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LACTOSE-FREE, MCT-CONTAINING FORMULAS IN SEVERE MALNUTRITION

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"Lactose-Free, MCT-Containing Formulas in Severe Malnutrition"

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British-American Hospital
Lima, Peru, S.A.

AID/~~CSD~~ CSG-2946

Department of State
Agency for International Development
Washington, D.C. 20523

Progress Report
7/66-2/73

Transient lactase deficiency is a common complication of severe diarrheal disease in infancy. In more prolonged and complicated cases other disaccharidases are also affected, and in extreme circumstances, secondary glucose and fructose malabsorption may further complicate dietary management.

The availability of medium chain triglyceride (MCT) - containing formulas, without lactose, or with no disaccharides at all, broadens the number of choices available and should increase the percentage of complex cases that can be managed successfully by the oral route. The present report covers an evaluation of two such formulas in the management of complex nutritional problems.

Lactose-free, MCT-containing formulas were found to be of great value in the dietary management of 18 severely malnourished infants and small children. Replacement of disaccharides with glucose may have been of further value in the treatment of severe diarrheal disease but this was not proven by these studies.

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Transient lactase deficiency is a common complication of severe diarrheal disease in infancy. In more prolonged and complicated cases other disaccharidases are also affected, and in extreme circumstances, secondary glucose and fructose malabsorption may further complicate dietary management (1). Although invasion of the upper gastro-intestinal tract by colonic bacteria is believed responsible for a direct adverse effect on disaccharidase activity and on monosaccharide transport, the mechanism of action has not been elucidated.

Severe malnutrition leads to flattening and atrophy of the intestinal mucosa, with a relative decrease in the activity of all disaccharidases and of the absorptive surface. Because of its normally much lower concentration, lactase is most severely affected, resulting in a limited tolerance for lactose-containing formulas. When malnutrition occurs after the first year of life, genetically determined decreases in lactase activity may already be present or may be precipitated by the malnutrition, with the consequent failure to recover maximal lactose tolerance during convalescence (2).

In some areas of the world where severe malnutrition is a common problem, medical personnel have learned to use milk cautiously in its initial management. In this country the use of lactose-free protein hydrolysates or of soy milks

during convalescence from severe diarrhea is a long-established practice. In some services this is a routine measure, while in others a trial-and-error method is followed.

Although some degree of fat malabsorption is evident in severe diarrheal disease and may aggravate it (3) and is present in malnutrition (4), it is either ignored or coped with by limiting the fat content of feedings: the loss of calorie density may delay weight gain and prolong convalescence. In many cases, particularly in the management of infants who have had extensive intestinal resections, fat malabsorption is a real stumbling block: medium chain triglycerides have been demonstrated to be of use in such circumstances (5).

The recent improvements in techniques for total intravenous alimentation have resulted in an abuse of this not so innocuous procedure, particularly in inexperienced hands (6). This is resulting in the practice of not making an educated guess, least of all a diagnostic effort, toward determining the cause of persistent diarrhea or malabsorption. The availability of medium chain triglyceride (MCT)- containing formulas, without lactose, or with no disaccharides at all, broadens the number of choices available and should increase the percentage of complex cases that can be managed successfully by the oral route. The present report covers an

evaluation of two such formulas in the management of complex nutritional problems.

MATERIALS

3200-AH is a "lactose-free" formula containing MCT's as its major fat component and casein as its nitrogen source. On a dry basis it contains 16.4% protein (14% of calories); 22.7% fat (40% of calories), of which 19.7% is MCT oil (34.3% of calories), 2.6% corn oil (4.9% of calories) and 0.4% lecithin (0.8% of calories); 53.9% carbohydrate (46% of calories) of which 40.5% is malto-dextrins (34.5% of calories), 13.3% sucrose (11.3% of calories) and less than 0.15% lactose (<0.13% of calories); 3.9% ash and 3.4% moisture. When diluted to 20 kcal/fl. oz., one quart contains 2667 USP units vitamin A, 267 USP units vitamin D, 10 I.U. vitamin E, 53 mg ascorbic acid, 1 mg thiamine, 1.2 mg riboflavin, 12 mg niacinamide, 1.3 mg pyridoxine, 7 mg pantothenic acid, 3.3 mcg cyanocobalamin, 67 mcg folic acid, 33 mcg biotin, 90 mg choline, 90 mg inositol, 670 mg calcium, 530 mg phosphorus, 12 mg iron, 100 mcg iodine, 400 mg sodium, 1 g potassium, 1 mg copper, 130 mg magnesium, 2 mg manganese and 4 mg zinc. It was made available to us by the Mead Johnson Research Center, Evansville, Indiana and is now marketed as "Lactose-Free" Portagen.

