Can Intravenous Feeding as the Sole Means of Nutrition Support Growth in the Child and Restore Weight Loss in an Adult?

An Affirmative Answer

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THE TREATMENT of most severe disease of the alimentary tract is surgical. Consequently, most malnourished patients in contemporary America are seen on surgical services. Parenteral nutrition has been progressively improved each decade, and many cases have been reported in which nitrogen balance was achieved for brief periods,[1,7] but sustained and meaningful restoration of the nutritionally depleted patient is a goal that has eluded regular achievement.[8]

The laboratory demonstration that normal growth and development can be achieved by supplying basic nutrients exclusively by the intravenous route[8] prompted use of this technic in surgical patients.[4,11] This report presents methods and results of total intravenous feedings, used as the sole means of nutritional support for prolonged periods of time, in adults and infants with severe gastrointestinal disability.

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Methods of Total Intravenous Nutrition

Catheter Placement

After extensive clinical evaluation, percutaneous catheterization of the superior vena cava by way of the subclavian vein has proven to be the safest and most reliable technic for long-term intravenous therapy in adults. The patient is placed in the Trendelenburg position to allow optimal filling and dilatation of the subclavian vein. The shoulders are thrown back maximally or hyperextended over a roll beneath the vertebral column, and the head rotated to the opposite side. The skin of the shoulder, chest and neck is widely shaved, defatted with ether or acetone, prepared with 2% tincture of iodine or merthiolate, and draped into a sterile field. Using strict aseptic technic with sterile gloves and instruments, local anesthetic is infiltrated into the skin and underlying tissues at the inferior border of the midpoint of the clavicle. A 2-inch long #14 needle,* attached to a 3 ml. syringe, is inserted through the weal and advanced beneath the inferior border of the clavicle with the needle point di-

* #1614 Bardic Deseret Intracath, C. R. Bard, Inc., Murray Hill, New Jersey 10016.

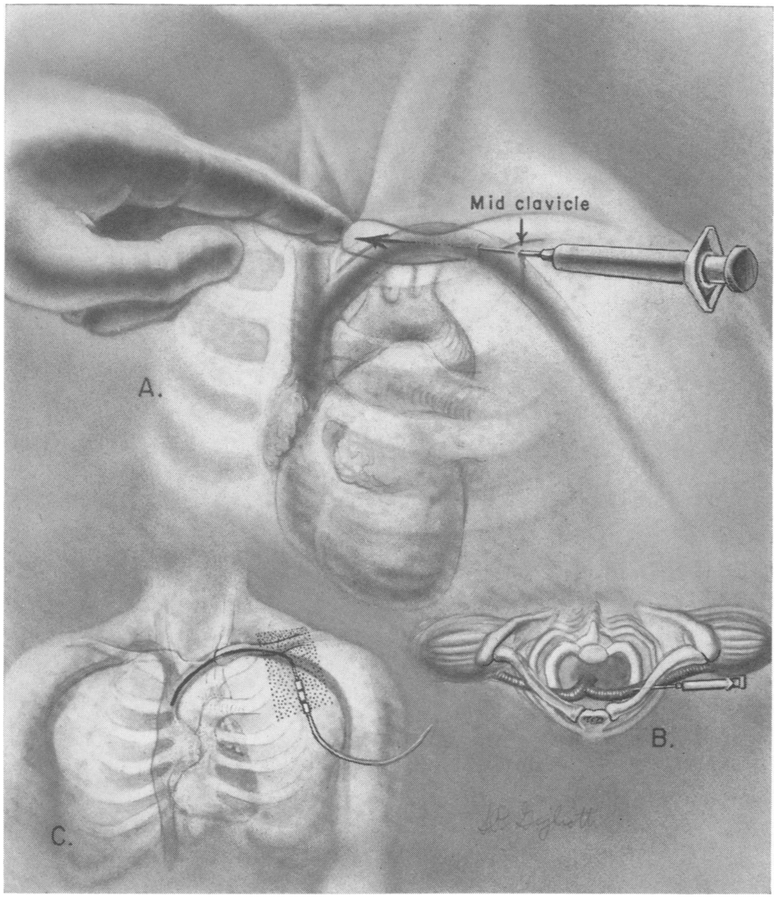

FIG. 1. Technic of percutaneous infraclavicular subclavian venous catheterization (see text).

