HYPERALIMENTATION—A CASE REPORT OF ITS USE IN PERFORATED NECROTIZING ENTEROCOLITIS*

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SUMMARY

A case of infective necrotizing enterocolitis with bowel perforation and recurrent melaena treated conservatively with parenteral intravenous nutrition is described. Total requirements are outlined and some modifications delineated. Mention is made of the poor results of surgery and the possible role of conservative management.

During the past two years, it has become increasingly evident that chronic bowel dysfunction with inanition can be successfully managed with the parental use of high osmolar/calorie feeding.[1-4] These feeds are administered via a catheter into the superior vena cava or right atrium. The method has recently been fully reviewed.[5] By this method prolonged resting of the gastro-intestinal tract can be achieved while concomitantly the infant or child can be kept in positive nitrogen balance enhancing recovery of bowel enzyme function.[6] Indications for parenteral hyperalimentation include chronic non-specific diarrhoea, short bowel syndrome, chronic intestinal obstruction, intraperitoneal sepsis and bowel fistulae.[5]

The indication for hyperalimentation in the case reported here was infective necrotizing enterocolitis, bowel perforation and recurrent melaena.

CASE REPORT

A 3-week-old White female infant, weight 2·7 kg, was initially admitted to the Transvaal Memorial Hospital for Children with a history of gastro-enteritis of 3 day's duration. Following routine supportive therapy she was discharged. A week later she weighed 2·5 kg and was readmitted with the same complaint. Type 0119/B14 enteropathogenic *E. coli* was cultured from stool specimens. Blood cultures were negative and all other investigations were compatible with a moderate isotonic dehydration. Following intravenous rehydration with half-strength Darrow's solution and ampicillin therapy for an associated pneumonia, clinical improvement occurred rapidly and oral feeds were commenced. On the 6th day of her second hospital admission, she was noted to be hypothermic, pale and mildly dehydrated. Investigations suggested a septicaemia and she was given kanamycin 15 mg/kg/day intravenously, whereupon improvement occurred.

On the 10th day, the patient suddenly collapsed and a diagnosis of progressive *E. coli* septicaemia and endotoxic shock was made. She was transferred to the Intensive Care Unit, where, following intravenous fluid, Isuprel, steroid and sodium bicarbonate therapy, improvement again occurred. Some hours later her condition deteriorated, hypoglycaemia was found, and examination of the cerebrospinal fluid showed 8 polymorphonuclears, 10 red blood cells, protein 48 mg/100 ml and sugar 22 mg/100 ml was noted while the blood sugar was 25 mg/100 ml. All other investigations were normal. With the onset of Cheynes-Stoke's respiration, respirator therapy was required. On this therapy rapid improvement occurred and the patient was weaned off the ventilator. On the following day oral feeds (half-strength Darrow's solution) were begun. Later that day, coffee-ground aspirates from the stomach were noted and her haemoglobin level dropped to 11 g/100 ml but no other evidence of a haematological disorder was found. Vitamin K[1] and fresh frozen plasma were given and oral feeds were stopped. The erect X-ray of the abdomen showed nothing abnormal. The following morning melaena was noted, the haemoglobin level had now dropped to 6 g/100 ml and the abdomen was soft. A repeat X-ray of the abdomen remained normal. A blood transfusion was given, following which she again improved.

Twenty-four hours later, the infant being wasted, oedematous, and weighing 2·8 kg, milk feeds were instituted. Again improvement was noted. Three days later (day 16) the baby's abdomen was seen to be distended and she was again hypothermic. An X-ray (erect) of the abdomen showed gas under the diaphragm. It was elected to treat the bowel perforation conservatively with continuous intravenous infusions and gastric suction. Improvement again occurred and 2 days later no free gas was noted on X-ray, indicating closure of the perforation and reabsorption of gas. After a further 2 days, as melaena had ceased, milk feeds were again given. Melaena again occurred. Oral feeds were then stopped and supportive therapy was instituted for the third time in 7 days.

