Enteral and parenteral nutrition

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Abstract: The aim of this research was to establish guidelines that will promote safe and effective use of enteral and parenteral nutrition. Our goal is to enhance the nutritional status of our patients and so drive improved clinical outcomes. These guidelines include initiation, follow-up, monitoring and modification of enteral and parenteral nutrition.

Key words: Enteral Nutrition (EN), Parenteral Nutrition (PN).

Introduction

Nutrition Therapy is a component of medical treatment that includes oral, enteral, and/or parenteral nutrition.

Enteral nutrition (EN) refers to the system of providing nutrition directly into the gastrointestinal (GI) tract bypassing the oral cavity **(Bankhead *et al.*, 2009)**. Each year in the United States, this nutrition support modality is used in 250,000 hospitalized patients annually from infants to older adults **Healthcare Utilization Project (HCUP) (2016)**. EN is also widely used in subacute, rehabilitation, long-term care, and home settings.

The EN process is the system within which EN is used. This involves a number of major steps: the initial patient assessment, the recommendations for an EN regimen, the selection of the EAD, the EN prescription, the review of the EN order, the product selection or preparation, the product labeling and dispensing, the administration of the EN to the patient, and the patient monitoring and reassessment, with documentation at each step as required. This process requires a multidisciplinary team of competent clinicians working in concert to provide safe nutrition care **(Hudson and Boullata, 2014)**.

Although clinician competence is assumed in the EN Use Process, an inherent risk of clinical complications is related to EN and the formulas used, as well as potential errors at each step in the process. Serious adverse events, including fatalities, can occur when lapses allow for errors **(Bankhead *et al.*, 2009; Malone *et al.*, 2012)**. These types of adverse events include the following:

- Clinical complications of using EN such as GI complications, refeeding syndrome, or gut ischemia.
- Process-related errors, including those associated with process steps, such as administration errors and misconnections.

Optimal communication and standardization across all steps of the EN Use Process is a risk management strategy **Hudson and Boullata (2014)**. To reduce the risk of adverse events and improve patient safety, effective communication among all members of the multidisciplinary team is necessary throughout the process **(Malone *et al.*, 2012)**.

Collectively, team members must also develop and adhere to policies and standardized procedures for daily practice and decision making related to patient care. Standardization does not refer to, and should not lead to, a one-size-fits-all strategy for patient care. Instead, it refers to the development and implementation of technical and practice standards into a process so that all healthcare providers deliver the same level of safe care **(Boullata *et al.*, 2016)**. Opportunities exist for standardization across the EN process (e.g. EN order templates). Process standardization may include independent double-checks and automation with forcing functions to help improve EN safety. Policies include the organization's mechanisms to maintain competency of individual clinicians involved in EN.

Parenteral nutrition (PN) refers to the intravenous infusion of specialized nutrition solution. This method of feeding may be required when the gastrointestinal tract is not functional or leaking, cannot be accessed, or the patient cannot be adequately nourished by oral or enteral means. PN is complex and expensive and should therefore be used with good clinical guidance for clinicians on the indications for PN, nutrition assessment of the PN patient, determining PN requirements, initiating PN, monitoring complications and ceasing PN.

PN is best managed by a multidisciplinary team that should be guided by an interested clinician (gastroenterologist, GI surgeon and intensivist), but that importantly involves nutrition nurses, dietitians and pharmacists, together with biochemistry and microbiology laboratory support if necessary **(Smith, 2011)**.

Review of Literature

Malnutrition is common in hospitalized patients. Prevalence rates of malnutrition reported in Australian hospitals are around 30% **(Middleton *et al.*, 2001; Banks *et al.*, 2007)**.

Nutritional status can decline significantly over the course of a patient's admission, due to a combination of reduced nutrition intake and increased requirements secondary to the impact of

the disease process (altered metabolic requirements, increased nutrient losses and reduced consumption, digestion and absorption).

Timely and appropriate nutrition support aims to prevent malnutrition in those at risk and treat those who are malnourished.

