Nutrition Support Handbook

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Information in this booklet should be used as a guide only. It is designed to assist medical professionals in the nutritional care of **adult** patients at Walter Reed Army Medical Center. The evolving nature of nutrition science mandates that the care of each patient be individualized.

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Introduction

MALNUTRITION can be defined as any nutritional imbalance, including over nutrition. In this handbook, malnutrition will usually refer to a deficiency of nutrients (under nutrition) relative to body requirements which contributes to an abnormality in body composition and/or function. This deficiency may arise from inadequate intake or absorption, abnormal losses or altered utilization.

The incidence of malnutrition can approach 50% of hospitalized patients. One study at WRAMC in June 2003 found that 33% of patients on a general medicine, general surgery or oncology ward were significantly malnourished. Compared to well-nourished patients, poorly nourished patients have higher complication rates, longer hospitalizations, increased healthcare costs, and higher mortality rates. Since nutritional problems may exist *before* admission, screening for nutritional risk in outpatient settings and initiating intervention, when indicated, is important.

Many studies using enteral and parenteral nutrition support have been done. These studies are of varying degrees of quality, have shown a range of clinical results from negative to positive, and have included many variables, such as patient selection, variations in the composition, timing, route and amount of feeding, and the type of outcomes assessed. Adverse outcomes from nutrition support can result from mechanical, infectious, metabolic, and GI complications. INAPPROPRIATE feeding can be as harmful as not feeding. Therefore, a major objective of the nutrition support specialist is to PREVENT HARM from under nutrition, support the host's metabolic, immune, and functional status, and minimize morbidity from nutrition support. In addition, nutrition support, like other forms of medical care, should be used in a cost-effective manner and with appropriate ethical considerations.

Nutrition Assessment

All hospitalized patients should be screened for risk or presence of malnutrition within 24 hr of admission. Once the screening process has identified significant nutritional risk, a nutrition assessment should be completed. Key components of nutrition assessment are discussed below.

History: weight changes over past 6 mo, appetite, satiety, recent vs. usual food intake, alcohol, dietary/herbal supplements, food intolerances, GI complaints (especially if >2 wk), changes in functional status.

Conditions associated with Malnutrition Risk: trauma, burns, prolonged NPO or clear liquids, sepsis, organ failure, BMT, bowel obstruction, severe digestive or absorptive disorders, severe pancreatitis, tobacco or alcohol abuse, poor oral health, dysphagia, poor functional capacity, elderly.

Physical Findings associated with Malnutrition: hollowing of temples, cachexia, muscle wasting (quads, deltoids), signs of dehydration (poor skin turgor, sunken eyes, dry mucous membranes), ascites, edema, poor hair quality, skin ulcers or rashes, nonhealing wounds, pallor or redness of gums, cheilosis, stomatitis, glossitis, obesity. Note abnormal vital signs.

Weight: Unintentional **weight loss of >10% within 6 mo** is associated with significant malnutrition, and is a negative prognosticator of clinical outcome in surgery and oncology patients. Weight loss of **>5% within 1 month** is also considered a marker of malnutrition.

Percent Body Wt by Body Parts (for missing body parts)

Hand:	0.7%	foot:	1.5%
forearm w/hand:	2.3%	lower leg w/foot:	5.9%
entire arm:	5.0%	entire leg:	16.0%

Body Mass Index (BMI) = $\frac{\text{Wt (kg)}}{\text{Ht (m}^2\text{)}}$

BMI	Classification	BMI	Classification
<16	grade III malnutrition	25-29.9	overweight
16.0-16.9	grade II malnutrition	30-34.9	grade I obesity
17-18.4	grade I malnutrition	35-39.9	grade II obesity
18.5-25	normal	≥40	grade III obesity

Desirable Body Weight (DBW) based on Hamwi Method

Men: 106 lb for the first 5 feet plus 6 lb for every inch thereafter
Women: 100 lb for the first 5 feet plus 5 lb for every inch thereafter
Small frame: Subtract 10% from DBW Large frame: Add 10% to DBW

<80% of DBW is associated with at least moderate malnutrition.

Adjustment in DBW for Spinal Cord Injury

Paraplegia: subtract 5-10% from DBW Quadriplegia: subtract 10-15% from DBW

Selected Serum Proteins:

Albumin, and **prealbumin (transthyretin)** are synthesized in the liver. They are negative acute-phase proteins. Serum levels decline (decreased synthesis, increased degradation and transport to extravascular pools) in response to inflammation, such as trauma, surgery, infection, and advanced cancer. They have an inverse association with C-reactive protein and will generally not return to normal until the inflammatory stress subsides. These proteins are depressed by untreated ESLD, nephrotic syndrome, and severe zinc deficiency. Albumin and prealbumin have been used to screen patients for malnutrition risk near time of hospital admission.

Albumin: not sensitive or specific to malnutrition; long half-life (14-20 d); sensitive to hydration status; in unstressed starvation it is usually WNL because of decreased catabolism and increased mobilization of extravascular stores; useful as a prognostic index for morbidity and mortality. Normal range at WRAMC: 3.9-5.0 g/dl.

Prealbumin: more sensitive than albumin for protein and/or calorie deficiency, also more responsive to nutrition therapy; 2-3 d half-life; increased by anabolic steroids, corticosteroids, renal failure, and Hodgkin's disease. Can have a (+) association with changes in nutritional adequacy (calorie and protein intake) and with nitrogen balance, although significant increases may take 6-7 days. Prealbumin <11 mg/dl has been associated with malnutrition. Normal range at WRAMC: 20-40 mg/dl (>30 mg/dl for chronic hemodialysis patients). (See p. 44 for more information on the use of prealbumin.)

Classification of Protein-Energy Malnutrition (using international diagnostic codes)

Kwashiorkor (ICD: 9-260) "Nutritional" edema with dyspigmentation of skin and hair

Criteria: 1. Wt >90% of DBW
2. Serum albumin <3 g/dl

Characterized by edema, fatty liver, muscle catabolism, weakness, neurologic changes, and dyspigmentation. Found almost exclusively in the tropics and assoc. w/ famine, infection and markers of inflammation. Not due simply to deficient protein intake. (Sometimes inappropriately used to describe hypoalbuminemia postoperatively or w/ catabolic illness.)

Marasmus (ICD: 9-261) Calorie deficiency

Criteria: 1. Wt <80% of DBW or wt loss >10% in last 6 mo
2. Serum albumin >3.0g/dl (relatively preserved visceral proteins)

Characterized by gradual loss of fat and muscle tissue, lethargy, and weakness. Nitrogen losses decrease to 2-4 g/d as fat and ketone utilization increases.

Protein-calorie (energy) malnutrition (PEM)— moderate to severe (ICD: 9-262 to 263)

Criteria: 1. Wt <80% of DBW or >10% wt loss in last 6 mo (edema may mask wt loss)
2. Serum albumin often <3 g/dl

The moderate to severe forms of PEM typically are associated with exposure to stress and may include edema, hypercatabolism, poor wound healing, and increased risk for infection. In **stressed metabolism**, hormonal and cytokine signals promote acute phase protein synthesis but net proteolysis, altered immune responses, accelerated gluconeogensis, and lipolysis. Urinary nitrogen losses are often >15-20 g/d. Elevated resting energy expenditure (hypermetabolism) may also be present.

Effect of Selected Drugs on Nutritional Status			
Alcohol	loss of thiamin, Mg, folate, vit B12, zinc Mg, zinc	**Corticosteroids**	glucose intolerance; protein catabolism; increase need for vit D, and possibly Ca, K, vit A and C CCtamin C
Amphotericin	loss of K, Mg	**Furosemide**	loss of K, Mg, thiamin, Ca, anorexia, nausea
Antacids	decreased absorption of iron, thiamin, folate	**Isoniazid**	pyridoxine (B6) depletion, decreased, folate
Anticonvulsants	decreased Ca, Mg, 25-OH vit D3	**Proton Pump Inhibitors**	decreased absorption of vit B12 from food; possibly decreased iron absorption
Aspirin	decreased vit C and B12	**Phenytoin**	may need vit D, Ca, folate, thiamin

Major Components of Nutrition Assessment (from Subjective Global Assessment, Detsky)

- Adequacy of recent (1-2 wk) nutritional intake

- Significant unintentional weight loss (or physical exam evidence of) over 1-6 mo

- Level of stress (diagnosis and markers of hypercatabolism or hypermetabolism)

- GI intolerance for >2 wks: vomiting, severe nausea, significant diarrhea

- Changes in functional capacity

Nutritional Requirements

Energy Requirements

Note: 1-kg normal body wt contains 7700 Kcal. (+) or (-) 1100 Kcal/day = 1 kg/wk change.
1-lb body wt contains 3500 Kcal. (+) or (-) 500 Kcal/day = 1 lb/wk change.

It is not always necessary to meet 100% of patients' **total energy expenditure (TEE)** with food or nutrition support on a short-term basis, although in most studies showing positive clinical outcomes, patients were fed **at least 50% of their TEE**.

Hypocaloric feeding with adequate protein can be justified by obesity (see page 54), poorly controlled glucose, or when starting to feed malnourished or highly stressed patients.

Hypercaloric feeding (mild) can be justified in underweight preoperative patients and during unstressed convalescence. Excess Kcal can increase risk of hyperglycemia, hypercapnea, hepatic steatosis, hypertriglyceridemia, and volume overload.

Basal energy expenditure (BEE) refers to energy expended in 24 hr to maintain life processes at complete rest, after a 12 hr fast in a thermoneutral environment. For practical reasons, BEE is now rarely measured. **Resting energy expenditure (REE)** refers to energy expended over 24 hr at rest under conditions other than strictly basal. Since the REE is only 5-10% > than BEE, the same equations to estimate BEE can be used to estimate REE.

Methods to Estimate Energy Expenditure

1) Harris-Benedict equation was designed to estimate **BEE** in healthy, unstressed adults, but more closely estimates **REE**:

(wt = weight in kg, ht = height in cm)

Men: **66.5 + (13.8 x wt) + (5 x ht) - (6.8 x age)**
Women: **655.1 + (9.6 x wt) + (1.8 x ht) - (4.7 x age)**

Stress and Activity factors - Multiples for stress and/or activity may be required along with the Harris Benedict equation to estimate TEE. Chemical neuromuscular paralysis decreases energy expenditure (EE) by as much as 30%. Heavy sedation also decreases EE.

TEE = REE x Stress Factor x Activity Factor

Stress Factors		**Activity Factors**	
<1.0	hypotensive shock (anaerobic)	**1.0 - 1.15**	bedrest
0.85	simple starvation	**1.2 - 1.3**	mildly ambulatory
1.1-1.2	elective surgery or medical patients		
1.2 - 1.5	multiple trauma, closed head injury, sepsis, SIRS		

1.07 for each degree above 98.6 F, or **1.13** for each degree above 37 C.

2) Obese patients: See section on Obesity (p.53-54) for energy equations.

3) Mean TEE in **hospitalized** adults**: 25 Kcal/kg/d**, (range, 20-45 kcal/kg). For moderately-severely **underweight** hospitalized adults, use **30-32 Kcal/kg** for TEE. Young adults generally expend more Kcal/kg, due to more active muscle mass, compared to older people. Remember that hypocaloric feeding (see p. 7) may be appropriate in some clinical situations.