rected at a finger tip pressed firmly into the suprasternal notch (Fig. 1A). With the needle and syringe barrel parallel to the frontal plane of the patient and adjacent to the anterior deltoid prominence, the needle enters the anterior wall of the subclavian vein (Fig. 1B). Slight negative pressure applied to the syringe after the needle is beneath the skin helps ascertain proper intravenous placement of the needle. The needle is advanced a few millimeters after venous blood is first obtained to insure the intraluminal position of the entire beveled tip. The syringe is carefully detached, and an eight inch long #16 radiopaque polyethylene catheter* is inserted into the needle and threaded into the vein its full length, placing the catheter tip in the superior vena cava. The proximal end of the catheter is attached to standard intravenous infusion tubing and the needle withdrawn. A 3-0 silk suture secures the catheter to the skin lateral to the puncture site. Antibiotic ointment is applied to the catheter puncture wound, a sterile gauze dressing positioned over the site and fixed to the skin with tincture of benzoin and adhesive tape (Fig. 1C).

Alternatively, vinyl, silastic or teflon catheters have been inserted percutaneously into the vena cava via the external jugular or subclavian veins through appropriate sized needles or with commercially available 8-inch long internal stylet-needle-catheter combinations.*†

In infants weighing 10 pounds or more,

* #6723 Longdwel Catheter (Teflon), Becton Dickinson and Co., Rutherford, N. J. 07070.

† #1967 Bardic Deseret Angiocath, C. R. Bard, Inc., Murray Hill, New Jersey 10016.

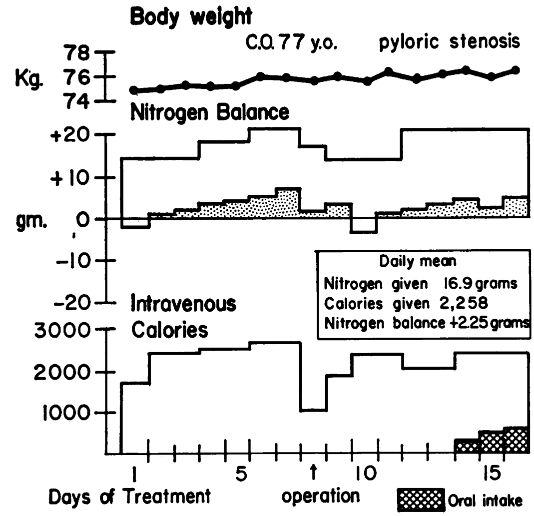

FIG. 2. Preoperative intravenous nutrition supported this 77-year-old patient with chronic ulcer disease, pyloric stenosis and massive gastric dilatation requiring prolonged naso-gastric suction. Weight gain, positive nitrogen balance, increased strength and activity accompanied rapid recovery and uncomplicated convalescence after subtotal gastrectomy.

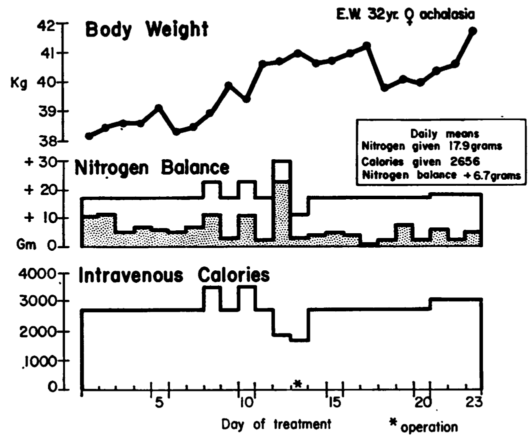

FIG. 3. Continued weight gain and persistent positive nitrogen balance accompanied successful esophagomyotomy on day 13 in this patient with achalasia, tuberculosis and recurrent staphylococcal infections.

small bore polyethylene, vinyl or silastic catheters can be inserted percutaneously into the superior vena cava via the subclavicular subclavian route without inordinate difficulty. In neonates and infants weighing less than 10 pounds, the percutaneous technic is more difficult because of the small size of the vessel, and the possibility of complications is increased. Long-term catheterization in these patients is accomplished by threading the catheter into the superior vena cava by way of the external or internal jugular vein exposed through a 1 cm. neck incision. After securing the catheter at the venotomy site, the proximal end is attached to a trocar and passed subcutaneously from the neck wound to a stab wound in the posterior parietal area of the scalp, displacing the skin exit site from the point of catheter entrance into the blood stream. The neck wound is closed, the catheter secured to the skin exit site with a 4-0 silk suture, the area treated with antiseptic, and antibiotic ointment and a sterile dressing applied.