Malnutrition Screening

Malnutrition is associated with increased morbidity and mortality; increased length of hospital stay and hospital costs; and increased risk of infections, delayed wound healing, impaired respiratory function, electrolyte disturbances and post-operative complications. Malnutrition screening enables the early identification of patients who may benefit from nutrition support. Leading nutrition groups worldwide recommend routine nutrition screening of hospitalized patients **(Elia, 2003; ASPEN, 2002**; **Kondrup *et al.*, 2003)**. There are several validated nutrition screening tools available, the most well-known being the MUST and MST **(Todorovic *et al.*, 2003; Ferguson *et al.*, 1999 and DAA, 2009)**. Nutrition screening should be undertaken on admission and repeated on a regular basis for long-stay patients. Patients should have their nutrition history and weight recorded and those at risk should be flagged and referred for further nutrition assessment and intervention. An automated screening tool has been developed and validated in upper gastrointestinal (GI) surgical patients **(Smith *et al.*, 2009)**. If screening indicates the patient is at increased risk of malnutrition, a thorough assessment should be done.

Indications for enteral feeding

Indications for enteral feeding include traumatic brain injury, stroke, dementia, and gastric dysfunction with malnutrition.

• Traumatic brain injury can alter the level of consciousness to the point where the patient can't eat or drink safely. Occasionally, a coma is induced to reduce pressure inside the brain or promote respiratory support.

• About 55% of patients with stroke experience dysphagia. Enteral feeding is an option if a speech therapist can't find a safe consistency of food that the patient can tolerate by mouth.

• For patients with dementia, enteral feeding is controversial if the condition stems from a progressive disease. In 2014, the American Geriatrics Society released a position statement against enteral feeding in advanced dementia, stating that hand feeding produces the same outcomes in terms of aspiration pneumonia, functional status, comfort, and death rates. However,

family members may opt for enteral feedings out of concern that their loved one may experience hunger.

• Gastric dysfunction with malnutrition (for instance, from chronic pancreatitis or gastroparesis) may warrant a postpyloric (jejunal [J]) feeding tube. Patients with chronic pancreatitis also may benefit from a J tube due to complications of prolonged decreased nutrient intake. J tube feedings help prevent ileus in these patients, minimize further organ damage, and reduce pancreatic stimulation.

In patients at high risk for aspiration due to gastroparesis, a postpyloric tube can help prevent tube-feeding intolerance **Houston and Fulauer (2017)**.

Other indications

Patients recovering from treatment for cancer of the throat, esophagus, or stomach also may require nutrition through enteral feeding. Sedated and mechanically ventilated patients may receive nutrition through an orogastric tube. Other conditions that may require enteral feeding include liver failure, prolonged anorexia, and critical illness that cause significant nutrient depletion.

Indications for Parenteral Nutrition

Parenteral Nutrition (PN) can sustain life when patients are unable to take sufficient nourishment via the gastrointestinal tract for prolonged periods. However, PN is associated with significant risks and complications. Alternative methods of nourishing patients should be considered in every case. A nutrition support algorithm is presented in Figure 1.

PN is necessary when the patient cannot be sustained with either increased intake of oral supplements or enteral nutrition alone. The use of PN should be considered when normal oral intake or enteral nutrition cannot be started after a period of five days.

