Selecting a method

If the gut works, use it
- When a person is unable to ingest enough food to meet their nutritional needs
  - nutrition support is needed
  - could be enteral if the gut works
  - could be parenteral if the gut doesn't work

Enteral Nutrition

Definition
- Could be
  - Oral Supplements
  - Tube Feedings
    - Nasogastric
    - Nasoduodenal or nasojejunal
    - Enterostomies
      - Gastrostomies Percutaneous Endoscopic Gast.(PEG)
      - Jejunostomies Multiple Lumen tubes

Rationale for Enteral Feeding

Advantages
1. Maintaining the structure and function of the GI tract
Dependant on the presence and composition of luminal nutrients as well as the presence of trophic hormones

Enteral Nutrition

Definition
- Artificial feeding method that includes the use of specialized feeding formulas, tubes and pumps, by way of the GI tract

Rationale for Enteral Feeding

The preferred route of nourishment if the GI tract is functioning and accessible
Rationale for Enteral Feeding

Advantages:
- Fewer metabolic and infectious complications
- Immunological and barrier functions of GI prevent antigenic invasion of the mucosa and thus prevent bacterial translocation to the portal or lymphatic systems
- Improved glucose tolerance and less hyperinsulinemia

Advantages:
- Stimulates bile secretion through biliary tract so reduces the development of gallbladder sludge and stones
- No potential infectious or technical complications associated with placement and use of central catheter
- Lower cost

Indications:
Patients with functional GIT must and an inability to orally ingest adequate nutrients to meet metabolic demands.

Enteral feeding should be part of routine care:
- Protein-calorie malnutrition with inadequate oral intake for the previous 5 days
- Normal nutrition status with > 50% required oral intake for the previous 7-10 days
- Severe dysphagia
- Major full-thickness burns
- Massive small bowel resection in combination with administration of TPN
- Low output enterocutaneous fistulas

Enteral feeding would usually be helpful:
- Major trauma
- Radiation therapy
- Mild chemotherapy
- Liver failure and severe renal dysfunction

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<td>Cystic fibrosis</td>
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<td>Extreme prematurity</td>
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</table>
Contraindications

- Complete mechanical intestinal obstruction.
- Intestinal Hypomotility (ileus).
- Severe pancreatitis.
- Intractable vomiting or severe diarrhea.
- Diffuse peritonitis
- Sever GI hemorrhage
- Chronic intestinal pseudo-obstruction
- Sever malabsorption

Functional Status of The GIT

Prior to initiation of EN, assess the GI Length:

The minimum length of functional small bowel required for nutrient absorption is 100-150 cm of jejunum and/or ileum

Functional Status of The GIT

Anatomy:

- Ileocecal valve acts as a break and reduces the transit time of GI content through the small bowel and into the colon.
- The colon maintains the fluid and electrolytes in an EN feed patient.

Motility

- Check for reduced Gastric emptying
- It can be reduced by:
  - Sepsis
  - Postoperative anesthetist agents
  - Opioid analgesics
  - Underlying pathology such as diabetic gastroparesis
- It increase the risk of:
  - N/V
  - Pulm. Aspiration of gastric content

Enteral Access

- Multiple options are available to provide therapy according to indication.
- All routes involve placement of a tube through which liquid formula is infused
- As the site of delivery moves away from the mouth, tube insertion becomes more difficult and invasive and more permanent.

Tube Identification

- Usually identified by start & end of tube
- Nasogastric
- Nasoduodenal
- Nasojunual
Tube Identification

- Esophagostomy
- Gastrostomy
- Jejunostomy

Route of Access

Several Factors to be considered

- Length of time required
  - Short term: usually through nasopharynx
  - Longer term through enterostomal routes
- Risk of aspiration
- Degree of digestion available
- If there is a planned surgical intervention

Nasogastric Tubes

**Definition**

- A tube inserted through the nasal passage into the stomach

**Indications:**

- Short term feedings required
- Intact gag reflex
- Gastric function not compromised
- Low risk for aspiration

French Units—Tube Size

- Diameter of feeding tube is measured in French units
- 1F = 33 mm diameter
- Feeding tube sizes differ for formula types and administration techniques
- Generally smaller tubes are more comfortable and better suited to NG or NJ feedings
- May be more likely to clog with viscous formula or formula mixtures

Nasogastric Tubes

**Advantages:**

- Ease of tube placement
- Surgery not required
- Easy to check gastric residuals
- Accommodates various administration techniques

