Nutrition, Feeding Access, and Short Gut

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Disease Demographics

- Malnutrition is present in 30% to 50% of hospitalized patients.
- On average, ICU patients receive only 55% of estimated protein requirements.
- Malnutrition is associated with poor wound healing, compromised immunity, organ dysfunction, and mortality.
- Short bowel syndrome is defined as < 200cm bowel length.
    - Patients with >70-90cm of small bowel and an intact colon are likely to be liberated from parenteral nutrition (PN).
    - Patients with >130cm-150cm small bowel without the presence of the colon are likely to be liberated from PN.
- Protein and calorie requirements vary based on type and duration of illness/injury, as well as co-morbid conditions; requirements should be calculated for each individual. A nutritionist/dietitian may be helpful as an additional resource.
    - Estimating energy (kcal) needs:
        1. General estimate:
            - Determine weight: if pre-injury BMI<30, use 25 to 30kcal/kg per kg of pre-injury wt. If BMI>30 use 25 to 30kcal/kg for a BMI of 24 (hypocaloric feeding)
            - Healthy patients: 25kcal/kg/day
            - Moderate/severe injury, illness: 30kcal/kg/day
        2. Direct Calorimetry:
            - Measures heat released from patient
            - Utility in research, not practical at bedside
        3. Indirect Calorimetry: (IC)
            - Gold Standard of nutrition assessment
            - Use of "metabolic cart", requires expertise to interpret, which limits is utility and use
            - Affected by: large wounds, chronic respiratory disease, malnutrition with altered body habitus (underweight, obese, limb amputation, edema, ascites), traumatic brain injury, sepsis, multiple organ failure, organ transplant
            - Calculates resting metabolic rate (RMR) and respiratory quotient (RQ)
                - RQ = ratio of carbon dioxide production to oxygen consumption
                - Physiologic range: 0.67 to 1.3
                - mixed substrate oxidation, goal for appropriate nutrition therapy = 0.85
                    - Ethanol oxidation = 0.67, fat oxidation = 0.71, protein oxidation = 0.82, carbohydrate oxidation = 1, lipogenesis = 1-1.2

4. The Mifflin-St. Jeor (MSJ) equation for RMR:
    - Men: Energy expenditure (kcal/day): 5 + 10 (wt in kg) + 6.25 (ht in cm) - 5 (age in yrs)
    - Women: Energy expenditure (kcal/day): -161 + 10 (wt in kg) + 6.25 (ht in cm) - 5 (age in yrs)
    - For critical illness: Penn State Equation (PS), based on above with the following adjustments:
        - PS (kcal/d)= MSJ (0.96) + Ve (32) + Tm (167)-6212
        - PS-modified for age > 60, BMI > 30 (kcal/d)=MSJ (0.71) + Ve (64) + Tm (85) -3085
            - Where:
                - Ve= minute ventilation (L/min)
                - Tm=max temperature in Celsius in past 24hr

- Estimating protein (g) needs:
    1. General estimate:
        - Healthy patients: 0.8g/kg/day
        - Critical illness: 1.5g/kg/day
        - Severe trauma/burns: 2g/kg/day
        - Open abdomen/soft tissue wounds, add 30g protein/L of negative pressure wound therapy loss/effluent per day to estimated protein needs
- Estimating fluid needs:
    1. General estimate: (varies with ongoing fluid losses)
        - 30-40ml/kg/day