At this stage, the patient had been in hospital for 22 days, she was hypoproteinaemic (total serum proteins 4·6 g/100 ml) wasted and oedematous, and repeated trials of oral feeding had only brought catastrophe. It was decided to manage the patient on parenteral hyperalimentation. A catheter was inserted via a subcutaneous tunnel through the scalp, the lower end being passed via the right internal jugular to the right atrium. Fluids, calories, nutrients and electrolyte requirements were calculated as per Table I and given as per Table II, via a constant infusion pump,* to which a micropore bacterial filter† was fitted. Blood and/or plasma were given 1 - 2 times per week for correction of trace elements, essential fatty acids and iron (50 ml aliquot). Vitamins and small doses of heparin were also administered.

After 6 days of total intravenous alimentation the patient began to pass normal stools, oedema had disappeared, and she weighed 2·4 kg. Carbenicillin and Colistin were instituted after *Pseudomonas aerogenes* was isolated from a single random blood culture. Following 17 days of hyperalimentation therapy, the patient weighed 2·7 kg, the total serum proteins were 5·5 g/100 ml, and her general condition was excellent. Oral feeds utilizing a protein hydrolysate-medium chain triglyceride prepara-

*Date received: 15 February 1971.

*Harvard pump. Protea Electomedical Services, Johannesburg.
†Sartorius membrane filter. Optical Instruments, Johannesburg.

TABLE I. SUMMARY OF TOTAL DAILY INTRAVENOUS REQUIREMENTS

A. Mean Maintenance Requirements

1. Calories*
   0 - 10 kg : 100 cal/kg
   10 - 20 kg : 1 000 cal + 50 cal/kg for each kg over 10
   20 kg+ : 1 500 cal + 20 cal/kg for each kg over 20
2. Fluids:
   100 ml/100 cal given
3. Protein
   1·5 - 2·5 g/100 cal given
   <1 000 cal/day : 2·5 g/100 cal given
   >1 000 cal/day : 1·5 g/100 cal given
4. Electrolytes
   Na : 3 mEq/100 cal given
   K : 2 mEq/100 cal given
   Cl : 2 mEq/100 cal given
   Ca : 4 - 10 mEq/100 cal given†
   Mg : 0·2 - 0·6 mEq/100 cal given†
   P : 1·5 - 4 mEq/100 cal given†
5. Vitamin requirements per day

	Oral	*Amount per 0·5 ml Bejectal C*	
Thiamine	0·4 mg	10 mg	
Riboflavine	0·6 mg	1·5 mg	
B_{12}	1 µg	1 µg	
Niacin	6 mg	37·5 mg	
Ascorbic acid	30 mg	50 mg	
Vitamin A	1 500 IU	—	intramuscular injection
Vitamin K_1	1·5 mg	—	
Vitamin D	400 IU	—	
Folic acid	0·35 mg	—	

B. Reparative and/or replacement requirements per day

1. Calories 30 - 50 cal/kg
2. Fluids 0 - 100 ml/kg
3. Protein 1·5 g - 2·5 g/kg
4. Electrolytes Na : 0 - 10 mEq/kg
   K : 0 - 8 mEq/kg
   Cl : 0 - 10 mEq/kg

*Computed for average hospital patients.
†15 - 40% oral requirements given intravenously per kg body-weight.

tion* were instituted. This was taken well, and 2 days later the intracardiac catheter was removed. The patient, 56 days after admission, weighed 3·6 kg.

