Nutrition in surgery

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Metabolic response to starvation

- After 12 hours of not feeding,
  - Plasma insulin level falls
  - Glucagon rises
  - Hepatic glycogen is gradually converted into glucose
  - With prolonged starvation, muscle glycogen is broken down and converted into lactate which is taken to the liver and converted to glucose
- After 24 hours
  - Hepatic gluconeogenesis from amino acids precursors start with loss of about 75 g of skeletal muscle protein per day

Metabolic response to starvation

- About 100 g of exogenous glucose is sufficient to prevent muscle breakdown in simple fasting
- With longer fasting
  - Fat stores are mobilized - Fat is broken down to glycerol and fatty acids
  - Adaptive ketogenesis occurs - Liver produces ketone bodies from fatty acids and after 2-3 weeks, the brain adapts to using ketone bodies instead of glucose leading to a reduction in need for muscle breakdown to generate glucose precursors

Indications for nutritional intervention

- Pt has involuntarily been inadequately nourished for > 9 days
  - Because prolonged malnutrition compromises
    - Physiologic function
    - Alters resistance to infection
    - Impairs wound healing
- Illness will last longer than 10 days
  - Pancreatitis
  - Severe peritonitis
  - Major injury (ISS > 15)
  - Extensive burns (> 20% of BSA)

Indications for nutritional intervention

- Baseline malnutrition (based on clinical assessment of nutrition, including muscle wasting, change in hair color, loss of subcut fat, peripheral oedema – defined as loss of > 10% of usual body weight in the last 3 months or loss of > 15% of usual body weight. Note however that body weight might be an unreliable indicator of nutrition status because of fluid retention which is common in very ill patients.
- Hand grip test and respiratory function
- Triceps skin fold thickness, mid-arm circumference are some parameters that can be measured and compared to average population values
- Biomarkers - short half life serum proteins such prealbumin, transferrin, or retinol-binding protein can be used as adjuncts to diagnosis of malnutrition

Indications for nutritional intervention

- Remember that patients may become nutritionally compromised after admission and re-evaluation may be necessary
- What about intensive care patients?
  - Priority should be given to ABC, adequate tissue oxygenation, acid-base balance and electrolyte status before nutrition

Nutrient requirements

- Based on age, sex, body size, and activity
- Hospitalized patients are largely inactive hence the BMR is the main energy expenditure
  - BMR (kcal/day) = 66 + (13.7Xwt[kg]) + (5Xht[cm]) – (6.8Xage[yr]) for males
  - BMR (kcal/day) = 665 + (9.6Xwt[kg]) + (1.7Xht[cm]) – (4.7Xage[yr]) for females

Nutrient requirements

- Certain diseases affect the BMR – infections, thyrotoxicosis
- Note that certain surgical conditions may be associated with metabolic disorders that make it impossible for patients to tolerate large amounts of nutrients
- Remember to adjust your calculations as patient begins to ambulate. This usually requires addition of 15 to 20% of the BMR.
- Remember that complex surgical conditions create a metabolic milieu mediated by the neuroendocrine and cytokine systems which makes utilization of supranormal amounts of nutrients impossible

Diseases that affect BMR

Table 1 - Alterations in Metabolic Rate

Patient Condition	Basal Metabolic Rate
No postoperative complications Fistula without infection	Normal
Mild peritonitis Long-bone fracture or mild to moderate injury	25% above normal
Severe injury or infection in ICU patient Multiorgan failure	50% above normal
Burn of 40%-100% of TBS	100% above normal

Typical requirements

- Energy – 35 kcal/kg body weight/day
- Protein 0.8g/kg body weight/day (60 – 70 g/day) rising to 100 to 150 g/day in critically ill patients
- 1 g of nitrogen (6.25g of protein) for every 150 kcal/day
- In general, administering excessive amounts of nutrients for acute correction of malnutrition is counterproductive because it can lead to excessive accumulation of liver glycogen, enhanced energy expenditure, increased urea production and elevation of Blood Urea Nitrogen.
- Weight maintenance and not weight gain is the goal.

