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Brief Communications

Studies on the Efficacy of a New 20% Fat Emulsion in Pediatric Parenteral Nutrition

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ABSTRACT. A new 20% safflower oil emulsion was studied in a small series of pediatric patients. Eight infants and children were evaluated over a 2-week period. The 20% fat emulsion supplied a major portion of daily caloric requirements. No serious side effects or toxicity were noted. No major changes in blood chemistries were observed; however, a statistically significant increase in serum albumin was noted. In addition, 63% of the patients gained weight during the study. This investigation supports the contention that 20% Liposyn is a safe and effective component of a parenteral nutrition program for children.

Total parenteral nutrition (TPN) programs routinely incorporate intravenously administered fat emulsions as a major nutritional component. In addition to providing essential fatty acids, fat emulsions also provide a concentrated source of energy substrates in an isotonic solution. These properties are important in the infant population in whom renal function limitations and glucose intolerance may negate the sole use of large volume glucose and amino acid (AA) solutions for IV nutrition.[1]

TPN regimens consisting solely of glucose and AA require prohibitively large fluid volumes if sufficient caloric intake necessary for growth is desired.[2] The supplementation of a portion of the TPN regimen with a fat emulsion providing 30–50% of the total caloric requirements makes peripheral TPN both an attractive and practical form of IV nutrition.[3, 4]

Having safely tested a safflower oil-based emulsion (Liposyn) at both 10 and 20% concentrations in two groups of pediatric patients, we proceeded to further evaluate Liposyn 20% as a major component of a parenteral feeding program[5, 6] This study was designed to document the efficacy of 20% Liposyn in children being managed with a parenteral feeding regimen.

MATERIALS AND METHODS

This study was conducted at the Mott Children's Hospital in the University of Michigan Medical Center from March through October, 1980.

Infants and children from 2 days to 12 years of age requiring TPN for a minimum of 2 weeks were candidates for the study. Patients demonstrating disturbances in normal fat metabolism such as pathological hyperlipemia, lipoid necrosis, or acute pancreatitis, if accompanied by hyperlipemia, were excluded from the study. Patients were allowed enteral calories during the course of study. Eight children completed the study (Table I).

After parenteral informed consent was obtained, the following preinfusion tests were performed: urinalysis, complete blood count with differential white blood cell count, platelet count, blood urea nitrogen, serum uric acid albumin total protein, cholesterol, triglycerides, total bilirubin, alkaline phosphatase, LDH, and SGOT. Subclavian vein catheterization was performed on patients 1, 3, and 5 while peripheral venous access was established in the remaining children.

All patients were begun on a TPN program of glucose, AA, and a safflower oil emulsion (Liposyn 20%). The lipid emulsion was infused through a Y-connector into the line containing the glucose-AA solution and the infusion was continuously administered over a 24-hr period. The solution for centrally administered TPN consisted of 25% glucose and 3.5% crystalline AA (Aminosyn, Abbott Laboratories) while the peripheral regimen consisted of 12.5% glucose and 2.5% crystalline AA (Aminosyn). The TPN solution also contained routine vitamin and mineral additives which are summarized in Table II. The composition of Liposyn 20%, which provides 2.0 kcal/ml, has been previously reported.[5, 6]

All data was statistically analyzed using Student's *t*-test with p values less than 0.05 considered significant.

Table III summarizes the TPN protocol and includes calculations of the average daily amount of various nutrients provided during the course of the study. Daily observations included vital signs, weight, and a report of advese symptoms or side effects. Estimated caloric requirements were computed daily and were compared to calories actually received. At weekly intervals, the initial

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TABLE I
Baseline data on 8 children receiving 20% Liposyn

Patient #	Sex	Age	Weight		Diagnosis
			Baseline	Post study	
			kg		
1	F	12 years	32.0	32.3	Esophageal perforation
2	F	2 days	3.5	3.3	Gastroschisis
3	M	2.3 years	10.8	9.6	Esophageal stricture
4	M	3 days	2.2	3.0	Gastroschisis
5	F	3 months	2.5	3.2	Short-gut syndrome
6	M	7 days	3.0	2.8	Malrotation and volvulus of the intestine
7	F	1.5 years	11.2	11.6	Ruptured appendix with multiple abdominal abscesses
8	F	5 days	2.4	2.6	Duodenal atresia and imperforate anus

