. Qualitative data like gender, mode of delivery and outcome were shown as frequency and percentages. Quantitative variables like age, birth weight, height, head circumference, gestational age, APGAR score at 5 minutes, TPN starting dose, day of life when 1st enteral feed started and days to reach full enteral feeding, duration of TPN and body weight at the time of discharge were represented as mean and standard deviation or median and interquartile range. For the comparison of qualitative data, chi-square test or fisher's exact test were used while independent sample-test or Mann-Whitney U test were employed for comparing quantitative data. Effect modifiers were controlled and compared through stratification with respect to outcome (effectiveness of TPN). Pearson's correlation was applied for bivariate correlational analysis. P-value below 0.05 was taken as significant.

RESULTS

In a total of 131 newborns, 69 (52.7%) were boys. Mode of delivery was cesarean section in 125 (95.4%) cases. The mean gestational age, and birth weight were 29.68±1.87 weeks, and 1024.50±144.23 grams, respectively. The mean Apgar score was 7.47±0.50. The mean head circumference was 30.14±1.41 cm. Table-I is showing details of baseline characteristics of newborns undergoing hospital nutrition program in this study.

Enteral feed was started on day-1, and day-2 in 72 (55.0%), and 59 (45.0%) babies. The mean duration of TPN was 5.22±0.78 days. The mean duration of hospitalization and hospital nutrition program were 32.66±13.44 days. The total mean body weight gain was calculated to be 407.37±166.41 grams. The mean net daily weight gain was 12.77±3.63 grams. The effective hospital nutrition program was noted in 23 (17.6%) babies.

Characteristics		Number (%)
Gender	Boys	69 (52.7%)
	Girls	62 (47.3%)
Delivery mode	Cesaraen section	125 (95.4%)
	Spontaneous vaginal delivery	6 (4.6%)
Birth weight (grams)	1000 to 1499	70 (53.4%)
	<1000 grams	61 (46.6%)
Apgar score at 5 minutes	7	69 (52.7%)
	8	62 (47.3%)
Head circumference (cm)	<30	53 (40.5%)
	≥30	178 (69.5%)
Gestational age (weeks)	≤28	49 (37.4%)
	>28	82 (62.6%)

Table-I. Baseline characteristics of newborns (n=131)

Table-II is showing stratification of effectiveness with respect to study variables. Effectiveness of hospital nutrition program was significantly associated with higher birth weight (1094.78±114.41 vs. 1009.54±145.93 grams, p=0.010), very low birth weight versus extremely low birth weight (87.0% vs. 13.0%, p<0.001), head circumference ≥30 cm(87.0% vs. 53.7%, p=0.003), and gestational age > 28 weeks (87.0% vs. 57.4%, p=0.008).Table-II is showing details about the comparison of effectiveness of hospital nutrition program with respect to baseline and outcomes variables.

Relatively weak and negative, but statistically significant relationship was found between average daily weight gain with respect to age at the time of discharge (r=-0.200, p=0.022), as shown in Figure-1.

Baseline Characteristics		Effectiveness of Hospital Nutrition Program		P-Value
		Yes (n=23)	No (n=108)	
Gender	Boys	15 (65.2%)	54 (50.0%)	0.184
	Girls	8 (34.8%)	54 (50.0%)	
Delivery mode	Cesarean section	23 (100%)	102 (94.4%)	0.274
	Spontaneous vaginal delivery	-	6 (5.6%)	
Birth weight (grams)		1094.78±114.41	1009.54±145.93	0.010
Birth weight categories	Very low birth weight (1000 to 1499 grams)	20 (87.0%)	50 (46.3%)	<0.001
	Extremely low birth weight (<1000 grams)	3 (13.0%)	58 (53.7%)	
Apgar score at 5 minutes	7	16 (69.6%)	53 (49.1%)	0.074
	8	7 (30.4%)	55 (50.9%)	
Head circumference (cm)	<30	3 (13.0%)	50 (46.3%)	0.003
	≥30	20 (87.0%)	58 (53.7%)	
Gestational age (weeks)	≤28	3 (13.0%)	46 (42.6%)	0.008
	>28	20 (87.0%)	62 (57.4%)	
Day of life when first enteral feed was started	Day-1	12 (52.2%)	60 (55.6%)	0.767
	Day-2	11 (47.8%)	48 (44.4%)	
Body weight at the time of discharge (grams)		1522.61±60.47	1412.55±67.96	<0.001
Total body weight addition (grams)		427.83±94.24	403.01±178.08	0.518
Age at the time of discharge (days)		23.17±5.51	34.68±13.78	<0.001
Net per day body weight addition		18.61±1.49	11.53±2.57	<0.001

Table-II. Comparison of effectiveness of hospital nutrition program with respect to study variables

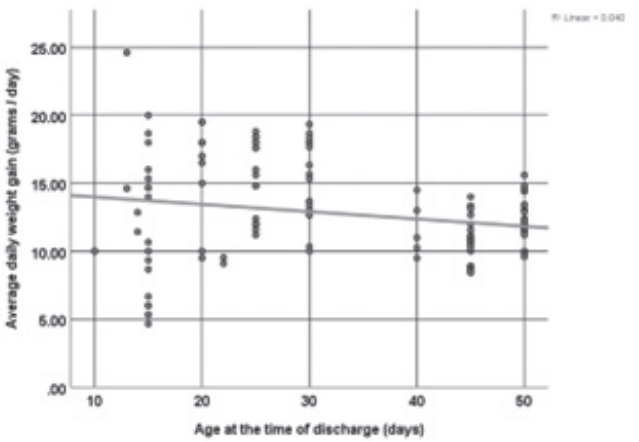

Figure-1. Relationship of average daily weight gain (grams/day) with respect to age at the time of discharge (days)