Daily vitamin requirements

Vitamin	Enteral	Parenteral
Thiamin	1.2 mg	3 mg
Riboflavin	1.3 mg	3.6 mg
Niacin	16 mg	40 mg
Folic acid	400 µg	400 µg
Pantothenic acid	5 mg	15 mg
Vitamin B-6	1.7 mg	4 mg
Vitamin B-12	2.4 µg	5 µg
Biotin	30 µg	60 µg
Choline	550 mg	not defined
Ascorbic acid	90 mg	100 mg
Vitamin A	900 µg	1000 µg
Vitamin D	15 µg	5 µg
Vitamin E	15 mg	10 mg
Vitamin K	120 µg	1 mg

Daily trace elements requirements

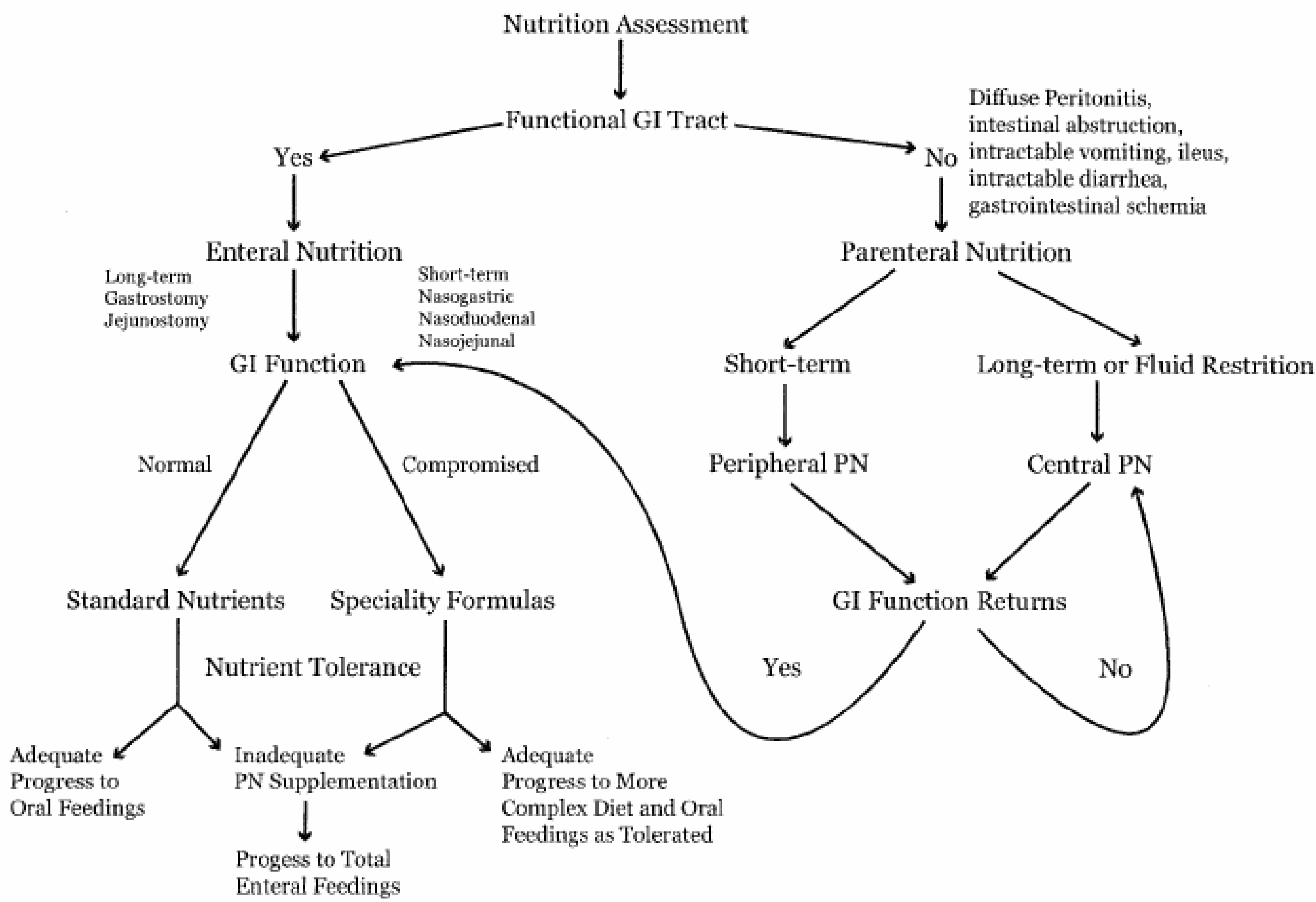
Trace element	Enteral	Parenteral
Chromium	30 μg	10–15 μg
Copper	0.9 mg	0.3–0.5 mg
Fluoride	4 mg	Not well defined
Iodine	150 μg	Not well defined
Iron	18 mg	Not routinely added
Manganese	2.3 mg	60–100 μg
Molybdenum	45 μg	Not routinely added
Selenium	55 μg	20–60 μg
Zinc	11 mg	2.5–5 mg

†Tables give general ranges for safe administration of nutrients in generally healthy people. Nutrient prescriptions must be individualized for each patient and clinical situation.

