Nutrition in surgical patient

Objectives:

- Not given

if you don't have the time, check out the Focused version of the lecture

Resources:

- Lecture slides
- Davidson's
- Surgical recall

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[Color index | Important | Notes | Extra]
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Nutrition

Introduction:

It goes without saying that without food there can be no life, that food is a basic human right, and that it behoves every doctor to pay attention to the nutritional needs of their patients. Nevertheless, approximately 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.

If pts stays in the hospital for a treatment or a surgery, and was not well nourished, the outcome of the treatment will not go well, so what is the importance of nutrition?

Nutrition: It's the provision of all basic nutrients and energy required for growth, repair and maintenance of the body.

Energy VS **nutrition**: we can get energy from many sources you can take carbs, fats, proteins… and generate **energy**, but at the same time patients can take a lot of alcohol and will generate tremendous amount of calories but has no nutritional value to it. So the goal is having a nutritional value and providing the pt with the energy to sustain their self.

Sources of nutrition:

1. **Carbohydrates**
2. **Protein**
3. **Fat**
4. Electrolytes
5. Minerals
6. Vitamines

The basal metabolic rate [BMR]: increases tremendously during illness [e.g. infections, malignancies, altered hormonal states, etc..]. In this state, more energy is burnt than consumed [imbalance] making the body prone to develop malnutrition. It affects all body systems.

When BMR increases it means your body is utilizing lots of calories, if you can't provide these calories, What will happen to you?

Let's say you have a body storage of **glycogen** (major storage of quick calories), but it will last only for 2 days, after that the body will start utilizing **fat** and **protein**, the **fat** will provide you with calories but some organs like the brain (or cells that doesn't have mitochondria) requires **glucose** to run.

Glucose will be derived from gluconeogenesis (breaking down proteins) so the protein catabolism increase thus to drive energy, so think of it all the body muscles especially the cardiac and respiratory muscles be affected, eventually the pt will deteriorate.

So in major trauma, sepsis, burn pts the protein catabolism increase and with that there will be consequences.

Keeping pt without providing them calories inventory the body will utilize glucose > glycogen > fat > protein > **severe malnutrition

Malnutrition:

there's 2 ways looking at it:

- pt not taking calories (energy) and ends up malnutrition
- pt taking **a lot** of calories but still go into malnutrition! Pts with high metabolic rate, like cancer, burn, pts after major surgery and the body requires tremendous amount of energy to repair their self back.

There are two methods for a person to develop nutritional disorders (malnutrition):

1. **Starvation** (inadequate intake) by restriction of oral intake, effects of a disease (e.g. celiac disease causes malabsorption of iron) or a combination of both.
2. **Metabolic changes** (↑ catabolism and ↓ anabolism) due to inflammation and stress on cells.

Types of malnutrition:

Kwashiorkor adequate calories but not enough protein	Marasmus low calories and protein
Inadequate protein intake in the presence of fair to good calories intake in combination with the stress response Here, you get your calories from macromolecules other than proteins [lipids-fat, and carbohydrates] **Common causes:** Chronic kidney disease (limit protein intake[1]), Liver cirrhosis (unable to synthesize protein), trauma, burns, hemorrhage, and critical illness (need lots of protein to repairing) **Clinical manifestations:** • Marked hypoalbuminemia • Edema and ascites (low oncotic pressure) • Muscle atrophy • Delayed wound healing • Impaired immune function 	A severe protein-calorie malnutrition characterized by calories deficiency **Common causes:** Burns, injuries[2], systemic infections, **cancers** ...etc or conditions where the patient does not eat (e.g. anorexia nervosa and starvation). **Clinical manifestations:** • **Weight loss** the hall mark • Depletion of skeletal muscles and adipose tissue (fat) stores • Bradycardia • Hypothermia (compensatory mechanism to consume less calories) 

Malnutrition risk factors:

- **Medical causes:**
  - Recent surgery or trauma
  - Sepsis
  - Chronic illness
  - Eating disorders (e.g.anorexia)
  - Dysphagia
  - Recurrent nausea, vomiting, or diarrhea
  - Gastrointestinal disorders (e.g. IBD)
- Psychological: anorexia nervosa
- Social causes: poverty

Consequences of Malnutrition:

Pts come to the hospital for something and end up with something else due to malnutrition, pt who are malnourished even tend to develop more complications then other nourished pt, which will cause longer stay, higher cost, and medical complications like cardiac arrhythmias, GI bleeding, infection and respiratory failure.

