



Nutrition Support in surgical patient

Done by:

Elham AlGhamdi
Abdarrahman AlKaff

Davidson's Notes:

Reema AlRasheed

Edited and Reviewed by:

Omar Al-Rahbeeni

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Nutrition:

-provides with all basic nutrients and energy required for growth, repair and maintenance of the body function.

-Nutrition comes from carbohydrate, fat, protein, electrolytes, minerals, and vitamins.

-Nutritional disorders in surgical practice have **two** principal components:

*First⇒ starvation, by the effects of the disease, by restriction of oral intake or both.

*Second⇒ the metabolic effects of stress/ inflammation.

Doctor Notes about this part

1-we may get distrubt from words :nutrition and calories:

***Nutrition:** when you get carbohydrate ,fat,protein and Vit what comes from real food.

***Calories:** given from different sources and don't have any nutritional value.

2-There will be problem if you didn't get nutrition eg: Ca diffectioncy, Vit B12 diffectioncy.

Malnutrition: (common problem in hospital setting)

-Comes from extended inadequate intake of nutrient **or** severe illness burden on the body composition and function (catabolic state) affect all systems of the body.

- Outside the hospital: poor people not getting enough calories.
- Inside the hospital:

1/we take care about medication and surgery and at the end you are not providing enough nutrition for long period of time and it will end up with malnutrition.

2/One-third of all patients admitted to an acute hospital will have evidence of protein-calorie malnutrition and two-thirds will leave hospital either malnourished or having lost weight.


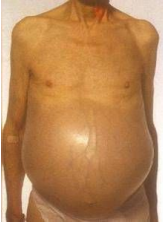




3/some patient will have high metabolic rate: burn,infection,trauma cancer and after surgery⇒ you keep them in a hospital and you know that you are providing adequate calories but the consumption of body metabolism set that it need more and more and for long period of time they will end up with a malnutrition.

-Malnutrition is associated with changes in body composition, and delayed wound healing, decreased functional capacity, impaired immune function and changes in the different organ systems.

Therefore, malnourished patients are at risk of experiencing infectious and cardiorespiratory complications, increased morbidity and mortality and prolongation of hospital stay.



Types of malnutrition

Definition	Kwashiorkor	Marasmus	Mixid
	<p>(kwashiorkor) is Protein malnutrition - caused by inadequate protein intake in the presence of fair to good calories intake in combination with the stress response</p>	<p>(ma-ras-mus) is protein-calorie malnutrition. -The patient with severe protein-calorie malnutrition characterized by calories deficiency.</p>	<p>Kwashiorkor-Marasmus mix (decreased fat, muscle protein, and serum proteins) Depleted somatic and visceral proteins. Patients appear : Cachectic and severely malnourished.</p>
Causes	<p>1-Chronic kidney disease patient cannot eliminate waste product. 2-liver cirrhosis(increase in protein will cause encephalopathy),3-trauma & burns(loss of protein), 4-hemorrhage 5-critical illness *أي شيء يخليك تخسر بروتينات.</p>	<p>1-severe burns, 2-injuries 3-systemic infections, 4-cancer 5- conditions where patient does not eat like : anorexia nervosa Anorexia bulimia starvation *أي شيء فيه استهلاك كبير للسعرات.</p>	<p>e.g. Chronic hypercatabolic patients and prolonged starvation or Trauma</p>
Clinical manifestation	<p>-Marked hypoalbuminemia -Edema and ascites. protein go to third space -Muscle atrophy -Delayed wound healing -Impaired immune function</p> <div style="display: flex; justify-content: space-around;">    </div>	<p>-Weight loss -Depletion skeletal muscle and adipose (fat) stores -Bradycardia; try to save energy -Hypothermia; try to save energy</p> <div style="display: flex; justify-content: space-around;">    </div>	

Risk factors for malnutrition:

1-Medical causes.	2-Psychological Causes.	3-Social causes.
<ul style="list-style-type: none"> -Recent surgery or trauma -Sepsis (high catabolic rate) -Chronic illness -Gastrointestinal disorders eg:celiac, crohn's -Anorexia, other eating disorders -Dysphagia -Recurrent nausea, vomiting, or diarrhea -Inflammatory bowel disease 	schizophrenia	anorexia nervosa

-Intestinal failure: a state in which the amount of functioning gut is reduced below a level where enough food can be digested and absorbed for nourishment.

Intestinal failure		
Types	Acute (usually reversible)	Chronic (frequently permanent)
Causes	<ul style="list-style-type: none"> Mechanical intestinal obstruction Paralytic ileus, frequently Abdominal sepsis Intestinal fistula 	<p>Short bowel syndrome:</p> <p>remaining intestine may adapt to regain nutritional independence.</p> <p>Reconstructive¹ surgery may also improve the function or even be employed to increase the functional length of remaining intestine in selected cases.</p>

Nutrition Assessment:

1-Based on weight loss	2-Based on current weight	3-Based on body mass index (BMI) = weight (kg)/height ² (m ²)
A 10% unintentional weight loss within a 6-month period is considered significant.	<p>*Obese: Greater than 130% IBW.</p> <p>*Mild malnutrition: 80%–89% ideal body weight (IBW).</p> <p>*Moderate malnutrition: 70%–79% IBW.</p> <p>*Severe malnutrition: Less than 70% IBW.</p>	<p>Less than 18.5: Underweight</p> <p>18.5–24.9: Normal</p> <p>25–29.9: Overweight</p> <p>30–34.9: Class I obesity</p> <p>35–39.9: Class II obesity</p> <p>Greater than 40: Class III obesity</p>
4-Serum proteins used in nutritional assessment	5- Physical examination	6- Subjective Global Assessment
<ul style="list-style-type: none"> • Albumin: Half-life 20 days not real indicator for malnutrition, we have to measure prealbumin • Transferrin: Half-life 7 days • Prealbumin: Half-life 2 days .the best indicator because of short half life 	Loss of subcutaneous body fat, muscle atrophy (including temporal wasting), presence of lower extremity edema and/or ascites	

