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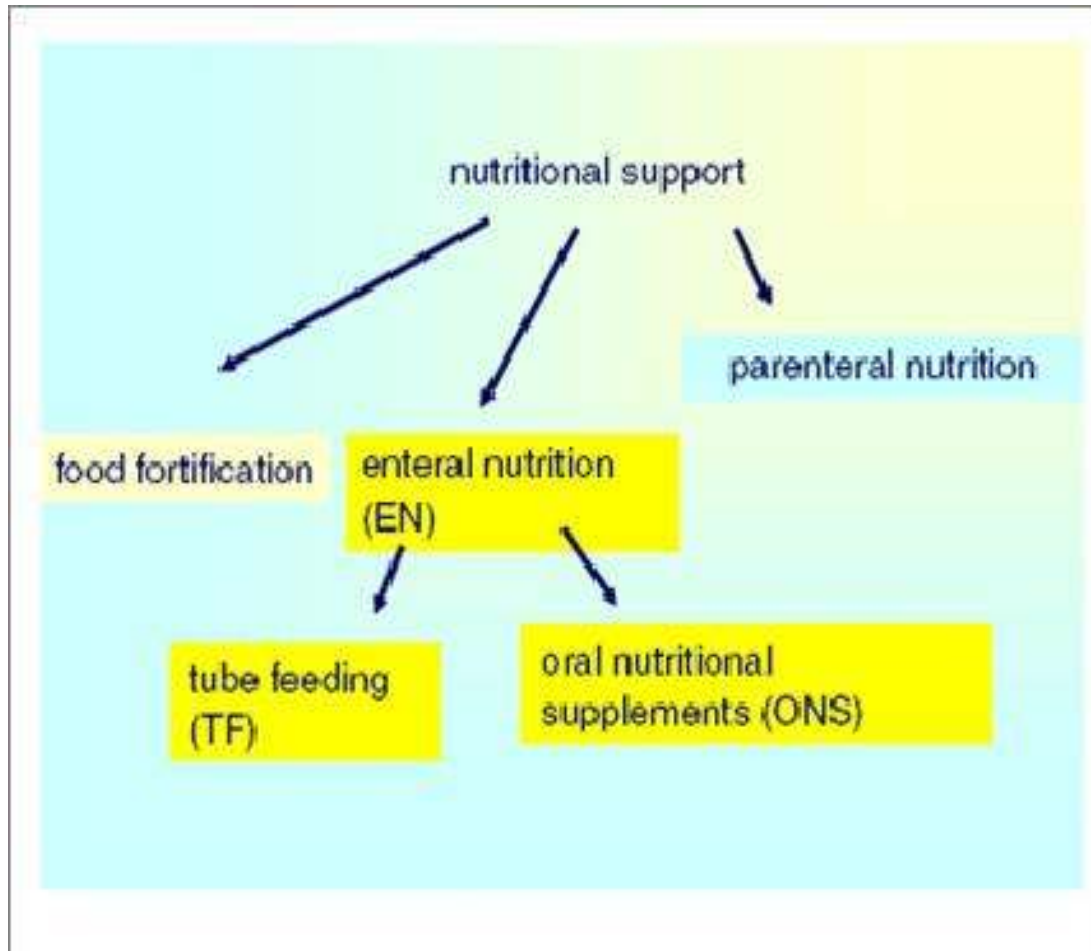
Nutrition Support Decision Algorithm

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What is Nutrition Support Therapy?

- The provision of oral, enteral or parenteral nutrients to treat or prevent malnutrition. This includes, but is not limited to, provision of total enteral or parenteral nutrition support and provision of therapeutic nutrients to maintain or restore optimal nutrition status and health (*ASPEN, 2009*).

Types of Nutrition Support



Who Needs Nutrition Support?

A-The expected duration of inadequate oral intake.
< 500kcal/d is expected to, or exceeds 3 days.

B- The nutritional status of the patient.

Poorer  Earlier initiation of nutrition support

Who Needs Nutrition Support?