- Increases risk for morbidity and mortality
- Longer recovery period from illnesses
- Impaired host immunity (infections)

Weight Loss Estimation

How do we say if the pt is malnourished? How do you classify it?

Significant weight loss: (unintentional)

- 10% of their weight in 6 month
- 5% of their weight in 1 month

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

[1] because they can't eliminate nitrogenous wastes which may lead to uremic syndrome

[2] some causes may overlap between the two conditions such as burns and trauma

Energy/Calorie Estimation

Basic Energy Expenditure (BEE):

Basically it's the amount of energy burned when your not physically active, energy used in breathing, ion transport, normal turnover of enzymes and other body components, etc.

- Basic energy expenditure, also called basal metabolic rate (**BMR**) is the rate of energy consumed to support the body's most basic functions when **at rest** in a neutral or non-stressful environment.
- BEE accounts for the largest portion of total daily energy requirements (up to **70%**)
- Can be calculated via **Harris-Benedict equation**:

BEE = 66 + (13.7 x weight) + (5 x height) - (6.8 x age)

BEE = 65.5 + (9.6 x weight) + (1.7 x height) - (4.7 x age)

Variables: gender, weight (kg), height (cm), age (years)

Total Energy Expenditure (TEE):

TEE (kcal/day) = **BEE** x **stress/activity factor** (a factor that estimates the extent of hypermetabolism)

نبي نحسب كم كالوري يحتاج مريض طريح فراش باليوم (TEE)؟ اول خطوة نحسب الـ BEE عشان نعرف هو بحاله الrest كم جالس يحرق؟ ثاني خطوة نضرب النتيجة بحالة المريض (مثلا مريض طريح فراش مو جالس يبذل اي مجهود غير عن مريض تروما يحتاج كالوريز أكثر للrepair) وهكذا

The activity factors	The stress factors
• 1.10 for patients on ventilator support • 1.15 for bedridden patients • 1.25 for patients with normal activity	• 1.3 for low stress • 1.5 for moderate stress • 2.0 for severe stress • 1.9-2.1 for burns

Example: a male 45 year old patient has weight of 50 kg and height 5.6 feet (175 cm), what's his TEE?

- First, calculate his BEE = 66 + (13.7 x 50kg) + (5 x 175) - (6.8 x 45) = 1320 kcal/day
- What's his TEE if he has normal activity. TEE = 1320 x 1.25* = 1650 kcal/day

*1.25 for normal activity

So this man needs 1650 kcal/day, anything more than that he's over eating and anything less he's not eating well.

Calorie Sources:

- 50 to **60%** of the caloric requirement should be provided as **glucose**
- The remainder 20-30% as **fat** (intralipid)
- 20% can be from **protein**
- To include protein calories in the provision of energy is controversial especially in parenteral nutrition

Protein Needs: The purpose of protein is to build muscles, enzymes and repair tissue.

- The average adult requires about 1.5 gm/kg or average of 100 grams of protein per day
- Stress or activity level Initial protein requirement (g/kg/day)
  - Baseline 1.5 g/kg/day (ideally intake)
  - Mild stress 1.8 g/kg/day (the more stressed the more protein needed)
  - Moderate stress 2.0 g/kg/day
  - Severe stress 2.2 g/kg/day

Fluid requirements: How much fluid should you be drinking? As much as you want as long you have a functional kidney and pee it out, but suppose a pt with renal impairment or CHF the requirement will be very different.