Consequences of Malnutrition:

- Malnutrition places patients at a greatly increased risk for **morbidity** and **mortality**
- Longer recovery period from illnesses
- Impaired host defenses (Infections)

Severe weight lost:

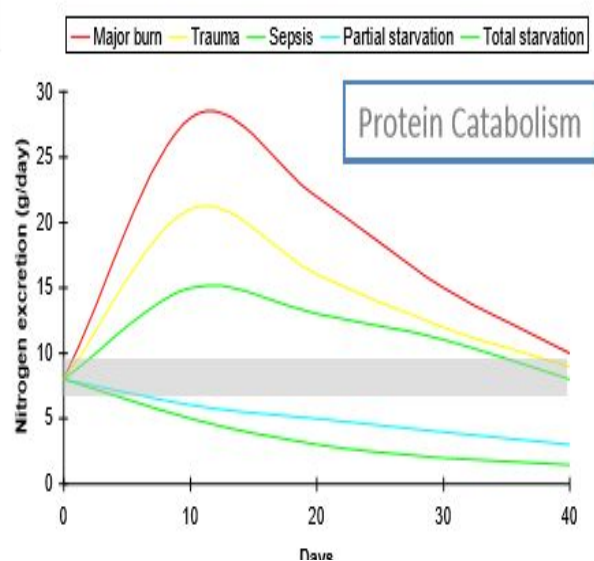
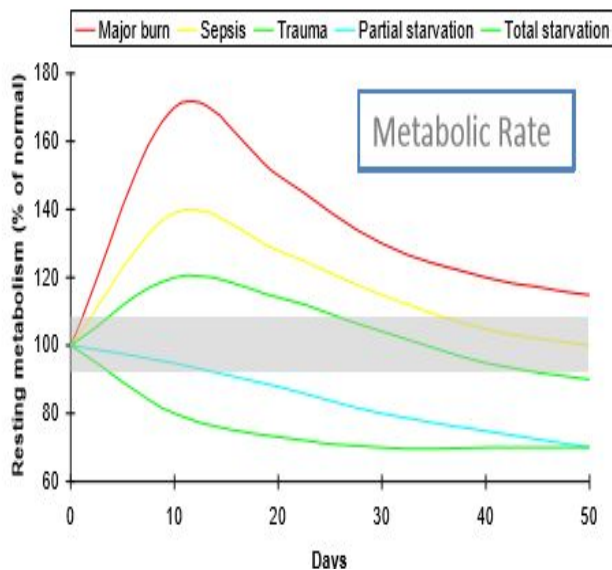
Time	Significant Weight Loss (%)	Severe Weight Loss (%)
1 week	1-2	>2
1 month	5	>5
3 months	7.5	>7.5 malnutrition
6 months	10	>10 sever malnutrition

Metabolic Rate:

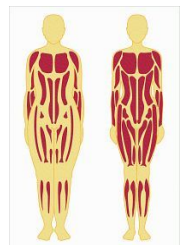
- *metabolic rate go up very fast
- *when you have increase in metabolic rate that means you will consume more energy and the body require calories generally from somewhere
- *we keep the patient NPO (specialty surgical patient) for investigation and they are on saline and then after few days they will end up with malnutrition

Protein Catabolism:

- *when your body glucose is consumed, your body will go to glycogen breakdown (it will be enough for 2-3 days after that your body will utilize fats into ketones that will generate calories for the body.
- *some cell in the body will need pure glucose and don't have mitochondria like brain cells, RBCs... , so they will need other sources, they will use protein what will be breaking down to glucose. After that protein muscle will be lost "meanly cardiac and respiratory" what will give further complications.



Obesity sometimes tricks you to think that the patient isn't malnourished!! However there is a subgroup with underlying muscle wasting (sarcopenic obesity) who are at high risk of metabolic syndrome and postoperative complications" pneumonia and wound infection and a prolonged hospital stay" They're difficult to recognize clinically due to the fact that their muscle wasting is obscured by overlying fat.



Estimating Energy/Calorie: (Just go through it) “No need to memorize calculation”