C-Severity of disease/associated hypercatabolism: The higher the severity, the earlier the initiation.

*10% weight loss is associated with increased:

- Chest Infections
- Wound Infections
- Wound breakdown/Delayed Healing
- Bacteraemia/Septicaemia
- Prolonged hospital stay
- Increased incidence of readmission to the hospital
- Increased mortality

D-Specific Conditions & stress factors
(Immunosuppression, burns, sepsis...)

Methods of Assessment of Nutritional Status

- **A-Nutrition Screening**

***Goal:** Identification of malnourished or at risk patients & subsequent referral for nutrition support

***Target Group:** All patients, within 48h of admission to the hospital.

***Methods:** Questionnaires

***Implementation:** Nurses/Dietitians

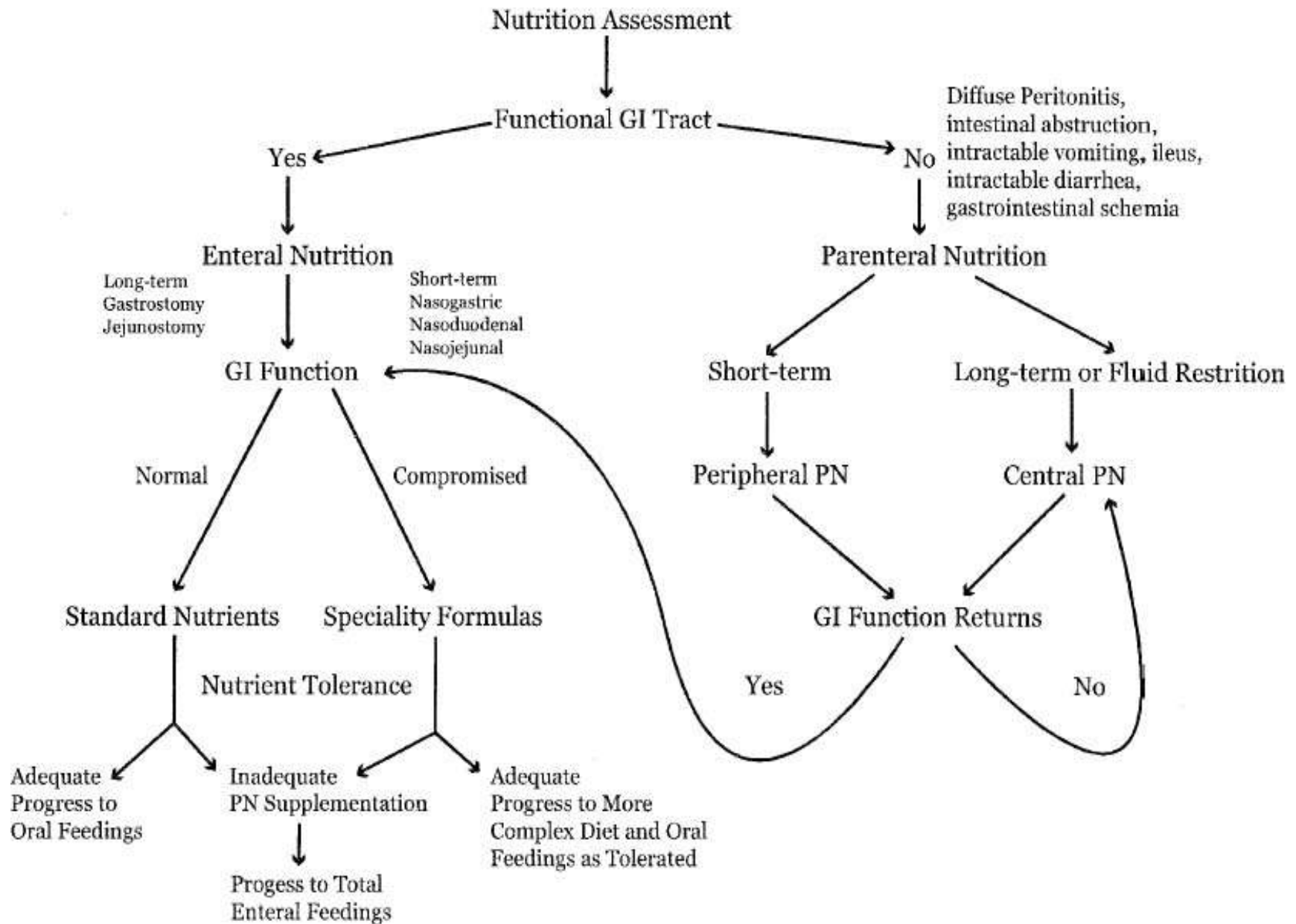
- **B-Nutrition Assessment:** A more detailed quantitative description.