4) Indirect Calorimetry - using a "metabolic cart" measures oxygen consumption and carbon dioxide production. It allows for **the most accurate clinical calculation of REE (including any stress).** It may be necessary to include an activity factor (p. 8) to estimate TEE, although not in ICU patients since they rarely have much physical activity. See p. 44-45 for more information.

Protein Requirements

Protein requirements are most accurately assessed using nitrogen balance (p. 43).
Factors used to estimate protein requirements:

	g/kg/day (using nonedematous body weight)
Non-stressed	**0.8 - 1.0**
Stressed*	**1.2 - 1.5 (up to 2.0)**
Repletion	**1.3 - 1.5**

In many **critically ill patients**, **1.2 - 1.3** g protein/kg of non-edematous weight (or **1.0** g/kg of current edematous weight) suffices to minimize net loss of body protein.

See handbook sections on liver failure, obesity, pancreatitis, pressure ulcers, renal failure, and trauma for additional protein guidelines.

Macronutrients For Dietary Reference Intakes (DRIs) on macronutrients: www.nal.usda.gov/fnic

Protein / Amino Acids (See Protein Requirements on previous page.)

- Protein = 4 kcal/g and 10-35% of total caloric intake
- Excessive protein can cause azotemia and lead to dehydration through diuresis.

Carbohydrate (CHO)

- Dietary carbohydrate = 4 kcal/g; IV dextrose = 3.4 kcal/g
- 45-65% of total caloric intake. Minimal requirement = 1 mg/kg/min (may be met by D5 IVF)
- CHO intake should not exceed 5-7 mg/kg/min (or 7-8 g/kg/d). Limit to 4 mg/kg/min in ICU.
- Complications from excessive CHO intake: hyperglycemia, hypercapnea, hypertriglyceridemia

Fat

- Dietary fat = 9 kcal/g; 20% IV fat = 10 kcal/g ; 10% IV fat = 11 kcal/g , (includes Diprivan).
- 20-35% of total caloric intake, with 11-17 g/d (5-10% of Kcal) from linoleic acid (minimum,1-2% of Kcal), and 1.1-1.6 g/d (0.6-1.2% of Kcal) from alpha linolenic acid (minimum, 0.5% of Kcal) to provide, respectively, essential omega-6 and omega-3 polyunsaturated fatty acids.
- Fat, especially rapid IV fat infusion, >0.11 g/kg/h or >1.0-2.5 g/kg/day increases risk of RES dysfunction, free radical production, gas diffusion abnormalities and hypertriglyceridemia. It may be reasonable to limit IV fat to no more than 1.5 g/kg/d (range of 1.0-2.5 g/kg/d).

Vitamins For DRI's on recommended intakes for individuals and Tolerable Upper Intake Levels (ULs) for specific vitamins: www.nal.usda.gov/fnic

If at risk for suboptimal vitamin status, supplementing with an oral MVI may be indicated.

Oral MVIs available at WRAMC include**:**

- **MVI:** 100% adult DRI levels of vitamins (except for negligible vitamin K); does not contain minerals. Note that the liquid MVI for oral/enteral use does NOT contain folate.
- **Centrum Kids Complete®**: chewable MVI with minerals; 1 tab = 100% adult vitamin RDAs (13% for vitamin K), 100% DRI for Fe, Zn, Cu, Iodine, etc.; 1/2 tab = RDA for 4-10 y/o
- **Prenatal vitamin** ("PNV")**:** MVI for pregnancy, also with some Fe, Ca, Mg, Zn and Cu
- **Nephrocap®**: water soluble MVI only; for renal failure patients, including dialysis
- It is recommended to give (enterally or parenterally) 50-100 mg/d of **thiamin** (and a standard MVI which includes folate and B12) for 3 days to patients at risk for alcohol abuse and also for other conditions associated with thiamin deficiency, e.g., prolonged NPO/poor intake.
- A synthetic source of **vitamin B12** which can be obtained from an oral B12 supplement, multivitamin (MVI) supplement, tube feeding formula, or highly fortified foods is recommended for adults >50 y/o and for all vegans, especially woman.
- Women of childbearing age should consume 400 ug/d of synthetic **folic acid** (in most MVIs).

Parenteral Multivitamins. 10 ml of standard parenteral MVI (see page 33) meets the normal daily IV requirements of all vitamins. Parenteral MVI can be added to ≥500 ml IVF. Many individual vitamins are also available, if needed, for parenteral infusion.

Electrolytes For DRI's on electrolytes: www.nal.usda.gov/fnic

Electrolytes are initially added to parenteral nutrition in amounts approximating the normal requirements in adults (see table 1), and see page 32 for acid-base considerations. Individual needs can vary greatly, therefore, need to monitor serum levels. Enteral formulas vary in electrolyte content. Additionally, absorption from the GI tract can be <100%, therefore, the oral dosage may be > the parenteral dosage. Review specific dosage/pharmaco-kinetics or contact a pharmacist or nutrition support dietitian for additional information.

Table 1. Estimated Normal Daily Parenteral Electrolyte Requirements

	Normal	Renal failure
Sodium (with chloride or acetate)	1-2 mEq/kg	30 - 90 mEq
Potassium (with chloride, acetate, or Phosphate)	1-2 mEq/kg	30 - 60 mEq
Calcium* (with gluconate)	10 - 15 mEq	10 - 15 mEq
Magnesium (with sulfate)	10 - 20 mEq	4 - 10 mEq
Phosphorus* (with sodium or potassium)	15 - 30 MMol	4 - 6 MMol
* Limited solubility in solution.	Note: 1 MMol KPhos = 1.5 mEq K	

Knowledge of the location and quantity of GI losses can better aid in replacing those electrolytes and preventing metabolic disturbances. (See table 2.)

Table 2. Approximate Electrolyte Composition of GI Secretions (mEq/L)				
Source	**Sodium**	**Potassium**	**Chloride**	**Bicarbonate**
Gastric	60	10	90	NA
Upper small bowel	100	15	100	20
Ileum	115	5	100	20
Bile	145	5	100	35
Pancreatic fistula	140	5	75	90
Diarrhea	60	45	45	45

Trace Elements For DRI's on recommended intakes for individuals and ULs for specific elements (minerals): www.nal.usda.gov/fnic

See Vitamins (p. 11) for **oral MVIs w/minerals**. Some individual trace elements are available.

- Possible loss of 12 mg **zinc**/L from diarrhea or bowel fistula output. Risk for Zn deficiency in alcoholics. Zinc def. symptoms include immune def., delayed wound healing, skin lesions, anorexia, and hypogeusia. However, large amts of supplemental Zn (>40 mg/d) can cause a **copper** def.. Signs of Cu def. include neutropenia, microcytic anemia, and possibly neuropathy w/chronic intestinal pseudoobstruction.
- For every dose of oral **iron**, can also give 250-500 mg of vitamin C to increase absorption. Avoid taking iron and calcium at the same time. Iron may decrease Zn absorption.

Parenteral Multiple Trace Elements. "MTE-5" (page 33) meets approximate normal parenteral requirements for trace elements (except iron). Iron is not compatible with IV fat emulsions.

Normal Fluid Requirements For DRI's on fluid: www.nal.usda.gov/fnic

- 30-35 ml/kg
- *Holliday-Segar Method:*

Body Wt	Fluid (ml)
first 20 kg	1500
each additional kg	20 (consider 15 ml/kg if over 50 y/o)

Note that intakes high in Na, fiber or protein (>1.5 g/kg/d) can increase fluid needs.

Oral Diets and Supplements

Prior to starting a patient on an oral diet, assess risk for dysphagia and aspiration, especially in individuals with mental status or neurological defects and those who were on a ventilator/trached.

Clear liquid diet supplies fluid, sugar, and salt (from broth). It is often ordered before or after surgery, or after prolonged fasting. This diet is inadequate in nutrients: 600 Kcal, 150 g CHO, and negligible protein and fat. Clear liquids can include Resource Fruit Beverage (p.16).

Full liquid diet may be used when solid foods are contraindicated. Adequate in most nutrients (especially if a high protein supplement is added...p.16-17). Because milk-based foods constitute a large portion of this diet, patients with milk/lactose intolerance may need a substitution for milk.

Blenderized liquids contains shakes, other liquids and baby foods for patients with a wired-jaw.

Pureed diet is for significant problems chewing or swallowing, but is too thick for wired-jaw.

Mechanical soft diet is appropriate for many patients having difficulty with solid foods because of mild difficulty chewing, mild dysphagia or weakness.

Soft postsurgical diet is modified for ostomy patients and general GI postop patients, but requires normal ability to chew.

Postgastrectomy diet has snacks, and limits simple sugars, size of meals, and liquids at meals.

Dysphagia diets and restrictions in fluid viscosity are only recommended by speech pathology.

Diabetic, cardiac, and renal diets restrict the type and amount of food provided, therefore, may not be appropriate in patients who are eating poorly. If only a Na restriction is desired, order a 2 gm Na diet, not a cardiac prudent diet that also restricts fat/chol.

Oral Liquid Supplements at WRAMC and Boost Pudding (none contain fiber)

***** In **elderly hospitalized** patients, prescribing 120 ml of a **nutrient-dense liquid supplement** TID, such as, Boost Plus, resulted in wt gain, and in the most poorly nourished patients was associated with improved function and reduced mortality (Potter, et al).

Resource Fruit Beverage: 8 oz, *clear liquid*, high sugar, some protein, fat free, lactose-free.
Berry, Peach, Orange. 250 Kcal (14% protein), 9 g Protein, 53 g CHO, 0 g Fat,
<80 mg Na, <20 mg K, 160 mg Phos, 10 mg Ca, 1 mg Mg

Ensure High Protein: 8 oz, *high protein*, moderately high Kcal, low residue, lactose-free.
Vanilla, Chocolate, Berry. 230 Kcal (21% protein), 12 g Protein, 31 g CHO, 6 g Fat,
290 mg Na, 500 mg K, 250 mg Phos, 300 mg Ca, 100 mg Mg

Boost Plus: 8 oz, *high Kcal*, moderate protein, low residue, lactose-free.
Vanilla, Chocolate, Strawberry. 360 Kcal (16% protein), 14 g Protein, 45 g CHO, 14 g Fat,
170 mg Na, 380 mg K, 310 mg Phos, 330 mg Ca, 105 mg Mg

MightyShake: 4 oz, *high Kcal*, moderate protein, dairy, contains lactose.
Vanilla, Chocolate, Strawberry. 200 Kcal (12% protein), 6 g Protein, 30 g CHO, 6 g Fat,
60 mg Na, 150-210 mg K, 100-150 mg Phos, 150 mg Ca, 24 mg Mg

Nepro: 8 oz, *renal*, *high Kcal*, moderate protein, low in K, Phos, Mg, and water, lactose-free.
Vanilla and Butter Pecan. 475 Kcal (14% protein), 16.7 g Protein, 53 g CHO, 23 g Fat,
200 mg Na, 250 mg K, 165 mg Phos, 325 mg Ca, 50 mg Mg

Carnation Instant Breakfast: Mix powder packet with 8 oz milk for high Kcal, moderate protein *dairy shake*, *high in lactose*. Vanilla flavor.
Mixed w/ 8 oz whole milk = 280 Kcal (17% protein), 12 g protein, 39 g CHO, 8 g fat,
200 mg Na, 610 mg K, 480 mg Phos, 550 mg Ca, 110 mg Mg

Carnation Instant Breakfast, No Sugar Added: Mix with 8 oz milk for high protein, high Kcal *dairy shake, high in lactose*. Box has Vanilla, Chocolate, and Strawberry flavors.
Mixed w/ 8 oz whole milk = 220 Kcal (22% protein), 12 g protein, 24 g CHO, 8-9 g fat,
220 mg Na, 630 mg K, 480 mg Phos, 540 mg Ca, 110 mg Mg

Scandishake: Mix powder packet with 8 oz milk (or substitute) for *very high Kcal*, *lower protein* shake, **no added vitamins or minerals**. Vanilla and Chocolate.
Mixed w/ 8 oz whole milk: 600 Kcal (9% protein), 13 g Protein, 69 g CHO, 29 g Fat,
215-240 mg Na, 650-970 mg K, no other specific nutrient info.