Vitamin and trace elements requirements

- Levels are monitored by regular blood tests
- Note that some elements may not be given to patients with renal failure
- Note that high protein intake is contraindicated in renal or hepatic failure
- Surgical patients normally receive multiples of the RDA for vitamins. Some recommend supranormal doses of vitamins for their anti-oxidant effect
- Some use Glutamine supplementation

Nutritional Assessment



Routes of administration

- Enteral
  - Preferred
  - Can be used if NG tube effluent is less than 600ml/day
  - Cannot be used in hemodynamically unstable patients, abdominal distension, gastroparesis, intestinal obstruction, ileus, high output fistulae, antibiotic induced colitis, idiopathic diarrhea, initial phase of short bowel syndrome, massive g.i. bleeding, poor prognosis and where patient or guardian disapproves aggressive nutritional support
  - Bowel sounds and passage of flatus are non-specific signs and unrelated to tolerance of enteric feeding
  - Use balanced or modified diets

Enteral Feeding is considered Routine Care in the Following

- Protein-calorie malnutrition with inadequate oral intake of nutrients for the previous 5-7 days
- Normal nutritional status but < 50% of required oral intake of nutrients for the previous 7-10 days
- Severe dysphagia
- Major full-thickness burns
- Low-output enterocutaneous fistulas
- Major trauma

Enteral Feeding is considered helpful in

- Radiation therapy
- Mild chemotherapy
- Liver failure and severe renal dysfunction
- Massive small bowel resection (> 50%) in combination with administration of total parenteral nutrition

Enteral Feeding is of limited or undetermined value

- Intensive chemotherapy
- Immediate postoperative period or post-stress period
- Acute enteritis
- > 90% resection of small bowel

Routes of administration - Enteral

- CHO = oligosaccharides, maltodextrin, polysaccharides
- Fats = medium chain fatty acids, long chain triglycerides to provide 10 – 15% of calories
- Nitrogen – natural sources
- Should be isotonic, lactose free, given as a continuous drip
- Non-proteinic calories can be derived from either fat or CHO

Routes of administration - Enteral

- CHO-based diets are hyperosmolar and may be useful in patients with steatorrhea while fat-based diets are usually isoosmolar and may be suitable in patients with hyperosmolar diarrhea
- Regardless, fat should not provide more than 30% of the total calories

Modified diets

- In modified formulas (also known as elemental or chemically defined diets), the proportions and types of nutrients differ from those of a regular Western diet. Such diets may be characterized according to the conditions for which they are formulated: stress, immunomodulation, and hepatic, renal, respiratory, or GI dysfunction
- Protein source is usually crystalline amino acids or short chain peptides, CHO is usually dextrose or oligosaccharides and fats are usually MCTs
- In GI dysfunction, protein is provided as short chain peptides and glutamine

Assessment of tolerance

- Feeding tolerance is assessed within the first 24 hours. Poor tolerance is indicated by:
  - Vomiting and severe abdominal cramps
  - Gastric residuum > 50% of the volume administered during the previous 4-hour feeding period
  - Increased abdominal distention (particularly in patients who are comatose or undergoing mechanical ventilation)
  - Worsening diarrhea
- If any of these conditions is present, parenteral nutrition is recommended.
- If there is no evidence of feeding intolerance, the patient is assessed for the aspiration risk.

