PARENTERAL NUTRITION

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PARENTERAL NUTRITION

- PN is used to treat children that cannot be fully fed by oral or enteral route, for example due to severe intestinal failure

- intestinal failure occurs when the gastrointestinal tract is unable to ingest, digest and absorb sufficient macronutrients and/or water and electrolytes to maintain health and growth

- children differ from adults in that their food intake must provide sufficient nutrients not only for the maintenance of body tissues but also for growth

INDICATIONS

- **GIT DISEASES DIRECTLY ASSOCIATED WITH SURGICAL PROBLEMS:**

  Volvulus, intestinal malrotation, gastroschisis, omphalocele, tracheoesophageal fistula, diaphragmatic hernia, meconium ileus with peritonitis, multiple intestinal atresia, jejunostomy, etc.

- **BOWEL DISEASES**

  Infant intractable diarrhea, severe malabsorption, Hirschsprung's disease (with enterocolitis), nonspecific inflammatory disease (ulcerative colitis, Crohn's disease - especially fistulizing form), pseudomembranous colitis, necrotizing enterocolitis (NEC), chronic idiopathic pseudoobstruction (motility disorders), radiation enteritis, vascular events affecting the gastrointestinal tract (eg, ischemia / mesenteric thrombosis).

- **SHORT BOWEL SYNDROME (SBS)**

  SBS is defined as malabsorption resulting from anatomical or functional loss of a significant length of the small intestine. Most commonly this occurs after bowel resection in the newborn period (necrotizing enterocolitis, volvulus, multiple intestinal atresia, vascular events GIT). The amount of bowel that must be lost to produce malabsorption is variable and depends on which section(s) is/are lost, and whether the ileocecal valve is preserved.

INDICATIONS

NEC in premature neonates:

The minimum length of the intestine, which may be at a later age potentially sufficient for full enteral nutrition, is considered in the newborn: a) at least 30 cm of small intestine with preserved ileocecal (IC) valve and complete colon, b) at least 60-70 cm of small intestine without the IC valve and complete colon, c) 100 cm of small intestine without IC valve and subtotal resection of the colon.

- **HYPERMETABOLIC STATES:**

  Burns, polytrauma, sepsis.