WRAMC also has various recipes for ice cream-based milkshakes. Consult a dietitian to order.

Boost Pudding: 5 oz, *high Kcal, low volume*, moderate protein, lactose-free. Vanilla and Chocolate.
280 Kcal (12% protein), 7 g protein, 33 g CHO, 9 g fat,
125 mg Na, 250 mg K, 200 mg Phos, 250 mg Ca, 60 mg Mg

Modular Enteral/Oral Additives at WRAMC

ProMod: Whey protein powder. 1 scoop = 5 g protein, 28 Kcal. Mix 1 scoop with 50-100 ml of lukewarm water for bolus administration into enteral tube (or mix with oral liquids or pureed foods). Addition to the enteral feeding bag is not recommended. Whey is a high-quality protein.

GlutaSolve: glutamine powder*, 1 pkg = 15 g glutamine, 90 Kcal. Mix with 80 ml water for bolus administration into enteral tube (or mix with oral liquids or pureed foods). Give 1-3 x day (see dosing below). Giving it mixed in the enteral feeding formula/ bag is not recommended.

Polycose Powder: Glucose polymers, 1 tbsp powder = 23 Kcal. May be added to most tube feeding formulas and most foods and beverages to add carb Kcal.

Microlipid: 50% safflower oil/50% water emulsion. 1 ml = 4.5 Kcal. For use in oral or tube-feeding formulas as a source of linoleic acid and fat Kcal.

Medium Chain Triglyceride (MCT) Oil: 15 ml (1 tbsp) = 115 Kcal. Does not require bile acids. Can be absorbed in colon. Adheres to feeding tube lumen. Does not provide essential fatty acids.

Instant Food Thickener See instructions on can for modifying liquids to a nectar, honey or pudding-like consistency, as recommended by speech pathology. Poor patient acceptance.

***Considered a "conditionally essential amino acid" in trauma, burn, SIRS, and high-risk elective surgery patients. Early use of supplemental glutamine (0.3-0.5 g/kg/d) for at least 5 days appears to reduce infectious complications and possibly hospital LOS (Melis, et al). How long the glutamine should be continued is not known, although generally it has been used for 7-10 days. The greatest treatment effect was in CPN w/added glutamine (not commercially available) vs standard CPN.

Nutrition Support

Nutrition support (NS) in this handbook refers to parenteral and/or enteral tube feeding**.**
If and when to begin NS is still unclear in some patient populations, but the following represent expert opinion and, where available, evidenced–based guidelines

Indications for NS

- Inadequate oral intake (or strong anticipation of) for 7 - 14 days, if previously well-nourished.

- Critically ill and inadequate oral intake (or strong anticipation of) for 5-7 days. Consider early (p. 20) enteral feeding if safe to do so, especially in major trauma, burns, and SICU patients. Enteral feeding versus no feeding was associated with improved survival in coma patients (Borum, et al).

- Moderate to severe malnutrition and inadequate oral intake (or strong anticipation of) for > 4 days.

- Moderate to severe malnutrition and critically ill . Consider early NS

- Moderate to severe malnutrition w/planned elective surgery. 1 wk preoperative/perioperative NS (using oral/enteral or parenteral) decreased postoperative complications (VA study; Russell, et al).

- In elective GI surgery patients (Sacks, et al) and patients preop for cardiac surgery and at high risk of infection (Tepaske, et al), drinking 250 ml 3-4 x day of an immune-modulating oral supplement for 5-10 days prior to surgery, reduces infectious complications and hospital LOS. (As of 2005, we do not have such a product on the WRAMC formulary.)

Early (started <48 hr after insult) vs Delayed Feeding

- In **SICU patients**, including surgical trauma, early enteral NS appears to decrease infectious complications and hospital LOS compared to delayed enteral feeding (Marik, et al).
- Heyland, et al. recommended early enteral NS in all **mechanically ventilated ICU** patients who were adequately resuscitated and hemodynamically stable based on trends (p= >0.5) toward reduced mortality and reduced infectious complications compared to delayed feeding.
- **Liver transplant**: Decreased postop viral infections with early enteral NS (vs. simple IVF). Decrease in ICU LOS with parenteral NS (vs. simple IVF). A study failed to show any differences between use of parenteral and enteral NS. (A.S.P.E.N. Guidelines…) suggest NS be provided to malnourished patients with complications or delayed oral intake following liver transplant.
- **Major Burns**: Positive outcome benefits have been seen with early enteral NS. (Note that this handbook does not address burn patients, therefore, no additional details on this topic.)
- **Well-nourished or mildly malnourished patients** should not routinely be given parenteral NS perioperatively secondary to increase in infectious complications (A.S.P.E.N. Guidelines…)

How much to Feed?

In human trials, there have been positive clinical outcomes reported when at least 50% of feeding goal was met, but very few positive outcomes when total intake was <50% of assessed protein and energy needs. In the first week of ICU admission, meeting 60-70% of estimated feeding goal (or 14-18 Kcal/kg) with NS has been associated with reduced infection, hospital LOS, and time on ventilator in obese and in MICU patients compared to feeding more (Dickerson, et al; Krishnan, et al) .

Ethical and Legal Issues in NS

- Legally and ethically, NS should be considered a medical therapy.
- The benefits and burdens of NS should be considered before offering this therapy.
- The use of enteral tube feeding has not been shown to improve outcomes in those with severe dementia. The preferable alternative is PO hand feeding.
- Adult patients or their legally authorized surrogates have the right to accept or refuse NS.
- If available and legally recognized, written advance directives such as the "living will", or durable power of attorney for medical care" may indicate the preference of a patient who has diminished capacity.
- The American Dietetic Association, 2002, stated the following position: "The nutritional concept of *when in doubt, feed* is applicable to all patients. Feeding should continue until the treatment is futile or until research has shown the futility of feeding. During feeding, it is essential to try to provide adequate nutrients and fluids. Feeding should only be stopped based on patient wishes, if feeding is medically contraindicated, or after the patient is diagnosed as persistently unconscious and the team has evidence of the patient's wish to stop nutrition and hydration."

Enteral versus Parenteral Nutrition

In controlled animal trials, chow fed animals do better than those given parenteral or liquid enteral formulations. Enterally fed mice generally have a better outcome than parenterally fed mice. Therefore, the use of oral intake with a variety of “real food” is preferable when possible.

The human literature on clinical outcomes between enteral nutrition (EN) and parenteral nutrition (PN) in hospitalized patients, especially the critically ill, favors the use of EN, although many of these studies had weaknesses that made results difficult to interpret. No difference in mortality was shown. The potential mechanical, metabolic, and infectious complications of both forms of delivery are significant but can be minimized with careful precautions and the use of NS specialists/teams.

"**If the gut works, use it**".....This expression is commonly heard on rounds. Why?

- Cost. Enteral formulas cost 1/2 to 1/20 the cost of parenteral solutions.

- Hepatobiliary dysfunction, to include cholestasis, gallbladder sludge and acalculous cholecystitis may be more frequent when enteral stimulation is absent and/or parenteral feeding is long-term.

- In a large meta-analysis (Braunschweig, et al), PN was associated with a higher risk of infection than EN (RR, 0.64) or no specialized NS (RR, 0.77). Aggregated results of studies in ventilated ICU patients showed a reduction in infectious complications with EN (RR, 0.61, p = .003) compared with PN (Heyland, et al, 2003).

- Absence of substances from parenteral solutions, such as choline, glutamine, nucleotides, fiber, phytochemicals, and others yet unidentified, may compromise immune and hepatic health.

In defense of parenteral feeding:

- There is little evidence that several processes described in animals, such as severe intestinal atrophy and increased bacterial translocation, significantly occur in humans on PN.
- We are not aware of any positive clinical outcomes in humans with (only) so-called “trophic” EN, providing considerably <50% of nutritional needs.
- In a large meta-analysis (Braunscheig, et al), studies of patients with high rates of malnutrition showed a significantly higher risk of mortality and a trend toward a higher risk of infection with no specialized NS than with PN.
- PN undertaken by experienced nutrition support teams may not cause more complications than EN. In a 562 patient trial Woodcock, et al, compared EN to PN. Sepsis rates were not different, but EN delivered less nutritional intake, and procedure-related complications were greater with EN compared to PN.

In ICU patients, glutamine-containing PN (not yet available in the USA) was associated with a reduction in mortality and hospital LOS compared to a standard PN control group.

Recommendation:

If the GI tract can **safely** be used for feeding it should be considered first. Strive to transition from parenteral to enteral or oral nutrition and to feed the gut with complex substances if possible.

Enteral Nutrition (EN)

Indications for EN: Patients with adequate GI function, inadequate oral intake, at significant risk for clinical malnutrition, and who are likely to benefit from nutrition support. See pages 19-23.

Contraindications (absolute or relative) for enteral EN:

- Complete bowel obstruction or severe bowel ileus
- Intractable vomiting or major UGI hemorrhage
- Complete inability to absorb nutrients through the GI tract
- Severe hemodynamic instability, severe post prandial pain, GI ischemia, diffuse peritonitis
- Inability to obtain safe or proper enteral access or maintain desirable body positioning
- GI abscesses, fistulas, or lymphatic (chylous) injury that seriously impair feeding integrity
- No outcome benefit expected or risk is greater than expected benefit
- Patient refuses (This does not suggest that CPN should necessarily then be offered.)

Enteral Access

- **Nasoenteric:** Into the stomach, duodenum, or jejunum (NJ). Appropriate for short-term use. Can cause patient discomfort, bleeding and sinusitis. **Postpyloric EN,** esp. **beyond the Ligament of Treitz**, reduces the risk of high gastric residuals and may reduce gastroesophageal reflux. NJ tubes are useful with gastric dysfunction, significant pancreatitis, and surgical trauma (see p.25).

- **Orogastric**: Desirable in mechanically ventilated patients to reduce risk for sinusitis.

- **Gastrostomy**: Long-term (>6 wk) access. Inserted by surgery, endoscopy or fluoroscopy.

Percutaneous endoscopic gastrostomy (PEG) is the most popular. Complications include tube dislodgment, bleeding, infection, leakage, and gastric fistula. PEG tubes with a jejunal extension (PEG/J) may be beneficial when a patient requiring long-term EN cannot tolerate gastric feeding short-term. PEG feeding has not shown (+) outcomes in advanced dementia.

- **Jejunostomy:** usually placed surgically for short or long-term intestinal EN . Indications: prolonged gastric ileus or obstruction, gastroparesis, reflux/aspiration, severe pancreatitis, or need for multiple surgeries, e.g., trauma wounds (no need to stop J-tube EN for surgery).