3200-AD is a protein hydrolysate formula with MCT's as the major fat component and dextrose as the major carbohydrate. It is made from 20% casein enzymatically hydrolyzed and charcoal treated, 17.4% MCT's, 2.0%

safflower oil, 17.9% arrowroot starch and 39.7% dextrose. When diluted to 20 kcal/fl. oz., one quart contains 1500 USP units vitamin A, 400 USP units vitamin D, 5 I.U. vitamin E, 50 mg ascorbic acid, 0.46 mg thiamine, 1.8 mg riboflavin, 4 mg niacinamide, 0.5 mg pyridoxine, 3.2 mg Ca pantothenate, 4.5 mcg cyanocobalamin, 50 mcg folic acid, 30 mcg biotin, 150 mg choline chloride, 900 mg calcium, 650 mg phosphorus, 12 mg iron, 65 mcg iodine, 550 mg potassium, 0.4 mg copper, 50 mg magnesium, and 3 mg zinc. It was also made available by Mead Johnson and is now marketed as Pregestemil.

METHODS

All the infants and children studied were admitted to the British American Hospital in Lima, suffering from severe malnutrition, with or without complicating acute diarrhea and dehydration, possible gram-negative sepsis, and other infections. Because of their underlying severe and prolonged malnutrition, nutritional support is urgent in most such children. Although intravenous hyperalimentation is available, it is used very sparingly because conditions are not ideal and many of our patients are already heavily infected. Prior to admission they have often received chloramphenicol and in the hospital they are often given powerful antibiotic combinations for proven or suspected gram-negative sepsis, making them extremely susceptible to super-infection with Pseudomonas or Candida.

Peripheral veins are used freely for electrolytes, dextrose, and amino acids but at least partial oral alimentation is attempted as soon as possible.

Techniques and methods used in the balance studies have been described previously, as have the vitamin and mineral mixtures used, either exclusively or to supplement those included in the products used (7). Na, K and Mg intakes from oral feedings are usually maintained at 2.0, 3.3 and 0.5 mEq/kg body weight/day respectively except in the initial management of the severely malnourished, when additional K and Mg are usually necessary. When additional energy is added to the formulas this is almost evenly divided between cottonseed oil and sucrose.

RESULTS

Because of the known high biological value of the nitrogen source in both products, only a limited number of studies were carried out to compare their utilization with that of our usual control mixture of casein, cottonseed oil, and sucrose. Two infants, 5.2 and 13.5 months of age, well advanced in their recovery from malnutrition, with body weights already appropriate to length, and normal serum albumins, received both formulas as the source of nitrogen, with preceding, intervening, and following casein periods. All periods were of 9 days each, with nitrogen balances during the last 6 days. Both received 100 kcal/kg/day, with 7.0 and 6.6% of calories as "protein", recalculated

daily. To achieve these critical percentages the formulas were diluted as indicated previously.

Stool dry weight, when estimated, was between 6.3 and 13.8 g/day, with stool fat between 2.3 and 8.1 g/day. Both dry weight and fat were lower on the two formulas than on the control diet, but the number of observations was too small for statistical analysis. Apparent nitrogen absorption was 80 to 90% of intake from the control casein diets, 83 and 86% from 3200-AH, and 85 and 88% from 3200-AD. Apparent nitrogen retention was 30 to 34% of intake for the control diets, 34 and 37% for 3200-AH and 29 and 34% for 3200-AD. None of the differences was significant when each test period was compared with the preceding and following control period. Calculated biological value, retention as a percentage of absorption, was similar for the three diets, although slightly higher for 3200-AH than for 3200-AD.

Serum albumin did not change significantly during any of the diet periods.

