Total Parenteral Nutrition: A Guide to Therapy in the Adult

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Total parenteral nutrition (TPN), often referred to as intravenous hyperalimentation, is a complex technique for parenteral feeding that can be lifesaving. A basic knowledge of the theory behind, indications for, and hazards of TPN can help the practitioner determine which of his patients will benefit from this procedure. In the community hospital, where a skilled hyperalimentation team is not available, TPN can be managed safely by a physician, pharmacist, and floor nurse if there is rigid adherence to a strict protocol. This paper presents the basic theory, indications, and contraindications associated with TPN, and details a protocol for administering total parenteral nutrition to the adult, hospitalized patient (Appendices 1, 2).

Total parenteral nutrition (TPN) is a method of administering intravenous nutrients to the patient who cannot tolerate food via his/her alimentary tract, or cannot meet his increased metabolic demands by means of oral or tube feeding. Nutrient solutions used in TPN promote tissue synthesis and anabolism by providing nitrogen from amino acids, calories from concentrated sugar, fatty acids from lipids, and vitamins, electrolytes, and trace metals.[1]

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Indications

Although there are no absolute criteria for instituting TPN, it is indicated in the starved or semi-starved patient with a nonfunctional gastrointestinal tract. The degree of malnutrition is often easily assessed from the history of weight loss or from the clinical picture, but due to obesity or edema, derangements of nutrition may be subtle and require additional studies such as: anthropometric measurements of upper arm circumference and triceps skin fold thickness (Figure 1); laboratory studies consisting of serum albumin levels, urinary nitrogen levels, total lymphocyte count, serum iron binding capacity; and reactions to multiple skin test antigens[2] (Figure 2).

Among the indications for instituting TPN are:

1. *Short Bowel Syndrome:* When the absorptive area of the small intestine has been bypassed or reduced as a result of fistula formation or resection, TPN can maintain the patient until the fistula has closed or until the remaining segment of intestine has regained its absorptive capacity.

2. *Prolonged Ileus:* A variety of metabolic, traumatic, and inflammatory conditions can paralyze the alimentary tract for extended periods. Poor nutritional states resulting from the prolonged ileus of peritonitis or retroperitoneal trauma can be improved until normal alimentation is resumed.

3. *Acute Inflammatory or Catabolic Processes:* Total parenteral nutrition can be used as an adjunct in treating acute pancreatitis, in supplying nutrients that do not stimulate digestive hormones, or in treating enterocolitis when the digestive tract must be placed at rest. Increased nutritional demands of hypermetabolism secondary to severe sepsis, multiple fractures, or extensive burns can be met when TPN is begun early.

4. *Mechanical Obstruction:* Although patients with acute gastrointestinal obstruction require immediate surgical intervention, individuals with partial obstruction from operable esophageal tumor, stenosing peptic ulcer, radiation enteritis, or diverticulitis often suffer from malnutrition that TPN can alleviate before surgical correction is undertaken.

5. *Cancer Therapy:* Poor nutrition, a common finding in advanced cancer patients, often prevents optimal antitumor therapy. Tumor patients having reasonable chances for response to antineoplastic therapy are often candidates for TPN. Intravenous hyperalimentation can nutritionally prepare, maintain, or rehabilitate cancer patients undergoing radiation therapy, chemotherapy, or immunotherapy, allowing increased treatment levels that otherwise might be limited by malnutrition.[3]

Contraindications

The ability of an individual to meet his nutritional needs by means of the alimentary tract is the only absolute contraindication to TPN. A severe diabetic or a patient in renal or hepatic failure after suitable study may be started on TPN since the underlying metabolic problem is no contraindica-

Appendix 1. Total Parenteral Nutrition Protocol for Physician

A. Initiating TPN:

1. Obtain baseline laboratory studies 24 hours prior to starting TPN, consisting of: complete blood count, urinalysis, SMA-6, SMA-12, serum magnesium level, blood ammonia level, prothrombin time, serum osmolality.
2. Order hyperalimentation formula (HAF) from pharmacy, 2,000 cc minimum.
3. Place Foley catheter.
4. Insert subclavian venous catheter (Appendix 3).
5. Order "TPN Regimen First 24 Hours" consisting of:
   - I. Routine HAF at 40 ml/hr for six hours; 65 ml/hr for six hours; increase by 20 ml/hr until maximum of 125 ml/hr* is reached.
   - II. SMA-6 and serum phosphate determination at four hours and eight hours.
   - III. Vital signs every two hours and observe patient closely for any signs of hyperglycemia.
   - IV. Urine sugar determination every four hours.
   - V. Sliding scale regular insulin.