Nasogastric Tubes

**Disadvantages:**

- Increases risk of aspiration (maybe)
- Not suitable for patients with compromised gastric function
- May promote nasal necrosis and esophagitis
- Impacts patient quality of life
**Nasoduodenal/Jejunal**

**Definition**
- A tube inserted through the nasal passage through the stomach into the duodenum or jejunum

**Indications:**
- High risk of aspiration
- Gastric function compromised

**Advantages:**
- Allows for initiation of early enteral feeding
- May decrease risk of aspiration
- Surgery not required

**Disadvantages:**
- Transpyloric tube placement may be difficult
- Limited to continuous infusion
- May promote nasal necrosis and esophagitis
- Impacts patient quality of life

---

**Orogastric**

- Tube is placed through mouth and into stomach
- Often used in premature and small infants as they are nasal breathers
- Not tolerated by alert patients; tubes may be damaged by teeth

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**Enterostomies: Pharyngotomies and Esophagostomy**

- More invasive and more permanent
- Use large bore tubes
- Located in the neck and passes through skin into esophagus or pharynx
- Site care is required and dressing changes can be difficult to perform by the patient himself

**Indicated in**
- Head and neck malignancies
- Maxillofacial anomalies
- Contraindicated nasopharyngeal access

**Complications:** Infrequent
- Recurrent laryngeal nerve damage
- Aspiration
- Infection
Gastrostomy

Definition
- A feeding tube that passes into the stomach through the abdominal wall. May be placed surgically or endoscopically

Indications:
- Long-term support planned
- Gastric function not compromised
- Intact gag reflex present

Enterostomy Placement

- Gastrostomy
- Jejunostomy

Surgical Gastrostomy

Indications:
- Patients with esophageal obstruction
- Impaired swallowing
- Must have adequate gastric emptying
- Use large bore tubes: less clogging
- Require general stoma site care
- Surgically placed under general anesthesia

Complication
- Wound infection
- Adhesion
- Continuous drainage
- Fistula formation
- Tube dislodgment
- Peritoneal contamination
- GI bleeding

PEG: Percutaneous Endoscopic Gastrostomy

- Can be performed safely and cost effectively under local anesthesia
- Similar complication rate to surgical gastrostomy
- Higher benefit to cost ratio

Jejunostomy

Definition
- A feeding tube that passes into the jejunum through the abdominal wall. May be placed endoscopically or surgically

Indications:
- Long-term feeding option for patients at high risk for aspiration or with compromised gastric function
- Stomach or duodenal obstruction
- Impaired gastric emptying
- Indication for gastrostomy
Jejunostomy

**Advantages:**
- Post-op feedings may be initiated immediately
- Decreased risk of aspiration
- Suitable option for patients with compromised gastric function
- Stable patients can tolerate intermittent feedings

**Disadvantages:**
- Requires stoma care
- Potential problems related to leakage or tube dislodgement/clogging may arise
- May restrict ambulation
- Bolus feedings inappropriate (stable patients may tolerate intermittent feedings)

**Administration of Enterals**

**Choice of method depends on:**
- Anatomic location of feeding tube
- Clinical condition of the patient
- Environment in which patient resides
- Intestinal function
- Patient’s tolerance to tube feeding
- See table 129-6

**Continuous Feedings**

**Definition**
- Enteral formula administration into the gastrointestinal tract via pump or gravity, usually over 8 to 24 hours per day

**Advantages:**
- May improve tolerance
- May reduce risk of aspiration
- Increased time for nutrient absorption
Continuous Administration

- Can be used for any route of administration
- Delivery system consist of feeding reservoir-extension set - pump
- Increase nursing time to routinely check the infusion
- Provides maximum tolerance by minimizing side effects of abdominal distention or diarrhea
- Infusion rate: 50-125 ml/hr
- Mandatory if tube is place in duodenum or jej

Continuous Feedings

Indications:
- Initiation of feedings in acutely ill patients
- Promote tolerance
- Compromised gastric function
- Feeding into small bowel
- Intolerance to other feeding techniques
- Patients with limited absorption capacity (due to rapid GI transit or impaired digestion

Continuous Administration

- Estimated total kcal needs are made
- Rate per hour determined based on the kcal content of formula
  - 2000 kcals needed per day
  - Formula has 1 kcal/cc
  - 2000 kcal/1 kcal/cc = 2000 cc's needed
  - 2000 cc/24 hrs = 83 cc's/hr is set as the goal volume