Rates of weight gain in one child were moderately higher, 3.3 and 4.1 g/kg/day for 3200-AH and 3200-AD respectively, than during the casein periods, when they were 2.4, 2.1 and 3.1 g/kg body weight/day. In the second child they were distinctly higher, 5.9 and 3.0 g/kg/day for 3200-AH and 3200-AD and 0.5, 0.5 and 0.2 g/kg/day during the casein periods. Although rates of weight gain during such short

periods are notably unreliable, they were inversely correlated with stool fat, and suggest that the MCT's of the formulas were better utilized than the cottonseed oil.

In a third child, 14.5 months of age, comparisons were made only between 3200-AD and casein, with similar results for both.

Product 3200-AH was used in the initial management of four boys with "uncomplicated" marasmic kwashiorkor, 23.3 to 38.8 months old, an age at which malnutrition (2) or racial factors (8) can be expected to result in a high incidence of relatively low intestinal lactase activity. Table I summarizes the results obtained. All 4 children, as part of another study, received casein or modified milk during the first day or two of treatment. In 3 of the 4 the diet was changed before normal serum albumin levels were achieved, only because our supply of 3200-AH was very small. They had all diuresed completely, three were gaining weight steadily, all had normal or rising serum albumins and all were in excellent clinical condition, with no diarrhea, when the change was made. Edema was no longer apparent on days 12, 11, 12 and 7, respectively.

Product 3200-AH was used in the further management of two infants initially treated with a wheat-soy blend, who had persistent hypoalbuminemia (9), one of them with a complicating obscure infection, probably tuberculous. A third infant, #249, had had an initial stormy course during

31 days: severe diarrhea, recurrent dehydration and acidosis, episodes of cyanosis, apnea and seizures, polyuria, thrombophlebitis, and a bleeding tendency, with two episodes of E. coli bacteremia and sepsis, Shigella sonnei in the stool, moniliasis, neutropenia and a prolonged prothrombin time. During 24 days he was maintained primarily by the intravenous route, as modified milk, our casein formula, and even a dextrose-electrolyte mixture led to diarrhea, probably the result in this last instance of transient glucose malabsorption. During the next 7 days an isolated soy protein milk was used with some initial success but diarrhea recurred, and on the 32nd hospital day product 3200-AH was introduced. On the 35th day a periphlebitic abscess, growing out E. coli, was drained.

From the results in Table II it is evident that in the first of the three cases product 3200-AH, even when diluted significantly, very rapidly corrected the hypoalbuminemia and established satisfactory weight gain. In the second case, despite the probably tuberculous granuloma of the liver demonstrated by biopsy, the undiluted product reversed the fall in serum albumin. Even when diluted, further improvement to the near normal range (over 3.8 g/100 ml in our laboratory) and steady weight gain were demonstrated. In the third case the undiluted product corrected the existing hypoalbuminemia and established steady weight gain. This was maintained despite the addition

of non-protein calories.

Product 3200-AD was used in the initial management of 4 infant girls with marasmus. Table III summarizes the results which, for the sake of brevity, have been compressed. During many of the periods, particularly the initial ones, the dietary intake listed is the average for those days, during which the amount given was gradually increased while tolerance was being tested. When oral intake of protein was still very low, the I.V. fluids contained amino acids, along with the necessary water, electrolytes and dextrose. This last met only the basal energy requirement. Two serious setbacks are indicated: the circulatory collapse may have been due to transient sepsis or hypoglycemia. Such episodes are common in the management of these infants. The fourth infant was discharged against medical advice on the 11th hospital day: she was not yet gaining weight but had established tolerance for the formula. The other three infants had rising serum albumins, after the characteristic initial fall which is the result of rehydration, of a probable lag in synthesis, and of initial extracellular fluid volume expansion (10): all three were gaining weight steadily.

Table IV summarizes the results obtained in a 22.4 month old boy with severe marasmus who received 3200-AD during most of a 105 day period. Initial response was satisfactory; he was gradually changed to a milk diet but subsequently

developed bulky stools and finally diarrhea. He was found to have Giardiasis and a flat lactose tolerance test (LTT). Response to 3200-AD was again satisfactory. Convalescence was interrupted by an episode of bloody diarrhea, pneumonia and anemia and still another episode of pneumonia. On day 106 he was changed to a hospital diet and he was discharged on day 114.