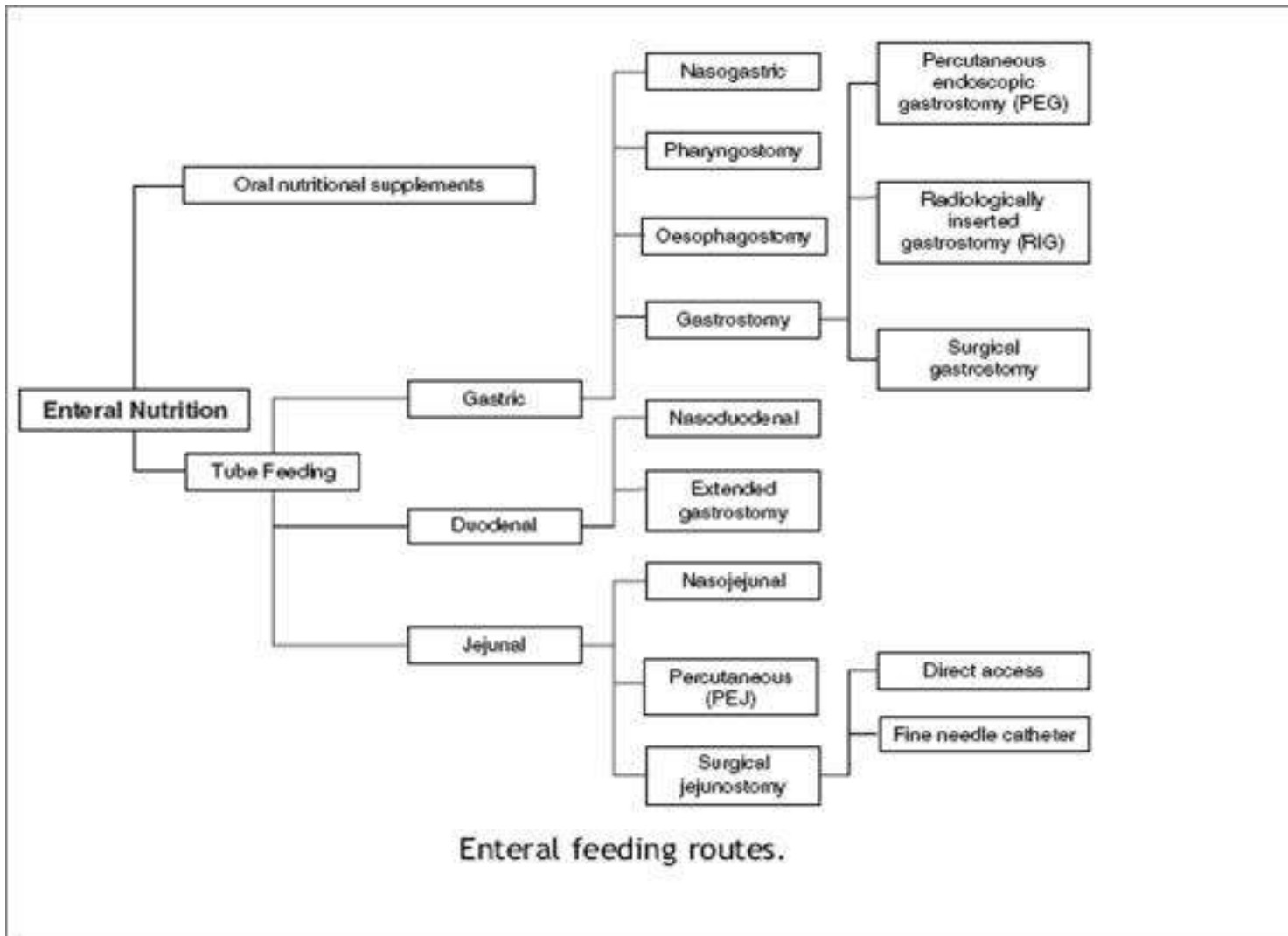
***Goal:** Identification of malnourished or at risk patients & subsequent referral for nutrition support