Catheter Maintenance

If safe long-term intravenous catheterization is to be achieved, meticulous maintenance of the catheter is just as important as proper insertion. Every 2 or 3 days the intravenous administration tubing is changed, and the dressing over the catheter exit site removed. Using aseptic technic with sterile gloves or no-touch technic with sterile instruments, the skin is defatted with ether or acetone, prepared with 2% iodine or merthiolate tincture, 2 cc. of antibiotic ointment * applied and a sterile occlusive dressing replaced. Antibiotics, heparin or steroids are not added routinely to the solutions, but may be administered through the catheter if indicated or desired. Withdrawal of blood or direct administration of medications through the infusion catheter is discouraged, for these practices increase the possibilities of clotting and intraluminal contamination with microorganisms.

Infusion Apparatus

In ambulatory adults standard parenteral fluid bottles and infusion tubing are used to deliver the nutrient solution by gravity

* Neosporin Antibiotic Ointment, Burroughs Wellcome and Co. (U.S.A.) Inc., Tuckahoe, New York 10707.

TABLE 1. *Composition of Daily Average Adult Nutrient Solution*

Water	2500–3500 mL.	Vitamin A	5,000–10,000 U.S.P. units
Protein Hydrolysates (Amino acids)	100–130 Gm.	Vitamin D	500–1,000
Nitrogen	12–20 Gm.	Vitamin E	2.5–5.0 I.U.
Carbohydrate (Dextrose)	525–750 Gm.	Vitamin C	250–500 mg.
Calories	2500–3500 Kcal	Thiamine	25–50 mg.
Sodium	125–150 mEq	Riboflavin	5–10 mg.
Potassium	75–120 mEq	Pyridoxine	7.5–15 mg.
Magnesium	4–8 mEq	Niacin	50–100 mg.
		Pantothenic acid	12.5–25 mg.

Calcium and phosphorus are added to the solution as indicated.

Iron is added to the solution, given intramuscularly in depot form as iron-dextran, or given via blood transfusion as indicated.

Vitamin B_{12}, vitamin K, and folic acid are given intramuscularly or added to the solution for intravenous administration as indicated.

Trace elements such as zinc, copper, manganese, cobalt, and iodine are added only after total intravenous therapy exceeds one month. Alternatively, one unit of plasma twice a week will provide required amounts of trace elements.

drip. A rolling intravenous stand allows activity and mobility which are essential for adequate nutritional rehabilitation. Use of closed filtered infusion systems prevents the intravenous introduction of airborne contaminants via the solution or tubing.

In infants and nonambulatory adults, the nutrient solution is delivered continuously at a constant rate by means of a peristaltic pump with variable speed control.** A standard pediatric administration set, attached to the reservoir bottle quantitates the infused fluid. Distal to the pump the infusion tubing is attached to a 0.22 μ membrane filter.*** This "final filter" protects against possible transmission of contaminants introduced into the solution or tubing with additives, and prevents inadvertent air embolism.

In infants the filter is attached to a blunt #19 gauge needle which is fitted into the proximal end of the catheter. In adults, the filter connects with a short length of intravenous extension tubing which attaches to the subclavian catheter. When in-line membrane filters are used in patients receiving nutrient solutions by gravity rather than propulsion by pump, a minimum pore size of 0.45μ is used in order to permit adequate rate of infusion. The filter and administration set are replaced every three days, or more often as needed.

Nutrient Solution

The hypertonic (1,800–2,200 milliosmoles) nutrient solution, prepared in the hospital's manufacturing pharmacy, consists of glucose, fibrin hydrolysate,* minerals and vitamins essential for the normal metabolism of adults. Slight modifications of this formula provide additional nutrients and trace elements to promote growth and development in infants.[11] Use of the manufacturing pharmacy allows large volume formulation together with proper sterilization and bacteriological and pryogen testing to insure the safety of the solution. However, smaller volumes of the solution can be prepared daily as needed with commercially available parenteral stock solu-

** #600-1203 Harvard Apparatus Co., Inc., Millis, Massachusetts 02054.

*** #XX30 025 00 Millipore Corp., Bedford, Mass. 01730.

* Aminosol, Abbott Laboratories, North Chicago, Illinois 60064.

