

Total Parenteral Nutrition in Pregnancy: Case Review and Guidelines for Calculating Requirements

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Abstract Although many aspects of the use of total parenteral nutrition (TPN) in pregnancy are controversial, the long-term sequelae of maternal malnutrition in fetal health are not.

To avoid these complications, TPN is advocated for use in pregnancies complicated by maternal starvation. The purpose of this paper is to outline an easy to follow method for prescribing TPN solution to meet the needs of the gravid patients. *J. Matern.-Fetal Med.* 6:215-217, 1997. © 1997 Wiley-Liss, Inc.

Key words: total parenteral nutrition; pregnancy; formulation

INTRODUCTION

Although many aspects of the use of total parenteral nutrition (TPN) in pregnancy are controversial, the long-term effects of maternal malnutrition on fetal well-being are unequivocal [1]. In addition to the adverse effects of maternal ketosis on the fetus, it is well established that decreased maternal protein intake leads to insufficient placental perfusion and fetal compromise [2]. To avoid these complications, TPN is advocated for use in pregnancies complicated by maternal malnutrition [3,4]. The purpose of this report is to present a clearly documented guide for calculating TPN requirements specifically tailored to meet the nutritional needs of the pregnant patient.

CASE REPORT

D.J. is a 25-year-old, G5P1031 who presented at 12 weeks' gestation with intractable nausea and vomiting, dehydration, and ketosis consistent with the diagnosis of hyperemesis gravidarum. After failing to respond to 7 days of conservative therapy of intravenous fluids, antiemetics, and a trial of nasogastric feeding, the patient was initiated on total parenteral nutrition by way of a peripherally placed central dwelling catheter. Thyroid and liver function tests were normal, as were screens for hepatitis.

The patient tolerated parenteral nutritional support well (~2,300 kcal/day) with adequate maternal weight gain and fetal growth, despite multiple hospitalizations between 12 and 36 weeks for exacerbations of severe nausea and

vomiting. Attempts to wean to cyclical TPN regimens were unsuccessful, requiring the patient to be maintained on a continuous schedule of infusion including treatment at home.

Her course was remarkable for the development of line sepsis with *Klebsiella pneumoniae* at 18 weeks' gestation. This infection occurred after a MacDonald cerclage placement for cervical incompetence and necessitated removal of the catheter. After treatment with IV antibiotics, the patient was able to tolerate oral intake with only intermittent recurrences of nausea and vomiting throughout the remainder of her pregnancy. The patient delivered a viable infant weighing 3,100 g at 39 weeks, without complications, and had a normal postpartum course.

Despite the controversy of the TPN use in pregnancy, it is well known that in cases of severe maternal starvation, decreased protein intake leads to decreased plasma volume expansion causing insufficient placental perfusion and fetal compromise [2]. Further, utilization of fatty acids in prolonged starvation leads to ketosis which also has adverse effects on the fetus [2]. For these reasons, prolonged caloric deprivation in pregnancy should be avoided.

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Received 6 June 1996; revised September 1996; accepted October 1996

In the presence of an intact gastrointestinal tract, enteral hyperalimentation is preferable [5,6]. However, in instances in which this mode of nutrition is not possible, total parenteral nutrition can provide an adequate nonprotein caloric source of glucose, lipids, electrolytes, and trace elements [2].

The hesitation in the use of total parenteral nutrition in pregnancy appears to stem from the paucity of obstetrical patients requiring this intervention, indicating that most cases of severe medical illness necessitating TPN preclude pregnancy. In addition, many facilities are not staffed with nutritionists and dietitians who readily understand the nutritional demands of pregnancy or how these demands can be met through TPN.