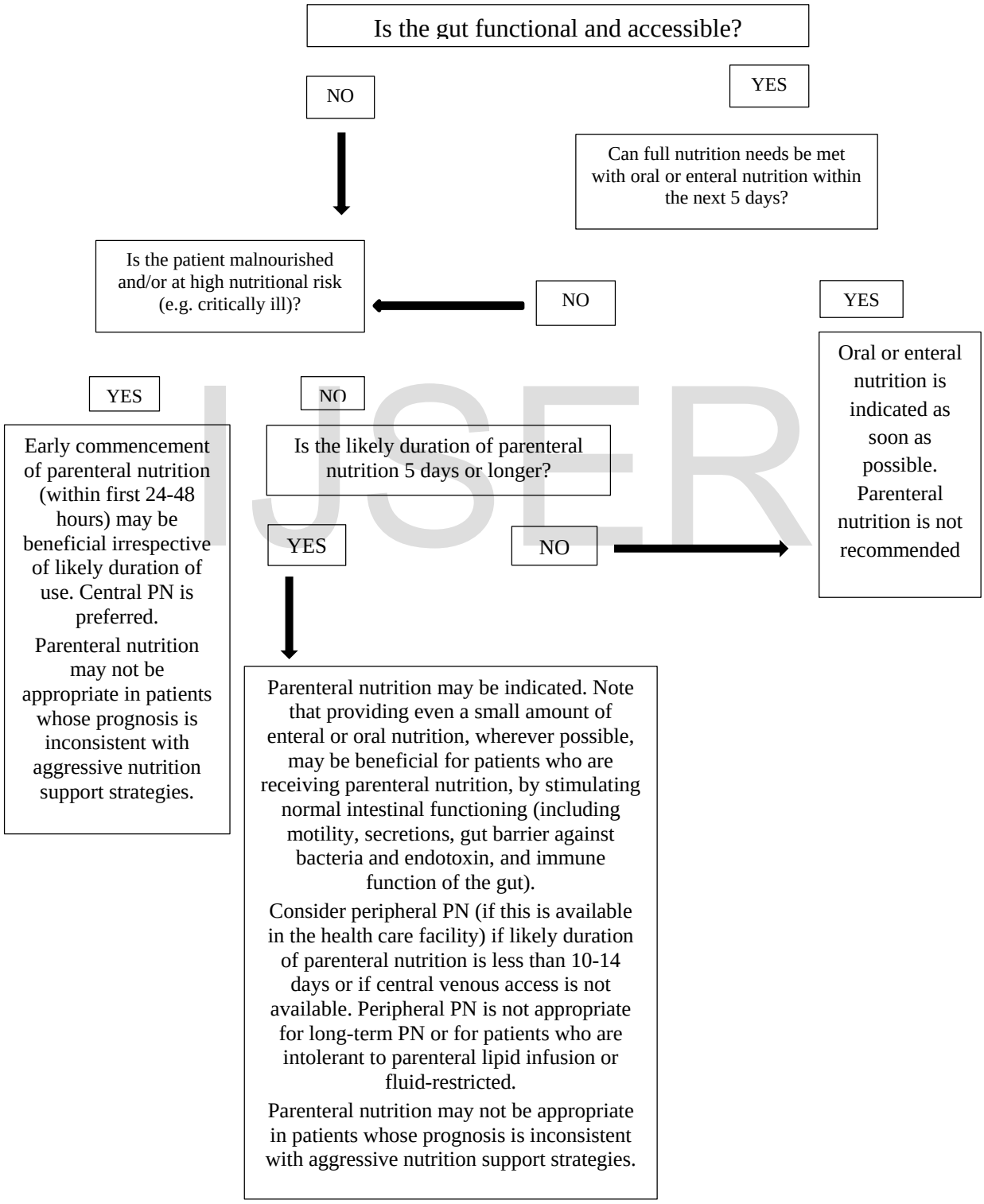
Short-term PN is appropriate in malnourished and/or severely catabolic patients unable to be adequately nourished enteral. In this patient group, the risks of complications of nutrition depletion are greater and PN should be started earlier. As PN is an invasive therapy, it must be used in a manner which limits the risk of sepsis, catheter insertion complications and metabolic complications.

PN is also a relatively expensive treatment which can only be justified for patients with clearly defined indications. The basic indication for using PN is a requirement for nutrition when the gastrointestinal tract is either:

- Not functional or leaking (e.g. obstruction, ileus, fistulae, dysmotility).

- Cannot be accessed (e.g. intractable vomiting with inability to establish jejunal access).
- The patient cannot be adequately nourished by oral or enteral means (e.g. in malabsorption states such as short bowel syndrome, radiation enteritis or inability to establish full enteral feeding) **National Institute for Health and Clinical Excellence (NICE) (2006)**.