4 + nitroprusside	15 units subcutaneously
3 + nitroprusside	10 units subcutaneously

   - VI. Strict intake and output.
6. Change electrolyte and insulin formulation in HAF according to laboratory data.

B. Maintaining TPN

1. Order "TPN Maintenance Regimen" consisting of:
   - I. HAF 125 ml/hr.
   - II. Vitamin intramuscular injection every Monday.

Vitamin K_1 (AquaMephyton)	10.0 mg
Folic acid	2.5 mg
Vitamin B_{12}	50.0 μg
Iron (Imferon)	100.0 mg

   - III. Soybean oil emulsion (Intralipid 10%) 500 ml every Monday and Friday.
   - IV. Vital signs every four hours.
   - V. Urine sugar determination every six hours.
   - VI. SMA-6 every AM X seven days, then Monday, Wednesday, Friday.
   - VII. SMA-12 every other day X three days, then Monday and Friday.
   - VIII. Serum osmolality every day X seven days, then Monday, Wednesday, Friday.
   - IX. Complete blood count Monday and Friday.
   - X. Blood ammonia level every Monday.
   - XI. Prothrombin time every Monday.
2. Remove Foley catheter when blood glucose is stable.
3. Change subclavian dressing and IV extension tubing every third day (Appendix III).
4. Consult with physical and occupational therapy.
5. After blood glucose and electrolytes are stable for two weeks, reduce SMA-6 and SMA-12 determinations to once or twice weekly.
6. After 30 days of TPN order trace metal formula 1.0 ml added to one bottle HAF every AM.
7. Adjust formulation of HAF according to laboratory data.

C. Discontinuing TPN:

1. Order "TPN Reduction Regimen," consisting of:
   - I. HAF reduce rate by 30 ml/hr every 24 hours.
   - II. Begin liquids 30 cc orally every hour, advance as tolerated.
   - III. No insulin to be added to last 1,000 ml HAF.
   - IV. Observe closely for any symptoms of hypoglycemia.
2. When patient's oral intake is sufficient for maintenance, remove subclavian line and culture tip.
3. Discontinue intramuscular vitamin injection.
4. Discontinue soybean oil emulsion.
5. Discontinue SMA-6, SMA-12, serum osmolality, complete blood count, prothrombin time, blood ammonia level.
6. Discontinue urine sugar determinations and sliding scale of insulin after HAF is stopped.
7. Discontinue flow sheet.

*Usual rate for average adult, to deliver all nutrients in 3000 ml.

Appendix 2. Total Parenteral Nutrition Protocol for Nurse

A. Instituting TPN:

1. Obtain all baseline laboratory data.
2. Weigh patient accurately.
3. Start accurate intake and output.
4. Begin flow sheet (two copies); place one copy on chart and send one copy to pharmacy (Figure 3).
5. Set up peripheral IV of 0.45 percent saline 1,000 ml and start with #18 indwelling needle and keep open rate.
6. Keep D-50-W two ampules, and D-10-W 1,000 ml at bedside.
7. Assemble subclavian catheterization material.
8. Assist with subclavian catheterization.
9. Obtain hyperalimentation formula (HAF) 2,000 ml from pharmacy and refrigerate; return any unused HAF after 24 hours.
10. Keep HAF infusion rate steady; notify physician of any change in rate.
11. Observe patient closely for any intolerance, particularly hyperglycemia.
12. Change HAF bottle every eight hours using mask and aseptic technique.
13. See that no blood is drawn from subclavian catheter line.
14. See that nothing other than HAF is administered through subclavian catheter line.
15. Change IV tubing, pump assembly, and filter every day using mask.
16. Obtain and record laboratory data as soon as possible, notifying physician of any abnormality.
17. Check urine sugar every four hours and administer insulin if required.

B. Maintaining TPN:

1. Vital signs every four hours.
2. Urine sugar determination every six hours and administer insulin if required.
3. Strict intake and output.
4. Weigh patient accurately every morning.
5. Maintain flow sheet.
6. Maintain steady flow rate of HAF; don't accelerate flow "to catch up."
7. If HAF is interrupted immediately begin D-10-W through subclavian line.
8. See that nothing is added to or taken from subclavian catheter line.
9. Store HAF in refrigerator; return all unused HAF to pharmacy after 24 hours.
10. Observe HAF closely for crystallization or clouding and check bottle for cracks.
11. Change HAF bottle every eight hours.