Basic energy expenditure (BEE): How much calorie they need!!	Total Energy Expenditure				
<ul style="list-style-type: none"> •Basal metabolic rate (BMR), also called the basic energy expenditure (BEE) support the body's most basic functions when at rest in a neutral, or non-stressful, environment. •It accounts for the largest portion of total daily energy requirements (up to 70%) 	<ul style="list-style-type: none"> •TEE (kcal/day) = BEE x stress/activity factor 				
<p>Harris–Benedict Equations “ no need to memorize calculation”</p> <ul style="list-style-type: none"> •Energy calculation <table border="1" data-bbox="90 734 855 1010"> <tbody> <tr> <td data-bbox="90 734 236 875">Male</td> <td data-bbox="236 734 855 875">•BEE = 66 + (13.7 x actual wt in kg) + (5x ht in cm) – (6.8 x age in y)</td> </tr> <tr> <td data-bbox="90 875 236 1010">Female</td> <td data-bbox="236 875 855 1010">•BEE = 655 + (9.6 x actual wt in kg) + (1.7 x ht in cm) – (4.7 x age in y)</td> </tr> </tbody> </table> <ul style="list-style-type: none"> •ICU patients should receive 25 kcal/kg/day increasing to target over the next 2–3 days (Grade C). 	Male	•BEE = 66 + (13.7 x actual wt in kg) + (5x ht in cm) – (6.8 x age in y)	Female	•BEE = 655 + (9.6 x actual wt in kg) + (1.7 x ht in cm) – (4.7 x age in y)	<p>Calculation: “ no need to memorize calculation”</p> <p>Our patient Wt = 50 kg , Age = 45 yrs Height = 5 feet 9 inches (175 cm)</p> $BEE = 66 + (13.7 \times \text{actual wt in kg}) + (5 \times \text{ht in cm}) - (6.8 \times \text{age in y})$ $= 66 + (13.7 \times 50 \text{ kg}) + (5 \times 175 \text{ cm}) - (6.8 \times 45)$ $= 66 + (685) + (875) - (306)$ $= 1320 \text{ kcal}$ <p>TEE = 1320 x 1.25 (normal activity) = 1650 kcal</p>
Male	•BEE = 66 + (13.7 x actual wt in kg) + (5x ht in cm) – (6.8 x age in y)				
Female	•BEE = 655 + (9.6 x actual wt in kg) + (1.7 x ht in cm) – (4.7 x age in y)				

A correlation factor that estimates the extent of hyper-metabolism:

- 1.15 for bedridden patients
- 1.10 for patients on ventilator support
- 1.25 for normal patients

The stress factors are:

- 1.3 for low stress
- 1.5 for moderate stress
- 2.0 for severe stress
- 1.9-2.1 for burn

1/Calorie sources:

Calories:

- **50 to 60%** of the caloric requirement should be provided as **glucose/carbohydrate**.
- The remainder **20% to 30%** as **fat**.
- **20%** can be from **protein**.
- To include protein calories in the provision of energy is controversial especially in parenteral nutrition, as we know excess amount of calorie and protein body will use it for anabolic.

Assessing caloric requirements:

- **Indirect calorimetry** – Measured energy expenditure by oxygen consumption and CO₂ production – The “gold standard”.
- **Respiratory quotient (V_{CO2}/V_{O2})**; 1 for carbohydrate oxidation; 0.7 for fat oxidation; 0.8 for protein oxidation; greater than 1 usually implies overfeeding (net fat synthesis), less than 0.7 suggests ketosis or an error in measurement (too much fraction of inspired oxygen [F_{IO2}] variability at higher F_{IO2} concentrations).

2/Fluid Requirements:

Fluid:

1-The average adult requires approximately 35-45 ml/kg/d (fluid lec:)

2-NRC² recommends 1 to 2 ml of water for each kcal of energy expenditure

3-⁴/2/1 formula (fluid lec:)

- the first 10 kg of body weight requires 4 ml/kg/h
- ➡ the next 10 kg 2 ml/kg/h
- ➡ rest, each kg of body requires 1 ml/kg/h

² NRC= National research council

3/Protein Needs:

Protein:

•The average adult requires about **1.5 gm/kg** or average of 100 grams of protein per day.

change with the severity of the problem in severe stressful situation like: severe sepsis ,burn,trauma. probably you will need higher in of calories and protein.

Stress or activity level Initial protein requirement (g/kg/day):

- Baseline** **1.5 g/kg/day**
- Mild stress** **1.8 g/kg/day**
- Moderate stress** **2.0 g/kg/day**
- Severe stress** **2.2 g/kg/day**

protein requirement = weight x 1.5

Table 3.1 Estimation of energy and protein requirements in adult surgical patients		
	Uncomplicated	Complicated/stressed
Energy (kcal/kg/day)	25	30–35
Protein (g/kg/day)*	1.0	1.3–1.5

*Grams of protein can be converted to the equivalent amount of nitrogen by dividing by 6.25.

Adverse effects of overfeeding:

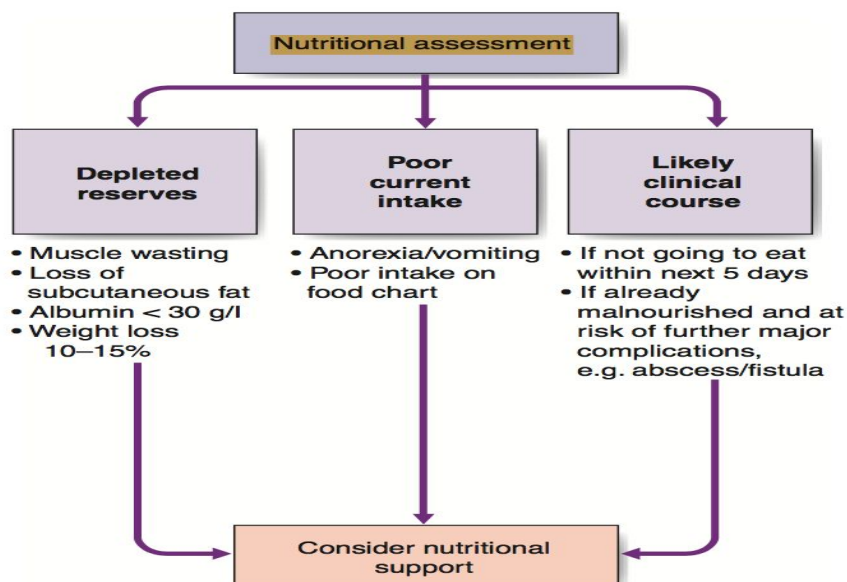
- Do not exceed 5 mg/kg/minute of glucose/carbohydrate, (more than 5 liver will not metabolize what will cause fatty liver).