Figure (1) Nutrition Support Algorithm **D.A.A. (2009)**



Types of enteral feeding tubes

The practitioner selects the type of feeding tube based on the specific enteral formula the patient requires and the anticipated duration of enteral feeding. The two main types of feeding tubes are prepyloric and postpyloric Table (1).

Table (1): Types of enteral feeding tubes along with their features

Tube type	Features
Prepyloric	
Nasogastric tube	• Can be placed at bedside by qualified nurse • With weighted tube (Dobhoff), fluoroscopic or radiologic confirmation of placement required before stylet removal • For short-term use (4-6 weeks); longer use poses risk of nasal mucosal damage or sinusitis
Gastrostomy tube	• Inserted surgically • Terminates in stomach • Poses risk of implantation in stomach wall • Allows administration of crushed medications
Percutaneous endoscopic gastrostomy tube	• Inserted endoscopically • Minimally invasive • Allows administration of crushed medications
Postpyloric	
Nasojejunal tube	• Terminates in jejunum • Commonly placed in radiology lab under fluoroscopic guidance; can be placed at bedside with radiographic confirmation • For short-term use (4-6 weeks); poses risk of nasal mucosal damage or sinusitis with longer use
Gastric-jejunal tube	• Terminates in small intestine • Can be used in patients requiring both stomach drainage and intestinal feeding at same time • Poses risk of jejunal extension becoming clogged from inappropriate medication administration or from attempt to rotate tube (as with G tube), causing it to curl back into

	stomach or protrude out through skin
Percutaneous endoscopic jejunal tube	• Terminates in small intestine • Preferred for patients who need single tube for feeding into small bowel • Required for gastrectomy or esophagectomy patients with gastric pull-up

Types of Parenteral Nutrition (NUMC) (2007)

- Central Parenteral Nutrition (CPN) is the delivery of nutrients via a central vein.
- Total Parenteral Nutrition (TPN) is the delivery of nutrients sufficient to meet metabolic requirements.
- Peripheral Parenteral Nutrition (PPN) is the delivery of nutrients via a peripheral vein.

Nutritional Needs of a Patient

Assessment of nutritional status of every patient is fundamental and includes four key components: nutritional history, anthropometric measurements, clinical examination and biochemical data. Assessment of these parameters will help to document presence of malnutrition and will help clinician to select best method for providing nutrients and allows objective monitoring of nutritional efforts. These assessments also are needed to estimate calorie, protein, micronutrient requirement and also help to select/make right kind of formula **(Nelson *et al.*, 1994)**.

Formula Composition

Energy:

The patient's caloric requirement will help to determine the quantity of formula needed. General purpose formulas tolerated by patients provide 1 kcal/ml. Other formulations also provide 1.5-2 kcal/ml, which are used when it is necessary to restrict fluids of the patient with cardiopulmonary, renal and hepatic failure.

Proteins:

Proteins in the diet provide essential amino acids that body cannot make and provides nitrogen for the synthesis of nonessential amino acids. In body, proteins serve the following functions (a) organic catalyst, for the structural formation of cells, (b) act as antibodies, (c) control cell metabolism. Inadequate protein intake causes diminished protein content in the cells and organs and deterioration of the cells' capacity to perform their normal function. Insufficient

protein intake can potentially affect all aspects of patient's care; for example; it can lead to muscle atrophy and can make it difficult to wean patient off ventilator **(Trujillo *et al.*, 1998)**.

In addition to the importance of adequate amounts of protein is the quality of protein. For example, formulas for renal failure patients are designed with highest quantities of essential amino acids. Protein is the most critical component of enteral formulations. Proteins can be modified in various ways in enteral formulation for example intact protein, hydrolyzed protein, amino acids.

Intact proteins are whole proteins from food or proteins isolates are intact proteins that have been separated from their source, e.g. whey, lactalbumin. Intact protein and protein isolates require normal pancreatic enzymes to catabolize them into small polypeptides and free amino acids **(Trujillo *et al.*, 1998)**.