- The average adult requires approximately 35-45 ml/kg/day
- National Research Council (NRC) recommends 1 to 2 ml of water for each kcal of energy expenditure

- 4/2/1 formula: (per hour) *forgot ? check the IV fluid lecture
  - first 10 kg of body weight requires 4 ml/kg/h
  - second 10 kg 2 ml/kg/h
  - rest, each kg of body requires 1 ml/kg/h

- 100/50/20 formula: (per day)
  - 1st 10 kg 100 ml/kg
  - 2nd 10 kg 50 ml/kg
  - Rest 20 – 30 ml/kg

Routes of Nutrition support

The nutritional needs of patients are met through:

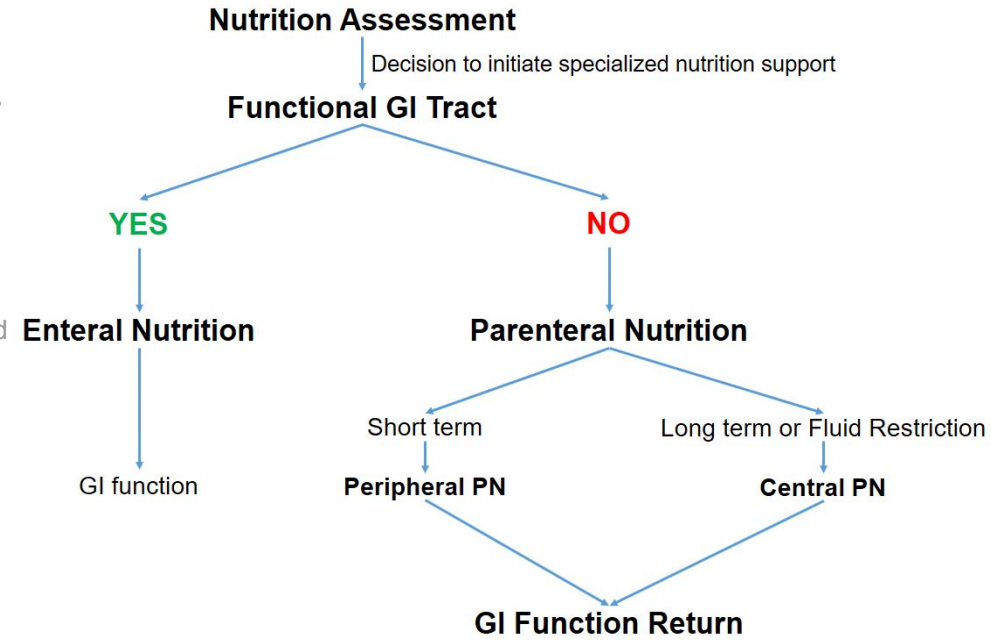
- **Parenteral (PN)**
- **Enteral (EN)**

"Enteral nutrition should be first choice for nutritional support in the critically ill surgical patient"

Very important ⇒

* **parenteral route** in case of GI obstruction, paralysis, crohn's disease, and cancer patients who suffer severe nausea and vomiting or after GI surgery to rest the GI e.g: severe pancreatitis

*short term = few days to 2 weeks



Enteral Nutrition:

enteral doesn't always mean taken by mouth, some pt in the ICU can;t take food orally but have functioning GI tract so we give them nutrition by NGT. Or in case of esophageal cancer you can't use the NGT! So what should we do? You put a tube directly into the stomach (gastrostomy tube)

- 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

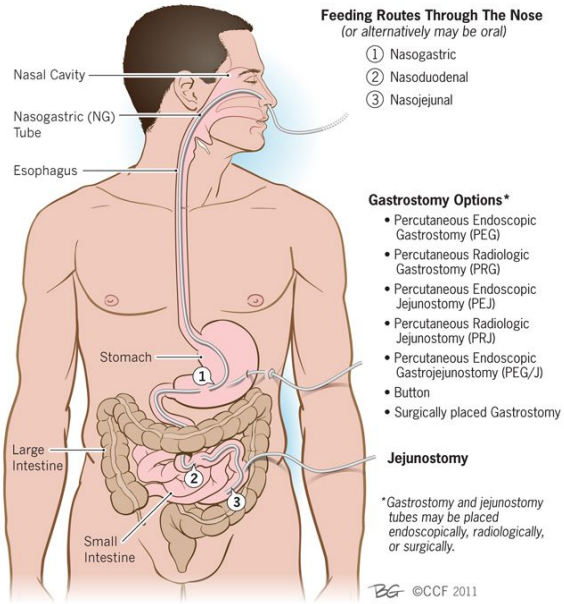
Rule of thumb: If the gut works, Use It. If the Gut Works Partially, use It Partially.