Continuous Feedings

Disadvantages:
- May reduce 24-hour infusion
- May restrict ambulation
- More expensive for home support
- Pumps are more accurate; useful for small-bore tubes and viscous feedings, but many payers have strict criteria for approval of pumps for home or LTC use

Initiation of Continuous Feedings

- Adults: Initiate at full strength at 10-40 ml/hour and advance to goal rate in increments of 10 to 20 mL/hour q 8-12 hours as tolerated
- Can be used with isotonic or hyperosmolar formulas
- Children: Isotonic formula full strength at 1-2 mL/kg/hour and advanced by .5-1 mL/kg/hour q 6-24 hours until goal rate is achieved

Caution when initiating
- If the gut has not been used lately
- If the formula is hyperosmolar

Cyclic Feedings

Definition
- Administration of enteral formula via continuous drip over a defined period of 8 to 12 hours, usually nocturnally

Indications:
- Ensure optimal nutrient intake when:
  - Transitioning from enteral support to oral nutrition (enhance appetite during the day)
  - Supplement inadequate oral intake
  - Free patient from enteral feedings during the day

Advantages:
- Achieve nutrient goals with supplementation
- Facilitates transition of support to oral diet
- Allows daytime ambulation
- Encourages patient to eat normal meals and snacks

Disadvantages:
- May require high infusion rates—may promote intolerance
- Monitoring GI tolerance is important

Continuous-Cyclic

Uses
- Non-critically ill patients
- Home tube feeding
- Patients in rehab.

Intermittent Feedings

Definition
- Enteral formula administered at specified times throughout the day; generally in smaller volume and at slower rate than a bolus feeding but in larger volume and faster rate than continuous drip feeding
- Typically 200-300 ml is given over 30-60 minutes q 4-6 hours
- Precede and follow with 30-ml flush of tap water
- more physiologically consistent with normal eating patterns
- require intact gastric motility and pyloric sphincter
Intermittent Feedings

**Indications:**
- Intolerance to bolus administration
- Initiation of support without pump
- Preparation of patient for rehab services or discharge to home or LTC facility
- Home tube feeding
- Patients unable to eat on their own (altered mental status)


Intermittent Feedings

**Advantages:**
- May enhance quality of life
  - Allows greater mobility between feedings
  - More physiologic
  - May be better tolerated than bolus

Intermittent Feedings

**Disadvantages:**
- Increased risk for aspiration
- Gastric distention
- Delayed gastric emptying

Intermittent Feedings

**Administration**
- Using an infusion pump of via gravity flow with a roller clamp
- into the stomach because it only is capable of handling large and more rapid volumes.
- stomach controls the volume and osmolality reaching the small intestine.

Intermittent Feeding

**Dumping syndrome**
- Lightheadedness
- Diarrhea
- Nausea
- Cramping
- Due to large quaintly of hyperosmolar solution introduced into the small intestine

Intermittent Feeding

**Bolus Feedings**

**Definition**
- Infusion of up to 500 ml of enteral formula into the stomach over 5 to 20 minutes, usually by gravity or with a large-bore syringe

**Indications:**
- Recommended for gastric feedings
- Requires intact gag reflex
- Normal gastric function
Bolus Feedings

**Advantages:**
- More physiologic
- Enteral pump not required
- Inexpensive and easy administration
- Limits feeding time so patient is free to ambulate, participate in rehabilitation, or live a more normal life in the home
- Makes it more likely patient will receive full amount of formula

Bolus Feeding

**Disadvantages:**
- Increases risk for aspiration
- Hypertonic, high fat, or high fiber formulas may delay gastric emptying or result in osmotic diarrhea

Initiation of Bolus Feedings

- Children: Initiate with 25% of goal volume divided into the desired number of daily feedings; increase by 25% each day divided among all feedings until goal volume is reached

Initiation of Bolus Feedings

- Adults: Initiate with full strength formula 3-8 times per day with increases of 60-120 ml q 8-12 hours as tolerated up to goal volume; does not require dilution unless necessary to meet fluid requirements

Intermittent or Bolus Feedings

- Figuring intermittent or bolus feedings similar to continuous
- Total Kcals determined
- Divided by number of hours feeding
- General: 4 to 6 feedings @ 20 to 60 min
Bolus or Intermittent Feeding

- Few pts can tolerate more than 450 ml per feeding
- Pt needs to be monitored for several potential problems

How much Formula

- Energy needs - start with 25-35 kcal/kg actual or dry weight. Order
- metabolic cart analysis if available.
- Protein needs - start with 1.0-1.2 g/kg and increase or decrease as needed.
  - Lower in encephalopathy and acute renal.
  - Higher in stress and trauma.