-overfeeding (calorie) come from **Dextrose**.

- **Hypercapnia:** If the patient experiences hypercapnia without a known cause, the nutrition therapy should be suspected and the caloric intake empirically decreased (especially if the patient is having trouble weaning from the ventilator).
- **Hyperglycemia:** Patients with stress-induced hyperglycemia or diabetes are even more susceptible to hyperglycemia with EN or PN.
- **Fatty infiltration of the liver:**

*in dextrose form: called steatosis / increase in ALT & AST.

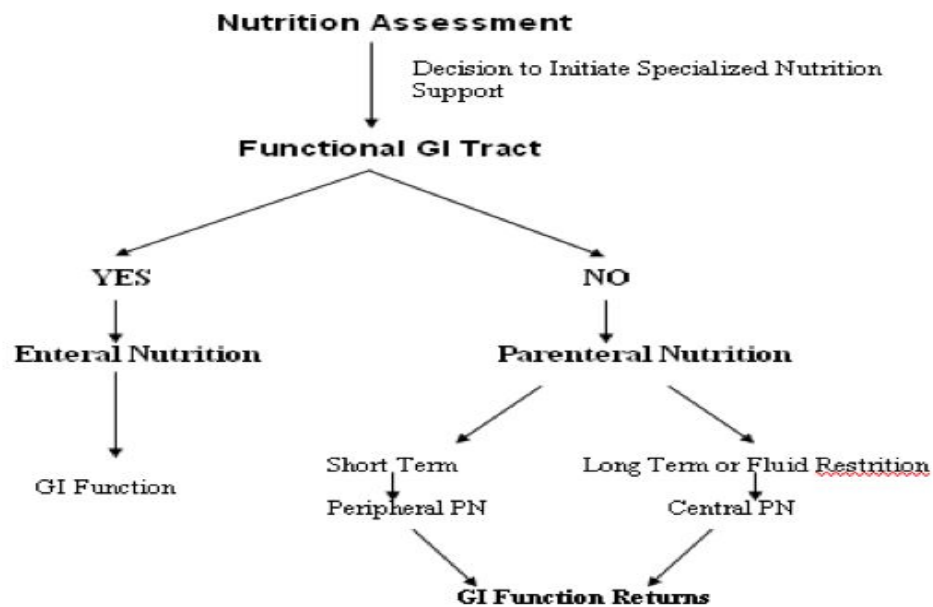
*in fat form: called cholestatic picture / increase in GGT , Alkaline phosphatase and bilirubin.



Routes of Nutrition Support:

*the images will be explained later in more details.

•The nutritional needs of patients are met through either **parenteral** or **enteral** delivery route.



Enteral Nutrition:

- The gastrointestinal tract is always the preferred route of support (Physiologic)
- EN is safer, more cost effective, and more physiologic than PN
- Nutrients are metabolized and utilized more effectively via the enteral than parenteral route
- EN provides proteins while PN provides nitrogen which is equivalent to protein

If the gut works, use it (**always first choice**) **The rule of thumb: If the Gut Work, Use It .**

If the Gut Works Partially, use It Partially.

- Before embarking on tube enteral feeding, it is important to manage actively any symptoms that can be treated (e.g. oral thrush with nystatin, nausea with anti-emetics, provision of adequate dental hygiene or artificial dentures).

Type of Enteral Nutrition:

Polymeric : Real or intact food is provided to the patient through the tube → used when you want to feed stomach

Monomeric → partially or predigested food → used when you want to feed duodenum

Catogary	Subcategory	Characteristic	Indications
Polymeric	Standard	Similar to average diet	Normal digestion
	High nitrogen	Protein more than 15% of the diet	*Catabolism. *wound healing.
	Carbon dense	2 Kcal/ml	1-Fluid restriction 2-Volume overload 3-Electrolyte abnormality
	Fiber containing	Fiber 5-15 g/L	Regulation of bowel movement
Monomeric	Partially hydrolyzed	* One or more.. *nutrients are hydrolyzed.	*Impaired digestive and absorbed capacity.
	Elemental	*The composition varies.	
	Peptide based		

Disease specific	Organ	The disease	Recommended food
	Renal	Renal failure	Low protein and electrolytes content
	Hepatic	Hepatic encephalopathy	High BCAA”Branched Chain Amino Acid”, low Amino acids and electrolytes
	Pulmonary	ARDS	High calories diet from Fat
	Diabetic	Diabetes mellitus	Low CHO
	Immune-enhancing	Metabolic stress Immune dysfunction	Arginine, glutamine, omega 3 Fatty acids, antioxidants