A 16.6 month old girl with marasmic kwashiorkor and a staphylococcal infection was treated with 3200-AD in gradually increasing amounts. By the 9th day edema was gone and by the 22nd day serum albumin had risen to 3.47 from an initial value of 1.22 g/100 ml. She was also gaining weight steadily and was clinically well. LTT was flat but she later tolerated up to 500 ml of cow's milk daily in a mixed diet.

Five malnourished, extremely sick infants with diarrhea were also given 3200-AD as their oral feeding during most of the initial treatment. Table V summarizes the results. The first of these, admitted with severe diarrhea, dehydration, acidosis, circulatory collapse and pneumonitis, responded slowly to parenteral therapy. On the 5th day product 3200-AD was introduced cautiously and was well tolerated. Subsequent course was uneventful.

The second case, #330, tolerated the formula without recurrence of diarrhea but weight gain was rapid and serum albumin level fell considerably, together suggesting impaired

protein synthesis. Blood and urine cultures were positive for Proteus vulgaris on day 9: after treatment there was some improvement but on day 23 there was a recurrence of acute diarrhea and the blood culture was again positive for Proteus. A brief period of improvement was followed by an episode of septic shock (probably a Pseudomonas superinfection) and eventual death. Even though feedings may be taken well and not produce diarrhea, a severe infection such as was present here prevents proper utilization of amino acids and leads to a severe protein-deficient state, with hypoalbuminemia, hypotonicity and extracellular fluid volume expansion.

The third case, #364, also demonstrated poor protein utilization until the systemic infection was brought under control. Progress thereafter was uninterrupted.

In the fourth case, #344, admitted with diarrhea, dehydration and hypoalbuminemia but no visible edema, initial parenteral management produced improvement but edema became apparent, while fever and signs of pneumonic involvement persisted. A recurrence of diarrhea further delayed recovery. When infection was controlled, her convalescence proceeded smoothly.

The fifth case, #345, also admitted with diarrhea, dehydration and acidosis, received parenteral fluids and amino acids during the entire first week. Oral feedings were

begun on the 4th day and were tolerated well but during the second week diarrhea recurred and blood culture was positive for Proteus vulgaris. Protein utilization was poor until a suprapubic abscess (at the site of a vesical tap) was discovered and drained. She was also treated for Ascaris, Tricocephalus and Giardia. An attempt to introduce a milk-containing hospital diet on days 37-38 resulted in diarrhea. LTT was flat and 3200-AD was re-introduced. On the 59th day milk was tried again and produced diarrhea but when the amounts were cut down, it was tolerated well.

DISCUSSION

The limited comparative studies confirmed the expected high nutritional value of the casein and the casein hydrolysate in the two formulas. They were suggestive of a higher calorie efficiency, possibly the result of better absorption of the MCT's than the vegetable oil. In the other studies, when our casein-sucrose-cottonseed oil mixture briefly replaced one of these two formulas, rates of weight gain at identical calorie intakes were also lower, possibly for the same reason. This slight advantage might be of real value to the very sick, severely malnourished infant. Whether a similar advantage exists in infants who have never been malnourished is not apparent from these studies.

The excellent results with 3200-AH in 4 cases of uncomplicated kwashiorkor and with 3200-AD in one are not

different from those we expect with our casein-sucrose-oil formula. Our results with lactose-containing modified milk have also been good, but in approximately 50% of children with kwashiorkor we have encountered decreased lactose tolerance and have had to dilute the formula with our casein-based mixture for a matter of days or even weeks. We have never encountered sucrose intolerance in this situation, nor have we found poor digestion of protein, so that there seems to be no advantage to the casein hydrolysate or to the glucose of product 3200-AD in this situation. Its moderately higher osmolal concentration might at times represent a problem. Since energy requirements are seldom a problem in kwashiorkor, the advantages of the MCT's are probably outweighed by the higher cost. Although casein-sucrose-vegetable oil mixtures can easily be put together at a low cost, there are other obvious advantages to a product such as 3200-AH. Errors or omissions of concept or of preparation in the addition of electrolytes can have disastrous consequences. The commercial vitamin mixtures generally available are far from being as complete as the one in this product. The trace minerals present in this preparation are also not put together easily. Severely malnourished infants are commonly depleted of many trace nutrients without its being evident until an adequate or generous supply of protein and energy is made available. In our fairly extensive experience with our own mixtures we

successively encountered acute Mg deficiency, inadequate niacin intake, probable Zn deficiency, and Zn toxicity.