***Target Group:** Patients identified as “at risk” or malnourished.

***Methods:** Anthropometrics, BIA, Biochemistry, Questionnaires.

***Implementation:** Nutrition Support team, Physician, Dietitian





What Types of Nutritional Support Should be Given?

- **Enteral Nutrition:** Whenever Possible
- **Enteral+Parenteral Nutrition:** When unable to tolerate full enteral nutrition.
- **Parenteral Nutrition:** If used initially, it should be gradually supplemented with and replaced by enteral feeding as soon as possible.

Oral Nutrition	Oral + Supplementary Enteral	Enteral Nutrition	Parenteral + Enteral Nutrition	Parenteral + “Minimal Enteral Nutrition”	Parenteral Nutrition
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Indications for Enteral Nutrition

Patients with minimal functioning digestive and absorptive capabilities, whose oral intake is insufficient to meet estimated metabolic needs:

-Well nourished patients unable to eat for 10-14 days

-Critically ill patients unable to eat for 5-7 days

-Severely malnourished patients before major surgery

When Enteral Nutrition Should be Started?

- Within 12-24h after surgery, accidents, burns or within 12h after hemodynamic stabilization (after the ebb phase).
- When no contraindications to enteral nutrition exists.
- Simultaneous application of enteral & parenteral may be necessary to meet requirements.
- As a “ Minimal enteral nutrition”.

Contraindications for Enteral Nutrition

- Presumed Massive Abdominal Distension
- Severe Acute Pancreatitis
- Intractable Vomiting or Diarrhea
- Gastric Residuals > 900ml/d
- High Output Proximal Fistulas

Considerations Before Using This Enteral Nutrition Formula

- Before using an enteral nutrition formula, the following should be considered:
- **Allergies:** The patient should report any history of unusual or allergic reaction to any of the ingredients listed in the formula. In addition to allergic response to any other substances, such as foods, preservatives, or dyes.
- **Pregnancy:** Studies on effects in pregnancy have not been done in either humans or animals.
- **Breast-feeding:** To this date, no enteral nutrition formula has been reported to cause problems in breastfeeding.

Modes of Delivery

A-Bolus Feeding

- Only with gastric tubes not with jejunal tubes
- Max 300ml/bolus
- High Volume syringe (60-100ml)
- Gravity
- Infusion Pump (max 20ml/min)
- Only if digestive functions are preserved

Potential Advantages

-Lower gastric pH during pause between boluses could mean less bacterial colonization.

-Potentially lower risk of pneumonia

-Possibly improved utilization of nutrients.

B- Continuous Infusion

*It can be used for intragastric application and **MUST** be used for jejunal application:

*An infusion pump should be used (max 120ml/h)

Potential Advantages	Potential Disadvantages
-Lower Frequency of Diarrhea	-Prolonged Increase in Gastric pH, thus more danger of bacterial colonization/aspiration
-Reduced Risk of Vomiting	
-Improved Nutrient Absorption	
-Facilitated Monitoring	
-Improved Metabolic Profile	

C- Intermittent (cyclic) Infusion

Potential Advantages
-Patients can be mobilized during the breaks
-Better utilization of nutrients

How Should Enteral Nutrition be Started?