- Enteral nutrition (EN) is preferred over PN as it promotes maintenance of gut mucosal integrity, first-pass metabolism, and normal gallbladder function (mitigating the risk of acalculous cholecystitis).
    - Prescribing enteral nutrition: *(Note: each institution has a specific formulary of available EN products; each product varies in its constitution of protein, calories, fat, and trace elements; your institution's registered dietitians and pharmacists can assist in choosing an appropriate product from those available. Most products have 1.0-1.5kcal/ml and contain 70-85% water but disease specific formulations vary wildly. The calculation demonstrated here is for teaching purposes that the reader may understand the rationale behind a prescription.)*
        - Sample calculation: 75kg man, moderate illness
            - Choose formula: 1.0 kcal/ml
            - Determine kcal/day needed: (as above): example: 75kg x 30kcal/kg/day = **2250kcal/day**
            - Divide total kcal by kcal/ml provided in chosen formula: 2250kcal/day ÷ 1.0kcal/ml = **2250ml/day**
            - Determine protein need: 1.5g/kg/day x 75kg = **112.5g protein/day**
            - Determine protein dose: 2250ml/day x 50g/L [specific to each formula] = 112.5g/day protein [if additional protein is needed, it can be added in powdered form]
            - Determine required fluid in da**y: 30ml/kg/day x** 75kg = **2250ml fluid/day**

- Determine fluid dose: 2250ml/day x 80% water [as above, most formulas are 70-85% water] = 1800ml water/day; Need-dose: 2250ml/fluid/day-1800ml/water/day= 450ml/day additional free water requirement
  - If not delivered via additional IV fluids/medications, can add as TID bolus of 150ml of water via enteral access device
- Determine administration rate: 2250ml ÷ 24hr/day = 94ml/hr

- Types of EN:
  1. General considerations:
     - Most formulas contain 1.0-1.5kcal/ml, 40-70% of kcal from carbohydrate, 20-30% fat, 35-60/L protein, 330-525 mOsm/kg, 75-80% water, and contain adequate amounts of fiber, vitamins and trace minerals to meet requirements when given in total volumes of 1000ml-1500ml/day. Patients who cannot meet this volume requirement may require supplementation in the form of enteral additives or intravenous fluids.
  2. Standard polymeric:
     - These formulas are either Abbott or Nestle products and include Replete, Promote, Isosource, Fibersource, Osmolite and Jevity
     - Contains intact nutrients
     - These formulas are the work horse of EN and are well tolerated by most patients
     - Provides calories in relatively predictable ratios of fat, protein, and carbohydrates across the spectrum of available commercial products
  3. Elemental and semi-elemental:
     - These formulas are either Abbott or Nestle products and include Peptamen, Vital and Vivonex
     - Partially or completely hydrolyzed nutrients (proteins) May be useful in malabsorption syndromes such as short gut syndrome.
     - Easier to digest as they contain medium chain triglycerides at 40-50% of fat, which are more readily absorbed in cholestasis, pancreatic disease, and short gut syndrome.
  4. Disease specific:
     - Altered composition to accommodate various disease states such as renal or liver failure
       - American Society for Parenteral and Enteral Nutrition (ASPEN) recommends against the routine use of disease specific formulas for diabetes, renal and/or hepatic insufficiency in critically ill patients due to the lack of FDA regulation and rigorous evidence to support their use

        - Limited use of these formulas may be appropriate in the chronic phase when the disease state is maximally managed
        - Use in the Acute Care Surgery population, while organ failure may be temporary, places patients at risk for protein, calorie and mineral deficiencies
    - Immune modulating formulas (IMF) (arginine and DHA enhanced):
        - There is sufficient evidence to support the use of IMF in patients with traumatic brain injury, severe trauma, and in the surgical ICU
5. Modular macronutrient supplements:
    - Used as supplementation to create a formula for a specific disease state or need
    - May be used to enhance standard polymeric formulas to fulfill protein or other needs