The infant who was clinically well but severely hypoalbuminemic after 51 days of a wheat-soy blend diet would undoubtedly have responded just as well to our casein-based mixture or to isolated soy protein milk (11). He did have lactose intolerance but this probably was transient. The second infant, with the tuberculous granuloma, would probably have responded as well to other products, but because of her younger age, without lactose intolerance. The third infant in this group, who had probable transient intolerance to all carbohydrates at one point, responded to 3200-AH after the isolated soy protein milk had not been well tolerated. He is more difficult to explain: this response may have been coincidentally due to the clearing up of his infection, or may represent better tolerance of the MCT's than of vegetable oil, or of the relatively lower sucrose content of 3200-AH.

The good results with 3200-AD in the 4 infant girls with marasmus would probably have been matched by 3200-AH or even modified milk, although the fairly prompt establishment of tolerance and weight gain, while maintaining improvement of serum albumin levels after the typical initial fall, was probably better than usually experienced in our unit. In the older boy with marasmus, because of his age, relative lactase deficiency was to be expected and was documented. The bulky

stools, with increased stool fat, may have been due to the Giardia infection.

In the five infants with severe diarrhea and malnutrition we would almost certainly have encountered two or three with severe transient deficiency of lactase and possibly other disaccharidases. Fortunately none had glucose malabsorption and 3200-AD was tolerated well, without producing recurrence of the diarrhea. When severe systemic infection is present one cannot expect adequate protein synthesis and this was well demonstrated in these examples. A disaccaride-free formula may well be of significant value in such a situation but our studies did not prove this, as lactose and other disaccharide tolerance tests were not carried out. One is understandably reluctant to carry them out in such sick infants but on the other hand, it might be safer to do so, using a reduced load, than to discover intolerance through an injudicious attempt to feed disaccharide-containing formulas.

SUMMARY

Lactose-free, MCT-containing formulas were found to be of great value in the dietary management of 18 severely malnourished infants and small children. Replacement of disaccharides with glucose may have been of further value in the treatment of severe diarrheal disease but this was not proven by these studies.

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TABLE I

Product 3200-AH in the initial treatment of 4 boys with "uncomplicated" marasmic kwashiorkor

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml Δ	Serum Albumin g/100 ml Final
#254: 26.1 months, 79.2 cm., 11.1 kg.							
1-2	Milk	1.5	54	10.8	-19.4	0.13	1.52
3-8	3200AH	2.0	65	12.2	-26.8	0.41	1.93
9-28	"	2.5	100	10.0	4.3	2.12	4.05
#255: 23.7 months, 78.5 cm., 8.6 kg.							
1	Casein	1.0	50	8.0	-15.2	--	1.03
2-9	3200AH	2.0	75	10.7	-7.7	0.59	1.62
10-23	"	2.0	100	8.0	3.1	0.71	2.33
24-34	"	2.5	100	10.0	5.8	0.73	3.06
#257: 38.8 months, 84.5 cm., 11.6 kg.							
1	Casein	1.0	50	8.0	-10.4	--	1.60
2-8	3200AH	2.0	75	10.7	-7.4	0.07	1.67
9-13	"	2.0	100	8.0	-4.8	0.39	2.06
14-20	Milk	2.0	100	8.0	-1.7	0.66	2.72
21-45	"	2.5	100	10.0	3.6	1.28	4.00
#262: 23.3 months, 78.1 cm., 9.1 kg.							
1	Casein	1.0	38	10.5	-6.1	-0.05	1.50
2-7	3200AH	2.0	75	10.7	-17.3	0.54	2.04
8-12	"	2.0	100	8.0	1.7	0.16	2.20
13-19	"	2.5	125	8.0	9.1	0.59	2.79
20-30	C+Milk	3.0	129	9.3	2.8	1.27	4.06

TABLE II

Product 3200-AH in the further management of three infants with unsatisfactory responses to previous diets. WS-1 refers to a wheat-soy blend

