University of Anbar - College of Pharmacy
Applied Therapeutics I – Enteral and parenteral nutrition 1

Malnutrition

Malnutrition can be described as a deficiency, excess, or imbalance of energy, protein, and other nutrients that causes measurable adverse effects on body tissue, size, shape, composition, function and clinical outcome.

Multiple causes may contribute to malnutrition. They may include inadequate or unbalanced food intake, increased demand as a result of clinical disease status, defects in food digestion or absorption or a compromise in nutritional metabolic pathways.
Onset may be acute or insidious. Even mild malnutrition can result in problems with adverse effects on clinical, physical and psychosocial status.

Enteral nutrition

Enteral nutrition or enteral feeding delivers nutrients by tube or mouth into the GI tract; this tube is called "feeding tube".
Enteral nutrition is indicated for the patient who cannot or will not eat enough to meet nutritional requirements and who has a functioning GI tract and a method of enteral access.

Potential **indications** include neoplastic disease, organ failure, hypermetabolic states, GI disease, and neurologic impairment.
Distal mechanical intestinal obstruction and necrotizing enterocolitis are the only absolute **contraindications** to enteral nutrition.
Conditions that **challenge** the success of enteral nutrition include severe diarrhea, protracted vomiting, enteric fistulas, severe GI hemorrhage, and intestinal dysmotility.

Enteral nutrition has replaced parenteral nutrition as the preferred method for the feeding of critically ill patients requiring specialized nutrition support. **Advantages** of Enteral nutrition **over** parenteral nutrition include maintaining GI tract structure and function; fewer metabolic, infectious, and technical complications; and lower costs.

The optimal time to initiate enteral nutrition is controversial. Early initiation within 24 to 72 hours of hospitalization is recommended for critically ill patients because this approach appears to decrease infectious complications and reduce mortality. If patients are only mildly to moderately stressed and well-nourished, enteral nutrition initiation can be delayed until oral intake is inadequate for 7 to 14 days.

Administration methods

Enteral nutrition can be administered by continuous, cyclic, bolus, and intermittent methods. The choice depends on the feeding tube location, patient's clinical condition, intestinal function, residence environment, and tolerance to tube feeding.

- ***Continuous enteral nutrition***

It is preferred for initiation and has the advantage of being well tolerated.
Disadvantages include cost and inconvenience associated with pump and administration sets.

- ***Cyclic enteral nutrition***

It has the advantage of allowing breaks from the infusion system, thereby increasing mobility, especially if enteral nutrition is administered nocturnally.

- ***Bolus enteral nutrition***

It is most commonly used in long-term care residents who have a gastrostomy.
Advantages include short administration time (e.g., 5–10 min) and minimal equipment (e.g., a syringe).
Bolus enteral nutrition has the potential *disadvantages* of causing cramping, nausea, vomiting, aspiration, and diarrhea.

- ***Intermittent enteral nutrition***

It is similar to bolus enteral nutrition except that the feeding is administered over 20 to 60 minutes, which improves tolerability but requires more equipment (e.g., reservoir bag and infusion pump). Like bolus enteral nutrition, intermittent enteral nutrition mimics normal eating patterns.

Options and considerations in the selection of enteral access

1. Nasogastric or orogastric

It is used for a short term and in patients with intact gag reflex and normal gastric emptying.

Advantages	***Disadvantages***
• Placement easily at bedside • Ease of placement • Allows for all methods of administration • Inexpensive • Multiple commercially available tubes and sizes	• Potential tube displacement • Potential increased aspiration risk

2. Nasoduodenal or nasojejunal

It is indicated for a short term in patients with impaired gastric motility or emptying and high risk of gastroesophageal reflux or aspiration.

Advantages	*Disadvantages*
• Placement at bedside • Potential reduced aspiration risk • Allows for early postinjury or postoperative feeding • Multiple commercially available tubes and sizes	• Manual transpyloric passage requires greater skill. Sometimes, it is placed by using fluoroscopy or endoscopically • Potential tube displacement or clogging • Bolus or intermittent feeding not tolerated

3. Gastrostomy

It is indicated for long-term use in patients with normal gastric emptying. It is placed surgically, endoscopically, radiologically or laparoscopically.

Advantages	*Disadvantages*
• Allows for all methods of administration • Low-profile buttons available • Large-bore tubes less likely to clog • Multiple commercially available tubes and sizes	• Attendant risks associated with each type of procedure • Potential increased aspiration risk • Risk of stoma site complications

4. Jejunostomy

It is indicated for long-term use in patients with impaired gastric motility or gastric emptying or high risk of gastroesophageal reflux or aspiration. It is placed surgically, endoscopically, radiologically or laparoscopically.

Advantages	*Disadvantages*
• Allows for early postinjury or postoperative feeding • Potential reduced aspiration risk • Multiple commercially available tubes and sizes • Low-profile buttons available	• Attendant risks associated with each type of procedure • Bolus or intermittent feeding not tolerated • Risk of stoma site complications

Formulations

Enteral nutrition formulations were created to provide essential nutrients, including macronutrients (e.g., carbohydrates, fats, and proteins) and micronutrients (e.g., electrolytes, trace elements, vitamins, and water).
Formulations have been enhanced to improve tolerance and meet specific patient needs. For example, nutraceuticals or pharmaconutrients are added to modify the disease process or improve clinical outcome.