C. Discontinuing TPN:

1. Observe closely for signs and symptoms of hypoglycemia.
2. Keep orange juice available by mouth, or D-50-W for IV administration.

tion. Altered immunologic states resulting from radiation, chemotherapy, or immunosuppression are not contraindications to TPN. Malignancy is a contraindication only when the disease is terminal – TPN should not be used to prolong any hopeless situation.

Nutrient Energy Requirements

In 1967, Dudrick[4] and associates demonstrated normal growth and development in pups maintained only with parenteral nutrients of glucose, protein hydrolysates, electrolytes, vitamins, and trace minerals. Experience has shown that all requirements of sustained anabolic metabolism in a critically ill patient can be met by means of these original nutrient solutions, but the addition of fat emulsion will prevent essential fatty acid deficiency while providing an additional source of calories and free water.

The average adult male requires 27 to 30 kcals/kg/day to supply his resting metabolic demands, while the average adult female requires only 23 to 26 kcals/kg/day. Elective surgery increases energy requirements minimally, by ten percent or less, but major trauma such as multiple fractures or extensive burns can double caloric needs.[5] Tissue anabolism requires energy, and the incorporation of 1 gm of nitrogen (6.25 gm of protein) into lean tissue requires 150 to 200 kilocalories.

In the TPN regimens currently approved for general use, calories are supplied mainly by carbohydrates. Glucose, the only unequivocally acceptable form of carbohydrate for TPN, supplies almost 4 kcal/gm that can be utilized by the normal adult at about 0.5 gm/kg/hr. To prevent fluid overload glucose must be administered in hypertonic solutions that require a centrally placed venous catheter to prevent thrombophlebitis. Significantly impaired glucose tolerance occurring in latent or overt diabetics or in patients who are stressed from trauma or sepsis requires that blood glucose levels be carefully titrated by controlling the rate of glucose infusion or administering insulin or hypoglycemic agents; prolonged hyperglycemia and glycosuria must be prevented.

The recent availability of lipid emulsion for intravenous use provides a non-osmotic source of calories that can be administered by peripheral vein.[6] This emulsion, which provides 1.1 kcal/ml, is an energy source that can minimize the hazard of hyperglycemia in the patient who is sensitive to large carbohydrate loads. Intravenous lipid emulsion is contraindicated in the patient with disturbances of fat metabolism or liver disease. Infrequent reactions of dyspnea, fever, headache, flushing, back pain, and coagulation defects, all of which have been noted to mimic transfusion reactions, occur in less than one percent of patients receiving intravenous lipids. Because such reactions are poorly understood, fat emulsion should not exceed 2.5 gm/kg of body weight, or more than 60 percent of the total caloric input.

Nitrogen Requirements

An adult ingesting protein that provides a suitable mixture of amino acids achieves nitrogen balance with an intake of 0.14 mg/kg/day of nitrogen (0.9 gm/kg/day of protein). Patients with decreased lean body mass or with severe tissue damage will require more amino acids to maintain the balance between protein synthesis and breakdown. To insure that nitrogen intake is used for tissue synthesis and not energy production, 150 to 200 kilocalories of non-nitrogen origin must be supplied to incorporate 1 gm of nitrogen (6.25 gm of protein) into lean body tissue. Maximum positive nitrogen balance is obtained with the administration of 0.24 gm/kg/day of nitrogen. The protein requirements of a patient on TPN must be supplied as free amino acids that are available either from hydrolysates of complete protein such as fibrin or casein, or from crystalline amino acid solutions (Table 1). Protein hydrolysates have the disadvantage of containing large amounts of dipeptides, tripeptides, and variable quantitites of nonessential amino acids; however, these nitrogen moieties can be utilized if adequate calories are available.

Fatty Acid Requirements

In the average adult American diet approximately 40 percent of calories are furnished by fats ingested as triglycerides. Carbohydrate can be used in TPN as the single source of energy, but patients who receive prolonged TPN without supplemental fat have exhibited derangements of serum lipids. The infusion of intravenous soybean emulsion has been effective in preventing or correcting fatty acid deficiencies.

Mineral Requirements

Mineral elements, although constituting a relatively small amount of total body mass, are essential to many vital processes. There is no absolute rule to follow in providing minerals to the patient receiving TPN, and the best assurance of electrolyte and other mineral balance is good renal function. In the absence of normal kidney function mineral supplements must be individualized. Normal metabolism plus the metabolism of large glucose loads by the patient receiving TPN require daily electrolyte supplements in addition to the electrolytes present in nutrient solutions.