To add to these limitations, Heller reported an increased incidence of premature labor and fatty infiltration of the placenta in pregnant animals given parenteral fat emulsions to provide 50% or more of the total daily caloric intake [2]. This statement is based on the presence of arachidonic acid and other precursor fatty acids (i.e., linoleic acid) found in most lipid emulsions used in TPN solutions [7]. The conversion of arachidonic acid to prostaglandins is felt to increase the risk of preterm labor. This phenomena, however, is usually seen with the use of experimental doses of fat emulsion, not with the usual therapeutic regimens. Preterm labor was most notably associated with the use of the compound Lipomul, which is no longer used in the United States [2].

The indications for TPN in pregnancy are well documented [2,6]. Total parenteral nutrition is indicated for any pregnancy in which the mother is unable to tolerate oral intake to the extent of causing maternal malnutrition [8]. Specifically, it is instituted for several obstetrical and nonobstetrical conditions including

1. Hyperemesis gravidarum not responsive to conservative therapy (intravenous fluid, antiemetics, sedatives, tube feedings)
2. Maternal weight loss exceeding 1 kg/wk times 4 consecutive weeks
3. Total weight loss of 6 kg or failure to gain weight
4. Prepregnancy malnutrition (patient below the 10th percentile of her ideal body weight)
5. Presence of a debilitating disease that increases nutritional demands and/or precludes enteral feedings (i.e., diabetic gastroenteropathy, inflammatory bowel disease, unremitting pancreatitis)
6. Persistent ketosis, hypocholesterolemia, hypoalbuminemia (<2.0 g/dl), macrocytic/microcytic anemia, negative nitrogen balance
7. Multiple gestations

Despite these well-established criteria, there has been no documentation of the exact calculations used in prescribing

TPN for the pregnant patient in the literature to date. In general, the average total weight gain during pregnancy of 12 kg is usually accomplished by an increase in maternal caloric intake of 200 to 400 kcal/day. One of the most common methods of calculating daily TPN caloric requirements utilizes the basal energy expenditure (BEE). For pregnancy, this equation is adjusted slightly [9,10].

$$\text{Bee (pregnant female)} = 655 + (9.6 \times \text{wt (kg)})^* \\ + [(1.8 \times \text{height (cm)}) - (4.7 \times \text{age})]$$

This value is then multiplied by the "stress factor" of 1.25 to account for the nutritional demands of pregnancy. Therefore, the total caloric requirement for 24 h for the pregnant patient is equal to

$$(\text{BEE} \times 1.25 \text{ kcal}) + 300 \text{ for singleton pregnancy} \\ \text{or } 500 \text{ for twin pregnancy.}$$

This value for the average pregnant patient is approximately 2,000 kcal. For a standard 2-liter solution, one first calculates the number of kcal supplied by protein. Using a 6% amino acid solution (standard in most institutions), the proportion of "protein" calories is calculated by

$$2,000 \text{ cc} \times .06 \text{ (6\% amino acid soln)} = 120 \text{ g of protein} \\ 120 \text{ g of protein} \times 4 \text{ kcal/gram} = 480 \text{ kcal.}$$

To calculate the nonprotein caloric component, the protein kcals are subtracted from the total caloric requirement.

$$2,000 \text{ kcal} - 480 \text{ kcal} = 1,520 \text{ nonprotein calories}$$

No more than 30–35% of these calories should be supplied by fats, therefore:

$$1,520 \times .35 = 532 \text{ kcal of fats are given.}$$

Using a standard 20% intralipid solution in which there are 2 kcal per cc, 266 cc of intralipids over 24 h should be supplied. The remainder of the total caloric requirement will be supplied by carbohydrates.

$$2,000 \text{ kcal} - (532 + 480) = 1,012 \text{ kcal}$$

$$1,012 \text{ kcal divided by } 3.4 \text{ kcal/g} = 294 \text{ g of carbohydrates}$$

To supply approximately 300 g of carbohydrate in a 2-liter solution, a 15% dextrose solution should be initiated.

$$2,000 \text{ cc} \times 15\% (.15) = 300 \text{ g}$$

Therefore, your TPN solution will consist of a D15 6% amino acid solution running at 83 cc/h supplemented with 260 cc of 20% intralipid over 24 h.