- Prescribing parenteral nutrition (PN): *(Note:: The specific prescription and safe formula for compounding PN are well beyond the scope of this review. Limitations in osmolality, volume, component compatibility, and management of component shortages—which are frequent—dictate that trained pharmacists approve any final PN prescription. The calculation demonstrated here is for teaching purposes that the reader may understand the rationale behind a prescription.)*
    - Sample calculation: 80kg man, moderate illness
        - Determine energy need: 30kcal/kg/day x 80kg = **2400kcal/day**
        - Determine protein need: 1.5g/kg/day x 80kg = **120g protein/day**
        - Determine IV fat emulsion (IVFE) need (20-30% total kcal/day): 2400kcal/day x 0.2 = **480 kcal/day to** 2400kcal/day x 0.3 =**720kcal IVFE/day**
        - Do not exceed 1g/kg IVFE per day
        - Determine fluid need: 30-40ml/kg/day x 80kg = **2400-3200ml fluid/day**
        - Determine amounts amenable to compounding and safe infusion:
            - IVFE: 250ml of 20% IVFE x 2kcal/ml = **500 kcal IVFE**; % energy from IVFE: 500kcal ÷ 2400kcal = 21%
            - So...energy needed to be supplied by protein and dextrose: 2400kcal total -500kcal from IVFE = **1900kcal combined dextrose and protein**
            - Energy to be supplied by protein: 120g/day x 4kcal/g = **480 kcal protein/day**
            - Energy to be supplied dextrose: 2400kcal – 500kcal IVFE – 480kcal protein = **1420 kcal dextrose/day**; 1420kcal/day dextrose ÷ 3.4kcal/g dextrose = **418g dextrose**
                - Glucose infusion rate (GIR) should not exceed 3mg/kg/min in severe stress/critical

illness and no more than 4mg/kg/min in moderate stress

- Choose 8.5% amino acids (AA) (standard for compounding):
  - 8.5g/100ml = 120g/ ? ml; solve for ? = 1411ml AA, round to 1400ml (contains 119g protein of the 120g calculated need); 119g protein x 4kcal/g = **476kcal/day from protein** (of the 480kcal calculated need as above)
- Choose dextrose 70% (standard for compounding):
  - 70g/100ml = 418 g/ ? ml, solve for ? = 597 ml dextrose 70%, round to 600ml (contains 420g dextrose of 418g calculated need as above); 420g dextrose x 3.4kcal/g = **1428kcal from dextrose** (of 1420kcal/day calculated need as above)
- So…600ml dextrose 70% + 1400ml AA 8.5% + IVFE 20% 250ml = 1428 kcal from dextrose + 476 kcal from protein + 500 kcal IVFE = **2404 kcal/day**
- Determine the rate of infusion:
  - 1400ml AA + 600ml dextrose = 2000ml/day
  - Add 30ml/L for additives (vitamins, trace elements); 30ml/L x 2.8L = 80ml/day additives
  - 2000ml + 84ml = 2084ml/day; ÷ 24hr = **87ml/day**
  - IVFE runs separately: 250ml/day ÷ 12hr (as per customary due to unsafe for prolonged hang time) = **21ml/hr**

Clinical Presentation

The following are disease processes that are commonly encountered in Acute Care Surgery practice that may impact a patient's nutritional state:

- Trauma/Injury
  - Direct injury: bowel injury requiring resection or repair
  - Secondary injury: ileus due to injury and immobility, bowel edema related to large volume resuscitation, hypermetabolic state of burns
  - Dysphagia: due to direct facial or aerodigestive tract injury, traumatic brain injury, or prolonged endotracheal intubation
- Acute illness
  - Bowel ischemia, large and small bowel obstruction, severe acute pancreatitis, peptic ulcer disease, necrotizing soft tissue infection, sepsis
- Chronic illness
  - Inflammatory bowel disease, malignancy, enterocutaneous fistula (ECF), short bowel syndrome, liver failure, renal failure, immunocompromised states (HIV/AIDS, hepatitis, post-transplant), neurologic disease (stroke, Parkinson's, multiple sclerosis); COPD, CHF, DM (poorly controlled)