Sodium, the major cation of *extracellular fluid,* regulates acid-base equilibrium and maintains osmotic pressure of body fluid. Sodium also functions in preserving muscle irritability and the permeability of cellular membranes. Extra renal losses from bowel fistulas or vomiting can increase the basal need for sodium, while heart failure, kidney, or liver disease may necessitate a decrease in sodium intake. Abnormal serum sodium levels are reflected as vague changes in activity or level of consciousness.

Chlorine, as chloride ion, is essential in maintaining osmotic pressure, and is of vital importance in regulating acid-base balance. This anion is also needed in the formation of hydrochloric acid by the stomach. Hyperchloremia can occur during infusion of crystalline amino acid solutions if the amino acids have been precipitated as chloride or hydrochloride salts. Excessive chloride can also result from the addition of mineral supplements.

Potassium is the main cation of *intracellular fluid,* influencing acid-base balance and osmotic pressure within the cell. It is essential in the activation of many enzymatic reactions, notably those involved in the transfer of high energy phosphate in carbohydrate metabolism. Since both tissue anabolism and hyperinsulinism resulting from TPN increase the requirements for potassium, hypokalemia, manifested by lethargy, weakness, or ECG changes, is one of the most common electrolyte derangements encountered in intravenous therapy, particularly in the initial stages of the procedure.

Phosphorus, as phosphate ion, is involved in critical intracellular energy transfer reactions. Hypophosphatemia usually occurs in patients on TPN not given phosphate supplement, and the clinical picture of lethargy and peripheral and circumoral paresthesia resulting from decreased phosphate blood levels can become evident in one week. Hemolytic anemia and increased oxygen affinity for hemoglobin can result from decreased phosphate levels within erythrocytes. Hypophosphatemia may contribute to an increased incidence of infection by depressing the phagocytic and bacterial activity of leukocytes.

Calcium, the most abundant mineral in the body, is found mainly in bone, with less than one percent present in body fluid. Serum calcium is present in both an ionized and an un-ionized form, the ionized portion being of prime importance in maintaining normal excitation of nerves and muscles and in controlling membrane permeability. The signs and symptoms of hypocalcemia – muscular irritability, paresthesia, Chvostek sign, and Trousseau sign – may develop suddenly in the TPN patient given supplemental phosphate. The precipitous drop in serum calcium can be prevented by routinely adding calcium as well as phosphate salts to all hyperalimentation regimens.

Magnesium influences tissue irritability, and the wide occurrence of magnesium in foods makes a deficiency of this element extremely unlikely under most circumstances. However, patients receiving TPN have magnesium stores that are often depleted because of prior malnutrition and continued losses from intestinal fistulas or diarrhea. Although slow to develop, magnesium deficits with resultant mental confusion, twitching, and hyperreflexia can result unless magnesium is regularly supplied in the hyperalimentation program.

Trace Metals: With the exception of iron deficiency and resultant hypochromic anemia, deficiencies of these elements are seldom recognized in man. Because symptoms attributable to decreased blood levels of zinc and copper have been noted in persons maintained on TPN for prolonged periods, patients requiring TPN for longer than one month should receive supplemental zinc, copper, manganese, iodine, chromium, and selenium.[7] These trace elements are best supplied by solutions of their salts added daily to a single infusion rather than by weekly plasma transfusion with their attendant risk of hepatitis. Iron is generally administered by weekly intramuscular injections.

Vitamin Requirements

Increased metabolic and anabolic activity in the typical debilitated individual receiving TPN probably accentuates the need for supplemental vitamins.

Vitamin A: While the mechanism of the effect of this vitamin is unknown, vitamin A is required for tissue repair, and wound healing may be slightly enhanced by supplemental amounts of this vitamin.

B Vitamins: In most cases the B vitamins have not been specifically important to wound healing but major deficiencies would probably affect reparative processes.

Vitamin C: Ascorbic acid is vital in the synthesis of collagen by acting as an essential cofactor for the hydroxylation of proline. Although clinical scurvy is rare, stress may quickly convert latent scorbutus into a clinical deficiency.

Vitamin D: Calciferol is essential to normal calcium metabolism, and its deficiency can lead to poor healing of fractures and to osteomalacia.

Vitamin E: Although alpha tocopherol may not be needed for wound repair, the need for vitamin E may be increased in the TPN patient receiving lipid infusions. The administration of polyunsaturated fatty acids is thought to increase the need for tocopherol.

Vitamin K: This vitamin is of critical importance in blood coagulation, and TPN patients with enteric fistulas or intestinal flora altered by antibiotics may have severe vitamin K deficiency.