- 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 antiemetics, provision of adequate dental hygiene or artificial dentures).

Routes:

Short-term nutrition:

- Nasogastric feeding:
  *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
- Nasoduodenal feeding
- Nasojejunal feeding



Long-term nutrition:

Fore pts who require nutrition for long time, like pts with dysphagia, esophagus cancer or a stroke pt whos unable to swallow, they are on life long enteral feeding, so you won't put a NGT its may cause irritation and infection by time, you directly insert the tube in the GI tract.

- Gastrostomy e.g.: pseudobulbar palsy or oesophageal fistula
- Jejunostomy e.g.: gastric or duodenal fistula

Let's assume you put the tube in the stomach (gastrostomy tube) you can give large of amount of calories at one time, but if you put the tube in the duodenum (duodenostomy tube) you can't give large amount of calories (large volume) at once (the duodenum is much smaller than the stomach)

Types of Enteral Nutrition: only know the difference between Polymeric and Monomeric (the rest not imp)

Category	Subcategory	Characteristic	Indications
Polymeric: Basically normal food blended in the blender and put in the tube Real or **intact food** is provided to the patient through the tube → used when feeding the **stomach**	Standard	Similar to average diet	Normal digestion
	High nitrogen	Protein more than 15% of the diet	1. Catabolism 2. Wound healing
	Carbon dense	2 kcal/ml	1. Fluid restriction 2. Volume intolerance 3. Electrolyte abnormality
	Fiber containing	5-15 g/L of fibers	Regulation of bowel movement
Monomeric: Pt that has a tube in the duodenum (you bypass the stomach), what's the function of the stomach? To hydrolyze the intact food (you can't feed the intact food to the duodenum) you need to have a digested food partially or **predigested** food → used when feeding the **duodenum**	Partially hydrolyzed	1. Nutrients are hydrolyzed. 2. The composition varies.	Impaired digestion and absorption capacity
	Elemental		
	Peptide based		

Disease Specific Enteral Nutrition:

Let's say the pt is protein restricted, so he'll get a renal formula (↓ protein + ↓osmolarity + ↓electrolyte), VS a pt with respiratory disease should we give more carbs or fat? Think of it when glucose is metabolized it generates CO_2 and water, so in pt with respiratory disease having high amount of CO_2 is not good for them so most of their calories are generated from fat.

System	Disease	Recommendation
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**
Endocrine	**Diabetes Mellitus**	Low CHO
Immune	**Metabolic stress immune dysfunction**	Arginine, glutamine, omega 3 Fatty acids, antioxidants

Indications of Enteral Nutrition:

- Inability to eat adequate amounts to achieve goal nutritional intakes. Ex.dysphagia & stroke pt.(long time)
- Lack of bowel sounds, flatus, or bowel movement
- Refusal to eat/anorexia

Contraindications of Enteral Nutrition:

- Gastrointestinal obstruction
- Severe acute pancreatitis
- High-output proximal fistulas
- Intractable nausea/vomiting or osmotic diarrhea

Complications of Enteral Nutrition:

- Diarrhea
- Vomiting
- Aspiration pneumonia[3]
- Excessive infusion of nasogastric feed may cause marked abdominal bloating, resulting in splinting of the diaphragm and impaired respiratory function.

[3] since the patient is not moving, the food will move on to the lungs (Only with NGT)
[4] ICU morbidity and mortality classification: Grade A (Excellent), Grade B (Very good), Grade C (Good), Grade D (Fair), Grade E (Poor): 0

Parenteral Nutrition: Pts who can't orally needs to take it intravenous, parenteral nutrition is complete whole thing (carbs, fat, protein..) not as IV fluid which only contains electrolytes.

- 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)[4], 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.

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

General Indications of PN:

Let's say you have a pt with partial bowel obstruction, so you'll put the pt on NPO for couple of days to investigate to do or not to do the surgery, put the pt on IV fluid (mostly dextrose & NS), if investigation takes longer time (more than 5-7 days) the pt should be on parenteral nutrition.

- 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 (N/V), or **should** not eat (GIT obstruction).