TABLE II
Guidelines for TPN additives

Constituent	Amt per kg/24 hr	Maximum per 24 hr
Heparin	100 IU	500 IU/liter
Sodium	2 to 4 mEq	150 mEq
Potassium	2 to 3 mEq	240 mEq
Chloride	2 to 4 mEq	120 mEq
Magnesium	0.6 mEq	24 mEq
Calcium	1.0 mEq	11 mEq
Phosphate	3.5 mm	50 mm
MVI	0.5 ml	2.5 ml
Folic acid		
Trace elements[a]		
Iron, vitamin B_{12}, vitamin K—as needed parenterally		

[a] Trace element solution (manufactured by University of Michigan Pharmacy Department: each ml contains: zinc, 2 mg (0.060 mEq); copper, 0.4 mg (0.030 mEq); manganese, 0.2 mg (0.015 mEq); iodide, 0.056 mg (0.00044 mEq).

battery of blood and urine tests was repeated and an assessment was made of any changes in the patient's nutritional status.

RESULTS

Weight (Table I)

Patients 2, 3, and 6 experienced an average weight loss of 7.9 ± 4.6%, while the remaining patients exhibited an average weight gain of 15.4 ±m 13.8% throughout the course of the study period. The mean weight change at the conclusion of the study was +6.7 ± 16.7%. This weight gain was not significantly different from the baseline measurements.

Serum albumin (Table IV)

All patients entered the study with abnormally low serum albumin levels. At the end of the study period, patient 8 had a further decrease in serum albumin, patient 4's value increased from baseline level but was still abnormally low, patient 2 remained unchanged and the remaining children showed marked increases in serum albumin levels to within the normal range. Mean serum albumin levels at the conclusion of the study period were significantly increased from the baseline values.

Serum Triglycerides (Table IV)

Baseline serum triglyceride levels were abnormally low in patient 1, abnormally high in patient 6, and normal in the rest. At the conclusion of the study period, triglyceride levels were abnormally low in patient 4, normal in patient 3, and abnormally high in the remaining children. The mean increase of serum triglyceride levels at the end of the study was significant.

Blood Urea Nitrogen (Table IV)

Patients 1, 3, 5, and 7 had abnormally low baseline blood urea nitrogen (BUN) levels, patients 4's was abnormally high, and the remaining baseline values were within the normal range. At the conclusion of the study period, patients 1 and 3 had abnormally low values, while the remaining patients had BUN values within the normal range. However, the mean change from baseline measurements was not statistically significant.

Serum Glutamic Oxaloacetic Transaminase (SGOT) (Table IV)

In all patients, the baseline levels of SGOT were abnormally elevated. Patients 2 and 3 concluded the study period with normal levels of SGOT; in the remaining patients, the values remained abnormally elevated. The mean change of SGOT values from baseline measurements was not statistically significant.

Serum Lactic Dehydrogenase (LDH) (Table IV)

All patients started and finished the study period with abnormally high serum LDH levels. However, no significant changes occurred during the study.

Serum Alkaline Phosphatase (Table IV)

Patients 6 and 7 had normal baseline levels of serum alkaline phosphatase and the remaining patients abnormally high values. At the conclusion of the study period, patient 1 had normal alkaline phosphatase while the rest of the children finished the study with abnormally elevated levels. Statistical analysis indicated a nonsignificant increase in mean alkaline phosphatase levels at the conclusion of the study period.