Water soluble vitamins and solubilized solutions of vitamins A, D, and K are added as a single solution to one of the daily infusions. Vitamin B_{12}, folic acid, and vitamin K are given as weekly injections. Despite mineral and vitamin supplements, patients on TPN often develop normochromic, normocytic anemia that requires periodic transfusion of packed red blood cells.

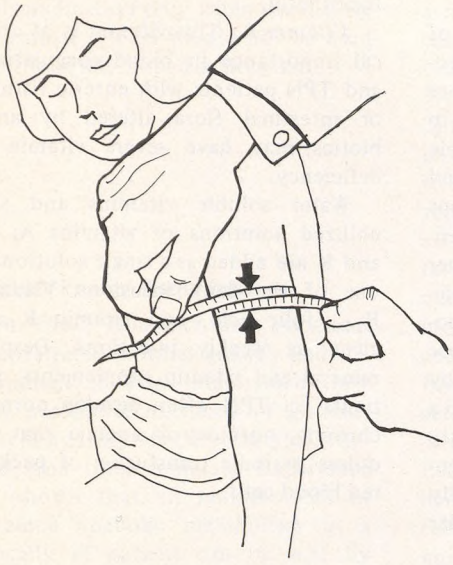
Complications

Difficulties associated with TPN arise from (1) catheter placement, (2) metabolic problems, (3) sepsis, and (4) psychological stress.

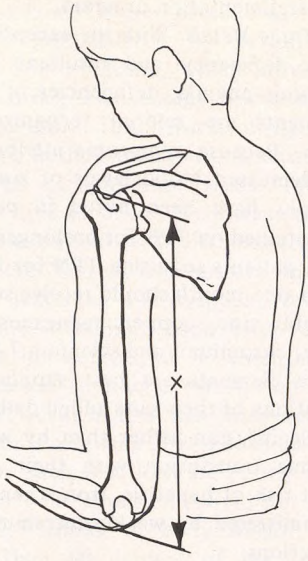
Catheter Placement

Hypertonic glucose, the primary energy source in TPN, requires that nutrient solutions be delivered to a central vein to prevent thrombophlebitis. Although not unanimously agreed upon as to site, a superior caval catheter introduced percutaneously via the subclavian vein is the preferred means of delivering these fluids. Initial puncture with the required large bore needle can result in air embolism, in hemorrhage if the vein is torn or the artery entered, or in pneumothorax if the pleura and underlying lung are lacerated. Perforation of the vein by the catheter tip can result in hemopneumothorax or hydrothorax, if the nutrient fluid is instilled into the chest

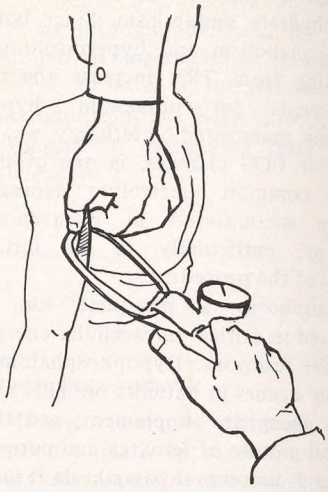
Measurement of Mid-Upper Arm Circumference



Assessing Midpoint of Upper Arm (Halfway between the Acromial Process of the Scapula and the Olecranon Process of the Ulna)



Measurement of Triceps Skin-Fold with Harpender Calipers



Arm Circumference, Adults, Sexes Separate

Sex	Arm circumference (cm)				
	Standard	50% standard	60% standard	70% standard	80% standard
Male	29.3	26.3	23.4	20.5	17.6
Female	23.5	25.7	22.8	20.0	17.1

Triceps Skin-Fold, Adults, Sexes Separate

Sex	Triceps skin-fold (mm)				
	Standard	90% standard	80% standard	70% standard	60% standard
Male	12.5	11.3	10.0	8.8	7.5
Female	16.5	14.9	13.2	11.6	9.9

Figure 1. Techniques for measurement of midupper arm circumference and triceps skin fold. This allows simple and quick assessment of nutritional status to identify muscle depletion and loss of caloric reserves. From Blackburn.[10]

