TOTAL PARENTERAL NUTRITION IN SURGERY

THESIS

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INTRODUCTION

Total Parenteral Nutrition is a technique for prolonged intravenous administration of all required proteins, calories and essential materials which are reserved for malnourished patients who cannot or should not use the G.I.T. for nutritional purposes.

This subject will be discussed under the following items:

1. Definition.

2. Indications.

3. Techniques:
   - Routes.
   - Formulae.
   - Care.
   - Precautions.
   - Monitoring.

4. Problems And Side Effects.

5. Values Of Parenteral Nutrition.

6. References.

بسم الله الرحمن الرحيم

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CHAPTER I

* Introduction And Definition.

* Evolution Of Total Parenteral Nutrition.

* Assessment Of The Nutritional Status.

TOTAL PARENTERAL NUTRITION

Introduction and Definition

Research has begun to illuminate nutrition's role in disease. Medical researchers have found that nutrition plays a part in many of the leading killers; e.g. malignancy and cirrhosis of the liver. In the field of surgery, the potential dangers of inadequate nutrition have been well documented. The correlation between the nutritional status and postoperative morbidity and mortality was noted by STUDLEY as early as the year 1936; he stated that: "those patients who lost greater than 20 percent of their usual weight before undergoing abdominal surgery for obstructing peptic ulcer disease fared worse than those patients without significant preoperative weight loss"; moreover, protein malnutrition results in wound dehiscence, impaired fracture healing, impaired antibody production, decreased resistance to infection and decreased liver resistance to toxic agents. In addition; nutritional therapy is now used with other treatments to save the lives of critically ill patients among which are prematures, fire victims and patients with major portions of their intestines removed.

Central to the new wave of nutritional studies and applications are enteral feeding and total parenteral nutrition.

Total parenteral nutrition which is sometimes described as an "artificial gut", could be defined as "a technique for prolonged intravenous adminstration of all required proteins, calories and essential materials for malnourished patients". This technique has a broad range of applications for patients who cannot or should not eat by mouth; the human intestine, in length about six times a person's height is very complex and considered - so far - almost impossible to transplant successfully. T.P.N., thus, totally by-passes the digestive system and delivers a complete mixture of all needed food constituents into a person's blood stream to correct or prevent deficiencies. Accordingly, such technique is used to either supplement or replace enteral feeding when the latter is either inadequate or impossible.

Evolution of Total Parenteral Nutrition

The search for an adequate intravenous solution began as early as the 17th century; when Sir Christopher Wren and others in England and France used a goose quill and pig's bladder to introduce oil, wine and sugar into a vein. The foundations were laid in 1930's and 1940's with clarification of the metabolic responses to starvation, and in particular the response to trauma and surgery.

Elman and Weiner described the intravenous use of protein hydrolysates in 1939; however , the first successful report of parenteral nutrition was by Helfrik and Abelson in 1944. During the next seventeen or so years, most attempts to repeat this success failed because of difficulties in maintaining venous access.

In 1961, Schuberth and Wretlind reported the use of a stable fat emulsion which could be given through peripheral veins without difficulty; with this as a calorie source, amino acids and low osmolarity sugar solution to provide proteins and CHO, the basic nutritional needs could be met. However, thrombophlebitis tended to limit the use of any single infusion site to 24 - 48 hours.

Modern parenteral nutrition - however, may be said to date from 1968 when Dr. Stanley Dudrick and his associates developed a way to drip T.P.N. solution - composed of hypertonic glucose and protein hydrolysate mixture - directly into the SVC for long periods of time in children with continued growth, development and positive nitrogen balance.

Since then and over the last decade hyperalimentation has shown great advances. It has become possible for many complex nutritional regimens to be used at home. One remarkable innovation is the "ambulatory T.P.N. prothesis vest", which was developed in 1974 by Dr. Henri Joyeaux of Montpillier, France and modified by Dr. Dudrick into a completely self-contained unit worn by the patient, and through a small battery operated pump, the T.P.N. fluid is forced through a catheter into the SVC.

