

Comparative Analysis of Early High-Dose vs. Low-Dose Amino Acid Infusion on Growth and Clinical Outcomes in Preterm Very Low Birth Weight Infants

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Abstract

Background: Because of their underdeveloped organ systems and decreased nutritional reserves, preterm very low birth weight (VLBW) babies have a higher risk of morbidity and death. Although the ideal amount and timing of amino acid infusion are still up for debate, it is an essential part of the nutritional support provided to these newborns.

Goal: To assess how early high-dose versus low-dose amino acid infusion affects weight gain, biomarkers, and clinical outcomes in prematurely born very small babies.

Methods: In a tertiary newborn intensive care unit, a randomized controlled experiment was carried out. During the first 24 hours of life, infants were randomly assigned to receive an early high dosage (3.5-4.5 g/kg/day) or low dose (1.5-2.5 g/kg/day) amino acid infusion. This treatment was given for four weeks. Gaining weight during a 4-week period was the main result. Serum amino acid levels, glucose levels, urea levels, length of hospital stay, sepsis incidence, and necrotizing enterocolitis incidence were among the secondary outcomes.

Findings: The study comprised 120 premature VLBW newborns in total. Compared to infants in the low dosage group, those in the high dose group showed a considerably higher rate of weight growth (20.5 grams/day vs. 15.0 grams/day, $p < 0.001$). There was no significant difference in the levels of glucose (70 mg/dL vs. 68 mg/dL, $p = 0.12$), but there was a significant increase in the levels of urea (26 mg/dL vs. 21 mg/dL, $p < 0.001$) and serum amino acid (155 $\mu\text{mol/L}$ vs. 120 $\mu\text{mol/L}$, $p < 0.001$). The high dose group saw a decreased incidence of sepsis (10% vs. 20%, $p < 0.001$) and a shorter hospital stay (28 days vs. 32 days, $p < 0.001$). In neither group were any incidences of necrotizing enterocolitis recorded.

Conclusion: Compared to low dosage infusion, early high dose amino acid infusion in preterm VLBW infants results in greater weight gain, improved biochemical indicators, and decreased clinical consequences. In this susceptible population, high dosage amino acid infusion might be more successful in encouraging optimal growth and enhancing clinical results. To validate these results and investigate the long-term consequences of an early high-dose amino acid infusion, more investigation is required.

Keywords: weight increase, amino acid infusion, preterm births, extremely low birth weight, and nutritional support.

Introduction

Preterm very low birth weight (VLBW) newborns are a vulnerable population in neonatal care, defined as birth weight less than 1500 grams and birth date before 37 weeks of gestation [1]. Because of their underdeveloped organ systems and low nutritional resources, these babies frequently experience a variety of difficulties that might raise their rates of morbidity and death [2]. In order to enhance neurodevelopmental outcomes and lower long-term health concerns, achieving optimal growth and development is a crucial goal in the management of premature VLBW infants [3].

For premature VLBW newborns, nutritional supplementation is essential for supporting their metabolic needs and fostering growth [4]. An important part of this nutritional support is the infusion of amino acids, which

provide the building blocks needed for metabolic activities, tissue repair, and cellular development [5]. Because of their rapid growth and undeveloped metabolic pathways, preterm newborns require more protein and amino acids per unit body weight than term infants [6]. In order to achieve optimal growth and lower the risk of nutritional deficiencies in this susceptible group, it is imperative to optimize amino acid intake [7].

There is ongoing debate on the best time and dosage for premature VLBW infants to receive amino acid infusions. It has been recommended that premature VLBW infants get early and intensive nutritional support, including high dose amino acid infusion, to address their elevated metabolic demands and support good growth [8]. High dosage amino acid infusion has been shown in multiple studies to improve weight gain and clinical outcomes in premature VLBW newborns [9]. On the other hand, metabolic problems such hyperammonemia, hypoglycemia, and metabolic acidosis could result with high dosage amino acid infusion [10].

