Case Report

Pediatric TPN: Efficacy and Toxicity of a New Fat Emulsion

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ABSTRACT. Fat emulsions are particularly valuable in pediatric total parenteral nutrition (TPN) because they provide an isotonic solution rich in calories. Little is known about the ideal composition of fatty acid emulsions, however, and very few formulations are commercially available. A new fat emulsion using a safflower oil base has recently been approved. We have used this new emulsion to provide a significant percentage of the nonprotein caloric requirements (24 to 42%) in 4 patients requiring TPN. These patients ranged in age from 1 to 15 years and received no enteral nutrition during the 3-week course of the study. Nutritional improvement without major toxic effects was documented in each patient.

Intravenously administered fat emulsions are now widely used in programs of total parenteral nutrition (TPN). In addition to providing essential fatty acids, they offer a concentrated energy source in an isotonic solution. These properties make them particularly useful in the pediatric population in whom glucose intolerance and renal function limitations may contraindicate the sole use of large volume glucose and amino acid (AA) solutions for intravenous (IV) nutrition.1 In concentrations that can be tolerated by peripheral veins, glucose and AA solutions alone cannot provide adequate calories for growth without the use of prohibitively large volumes. However, the addition of a fat emulsion which provides up to 20 to 50% of the caloric requirements makes peripherally administered TPN more widely applicable.2,3

Fat emulsions using soybean or cottonseed oil as the major lipid source have been used clinically. The most widely used product in this country has been a 10% soybean oil emulsion (Intralipid). The cottonseed preparation has been used in Europe. We have recently tested a new 10% safflower oil emulsion (Liposyn, Abbott Laboratories) in a small group of pediatric patients. Using this new emulsion as a major caloric source in TPN, this study has evaluated weight changes, routine laboratory findings, changes in nutritional status, and side effects during 21 days of treatment in 4 children ranging in age from 1 to 15 years.

MATERIALS AND METHODS

The study was conducted in Mott Children's Hospital, University of Michigan Medical Center, Ann Arbor, Michigan, during February, March, and April 1979. Children under age 16 requiring TPN for at least 21 days were candidates for the study. Patients receiving any enteral nutrition, and those with liver damage, renal failure, or massive systemic infection were excluded. Four patients completed the study. Their histories are summarized below and their nutritional assessments are summarized in Table I.

Patient 1 is a 7-year-old white female with ulcerative colitis who was admitted for weight loss and diarrhea. Seven months previously she had undergone a subtotal colectomy, endorectal pull-through and loop ileostomy. Five months before admission her ileostomy was closed.

Patient 2 is a 1-year-old white male born with a tracheoesophageal fistula. Primary repair was attempted at another hospital, but was complicated by an anastomotic disruption which was treated with a feeding gastrostomy and a cervical esophagostomy. He underwent esophageal replacement with a colon interposition 3 days prior to initiation of TPN therapy.

Patient 3 is a 15-year-old white male with Crohn's disease who was admitted for hypoproteinemia and marked edema. He had done well on medical management for 3½ years until shortly before this admission.

Patient 4 is a 15-year-old white male who is presumed cured of his stage 1A Hodgkins disease treated 7 years before admission. An episode of Hemophilus influenzae meningitis 2 years before admission left him with a neurogenic bladder. He was admitted for vomiting and weight loss of unknown origin.

Parental informed consent was obtained and additional subject consent was received from children over 7 years old. The following preinfusion tests were performed: urinalysis, complete blood count with differential white blood cell count, platelet count, serum electrolytes, urea nitrogen, creatinine, glucose, calcium, phosphorus, uric acid, albumin, total protein, cholesterol, triglycerides, total bilirubin, alkaline phosphatase, LDH, and SGOT. Subclavian vein catheterization was carried out in pa-
tients 1, 3, and 4. In patient 2, peripheral venous access was established. All 4 patients were begun on a TPN program of glucose, AA and the new safflower oil emulsion. The emulsion was infused through a Y-connector into the line containing the glucose- AA solution and the infusion was then administered continuously during each 24-hour period for 21 days.

A typical solution used for centrally administered TPN consisted of 25% glucose and 3.5% AA (Aminosyn, Abbott Laboratories). The peripheral regimen consisted of 12.5% glucose and 2.5% AA. The TPN solution also contained routine vitamin and mineral additives which are summarized in Table II.