Special Indications of PN:

- **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**
- Burns, sepsis, trauma, long bone fractures
- Premature newborn
- Renal, hepatic, respiratory, and cardiac failure (rarely)
- 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

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:

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** (for peripheral parenteral nutrition only)
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.

***Midline catheter, Femoral vein** and **Peripheral vein** catheters are **only** for **peripheral parenteral nutrition**

Central line VS Peripheral 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	• More complications
	• More Infections
	• Such as:
	  ○ Catheter sepsis
	  ○ Pneumothorax
	  ○ Catheter embolism
	  ○ Arterial laceration (tears or rupture)
		• Less complications
		• **Thrombophlebitis** (if high osmolarity)

Diet requirements in Parenteral Nutrition:

Glucose Requirement

- 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

Exp: our patient is 50 kg
5mg x 50kg x 60min x 24 hr =360 gm
360gm x 3.4 kcal/gm = 1224 kcal
Maximum cal from glucose = 1224 kcal
If more than 1224 Kcal the pt will be hyperglycemic

Protein Requirement

- 150 kcal to 6.25 gm of protein لكل 150 كالوري نحتاج 6.25 قرام بروتين

Exp: 1650 kcal/150 x 6.25 gm = 68.8 or 70gm

- 100 to 150 non protein calories to 1 gram of nitrogen to avoid protein catabolism
- approximately 1.3–1.5 g/kg in ideal body weight per day

Fat Requirement

Recommended allowance: 1-2.5 grams/kg/day
Exp: 2.5 x 50 kg = 125 gm
125gm x 9 kcal/gm = 1125 kcal

Electrolytes and Vitamins Requirements:

Electrolytes

- 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

Vitamins

- 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
• 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)

Complications of Total Parenteral Nutrition (TPN):

- ***Mechanical complications:***
  - Improper placement of catheter may cause pneumothorax, vascular injury with hemothorax, and cardiac arrhythmia.
  - Venous thrombosis after central venous access
  - Catheter sepsis
  - Catheter embolism
  - Arterial laceration

- ***Septic complications:***
  - 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

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

Early Metabolic Complications early in the process of feeding and may be anticipated	**Late Metabolic Complications** 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 (Vit K deficiency)
	Anemia

Summary:

- Nutritional support in the ICU (surgical setting) represents a challenge but it is fortunate that its delivery and monitoring can be followed closely.
- Parenteral (PN) represents an alternative approach when other routes are not succeeding or when it is not possible or would be unsafe to use other routes.
- The main goal of PN is to deliver a nutrient mixture closely related to requirements safely and to avoid complications.

The doctor didn't go through the rest, read it just in case.

1) Should we use (PN)? When should we start PN in patients?

Patients should be fed because starvation or underfeeding in ICU patients is associated with increased morbidity and mortality. (Grade C)

Reasons:

- Increased metabolic needs related to stress in ICU pt. are likely to accelerate the development of malnutrition which associated with impaired clinical outcome.
- In a randomized study, 300 patients undergoing major surgery received continuous total PN or exclusively glucose 250–300 g/d intravenous administration for 14 days.
- **Those on PN had 10 times less mortality than those on glucose.**

2) Should we wait for recovery and the ability of the patient to take normal nutrition or should we start PN in pt. who have not resumed normal intake within 10 days?

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.(Grade C).

Comments:

- 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.
- Tight glucose control can over come such infection in ICU.

3) Should we use central venous access or peripheral line for PN administration?

Peripheral venous access devices may be considered for low osmolarity (<850 mOsmol/L) mixtures designed to cover a proportion of the nutritional needs and to mitigate negative energy balance (Grade C).

If peripherally administered PN does not allow full provision of the patient's needs then PN should be centrally administered (Grade C).

Comments:

- PN is usually administered into a large-diameter vessel, normally the superior vena cava or right atrium, accessed via the jugular or subclavian vein.
- For longer-term ICU use,a tunneled-catheter or implanted chamber is occasionally used as alternatives to a standard central venous access device.
- PICCs were associated with a lower risk of CVC-associated BSI.
- Antimicrobial-impregnated CVC reduced the risk of CVC-associated BSI[4].
- PICC lines offer a suitable middle way between peripheral catheters & conventional central lines.