However, low dose amino acid infusion might not be able to keep up with the higher metabolic needs of preterm VLBW babies, which could result in stunted growth and development [11]. There is disagreement about the ideal amino acid infusion dosage and timing despite a large body of research examining the impact of infusion on growth and clinical outcomes in premature VLBW infants [12]. The lack of agreement has resulted in inconsistent clinical practice and emphasizes the need for additional study to identify the best amino acid infusion plan for premature VLBW newborns.

Current methods for managing preterm VLBW infants have a chance to be reviewed and improved in light of recent developments in newborn care and nutritional support [13]. Optimizing amino acid intake and improving growth outcomes in this susceptible population may be possible with the implementation of standardized methods and guidelines for nutritional support [14]. However, creating such regimens necessitates a thorough comprehension of how various amino acid infusion techniques affect the development, biochemical markers, and clinical outcomes of preterm VLBW infants [15].

By contrasting the effects of early high dose versus low dose amino acid infusion on weight gain, biochemical markers, and clinical outcomes in preterm VLBW infants, this study seeks to close this gap in the literature. It is essential to comprehend the effects of various amino acid infusion techniques in order to maximize nutritional support and enhance long-term results in this susceptible group.

Materials and Methods

Participants and Study Design

In order to compare the effects of early high dose versus low dose amino acid infusion on weight gain, biochemical markers, and clinical outcomes in preterm VLBW newborns, a tertiary neonatal intensive care unit (NICU) performed a randomized controlled trial. The Institutional Review Board approved and the study was carried out in compliance with the Declaration of Helsinki.

Preterm infants born between 28 and 32 weeks gestation and weighing less than 1500 grams met the study's inclusion criteria. Major congenital malformations, metabolic problems, and newborns with inadequate data were among the exclusion criteria.

Intervention

Using a computer-generated randomization sequence, infants were randomized at random to two groups. Group B received a low dosage of amino acid infusion, while Group A received an early high dose. Intravenous amino acid solutions were started within the first 24 hours of life and continued for 4 weeks.

Protocol for Amino Acid Infusion

- Group A (High Dose): During the first week of life, the infants in Group A received an amino acid infusion rate of 3.5 g/kg/day, which was subsequently increased to 4.5 g/kg/day.
- Group B (Low Dose): During the first week of life, the infants in Group B got an increase in their amino acid infusion rate from 1.5 g/kg/day to 2.5 g/kg/day.

Outcomes: Gaining weight over the course of four weeks was the study's main outcome measure.

Measures of secondary outcomes included:

1. biochemical indicators

- Levels of serum amino acids
- Blood sugar levels
- Levels of urea

2. Clinical results:

- Length of hospitalization
- The prevalence of sepsis
- Necrotizing enterocolitis frequency

Data Gathering

For every research participant, baseline data such as sex, birth weight, and gestational age were noted. After the first week of life, weight measurements were taken every week until the patient was released from the NICU. Serum amino acid levels, glucose levels, and urea levels were measured using blood samples taken at baseline and once a week after that. Recorded clinical outcomes included the length of hospital stay, the occurrence of sepsis, and the incidence of necrotizing enterocolitis.

Analytical Statistics

SPSS version 25 was used to analyze the data. The baseline characteristics were compiled using descriptive statistics. The two groups' categorical and continuous variables were compared using the chi-square test and the t-test, respectively. Less than 0.05 was the threshold for statistical significance.

Based on identifying a 5-gram difference in weight gain between the two groups at a significance level of 0.05 and a power of 80%, the sample size was determined. A total of 120 infants—60 per group—were recruited for the study, assuming a 10% dropout rate.

Results

Table 1: Study Participants' Baseline Characteristics

Participants' initial characteristics were similar in Group A (High Dose) and Group B (Low Dose) of the trial. Group A had a slightly larger number of male infants (52%) than Group B (48%). The mean birth weight was 1205 grams in Group A and 1198 grams in Group B. The mean gestational age was 30.2 weeks in Group A and 30.1 weeks in Group B. Additionally, Group A (85%) used prenatal steroids slightly more frequently than Group B (80%). There were no discernible differences in the two groups' baseline characteristics, as indicated by the non-significant p-values.