Characteristic of Enteral Formulas

- Macronutrients
  - Protein 4 Kcal/g
  - Carbohydrate 4 Kcal/g
  - Fat 9 Kcal/g
- Micronutrients
  - Electrolytes
  - Vitamines
  - Trace éléments
  - Do not contribute to calorie content.

Characteristic of Enteral Formulas Nutrient complexity:

- The amount of hydrolysis and digestion a substrate source requires prior to intestinal absorption

Polymeric formulas:

- Contain intact substrate similar molecular form to food we eat

Defined formulas:

- Contain partially hydrolyzed or elemental substrate
Protein

**Quality:**
- According to content of essential amino acids

**Molecular form:** determine the amount of digestion required
- Polymeric: require complete digestion to small peptides and free amino acids
- Partially hydrolyzed proteins: peptides or amino acids, most readily absorbable

Conditionally Essential AA

Normally non-essential
Become deficient in disease states of high physiological stress

**Glutamine:**
- Primary fuel for enterocytes, Synthesized in muscle
- May have role in maintaining integrity of GIT
- May play a role in preventing bacterial translocation
- Can be added as glutamic acid which is immediate precursor

Carbohydrate

- Major source of non-protein calories
- polymeric formulas contain:
  - starches and glucose polymers
  - as hydrolysis ↑ → osmolality ↑

Protein

- As molecular form is reduced osmotic load increases
- As molecular form decreased → ↑ AA with free sulfur→ bitter flavor and foul odor → less desirable for consumption

Conditionally Essential AA

**Arginine:**
- May not be synthesized in sufficient quantities in stress or trauma
- Has anti-tumor effect
- ↓ protein catabolism
- enhance nitrogen retention
- accelerate wound healing

Carbohydrate

- **Glucose polymers are mostly used**
  - Tolerated by most individuals
  - large chains that contribute minimal osmotic load
  - easily absorbed by the intestine
  - not as sweet as simple glucose
- **Most formulas are lactose free because**
  - Some population are lactase deficient
  - the enzyme is reduced during illness or bowel rest
### Fat

- Provides concentrated calorie source
- Serves as a carrier for fat soluble vitamins
- 1-3% of total calories as linoleic acid is required to prevent essential fatty acid deficiency (EFAD)
- Fat digestion requires pancreatic enzymes
- Absorption requires bile salts

#### Polymeric Fat
- Source is vegetable oils (soy or corn) LCTs
- Derived from palm or kernel oil
- 8.4 Kcal/g
- Do not contain essential fats
- More water soluble and undergo hydrolysis
- Require little to no pancreatic lipase or bile salt for absorption

### Omeg-3 fatty acids:

- Does not produce same products as omeg-6 which are thought to be potent inflammatory mediators and decrease immunity (prostaglandins, thromboxanes, and leukotriens)

### Fiber

#### Benefits:
- Trophic effect on large bowel mucosa
- Promotion of sodium and water absorption in the colon
- SCFAs are excellent energy source
- Regulates bowel function by moderating intestinal transit time
- Decrease transit time in patients prone to constipation

- Increase transit time in patients prone to diarrhea
- Recommended intake 20-35 g/day
- Formulas usually contain 5-15 g/l
- Supplementation may be beneficial in long-term tube feeding of constipated patients
- Not beneficial in acute care where drugs and stress have more powerful effect on bowel function
### Osmolality and renal solute load

**Osmolality**
- Function of the size and quantity of ionic and molecular particles
- The greater amount of elemental substrates the higher the osmolality
- Increased caloric density increases osmotic load

### Osmolality and renal solute load

**Hyperosmolar administration produce**
- Gastric retention
- Diarrhea
- Abdominal distention
- N/V

### Osmolality and renal solute load

**Renal Solute Load**
- Protein, Na, K, Cl content of the formula
- ↑ Solute load → ↑ obligatory water loss
- 40-60 ml are needed to excrete 1 g nitrogen
- patients who receive high N formulas and are not able to ingest free water are at risk of dehydration