TABLE 2. *Clinical Application of Total I.V. Nutrition on First 100 Adults*

Diagnosis	No. of Patients	Average Length of Rx
Esophageal obstruction	8	23
Peptic ulcer disease	7	14
Gastric carcinoma	5	18
Biliary tract disease	4	13
Regional enteritis	9	52
Small bowel fistula	9	18
Pancreatitis	5	25
Pancreatic carcinoma	4	22
Colon carcinoma	5	12
Diverticulitis	4	21
Ulcerative colitis	4	9
Burns	1	28
Portal vein thrombosis	1	100
Small bowel sarcoma	1	32
Liver failure	3	32
Renal failure	7	16
Colon fistula	2	30
Pelvic carcinoma	2	15
Z-E syndrome	2	15
Aortic aneurysm	2	8
Portacaval shunt	2	10
Others	13	21

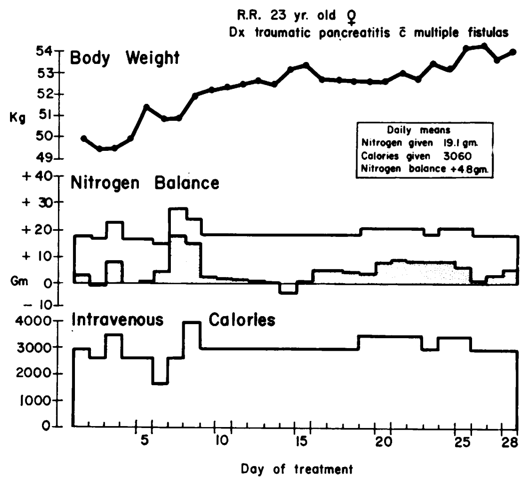

FIG. 4. Metabolic events following total parenteral nutrition in a patient with pancreatitis, peritonitis and hemorrhage secondary to abdominal trauma sustained in an automobile accident. Abdominal exploration, resulting in small bowel resection, splenectomy and peritoneal drainage, was followed by wound disruption, multiple enterocutaneous fistulas and prolonged ileus. Recovery and rehabilitation was complete with spontaneous fistula closure which occurred during the period of total parenteral hyperalimentation.

tions. Using aseptic technic and working preferably under a laminar flow filtered air hood, 250 ml. is discarded from a liter bottle of 5% dextrose in 5% protein hydrolysate or amino acid solution, and 350 ml. of 50% glucose is added. The resultant 1100 ml. of solution will provide approximately 5.25 Gm. nitrogen, 212 Gm. dextrose and 1,000 calories. Electrolyte concentrates are added as required, usually 50 mEq sodium chloride and 40 mEq potassium chloride per bottle of solution. To one bottle, 10 ml. of a multivitamin preparation * containing fat and water soluble vitamins are added. Calcium, phosphorus and magnesium are added to the solution when indicated by serum deficiencies (Table 1).

Administration

The basic nutrient solution, composed of 20% glucose and 5% fibrin hydrolysate, contains 1,000 calories and 6 Gm. of nitrogen per 1,000 ml. Each morning the mineral requirements are determined from serum or urine studies and appropriate electrolyte concentrates, vitamins and trace elements are added. Starting at established levels of fluid metabolism (2,500 ml.) and carbohydrate utilization (0.5 Gm./Kg./hr.) the parenteral mixture is gradually increased to levels of tolerance (up to 5,000 ml. and 1.2 Gm. glucose/Kg./hr.).

The solution is administered continuously at a constant rate 24 hours per day to achieve maximum metabolic efficiency and assimilation of the nutrients. Daily determinations of body weight and fluid balance, fractional urine sugar concentration and regular serum electrolytes, blood urea nitrogen and sugar are basic guides for safe administration of the intravenous solution.

Periodic adjustment of glucose and electrolyte administration may be required during the clinical course of the critically ill patient. Relative glucose intolerance may occur during operation, in the immediate postoperative period, in the presence of

* M.V.I., USV Pharmaceutical Corp., New York, N. Y. 10017.

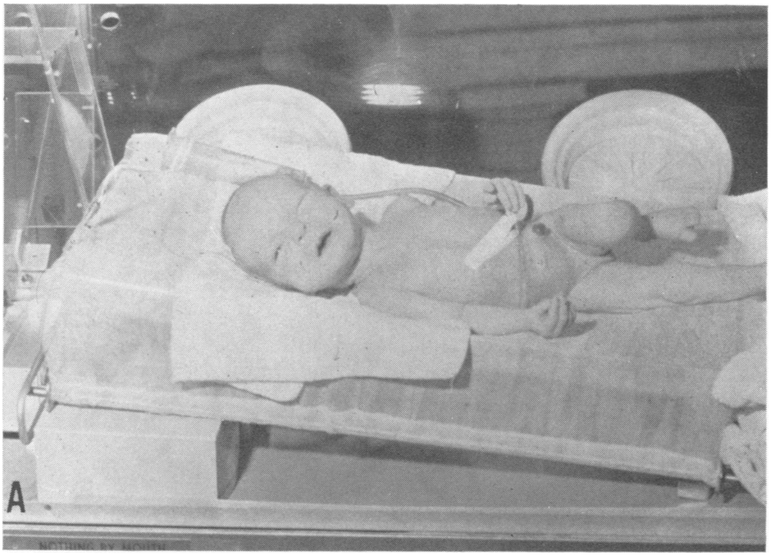

FIG. 5A. Infant with near-total small bowel atresia supported with parenteral hyperalimentation from 25 days of age.