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml Δ	Serum Albumin g/100 ml Final
#244M: 14.7 months, 69.6 cm., 4.9 kg.							
1-36	WS-1	1.0 to 3.5	30 to 150	13.3 to 9.3	4.8	-1.58	2.69
37-51	WS-1	4.0	150	10.7	-0.9	-0.52	2.17
52-67	3200AH	4.0	150	10.7	11.1	1.97	4.14
68-71	Milk	3.5	150	9.3	0.7	0.28	4.42
72-80	3200AH	2.0	125	6.4	2.3	0.09	4.51
81-86	"	2.5	125	8.0	10.4	-0.47	4.04
#246F: 5.3 months, 59.6 cm., 3.4 kg.; prolonged fever, + tuberculin, hepatic granuloma							
1-24	WS-1	1.4 to 3.5	55 to 150	10.1 to 9.3	5.6	-1.26	2.48
25-38	WS-1	4.5	150	12.0	6.3	-0.30	2.18
39-47	3200AH	4.0	114	14.0	0.5	0.69	2.87
48-73	"	4.0	150	10.7	5.4	0.58	3.45
#249M: 4.1 months, 61.2 cm., 4.97 kg.; multiple infections, diarrhea (see text)							
1-24	I.V. fluids, casein, milk, etc.				0.2	-1.76	2.94
25-31	Soy	1.2	40	12.0	-6.8	-0.14	2.80
32-36	3200AH	2.2	63	14.0	-4.3	0.74	3.54
37-40	"	3.0	86	14.0	4.3	0.34	3.88
41-47	"	3.5	100	14.0	1.5	0.54	4.42
48-54	"	3.5	125	11.2	9.0	-0.27	4.15

TABLE III

Product 3200-AD in the initial management of 4 infant girls with marasmus

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml Δ	Serum Albumin g/100 ml Final
	#328: 12.5 months, 70.5 cm., 6.1 kg.						
1-2	I.V. fluids + amino acids				17.9		
3-5*	3200AD	1.0	50	8.0	-17.1	-0.92	2.91
6-11*	"	1.6	50	12.8	18.9	0.21	3.12
12-13*	"	2.0	75	10.7	-8.4		
14-17	"	2.5	100	10.0	-3.1	0.48	3.60
18-23	"	3.0	125	9.6	13.2		
24-34	"	4.0	150	10.7	2.8	0.31	3.91
	#346: 8.1 months, 63 cm., 4.4 kg.						
1-4*	3200AD	1.4	70	8.0	29.0		
5-11*	"	2.5	125	8.0	-5.0	-0.77	2.86
12-14	"	3.0	150	8.0	-0.7		
15-16†	I.V. fluids				-7.5	0.09	2.95
17-19*	3200AD	2.5	100	10.0	18.2	-0.01	2.94
20-25*	"	3.0	125	9.6	3.7		
26-40	"	4.0	150	10.7	7.5	0.80	3.74
	#348: 5.6 months, 60.5 cm., 4.7 kg.						
1-8*	3200AD	1.5	53	11.3	4.7	-0.90	3.13
9-10††	I. V. fluids				1.0		
11-13*	3200AD	0.9	33	10.0	-11.2	-0.19	2.94
14-18	"	2.2	85	10.4	-1.7	0.32	3.26
19-23	"	3.0	125	9.6	9.6	0.17	3.43
	#355: 3.6 months, 57.3 cm., 3.5 kg.						
1	I. V. fluids				1.4		
2-3*	3200AD	0.8	25	12.8	6.4		
4-5	"	1.6	50	12.8	-9.9		
6-8	"	2.0	75	10.7	1.0		
9-10	"	2.5	100	10.0	-1.4	-0.75	3.61

* plus intravenous fluids
† episode of circulatory collapse and Pseudomonas bacteremia
†† episode of bloody diarrhea

TABLE IV

Prolonged use of product 3200-AD in the management of a 22.4 month old boy with marasmus: length 72 cm., weight 6.25 kg. on admission; 73.5 cm., 8.68 kg. on last day of study