Evaluation/Diagnostics/Imaging

- History and physical exam are the best tools to recognize presence of malnutrition or risk for malnutrition.
    - Unintentional weight loss of 10lb over 6 months, weight loss of >10% usual, or BMI < 18.5kg/m2body weight are indicative of malnutrition.
    - Temporal muscle wasting, peripheral edema, hair loss, perioral rash, dermatitis, petechiae, night blindness, and easy bruising can all be signs of malnutrition and micronutrient deficiencies.
- Lab values:
    - Albumin and prealbumin should be interpreted with caution as they are acute phase reactants and will fluctuate with the severity of acute illness
    - Nitrogen balance studies: more reliable method of assessing protein adequacy
        1. Assesses balance between nitrogen intake and renal removal (or nitrogen loss), such as urine urea nitrogen (UUN); goal is a *positive* balance (not a specific number).
        2. Less reliable in patients eating of their own volition (used mostly when protein delivery is strictly EN or PN).
        3. Limited by renal failure (CrCl < 50mL/min), large volume insensible fluid losses such as high output fistula, burns or extensive wounds which cannot be quantified by negative pressure wound therapy devices or other external collection systems.
        4. Order after > 48hr stable nutrition delivery, not reliable in acute resuscitative, inflammatory phase of injury or illness.
        5. Requires accurate 24hr urine collection
        6. Serial, weekly UUN and nitrogen balance help identify trends in catabolism and adequacy of protein nutrition
        7. Note: 1g nitrogen = 6.25g protein
            - Calculation: Nitrogen balance = nitrogen intake – nitrogen losses
                - Nitrogen intake (g) = protein intake / 6.25
                - Nitrogen losses (g) = UUN + non-UUN (1-2g) + fecal nitrogen (1-2g) + miscellaneous losses (desquamation of skin, sweat, etc) (1g)
                - Add 4.6g loss for each liter of soft tissue and/or open abdomen output
                - Nitrogen balance (g) = (protein intake in g/6.25) – (UUN + 3-5g)
    - Screening and Assessment: Nutrition risk screening is required by the Joint Commission within 24 hours of admission to an acute care hospital and is often completed by bedside nursing staff using a tool such as the following:
        1. Mini Nutritional Assessment MNA® Short Form (Nestle NutritionInstitute, 2009, Vevey Switzerland.):
            - Queries food intake, weight loss, mobility, stress/acute disease, neuropsychological disorders, and BMI.

- Points are assigned to responses from each category and a final score is tallied on a 14-point scale; a score < 12 indicates nutrition risk, <8 suggests the diagnosis of malnourishment
- Can be completed by patient or surrogate

2. NUTRIC Score (used in critical illness)
    - Queries for age, APACHE/SOFA score, comorbid conditions, days in hospital prior to ICU admission and IL-6 level
    - (https://www.criticalcarenutrition.com/docs/PEPuPCollaborative/NUTRIC%20Score%201%20page%20summary_19March2013.pdf)

- Degree of malnutrition, Assessment: If a patient screens positive for malnutrition risk, more comprehensive assessment should be completed with a tool such as
    1. ASPEN/Academy of Nutrition and Dietetics Etiology Based Malnutrition Definitions: (categories)
        - Starvation related (including eating disorders)
        - Chronic disease related malnutrition (as listed above)
        - Acute disease/injury related malnutrition
        - The presence of one of the following identifies *risk* of malnutrition and the presence of two or more the *presence* of malnutrition (classified as mild/moderate or severe)
            - Weight loss > 10lb or 10% body weight/6 months
            - Insufficient energy (kcal) intake
            - Skeletal muscle wasting
            - Subcutaneous fat loss
            - Presence of edema
            - Diminished functional status

    2. Subjective Global Assessment (Canadian Malnutrition Task Force)
        - Queries for nutrient intake, weight change, subjective symptoms, functional capacity, edema, body fat and muscle mass.
        - A rating of degree of malnutrition is assigned as normal, mild/moderate, or severe

- Guidelines for initiating enteral nutrition:
    - Obtain enteral access via nasogastric or nasojejunal feeding tube as soon as feasible.
    - Initiate tube feedings as soon as possible after resuscitation.
        1. Bowel sounds, passage of flatus or stool are ***not*** required prior to starting enteral nutrition.
        2. Initiate tube feeding cautiously with low dose vasopressors. Hold tube feeding if vasopressor dose escalates or additional vasopressor are added.
        3. Tube feeding with an open abdomen is encouraged in favor of parenteral nutrition and generally well-tolerated.