Hydrolyzed protein is one which has been enzymatically hydrolyzed to smaller peptide fragments and free amino acids. Formulas containing di and tripeptides and crystalline amino acids are often referred to as elemental or predigested formulas. These formulas can be directly absorbed into the blood stream. These feeds can be administered when the feeds are administered via jejunum where only absorption of proteins takes place.

Glutamine and Branched Chain Amino Acids:

Glutamine and Branched Chain Amino Acids are amino acids found in skeletal muscle. They have been identified as key amino acids in preserving nitrogen balance during stress and injury. Numerous studies have indicated that glutamine is necessary to maintain integrity of intestinal mucosa, immune function of lymphocytes to preserve muscle glutamine pool and to improve overall nitrogen balance. Glutamine is considered an essential amino acid in critically ill patients **(Trujillo *et al.*, 1998)**.

The BCAA valine, leucine and isoleucine are EAA and therefore are contained in all enteral formulas. Standard enteral formulas contain 20% of BCAA while enriched solutions have 45% BCAA.

Arginine and Nucleotides:

Arginine is a conditionally essential amino acid; that is, it can be conditionally essential after injury. Human and animal studies have shown that increased intake of arginine after trauma decreases nitrogen losses and accelerates wound healing.

Standard formulas contain arginine in the amount of 1-2 g/L, and enriched formulas contain 14-15 g/L.

Nucleotides:

The nucleotides are important intracellular molecules that participate in a wide variety of biochemical processes, the best known are DNA and RNA. Nucleotides are added to some formulas as immunity enhancers. In animals, dietary supplementations of nucleotides have shown to facilitate growth and maturation of developing gut.

Taurine:

Taurine is conditionally essential nutrient since it can be synthesized by dietary cysteine or methionine.

High Nitrogen Products:

These have increased proportions of branched chain amino acids. These products are used for patients with catabolic stress. In one study, nitrogen retention appears to be better in patients with moderate to severe stressing that were given products rich in branched chain amino acids **(Alpers *et al.*, 2002)**.

The amount of protein provided by formula depends on the amount of formula administered daily and concentration of protein in the formula. Most of formulas contain a nonprotein kcal: nitrogen ratio of 150:1 (with ranges between 100-1:200-1) which is thought to be optimal for patients. In patients who have sustained severe trauma, the requirement for protein synthesis is so great that lower ratio of calories to protein may be optimal. This ratio is expressed as nonprotein kcal to nitrogen. The conversion of nitrogen to protein and vice versa as follows: amount of N2 = Gm of protein/6.25.

Most of the enteral formulations offer high nitrogen products. Patients who do not need high nitrogen formulas are likely to use amino acids for energy and increase urea production. As a result these formulas should be given carefully to renal patients.

Carbohydrates:

Carbohydrates provide 30-90% of total calories of enteral formulas and in most of the formulas they are the principle source of energy. The main difference among the formulas is the form and composition of CHO. The CHO form ranges from starch to simple sugar and contributes to characteristic of sweeteners, osmolality, and digestibility. In general, the larger carbohydrate molecules have low osmolality, are less sweet and require longer time to digest than the shorter/smaller ones **(Trujillo *et al.*, 1998)**.

Starches found in cereals, potatoes, legumes, and other vegetables are important sources of carbohydrates and are easily digested. As starches are insoluble in water, they are difficult to use in enteral formulations. Amylase rich flours made by sprouting and dry roasting cereals and pulses can be used for enteral feeding. Due to this kind of processing, starches become less viscous and are easy to feed through tubes. Oligosaccharides and polysaccharides are most abundantly used carbohydrates in enteral formulations. They require pancreatic enzymes and rarely cause intolerance. Disaccharides, e.g. sucrose and lactose, require disaccharide enzyme in the small bowel mucosa. Lactase deficiency is most prevalent disaccharide deficiency and hence most of the enteral formulas are lactose free **(MacBurney *et al.*, 1990; Ideno *et al.*, 1993)**. Monosaccharides found in enteral formulas are glucose and fructose. Due to their small molecule size, they make the formula hypertonic.