Formula Selection Considerations (see table 3, p 28, for more information**):**

- **Average patients** generally tolerate standard 1 Kcal/ml isotonic formulas, 16-17% of Kcal from protein, e.g., **Osmolite 1 Cal** (low residue) and/or **Jevity 1 Cal** (contains soy fiber).

- **Volume intolerance** - use a 1.5 Kcal/ml formula, e.g. **Isosource 1.5**, which may help to reduce gastric residuals, as well as limit water volume.

- **High protein** needs **-** e.g. **Promote with Fiber** (oat and soy fiber). May need to advance intake of this, as well as Jevity 1 Cal, gradually to avoid excessive boating/gas from fiber.

- **Renal failure** - generally use a renal formula to limit fluid, electrolytes, and protein, e.g. **Nepro.**

- **Malabsorption** or **Fat Intolerance -** consider a peptide, low fat formula, e.g. **Peptinex,** however, there is little data on any benefits/outcomes and these products may delay intestinal hypertrophy in patient with short bowel syndrome compared to more complex foods. The very low fat content (with 50% MCT) may be beneficial in fat overload, chylous fistula, pancreatitis, or cholesistitis.

- **Reassess choice of formula** if the selected one does not provide sufficient calories, protein, or glutamine and then consider need for additional nutrient (modular) additives (p 29), and additional water, vitamins or minerals.
- **Constipation** or **diarrhea**, may be helped by gradually advancing to a **fiber-containing formula or psyllium** (in 8 oz water 1-3 x day). Some patients appear to have better GI tolerance of a 50:50 mixture of a low residue (low fiber) and a high fiber formula rather than just one or the other.

Administration Guidelines for TF:

- WRAMC has an **Enteral Feeding Protocol** available for use in CIS "Standard Orders".

- Nasoenteric or orogastric **tube placement** should be **verified radiographically** before feeding. (If the tube has moved >10 cm it should be reinserted and radiographic confirmation obtained.)

- **Avoid handling**. Adding anything to the formula increases potential for microbial contamination. Usually better to bolus water and meds. Routine addition of dye, such as **blue food coloring,** to EN is **not recommended** due to an FDA warning and lack of usefulness.

- **Label bag with formula**, **date and time** hung and **change feeding bag** and tube **q 24 hr** (or less if any of the same formula is still in the bag after 8-12 hr. Since "hang-time" of formula should be no more than 8-12 hr to minimize risk of food poisoning, if rate of infusion is **<20-25 ml/hr, order "change feeding bag q 8 (or 12) hr"** instead of q 24 hr .

- **Elevate head of bed 45 degrees** during, and at least 30-60 minutes after discontinuing EN.

- **Continuous pump-assisted feeding:** for most critically ill patients, jejunally-fed patients, and often for patients beginning EN to minimize risk of reflux, aspiration, distention and diarrhea.

- **Initiate** continuous EN at 20-25 ml/hr and **advance rate** by 10-25 ml q 4 hr, as tolerated, to goal. Calculate EN **goal rate** in the ICU based on 20-22 hr/d (or less) to compensate for interruptions in feeding. Can cycle TF over only 16 hr/d if "time off" is desired and higher infusion rate tolerated. In stable patients, consider transition to 4-6 intermittent feedings/d at 240-300 ml/hr (or per bolus).
- **Restart EN** at last tolerated rate of infusion if EN held for routine tests, procedures, or surgeries.

- **Bolus** EN with a 60 ml syringe can be done in very stable patients, up to 500 ml/feeding if tolerated. Consider **avoiding bolus** feeding, esp. >350 ml bolus, in severe neurologically-impaired or critically-ill patients and those with gastroparesis or severe GERD.

- **Flush tube** with 15-30 ml of water: q 4-8 hr during continuous EN, **immediately after stopping infusion**, and **before** and **after each medication**.

- Avoid giving any medications, if possible, through small-bore (<10Fr) tubes.

- Hold EN 1 or 2 hr before and after enteral **phenytoin** or **warfarin**. Adjust rate of EN if needed.

- **Hold feeding** if there is need for increased vasopressors, emesis, increasing abdominal distention or pain, or repeated gastric residuals of >**200**-250 ml. Paralytic agents are (+) associated w/GI ileus.

- **Unclear or potentially harmful feeding orders should be addressed directly with physician**.

Table 3. **WRAMC Enteral Formulary**	Kcal/L	Protein g/L (% kcal)	CHO g/L (% kcal)	Fat g/L (% kcal)	% water	Osmolarity	Na mEq/L	K mEq/L	Phos mM/L	Mg mEq/L	Micronutrient base (ml)
Osmolite 1 Cal (standard, no fiber)	1060	44 (17)	144 (54)	35 (29)	84	300	40	40	25	25	1321
Jevity 1 Cal (standard, 14 g fiber/L	1060	44 (17)	155 (54)	35 (29)	83	300	40	40	25	25	1321
Promote w/Fiber (high pro, 14 g fiber/L)	1000	62 (25)	139 (50)	28 (25)	83	370	57	51	39	33	1000
Isosource 1.5 (fluid restriction)	1500	68 (18)	170 (44)	65 (38)	78	650	56	58	35	35	933
Nepro (renal failure only)	2000	70 (14)	223 (43)	96 (43)	70	665	37	27	22	18	947
Peptinex DT (low fat, peptides)	1000	50 (20)	160 (65)	17 (15)	83	460	74	21	22	22	1500

Modular Enteral/Oral Additives at WRAMC

- **ProMod:** Whey protein powder. 1 scoop = 5 g protein, 28 Kcal. Mix 1 scoop with 50-100 ml of lukewarm water for bolus administration into enteral tube (or mix with oral liquids or pureed foods). Addition to the enteral feeding bag is not recommended. Whey is a high-quality protein.
- **GlutaSolve:** glutamine powder*, 1 pkg = 15 g glutamine, 90 Kcal. Mix with 80 ml water for bolus administration into enteral tube (or mix with oral liquids or pureed foods). Give 1-3 x day (see dosing below). Giving it mixed in the enteral feeding formula/ bag is not recommended.
- **Polycose Powder:** Glucose polymers, 1 tbsp powder = 23 Kcal. May be added to most tube feeding formulas and most foods and beverages to add carb Kcal.
- **Microlipid:** 50% safflower oil/50% water emulsion. 1 ml = 4.5 Kcal. For use in oral or tube-feeding formulas as a source of linoleic acid and fat Kcal.
- **Medium Chain Triglyceride (MCT) Oil:** 15 ml (1 tbsp) = 115 Kcal. Does not require bile acids. Can be absorbed in colon. Adheres to feeding tube lumen. Does not provide essential fatty acids.
- **Instant Food Thickener** See instructions on can for modifying liquids to a nectar, honey or pudding-like consistency, as recommended by speech pathology. Poor patient acceptance.

*****Considered a "conditionally essential amino acid" in trauma, burn, SIRS, and high-risk elective surgery patients. Early use (within 1st wk) of supplemental glutamine (0.3-0.5 g/kg/d) for at least 5 days appears to reduce infectious complications and possibly hospital LOS (Melis, et al). How long the glutamine should be continued is not known, although generally it has been used for 7-10 days. The greatest treatment effect was in CPN w/added glutamine (not commercially available) vs standard CPN.

Potential Complications with EN

- **Aspiration risk** greatest in ICU patients with: previous aspiration, decreased consciousness, neuromuscular disease, endotracheal intubation, vomiting, failure to maintain elevated head of bed . **Recommendations**: 1) Verify tube placement if in doubt. 2) Avoid high-volume bolus feeding. 3) With multiple risk factors for aspiration (see above) or gastroparesis, consider a promotility agent, e.g., metoclopramide. 4) If gastric emptying remains poor (residuals >**200**-250 ml) or if multiple risk factors for aspiration, feed into small bowel, preferably jejunum.

- Case reports of **bowel ischemia, necrosis** and/or **perforation** have been associated w/EN during extreme hypotensive shock

- **Obstruction of feeding tube lumen**. Suction, then attempt flush with warm distilled water. If unsuccessful try the following: suction; inject a mixture of 1/4 tsp Viokase powder or 1 crushed tablet of pancreatic enzymes (NOT the enteric coated capsule form), one crushed 324 mg Na bicarbonate tablet and 5-10 ml tap water. After 30 min., flush tube with warm water. (Acidic pH fluids, such as cranberry juice, can precipitate protein and cause tube clogging.)

- **Diarrhea**. Stool assay for C. difficle. Avoid rapid high-volume feeding. Avoid enteral meds, esp. those containing sorbitol (elixirs), Phos and Mg. Dilute hypertonic meds and feeding formulas if diarrhea is osmotic. Consider trying a low-fat, peptide (very limited evidence for) or fiber-containing formulas (limited evidence for); psyllium mixed with water, and/or antidiarrheal meds.

- **Microorganism contamination** can occur from additional handling of the EN (e.g. adding water or supplements to the EN bag), from prolonged formula hang time (> 8-12 hours), or use of our feeding tubing and bag for >24 hr. The enteric tube can also be a source of infection, such as sinusitis associated with nasoenteric tubes.

Parenteral Nutrition (PN)

Indications for PN: Severely malnourished or at significant risk (see page 19-23), unable to obtain > 50% of nutritional needs from oral or enteral nutrition, and likely to benefit from nutrition support.

* Massive Small Bowel Resection
* Intractable Vomiting
* Diffuse Peritonitis
* Some GI Abscesses or Fistulas
* GI Ischemia or Post-Prandial Pain
* Prolonged Bowel Obstruction/Ileus
* Severe Radiation Enteritis
* Moderately to severely malnourished, planned elective surgery, and unable to feed enterally

Clinical Conditions Warranting Very Cautious Use of PN (See section on Complications)

- Hyperglycemia (>150-200 mg/dL) or Hyperosmolality (>350 mOsm/L)
- Severe Azotemia (BUN >100 mg/dL)
- Serum Deficit or Excess in Na, K, Phos, Cl
- High risk for Fluid Overload (risk can be minimized by decreasing previously ordered IVF)

Definition of terms: **3-in-1**, or **total nutrient admixture** (TNA) refers to a PN mixture of amino acids, glucose, and fat emulsion in one bag. Electrolytes, vitamins, and trace minerals are also added.

Note: **Calorie requirements via PN** may be 5-10% < from oral or enteral bolus feeding.

Constituents of PN

Amino Acids = 4 Kcal/g, if oxidized**;** does not contain glutamine; buffered with acetate
Travasol 10% is 10% amino acids by volume and wt (45% essential); meet needs of most patients
Freamine HBC 6.9% contains high levels of branched chain amino acids and theoretically could be used in refractory hepatic encephalopathy (See Hepatic Failure section.)

Dextrose 70% = 3.4 Kcal/g of dextrose; 70% of volume and wt of D70 is dextrose

Lipid Emulsion 20% = 10 Kcal/g from soybean oil and glycerol; has phospholipid emulsifiers

- IV fat infusion should not exceed 0.11 g/kg/hr to avoid variable changes in pulmonary blood flow, reticuloendothelial dysfunction, and increased risk for significant hypertriglyceridemia.