- For patients without pre-existing malnutrition, reserve initiating PN for 7days (including days spent pre-hospital without nutrition) post-injury or illness.
- For patients with malnutrition, start PN immediately for patients unable to tolerate PO/EN.
- When should post-operative EN start?
    1. Studies are on-going regarding optimal timing. Traditionally, passage of flatus and minimal NG output are recommended. Recent studies initiating feeding with 24-48hr after upper GI tract surgery, pancreatic surgery and even some gastric surgery have failed to demonstrate harm. Thus consideration to EN once resuscitation has abated and access established can be given full consideration.
- Reserve PN for patients expected to require at least 5-7 days of PN; risk/benefit ratio does not favor very short course of PN therapy.
- Wean or stop PN when patients are able to tolerate >60% of energy requirements via enteral route.
    1. In significantly malnourished individuals, the clinician must monitor for re-feeding syndrome after initiating nutritional support
    2. Refeeding syndrome:
        - Shift of fluids, electrolytes, and minerals that occurs during a period of rapid resumption of full caloric feeding
        - Seen especially with aggressive carbohydrate administration, such as the over zealous use of dextrose containing fluids.
        - Hallmark: hypophosphatemia
            - Also: fatigue, lethargy, weakness, edema, cardiac arrhythmias, hemolysis, respiratory distress
        - Prevention/Treatment:
            - Monitor, aggressively replace potassium, phosphorus, magnesium
            - Supplement thiamine 100mg/day x 5 days
            - Start with 50% of caloric needs and advance to goal over a period of 2-3 days
            - Temper the use of dextrose containing fluid during initial resuscitation

- Guidelines for monitoring feeding tolerance:
    - Routine use of gastric residual volume (GRV) measurements is not necessary. Recent studies in medical ICU patients have concluded that in the asymptomatic patient (no abdominal distention or pain, no emesis) that checking GRV does not prevent aspiration but does inhibit meeting nutrition goals. The literature is less clear in surgical patients, but in the ICU setting where there is constant monitoring, it may not be necessary to routinely check GRV.
    - In cases where GRV is measured, the threshold for holding nutrition is a volume of >500ml.
    - Use a combination of physical exam, radiographic findings, and bowel function to assess feeding tolerance.

- It is safe to trial enteral nutrition even during an ileus. If a gastric ileus prevents EN via the gastric route, attempt distal access for EN (Dobhoff tube or endoscopically placed nasojejunal tube).

Indications for Operative Management/Pre-op Preparation/Operative Techniques

- Asses the need for durable enteral or vascular access.
  - Ask yourself:
    1. In the OR: How will I feed this patient after surgery? If I don't place a feeding tube now, will the patient be able to eat or safely pass an access device radiographically or blindly at the bedside? Does the patient need temporary access or long term access?
       - Frequently, a well placed nasojejunal tube while in the OR, manually palpating the tube past the ligament of Trietz, will suffice.
    2. At the bedside: Is enteral nutrition safe for this patient today? Via what route? If EN is not safe today, is it time for PN? Justify every day of NPO status.
- Short term access (< 4 weeks): nasogastric or nasojejunal access
  - Polyurethane tubing: less comfortable, stiffer overall but thinner walled
  - Always confirm placement radiographically
- Long term access: (> 4 weeks)
  - Gastrostomy tube:
    1. Percutaneous endoscopic gastrostomy (PEG) or open gastrostomy tube.
       - Silicone tubing: more comfortable, more durable, more pliable, thicker walled
    2. Allows for bolus or continuous feeding. Contraindicated in dysmotility syndromes such as diabetic gastroparesis.
    3. Relative contraindications: ascites, coagulopathy, varices, head and neck cancers (for PEG placement - concern of seeding via oral route when endoscope passed), other abdominal cancers, and morbid obesity (concern of dislodgement)
    4. Prior abdominal surgery is not a contraindication to PEG placement. If trans-illumination can be achieved, PEG is generally a safe option.
    5. If a PEG tube is required but is determined to not be safe via the traditional "pull" technique (such as in the case of head and neck cancer or major facial trauma), the "push" technique can be used under radiographic guidance such as in the interventional radiology (IR) suite, which obviates the need for endoscopy
    6. PEG tubes can be used with 4-6 hours of placement.
  - Jejunostomy tube:
    1. Can be placed surgically at the time of index operation or percutaneously, though these are more technically difficult and are prone to being dislodged.
    2. Not suitable for bolus feeding, used only for cyclic or continuous feeding.
    3. More prone to clogging than PEG tube.