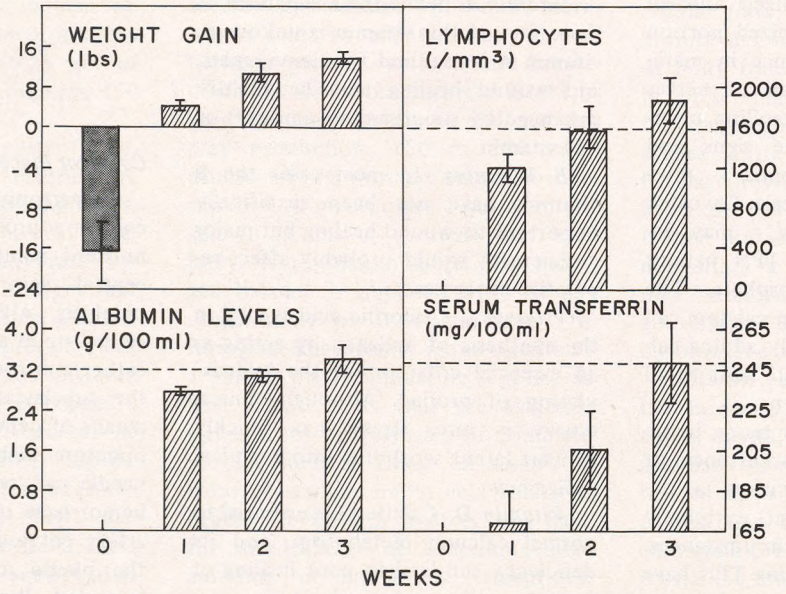


Figure 2. Response to nutritional support in 35 malnourished patients. Significant ($P<.05$) results except for albumin occurred by second week of therapy. These parameters represent the best criteria for assessing the efficacy of nutritional therapy. Transferrin in mg/100 ml = .8 X total iron binding capacity (TIBC) −43. From Blackburn.[10]

PATIENT: _____ DIAGNOSIS: _____

SOLUTION DATA										LABORATORY DATA																	
DATE	Volume (ml) IN	Volume (ml) OUT	Na^+ (mEq)	K^+ (mEq)	Ca^{++} (mEq)	$PO_4 \equiv$ (mEq)	Vits	Trace Metal	Insulin (Units)	Na^+ (mEq)	K^+ (mEq)	CL^- (mEq)	$CO_2 =$ (mEq)	Ca^{++} (Mg %)	$PO_4 \equiv$ (Mg %)	Mg^{++} (mEq)	BUN CR	T. Prot (Gm %)	Alb. (Gm %)	Hct. %	ProTime Control	Blood Glucose (Mg %)	Serum Osmol (mOsm)	Urine Acetone	Weight Lbs Kg
										135-145	3.5-5	95-105	24-32	8.5-10.5	2.5-4.5	1.3-2.5	10-20 .7-1.5	6-8	3.5-5	37-50	secs secs	65-110	285-295		

Figure 3. Total Parenteral Nutrition Flow Sheet

Table 1. FreAmine II (Amino Acid Injection, McGaw)

Each 100 ml contains:	
L-amino acid mixture	8.50 gm
Total nitrogen	1.42 gm
Essential Amino Acids (approximate concentration per 100 ml)	
L-isoleucine	0.59 gm
L-leucine	0.77 gm
L-lycine acetate 0.87 gm (free base)	0.62 gm
Methionine	0.45 gm
L-phenylalanine	0.48 gm
L-threonine	0.34 gm
L-tryptophan	0.13 gm
L-valine	0.56 gm
Nonessential Amino Acids (approximate concentration per 100 ml)	
L-alanine	0.60 gm
L-arginine	0.31 gm
L-histidine	0.24 gm
L-proline	0.95 gm
L-serine	0.50 gm
Aminoacetic acid (glycine)	1.70 gm
L-cysteine · HCl · H_2O	0.02 gm
Electrolytes (per 100 ml)	
Sodium	10 mEq
Phosphate	20 mEq
Chloride	Negligible

cavity. The catheter tip may inadvertently enter the jugular vein or internal mammary vein and cause phlebitis and subsequent thrombosis of the superior vena cava.

Metabolic Problems

Although metabolic difficulties associated with TPN are varied, the most frequent problems encountered are those associated with the metabolism of glucose, calcium, phosphorus, and electrolytes. As does a normal person, a patient receiving TPN has a blood glucose level that is dependent upon glucose supply and glucose utilization (tolerance). The former is dependent upon the concentration and rate of delivery of the intravenous carbohydrate, while the latter is dependent upon endogenous insulin utilization. Significantly impaired glucose tolerance can occur in patients with diabetes, stress, sepsis, or shock. Greatly elevated blood glucose levels and associated glycosuria can result in hyperosmolar nonketotic coma, dehydration, and death.[8]

Nondiabetic patients on TPN, upon receiving an initial glucose-containing nutrient infusion, will have a lag before endogenous insulin is at a level sufficient to prevent hyperglycemia; therefore, TPN infusion rates must be carefully controlled and frequent blood glucose and urine sugar levels determined in order that the infusion can be cautiously increased to the maximal tolerated rate. Diabetic patients on TPN respond as they would to an oral glucose load, and supplementary insulin or hypoglycemic agents must be added to the infusion, or insulin must be given subcutaneously, to prevent hyperglycemia. Because a poor feedback mechanism exists between blood insulin level and the pancreas, a patient initially requiring a specific amount of exogenous insulin may develop hypoglycemia at the same glucose level at a later time.

