

# THE ROLE OF INTRAVENOUS NUTRITION IN LOW BIRTH-WEIGHT INFANTS

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## SUMMARY

*Seven infants with birth weights less than 1500g received total parenteral nutrition for seven to 16 days through the peripheral route, commencing within the first 24 hours of life. Excessive weight loss was prevented and the infants showed significant weight gain. The time required to regain the initial birth weight showed an improvement over that expected in conventionally managed infants. Metabolic and septic complications were minimal and easily manageable. The results demonstrate that the technique, when properly used, warrants consideration in feeding low birth weight infants incapable of tolerating enteral feeding.*

## INTRODUCTION

In most low birth weight (LBW) infants, adequate nutrition by the oral route simply cannot be met, either because of poor or unsustained sucking reflex,<sup>1</sup> uncoordinated swallowing mechanism,<sup>2</sup> delayed gastric emptying time,<sup>3</sup> relative immobility of the gastrointestinal tract,<sup>4</sup> or because systemic diseases which complicate their early life preclude oral feeding. On the other hand, it has been

increasingly recognised that LBW infants have virtually no reserves of nutrient materials;<sup>5</sup> and it has been estimated that such infants can survive for only three to five days on water alone.<sup>6</sup> It will need new carbohydrates for growth, free amino acids if new proteins, enzymes, hormones and antibodies are to be synthesised, and essential fatty acids to myelinate the nerve cells. Since there are virtually no reserves, tissue catabolism occurs, and the infant actually dies of inanition in some cases.

With improvement in the management of the complications which LBW infants develop, greater attention is being focussed on the provision of adequate nutrients to these infants. The advent of total parenteral nutrition *via* a central vein has given a new scope to feeding LBW infants. However the multitude of hazards associated with it has somewhat dampened its application to LBW infants.<sup>7</sup> In recognition of this, we have embarked on a modified regime of feeding these infants. This small study reflects the experience in a small hospital set-up.

## MATERIALS AND METHODS

LBW infants were selected from all infants admitted to the Special Care Nursery according to the following criteria: birth weight less than 1500g; inability to tolerate oral feeding within 24 hours after birth; presence of clinical conditions which precluded oral feeding; informed parental consent.

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Using the Dubowitz score<sup>8</sup> for gestational assessment, five infants were appropriate for gestational age (range between 27 weeks to 32 weeks) and two were small for gestational age (range between 31 to 35 weeks). Their birth weights ranged from 1000 g to 1475 g (mean 1253 g). Four infants had hyaline membrane disease, two recurrent apnoea, and one had aspiration pneumonia after attempts at oral feeding. Parenteral feeding was started within 24 hours of life in all instances, the earliest being at six hours after birth in the smallest infant.

An umbilical arterial catheter was initially introduced under strict aseptic conditions and dressed with an occlusive dressing. This route was initially used for infusion as this would do away with the problem of frequent resiting of intravenous drip sites, particularly during the crucial first 48 hours. After a period ranging from two to five days (mean 3.5 days), the catheter was removed and the infusion continued *via* a peripheral vein.

The nutrient solution used contained glucose, initially a 5% solution, and gradually increasing to 7.5% glucose and thence to a 10% solution over three to four days; and a crystalline amino acid solution (Vamin, Kabi-Vitrium), commencing with 0.1 g of nitrogen and increasing incrementally to 0.4 g/kg over four to five days. Sodium, potassium, chloride, calcium, magnesium, phosphorous and multivitamins were added to the daily infusate according to the recommendations of the American Pediatric Association (Table I).<sup>9</sup> The nutrient solutions were initially infused at a rate of 60 ml/kg/day and increased gradually to 150 ml/kg/day over five to six days. Once any respiratory problems have improved and if any hyperbilirubinemia present have decreased to a safe level, an intravenous fat emulsion (Intralipid 20%, Kabi-Vitrium) was added to the regime, through a Y connector, commencing with 1.0 g/kg/day and increasing gradually to 2.0 g/kg/day. The commencement of the fat emulsion varied from five to seven days after birth.