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml	Observations
1	Casein	0.5	25	8.0	-24.2	3.66	Diarrhea, pneumonia
2-7	3200AD	1.8	67	10.7	6.3		
8-13	"	3.2	154	8.3	11.3	3.56	
14-18	AD+Milk	2.5	140	7.1	-3.0	3.73	
19-41	Milk	2.5	150	6.7	2.5	3.41	↑stool wt. & fat, diarrhea
42-43	3200AD	0.8	50	6.4	5.7	3.34	Giardiasis, flat LTT
44-49	"	2.0	125	6.4	2.5	3.99	
50-62	"	2.3	140	6.6	3.7	4.27	
63-70	Casein	2.6	150	6.9	5.1		Diarrhea, pneumonia
71-75	3200AD	1.0	45	8.9	-7.3	3.71	Hypothermia, IV fluids
76-85	"	2.9	118	10.0	5.8	4.27	
86-98	Casein	2.0	125	6.4	2.0	4.29	Pneumonia
99-105	3200AD	3.0	125	9.6	4.4		

TABLE V

Product 3200-AD in the dietary management of five extremely sick malnourished infants

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml	Observations
				#359M: 8.8 months, 63.5 cm., 4.4 kg.			
1-4	I. V. fluids + amino acids				6.2	2.82	Diarrhea, acidosis, shock
5-8	3200AD	1.2	38	12.8	-4.0	2.59	Pneumonitis
9-11	"	2.0	75	10.7	-3.0	2.73	
12-21	"	2.9	125	9.3	7.4	3.61	
22-25	"	4.0	175	9.1	10.8	3.50	
				#330M: 3.5 months, 55.5 cm., 3.15 kg.			
1-7	3200AD	1.2	60	8.0	-2.7	3.52	Diarrhea, scabies
8-10	"	2.0	125	6.4	12.8	2.95	Proteus vulgaris sepsis
11-16	"	3.0	135	8.9	15.6	2.35	
17-23	"	4.0	160	10.0	7.6	2.81	
24-28	"	1.6	70	9.1	-10.7	2.14	Proteus sepsis, diarrhea
29-35	"	2.8	115	10.0	-5.0	2.82	
36-40	"	4.0	150	10.7	9.0		Sepsis-death, day 45
				#364M: 15.3 months, 72 cm., 5.45 kg.			
1	I. V. fluids				22.6	3.19	Dehydration, ? sepsis
2-5	3200AD	1.6	56	11.4	6.5	2.10	E. coli in blood
6-10	"	2.5	100	10.0	3.8	2.59	Still very sick
11-22	"	3.0	100	12.0	-2.1	3.40	Infection controlled
23-41	"	3.5	150	9.3	10.5	4.51	
42-59	"	2.6	140	7.4	2.5	4.43	

continued ....

TABLE V (Continued)

Hosp. Day	Daily Diet: Protein Source	Protein g/kg	Kcal /kg	Kcal % Prot.	Δ Wt. g/kg/day	Serum Albumin g/100 ml	Observations
	#344F: 17 months, 71 cm., 5.74 kg.						
1-3	I. V. + oral fluids				37.8	1.34	Diarrhea, dehydration
4-9	3200AD	1.6	58	10.9	-8.5	1.52	Edema
10-17	"	2.8	113	9.8	-6.3	1.63	Pneumonitis, diarrhea
18-19	I. V. fluids + blood				18.6		Still edematous
20-25	3200AD	1.6	54	11.9	-14.4	2.34	Edema gone
26-58	"	3.7	140	10.5	5.3	4.02	
	#345F: 11.4 months, 65 cm., 4.45 kg.						
1-3	I. V. fluids				12.5	3.51	Diarrhea, acidosis
4-6	3200AD	1.1	33	13.3	-8.8	2.21	I.V. amino acids
7-16	"	2.6	105	10.0	-5.2		Diarrhea, Proteus vulgaris sepsis
17	I. V. fluids				4.6	2.19	
18-25	3200AD	2.0	75	10.6	9.5	2.44	Suprapubic abscess
26-36	"	3.0	140	8.6	8.3	3.13	Ascaris, tricocephalus
37-38	Varied diet				-38.6	3.82	Diarrhea
39-44	3200AD	2.3	80	11.5	12.8	4.01	Giardia
45-58	"	3.8	150	10.5	7.7	4.22	