sepsis or at the initiation of intravenous nutrition therapy. To avoid persistent glucosuria and secondary osmotic diuresis, the glucose is infused at a rate that will not allow quantitative urine glucose to exceed 2 per cent. The glucose administered is gradually increased as the normal pancreas increases the output of endogenous insulin in response to the carbohydrate infusion. In patients with diabetes mellitus, crystalline insulin is given subcutaneously in evenly divided doses every 6 hours, or the appropriate dosage equally distributed in the intravenous fluid. Supplemental crystalline insulin is sometimes added to the nutrient solution in amounts of five to fifteen units per 1,000 calories to encourage more rapid and efficient glucose utilization and positive nitrogen balance in elderly patients with borderline glucose tolerance, patients with pancreatic disorders, and critically ill, nutritionally depleted patients in whom the achievement of positive caloric and nitrogen balance are deemed urgent for survival.

Careful attention to potassium administration is essential to achieve positive nitrogen and potassium balance, and restoration of depleted intracellular stores while maintaining a normal serum potassium level. The usual daily intravenous dosage of 40–60 mEq potassium is generally insufficient to maintain normal serum potassium with the intracellular movement of this cation associated with anabolism. The obligatory daily excretion of potassium in the urine in the usual surgical patient receiving isotonic intravenous fluids approximates

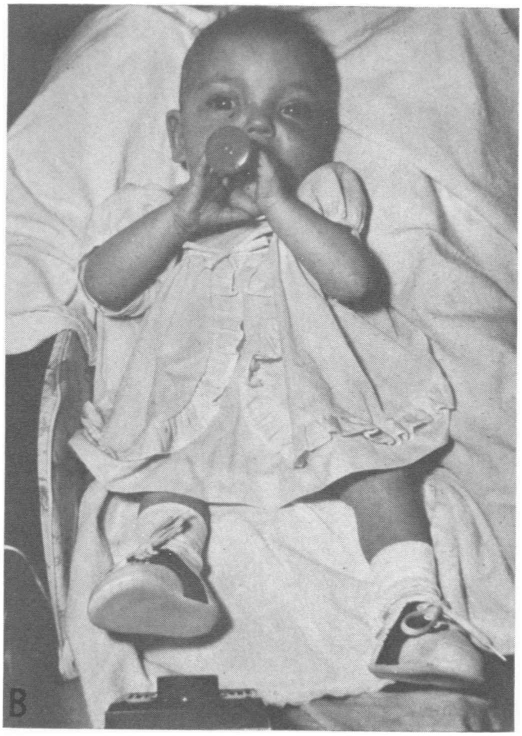

FIG. 5B. Same infant shown in Fig. 5A, at 400 days.

TABLE 3. *Total Parenteral Hyperalimentation with Weight Gain during Conditions Generally Associated with Catabolism*

Patient	Diagnosis	Operation	Days of Hospitalization	Days of I.V. Therapy	Body Wt. in Lbs. Admission	Body Wt. in Lbs. Discharge	Weight Change
C. D.	Pyloric obstruction	Subtotal gastrectomy	17	13	165	167.5	+2.5
M. W.	Esophageal tumor	Distal esophagectomy	48	19	97.5	112	+14.5
J. H.	Pancreatitis, colocutaneous fistula, sepsis	Transverse colostomy, right colectomy	45	39	136	140	+4
E. W.	Achalasia of esophagus	Esophagomyotomy	150	54	80	105	+25
D. D.	Chronic pancreatitis, portal vein thrombosis	Mesocaval shunt, drainage subphrenic abscess	138	100	106.5	115	+8.5
A. H.	Granulomatous enteritis and colitis	Right colectomy	41	22	110	116	+6
D. B.	Regional ileitis with enterocutaneous fistula	Subtotal ileocolectomy	38	31	116	131	+15
J. B.	Granulomatous colitis	Total colectomy with A-P resection	43	9	90	93	+3
R. R.	Regional duodenitis with obstruction	None	31	14	142	150	+8
F. G.	Granulomatous colitis	None	22	12	162	171	+9
R. D.	Granulomatous colitis	None	40	21	89.5	103.5	+14