Appendix 3. Subclavian Catheter Insertion and Care Protocol for Nurse and Physician

CATHETER INSERTION

Materials:

1. Disposable razor prep kit
2. Sterile gauze pad 4 in X 4 in
3. Acetone
4. Povidone-iodine (Betadine) solution
5. Subclavian catheter (Deseret)
6. Sterile towels (four)
7. Lidocaine solution one percent unopened
8. Ten cc syringe sterile
9. 22 gauge 1 1/2 inch sterile needle
10. Suture set
11. 2-0 nylon suture with cutting needle
12. Povidone-iodine (Betadine) ointment
13. IV tubing
14. IV filter 0.5 micron (Travenol)
15. IV extension set
16. D-5-W 500 cc
17. IV pump (IMED)
18. Tincture benzoin liquid
19. Adhesive paper tape
20. Mask

Method:

1. Assemble IV tubing and attach to D-5-W 500 cc.
2. Shave, degrease skin.
3. Prep skin for two minutes with povidone-iodine solution.
4. Raise skin wheal and infiltrate subclavian area with local anesthesia.
5. Subclavian venipuncture with patient in Trendelenburg position and head turned.
6. Attach D-5-W to catheter, lower bottle, and see blood flash back; run at slow rate.
7. Suture catheter to skin, apply povidone-iodine ointment and sterile dressing.
8. Check catheter placement by x-ray film of chest.
9. Run D-5-W with IMED pump at slow rate through IV filter.

DRESSING CHANGE

Materials:

1. Mask and sterile gloves
2. Acetone
3. Povidone-iodine (Betadine) solution
4. Sterile gauze pad 4 in X 4 in
5. Extension tubing
6. Tincture benzoin liquid
7. Paper tape

Method:

1. Every third day, with mask on, remove dressing and inspect catheter site carefully.
2. Defat skin and prep in sterile fashion with povidone-iodine (Betadine) solution.
3. Change extension tubing with minimal interruption of flow.
4. Apply povidone-iodine (Betadine) ointment to puncture site and cover with sterile dressing.

Appendix 4. Total Parenteral Nutrition Protocol for Pharmacist

Preparation of Hyperalimentation Formula (HAF)

A. Materials:

1. FreAmine II Kit (McGaw)
   - Amino Acid Mixture 8.5%, 500 ml (equivalent to 39 gm protein)
   - Hypertonic glucose in water 50 percent, 500 ml
   - Transfer Set
   - Sterile Bottle Cap
   - Pressure Label
2. Electrolyte Additive Solutions
   - Sodium (chloride, phosphate, or acetate)
   - Potassium (chloride, phosphate, or acetate)
   - Magnesium (sulfate)
   - Calcium (gluconate)
   - Phosphate (potassium acid salt)
3. Multiple Vitamin Infusion, MVI (USV Pharmaceutical) 10 ml

Ascorbic acid (C)	500 mg
Vitamin A	10,000 IU
Vitamin D (ergocalciferol)	1,000 IU
Thiamine HCl (B_1)	50 mg
Riboflavin (B_2)	10 mg
Pyridoxine HCl (B_6)	15 mg
Niacinamide	100 mg
Dexpanthenol	25 mg
Vitamin E (dl-alpha tocopherol acetate)	5 IU

4. Trace Metal Solutions 1.0 ml

Zinc (sulfate)	2.0 mg
Copper (sulfate)	0.4 mg
Manganese (sulfate)	0.20 mg
Iodide (sodium)	0.056 mg

5. Insulin, regular
6. Mask
7. Isopropyl alcohol 70 percent

B. Method:

Under a laminar flow hood using mask and asceptic technique:

1. Swab work surface with alcohol and let dry.
2. Swab neck and shoulders of all containers with alcohol and let dry.
3. Calcium gluconate,[A] add to D-50-W solution and mix thoroughly.
4. Electrolyte solutions,[A] insulin,[A] and trace metal solutions,[B] add to amino acid solution and mix thoroughly after each addition taking care not to loose vacuum.
5. D-50-W solution with calcium gluconate, add to amino acid mixture using transfer set.
6. Multivitamin solution,[C] add to amino acid D-50-W solution.
7. Cap bottle with sterile cap after washing top with alcohol.
8. Label bottle detailing each additive.
9. Refrigerate (store no longer than 24 hours).