Risk of aspiration

- Aspiration is a major complication in patients receiving enteral nutrition. The propensity to aspirate enteral feedings is often related to the patient's primary disease and neurologic status as well as to the site of GI access and the method of delivery.
- Important factors in assessing risk of aspiration include depressed sensorium, increased gastroesophageal reflux, and history of previously documented episodes of aspiration.
- To reduce risk, elevate patients’ head after feeding

Access

- N-G tube
- Naso-jejunal tubes – may require special procedures to position
- Simultaneous gastric decompression with naso-jejunal feeding is possible
- PEG
- Gastrostomy
- Jejunostomy

Technique of naso-gastric intubation

- Provide privacy.
- Explain procedure and its purpose.
- Place patient in sitting position with neck flexed slightly and head of bed elevated to 45°.
- Lubricate stylet and insert into feeding tube. Inspect nares and determine optimal patency by having the patient breathe through one nostril while the other is temporarily occluded.
- Estimate the length of tubing required to reach into the stomach by measuring the distance from the tip of the nose to the earlobe and then from the earlobe to the xiphoid process.

Technique of naso-gastric intubation

- Add 25 cm to this length for nasoduodenal intubation. If the patient seems uncooperative, instill generous amounts of lidocaine jelly into the nares and nasopharynx before tube insertion.
- Lubricate the end of the tube and pass it posteriorly. Ask a cooperative patient to swallow water to facilitate passage of the tube.
- Once the tube is beyond the nasopharynx, allow the patient to rest.

Technique of naso-gastric intubation

- Have the patient continue neck flexion and swallowing while the tube is advanced.
- If the patient begins to cough, withdraw the tube into the nasopharynx and then reattempt passage.
- Confirm passage into the stomach by obtaining an abdominal x-ray. Remove stylet.
- Secure tube to bridge of nose or upper lip with nonallergenic tape and prevent undue pressure on external nares.

Feeding regimens

- Patients fed through the stomach should have isotonic feed delivered at 30 ml/hr and this can be increased daily by 30 ml/hr
- Naso-duodenal or naso-jejunal feeds should be 300 mOsm/kg in concentration and delivered at an initial rate of 30 ml/hr using a peristaltic pump
- Monitoring of feeding is best done with a checklist

Checklist for monitoring patients on enteral feeding

- Obtain abdominal x-ray to confirm tube location before feeding
- Elevate head of bed 45° when feeding into the stomach
- Record type and strength of diet and rate of infusion
- Check gastric residuum every 4 hr in patients receiving gastric feedings. Withhold feedings for 4 hr if residuum is 50% greater than ordered volume
- Notify physician if two consecutive measurements detect excessive residuum

Checklist

- Check for abdominal distention
- Check frequency, consistency, and volume of stool output
- Weigh patient on Monday, Wednesday, and Friday. Record weight on graph
- Record intake and output daily
- For every shift, chart volume of formula administered separately from water or other oral intake
- Change administration tubing and cleanse feeding bag daily
- Irrigate feeding tube with 20 ml of water at the completion of each intermittent feeding, when tube is disconnected, after the delivery of crushed medications, of if feeding is stopped for any reason

Checklist

- When patient is ingesting oral nutrients, ask the dietitian to provide calorie counts daily for 5 days, then weekly thereafter
- On a weekly basis, obtain complete blood count with red blood cell indices, SMA-12, serum iron, and serum magnesium
- Obtain SMA-6 every Monday and Thursday
- Once a week, collect urine for 24 hours, starting at 8:00 A.M., and analyze for urea nitrogen

Complications of enteral feeding

- Aspiration
- Peritonitis
- Fistula formation
- Intestinal obstruction
- Diarrhea (Stool wt > 300 gm/24hrs or >300 ml/24 hrs or more than 3 loose motions/24 hrs) – occurs in 75% of patients. Treat by altering each component of the feeding at a time – osmolarity, rate, type of feed, volume. Consider kaolin-pectin. Rule out infective basis
- Vomiting
- Peptic ulcer – use antacids rather than H_2 receptor antagonist

Complications of enteral feeding

- Mechanical
  - Tube dislodgement, clogging of tube, leakage of enteric contents, tube fracture
- Metabolic
  - Dehydration
  - Malnutrition
  - Hyperglycemia, particularly in insulin-resistant severely injured and septic patients
- Infection
  - *Clostridium difficile*

Parenteral nutrition

- 2 routes
  - Peripheral – Limited indications
  - Central – often preferred because critically ill patients require a lot of nutrients and cannot tolerate large fluid infusions. Allows delivery of fluids with high density and tonicity
  - Can be inserted through the standard subclavian or internal jugular vein routes or where these are unavailable, the interventional radiologist can do peripherally inserted central catheter (PICC) through the antecubital or femoral vein

Parenteral route

- If the femoral vein is used, catheter should be changed every two days to reduce risk of infection and if nutrients are delivered into the inferior vena cava or iliac veins, lower osmolar feeds should be used
- Hypertonic nutrient solutions are infused into these veins, where they are rapidly diluted. Usually, such solutions contain hypertonic glucose (25%), amino acids (5%), and other essential nutrients. Their tonicity (> 1,900 mOsm/kg) is so great that administration into peripheral veins would cause severe thrombophlebitis and venous sclerosis.