40–60 mEq, and this loss may be increased with additional stress.[5] Not only is it necessary to replace this obligatory loss, but increased intake of potassium is essential to achieve weight gain and protein synthesis[2, 6] Therefore, in order to maintain adequate serum levels and the normal potassium-nitrogen ratio (2.43–3.5:1) required for tissue synthesis, potassium must be administered in larger doses than with routine intraveous therapy. Usually, 40 mEq potassium chloride are needed for each 1,000 calories (1 liter solution) and, at times, patients with large losses from the gastrointestinal tract may require up to 250 mEq potassium per day. In the presence of varying degrees of renal, cardiac or hepatic failure, vigilance must be maintained in the daily observation of serum values, urine output and quantities administered of potassium to prevent serious complications of hypo- or hyperkalemia.

Fifty milliequivalents of sodium are usually given per 1,000 calories, either completely as the chloride salt or ⅔ sodium chloride and ⅓ sodium bicarbonate. Adjustments in the amount and form of sodium administered are sometimes necessary. Compromised function of the heart, liver or kidneys may dictate significant reduction or even total restriction of sodium in the intravenous ration for varying periods of time.

In patients with marked hypoalbuminemia, 12.5 to 25 Gm. of albumin are sometimes given to rapidly restore colloid osmotic pressure while supplementing nutrition. In the vast majority of cases, however, serum albumin will increase sufficiently with the judicious administration of the nutrient solution alone.

Results

Over 300 adult patients with a multitude of diseases precluding nourishment by the gastrointestinal tract have been supported exclusively by vein with 2,400 to 5,000 calories per day for 7–210 days (Table 2). Weight gain and increased strength and activity were consistently observed in all patients despite a wide variety of conditions usually associated with a catabolic response (Table 3).

Strongly positive nitrogen balance has been regularly achieved in adults fed entirely intravenously during preoperative preparation (Fig. 2), intraoperative therapy (Fig. 3), and postoperative management (Fig. 4). Increases in body weight of as much as 25 pounds were observed in patients during the clinical courses complicated by prolonged ileus, sepsis and wound disruption, often requiring multiple operative procedures. Prompt healing of previously indolent wounds and sinuses was associated with the achievement of the anabolic state. Persistent fistula closure occurred with total parenteral hyperalimentation which not only supplied adequate nutrients but minimized gastrointestinal secretory and motor activity (Table 4).

More dramatic has been the normal growth and development of twelve newborn infants (Table 5) nourished by intravenous feedings for 7–400 days (Fig. 5).

Despite multiple or complex congenital anomalies of the gastrointestinal tract and repeated operative procedures (Fig. 6) a constant and predictable weight gain was obtained with total parenteral nutrition associated with normal metabolism,[10] wound healing (Fig. 7), increased activity and survival (Fig. 8).

Discussion

Parenteral nutrition has been progressively improved in each decade, but rarely, if ever, has a prolonged sustained and meaningful state of anabolism been achieved exclusively with intravenous feeding. The depleted patient with severe disability of the alimentary tract requires increased nutritional support for restoration of body tissues and metabolism.[9] Superimposed on this need are the increased en-

TABLE 4. *Healing of Enterocutaneous Fistulas on Total I.V. Nutrition*

Location of Fistula	Patients	Avg. Days of Therapy
Cervical esophagus	1	10
Thoracic esophagus	1	33
Abdominal esophagus	1	21
Gastroduodenostomy	1	20
Gastrojejunostomy	1	23
Duodenum	3	28
Pancreas	4	33
Jejunum or ileum	10	19
Colon	3	30

ergy and nitrogen requirements resulting from the preoperative and intraoperative periods of starvation, the postsurgical catabolic response and the accelerated catabolism resulting from postoperative complications. The administration of 5% dextrose solutions supplies about 500 calories per day, approximately one sixth the requirement of the depleted surgical patient. Ten per cent dextrose solutions also fall short of meeting caloric needs, intravenous fat emulsions are currently still unavailable in this country, and intravenous ethanol has limited usefulness. To achieve tissue synthesis and anabolism, large quantities of essential nutrients—nitrogen, calories, vitamins and minerals—are required, and this requirement can be satisfied with parenteral hyperalimentation.