	Indications	Contraindications	Routes
Enteral Nutrition	<p>1/If the patient is unable to eat adequate amounts to achieve goal nutritional intakes.</p> <p>2/Lack of bowel sounds, flatus, or bowel movement</p> <p>3/Refusal to eat/anorexia</p>	<ul style="list-style-type: none"> ➤ Gastrointestinal obstruction ➤ Severe acute pancreatitis ➤ High-output proximal fistulas ➤ Intractable nausea and vomiting or osmotic diarrhea <div data-bbox="679 824 967 1084" data-label="Image"> </div>	<ul style="list-style-type: none"> ● If nasogastric feeding is impossible due to disease or obstruction of the upper alimentary tract, nutrients may be given through a tube placed into the gastrointestinal tract below the lesion ● Long-term nutrition: <ul style="list-style-type: none"> ❖ Gastrostomy “ex.pseudobulbar palsy³ or an oesophageal fistula” ❖ Jejunostomy”ex.gastric or duodenal fistula” ● Short-term nutrition: <ul style="list-style-type: none"> ❖ Nasogastric feeding ❖ Nasoduodenal feeding ❖ Nasojejunal feeding

Parenteral nutrition (PN):

- Provide patients with adequate calories and protein to prevent malnutrition and associated complication.
- The main goal of PN is **to deliver a nutrient mixture closely related to requirements safely and to avoid complications.**
- Patients should be fed by PN to avoid starvation or underfeeding in ICU patients because they are associated with increased morbidity and mortality(Grade C) ,so increased metabolic related to stress are likely to accelerate the development of malnutrition which associated with impaired clinical outcome.
- All patients who are not expected to be on normal nutrition within 3 days should receive PN within 24–48 h if EN is contraindicated or if they cannot tolerate EN. (such as those in Grade C).
- PN therapy must provide:
 - ❖ Protein in the form of amino acids
 - ❖ Carbohydrates in the form of glucose
 - ❖ Fat as a lipid emulsion
 - ❖ Electrolytes, vitamin, trace elements and minerals

³ medical condition characterized by the inability to control facial movements (such as chewing and speaking)

General Indications of PN:

- ❑ Requiring NPO > 5 - 7 days
- ❑ Severe gut dysfunction “ex. Intestinal failure” or inability to tolerate enteral feedings.
- ❑ Can not eat (such as dysphagia), will not eat (Anorexia) , should not eat (GIT obstruction)

Special Indications of PN:

- | | |
|---|---|
| <ul style="list-style-type: none"> ● After major surgery ● Patient with bowel obstruction ● Patient with enterocutaneous fistulas (high and low) ● Massive bowel resection ● Malnourished patients undergo chemotherapy ● NPO for more than 5 days for any reasons ● Necrotizing pancreatitis | <ul style="list-style-type: none"> ● Burns, sepsis, trauma, long bone fractures ● Premature newborn ● Renal, hepatic, respiratory and cardiac failure(rarely) <ul style="list-style-type: none"> ● Short bowel syndrome ● Severe paralytic ileus ● Gut ischemia ● Refractory diarrhea or vomiting ● Intolerance to enteral feeding ● If the energy and nutritional requirements cannot be met after maximizing enteral support ● Failure to Thrive |
|---|---|

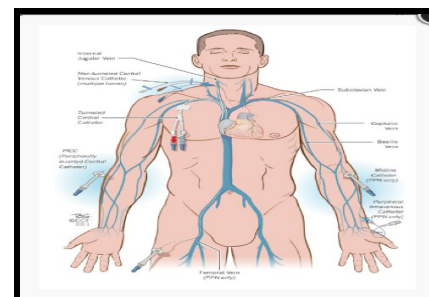
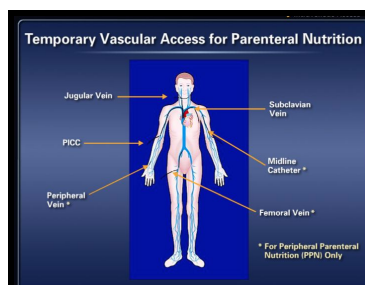
Criteria for Starting PN:

- *Expected Duration of PN therapy greater than 7 days.
- *Venous access available
- *Hemodynamically **stable** patient. **emergency patient** ⇒ NO

Administration of PN:

Central line: used in long term or large amounts of food

Peripheral line: Peripheral venous access devices may be considered for low osmolarity (<850 mOsmol/L) to cover a proportion of the nutritional needs and to reduce negative energy balance in Grade C patients. **used also in short term.**



Administration of central line:

Is usually administered into a large-diameter vessel, normally the superior vena cava or right atrium and accessed through :

- 1-Subclavian (the most commonly used)
- 2-Jugular vein (the easiest ,but associated with a lot of infections)
- 3-Femoral vein (the most common site in pediatric)
- 4- Peripheral Inserted central catheter (PICC) :

- PICCs were associated with a lower risk of central vein catheter (CVC) associated bloodstream infection (BSI).
- PICC lines offer a suitable middle way between peripheral catheters & conventional central lines.

Composition of PN “PN = IV Food”			
Micronutrients	Macronutrients	Other additives	Water
Electrolytes	Amino Acid		
Trace elements	Dextrose		
Vitamins	Fat		

Comparison between Central line and peripheral line:

Type of line	Central line	Peripheral line
Site	Subclavian line (usually)	Peripheral
Osmolality	High osmolality > 2000 mOsm/L	Low osmolality < 1000 mOsm/L
Volume	Minimum volume	Large volume
Period	Long period	Short period < 14 days
Calories	Full Calories	Minimum calories
Complications	<ul style="list-style-type: none"> ● More complications ● More Infections 	<ul style="list-style-type: none"> ● Less complications ● Thrombophlebitis

Some Complications from central line insertion:

- Catheter sepsis
- Pneumothorax
- Catheter embolism
- Arterial laceration (tears or rupture)