- Note: IV lipid can cause an **acute adverse clinical reaction** (see page 41)

- Reasonable to limit fat to ≤1 gm/kg/d with critical illness, esp. burns, and long-term CPN

Electrolytes - See table 1, page 12.

Acid-Base Considerations (Chloride and Acetate) - Chloride and/or acetate are also ordered when Na (and usually K) are ordered. Suggested amounts are a chloride to acetate ratio of 2:1 - 1:1. Chloride causes H ion retention, which can induce a metabolic acidosis. Acetate is converted to bicarbonate, which can induce a metabolic alkalosis. If primary metabolic acidosis or alkalosis is diagnosed, the chloride to acetate ratio can be modified in the PN solution if physician desires.

Vitamins

Infuvite Adult MVI per 10 ml dose

Ascorbic Acid	200 mg	Niacinamide	40 mg
Vitamin A	3300 IU	Pantothenic Acid	15 mg
Vitamin D	200 IU	Vitamin E	10 IU
Thiamine (B1)	6 mg	Biotin	60 mcg
Riboflavin (B2)	3.6 mg	Folic Acid	600 mcg
Pyridoxine (B6)	6 mg	Cyanocobalamin (B12)	5 mcg
		vitamin K	150 mcg

Multiple Trace Elements **(**Also see page 14.)

MTE-5 per 4 ml dose .

Zinc	4 mg
Copper	1.6 mg
Manganese	0.4 mg
Chromium	16 mcg
Selenium	80 mcg

Sterile Water is added to all PPN solutions (see next page) to reduce the osmolarity and can also be added to an individualized CPN formula by increasing the ordered volume of solution.

Peripheral Parenteral Nutrition (PPN)

The administration of amino acids, dextrose, fat emulsion, electrolytes, vitamins, and trace elements via the peripheral venous system.

- It may be used for up to 2 weeks but often for only 5 days secondary to phlebitis. Men and younger patients tend of have better venous tolerance of PPN.

- Order in liters/day (e.g., 1.6-3.0 L/d), usually based on how much fluid volume and fat the patient can tolerate. WRAMC PPN usually meets 75-80% of patient's TEE and 0.8-1.0 g protein/kg/d, starting with first bag. This is usually adequate to meet many patients' short-term needs.

- Total osmolarity of our standard PPN = 800 mOsm/L. PPN should not exceed 900 mOsm/L.

WRAMC Standard PPN

Calories	650/L	KCl	20 mEq/L
Protein	28 gm/L (17% of Kcal)	CaGluc	4 mEq/L
Dextrose	55 gm/L (29% of Kcal)	MgSO4	8 mEq/L
Fat	35 gm/L (54% of Kcal)	KPhos	6 mM/L
NaCl	30 mEq/L	MVI-12	10 ml/day
NaAc	30 mEq/L	MTE-5	4 ml/day

If an Individualized PPN formula is desired, request a new note with the name "Individual" (not "PPN") to get the correct order template. Contact a member of the nutrition support team (see inside cover) for assistance if needed.

A Peripherally Inserted Central Catheter (PICC) is not necessary for the administration of PPN and obviates the primary advantage associated with PPN in comparison to CPN. (See table 4. below.)

If proper placement of a central line has not been confirmed, only PPN should be ordered that day. PPN can be given through a central or peripheral IV catheter.

Table 4. Advantages and Disadvantages of PPN
Advantages
Does not require a central line.
Associated with less hyperglycemia due to lower dextrose concentration..
Initiated at goal rate/volume on day 1; no need to taper rate when terminating.
Disadvantages
High risk for peripheral vein thrombophlebitis. Requires good peripheral veins.
Contains significant amount of fluid and fat.
Requires inserting a new peripheral line every 48-72 hours.

Central Parenteral Nutrition (CPN)

PN via a central vein is indicated in patients when parenteral feeding is required for >one week, PPN is not possible (poor venous access, fluid or IV fat restriction), or nutrient needs are significantly greater than what PPN can provide. Only order PPN if central access has not been confirmed.

1. **Standard CPN** - formula meets the needs of many patients requiring CPN. It contains a fixed macronutrient, electrolyte and micronutrient content. Ordered by volume but the amount ordered should be **based on the patient's energy and protein needs.** Supplemental fluid may be required to satisfy full fluid requirements. For patients without protein, mineral, acid or base restrictions. Standard CPN contains:

Kcal	1000/L		
Protein	50 gm/L (20% of Kcal)	KCL	25 mEq/L
Dextrose	153 gm/L (52% of Kcal)	CaGluc	6 mEq/L
Fat	28 gm/L (28% of Kcal)	MgSO4	10 mEq/L
Kcal	1000 per L	KPhos	10 mM/L
NaCl	30 mEq/L	MVI-12	10 ml/day
NaAcetate	30 mEq/L	MTE-5	4 ml/day

2. **Individualized CPN** - can be ordered if the standard CPN is not desirable. Amount of each ingredient can be individualized. A new CPN order form must be initiated in CIS when changing from standard to individualized CPN (do not copy and edit the standard CPN). See the ordering guidelines on the next page. A nutrition support dietitian or nutrition support pharmacist (see inside cover) will be glad to assist you.

Ordering Guidelines for an Individualized CPN (CPN template in CIS can do these calculations.)

a. Fill in dosing weight and hospital ward. Select "central" venous route.

b. Select protein source (Travasol 10%), requirements in g/day = _____ and calculate **protein calories**

Grams of protein x 4 Kcal/g = Protein calories = _____

c. Determine daily **total Kcal desired** = _____ (will get 50% on day 1)

d. Determine **non-protein calories (NPC)**

Total calories - protein calories = NPC = _____

e. Calculate grams of **dextrose** and **fat** from NPC

$$\text{Grams of dextrose} = \frac{0.6\text{-}\mathbf{0.7} \times \text{NPC}}{3.4} = \_\_\_\_\_$$

$$\text{Grams of fat} = \frac{\mathbf{0.3}\text{-}0.4 \times \text{NPC}}{10} = \_\_\_\_\_$$

f. Order **electrolytes*** (see p. 12-13), **vitamins** (p. 11, 33) and **trace elements** (see p. 14, 33)

The default amount of lytes on the form will meet typical needs. The default dosage of MVI and trace element (mineral) solutions are standard and rarely need modification.

*Note that 1 mMol of **KPhos** = 1.5 mEq of K and 1 mMol of **Na Phos** = 1.33 mMol of Na.

g. Determine **fluid requirements** (see p. 14). Note the Minimal Volume that appears on the order form. If additional volume is desired in the CPN, modify the Ordered Volume block of the Individualized CPN order form. (Unfortunately, this template reverts back to the minimal volume whenever it is edited, therefore, modify the volume **after** all other changes are made in the CPN order.) The amount of Na may need to be adjusted as the default amounts of NaCl and Na acetate are based on an average CPN volume of approximately 1.5-2.5 L for patients with normal Na status.

* Don't forget to activate the "**CPN/PPN Standard Orders**" in the standard order section of CIS to ensure that initial baseline chemistries (see table 5), daily wt, I's and 0's, etc., are ordered. This order set includes that the CPN or PPN should be administered at the rate printed on the label of the bag (unless overridden by physician order).

Table 5. Standard Chemistry Monitoring with Parenteral Nutrition

Lab	Frequency
Na, K, Cl, HCO3, Glucose, BUN, Cr	Days 1, 2, and 3 of CPN or PPN, then as needed
Ca, Phos, Magnesium	Days 1, 2, and 3 of CPN or PPN, then as needed
Alk Phos, AST, ALT, Bilirubin, PT	Day 1 of CPN or PPN, then as needed
Glucose	BID if on CPN, adjusted frequency as needed
Triglyceride, Prealbumin	Day 1 of CPN or PPN, (order prealbumin q wk)

Medication Additions to Parenteral Nutrition

- **Insulin** - can be added to the CPN if glucose remains above 150-200 mg/dl and the use of an insulin drip is not feasible. See page 46 for specific guidelines on blood sugar control.

- **Ranitidine** - has been shown to be compatible with PN solutions. The 24 hour IV dose can be ordered in the PN, although only do this if it is anticipated that the entire bag will be given in 24 hr, otherwise patient will not get the full med dose. (Avoid duplicate med orders in CIS.)

- **Individual vitamins and minerals** - such as zinc, vitamin K, C, B12, folic acid, and thiamin are available as additives and are used when a deficiency exists or is anticipated. Additional vitamin C should probably not be added to CPN since it easily degrades to oxalic acid and can form calcium oxalate precipitates, as well as hyperoxaluria. Iron is not compatible in fat containing PN.

- **Albumin** has not been proven beneficial and addition should be avoided in lipid-containing PN.

Tips on WRAMC Parenteral Nutrition

1. The CPN/PPN order template is in the Note section of CIS. Use the standard CPN or PPN solution if possible and specify volume desired in L/d (not mL). Do not order the standard CPN formula to meet 100% of volume requirements if the Kcals will be excessive.

2. Ingredients in a standard CPN are expressed “per Liter”, but in an individualized CPN are “per Day". If you wish to switch from a standard CPN template to an individualized CPN (or vice versa) initiate a new order (in Notes section); don't use the copy and edit function.

3. A weight must be indicated on the PN order, especially on an individualized PN order.

4. Unless otherwise ordered, the pharmacy only makes 1/2 of the CPN order on the first day of CPN to minimize risks of refeeding syndrome and hyperglycemia. The full CPN order is made by the 2nd bag and thereafter. (A full order of PPN is made on day 1 since PPN has a low dextrose concentration.)

5. Activate the applicable "CPN/PPN Standard Orders" in the Standard Order section to ensure that baseline lab work, daily wt, "In's and Out's", etc., are ordered. This order set includes that the CPN (or modify to "PPN") should be administered at the rate printed on the label unless overridden by a physician order (and prompts nursing to record volume of PN intake).

6. CPN/PPN must be ordered daily before 1300 hr. The first order must be printed and hand-delivered to 2nd floor pharmacy. To reorder, first "copy", then "edit" if needed, and then store the "note". If PN is discontinued, then reordered, a copy of the order must be delivered to the pharmacy and CPN/PPN Standard Orders reactivated.

7. Do NOT attempt to use CPN to correct acute electrolyte deficits.

8. The Nutrition Support team members are usually available to assist you. Please refer to the latest Nutrition note since that may answer your questions. If not, page us (see front cover).

Complications Possible with PN

See page 45-47, Management of Metabolic and Fluid Complications!

Acute Adverse Reactions to PN: Note that the IV lipids can cause an acute adverse clinical reaction**,** such as back or chest pain, dypsnea, cyanosis, flushing, dizziness, headache, nausea, etc., requiring immediate cessation of the infusion and omission of lipid from any future PN. Submit an Acute Drug Reaction (ADR) report. The IV sedative Diprivan (Propofol) contains the same type of IV lipid.

Precipitation of Calcium and Phosphorus: The potential precipitation of CaPhosphate from PN has been documented and was thought to be the cause of deaths from PE. This problem is difficult to predict because solubility in solution is dependent on many factors (e.g. pH, temp, amino acids). Do not increase the amt. of Ca or Phos by >double the standard amount without assistance from pharmacy. As an added safe-guard, all PN solutions must have a 1.2 micron filter in the line.

Visually inspect TNAs for: precipitates, discoloration, or breaking of the fat-water emulsion. Since these problems may not be easily detected visually, it is mandatory that a 1.2 micron filter (provided by the pharmacy) be placed on each CPN or PPN line and not removed.