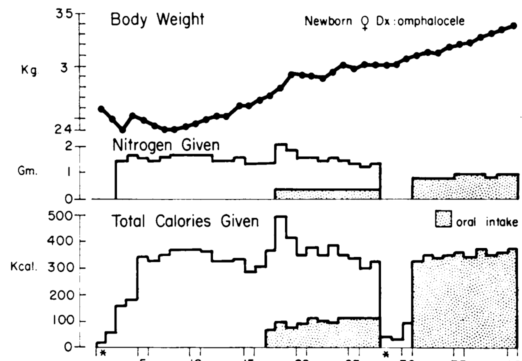

FIG. 6. Parenteral hyperalimentation in an infant with intrauterine rupture of a large omphalocele allowed decompression of the intestine, growth of the abdominal cavity and enlargement of the skin flaps of the abdominal wall permitting closure of the defect on the 35th day.

FIG. 7A.

By the intravenous administration of basic nutrients, tissue synthesis, weight gain, growth and development can be achieved, to the benefit of patients with complex gastrointestinal disease. Fistula closure is best accomplished by a therapeutic combination of tissue anabolism and bowel rest. Patients with inflammatory diseases of the gastrointestinal tract may gain weight as total parenteral nutrition minimizes the mechanical and secretory irritation of the bowel, providing optimal conditions for resolution and healing of the diseased viscera. If surgical procedures are eventually undertaken, the patient is in a better nutritional state to resist infection and withstand operative and anesthetic stress. Infants with multiple or complex anomalies may grow and develop while reconstructive procedures are staged as indicated in their rehabilitative courses. Finally, maintenance of the anabolic state in all patients requiring major operative procedures may allow a decreased incidence in operative complications and infections, reduce duration and cost of patient hospitalization, and allow more rapid patient rehabilitation and restoration to productive life.

FIG. 7A and B. Complete healing of the omphalocele fascial defect occurred during the period of total intravenous nutrition.

Parenteral hyperalimentation should be considered a primary mode of therapy rather than a modified method of standard intravenous treatment. Every effort should be exerted to insure strict asepsis and antisepsis in dealing with the nutritional solution, intravenous infusion tubing, the indwelling catheter and the catheter entrance site. The nutrient solution is an excellent culture medium for bacteria and fungi with direct access to the blood stream, and vigorous precautions must be taken to avoid their contamination. The possibilities of infection are greatly minimized by using a closed infusion system to avoid air-borne contamination, in-line membrane filter to insure solution sterility, laminar air flow hood for mixing and handling solutions and additives, and meticulous technic in the insertion and maintenance of the catheter. The nursing staff must be made aware of their responsibility to insure constant continuous infusion of the nutrient solution. The intern and resident staff must be knowledgeable of the expected sugar and electrolyte flux and the possibility of osmotic diuresis with secondary hyperosmolar dehydration. Finally, the surgeon may re-

TABLE 5. *Results of Total Parenteral Nutrition in the First Nine Newborn Infants*

Patient	Sex	Diagnosis	Length of Therapy (Days)	Weight Gain (Gm.)
M. M.	M	T. E. Fistula duodenal atresia	24	420
L. D.	F	Intrauterine ruptured omphalocele	28	700
K. B.	F	Massive small bowel atresia	400	4,000
L. P.	F	Pharyngeal-esophageal dyskinesia	68	1,350
Y. J.	F	Mid gut volvulus	26	420
M. W.	M	Idiopathic diarrhea	14	350
B. M.	M	Malabsorption, congenital heart disease	7	100
M. G.	M	Diaphragmatic hernia	14	620
W. R.	F	Intrauterine rupture gastroschisis	40	440

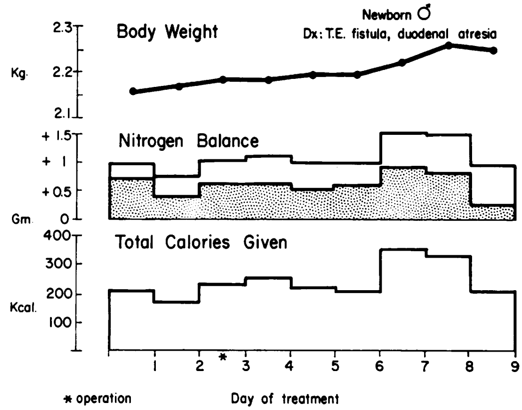

FIG. 8. Premature infant with tracheo-esophageal fistula, duodenal atresia, cleft palate, inguinal hernia, atrial septal defect, pneumonia and coagulation disorder survived multiple operative procedures. Division of the T-E fistula, esophageal reconstruction and correction of the abdominal defects were staged while the patient was supported with total intravenous nutrition. Metabolic data obtained during bypass of the duodenal atresia demonstrate consistent tissue anabolism throughout the operative and postoperative period.

quire the help of the pharmacist, biochemist, psychiatrist, social worker and physical therapist to meet the needs of the extremely ill, nutritionally depleted patient.