This regime delivered 0.4 g/kg/day of nitrogen, up to 80 kcal/kg/day of non protein calories as glucose and fat, the ratio of grams of nitrogen to non nitrogen calories being 200:1.

TABLE I  
COMPOSITION OF NUTRIENT SOLUTION

Constituent	Amount (per kg)
Amino acid solution (Vamin)	40 ml
Glucose 10%	100 – 130 ml
Sodium	3.0 mmol
Potassium	3.0 mmol
Calcium	2.0 mmol
Magnesium	0.15 mmol
Phosphorous	1.2 mmol
Multivitamin Infusion (MVI)	1.0 ml
Vitamin K	0.5 mg
Folic acid	0.5 mg

The nutrient solutions were prepared daily under strict aseptic conditions in a clean environment (the operation theatre was used here), and all resiting of intravenous drip sites, daily changing of infusion sets and change of dressing were done solely by one person (ZA) under strict aseptic conditions, using no touch technique.

Laboratory cooperation was obtained so that the many biochemical estimations required could be done on small samples of blood. Sodium, potassium, sugar and blood urea nitrogen were done on alternate days initially and then twice weekly when stable; calcium, magnesium, and phosphorous twice weekly; and full blood count weekly. Urine specimens were tested for glycosuria twice daily. All venepunctures were done in the morning so that the results could be ready by noon, thus facilitating any adjustment of the nutrient solutions before they were prepared, usually in the afternoon.

Once the clinical condition permitted, oral feeding through a nasogastric tube was introduced, using either expressed breast milk or infant formula, commencing with 1–2 ml/kg/hour and increasing the volume gradually as tolerance developed, along with concurrent proportionate reduction of the intravenous nutrient solution. The time of commencement of oral feeding varied from six to ten days after commencement of parenteral feeding.

## RESULTS

Table II shows the clinical detail of the infants and the anthropometric data of the infants over the

**TABLE II**  
**CLINICAL AND ANTHROPOMETRIC DETAILS OF**  
**LBW INFANTS ON PARENTERAL NUTRITION**

	Range	Mean
Birth weight (gram)	1000 – 1475	1253
Gestational age (wk)	27 – 34	31.4
Days of IV feeding	7 – 16	10.3
Time to regain birth weight (days)	8 – 15	10.7
Weight gain (g/kg/day)	9.0 – 10.0	9.5*
Length gain (cm/wk)	0.81 – 0.98	0.87*
Head circumference gain (cm/wk)	0.68 – 0.78	0.71*

\* Corresponding figures for intrauterine growth rates are 14.8 g/kg/day, 1.23 cm/wk, 0.98 cm/wk.<sup>15</sup>

course of the intravenous nutrition. The pattern of weight changes were similar to that expected in conventionally managed infants,<sup>10</sup> with initial weight loss followed by a persistent weight gain. The time required to regain the birth weight varied from eight to fourteen days, representing a significant improvement over that expected in conventionally managed infants of similar weight.<sup>10</sup> The average weight gain was 9.5 g/kg/day.

With few exceptions, the plasma sodium and potassium showed little variation from expected values. Blood glucose and blood urea nitrogen were also within normal limits in all instances. No episode of hypoglycemia was documented. Two infants developed hypocalcemia associated with mild elevations of inorganic phosphate, with one of them exhibiting clinical symptoms as well. These were easily rectified by appropriate adjustments of the nutrient solutions. Four infants developed anemia and required the transfusion of packed cells.

Gross tests of lipemia, done by visual inspection of a centrifuged specimen of blood revealed the occurrence of lipemia in the smallest infant, when the amount of fat infused was at 2.5g/kg/day. It however cleared up after the fat infused was reduced to 2 g/kg/day.

Four infants developed superficial thrombophlebitis but none developed skin necrosis.

Sepsis as evidenced by pyrexia and polymorpho-leucocytosis was seen in one infant, and this was in

the smallest infant (birth weight 1000 g) in which the umbilical catheter was kept *in situ* for six days. This infant also developed oral candidiasis during treatment of the sepsis.