Mildly elevated transaminase and alk phos concentrations may occur days to weeks after initiation of CPN. Enzyme levels almost always normalize when CPN is stopped. More serious **hepatic steatosis, cholestasis**, and **metabolic bone disease** occur with significant frequency in long-term CPN. See sections on Home (or Long-Term) Nutrition Support , Liver Failure, and Short Bowel Syndrome for recommendations to minimize these complications.

Discontinuing PN

- Decrease the **full CPN** volume/rate by 50% for 1 or 2 hrs before stopping it completely. This reduces the risk of rebound hypoglycemia. If abrupt discontinuation of full CPN cannot be avoided and the patient is not receiving oral/enteral nutrition, 10% dextrose may be administered at the same rate for 1-2 hours and then discontinued. (Prolonged administration of D10W can cause hyponatremia and other serum electrolyte deficits, therefore, should be generally be avoided.)

- Full rate **PPN** may be stopped without decreasing the rate, if desired, since it only contains 5.5% dextrose and does not result in rebound hypoglycemia.

- CPN can have a negative effect on appetite, therefore, it is reasonable to decrease the rate of CPN (usually by 50%) when a PO diet (more than clear liquids) is ordered.

- In relatively well-nourished patients, CPN can be discontinued soon after oral or enteral nutrition is tolerated. In patients at higher risk for malnutrition, feeding should be gradually transitioned from parenteral to oral/enteral to ensure adequate intake. Once $\geq$ 60% of goal energy and protein is met orally or enterally, CPN may be completely stopped.

Evaluating Nutrition Support Effectiveness

Weight. Although it is sometimes difficult to obtain a reliable weight it can be an important parameter to follow to help assess fluid balance and long-term appropriateness of caloric intake.

- A body fluid increase of **1 Liter = 1 Kg** wt gain
- Add or subtract 500 or 600 Kcal/d to promote 1-lb/wk or 0.5 kg/wk **wt gain or loss**, respectively
- Assuming normal fluid status, most patients should gain or lose no more than 1 kg/wk when receiving repletion (hypercaloric) or hypocaloric feeding, respectively.

Nitrogen Balance (NB) is the difference between the N intake and N excretion. It can help to determine degree of catabolism and protein requirements. NB is estimated by the N intake along with collecting a "urine urea nitrogen, 24 hr". Stable N intake is required for accurate assessment. A factor of 3 to **4 g** is added to the N excretion to account for insensible N losses. The standard equation is:

$$\text{NB} = \frac{\text{protein (g) intake}}{6.25} - (\text{24 hr UUN converted to grams, plus 4 g nitrogen})$$

This equation has an standard error of (+) or (-) 2 g. Consider increasing protein intake if in negative NB, however, negative NB may be unavoidable during high stress states, regardless of the amount of nutrients provided. Positive NB may be a reasonable goal during recovery, but may also require increased Kcal. Limitations of the NB equation exist with renal impairment (Cr Cl <50) and large insensible losses (e.g., GI fistulas). NB can be fraught with inaccurate urine collection (especially if not catheterized), CHCS order entry error, lab error and miscalculations.

Prealbumin: (See page 4.) Monitor 1-2 x wk as a marker for short-term gross adequacy of calorie and protein intake (≥ 2/3 of estimated needs) in patients with stable renal function, preferably not receiving corticosteroids. Levels <11 mg/dl were associated with malnutrition, but are also depressed by stress, surgery, hepatic failure, nephrotic syndrome, hypothyroidism and blood loss. Levels >13.5 were associated with return to stable nutritional status in hospitalized patients. With adequate feeding prealbumin can increase ≥ 4 mg/dl/wk (lack of increase is an indicator of poor outcome/prognosis).

Indirect calorimetry using a **"metabolic cart"** measures oxygen consumption (VO2) and carbon dioxide production (VCO2) by the patient and calculates respiratory quotient (RQ) and energy expenditure, extrapolated to 24 hr. Ideally, the measurement should be done in a resting state to = REE. The measured REE is reliable (and includes any "stress"). The **RQ** is the ratio of VCO2 to VO2.

Indications for indirect calorimetry:

- Difficulty weaning from mechanical ventilation and suspected underfeeding or overfeeding.
- Unexplained hyperglycemia or hypertriglyceridemia associated with feeding
- Failure to respond to current feeding as expected
- Patients with altered body composition (e.g., ascites) in whom standard energy equations are N/A
- Conditions, such as sepsis or trauma, in which the range of EE can be highly variable.

Interpretation of RQ:

- If the RQ is outside the physiological range of 0.67-1.3, the test may be invalid.
- RQ < 0.81-0.85 suggests underfeeding (mostly lipolysis) but sensitivity is poor.

- RQ 0.85 - 0.90 suggests mixed fuel oxidation and roughly meeting TEE.
- RQ > 1.0 suggests overfeeding (lipogenesis) and is correlated with tachypnea and decreasing tidal volume (suggesting respiratory intolerance) but overfeeding Kcal with fat will not elevate RQ>1.
- RQ does not reliably reflect fuel utilization or under-/overfeeding.

Limitations of our metabolic cart:

- Unable to get accurate results if ventilator FiO2 is >50%, if on bi-level ventilation, if any air leaks, and if unable to obtain consistent measurements (steady state) within 15-30 min.
- Requires patient to be at rest, preferably with no interventions for 1 hr prior to study
- Inaccurate during hemodialysis and just following anesthesia/surgery.
- Cannot be used in patients getting supplemental oxygen unless they are on a mechanical ventilator
- Does not include energy expended in physical activities, such as ambulation

Management of Metabolic and Fluid Complications

- **Refeeding Syndrome** - may result when refeeding malnourished patients, patients unfed for >1 wk, or highly stressed patients. Large amounts of calories, especially from carbohydrates, stimulate a surge in insulin release which can result in electrolyte abnormalities such as hypophosphatemia, hypokalemia, and hypomagnesemia. Refeeding syndrome may also be characterized by volume overload which may precipitate congestive heart failure. Begin nutrition support with less than the REE and correct any significant electrolyte abnormalities and volume overload before advancing calorie intake. The initial feeding goal should not exceed TEE.

Hyperglycemia is a common metabolic abnormality associated with CPN, but also seen in EN. It can lead to osmotic diuresis and immune dysfunction. Several studies have found that postoperative hyperglycemia was related to a significant increase in infections (Bistrian). In a study of postop, mostly cardiothoracic ICU patients (Van Den Berghe, et al), those in the intensive insulin therapy group (mean AM glu,103 mg/dL) had significantly less morbidity and mortality than the group with conventional treatment (mean AM glu,153 mg/dL).

Recommendations to prevent or treat hyperglycemia:

* **Avoid excessive total CHO and Kcal** intake. Limit CHO to < 4-5 mg/kg/min.
* **Aim intial goal of CPN to meet 60-100% of estimated or measured EE** (hypocaloric feeding on day #1, per WRAMC policy to make only 50% of the CPN order).
* **Hypocaloric feeding** may be appropriate, especially in the obese (see page 54).
* **PPN** (page 34) can be used for short-term feeding and has a lower % dextrose than CPN.
* **Do not increase Kcal intake if Glu** >200. If Glu >150 mg/dl, monitor Glu q6h, order an **appropriate SSI**. Consider **insulin drip** (ICU only) w/glu checks hourly.
* In **insulin-requiring DM**, can initially add 0.1 units of regular insulin to CPN for each g of dextrose in CPN. Consider adding 50-75% of the previous 24 hr SSI to next CPN order. If NPH SQ insulin is used BID, will need a ratio that is close to 1:1 for AM and PM insulin dosage if feeding over 24 hr/d. Glargine can also be used q day.
* Use **continuous** rather than cyclic feeding short-term (also decreases hypoglycemia risk).

Hypoglycemia may be avoided by not adding insulin to CPN when hyperglycemia is transient. Tolerance to glucose infusions may improve with time, so the amount of insulin required may decrease with duration of infusion. Patients at high risk for hypoglycemia (on long-acting insulin; severe hepatic or pancreatic failure), may require supplemental CHO when feeding is stopped.

- **Fluid Imbalances**. Water provided needs to be compared to the patient's estimated total losses.* High-protein intake (≥ 1.5 g//kg/d) can increase urinary fluid losses. Concentrated EN formulas (1.5-2.0 Kcal/mL) provide limited amounts of water. Minimal-volume CPN without additional fluids may not meet water requirements. Dehydration and overhydration can be assessed by monitoring fluid intake and output, wt change of > or < 0.2 kg/day, serum sodium, BUN**:**Cr, etc..
  * Be aware of the electrolyte composition of fluid losses (Table 2, page 13).
  Hypernatremia can be a sign of dehydration. Free water deficit can be calculated as follows:
  Water deficit = Wt (kg) x 0.6 for males or 0.5 for females x (serum Na/140-1)
  Water can be replaced w/boluses via enteral tube or increasing the volume of individualized CPN.

- **Hypertriglyceridemia** has been associated with immune suppression, acute pancreatitis, and decreased alveolar oxygen transfer. Fat emulsions having a high phospholipid-to-triglyceride ratio (the 10% product found in Diprivan has 4x the quantity than the 20% product used in PN) are more likely to produce high serum levels of phospholipids and plasma triglycerides. Hypertriglyceridemia is more likely when fat infusion rates are high, esp. in poorly controlled diabetes, renal failure, and severe stress. Decrease infusion of fat, including Diprivan (Propofol), when TG is >400 mg/dl and D/C IV fat when TG is >500 mg/dl.

- **Hypercapnia**. Common in COPD. Worsened by the infusion of **excess Kcal,** esp. CHO, causing an increase in CO_2 production, esp. from synthesis of new fat, and may exceed ability to rid the CO_2 through the lungs. It may lead to hyperventilation, respiratory acidosis and decompensation, resulting in need for mechanical ventilation or in difficulty in weaning off. If you suspect overfeeding, reduce total Kcal or request a metabolic cart study. If total Kcal intake is not excessive, the feeding may be modified by decreasing CHO and increasing fat.

Diabetes Mellitus

* See page 46 for guidelines to prevent and treat hyperglycemia and hypoglycemia associate with nutrition support in hospitalized patients. Oral diabetic agents may be appropriate in fairly stable patients with type 2 diabetes, especially those on TF.

* Aim for a blood glucose of <150 mg/dl while minimizing significant hypoglycemia. Remember that in addition to increasing risk for co-morbidities, hyperglycemia may decrease the efficacy of fuel utilization. Hyperglycemia may be more detrimental than underfeeding Kcal.

* Avoid very low-fat, high-carbohydrate feeding unless there is a compelling reason. Be cautious in giving large amounts of D5 from IVFs.

* Fiber-containing commercial EN formulas have not been shown to result in lower blood glucose than formulas without added fiber.

* The use of specialized diabetes EN formulas in hospitalized patients have not been studied well, therefore, they have not been shown to be superior to other, less expensive, enteral formulas. (Diabetes formulas are frequently used in long-term care, in-part, because of higher insurance reimbursement.) Can consider a trial of a diabetes EN formula in long-term-care patients if unsuccessful in controlling blood glucose with a standard formula.