[A] Each 1000 ml of routine hyperalimentation fluid (HAF) contains the following additives:

Calcium gluconate	4.5 mEq
Potassium chloride*	40.0 mEq
Sodium chloride*	40.0 mEq
Potassium acid phosphate	20.0 mEq
Magnesium sulfate	10.0 mEq
Crystalline insulin**	15.0 μ

* Acetate salts of potassium and sodium may be substituted for chlorides when metabolic acidosis is present.

** Decreased or increased amounts of insulin may be required in those with impaired glucose tolerance.

[B] Trace metal solution 1.0 ml is added to one bottle HAF each day after one month of TPN.

[C] MVI, ten ml ampule is added to one bottle HAF each day.

Sepsis can increase the need for exogenous insulin, and a sudden rise in blood glucose levels or the appearance of glycosuria may forewarn of infection.

Because severe hypoglycemia can result in shock and death, blood glucose levels must not be allowed to drop much below normal range. Rebound hypoglycemia, particularly in fasting patients, can result if the infusion is suddenly stopped, therefore TPN must be slowly decreased to allow endogenous insulin levels to decline. If at any time TPN is interrupted, the patient must receive supplemental glucose by vein or mouth. In order that blood glucose levels be kept at normal or only slightly elevated levels, delivery of the glucose-containing solutions must be maintained at a constant rate.

Sepsis

Sepsis is the most frequent fatal complication linked to TPN, its occurrence not surprising since the majority of patients requiring TPN have a low resistance to infection resulting from malnutrition or chronic illness. These patients may have additional depletion of defense mechanisms as a result of steroid or antibiotic therapy, radiation, chemotherapy, or immunosuppression. Infection acquired during the first month of therapy is usually caused by bacteria, while infection appearing after this period is often caused by fungi.

Although nutrient solutions used in TPN are capable of supporting growth of microorganisms, particularly *Candida albicans*, catheters appear to be the primary source of infection. An indwelling catheter passing through the skin into the vena cava provides a direct path for organisms to enter the blood stream, either by way of the lumen or the outside of the cannula. Fibrin deposits on the catheter tip can become infected and act as a continual source of septicemia.[9]

The incidence of catheter sepsis can be decreased by strict adherence to aseptic technique in the insertion and subsequent care of the puncture site and maintenance of an absolutely inviolate, closed delivery system (Appendix 3). All nutrient solutions and additive solutions must be prepared in sterile conditions under a laminar flow hood (Appendix 4).

When a patient on TPN exhibits signs and symptoms of sepsis without an obvious source of infection being found, the indwelling caval catheter should be suspected. After a patient has had a blood culture and a urine culture, the catheter must be removed and its tip cultured. The catheter should be changed in the patient with recurrent positive blood cultures.

An indwelling caval cannula with proper attention given to its care can remain in place for several months.

Psychological Stress

The common bond that joins all patients on TPN is the chronicity of their underlying problems. Although all of these patients are not critically ill, all are chronically ill. Even the most acute burn case is a chronic problem in that he/she faces an extended period of hospitalization and recovery. The person receiving TPN as an adjunct to cancer treatment is the most chronically ill of all patients, because TPN is most often indicated in the individual receiving radiation therapy, chemotherapy, or immunotherapy for advanced or recurrent malignancy; this patient will never be free of his disease and ultimately will face death from it.

Fear and depression arising from the primary problem are compounded in the patient on TPN by the routine and ritual of the procedure. Continuous observation and supervision tend to remove all vestiges of privacy. The patient on TPN is dependent upon an artificial fluid for sustenance, with every bodily function monitored by invasive and noninvasive techniques. The patient on TPN quickly and correctly realizes that he has little to do with the conduct of his care.

Because the patient on TPN is so dependent on those around him for his most basic needs, it is necessary that all personnel concerned with the care of the patient instill in him an extra measure of trust based on their competency. The smallest break in routine or slip in technique can be a source of apprehension. The frequent alarm sounding from an intravenous pump, indicating a transient kink in the delivering tubing, can demoralize an individual on TPN.

To fight apathy and promote a sense of well-being, the person receiving TPN should be given some role in promoting his recovery. Goals should be set for the patient; the individual who is unable to get out of bed should be given a footboard or trapeze and their use in preventing muscle wasting and bone dissolution explained. The accomplishment of a certain number of pull-ups or press-downs can be a great psychological as well as physiological boost to a debilitated patient.

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