Each 100 ml of the new fat emulsion contains 10 g safflower oil, 1.2 g emulsifying agent egg phosphatide, 1.2 g glycerin to make the emulsion isotonic (340 mOsm/L), and is adjusted to a pH between 5.0 and 9.0. The solution provides 1.11 kcal/ml. The fatty acid composition of this oil is compared to that of soybean and cottonseed oils in Table III.

Table IV summarizes the TPN treatment of these 4 children, and includes calculations of the amount of various nutrients provided. Daily observations included vital signs, weight, and a report of adverse symptoms or side effects. Estimated caloric requirements were computed daily and compared to calories actually given. At weekly intervals, the initial battery of blood and urine tests were repeated and an assessment was made of any changes in the patient’s nutritional status.

**RESULTS**

Each patient survived the observation period and showed clinical improvement. Daily weight information is summarized in Figure 1. Patient 1 showed a weight gain of 3.1 kg over the 3 week period and her strength improved markedly. Her initially low serum albumin and total lymphocyte counts showed no significant change, however. Patient 2 showed stable weight maintenance despite increased demands secondary to pneumonia which required assisted endotracheal ventilation. He did not, however, receive sufficient calories for growth, due to the limitations on total calorie infusion with a peripheral line. His serum albumin, which was initially low, did not change significantly. Patient 3 gained 5 kg during the study. His edema resolved as his serum albumin increased from 2.7 to 3.7 g%. Patient 4 gained 6.8 kg and his initially normal laboratory finding remained unchanged.

The patients were closely monitored for any signs of toxicity. Each episode of nausea, vomiting, chills, or headache was noted. No such symptoms were attributed to the fat emulsion infusion. Patient 3 had fever second-ary to his pneumonia. Patient 4 complained of nausea, vomiting, chills, and headache prior to and throughout the course of the study. These symptoms decreased in frequency and severity during therapy. He developed a significant fever on the 16th day of infusion which was thought to be related to his central venous catheter. Though no culture evidence of infection was found, the fever resolved following discontinuance of his old CVP and insertion of a new central line.

No significant toxicity was noted by laboratory examinations. Hypertriglyceridemia in the range of 1.5 to 2 times normal values was seen in all the patients. Patient 3 and 4 had only transient elevations which returned to normal by the end of the study. The younger patients (1
and 2) showed significant elevations initially, followed by gradually declining values. Serum cholesterol levels were all normal at the completion of the study and showed only mild early elevations of 15% above normal in patients 1 and 2. Serum urea nitrogen remained normal in all the subjects. Serum GOT levels showed an initial elevation to approximately twice normal followed by a return toward normal. Three of four subjects showed an actual increase in LDH and alkaline phosphatase levels during the study. Patient 1 showed a small increase in LDH and patient 2 had a small increase in alkaline phosphatase. Serum bilirubin remained normal in all the patients.

**DISCUSSION**

The practice of using fat as a component of TPN is well accepted. However, a wide variation in the biological activity of various fat emulsions makes it difficult to generalize about safety or effectiveness. The effects of different fatty acid combinations are not fully known. The new safflower oil emulsion may offer a theoretical advantage since it contains a higher percentage of the essential fatty acid linoleic acid than previously available oil emulsions. It does not contain the linolenic acid found in small amounts in soybean oil emulsions. Structures related to linolenic acid are found in some human tissues, but there is no conclusive evidence that linolenic acid is essential to man's diet. This area needs further investigation.

This study does not show isolated effects of the new safflower oil emulsion, since it was given in a multiple-nutrient program of TPN. Changes in liver function tests similar to those observed in our patients have been frequently noted during TPN with or without a fat emulsion. Changes in serum cholesterol with different oils have been variable, and the small, transient elevations noted in this study are consistent with previous findings for other preparations. The mild serum triglyceride elevations seen as the body processes this exogenous oil are expected. None of the patients exhibited signs of the "overloading syndrome" seen with some other preparations. None exhibited any clinical signs of essential fatty acid deficiency.

It can be concluded that no serious side effects or toxicity occurred in this small group of children who received a significant percentage (24 to 42%) of their nonprotein caloric requirements from a new safflower oil emulsion. They all maintained or gained weight, and improved clinically during the 3-week study period. These early results suggest that this safflower oil emulsion is safe and effective, and deserves further use and evaluation.

**REFERENCES**