Home (or Long-Term) Nutrition Support

When considering long-term EN or CPN, the demonstrated or anticipated benefits versus burdens of the therapy must be weighed. The use of EN has not been shown to improve outcomes in those with severe dementia. The preferable alternative is PO hand feeding (Ina LI).
Criteria for patient selection include:
* Documented inability to meet nutrient requirements without “forced feeding”.
* Clinical status appropriate for home discharge.
* Demonstration of tolerance (e.g., blood glucose) to the prescribed infusion.
* Willingness and ability of the patient/caregiver to perform the necessary tasks and lifestyle changes for safe EN or PN feeding. Multidisciplinary patient/caregiver education and FU is recommended.

The inpatient’s discharge planner may need to arrange for a home health care agency (and insurance payment) to provide equipment, feedings, and possibly the education and monitoring required for home NS. Medicare, Part B, covers EN and PN benefits and specifies criteria that must be documented. There may be significant financial costs to the patient with home CPN.
Hospice almost never accepts patients on CPN.

Transitioning to long-term, cyclic CPN:
CPN infusion may be changed from 24 hr/d to a cyclic infusion, 16-18 hr/d, given at roughly half-rate over the first and last hr of infusion to minimize risk for hyperglycemia at the start of the infusion and reactive hypoglycemia after the CPN is stopped. If a 16-18 hr/d cycle is well-tolerated, can consider further decreasing time of infusion, but not <10-12 hr/d. To do a CPN cycle at WRAMC, the rates for the infusion MUST be included on the order form AND in the “Crystalloid” orders.

Complications of long-term CPN:

See p.45-47 for some potential metabolic and fluid complications.

Iron deficiency is a concern with long-term CPN because iron is incompatible with the fat in CPN. Can add iron to fat-free CPN and give IV fat separately, as needed. Maintenance IV iron needs are 1-2 mg/d. Note that separate infusions of IV fat should infuse for 10-12 hr, but not >12 hr, due to risk of microbial contamination.

Choline deficiency appears to cause reversible hepatic abnormalities in patients receiving long-term CPN. (See Liver Failure.) Choline for IV use is not yet available, although a large randomized prospective trial of IV choline in CPN-dependent patients is in progress.

CPN-associated hepatobiliary dysfunction may be minimized by

- avoiding overfeeding, especially fat and dextrose
- cycling CPN (rather than continuous infusions), also by giving IV fat <daily
- avoiding sepsis
- use of some medications to stimulate bile flow
- and most-importantly, by the use of the GI tract for feeding, if possible.

The etiology of metabolic bone disease is likely multi-factorial and may include aluminum toxicity, alcohol abuse, smoking, excessive amino acids, chronic acidosis, very short CPN cycles, inactivity, mineral deficiencies (Phos, Ca, Mg, Cu), parathyroid disease, heparin and corticosteroids.

Liver Failure

It is common for patients with advanced liver disease to have inadequate food intake and varying degrees of malnutrition. Intracellular mass declines and extracellular space expands. Energy expenditure (per kg actual weight) may be relatively normal owing to a mild hypermetabolism of the remaining lean tissue. These patients may or may not be hypercatabolic. When >80% of hepatocytes are dysfunctional, the patient is vulnerable to fasting hypoglycemia and insulin resistant hyperglycemia. Fatty acid deficiency is believed to be from poor intake, malabsorption (including vitamins A, D, E, and K), and increased oxidation. Additional deficiencies of zinc, Mg and most B-vitamins, esp. thiamin, are associated with alcoholic liver disease. Consider iron losses w/GI bleeding.

Ammonia may be an important neurotoxin that causes hepatic encephalopathy in susceptible patients. The main source of ammonia is endogenous production in the GI tract (the degradation of bacteria and blood). Therefore, drugs such as lactulose and neomycin are given. The endogenous synthesis of glutamine removes ammonia.

It has been estimated that 40% of long-term CPN patients develop severe liver dysfunction.

Therapy Considerations (Use estimated "dry" weight in patients with ascites.)

- Only restrict **water** and **sodium** intake if clinically necessary.

- **Kcal:** 25-35***/***kg/d (in 4-6 meals/d, including a late evening snack to minimize fasting hypoglycemia and excessive satiety). A metabolic cart for indirect calorimetry may be helpful. Use a normal mix of fuel (CHO as 50-55% of total Kcal and fat as 30-35% of total Kcal).

- **Protein**: 0.8-1.0 gm/kg/d to achieve nitrogen balance; at least 1.2-1.3 gm/kg to promote positive nitrogen balance; at least 1.5 gm/kg/d w/high stress (e.g., severe hepatitis, sepsis). Only in acute or chronic encephalopathy, limit protein to 0.6-0.8 g,/kg/d. Do not give supplemental glutamine (since this may result in increased ammonia).
  Vegetable protein may be less likely to precipitate encephalopathy than animal protein.

- Some trials demonstrate more rapid recovery from **encephalopathy** and/or better nitrogen balance using feeding formulas containing higher levels of branched chain amino acids (BCAA) and lower levels of aromatic amino acids and methionine, but many of these were not controlled against standard amino acid preparations. Consider a trial of these special formulas only in chronic encephalopathy unresponsive to other dietary modifications or pharmacotherapy. If CPN is needed, Freamine HBC 6.9% could be used in place of Travasol 10% (see p. 32).

- Supplement with RDA of vitamins. Screen for **micronutrient deficiencies**, including vitamins A, D, E, K, and zinc. In 1 study, 200 mg oral zinc sulfate TID for 3 months normalized serum zinc level, improved amino acid metabolism and reduced encephalopathy (Marchesini et al).

- A.S.P.E.N. Guidelines suggest NS be provided to malnourished patients with complications or delayed oral intake following **liver transplant** to reduce complications and ICU stay (see p. 20).

- **Choline** is not currently added to CPN, however, choline deficiency causes reversible hepatic abnormalities in patients receiving long-term CPN. In an experimental study, 2 gm of IV choline/d was associated with resolution of hepatic steatosis (Buchman). (IV choline is not commercially at this time.) If some GI absorption is present, can give PO/enteral lecithan to supply choline.

Obesity

As the degree of obesity and the severity of concomitant illness increase, estimating nutritional losses/needs by any formula becomes more difficult and inaccurate, and the risks of adverse consequences from overfeeding increase. Underfeeding Kcal has been associated with better outcomes than meeting estimated EE (see p. 20 and 54).

Note: ABW = actual body weight; DBW = desirable body weight

***REE formulas** based on indirect calorimetry in hospitalized obese patients**:**

1) **Barak** equation = "adjusted body weight" (average of the ABW and DBW) in the Harris Benedict equation (see page 8) x 1.3 (stress factor) This equation was derived from patients referred to a nutrition support service and includes ICU and non-ICU patients.

2) **Ireton-Jones** equation **= 629 - 11(age) + 25 (ABW in kg) - 609**
This equation was developed/validated in patients not on a mechanical ventilator.

3) **Amato** formula **= 21 Kcal x ABW in Kg**
This equation was validated in mechanically ventilated patients.

*Ambulation may increase EE. Subtract 250-750 Kcal/d for **0.5 to 1.5 lb/wk wt loss**, if desired.

Hypocaloric Protein-Sparing Feeding in hospitalized obese patients:

1.5-2.0 g protein /kg/day of DBW and a total Kcal to nitrogen ratio of 75:1 (1 g N = 6.25 g protein)
This was equivalent to 14 Kcal/kg ABW or 22-25 Kcal/kg DBW.

This formula provides approximately 50-60% of EE, yet was shown to achieve zero to positive nitrogen balance (Choban PS, et al). The higher end of protein range is recommended for the more highly stressed patients. In a retrospective ICU study, by Dickerson, et al, obese patients on hypocaloric feeding including 2 g protein/kg DBW had no differences in prealbumin or nitrogen balance, but had a significant reduction in length of stay and time on antibiotics compared to patient receiving eucaloric feeding (also including 2 g protein/kg DBW).

Multivitamin/mineral supplementation will be needed if feeding does not meet requirements for vitamins and trace minerals.

Guidelines for calculating Protein requirements:

Hepatic encephalopathy or severe azotemia:	0.8-1.0 g protein/kg DBW or adjusted wt (page 48)
Normal maintenance needs:	1.0-1.2 g protein/kg DBW
Hypocaloric feeding (see above):	1.5-2.0 g protein/kg DBW
Stressed:	1.5-2.0 g protein/kg DBW

Oncology

Therapy Considerations

1. Routine use of CPN in patients undergoing cancer treatment has been associated with an increased rate of infection and is not recommended. Nutrition support is appropriate for those receiving active anticancer treatment who are malnourished and anticipate to be unable to ingest and/or absorb adequate nutrients for a prolonged period of time. (See p. 19.)

2. CPN should not be used routinely in patients undergoing cancer surgery. However, in moderately to severely malnourished patients, 1-2 weeks of preoperative CPN, continued postop until eating, was associated with decreased postoperative complications (The Veterans Affairs Total Parenteral…).

3. Consensus guidelines from 2001 (Proceedings from Summit on Immune-Enhancing Therapy) recommended use of early postop or periop TF w/an immune-modulating (IM) product for 5-10 days in significantly malnourished elective GI cancer surgery patients. The IM formulas include at least one of the following: arginine, glutamine, omega-3 fatty acids, and RNA. Compared with standard EN with the same Kcal and nitrogen, patients randomized to the IM product had significantly lower infectious complications and decreased hospital LOS. A more recent analysis (Sacks, et al) generally supports the 2001 guidelines but also demonstrates that postoperative IM feeding (after preop oral IM intake) offers no outcome benefits vs. only preop IM supplementation (BID or TID) for 5-7 days. Also, 2 studies showed the same outcomes in well-nourished GI cancer surgery patients. The oral IM product used was Impact Recover (previously, Oral Impact) from Novartis, not currently on the WRAMC formulary.

Pancreatitis and Pancreatic Insufficiency

- REE varies widely (105-149% REE) and is generally highest in those with sepsis.

- Protein needs also vary widely (0.8-1.5 g Pro/kg or sometimes higher in very severe stress).

- Mild pancreatitis can be supported with simple IV fluids with electrolytes and generally a rapid return to oral diet. Studies have not shown nutrition support to improve outcome.

- In more severe acute pancreatitis, oral or gastric feeding is usually withheld. In a meta-analysis by Marik, jejunal feeding was associated with less infection, fewer surgical interventions, and reduced hospital LOS, compared to CPN. Peptide, elemental, and standard (intact protein) EN formulas have been successfully used. If enteral feeding is not feasible or tolerated, CPN may become necessary. A mixed fuel regimen should be used and labs monitored for Glu, Na, K, Phos, Ca, Mg, and triglycerides (omit any IV fat if TG >400 mg/dl). Hyperglycemia is common.

- Chronic pancreatitis patients are at risk for chronic malnutrition. Pain, nausea, vomiting, and/or diarrhea may be associated with eating. Nonenteric coated pancreatic enzymes may decrease pain. Large, high-fat meals and alcohol should be avoided.

- When 90% of pancreatic function is lost, expect maldigestion/malabsorption of fat, protein, and possibly starch, fat-soluble vitamins, zinc, and vit B12 from food. Pancreatic enzyme replacement (nonenteric coated or enteric coated) becomes mandatory. Dietary fat should be the max tolerated without increased steatorrhea or pain. Modest amounts of MCT oil can supplement Kcal intake. Monitor for nutrient deficiencies. Endogenous insulin and glucagon secretion may be inadequate.