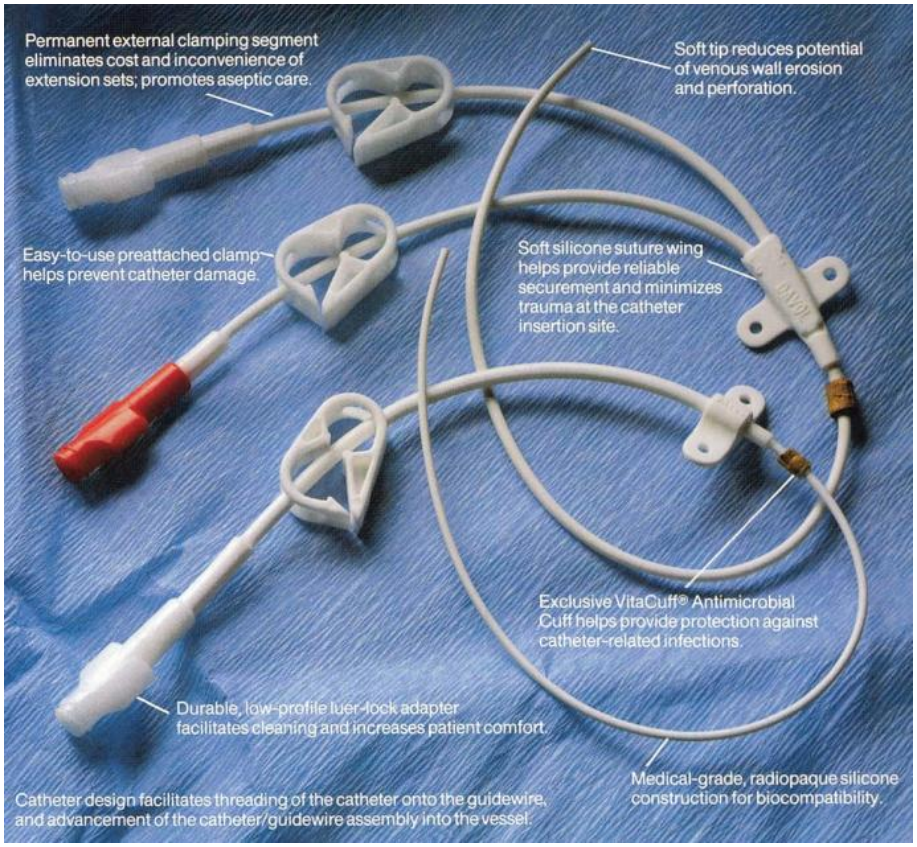
- **NEONATOLOGY:**

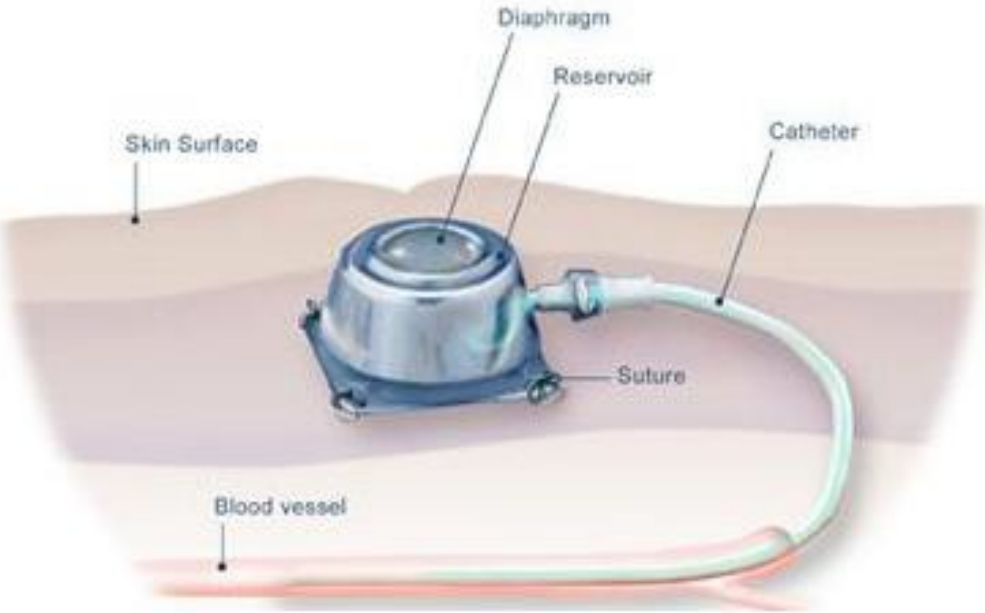
  Newborns with low birth weight, asphyxia, IRDS, necrotising enterocolitis.

- **OTHER INDICATIONS:**

  Renal failure, cardiac or hepatic failure, pancreatitis, oncological diseases, conditions after organ and bone marrow transplantation, anorexia nervosa, cystic fibrosis.

VENOUS ACCESS





CENTRAL VENOUS ACCESS DEVICE (CVAD)