Complications of Total parenteral nutrition (TPN)

1. Mechanical complication

- Improper placement of catheter may cause pneumothorax, vascular injury with hemothorax, and cardiac arrhythmia. “Ultrasound guidance helps avoid such problem”.
- Venous thrombosis after central venous access
- Catheter sepsis
- Catheter embolism
- Arterial laceration

2. Septic complication

- PN is associated with more hyperglycemia than EN, hyperglycemia reduces neutrophil chemotaxis and were found to be an independent risk factor for short-term infection in patients undergoing surgery, so tight glucose control can overcome such infection in ICU. (Grade B).
- The mortality rate from catheter sepsis is high
- The usual offending organisms are: coagulase-negative staphylococci, *Staphylococcus aureus* “most commonly” and coliforms, but the incidence of fungal infection is increasingly because many of the patients requiring TPN are (immunocompromised or receiving broad-spectrum antibiotics).
- Aseptic technique : inserting the venous catheter + compounding the solution
- Antimicrobial-impregnated Central vein catheter (CVC) reduced the risk of CVC-associated Bloodstream infection
- Catheter care at the site – regular dressing

Table 3.4 Detection and treatment of catheter related sepsis

If a pyrexia > 38°C develops, or there is a further rise in temperature if already pyrexial

- Stop parenteral nutrition and check for other sources of pyrexia (e.g. chest or urinary tract infection)
- Take peripheral and central line blood cultures
- Administer intravenous fluids
- Heparinize catheter
- Consult senior medical staff

If blood culture is negative

- Restart parenteral nutrition and continue to monitor for signs of sepsis

If blood culture is positive

- Remove catheter and send tip for bacteriological analysis
- Administer appropriate antibiotic therapy
- If necessary, replace catheter and restart parenteral nutrition within 24–48 hours

Where central access must be preserved

- Seek specialist advice from hospital nutrition team

3. Metabolic Complications

- Metabolic complications include under- or overhydration.
- Hyperglycaemia ⇒ Intolerance of glucose ⇒ insulin resistance.
- Fatty infiltration of the liver and abnormal liver enzymes
- Hypokalemia and hypophosphatemia ⇒ when severely malnourished patients are refeed after a long period of starvation due to the large flux of potassium and phosphate into the cells.

3. Metabolic complications (Cont.)	
Early complications	Late complications
<ul style="list-style-type: none"> early in the process of feeding and may be anticipated 	<ul style="list-style-type: none"> caused by not supplying an adequate amount of required nutrients or cause adverse effect by solution composition
Volume overload	Trace mineral deficiency
Hyperglycemia	Essential Fatty acid deficiency
Refeeding syndrome	Vitamin deficiency
Hypokalemia	Metabolic bone disease
Hypophosphatemia	Hepatic steatosis
Hypomagnesemia	Hepatic cholestasis
Hyperchloremic acidosis	Bleeding (from Vit K deficiency)
	Anemia

- The first step of management of metabolic complications is correcting the electrolytes imbalance

Monitoring of PN:									
Fluid tolerance: Weight Ins/outs Sign of edema/ dehydration	Glucose tolerance: Glucocheck	Protein tolerance BUN Nitrogen balance	Fat tolerance: Triglycerides	Electrolytes: U/E, Ca, Ph & Mg	LFT	Visceral proteins: Albumin, prealbumin, transferrin	Central line Infection: Fever, WBC, Clinical S/S	Trace elements	Vitamins

Discontinuation of PN:

- PN must be tapered gradually to avoid hypoglycemia
- If PN has to be stopped abruptly (going to OR or PN bottle leakage), replace with D10W at same rate
- Consider stopping PN When PN provides less than 25% of total daily caloric intake.
- PN should be tapered off slowly before discontinuation. (eg: decrease rate by 50% x 2 hours, repeat rate reduction twice then discontinue).
- PN should be used for the shortest possible duration.
- If patient to be continued on PN for more than one month switch to cyclic PN.

Diet requirements in Parenteral nutrition

Glucose

Maximum **oxidized** rate for glucose is 4 - 7 mg/kg/min (adult)

Obligatory requirements for central nervous system, renal medulla, bone marrow, leukocytes, etc.: Around 130 g/day

Caloric contribution of glucose: 3.4 kcal/g

Protein requirement

- 150 kcal to 6.25 gm of protein
- 100 to 150 non protein calories to 1 gram of nitrogen to avoid protein catabolism
- When PN is indicated, a balanced amino acid mixture should be infused at approximately 1.3–1.5 g/kg ideal body weight per day in conjunction with an adequate energy supply (Grade B)

Assessing protein requirements

Nitrogen Balance

*NB = nitrogen in (N in) – nitrogen out (N out).

*N in (g/day) = protein (g/day)/6.25

*N out: N out (g/day) =

$(UUN^4 + 4g)^* \Rightarrow$ for compensation b/c of some of N get out of the body by sweating, feces..

Calculate the NB:

NB (g/day) = N in(g/day) – N out (g/day).

Glutamate

How much glutamine is required?

According to guidelines recommendations & Dipeptiven SPC IV glutamine dose should be

1.5 - 2.5 ml of IV glutamine per kg body weight (equivalent to 0.3 - 0.5 g N(2)-L-alanyl-L-glutamine per kg body weight).