Pressure Ulcers

Epidemiologic data have indicated that poor nutrition status, low body wt and poor food intake are risk factors for the development of pressure sores. Currently, there are only limited data available on the efficacy of nutrition in treating pressure ulcers. The following guidelines were suggested (Schols, et al):

- Perform and document a comprehensive nutritional assessment, including regular weighing of the patient, documentation of PO intake, and possible reasons for undesired wt loss.

- Provide a well-balanced diet with sufficient Kcal (30-35 Kcal/kg), protein (1.0-1.5 gm/kg), and fluid (at least 1 mL/Kcal) to possibly prevent ulcers or accelerate healing.

- Monitor effectiveness of nutrition intervention (e.g., wt, functional status, quality of life, incidence of new ulcers, and healing of established ulcers)

- If the usual diet is inadequate, consider supplemental oral nutrition by sip feeding or tube feeding.

- All decisions with regard to diagnostic and therapeutic actions should be taken with regard to patient choice and in light of overall treatment goals.

Micronutrient deficiencies should be prevented, or if properly diagnosed, treated. However, there is inadequate data to recommend high-dosage supplements of any vitamin or mineral.

Pulmonary Insufficiency/Failure

Respiratory failure and emphysema are risk factors for developing malnutrition.

Therapy Considerations

* **Aspiration** considerations: see p. 30.

* **Early EN** in mechanically ventilated (MV) ICU patients has been recommended by Heyland, et al to reduce infectious morbidity (however, statistical significance was not achieved and there was considerable heterogeneity in trial designs) .

* Most patients expend 20-30 Kcal/kg/day, however, there is controversy (and limited outcome data) about what the optimal amount of NS should be to attain positive outcomes.

  In the ICU, meeting 60-70% of estimated EE (or 14-18 Kcal/kg) with NS has been associated with reduced infection, hospital LOS, and time on ventilator in **obese** patients compared to meeting 100% of estimated EE (Dickerson, et al, etc.).

  In a cohort study, Krishnan, et al evaluated the relationship of caloric intake from NS with guidelines for a feeding goal of **25 Kcal/kg** and with **clinical outcomes** in **medical ICU** patients. The average Kcal intake was 13 Kcal/kg. Tertile II (33-65% of Kcal goal = 9-18 Kcal/kg/d) was significantly more likely to achieve spontaneous ventilation before ICU discharge vs tertile I (0-32% of Kcal goal). Tertile III (≥66% of Kcal goal) was significantly less likely to be discharged from hospital alive vs tertile I.

  Indirect calorimetry (page 45) may help to determine EE and avoid overfeeding.

* Do not exceed EE under most ICU conditions since overfeeding will:
    - **increase** CO_2 production, work of breathing, and risk of respiratory acidosis and ventilator dependence
    - increase risk of hyperglycemia and (+) fluid balance
    - increase risk of an **acute drop** in serum K, Phos and Mg

* Special high-fat formulas marketed for patients with pulmonary insufficiency may not be necessary (Russell, et al) and may delay gastric emptying. However, it is prudent to include a moderate amount of fat in the diet to decrease the risk of CHO overfeeding since CHO overfeeding increases CO_2 production. One study in early acute respiratory distress syndrome (ARDS), Gadek, et al, demonstrated that patients on a EN formula high in omega-3 fatty acids and antioxidants spent less time on mechanical ventilation, less time in the ICU, and had a decrease in organ failure. Unfortunately, dropout rate was high and the control formula was extremely high in omega-6 fatty acids and extremely low in omega-3 fatty acids (not comparable to any of our standard EN formulas). Note that Diprivan, a commonly used ICU sedative, is high in omega-6 fat.

* The use of a standard 1.5 Kcal/ml EN formula may help to minimize fluid, CHO and gastric volume.

* If weight gain is desired in stable COPD patients, consider increasing fat intake, including omega-3s.

* Protein needs are generally 1.2-1.4 gm/kg.

* Time on mechanical ventilation and LOS are increased in patients with hypophosphatemia.

Renal Failure

Therapy Considerations for Acute Renal Failure (ARF) and Chronic Renal Failure (CRF)

- **Dosing weight** may be somewhere between the ideal body wt and usual (or actual) "dry" wt.
- **Energy requirements** are not significantly altered by renal failure, per se.
- **Protein requirements:**
  ARF: 0.8-1.0 g/kg/day without dialysis; 1.0-1.5 g/kg/day with dialysis or hemofiltration
  CRF: 0.6-0.8 g/kg/day without dialysis; 1.0-1.3 g/kg /day with dialysis
- **Minerals:** Restriction of Na, K, Phos and Mg may be needed. See p. 12 for estimated daily parenteral electrolyte needs. Supplemental oral Ca is often given w/meals to bind Phos. Iron (IV or oral) is often needed due to increased needs associated with EPO therapy.
- **Fluid** restriction may be needed if oliguric or anuric.
- **Vitamin** supplementation:
  - water soluble B-vitamins and vitamin C, esp. w/dialysis (e.g., Nephrocaps®).
  - consider need for dihydroxy-vitamin-D
- **Glucose abnormalities and hypertriglyceridemia** are fairly common, therefore glucose (p. 46) and TG (p. 47) should be monitored.
- **Nepro®** (pages 17 and 28) can be used for an oral supplement or EN to restrict water and electrolytes. If additional protein is needing, consider supplemental **ProMod** (p. 29).
- **Reassess** fluid, protein and electrolyte needs frequently in ARF.

Short Bowel Syndrome

The **normal** small intestine is 300-800 cm (10-25 ft) in length (1/3 jejunum and 2/3 ileum). The normal colon is approximately 150 cm. Most nutrients are absorbed in the jejunum. Nine liters of fluid/d enters the small bowel, and normally, all but 1 liter is absorbed proximal to the colon. The colon absorbs >80% of the remaining fluid, and can absorb up to 3-4 liters daily. The colon also has the capability to salvage energy by the fermentation of complex CHO and soluble fiber to short chain fatty acids.

Loss of significant distal ileum, ileocecal valve, and/or colon results in faster overall transit and the potential for greater fluid and nutrient losses. Following a resection, the ileum has a greater ability to adapt than the jejunum. The tolerable amount of small bowel loss is always less when a sizable section of ileum or colon is removed or nonfunctional. The function of the remaining bowel may be hindered by mucosal disease, bacterial overgrowth, rapid gastric emptying, excessive gastric acid with inactivation of pancreatic lipase and deconjugation of bile salts, or pancreatic insufficiency. Oxalate nephrolithiasis develops in the setting of steatorrhea and an intact colon.

Loss of 100 cm or more of terminal ileum will significantly impair absorption of vitamin B12 and bile salts (and thus, fat and fat soluble vitamins). Less than 100 cm of remaining jejunum or ileum (without a colon or ileocecal valve) or < 50 cm of small bowel with a colon may require at least some CPN for an indefinite period. The process of intestinal adaptation is facilitated by complex foods and continues for approximately 2 years in adults. Stool output (diarrhea) was (+) associated with intake of simple CHO, but not other macronutrients (Cren, et al). Hyperphagia is an important adaptive response to maldigestion and malabsorption.

Therapy Considerations (general reference: AGA Technical Review on Short Bowel…)

- Initially post-op: NPO, IVF w/lytes, CPN, if needed, then gradually increase oral intake when clinically stable, starting w/6 small feedings/d , avoiding hyperosmolar liquids.
- Advance to regular diet, mostly unrestricted (see modifications below) with high Kcal/high Protein intake. Usually lactose is well-tolerated except after significant jejunal resection.
- Require supplemental MVI (probably with trace elements/minerals); often require supplemental Ca, Mg, and possibly additional zinc. Vitamin B12 (IV or IM) will be needed if no distal ileum.
- Monitor volume status, weight, electrolytes, Mg, liver function, zinc, folate, vitamin B12, bone density, and urinary calcium and oxalate.
- With **end jejunostomy** (no ileum or colon): Dehydration is the greatest concern. Sipping an oral rehydration solution containing approximately 90 mMol/L(or mEq/L) of Na can reduce the need for IV fluid, but intake is limited by its palatability. One commercial product is CeraLyte 90.
- With **colon**: Consume soluble fiber (fermented to short-chain fatty acids). Supplemental MCT can increase total calories (absorbed in the small bowel and the colon). Restrict oxalate. (Ca supplements may bind oxalate.) Restrict intake of sugars to avoid osmotic diarrhea or if (+) D-lactic acidosis. Consider fat restriction if (+) steatorrhea and >100 cm distal ileum removed.
- Consider need for supplemental EN. Peptide-based formulas have generally not been found superior to intact protein formulas, but few studies have been done on EN in short bowel.)
- In **severe short-gut**, combined therapy with growth hormone (short-term), oral glutamine (long–term), and modified diet (long-term) based on presence/absence of colon has shown some positive outcomes in reducing CPN dependence, although is controversial (Matarese, et al)

Trauma

- Once the trauma patient has been hemodynamically stabilized, early initiation of EN should be considered if the patient is likely to be unable to eat for >4 days since early enteral EN appears to decrease infectious complications and hospital LOS compared to delayed EN (Marik, et al).

- Preferably feed by the enteral route, since aggregated results of studies in ventilated ICU patients, including trauma patients, showed a reduction in infectious complications with EN (RR, 0.61, *p* = .003) compared with CPN (Heyland, et al, 2003).

- Positive clinical outcomes have been shown in studies of trauma patients using early EN with immune-modulating ingredients containing one or more of the following nutrients: glutamine, arginine, omega-3 fatty acids, and nucleotides. Supplemental glutamine (see p. 29) appears to reduce infectious complications and possibly hospital LOS in trauma patients.

- It is reasonable to give 25-30 Kcal/kg and 1.5-2.0 g Pro/kg. Fever, tachycardia, and tachypnea are associated with increased energy expenditure (EE). EE may be higher (35-40 Kcal/kg) in some forms of head injury and during the second week after onset of sepsis. Metabolic cart measurements of EE may be helpful given the significant range of EE possible in these patients. However, it has been reported that varying the non-protein Kcal intake of trauma patients during the first week following injury did not affect catabolic rate or N-balance, which was about negative 8 g/d when also fed 2 gm protein/kg/d.

- Another way to estimate EE of ventilator-dependent patients is the Ireton-Jones equation:
  EE = 1784 - 11(age) + 5(Wt in Kg) + 244(if male) + 239(for trauma) + 804(for burns)

- Delayed gastric emptying can be a problem, therefore, consider use of promotility medication and/or consider placement of jejunal feeding tube, especially if frequent surgery is anticipated.

- There are no evidence based recommendations for when to initiate CPN, however, it is reasonable to start it if the enteral route has not or will not provide >60% of estimated protein/Kcal needs for 7 days or longer.

- As in all critically ill patients, significant overfeeding and hyperglycemia should be avoided. Monitor K, Phos, Mg, glucose and triglyceride levels, esp. with continuous Diprivan infusion. Fluid and electrolyte changes can occur rapidly, therefore, require frequent monitoring, especially during initial refeeding.

- Vitamin and trace mineral requirements for these patients are unknown although at this time it is recommended that 100-200% of RDA for vitamins and trace minerals be provided. Most EN formulas will supply 100% of RDA for micronutrients if 2/3 of patient's energy and protein needs are met.

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