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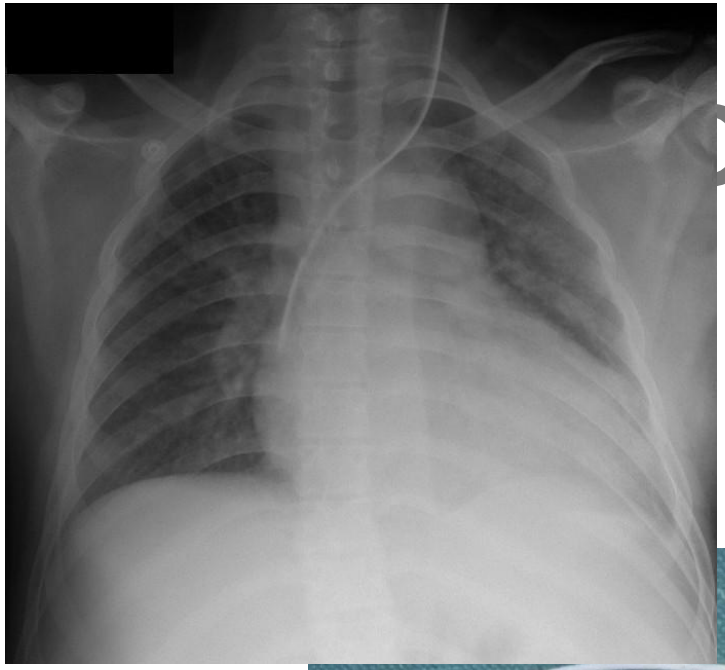
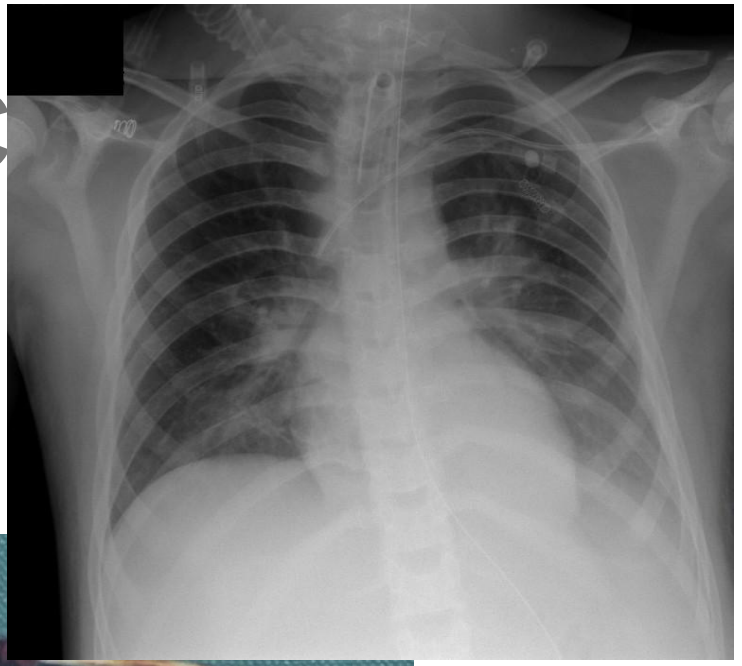
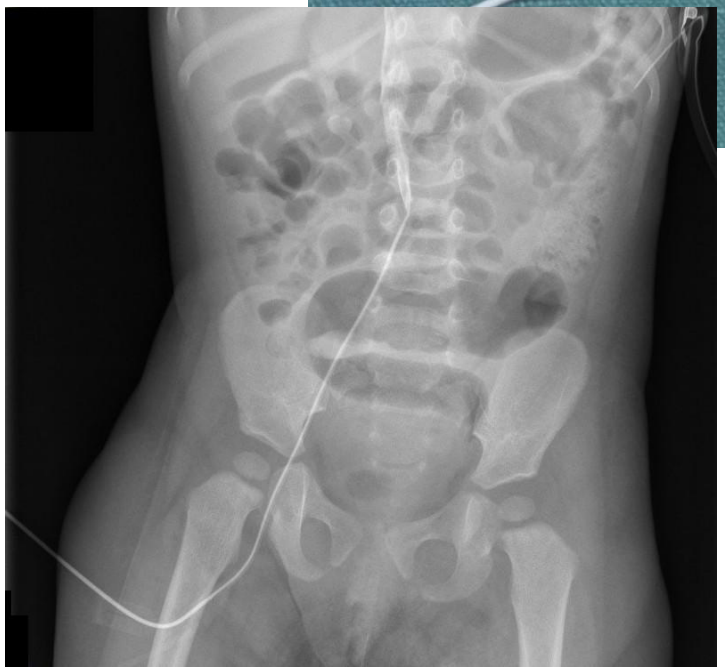