- Slowly at about 50% of goal infusion rate to reduce metabolic complications & intestinal intolerance.
- As “Minimal enteral Nutrition”
- *Gastric residuals should be checked every 4-6h or immediately before every bolus application.
- *Interruptions should be considered:
 - For stable patients:*** Minimum 2/day of approximately >30mn depending on gastric residual volume to allow acidification of the stomach and thus prophylaxis against gastric colonization by MO.
 - For ICU patients:*** 4-6/day, each approximately 30 mn to check gastric residuals and to lower the risk of aspiration.

Complications of Enteral Nutrition

- ***Diarrhea*** (Drugs, antibiotics, v cold nutrition solution, fast build up, impaired lipid absorption, bolus regimen, bacterial contamination, slipped gastric tube into the duodenum).
- ***Constipation***(Diet without fiber, inadequate fluid).
- ***Vomiting, Risk of Aspiration*** (supine body position, impaired gastric emptying, disturbed bowel motility, tube incorrectly positioned).
- ***Lesions of the Skin and/or Mucous Membranes*** (PVC tubes, pressure ulcers in nasal mucosa, pressure necrosis).
- ***Obstructed Feeding Tubes*** (Inadequate rinsing after applications, displacement of tube).
- ***Intestinal Obstruction*** (Malpositioned tube, anatomical variations, fluid deficit/impaired motility, co-medication).
- ***-Non Occlusive Intestinal Obstruction*** (Forced feeding into a dysfunctional gut)

Complications of Enteral Nutrition

Complication	Possible Causes	Management
Overhydration	A-Refeeding B-Fluid overload	A-Decrease delivery rate Restrict free water B-Change to concentrated formula OR administer diuretics
Dehydration	A-High osmolality formula B-Diarrhea C-Excessive protein intake with inadequate fluid	A/B-Change formula C-Change decreased protein content formula OR provide additional water
Rapid, excessive weight gain	A-Excess calories, fluids B-Electrolyte imbalances	A-Change formula or decrease delivery rate B- Evaluate electrolytes
Insufficient weight gain	A-Inadequate calories B-Malabsorption C- Catabolic state	A-Change formula or increase delivery rate B-Change to semi-elemental C- Nutrition support for weight maintenance along w medical issues
Hyperglycemia	Insulin deficiency	-Give insulin (insulin drip used more successfully for tube fed patients) -Change formula to higher fat/ lower CHO, high fiber

Hypoglycemia	-Sudden cessation of feedings	-Taper feedings -Monitor blood sugar if feedings interrupted
Hyperkalemia	A-Metabolic acidosis B-Renal insufficiency C-Anabolic metabolism	Reduce K intake/use reduced K formula
Hypokalemia	A-Refeeding syndrome B-Insulin administration C-Diuretics D-Diarrhea	A-Monitor serum K daily and replete until stable B-Lower dose or discontinue C-Discontinue if possible
Hyperphosphatemia	-Renal insufficiency	Use reduced PO ₄ formula •Administer phosphate binder
Hypophosphatemia	-Refeeding syndrome -Insulin administration	Monitor serum PO ₄ daily and replete until stable
Hyponatremia	-Fluid overload	Restrict free water Use NS to flush tube and provide hydration instead of water
Elevated BUN	A-Renal failure B-Excess protein (nitrogen) intake C-Dehydration D-Medications:(diuretics..	A-Reassess renal function B-Reassess protein needs C-Increase free water D-Reassess medications
Hypomagnesemia	-Refeeding syndrome, -Alcoholism	Monitor serum Mg daily and replete until stable

Enteral Nutrition Formulas

Enteral feeds can be classified into four categories:

I-Chemically defined or elemental diets

II-Specifically formulated diets

III-Standard polymeric diets

IV-Modular diets

I-Chemically Defined Diets

Chemically defined or elemental diets contain nutrients that require little or no digestion and hence are easily absorbed.

*Elemental Formulas

-Nutrient Composition:

*Proteins: Peptides, amino acids

*Carbohydrates: Glucose oligosaccharides, sucrose

* Fats: Vegetable oil, MCT oil

-Need minimal digestion, low residue

-Possible indications

Inflammatory bowel disease, malabsorption, pancreatic insufficiency

II-Specifically formulated diets

Specially formulated diets are those designed to overcome a specific problem in digestion such as lactose intolerance.