Assessment of the Nutritional Status of Patients

Bistrian and others demonstrated that greater than 40 percent of medical and surgical patients in a Boston teaching hospital had significant malnutrition;"1974, 1976". In spite of this, many physicians fail to diagnose malnutrition or accept it as an unavoidable consequence of illness. In addition, malnutrition in hospitalized patients is further aggrevated when patients undergo a variety of diagnostic and therapeutic procedures, which interfere with normal enteral feeding. moreover, the surgical trauma promotes excessive nitrogen losses and accentuates any existing protein deficiency. For such reasons and for the purpose of making a decision of T.P.N.; proper assessment of the nutritional status and diagnosis of malnutrition should be accomplished.

Clinically, protein-calorie malnutrition may be divided into three categories; namely, Kwashiorkor, Marasmus amnd a mixed category.

* Kwashiorkor: This condition develops in patients who exist on a diet with sufficient calories derived mainly from carbohydrates with little or no proteins. Such patients may be of normal weight or overweight and have severe depletion of visceral protein stores manifested by low serum proteins and an expanded extracellular fluid space; they may have peripheral oedema, fatty liver infiltration and impaired wound healing.

* Marasmus: Results when the diet is deficient in calories and proteins

but with an appropriate protein to calorie ratio. These patients usually exhibit marked weight loss, but serum proteins and liver morphology are normal.

* Mixed Category: Most patients fall into the mixed category demonstrating characteristics of both disorders.

Nutritional Profile: "The Diagnosis of Malnutrition"

Malnutrition may be diagnosed by various techniques. The most accurate method for determining body composition and estimating calorie and nitrogen requirements is through the use of multiple isotope dilution techniques. However, such techniques are not readily available. Accordingly, less accurate but clinically useful measures are routinely employed to evaluate the nutritional status -including- history, physical examination and a series of clinical and laboratory studies.

1. History

Evaluation of the malnourished patients should begin with a careful dietary history. The patient's usual body weight and a history of involuntary recent weight loss occuring within six months is especially important.

The presence of any chronic illness such as diabetes, hyperlipidemia, liver diease, renal failure and a through medication history should be elicited.

Previous gastrointestinal tract surgery, history of gastrointestinal disease and personal special habbits as consumption of alcohol are important as they can have great impact on the nutritional status of the patient.

2. Physical Examination

the muscle and fat wasting of Marasmus and the expanded extracellular compartment of fluid, manifested as ascites or peripheral oedema, of Kwashiorkor may be evident on physical examination. However, most instances fall between these extremes as mentioned before.

Weight, height and built should be noted and compared to standard tables of desirable weight for height and built.

Physical findings which may be associated with specific vitamin deficiencies, should be sought. The eyes should be examined for conjunctival pallor, Bitot's spots, corneal xerosis and keratomalacia. The skin may show signs of nutritional deficiencies including areas of diffuse pigmentation, xerosis, dyssebacea, purpuric erruptions and poor wound healing.

In the nails, friability, banding and koilonychia should be noted. Cheilosis , fissuring, gingivitis, dental caries, stomatitis and glossitis are all mouth signs of malnutrition that should be excluded.

3. Anthropometric Measurements

The estimate of the reserves of body fat indicates the length of starvation in patients with inadequate calorie intake. Subcutaneous fat is considered a good index of total body fat, and triceps skinfold thickness (TST) is commonly used as a measure of subcutaneous fat stores. Accuracy of this method requires standardization of technique to minimze variation when performed by different examiners. Constant pressure skinfold calipers make this measurement reliable. With the patient's right arm flexed at 90 degrees, a tape measure is used to accurately locate, on the back of the triceps, the midpoint between the tips of the acromion and olecranon. A fold of skin pulled away at that site is then measured with the caliper.

* Normal Standard Triceps Skin Fold Thickness Average Values:
  12.5 mm (male) - 16.5 mm (female)

Measurements of midarm cicumference are used to approximate the patient's muscle mass. The circumference of the middle portions of the arm along with the measurements of the triceps skin fold is used in an equation to calculate the patient's midarm muscle mass which can evaluate the skeletal muscle compartment.

* MIDARM MUSCLE CIRCUMFERENCE = [ARM CIRCUMFERENCE in cm]
  -[CONST. K (0.13) x TST in mm]

* Ideal Values Are: 25.3 cm (male) - 23.2 cm (female).

Values of 90% are considered normal, 80-90% are mildely depleted, 60-80% are moderately depleted and values below 60% represent severe depletion.

It is worthy to mention that measurements of triceps skinfold (TST) have been correlated with increased morbidity and mortality in surgical patients, but measurements of midarm muscle circumference have not.