← v. jugularis

v. subclavia →





← v. femoralis

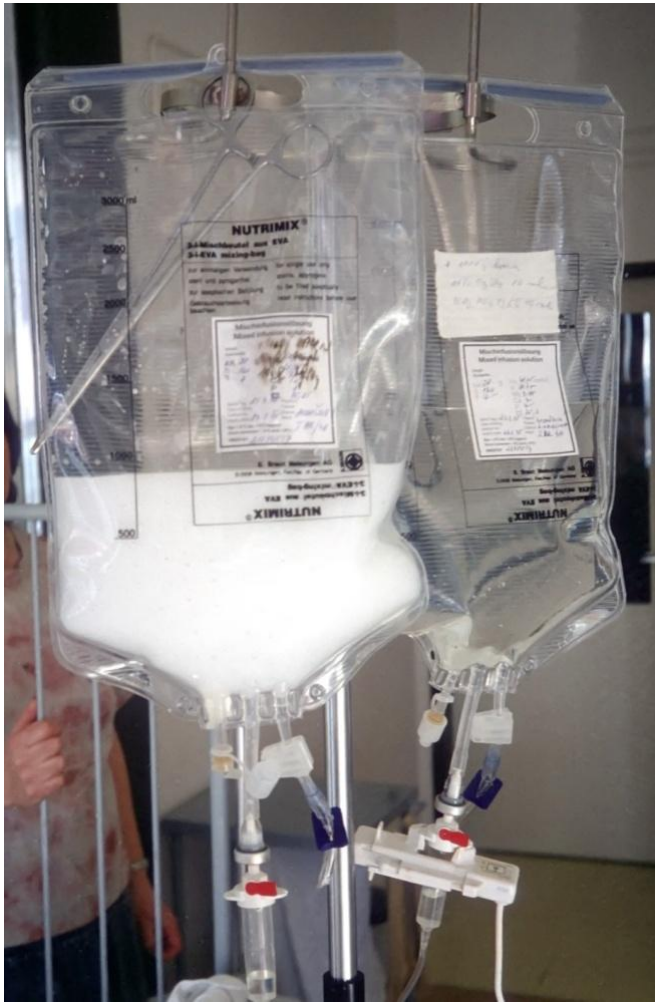
PORT →

The position of catheter is controlled by X-ray!

COMPOSITION OF PN

- currently are used AIO bags (all-in-one bags) containing all ingredients - carbohydrates, proteins, lipids, electrolytes, minerals, trace elements and vitamins

- the older system of parenteral nutrition "multi-bottle" (individual components are administered by separate routes) is not used routinely



FLUIDS IN PN

- **RECOMMENDED DAILY INTAKE OF FLUIDS:**

AGE	INTAKE OF FLUIDS [ml/kg/day]
1. day of life	50-70
2. day of life	70-90
3. day of life	80-100
4. day of life	100-120
5. day of life	100-130
1.-6. month of life	100-150
7.-12. month of life	100-120
2. year of life	80-120
3.-5. year of life	80-100
6.-10. year of life	60-80
11.-14. year of life	60-70

FLUIDS IN PN

- **RECOMMENDED DAILY INTAKE OF FLUIDS :**

  children 1-10 kg - 100 ml/kg

  children 10-20 kg - 1000 ml + 50 ml/kg for each kg over 10 kg

  children >20 kg - 1500 ml + 20 ml/kg for each kg over 20 kg

  + individual volume adjustment according to the clinical status:

  ↑ - fluid loss at temperatures (eg, increase in body temperature of one degree increases the need of fluids by 30%), diarrhea, osmotic diuresis, simultaneously performed phototherapy, stay on a heated bed,…

  ↓ - cardiac or renal insufficiency, muscular hypotonia, significant sedation, arteficial ventilation

- **MONITORING:**

  - body weight, fluid balance, clinical signs of hydration, presence of edema, laboratory parameters (including the determination of waste ions in urine and urine osmolality)

ELECTROLYTES, MINERALS

Electrolytes, minerals	Daily requirement [mmol/kg/day]
Sodium (Na)	3-5
Potassium (K)	1-3
Calcium (Ca)	0.1-1 (premature infants up to 3)
Magnesium (Mg)	0,1-0,5
Chlorides (Cl)	3-5
Phosphate (P)	0.5-1 (premature infants up to 2,5)

- **MONITORING:**

  plasma ions, waste ions in urine, markers of calcium-phosphate metabolism (levels of vitamin D, parathyroid hormone and alkaline phosphatase)

AMINO ACIDS (AA)

- 5%, **10% solutions** of amino acids containing all essential and nonessential AA
- **1 g of protein = 4 kcal**
- to protect the protein synthesis PN should contain enough non-protein energy (30-40 kcal of non-protein energy/ 1 g of amino acids)

- special amino acid mixtures - for example for patients with:

  - hepatic failure (higher proportion of branched chain amino acids (leucine, isoleucine and valine), reduced content of sulfur and aromatic amino acids, higher content of arginine)

  - renal insufficiency (higher proportion of tyrosine, lysine, threonine and branched-chain amino acids, reduced content of alanine, glycine and arginine)

  - sepsis, catabolic states, patients with cancer (higher proportion of branched-chain amino acids, lysine and arginine)

  MONITORING:

  - plasma levels of albumin, prealbumin, total protein, urea, ammonia

  - nitrogen balance, acid-base balance

  - in the longer term are significant anthropometric data

CARBOHYDRATES

- **5%, 10%, 20%, 40% solutions** of glucose (peripheral vein - max. 10-12% solution)
- **1 g of carbohydrates = 4 kcal**
- glucose is the main source of energy (for brain cells the only source of energy)
- glucose should cover 60-75% of non-protein energy sources

- **MONITORING:**

  - glycemia, glycosuria

  - hyperglycemia is usually due to excessive speed application glucose, impaired glucose tolerance is common in patients in septic conditions, after surgery or trauma