III-Standard Polymeric Diets

- Composed of complex sources of protein, carbohydrates, and fat and is appropriate where there is normal or near normal gastrointestinal function.
 - *Require digestion, absorption by functional GI tract.*
 - *Calorically dense formulas available.*
 - *Many are lactose-free.*
- Preparations suitable for tube feeding are of three types:
 - Normal food that has been blenderized and sieved
 - Reconstituted powder preparations which require the addition of water or milk.
 - Ready-to-feed products.

IV-Modular Formulas

-Composed of single nutrients:

- *Proteins: Casein

- *Carbohydrates: Glucose polymers, corn syrup

- *Fats: Vegetable oil, MCT oil

Combine to create customized formula added to existing formula or oral diet.

-Possible Indications

- *Calorie and/or protein deficit

Modular products containing fat, protein, or carbohydrate can be used to formulate an entire tube feed, allowing greater flexibility of content

Equipments for Tube Feeding

Feeding tubes are manufactured from polyurethane, silicone rubber (Silastic), polyethylene, or polyvinyl chloride.

Polyurethane & Silastic tubes	Polyethylene & Polyvinyl chloride tubes
-Softer, cause less discomfort, and can remain in situ for several weeks	-Have a wider lumen & can be used for blenderized whole diets or home-prepared feeds.
-Have a small internal diameter and hence are not suitable for all types of feeds.	-Are more suitable for bolus feeding than the polyurethane or Silastic products, although can also be used for continuous infusion.
-Pumps are often required	-Are easier to introduce than the softer tubes; however, they harden in situ.
-Usually, it is difficult to aspirate from this type of product, and the unweighted tube is easily dislodged by coughing.	-Have been reported to cause gut perforation unless they are changed frequently (every 3-5 days).

Equipment for tube feeding

**Small bowel*: Radiologic confirmation is useful.

**Stomach*: Air can be injected and the end of the tube auscultated at the presumed site of the opening to ensure that the bronchi have not been cannulated.

-All containers and gavage sets must be sterile when the feed is introduced and should be changed every 12-24 h in order to reduce the likelihood of introducing pathogens.

-Home prepared feeds food are difficult to achieve a uniform consistency that will readily pass through an enteric feeding tube & will block the small lumen of polyurethane or Silastic tubes.

Indications for Parenteral Nutrition

-Gastric Distension/ Increased Intraabdominal pressure

-Gastrointestinal Hemorrhage

-Acute Abdomen

-High Output Enterocutaneous Fistula

Contraindications for Parenteral Nutrition

- Acute Phase (ebb phase) immediately after surgery and trauma
- Any state of shock
- Serum lactate >3-4mmol/L
- Hypoxia
- Severe acidosis-
- Adequate Enteral Nutrition is possible
- Ethical Aspects

Complications for Parenteral Nutrition

- ***Hyperglycemia:** Drugs, hydrocortisone, immunosuppressants, diabetic patients insulin resistance under development, high rates of infusion.
- ***Hypoglycemia:** Unintended interruption feeding, insulin overdose, hepatic insufficiency
- ***Triglycerides:** High intake of lipids, disturbed lipolysis as in renal failure, sepsis, infection).
- ***Azotemia,** excessive BUN increase due to excessive protein/aa intake, impaired UUN excretion in renal insufficiency, GI bleeding, dehydration, pre-renal state, high BUN-20:1 as in cardiac insufficiency).

Catheter Associated Infections

PPN

- *Catheter in place for more than 3 days
- *Moisture under the cover
- *Contaminated connector

CPN

- *Multilumen Catheters
- *Number of connectors
- *Position of the catheters
- *Frequent manipulations of the catheter

Routes of Access for Parenteral Nutrition

- **Peripheral Venous Access**

- *Should be considered for short term and/pr supplementary application of PN < 5 days

- *The osmolality of the infusion should not exceed 800-900 mosmol/L

- *The access device can remain in place for 48-72h unless thrombophlebitis develops, the canula should be removed immediately.