Can intravenous feeding as the sole means of nutrition support growth in the child and restore weight loss in the adult? The answer is definitively affirmative. The technic of parenteral hyperalimentation offers a new dimension in the study, care and management of the surgical patient.

Summary

Continuous infusion into the superior vena cava of hypertonic nutrient solutions containing large amounts of nitrogen, calories and vitamins and required amounts of electrolytes can be accomplished safely for long periods of time with meticulous attention to preparation and administration of the solution. With the exclusive use of parenteral hyperalimentation, weight gain, positive nitrogen balance, growth and development have been regularly achieved. This technic allows adequate metabolic support of patients with severe nutritional debility or prolonged disability of the gastrointestinal tract and adds a valuable tool to the repertoire of the surgeon and investigator.

Acknowledgment

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Discussion

Dr. Ward O. Griffen, Jr. (Lexington): I'd just like to congratulate Dr. Rhoads on his beautiful paper and presentation, and also say that Dr. van Rush and I have been interested in the use of this material in patients undergoing surgery, and in our Clinical Research Center at Lexington, Kentucky, have done extensive balance studies on these patients.

We would concur that it is possible in major surgery to develop positive nitrogen balance and maintain it with the continual use of this intravenous material. We have not seen any glycosuria in these patients, all of whom have had excellent renal function.

We have now studied 14 patients who have had a variety of procedures, including laryngectomy and bilateral neck resection, abdominal perineal resection, posterior exenteration, et cetera. So they are, on Dr. Moore's old scale, fairly extensive operations which usually have been considered to produce negative nitrogen balance.

In studying the electrolyte balance, however, we have been interested in the fact that we can maintain positive potassium and sodium balance, but, even more interesting, we have a fantastic postive chloride balance, which we have been unable to explain—where the chloride is going.

I wonder if you have seen this, and if you have any explanation for it.

Dr. Stanley J. Dudrick (Closing): In response to Dr. Griffen, I am not exactly sure where all the chloride goes myself. We have noted, as he has, a marked potassium and sodium balance, and have felt that this represented intracellular movement of the potassium and sodium, which would be the normal flux of these electrolytes with an embolism and incorporation of nitrogen and protein into the cell.

We have had likewise an inordinate chloride balance. Whether this is because we have been giving the salts primarily as chloride salts has not really been investigated at this point sufficiently to give you an adequate answer.

We are now engaged in isotopic studies of the basic electrolytes, and I hope that in the next year or so we might be able to give a little more basic knowledge to exactly what does happen to the various electrolytes and, eventually, amino acids of the mixture.

I want to show you one other rather striking case that we had in a newborn infant with an alkalocele, with most of his gut cut out, as you see, on the abdominal wall. We have had experience now with three such infants. Generally in patients such as this there is a mortality of about 94 to 100 per cent. Thus far we have been fortunate enough to save all three of these infants that have come to us, by a combination of, probably, good surgery and Children's Hospital, and, hopefully, some support from parenteral hyperalimentation.

This child was operated on immediately after admission. However, the body was too small to admit all this bowel that you see here, and, therefore, a silastic mesh was sewn around the perimeter of the fascial defect, and then covered over with moist gauze that was kept wet with Zephiran for a period of several weeks.

The next slide I believe shows (slide) the period during which she was fed entirely by vein from the operation and from her day of birth, for the first 26 days. At that point she had gained sufficient weight and had expanded her body wall sufficiently that we could then take out the mesh and close the fascia, primarily.

(Slide) The next slide shows that having been done, and you can see the skin granulating in over the closed fascial defect; and this child went on to be discharged from the hospital and to grow in a normal percentile for her weight.

(Slide) The last slide just shows the subclavicular-subclavian technic, which we believe is very essential to the success of our parenteral feeding. We feel it is very important to have the minimum length of catheter intravascularly, with the minimum amount of dead space around the catheter, and therefore go percutaneously into a large bore vessel, rather than threading the catheter up a cephalic or median antecubital vein.

With this technic, with proper attention to anatomical landmarks, pneumothorax has never been a complication in the over 700 patients that we have utilized this technic on thus far.