Table 2: Weight Gain as the Main Outcome

Over the course of four weeks, weight gain was the study's main result. Compared to Group B (Low Dose) where infants gained an average of 15.0 grams per day, infants in Group A (High Dose) gained an average of 20.5 grams per day, a significant difference ($p < 0.001$).

Table 3: Biochemical Markers as Secondary Outcomes

Serum amino acid levels in Group A (High Dose) were much greater than in Group B (Low Dose) (155 $\mu\text{mol/L}$ vs. 120 $\mu\text{mol/L}$, $p < 0.001$). The glucose levels in the two groups, however, did not differ significantly (70 mg/dL in Group A vs. 68 mg/dL in Group B, $p = 0.12$). Additionally, Group A's urea levels were greater than Group B's (26 mg/dL vs. 21 mg/dL, $p < 0.001$).

Table 4: Hospital Stay Duration - Clinical Outcomes

The mean length of hospital stay for infants in Group A (High Dose) was shorter than that of Group B (Low Dose) (28 days vs. 32 days, $p < 0.001$).

Table 5: Clinical Results - Sepsis Incidence

Sepsis was far less common in Group A (High Dose) than in Group B (Low Dose) (10% vs. 20%, $p < 0.001$).

Table 6: Clinical Results - Necrotizing Enterocolitis Incidence

Neither Group A nor Group B reported any occurrences of necrotizing enterocolitis, and the difference was not statistically significant ($p=0.50$).

Discussion

Research and discussion on the best nutritional care for preterm infants with very low birth weights (VLBW) are still ongoing. The objective of our research was to evaluate the impact of early high-dose versus low-dose amino acid infusion on clinical outcomes, biochemical markers, and weight gain in premature twins born before their full gestation. Our study's conclusions have a number of significant ramifications for this vulnerable population's nutritional management.

Weight gain.

The greater weight growth seen in infants receiving early high dose amino acid infusion as opposed to those getting low dose infusion was one of our study's most important findings. Compared to the low dosage group, which saw infants acquire 15.0 grams per day, the high dose group's infants gained 20.5 grams on average per day ($p<0.001$). This result is in line with earlier research showing a beneficial relationship between higher weight growth in preterm VLBW newborns and high dosage amino acid infusion [1,2].

The larger consumption of amino acids in the high dose group is probably what contributed to their improved weight gain, as these infants' heightened metabolic needs may have been better satisfied. Inadequate consumption of amino acids can result in stunted growth and poor developmental outcomes since they are necessary for metabolic activities, tissue repair, and cellular growth [3]. According to our research, early high-dose amino acid infusion may be a more successful strategy for encouraging preterm VLBW infants' optimal growth.

Secondary Results: Enzymatic Markers

The effect of amino acid infusion on biochemical indicators, such as serum amino acid levels, glucose levels, and urea levels, was also assessed in this study. Compared to infants in the low dosage group, individuals in the high dose group had significantly higher blood amino acid levels (155 $\mu\text{mol/L}$ vs. 120 $\mu\text{mol/L}$, $p<0.001$). The results of this study indicate that high dosage amino acid infusion can efficiently address the elevated metabolic needs of premature VLBW newborns, resulting in enhanced biomarkers.

It's interesting to note that the two groups' blood glucose levels did not differ significantly (70 mg/dL in the high dose group vs. 68 mg/dL in the low dose group, $p=0.12$). According to this research, premature VLBW infants that get high dosage amino acid infusion do not have a higher risk of hyperglycemia, which is a typical worry when providing intensive nutritional support [4]. In addition, the high dose group had higher urea levels than the low dose group (26 mg/dL vs. 21 mg/dL, $p<0.001$), suggesting that the high dose group was more adept at protein metabolism and amino acid consumption.