Routes of Access for Parenteral Nutrition

- **Central Venous Access**

- *Non-Tunnelled (single, double or triple lumen) catheters for hospitalized patients.

- *Tunnelled catheters (single or double lumen) for home care, TPN>4 weeks or continuous infusion.

- ***PICC:** Peripherally inserted central catheter

- ***Subcutaneous Infusion Ports:** For home care, TPN> 4 weeks or intermittent infusion.

Parenteral Nutrition: Components/ Formulas

- **A-Macronutrients**

- *Individual substrates should not be administered alone, only in combination

- 1-Amino Acids:**

- Complete, well balanced, optimal ratio.

- *Always be given together with other energy substrates

- *Standard solutions available: 3.5%-15% aa.

- (Low concentration more used for PPN, higher for CPN to ensure adequate Nitrogen supply without fluid overload).

***Disease Specific Amino Acids:**

-Hepatic Failure: 5-8% aa solutions with a higher proportion of BCAA, lower of AAA.\

-Renal Failure: 7.5-10% aa solutions, higher portion of EAA.

*Formulas that contain a dipeptide as source of tyrosine are beneficial since tyrosine is indispensable in renal failure.

Special Amino Acids

- Glutamine is conditionally indispensable in catabolic illness, and/or after prolonged fasting >7 days & must be provided as a dipeptide as alanyl-L-glutamine or glycyl-L-Glutamine.
(Recommended:20-30g/day)

- L-Carnitine: becomes conditionally indispensable in patients with hepatic, renal failures & during high lipid intakes.
(Recommended:0.5-1g/day)

Parenteral Nutrition: Components/Formulas

2-Carbohydrates:

*Glucose is essential & the main CHO.

*Glucose is available in concentration: 10-60%

*The use of fructose & sorbitol is highly restricted in many countries due to its associative risk of inducing liver necrosis in patients with inherited glucose intolerance & the use of xylitol due to its potential induction of secondary oxalosis.

Parenteral Nutrition: Components/Formulas

3-Lipid Emulsions

*Modern lipid emulsions contain variable mixtures of:

- LCT: Soybean oil and/or olive oil, safflower oil

- MCT: physical mixtures or structured lipids

- Omega 3: Fish oil

- Emulsifying Agent: Phospholipids

- Plant Sterols

- Glycerine (To adapt osmolarity).

- Fat Soluble Vitamins

*There is an ongoing debate of potential pro-inflammatory side effects of lipid emulsions with a high PUFA content such as those with soybean oil.

*Modern emulsion should have reduced PUFA by:

- Replacing one part of the soybean oil by MCT, olive oil rich in MUFA, fish oil rich in eicosanoids with anti-inflammatory & vasodilatory effects.

Parenteral Nutrition: Components/Formulas

B-Micronutrients

- In most cases addition is required.
- Consider stability and compatibility of the solution * the maximum tolerated amounts.

**Electrolytes*

- Organic salts of phosphate and calcium must be added to prevent the formation of precipitates.

**Vitamins*

- If preparations do not contain vitamin K this should be added when PN is given for more than 7 days.

**Trace Elements*

- Should not be added in pharmacological doses.
- Ampoules with iron as the only active ingredient should not be administered.

Nutrition Solution for PN

- **A-Incomplete Formulas (2 chamber bags)**

- *Lipid Free Formulas: AA(3.5-7% +glucose around 10%
+Electrolytes

- For short term PN

- Supplementary PN

- In patients with high TG

- *Vitamins should be added

- *Considerations about osmolality when using the peripheral
venous access

- *Large volumes of infusion solutions necessary to cover
requirements

- **B-Complete Formulas (All-in-One & 3 chamber bags)**

- Constant intake of infusions, facilitated monitoring, improved hygiene, less preparation, lower costs and reduced risk of infections.

- 1-All in one bags**

- Better stored at cool temperatures: 2-8 degrees C

- Shelf life: 6 months

- Micronutrients must be added immediately before use.