- Gastro-jejunal tube:
    1. Used in cases where both gastric decompression and distal enteral feeding is desired.
        - Pancreatitis, impaired gastric motility, gastric outlet obstruction
        - May be placed at the time of surgery or endoscopically
- Managing enteral nutrition tubes:
        - Life span of balloon: 3-6 months, so needs to be periodically changed
        - Tubes may be exchanged or removed after two weeks, when the tract around them has sealed and the risk for leakage of enteric contents into the abdominal is less.
- Tunneled or peripherally inserted central catheters for PN.
    1. Central venous catheters or peripherally inserted central catheters (PICC) with a dedicated port for PN.
    2. Cuffed catheters are preferred for long term, home parenteral nutrition to reduce the risk of infection.

Intra-operative Considerations

- Inadvertent injury to colon, liver or small bowel possible with PEG placement.
    - Ensure adequate trans-illumination and insufflation of the stomach during placement. Failure to trans-illuminate dramatically increases the risk of injury to surrounding organs.
    - Ensure the needle entering the abdominal wall is at a 90 degree angle to the skin, otherwise the PEG tube will be tunneled in the subcutaneous tissue and is prone to kinking.
    - May be combined with laparoscopy in the operating room to ensure appropriate placement.
    - It is not uncommon to note "free air" on an abdominal CT or XR 24-48hr after PEG placement. In the absence of peritonitis or other clear signs of hollow viscous injury, it is not necessary to take the patient for exploratory laparotomy for this finding alone.
- Kinking of small bowel with jejunostomy placement
    - The Witzel technique (the creation of a submucosal tunnel to stabilize the tube) may alleviate this issue.
    - Technique:
        1. A site on the abdomen is chosen, the skin punctured, and a tube passed through the abdominal wall
        2. A segment of jejunum is selected about 20-30cm from the ligament of Treitz
        3. A purse-string suture is placed on the antimesenteric side of the bowel
        4. An enterostomy is made in the purse string
        5. The tube is inserted and directed distally
        6. A serosal tunnel is created by placing 3-5 seromuscular sutures along the length of the tube to imbricate the bowel over the tube

7. The tube is secured to the peritoneum using the aforementioned seromuscular sutures to tack it up, or separate sutures can be placed
8. Ensure the tube lies flush against the abdominal wall, is not kinked at the level of the abdominal wall or distally

- Always secure jejunostomy tubes at the skin level with a stitch.

Complications

- **Enteral**
  - PEG dislodgement
    1. Protect the tube from being accidentally removed by the patient
       - Consider placement an abdominal binder to prevent accidental dislodgement
       - Keep excess tube length to a minimum to avoid kinking, pulling (about 10cm is sufficient)
  - Jejunal tube migration/volvulus
    1. Occurs when tubes have been placed without being secured
  - Buried Bumper Syndrome
    1. Avoid routine snugging of flange on skin
    2. Mark, record level daily
       - If level migrates more shallow, obtain contrast imaging to ensure enteral positioning remains
  - Tube clogging
    1. Clogging:
       - To prevent clogging, feeding tubes must be flushed with 5-20ml sterile water after each bolus infusion or 3x/day in the case of continuous feeding.
       - If a tube cannot be flushed with water, instillation of pancreatic enzymes can reopen the tube; this method is superior to instillation with carbonated beverages (which degrade the tube and should be avoided); mechanical clearing can be accomplished with a cytology brush.
- **Parenteral**
  - Line sepsis
    1. Catheter must be removed
    2. Consider "line holiday" or place temporary central venous catheter
    3. Do not place a new tunneled central catheter until bacteremia has resolved (negative blood cultures)
  - Electrolyte derangements, metabolic bone disease, PN-associated liver disease (PNALD)
    1. Risk may be attenuated by cycling PN for 8-12hr infusion instead of 24hr infusion.
    2. Soybean oil-based IVFE is a source of phytosterols which can have hepatotoxic effects; reduce daily phytosterol exposure by limiting lipid infusion to 2-3 days/week or consider the use of alternate fat emulsions.