Hydrolysis is not required for digestion, but tolerance may be limited by the absorptive capacity of the small bowel **(MacBurney *et al.*, 1990; Mayes *et al.*, 1985)**.

Fiber:

Enteral formulas containing fiber may have potential clinical applications including ameliorating constipation and tube feeding-associated diarrhea, improving mucosal healing in inflammatory bowel disease, supporting gut barrier of critical patient and increasing intestinal adaptation in short bowel syndrome.10-15 Predominant source of fiber in enteral formulas, is soya derived polysaccharides.

Fiber supplemented enteral formulas have been shown to improve bowel regularity in stable patients by increasing number of bowel movement per day **(Zarling *et al.*, 1994)**.

Lipids:

Fat is a dense source of energy and also serves as a vehicle for fat soluble vitamins and essential fatty acids. Most of the enteral formulas contain vegetable oil as primary source of fat. Vegetable oil is also a good source of essential fatty acid.

Fat does not contribute to osmolality of enteral formula. Common sources of fat in enteral formulations are soyabean oil, corn oil, medium chain triglyceride, lecithin, and milk fat. Other fat sources which have emerged as potentially important source of nutrients are immune regulator like fish oils.

Long Chain Triglycerides:

Vegetable oils are predominant source of fat in enteral formulas. Long chain triglycerides are slowly cleared from blood stream and require carnitine for its absorption. More information is needed to confirm their utility.

Medium Chain Triglycerides (MCT):

MCTs are 6-12 carbon long and are usually prepared from palm kernel or coconut oil. They offer many advantages over long chain triglycerides, as they are absorbed intact without appreciable pancreatic or biliary function and are subjected to more rapid clearance from blood stream **(Adams *et al.*, 1993)**.

They are transported to the liver principally via portal venous system where they cross mitochondrial membrane and can be oxidized independent of carnitine **(Seidner, 1994)**. They should not be used in patients who are prone to high ketone levels as they produce ketones **(Mascioli *et al.*, 1987)**.

Vitamins, Minerals and Trace Elements:

Enteral formulations must fulfil the RDA of vitamins and minerals. Supplemental vitamins and minerals may have to be administered when they are not in adequate dosages in the formula. The individual nutritional status should be monitored and amounts of vitamins and minerals should be adjusted accordingly. Known essential trace elements are present in most of the formula and necessary supplementations with additional trace elements are done only if deficiency is detected.

Water:

The daily water requirement for a healthy adult is 1 ml/kcal taken for approximately 30-32 ml/kg **(Washington, 1989; Randall *et al.*, 1988)**. Fluid requirement of hospitalized patients varies and should be monitored and maintained. Water is given in addition to that provided by the formula as flushes at intervals throughout the day. A minimum of 30 ml of water every 6 hours is recommended as a flush for tube patency alone.

Physical Characteristics of a Formula

Osmolality:

Osmolality is a physical phenomenon of net permeability resulting in equilibrium across the cell membrane. It is a measure of concentration of free particles, molecule or ions in a given

solution in water. These particles include electrolytes, minerals, carbohydrates, proteins or amino acids. It is measured by determining number of particles of solute present per unit weight of water and is expressed in milliosmoles per kg of water. All nutrients and dietary components except water contribute osmolality of the solution. Osmolality of enteral formulation is increased by nutrient hydrolysis. Therefore, formulas with hydrolyzed nutrient have higher osmolality. Lipids contribute minimally to osmolality with exception of MCTs, owing to their water solubility.

Minerals and electrolytes contribute significantly **(MacBurney *et al.*, 1990; Ideno *et al.*, 1993 and Krey *et al.*, 1986)**. It has been widely thought that isotonic formulas (osmolality ranging from 280-320 milliosmoles/kg) are tolerated well than hyper or hypotonic formulas.

Complications of enteral feeding

Patients with feeding tubes are at risk for such complications as aspiration, tube malpositioning or dislodgment, refeeding syndrome, medication-related complications, fluid imbalance, insertion-site infection, and agitation. To identify these problems, thoroughly assess the patient before tube feeding begins and monitor closely during feedings.