## DISCUSSION

Although there has been a dramatic improvement in the overall survival of LBW infants, completely intact neurological status of these infants have not improved as dramatically. More meticulous nutritional management during the critical early period may improve the long term morbidity, since recent evidence have indicated that malnutrition during critical periods of brain growth results in irreversible deficits in brain mass and perhaps function.<sup>11,12,13</sup> The search for better means of guaranteeing early optimal nutrition is therefore justified. Previously such infants were solely maintained on 10% glucose solution and electrolytes, providing no nitrogen and only half the caloric intake generally thought to be necessary for optimal growth.<sup>14</sup> This resulted in severe weight loss due to catabolism of structural proteins and destruction of structural lipids and carbohydrates. The infants are then ill adapted to meet the metabolic stresses that accompany systemic illnesses and sepsis.

Our results show that total parenteral nutrition given peripherally to LBW infants is feasible and can be associated with minimal complications. These infants too are able to regain their body weight faster than expected, implying that tissue catabolism has been prevented and significant tissue anabolism has occurred. Furthermore their subsequent growth as measured by gain in body weight is equivalent to conventionally managed infants.<sup>10</sup> Their growth however falls short of the intrauterine growth rate,<sup>15</sup> which is hardly surprising since the calories provided by the regime used is much less than that required for such a growth (120 kcal/kg/day).<sup>16</sup> However data to support the concept that maintenance of intrauterine growth rate is either necessary, efficacious, or safe is lacking.<sup>17</sup>

The incidence of metabolic complications we encountered were few and easily correctable.

This is no doubt attributable to gradual increment of the glucose and amino acid concentration used in the nutrient solution. In addition, keeping the glucose concentration to no more than 10% solution prevents the occurrence of glucose intolerance which LBW infants are prone to develop.<sup>18</sup> The close biochemical monitoring which we did however led to anemia in several of the infants; although this could also be due to the absence of iron in the nutrient solutions.

In recognition of reports that LBW infants receiving fat free parenteral nutrition develop essential fatty acid deficiency rapidly,<sup>19</sup> we provided 20% fat emulsion in all our infants, not only to prevent its occurrence but also to provide a high caloric density energy source. The occurrence of lipemia in the smallest infant suggested that very low birth weight infants have a decreased rate of clearance of fat emulsion from their blood, probably due to decreased levels of activity of lipoprotein lipase. Reduction of the amount of fat infused was associated with disappearance of the lipemia, indicating that very low birth weight infants should receive no more than 2 g/kg of intravenous fat emulsion per day.

The use of peripheral vein for a prolonged period is difficult, but not impossible. In newborn infants, we have the advantage of having the whole scalp and a lot of other sites for peripheral infusion. With good planning we were able to identify the potentially useful veins and use them in turn, commencing distally and progressing proximally. With meticulous attention to aseptic techniques and good nursing care, we were able to keep the incidence of sepsis to a low level.

It would appear then at least for the short term, a nutritional regime such as this, does prevent tissue catabolism and allows some increment in body weight and lean body mass. More could have been achieved if more calories were provided through a large central vein, but the hazards would have been much more. An additional consideration is LBW infants with hyaline membrane disease, recurrent apnoea, or pneumonia can usually be fed by the end of the first week of life, thus making central venous insertion unnecessary. Therefore this gives merit to a

nutritional regime that maintains existing body composition without imposing unnecessary or unwanted risks.

We are not however advocating total parenteral nutrition in all LBW infants. A more practical approach would be, within reason, to give a trial of conventional feeding first (i.e. tube feeding) of standard premature infant formula or expressed breast milk. Nasogastric feeding overcomes the problem of poor sucking or uncoordinated swallowing mechanism, but not the delayed gastric emptying or poor intestinal motility. However by increasing the infusion rate very gradually, we have managed to keep the problem to manageable levels. The enteral feedings could of course be supplemented with intravenous glucose plus amino acids with or without intravenous fat emulsion. In the event that enteral feedings are not tolerated or hazardous, administration of a balanced nutritional mixture by peripheral vein deserves serious consideration.

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