3. Micronutrient deficiences can occur with long term PN, especially with high output ECF; add 5mg zinc and 100mcg selenium; with chronic renal replacement add 10mg pyridoxine, 100mg thiamine, 1mg folate, and 100mcg selenium.
4. If cholestasis is present with direct bilirubin > 3, remove manganese and copper; these trace elements are normally excreted in bile and be toxic with excretion is compromised .

Special Populations

- Short Bowel Syndrome (SBS) (<200cm bowel):
  - After initial insult, the bowel goes through period of adaptation and hypertrophy.
  - Monitor closely for dehydration, the most common complication.
  - Other complications:
    1. Loss of bile salts when terminal ileum is lost: choleric diarrhea
    2. Osteoporosis due to impaired absorption of Vitamin D and calcium
    3. Nephrolithiasis due to calcium oxalate stones (with intact colon); due to accelerated absorption of oxalate in the colon when small bowel missing
  - Patients with jejunostomies/ileostomies should have a diet higher in fat (20-30% carbohydrates, 20-30% protein, 50-60% fat). Add salty meals and snacks.
  - Patients with intact colon should have a diet higher in carbohydrates (50-60% carbohydrates, 20-30% protein, 20-30% fat).
  - Separate solid and liquid foods, eat solids first to slow emptying
  - Avoid large volumes of fluid at once, has a column effect
  - Limit stimulants such as alcohol and caffeine
  - Colonic salvage can promote fermentation of non-digestible fiber into short-chain fatty acids (SCFAs) which enter the enterohepatic circulation and add up to 500 cal/d towards the energy requirements of SBS patients. SCFAs also promote Na and fluid uptake, decreasing stool volume.
  - Do not use soluble fiber without a colon in continuity as soluble fiber will retain fluid in the lumen and increase ostomy output dramatically.
- Entercutaneous Fistulae
  - Proximal fistulas can functionally render the patient with SBS.
  - Low output fistulas (<500ml/day) are more likely to close spontaneously.
  - Ok to continue to feed/use EN in patients with low output fistula; in high output (> 500ml/day), trial of NPO to determine if EN affects output, if not, ok to continue feeding.
  - If the distal portion of the bowel can be radiographically identified (ie, fistulogram), this site can be used as a enteral access site by placing a soft rubber tube.
    1. If bile can be retrieved from a very proximal fistula, it can be refed through this distal site and may enhance EN absorption and maintain the enterohepatic circulation prevention bile acid depletion

- Patients with high output fistula (or proximal jejunostomies or ileostomies) are at risk for zinc losses; supplementation with 12mg zinc/day may decrease the output; zinc promotes immune function and wound healing as well.

- Elderly/End of Life Care: Artificial Nutrition and Hydration (ANH):
  - Placement of a PEG tube at the end of life does not prevent aspiration pneumonia, prevent or heal pressure sores, or extend life.
  - Provision of ANH may increase the burden of gastrointestinal fluids, which may cause nausea, vomiting and the need for suctioning of oral secretions. Fluid overload may lead to respiratory distress, generalized edema, and frequent voiding necessitating the placement of a urinary catheter, with its attendant complications.
  - Evidence exists to support the theory that starvation boosts the production of ketones, which have an anesthetic effect, and dehydration may have the added effect of increasing endogenous opioids.

Suggested Readings

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