Aspiration:

Gastrostomy (G) tube feedings can cause pulmonary aspiration. Multiple factors contribute to aspiration including recent hemorrhagic stroke, high gastric residual volume (GRV), high bolus feeding volumes, supine positioning, and conditions that affect the esophageal sphincters (such as an indwelling endotracheal or tracheostomy tube with dysfunction of the upper esophageal sphincter and a nasogastric or an enteral tube traversing both esophageal sphincters).

Studies show that patients who received tube feedings of 500 to 1,500 mL/day didn't have a higher aspiration risk than those fed lower daily volumes; even some who received low volumes aspirated. However, relatively fast feeding rates with volumes exceeding 1,500 mL/day did place patients at higher risk for aspiration.

To help reduce risk, monitor GRV every 4 hours (or according to protocol) in patients receiving continuous tube feedings. A.S.P.E.N. and the Society of Critical Care Medicine guidelines for critically ill patients advise against halting tube feedings for GRVs below 500 mL unless the patient has other signs and symptoms of intolerance.

Sometimes, healthcare providers order withholding of tube feedings at lower GRVs because of specific risk factors. If you find tube feeding contents in the patient's mouth during

oral care, assume the presence of reflux, which increases aspiration risk. To help prevent this problem, keep the head of the bed elevated 30 degrees or higher when possible.

During patient transport or when placing the head of the bed flat for patient repositioning, turn the tube feeding off, especially if the patient has a high aspiration risk. However, be aware that no conclusive evidence shows that pausing tube feeding during repositioning reduces aspiration risk for patients with high GRVs.

Tube malpositioning or dislodgment:

During initial placement, the feeding tube may be positioned improperly. To prevent this problem, the tube should be placed by experienced personnel and its position confirmed radiographically. After initial placement, the tube may become fully or partially dislodged, causing such problems as bleeding, tracheal or parenchymal perforation, and GI tract perforation. To help prevent malpositioning and dislodgment, verify feeding tube integrity at the beginning of each shift. Be aware that verbal patients with dislodged tubes may complain of new-onset pain at or near the insertion site of a percutaneous endoscopic gastrostomy (PEG) tube, G tube, gastric-jejunal (GJ) tube, or J tube. Nonverbal patients may respond with vital-sign changes (such as increased blood pressure or heart rate), increased agitation, and restlessness.

Refeeding syndrome:

Patients with sustained malnutrition are at risk for refeeding syndrome— the body's reaction to digestion after depleted electrolytes shift from the serum to the intracellular space. This syndrome may trigger life-threatening arrhythmias and multi-systemic dysfunction. It occurs when a depleted metabolic system with little to no mineral reserve (for instance, from vitamin B deficiency) becomes exhausted by the body's increased demands to process proteins and produce glycogen. An insulin response to reintroducing nutrition causes an anaerobic state, as the body can't meet the demand for oxygen and other resources needed to metabolize nutrients. Serum electrolytes then move into the intracellular space to help satisfy the higher demands, resulting in acute electrolyte abnormalities.

In patients with long-term malnutrition, monitor for intolerance at the onset of enteral feedings by checking heart rate and rhythm and electrolyte levels. Although refeeding syndrome incidence is low, failure to recognize the sudden drop in potassium and magnesium levels can have catastrophic consequences.

To reduce the risk of refeeding syndrome in patients with vitamin and mineral deficiencies, supplements may be ordered for parenteral administration before enteral feedings

begin. Refer to specific guidelines based on total energy needs and specific micronutrient deficiencies; thiamine and other B-vitamin deficiencies are the most pressing ones to address before initiating enteral feeding. As the tube-feeding goal rate is achieved, taper micronutrient supplements dosages as indicated.

Fluid imbalance:

Most patients need supplemental free-water flushes to maintain adequate hydration; on average, they need 30 mL/kg of water per day, given either as free-water flushes or I.V. hydration. If a free-water flush is ordered, calculate its volume by subtracting the volume of water in the feeding formula from the patient's total daily requirement; then divide the remaining volume over a regular routine of tube flushing. Before and after medication administration, flush the tube with about 30 mL of fluid or more, depending on drug characteristics.