  - we recommend a half speed of application of PN during first / last 30 minutes (it eliminates the risk of hyperglycemia at the beginning and hypoglycemia after sudden termination of application of PN)

  - overintake of glucose leads to hyperglycemia, and possibly to hepatic steatosis due to increased lipogenesis, infectious complications are more often

LIPIDS

- usually **20% emulsions** (Soya oil, Medium-chain Triglycerides, Olive oil, Fish oil)
- **1 g of lipids = 9 kcal**
- energy intake of lipid sources should represent 25-40% non-protein energy
- the dose is increased gradually
- optimal use of lipids is cyclic (alternating applications of lipid and non-lipid AIO bags)

  - the risks resulting from excessive intake of lipids include hepatopathy and cholestasis (elevated liver enzymes and hyperbilirubinemia), rarely can be observed thrombocytopenia

  - therapeutic intervention for all these conditions is the reduction of the lipid component in PN;

  - lipids are withdrawn from PN during sepsis

- **MONITORING:**

  - levels of triglycerides, liver enzymes

Age	Amino acids [g/kg/day]	Glucose [g/kg/day]	Lipids [g/kg/day]	Energy [kcal/kg/day]
1st year	1.5-2.5	8-15	2-3	90-110
2nd year	1,5	12-16	2-3	80-100
3rd - 5th year	1,5	12	1-2	60-80
6th - 10th year	1,0	10	1-2	50-70
10th - 14th year	1,0	8	1	50-60

	The increasing of energy needs [%]
Fever	12% for each °C over 37°C
Heart failure	15-25%
Extensive trauma	20-30%
Sepsis	40-50%
Burns	100%
Long-term malnutrition	up to 200%

VITAMINS, TRACE ELEMENTS

- PN should include water-soluble and lipid-soluble vitamins and trace elements (zinc, copper, iron, chromium, iodine, cobalt, selenium). It is recommended to use commercially produced concentrates with a defined content of trace elements (Tracutil, Addamel, Peditrace) or vitamins (Cernevit, Soluvit, Vitalipid).

- when possible water and lipid soluble vitamins should be added to the lipid emulsion or a mixture containing lipids to increase vitamin stability

- **MONITORING:**

  - levels of vitamins and trace elements

COMPLICATIONS OF PN

- **A) complications of central venous catheters** (complications during catheter insertion, infection, occlusion, central venous thrombosis, pulmonary embolism, accidental removal or damage of CVC)

- **B) complications related to the stability of infusion solutions**

- **C) metabolic complications** (complications resulting from incorrect composition of infusion solutions - the amount of fluids, calories, nutrients, electrolytes, minerals, trace elements, vitamins, drug interactions)

- **D) complications affecting other organ systems** (hepatobiliary disease - Intestinal Failure Associated liver disease (IFALD), Metabolic Bone Disease (MBD) - calciophosphate metabolic disorder, growth failure, refeeding syndrome)

- **infant, 7 kg, after small surgical procedure - PEG (Percutaneous Endoscopic Gastrostomy) >>> prescribe parenteral nutrition**

- FLUIDS
  150 ml/kg/day - 1000 ml
- WHICH TYPE OF SOLUTION?
  10% glucose (CARBOHYDRATES) - 1000 ml (total volume of the infusion)
  (100 g of glucose/day ….. 15 g/kg/day)
- AMINO ACIDS
  10% Primene
  1.5 g/kg/day
  - 100 ml
- LIPIDS
  X
- Na
  5.8% NaCl (1 ml ...1 mmol Na)
  4 mmol/kg/day
  - 28 ml
- K
  7.5% KCl (1 ml ...1 mmol K)
  2 mmol/kg/day
  - 14 ml
- Ca
  10% Ca gluconate (1 ml … 0,25 mmol Ca)
  0.1-0.2 mmol/kg/day
  - 5 ml

- **infant, 7 kg, after small surgical procedure - PEG (Percutaneous Endoscopic Gastrostomy) >>> prescribe parenteral nutrition**

Total volumes of solutions/ 24 hours

10% glucose	853 ml [1000-(100+28+14+5) ml]
10% Primene	100 ml
5.8% NaCl	28 ml
7.5% KCl	14 ml
10% Ca gluconate	5 ml

x 500 ml infusion bottles

> 2 bottles:

10% glucose	430 ml
10% Primene	50 ml
5.8% NaCl	14 ml
7.5% KCl	7 ml
10% Ca gluconate	2.5 ml

speed

1000 ml/ 24 hours > 40 ml/hour