DISCUSSION

Despite the critical importance of early nutritional interventions in promoting growth among preterm infants, the overall effectiveness of the program in this study was limited, with only 17.6% of infants achieving the recommended weight gain of 17-20 g/kg/day by discharge. This study highlights the challenges of achieving optimal growth outcomes in VLBW and ELBW infants through hospital nutrition programs. The study by Mabhandi et al found that growth outcomes in ELBW infants were generally poor, with only 13% of infants achieving a discharge weight above the 10th percentile when using the Fenton Growth Chart.[13] Elbeely et al reported that 68% of VLBW infants had discharge weights below the 10th percentile.[14] These findings indicate that postnatal growth failure remains a significant concern in this population, despite advances in neonatal care and nutrition. One possible explanation for the limited effectiveness of the hospital nutrition program is the inherent difficulty in meeting the complex nutritional needs of VLBW and ELBW infants. These infants often face multiple medical challenges infection, and gastrointestinal immaturity, which can hinder their ability to tolerate and absorb nutrients. The work of Perrem et al supports this notion, as their study found that early discontinuation of parenteral nutrition (PN) led to delays in regaining birth weight, particularly in infants weighing less than

1000 grams.[15]

Similarly, the current study's findings suggested that while early initiation of TPN and enteral feeding is very important, achieving the right balance and timing of nutritional interventions remains challenging, especially for the most fragile infants. The limited overall effectiveness of the hospital nutrition program in this study raises questions about the adequacy of current nutritional protocols. While this study employed standard practices, including the gradual transition from TPN to full enteral feeding and the introduction of micronutrients, the results suggest that these strategies may not be sufficient to meet the growth needs of all VLBW and ELBW infants. This is further supported by the work of Senterre and Rigo, who demonstrated that optimizing nutrition from the first day of life can significantly reduce postnatal growth restriction.[16]

The current study's limited effectiveness indicated that further adjustments to nutritional protocols, such as higher protein and calorie intakes or earlier introduction of fortifiers, may be necessary to achieve better growth outcomes. Johnson et al reported progressive improvements in growth outcomes with enhanced protein intake over time, reinforcing the importance of not only providing early nutrition but also ensuring that it meets the latest evidence-based guidelines.[17] The current study's nutrition protocol, while effective for some infants, may not have provided sufficient protein or energy to support optimal growth in the majority of infants. This discrepancy points to the need for ongoing evaluation and adjustment of nutrition strategies to ensure that they align with the latest research on neonatal nutrition.

Another key finding in this study was the significant association between higher birth weight, gestational age, and head circumference with more favorable growth outcomes. These results are consistent with a previous research conducted by Abdallah et al which identified birth weight and gestational age as critical predictors of post-discharge growth. Infants with higher birth weights and more advanced gestational ages are typically more physiologically mature, with better-developed organ systems that allow for more efficient nutrient utilization and growth.[11] This suggests that while nutritional interventions are crucial, the underlying biological capacity of the infant to grow also plays a significant role in determining outcomes. Infants with lower birth weights and earlier gestational ages may require even more aggressive and specialized nutritional strategies to support adequate growth.[18] Our findings suggest that a one-size-fits-all approach may not be sufficient, particularly for ELBW infants, who require more specialized care. This is echoed in the findings of Ahuja et al who demonstrated that rapid amino acid infusion with early increases in dose can lead to better growth outcomes in resource-limited settings.[19] Individualized nutrition plans that account for the infant's medical condition, growth trajectory, and tolerance to feeds are essential for optimizing growth and preventing postnatal growth failure.

This study found a relatively weak but statistically significant negative correlation between daily weight gain and age at discharge, indicating that infants who were discharged later tended to have lower daily weight gains. This finding is consistent with the work of Steward et al who observed that infants who took longer to regain their birth weight had more significant decreases in growth z-scores by discharge.20 The negative correlation suggests that prolonged hospital stays may be associated with more severe medical conditions that hinder growth, highlighting the importance of closely monitoring and adjusting nutrition in infants who require extended hospitalization.

This study had some limitations. The study relied on growth parameters as the primary outcome measure, which may not fully capture developmental benefits. We were unable to record weight or height Z-scores which could have provided further valuable insights about the effectiveness of hospital nutrition program.

CONCLUSION

The study revealed that the hospital nutrition program had limited effectiveness, with only 17.6% of VLBW and ELBW infants achieving the recommended weight gain by discharge.

The findings suggest that while early nutritional interventions, including parenteral and enteral feeding, have the potential to improve growth outcomes, they were not sufficiently effective for the majority of babies. Further optimization of nutritional protocols and individualized care strategies are necessary to enhance the effectiveness of hospital nutrition programs in promoting better growth outcomes for preterm infants.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	Ather Razzaq	Concept and Designing, Proof reading, Critical revisions, Approved for publication.	
3	Syed Hassan Ahmad	Data synthesis, Data analysis, Proof reading, Approved for publication.	
4	Sidra Saleem	Data synthesis, Data analysis, Proof reading, Approved for publication.	
5	Meh Jabeen	Data synthesis, Data analysis, Proof reading, Approved for publication.