IV glutamine beneficial in the following patient groups:

- Severe catabolic illness.
- Acute/chronic infection
- Intestinal dysfunction
- Infectious enteritis
- necrotizing enterocolitis
- Short bowel syndrome
- Mucosal damage following chemotherapy, radiation or critical illnesses
- Burn/trauma/major operation
- Bone marrow transplantation
- Inflammatory bowel disease
- Intestinal immaturity or

⁴ UUN is 24-hour urine urea nitrogen excretion (grams per day)

Fat emulsion /Lipid requirements:

- Recommended allowance (1-2.5 grams/kg/day)
- Lipid emulsions should be an integral part of PN for energy and to ensure essential fatty acid provision in long-term ICU patients. (Grade B).
- Intravenous lipid emulsions can be administered safely at a rate of 0.7 g/kg up to 1.5 g/kg over 12–24 h (Grade B)
- Main source is **soybean oil** – May be given separately from the PN admixture or as part of the PN solution. When given separately from the dextrose/amino acid formulation, the maximum allowable hang time according to the U.S. Food and Drug Administration (FDA) is 12 hours.
- Intravenous fish oil requires permission from the FDA.
- Caloric contribution of intravenous fat emulsion: 10% = 1.1 kcal/mL; 20% = 2 kcal/mL; 30% = 3 kcal/mL or around 11 kcal/g for 10% emulsion, 10 kcal/g for 20% and 30% emulsion
- Dosage: About 100–150 g weekly (or 1–1.5 g/kg weekly) is enough to prevent essential fatty acid deficiency (EFAD). Usually 2-4% of total calories.
- Clinical symptoms of EFAD (dry, scaly skin; hair loss; poor wound healing) occur about 2 weeks after biochemical evidence of deficiency in adults. Therefore, in most adults, the earliest you will see EFAD is after about 3 weeks of fat-free full-calorie continuous PN. **they will utilize their own body fat**
- Serum triglyceride concentration should be monitored at least weekly and more often for those with proven or suspected impaired triglyceride clearance.

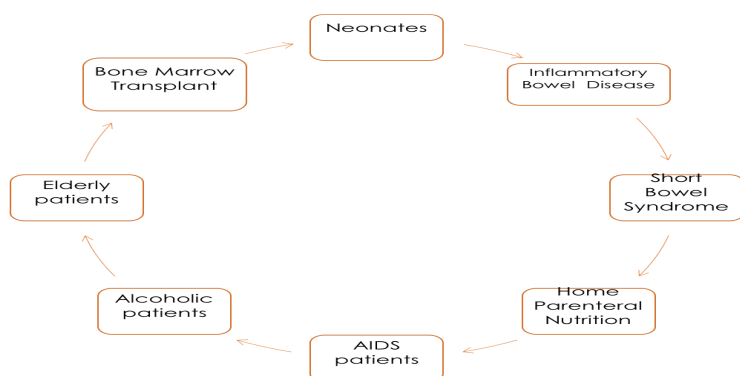


Predisposing conditions that may result in impaired clearance of triglycerides:

- End-stage sepsis (multisystem organ failure).
- History of hyperlipidemia.
- Obesity.
- HIV (human immunodeficiency virus) (occurred even before current antiretroviral therapy).
- Pregnancy.
- Small-for-gestational-age neonates (carnitine synthesis is maturation-dependent).
- Excessive lipid intake (often caused by propofol therapy).
- Acute pancreatitis.
- Uncontrolled diabetes.
- Liver failure.
- Kidney failure (decreased lipoprotein lipase activity, carnitine deficiency with long-term hemodialysis patients).

Electrolytes:	Vitamins:	
<ul style="list-style-type: none"> • TPN should contain appropriate doses of electrolytes that meets patient specific needs • Patient's medical condition, medications, electrolytes levels, bolus doses received, and any source of drainage should be clinically evaluated by clinical pharmacist prior to TPN calculation on a daily basis • In ICU setting, most patients are managed by electrolyte replacement protocol • The electrolyte content in the TPN should be taken into consideration by physicians 	<ul style="list-style-type: none"> • An organic compound required as a nutrient in tiny amounts • Essential for maintenance of normal metabolic and cellular functions of the body • Cofactors for enzymatic reactions • Some vitamins act as antioxidants: protect membrane lipid receptors and other components of immune cells from oxidation 	
	Water soluble	Fat soluble (Kade)
	B1 (Thiamine) Folic Acid B2 (Riboflavin) B8 (Biotin) B3 (Niacin) Pantothenic Acid B6 (Pyridoxine) Vit C(Ascorbic Acid) B12 (Cyanocobalamin)	Retinol (Vitamin A) Ergocalciferol(Vitamin D) Tocopherol (Vitamin E) Phytonadione (Vitamin K)

Patients Who Are at a Potential Risk for Vitamin Deficiencies :



Excretion Pathways:

Renal route Zinc, Selenium, Chromium, Iodine, Molybdenum
Biliary route Copper, Manganese
Renal & Biliary route Iron

Surgical Recall

1. What dietary change can be made to decrease CO₂ production in a patient in whom CO₂ retention is a concern (RQ)⁵?

Decrease carbohydrate calories and increase calories from fat

2. What are the surgical causes of vitamin B12 deficiency?

Gastrectomy, excision of terminal ileum, blind loop syndrome

⁵ Respiratory Quotient

3. Mention the site of absorption of the following?

iron⇒ Duodenum (some in proximal jejunum)

vit B12⇒ Terminal ileum

bile salts⇒ Terminal ileum

fat-soluble vitamins⇒ Terminal ileum

4. What is in TPN?

Protein Carbohydrates Lipids (H2O, electrolytes, minerals/vitamins, insulin, H2 blocker)