Clinical Results

We evaluated the effect of amino acid infusion on clinical outcomes such as length of hospital stay, sepsis rate, and necrotizing enterocolitis rate. Compared to infants in the low dosage group, those in the high dose group spent an average of 28 days less time in the hospital ($p<0.001$). According to this research, high dosage amino acid infusion would enable NICU discharge earlier, which would lower medical expenses and better utilize available resources.

Additionally, the high dosage group saw a considerably reduced incidence of sepsis (10% vs. 20%, $p<0.001$) than the low dose group. This result is in line with other research that found a beneficial relationship between high dosage amino acid infusion and a lower risk of sepsis in premature VLBW babies [5, 6]. Because high dose amino acid infusion improves nutritional status and boosts immunological response, there may be a lower incidence of sepsis in the high dose group [7].

In both groups, there were no reports of necrotizing enterocolitis cases, and the difference was not statistically significant ($p=0.50$). Necrotizing enterocolitis is a dangerous and potentially fatal illness that is linked to considerable morbidity and mortality in preterm newborns [8], thus this discovery is comforting. The lack of variation between the two groups implies that, in this study population, neither high dosage nor low dose amino acid infusion is linked to an elevated risk of necrotizing enterocolitis.

Comparing This Work to the Current Literature

Our results are in line with earlier research that found a positive relationship between high dosage amino acid infusion and better biochemical indicators, higher weight growth, and worse clinical outcomes in premature VLBW infants [1,5,6]. Nonetheless, by explicitly contrasting the outcomes of early high dose versus low dose amino acid infusion, our study contributes to the body of literature and offers important new information about the best amino acid infusion approach for preterm VLBW children.

Limitations

Although our study offers several advantages, there are a few drawbacks that need to be taken into account when analyzing the data. Firstly, the findings might not be as broadly applicable given the limited sample size. Second, the results' external validity might be hampered by the study's single-center design. Third, there was no blinding of the trial, which could have influenced the findings.

Conclusion

Our research concludes that, in preterm VLBW infants, early high dose amino acid infusion results in improved biochemical indicators, better weight gain, and worse clinical outcomes than low dosage infusion. According to these results, early high-dose amino acid infusion might be a more successful strategy for encouraging ideal growth and enhancing therapeutic effects in this susceptible group. To validate these results and investigate the long-term impacts of an early high-dose amino acid infusion on the development and growth outcomes of preterm VLBW infants, more research is required.

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Tables

Table 1: Baseline Characteristics of Study Participants

Characteristic	Group A (High Dose)	Group B (Low Dose)	p-value
Gestational age (weeks)	30.2 ± 1.5	30.1 ± 1.4	0.72
Birth weight (grams)	1205 ± 130	1198 ± 125	0.85
Male sex (%)	52%	48%	0.63
Antenatal steroid use (%)	85%	80%	0.45

Table 2: Primary Outcome - Weight Gain

Group	Mean Weight Gain (grams/day)	Standard Deviation	p-value
A (High Dose)	20.5	2.3	<0.001
B (Low Dose)	15.0	2.1	

Table 3: Secondary Outcomes - Biochemical Markers

Marker	Group A (High Dose)	Group B (Low Dose)	p-value
Serum amino acid levels (μmol/L)	155 ± 10	120 ± 15	<0.001
Glucose levels (mg/dL)	70 ± 5	68 ± 6	0.12
Urea levels (mg/dL)	26 ± 3	21 ± 4	<0.001

Table 4: Clinical Outcomes - Duration of Hospital Stay

Group	Mean Duration of Stay (days)	Standard Deviation	p-value
A (High Dose)	28	4	<0.001
B (Low Dose)	32	5	

Table 5: Clinical Outcomes - Incidence of Sepsis

Group	Number of Cases	Percentage (%)	p-value
A (High Dose)	6	10%	<0.001
B (Low Dose)	12	20%	

Table 6: Clinical Outcomes - Incidence of Necrotizing Enterocolitis

Group	Number of Cases	Percentage (%)	p-value
A (High Dose)	0	0%	0.50
B (Low Dose)	0	0%	