4) How much parenteral nutrition should critically ill patients receive?

ICU patients should receive: 25 kcal/kg/day increasing to target over the next 2–3 days (Grade C).

5) Carbohydrates: which level of glycemia should we aim to reach?

- Hyperglycemia (glucose >10 mmol/L) contributes to death in the critically ill pt and should also be avoided to prevent infectious complications (Grade B).
- Tighter glucose control (4.5-6.1 mmol/L) increases in mortality rates have been reported in ICU patients.
- No unequivocal recommendation on this is therefore possible at present.

6) Should we use lipid emulsions in the parenteral nutrition of critically ill patients?

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).

7) Is it safe to administer lipid emulsions (LCT without or with MCT, or mixed emulsions) and at which rate?

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)

8) How much should be administered to meet protein requirements?

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)

*4 pictures were in the slides but the doctor didn't mention them, check them here

[4] BSI: bloodstream infections

Recall :

What is the motto of surgical nutrition?
If the gut works, use it
What are the normal daily dietary requirements for adults of the following:

- **Protein =** 1 g/kg/day
- **Calories =** 30 kcal/kg/day

What are the calorie contents of the following substances:

- **Fat =** 9 kcal/g
- **Protein =** 4 kcal/g
- **Carbohydrate =** 4 kcal/g

What is the formula for converting nitrogen requirement/loss to protein requirement/loss?
Nitrogen X 6.25 = protein
Where is iron absorbed?
Duodenum (some in proximal jejunum)
Where is vitamin B12 absorbed?
Terminal ileum
What are the surgical causes of vitamin B12 deficiency?
Gastrectomy, excision of terminal ileum, blind loop syndrome
Where are bile salts absorbed?
Terminal ileum
Where are fat-soluble vitamins absorbed?
Terminal ileum
What are the signs of the following disorders:

- **Vitamin A deficiency:** Poor wound healing
- **Vitamin B12/folate deficiency:** Megaloblastic anemia
- **Vitamin C deficiency:** Poor wound healing, bleeding gums
- **Vitamin K deficiency:** Decrease in the vitamin K–dependent clotting factors (II, VII, IX, and X); bleeding; elevated PT

What are the vitamin K–dependent clotting factors?
2, 7, 9, 10 (think: 2+7=9, and then 10)
What is in TPN?
Protein Carbohydrates Lipids (H_2O, electrolytes, minerals/vitamins, insulin, H2 blocker)
How much of each in TPN:

- **Lipids =** 20% to 30% of calories
- **Protein =** 1.7 g/kg/day (10%–20% of calories) as amino acids
- **Carbohydrates =** 50% to 60% of calories as dextrose

What are the possible complications of TPN?
Line infection, fatty infiltration of the liver, electrolyte/glucose problems, pneumothorax during placement of central line, loss of gut barrier, acalculous cholecystitis, refeeding syndrome, hyperosmolarity
What is “refeeding syndrome”?
Decreased serum potassium, magnesium and phosphate after refeeding (via TPN or enterally) a starving patient
What is the major nutrient of the gut (small bowel)?
Glutamine

MCQS

1) Enteral nutrition is preferred over parenteral nutrition for all of the following reasons EXCEPT:

A. Lower risk of electrolyte abnormalities
B. EN is safer
C. EN provides Nitrogen
D. Stimulate gut function

2) Which one of the following options represents potential complications of enteral nutrition?

A. Osteoporosis and refeeding syndrome
B. Diarrhea and cholestasis
C. Esophagitis and pancreatitis
D. Aspiration

3) Which of the following nutritional strategies can prevent gut mucosal atrophy and subsequent bacterial translocation ?

A. Parenteral nutrition enriched with glutamine.
B. Parenteral nutrition with branched chain AAs.
C. Enteral nutrition.
D. Zinc supplementation.

4) Which of the following parenteral nutrition formula can be safely administered through peripheral catheter?

A. 10% dextrose and 3% amino acid .
B. 20% dextrose and 3% amino acid.
C. 10% dextrose and 10% amino acid.
D. 20% dextrose and 10% amino acid.

Answers:

1- C
2- D
3- C
4- A