DISCUSSION

Since 1658, when Sir Christopher Wren[7] first used the intravenous route for fluid administration, advances in intravenous therapy have ocurred *pari passu* with advances in basic blood and electrolyte knowledge and improvements in administering apparatus. Maintenance intravenous requirements in terms of fluid, calories and some electrolytes (Na^+, K^+ and Cl) have been worked out.[8] For other macromolecules, however, e.g. Ca, Mg, P, only oral requirements are known.[9] Previously reported studies use no fixed relationship between oral and intravenous requirements. However, it would appear from balance studies that a wide latitude is possible. Taking into account the variations in bowel absorption normally found for these molecules, it seems that 15 - 40% of the oral requirements should be adequate via the intravenous route. Reparative and replacement requirements vary widely and depend on many factors, viz. the degree of inanition and the presence or absence and severity of vomiting or diarrhoea. Thus, in spite of calculated maintenance and reparative and/or replacement requirements, bedside adjustments, particularly with potassium, are often required.

The scheme used for hyperalimentation in the paediatric Intensive Care Unit at this hospital utilizes all presently available data, though it differs from previously reported schemes by one major addition—the use of a high-calorie emulsified fat solution; one minor change—the utilization of a valved intracardiac catheter; and one variation in emphasis.

Intralipid* which is useful, because a concentration of glucose above 25% cannot be utilized if osmotic diuresis is to be avoided, is a soy-bean oil, lecithin-glycerol in water mixture of high calorie value (1 100 cal/litre). It is stable at room temperature for 4 - 6 hours and for many days at ±4°C. Because of its tendency to come out of solution, it cannot be added to a vacolitre containing full daily requirements, but must be administered separately. Reported side-effects, due to possible metabolic overloading when more than 3 g/kg/day is given or infused at a rate above 3 - 4 ml/min, are febrile reactions, bleeding diathesis and hepatosplenomegaly.[10] However, none of these complications was encountered in this patient, and only small amounts of the fat emulsion were required. Moreover, it was given over a 6-hour period and at a very much slower rate (0·138 ml/min) than previously described.

Pudenz-Hayer catheters have been extensively used for prolonged intracardiac catheterization in the decompression of obstructive hydrocephalus. The catheter is soft, smooth-tipped and coated with non-irritating silicone. Blood reflux cannot occur, thus preventing intraluminal clotting and eliminating the necessity for heparin utilization other than that required for fat clearance. One of us (M.D.) has now utilized this catheter in 4 cases, for 21 - 28 days hyperalimentation, and, as in this case, no complications ocurred.

Too little emphasis has been placed on the benefits derived from using a constant infusion pump, particularly in very small infants. The advantages of maintaining a patent catheter are obvious, less so is the ability of staff to guarantee constant infusion rates of 0·008 ml/min.

*Biosorbin MCT. Remedia, Johannesburg.

*Vitrum, Sweden. Agents: Petersen Ltd, Johannesburg.

TABLE II. COMPOSITION OF INFUSATE

	Cal	*H_2O (ml)*	*Na^+ (mEq)*	*K^+ (mEq)*	*Ca^{++} (mEq)*	*Mg^{++} (mEq)*	*PO= (mEq)*	*Protein (g)*	*Heparin (units)*
Intralipid	55	50	—	—	—	—	—	—	100
Amigen 800*	160	200	7	3·5	5	0·4	6	10	50
Dextrose 50%	100	50	—	—	—	—	—	—	—
NaCl 20%		3	10	—	—	—	—	—	—
K acetate†		3	—	6	—	—	—	—	—
CaCl 10%		5	—	—	9	—	—	—	—
$MgSO_4$ 50%		1·0	—	—	—	8	—	—	—
Total	315	312·5	17	9·5	14	8·4	6	10	150

*Abbott Laboratories, Johannesburg.
†Adjusted at bedside.

This may be particularly important when using fat emulsions where side-effects may be dose- and rate-dependent.

Finally, in spite of what has been accepted previously,[11] this case emphasizes that the conservative medical management of necrotizing enterocolitis of *infective origin* with diffuse involvement and perforation may be the management of choice, as in general the condition of patients brought to surgery is poor, lesions of the bowel are widespread, and surgical interference carries an almost uniformly bad prognosis.[12]

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