5. What are the signs of the following disorders:

Vitamin A deficiency	Poor wound healing⇒ Lessens the deleterious effects of steroids on wound healing.
Vitamin B12	folate deficiency Megaloblastic anemia. -Causes: Gastrectomy”Must bind Intrinsic factor from the gastric parietal cells“, excision of terminal ileum, blind loop syndrome.
Vitamin C deficiency	Poor wound healing, bleeding gums -Vit C increases the PO absorption of iron
Vitamin K deficiency	Less vitamin K–dependent clotting factors (II, VII, IX, and X); bleeding; elevated PT
Chromium deficiency	Diabetic state
Zinc deficiency	Poor wound healing, alopecia, dermatitis, taste disorder
Fatty acid deficiency	Dry, flaky skin; alopecia

6. What is the major nutrient of the gut (small bowel) and the colon respectively?

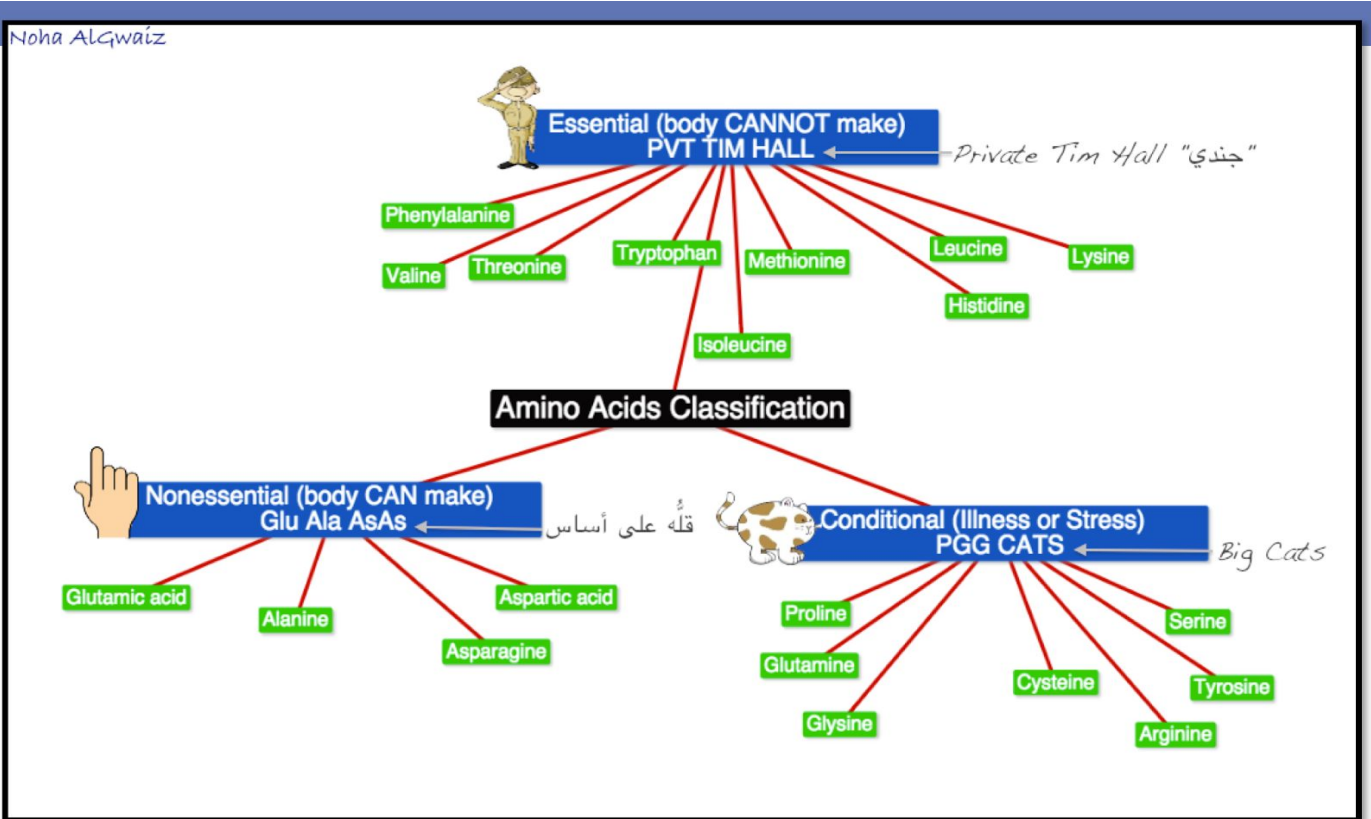
Glutamine, Butyrate (and other short-chain fatty acids)

7. What is the major nutrient of What sedative medication has caloric value?

Propofol delivers 1 kcal/cc in the form of lipid!

8. What is the best way to determine the caloric requirements of a patient on the ventilator?

Metabolic chart which is Resting energy expenditure by measuring O2 intake and CO2 output by calorimetry



MCQs.

1- What is the most common vein used in administration of central line in Pediatric?

- A) Subclavian.
- B) Jugular.
- C) Femoral.
- D) Saphenous.

2-Which of the following is true regarding the complications of TPN?

- E) EN is associated with more hyperglycemia than PN.
- F) The mortality rate from catheter sepsis is low
- G) Volume overload is considered as early metabolic complication.
- H) Hyperglycemia is considered as late metabolic complication.