*If the patient is obese but less than 130% of her ideal body weight, the patient's actual weight should be used. If the patient is 130% or greater of her IBW, then the weight is calculated by (actual body weight - ideal body weight) \times .25 + ideal body weight.

Trace elements such as zinc, selenium, manganese, and chromium are added to the TPN solution. Iron must be given intramuscularly. Hypocalcemia (level less than 6) with a normal albumin level adjusted for pregnancy should also be corrected. Vitamins A, E, B6, and folate are given daily to meet the increased erythropoietic demands of pregnancy. By monitoring daily electrolytes, particularly in the first few days of TPN administration, adjustments in TPN sodium, potassium, magnesium, and phosphorus can be made appropriately.

Careful follow-up of maternal liver function tests, cholesterol, electrolytes, and renal function tests are imperative. Maternal weights and serial fetal ultrasound should also be followed to document the adequacy of the TPN caloric supply.

With physiologic insulin resistance increasing in advancing pregnancy, the risk of hyperglycemia with TPN also increases. This is particularly true with patients during the initiation of their infusion or with those patients who are on cyclical regimens. Although it is suggested by early researchers that increased serum glucose may lead to the sequelae of gestational diabetes, this has not been seen in the literature. Insulin supplementation should be used, however, for persistent hyperglycemia, particularly during early pregnancy. These patients are best managed with a continuous infusion in a hospital setting [11].

In reviewing the literature, maternal and neonatal outcome, measured by adequate maternal weight gain and fetal growth, were not found to be compromised with the use of TPN [2]. Outcome was more dependent on the underlying medical or surgical indication for the TPN itself. Pregnancy outcome was better for conditions such as hyperemesis gravidarum that did not represent chronic or progressive disease. Intrauterine growth retardation (IUGR), fetal mortality, and even maternal mortality were more frequently seen in patients with chronic medical conditions such as advanced diabetes with end organ disease [2].

In a study by Levine and Esser, the nutritional status and maternal/neonatal outcome were examined in 10 severely hyperemetic patients treated with TPN [2]. In addition to a transition from a predominately catabolic to an anabolic nutritional state in the mother, there was no increased incidence of IUGR, preterm labor, or in placental insufficiency caused by fatty infiltration in any of the treated patients.

In yet another review by Lee, 42 cases of TPN use in pregnancy were examined [1]. The average daily intake received by the patients through TPN was 2,430 kcal (1,500–3,000). All of the patients were treated with concentrated dextrose (12.5–20%) and amino acid solutions, with half the patients also receiving lipid emulsions (supplying less than 25% of the total daily caloric requirement). Although diabetic patients did require adjustments of their

insulin requirement, only a minority of the nondiabetic patients required any insulin supplementation. Of the four diabetic patients, three had underlying diabetic nephropathy which was exacerbated by the relatively high amino acid content of the TPN solution. As previously stated, over 50% of the 42 patients were treated with lipid emulsions. Although these patients were usually started on TPN earlier, were treated longer, had shorter pregnancies, and had a higher incidence of cesarean section, there was no difference in the average birthweight in the patients treated with lipids compared to those that were not, controlling for gestational age.

In summary, despite the controversy surrounding the use of TPN in pregnancy, it has been found to be both nondetrimental and effective in the treatment of severe maternal malnutrition that precludes enteral feedings. It has not been associated with an increase in preterm labor, IUGR, sequelae of gestational diabetes, or perinatal mortality. This protocol is the first to outline an easy-to-follow, step-by-step method for prescribing TPN solutions specifically designed to meet the needs of the pregnant patient. Through this review, it is hopeful that this mode of nutrition can be more easily initiated by the primary obstetrician in conjunction with the nutritional consultants, thus allowing the primary caregiver a more active role in the management of these patients.

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