Adult enteral feeding formulation classification system

1. ***Standard polymeric formulations:*** They are isotonic and may contain fiber. They are designed to meet the needs of the majority of patients. They are indicated in patients with functional GI tract, but are not suitable for oral use.
2. ***High protein formulations:*** They may contain fiber. They are indicated in trauma patients and those with burns, pressure sores, or wounds. Also, they are used for patients receiving propofol.
3. ***High caloric density formulations:*** They are hypertonic with lower electrolyte content per calorie. They are indicated for patients requiring fluid and electrolyte restriction, such as kidney insufficiency
4. ***Elemental formulations:*** They contain high proportion of free amino acids but it is low in fat. They are indicated for patients who require low fat. Their use has generally been replaced by peptide-based formulations.
5. ***Peptide-based formulations:*** They contain dipeptides, tripeptides and medium-chain triglycerides.
6. ***Disease-specific formulations:*** Different formulations are available according to type of disease (e.g.; kidney, liver, lung and diabetes mellitus).
   Immune-modulating formulations are supplemented with glutamine, arginine, nucleotides and omega-3 fatty acids.
7. ***Oral supplements:*** They are hypertonic and sweetened for taste. They are indicated for patients who require supplementation to an oral diet.

Drug delivery via feeding tube

Administering drugs via tube feeding is a common practice. If the drug is a solid that can be crushed (e.g., not a sublingual, sustained-release, or enteric-coated formulation) or is a capsule, it is administered after mixing with 15 to 30 mL of water or other appropriate solvent. Otherwise, a liquid dosage preparation should be used. Multiple medications should be administered separately, each followed by flushing the tube with 5 to 15 mL of water.
Mixing of liquid medications with enteral nutrition formulations can cause physical incompatibilities that inhibit drug absorption and clog small-bore

feeding tubes. Mixing of liquid medications and enteral nutrition formulations should be avoided whenever possible.
The most significant drug–nutrient interactions result in reduced bioavailability and suboptimal pharmacologic effect. Continuous feeding requires interruption for drug administration, and medications should be spaced between bolus feedings.

Parenteral nutrition

Parenteral nutrition provides macro- and micronutrients by central or peripheral venous access to meet specific nutritional requirements of the patient.
Parenteral nutrition should be considered when a patient cannot meet nutritional requirements through use of the GI tract.
Parenteral nutrition must always be administered under the control of an **infusion pump**. Acute overload of fluid, nutrition and electrolytes can have morbid consequences. For home patients, small, simple battery-powered ambulatory pumps are favored.
Parenteral nutrition should be at room temperature when it is infused.

Pediatric parenteral nutrition regimens typically require an individualized approach. Labeling should reflect "*amount per day*" or "*amount per kilogram per day*."

Components of parenteral nutrition

a) Macronutrients

They include water, protein, dextrose, and IV fat emulsion.

- ***Protein*** is provided as crystalline amino acids (CAAs).
- The primary energy source in parenteral nutrition solutions is ***carbohydrate***, usually as ***dextrose*** monohydrate.
- Commercially available ***intravenous fat emulsions*** (IVFEs) provide calories and essential fatty acids. These products differ in triglyceride source, fatty acid content and essential fatty acid concentration.

b) Micronutrients

They include vitamins, trace elements, and electrolytes. They are required to support metabolic activities for cellular homeostasis such as enzyme reactions, fluid balance, and regulation of electrophysiologic processes.

- ***Multivitamin*** products have been formulated to comply with guidelines for adults, children, and infants. These products contain ***13 essential vitamins***, including vitamin K.

- Requirements for ***trace elements*** depend on the patient's age and clinical condition. ***Chromium***, ***copper***, ***manganese***, ***selenium***, and ***zinc*** are considered essential and available as single- or multiple-entity products for addition to parenteral nutrition solutions.
- ***Electrolytes*** (*sodium, potassium, calcium, magnesium, phosphorus, chloride, and acetate*) requirements depend on the patient's age, disease state, organ function, drug therapy, nutrition status and extra-renal losses. They are necessary components of parenteral nutrition for maintenance of numerous cellular functions.

Routes of administration of parenteral nutrition

- ***Peripheral parenteral nutrition*** (PPN) candidates do not have large nutritional requirements, are not fluid restricted and are expected to regain GI tract function within 10 to 14 days. Solutions for peripheral parenteral nutrition have lower final concentrations of amino acid, dextrose and micronutrients as compared with central parenteral nutrition.
- ***Central parenteral nutrition*** (CPN) is useful in patients who require parenteral nutrition for more than 7 to 14 days and who have large nutrient requirements, poor peripheral venous access or fluctuating fluid requirements. Central parenteral nutrition solutions are highly concentrated hypertonic solutions that must be administered through a large central vein.
- **Peripherally inserted central catheters** (PICCs) are typically inserted into a peripheral vein, usually the cephalic or basilic in the upper arm, with the exit tip in the superior vena cava just above the right atrium.

Complications of parenteral nutrition

Complications of parenteral nutrition fall into two main categories:

- catheter related complications, such as line sepsis and line occlusion
- metabolic complications.

Refeeding syndrome is 'the potentially fatal shifts in fluids and electrolytes that may occur in malnourished patients receiving nutrition'.

Long-term parenteral nutrition can lead to "**chronic intestinal failure**", which is described as 'the long lasting reduction of gut function below the minimum necessary for the absorption of macronutrients with or without water and electrolytes, such that intravenous supplementation is required to maintain health with or without growth'.