- Consider stability and compatibility.

- 2-Three chamber bags**

- Can be stored at room temperature

- Shelf life: 12-24 months

- 3- Custom made formulas by the in-house pharmacy:**

- Stored at room temperature

- Shelf life: usually < 48h

- Should only be used in patients with highly altered nutrient requirements.

Precautions when using PN

- Never administer drugs simultaneously with a nutrition solution through the same lumen because it may change solubility and precipitation.
- Never dilute a complete formula with electrolyte solutions.
- Never use a nutrition formula for fluid/ electrolyte therapy beyond covering basic requirements; severe disturbances of electrolyte imbalances must be corrected separately.
- Infusion bags can be used for a period of 36h without increasing the risk of infections
- Light protection: Additional cover over nutrition bag is necessary for lipid free solutions containing water soluble vitamins since light can deactivate vitamins.

Nutrition Support in Special Diseases

Guidelines for nutrition support developed by ESPEN in 2006:

- ***Liver Diseases:** PEM is very common in Chronic Liver Disease & negative nutrient balance due to inadequate intake is frequent. Thus instead of imposing restrictive diets, which may be harmful, the goal of nutrition therapy is to ensure adequate provision of energy, nitrogen & micronutrients
- ***Renal Diseases:** Depending on the type or severity of kidney impairment, degree of malnutrition & associated diseases.
 - CRF without associated diseases are at higher risk of malnutrition due to uremia associated factors, metabolic acidosis, impaired appetite oral food intake & GI side effects of uremia: Prevention of malnutrition, reduce or control of the accumulation of waste products & prevention of bone and cardiovascular disease.
 - CRF with associated diseases: Wound healing, stimulation of immunocompetence & other reparative functions.

***Pancreatic Diseases:**

- Fluid resuscitation is necessary in any form if AP.
- The use of early enteral nutrition can reduce the risk of nosocomial infections, the duration of the systemic inflammatory response & overall disease severity.
- Pancreatic enzymes & fat soluble vitamins are very important in the management of CP (50-100g fat/d), if steatorrhea=50-70g/d

***Neurological Diseases**

- **Temperature:* Cold drinks stimulate sensation of the mouth & foster swallowing, drink chilled drinks during meals.
- **Acidity:* Swallowing receptors react positively to acid foods.
- **Sweets:* Cause excessive saliva stimulation which may cause problems in swallowing disorders.
- **Bolus:* Large food portions cause swallowing problems, 6 meals.day
- **Consistency:* Energy & proteins needs
- **Saliva:* Try sour foods to decrease thick saliva problems

Potential Benefits of EN vs PN

- **1-Physiologic**

- *Nutrients are metabolized and utilized more effectively
- *The gut & the liver process enteral nutrients before they are released into the circulation.
- *The gut & the liver maintain the homeostasis of the amino acid pool as well as the skeletal muscle tissue.

2-Immunologic

- *Lack of GI stimulation may promote bacterial translocation
- *Gut integrity is maintained
- * Minimize the risk the risk of gut related sepsis

Potential Benefits of EN vs PN

3-Safety

- *Catheter Sepsis
- *Pneumothorax
- *Catheter Embolism

4-Cost

- *Lower cost of equipments, personnel, formulas.

Monitoring Patients on Nutritional Support

-Clinical status

-Metabolic and biochemical aspects

-Delivery of feeds

Tube position and function

Pump flow rate

Gastric residuals if receiving gastric feeds

Percentage of volume infused

Temperature of the delivered feed

-Nutritional status/Reassessment

**Children require a team approach to ensure appropriate nutrition, continuation of development of oromotor skills and intake of nutrients by mouth whenever possible appropriate support of the equipment and ostomy site & psychological support whenever necessary.*

References

- American Society of Enteral & Parenteral Nutrition, 2009
- European Society of Enteral & Parenteral Nutrition, 2009
- Clinical Nutrition & Metabolism- Blue Book, Lucas Sabotka, 2006
- Austrian Society of Clinical Nutrition, 2008