TABLE III
Average daily nutritional components

Patient #	1	2	3	4	5	6	7	8
Type of access	Central	Peripheral	Central	Peripheral	Central	Peripheral	Peripheral	Peripheral
Caloric requirements/kg (estimated)	70	110	80	110	100	90	85	110
Calories/kg received	74.1	76.2	109.5	86.7	100.1	68.9	70.0	85.5
Total caloric requirement (estimated)	2240	387	888	245	250	266	1059	267
Calories received	2596	273	1278	208	250	208	911	236
Total volume (cc/kg)	69	114	44	131	108	115	117	146
Volume of fat emulsion (cc)	485	54	128	50	64	37	164	38
Calories provided as fat	873	97	230	90	115	67	295	68
% Total caloric requirement given as fat	39%	25%	26%	37%	46%	25%	28%	25%
% Nonprotein caloric requirement given as fat	43%	28%	29%	41%	51%	28%	31%	28%
g Fat/kg	2.9	3.3	2.4	3.5	4.0	2.7	2.7	3.0
g Protein/kg	1.5	2.9	4.0	2.8	2.1	2.2	2.0	2.9
Nonprotein calorie/protein calorie ratio	12.8/1	7.2/1	7.4/1	8.4/1	12.5/1	8.5/1	9.5/1	8.0/1

TABLE IV
Changes in blood chemistries during the infusion of 20% Liposyn in 8 children

Blood constituent	Baseline value (mean ± SD)	Post study value (mean ± SD)	p Value
Albumin (g%)	3.0 ± 0.3	3.4 ± 0.4	<0.05
Triglyceride (mg%)	89.6 ± 42.0	184.1 ± 0.2	<0.05
Blood Urea Nitrogen (mg%)	10.5 ± 7.0	11.4 ± 4.6	>0.05
SGOT (IU/liter)	67.9 ± 42.2	57.9 ± 59.8	>0.05
LDH (IU/liter)	668.1 ± 559.0	373.9 ± 168.8	>0.05
Alkaline phosphatase (IU/liter)	149.0 ± 77.4	232.0 ± 99.2	>0.05
Total bilirubin (mg%)	3.9 ± 5.8	3.2 ± 2.9	>0.05

Total Serum Bilirubin (Table IV)

All patients except 1, 3, and 7 had abnormally elevated baseline measurements of bilirubin. At the conclusion of the study period, patients 3 and 7 retained normal levels, whereas the remaining children had bilirubin levels which were abnormally high. Mean changes were not statistically significant.

DISCUSSION

The variable biological activity of commercial fat emulsions makes it difficult to generalize about their toxicity and efficacy in a parenteral nutrition program.[7] The available lipid emulsions have different fatty acid compositions, and the effect of these combinations on the nutritional efficacy of a TPN regimen is unknown. Liposyn 20% offers the theoretical advantage of having a higher concentration of essential fatty acids (linoleic acid) than other commercial fat emulsions.

Two previous reports from this institution have verified that no serious side effects or toxicity occurred in children receiving 10 or 20% Liposyn as part of a TPN program.[5, 6]

In this study, the mean weight gain was not statistically significant; however, 63% of the patients gained weight at the conclusion of the study period. Once again, although the mean BUN did not significantly change during the observation period, 75% of the patients concluded the study with BUN values in the normal range compared with 38% of the patients at the beginning of the study.

The mean serum albumin significantly increased from abnormally low baseline values to normal levels at the conclusion of the study period. All of the patients started the study with moderate to severe deficits in serum albumin, whereas 63% of the children finished with normal levels. This was the only statistically significant improvement in nutritional parmeters documented in this investigation.

There were no significant increases in mean SGOT, LDH, or bilirubin during the observation period. However, the majority of the patients concluded the study period with elevated levels.

There was an increase in mean alkaline phosphatase, an observation noted in other studies of patients treated with and without fat emulsions.[8]

Serum triglyceride levels were abnormally elevated in 63% of the patients at the conclusion of the study period, and the mean serum triglyceride level was significantly increased from baseline measurements. Changes in serum cholesterol and triglycerides with different fat emulsions have been variable, and the transient elevations in serum triglycerides noted in this study are consistent with the findings of other studies in which different emulsions were used.[9, 10]

No instance of the "overloading syndrome," reported with other preparations, was observed nor was fatty acid deficiency documented in any of the patients studied.[11]

The positive trends in weight gain and BUN levels coupled with significant improvement in serum albumin values document the improved nutritional status of these patients.

The significant, although mild, increases of both the mean serum triglyceride and alkaline phosphatase levels are consistent with the findings of preivously reported studies. No other significant differences were noted during the TPN therapy. Although the number of patients in this study is small, the above findings together with the absence of serious side effects or toxicity support the conclusion that Liposyn 20% is a safe and relatively effective component of a parenteral nutrition program for children.

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