Characteristics of Central Parenteral Nutrition

- Hypertonic solutions (~ 25% glucose, 5% amino acids, osmolarity > 1,900 mOsm/kg) containing at least 1 kcal/ml is used so that infusion of 2 to 2.5L/day provides 2,000 to 2,500 kcal/day
- Use either single lumen of multilumen central catheters. Avoid using the dedicated lumen for any other purpose
- Not clear which of these may be associated with higher incidence of catheter related infection

Formulations of Feeds

- 500 ml of 50% glucose
- 500 ml of 10% AA solution
- Add electrolytes, trace elements and multivitamins as required
- Administer about 2 L/day of this mixture
- In addition, 500 ml of 20% fat emulsion/day will supply essential fatty acids
- Or use a triple mix of all 3 in proportion of 70% glucose, 10% AA and 20% fat emulsion and give 3L/day
- Titrate electrolyte requirements, remember zinc, phosphates

Composition of parenteral feeds

	Standard Solution	Triple-Mix Solution
Volume	500	1,000
Amino acids 10% (ml)		
Dextrose 50% (ml)	500	1,000
Fat emulsion 20% (ml)	-	250
Total (ml)	1,000	2,250
Contents		
Amino acids (g)	50	100
Dextrose (g)	250 (25%)	500
Total nitrogen (g)	8.4	16.8
Total calories (kcal)	1,050	2,600
Ratio of nitrogen to calories	1:125	1:154
Caloric density (kcal/ml)	1.0	1.15
Osmolarity (mOsm/kg)	~ 1,970	~ 1,900

Electrolyte content of parenteral feeds

Electrolyte	Usual Conc	Usual Range of Conc
Na (mEq/L)	30	0-150
K (mEq/L)	30	0-80
PO_4 (mmol/L)	15	0-20
Mg (mEq/L)	5	0-15
Ca (mEq/L)	4.7	0-10
Cl (mEq/L)	50	0-150
Acetate (mEq/L)	70	70-220

Trace element needs are satisfied by adding commercially available solutions to I.V. solutions or triple-mix bags

Complications

- Infections
  - Primary catheter infection – present when there is a febrile episode and the catheter is the only anatomic focus. Symptoms abate upon removal of catheter
  - Secondary catheter infection – present when there is a primary focus of infection causing bacteremia and contaminating the catheter
  - Catheter related bloodstream infection (CRBSI)
  - Clinical evaluation is similar to that of any critically ill patient with fever
  - Prevent by removing dressing, inspecting site and applying antibiotic creams every 2 to 3 days
- Infective endocarditis

Complications

- Mechanical
  - Pneumothorax
  - Hemothorax
  - Venous and cardiac thromboembolism
  - Air embolism
  - Catheter embolism
  - Arrhythmias
  - Venous, thoracic duct, stellate ganglion, brachial plexus and subclavian artery injury
  - Catheter tip misplacement

Complications

- Metabolic
  - Hyperglycemic, hyperosmolar nonketotic coma
  - Hypoglycemia
  - Hypertriglyceridaemia
  - CO_2 retention
  - Azotemia
  - Hyperammonemia
  - Essential fatty acid deficiency
  - Hypophosphatemia
  - Abnormal liver enzymes
  - Hypomagnesemia
  - Hypermagnesemia
  - Trace element and vitamin deficiency states

Peripheral nutrition

- 10% Dextrose
- 5% AA solutions
- 20% fat emulsion
- Added together to make a slightly hypertonic solution with low caloric density
- Particularly useful as a supplement to enteral feeding
- Watch out for phlebitis and extravasation
- Give fat emulsions overnight so that triglycedemia does not interfere with venous sample during the day
- Monitor like patients on central venous feeding