4. Somatic Protein Mass

Depletion of the somatic protein mass may be clinically estimated in terms of weight as a percentage of usual body weight or ideal body weight as calculated from the following formulae:

$$\text{* Percent Usual Body Weight (UBW)} = \frac{\text{Current Weight}}{\text{UBW}} \times 100$$

$$\text{* Percent Ideal Body Weight (IBW)} = \frac{\text{Current Weight}}{\text{IBW}} \times 100$$

* Recent Change In Weight May Be Related In The Following Way:

$$\frac{\text{UBW - Present Weight}}{\text{UBW}} \times 100 = \text{Percent Of Weight Change}$$

A present weight of 80-90 percent of the usual or ideal body weight usually indicates mild nutritional depletion. 70-80 percent moderate depletion; and less than 70 percent severe depletion. Ideal body weight may be obtained from special standard tables.

A 24-hour urinary creatinine excretion test may also be used to estimate somatic protein mass. Creatinine is derived mainly from muscle tissue, and comparing the amount excreted in the urine over 24 hours with the quantity excreted by a healthy individual of similar age, sex, and height will reveal the degree of depletion of muscle protein. However, the creatinine height index suffers from errors inherent in the collection of any urine specimen during 24 hours.

* Normal Values = 20-26 mgm/Kgm/day (male) and 14-22 mgm/Kgm/day (female)

5. Visceral Protein Mass

Depletion of visceral protein mass may not be as evident clinically as depletion of somatic protein mass. Assessing this body compartment relies upon biochemical measurements of serum transport proteins. These proteins are synthesized by the liver, and a decrease in their serum concentrations indicates a decrease in the amount available for their biosynthesis, as well as a decrease in liver function and mass associated with malnutrition.

Proteins commonly measured include Serum Albumin, Prealbumin and Serum Transferin; a betaglobulin that transports iron. The critical levels of serum proteins, below which there is obligatory oedema formation, have been found to be 5.5 gm/100 ml. for total serum proteins, and 3.0 gm/100 ml. for albumin.

Serum transferrin more accurately indicates stores of visceral proteins because of its small circulating pool and shorter serum half-life; approximately 8 days compared with 20 days for albumin. Reduction in the level of the serum proteins has been associated with increased postoperative morbidity and mortality.

* Serum Albumin: 35-45 gm/L * Serum Prealbumin: 240-320 mgm/L
* Serum Transferrin: 1.7-2.5 gm/L

6. Immunocompetence

An important effect of malnutrition is impairement of cell-mediated immunity. Measuring the total lymphocyte count gives an objective value of immunocompetence and can be easily obtained from the differential of a routine complete blood count. Lymohocyte counts of less than 2000 per cubic mm. are felt to represent mild to moderate depletion and in the study performed by Lewis and Klein; 1979, was associated with postoperative infection.

Depressed, delayed reactions of hypersensitivity to skin test antigens is a simple and effective means for measuring the function of the cellular immune system. Test antigens often used include Streptokinase-Streptodornase, Tuberculin (PPD), Mumps, Trichophyton and Candida. An area of induration of greater than or equal to 5mm. is considered a positive result and the degree of immunocompetence is scored according to the number of tests positive after 24 to 48 hours.

Increased postoperative morbidity and mortality correlates significantly with relative anergy "One Skin Test Positive" or anergy "No Positive Skin Tests".

Prognostic Nutritional Index

Physicians have recently become interested in using routine nutritional factors as predictors of hospital morbidity and mortality in surgical patients. A prognostic nutritional index has been formulated and tested prospectively by Mullen and Colleagues; 1979, who found four nutritional values with predictive value. These values include Serum Albumin (ALB), Serum Transferrin (TFN), Triceps Skin Fold Thickness (TST) and Immune Status (IS) as assessed by recall skin test antigens and graded as "0" for anergic, or "1-5" depending on the number of positive skin tests. A mathematical model was developed relating these four variables. The formula is as follows:

Prognostic Nutritional Index (%) = 158 - 16.6 (ALB. gm %) - 0.20 (TFN mgm/100 ml) - 0.78 (TST mm.) - 5.8 (IS)

The higher the prognostic nutritional index - the greater the incidence of morbidity and mortality. The use of predictive nutritional