Note: Be aware that some patients are at high risk for fluid overload and depend on a concentrated feeding formula to meet dietary needs.

Medication-related complications:

Until recently, clinicians assumed diarrhea in patients receiving enteral feedings stemmed from malabsorption and feeding intolerance. But more recent research points to medications, especially those high in sorbitol, as the main culprit. So be sure to rule out medications as the cause of diarrhea before looking for other causes, including malabsorption and rapid delivery rates. The sorbitol content of certain premade liquid drugs (such as potassium chloride, acetaminophen, and theophylline) can cause a rapid fluid shift into the intestines, leading to hyper osmolarity and diarrhea. This effect increases when sorbitol based liquid medications are given through a J tube. (Gastric acid in the stomach acts as a buffer to medications and reduces osmolarity of fluid entering the small intestine.) Consider a pharmacy consult for patients who experience diarrhea while receiving multiple sorbitol-based drugs. Changing the administration time as appropriate or switching to a non-sorbitol-based alternative may relieve diarrhea without necessitating feeding-rate adjustment.

Medications administered through a feeding tube also may cause clogging, especially if they're crushed. Don't give medications that must be crushed through a J tube, because the clogging risk is greater than with a G tube. Take additional precautions with medications linked to a higher clogging risk, including psyllium, ciprofloxacin suspension, sevelamer, and potassium chloride tablets that can be dissolved in water.

Know that tube replacement due to clogging is costly and subjects the patient to anesthesia. To help prevent clogging, maintain proper tube maintenance and flushing. For instance, massage potential clots in the tube, irrigate with warm water, administer alkalinized enzymes as ordered, and use a manual declogger (such as the Bionix DeClogger® or CorPak Clog Zapper®) if needed.

Be aware that some medications must be given on an empty stomach to ensure effective absorption, including phenytoin, carbamazepine, alendronate, carbidopa levodopa, and levothyroxine. You may need to withhold tube feedings for 1 to 2 hours before and after administering these medications. For a patient with a GJ tube, as long as medications are given through the gastric port, you needn't withhold feedings from the jejunal port; follow pharmacy guidelines. Keep in mind that patients receiving multiple drugs may have absorption problems due to extended withholding of feedings, causing dehydration and malnutrition.

Other enteral-feeding complications:

As described below, take steps to prevent infection at the tube insertion site and to manage patient agitation.

• **Infection at the insertion site of an abdominally placed tube:** Secure the tube to minimize movement and erosion at the site. Assess the site daily and cover it with a dry gauze dressing. Change the dressing daily or more often as needed for drainage or suspected infection. Monitor for redness and drainage at the site, and report these findings to the provider promptly.

• **Agitation:** Patients with traumatic brain injury or other cognitive deficits may become agitated by tube presence. To help prevent them from removing it apply an abdominal binder, mitten restraints, or limb restraints as necessary. (Use the least restrictive method before resorting to limb restraints) If an agitated patient is at risk for pulling out the tube, encourage family members to stay at the bedside to help distract their loved one. However, know that in some cases, their presence may increase agitation, not reduce it. Nonetheless they may be able to tell you what techniques could help calm the patient. As indicated, take steps to provide a calm environment by dimming lights, playing soft music, and offering comfort, as appropriate.

Complications of parenteral nutrition

The complications of parenteral therapy can be divided into three categories: technical – Pneumothorax, malposition, subclavian artery puncture, air embolism etc.; septic – catheter related sepsis, septic thrombosis; and metabolic – hyperglycemia, hypoglycemia,

hyperkalemia, hypophosphatemia, etc. With proper patient monitoring, most of these complications can be minimized **(Nelson *et al.*, 1994)**.

Conclusions:

Medical Nutrition Therapy is an evidence-based application of the Nutrition Care Process.

Recommendations:

- Healthcare providers must work as a team to treat the patient holistically.
- Artificial nutrition support is needed when oral intake is absent or likely to be absent for a period 5–7 days.

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