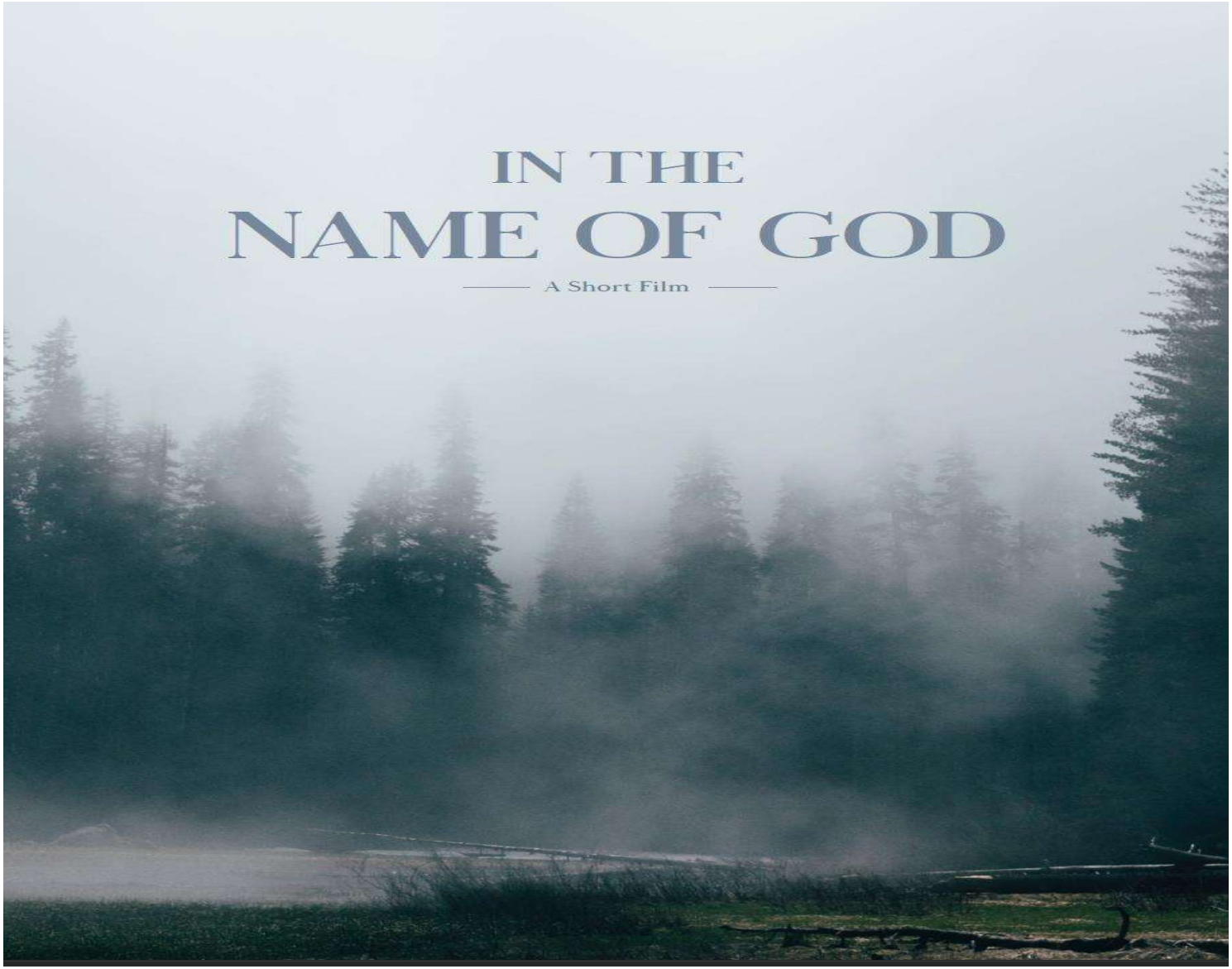
IN THE
NAME OF GOD
A Short Film

PARENTERAL NUTRITION IN INFANTS AND CHILDREN

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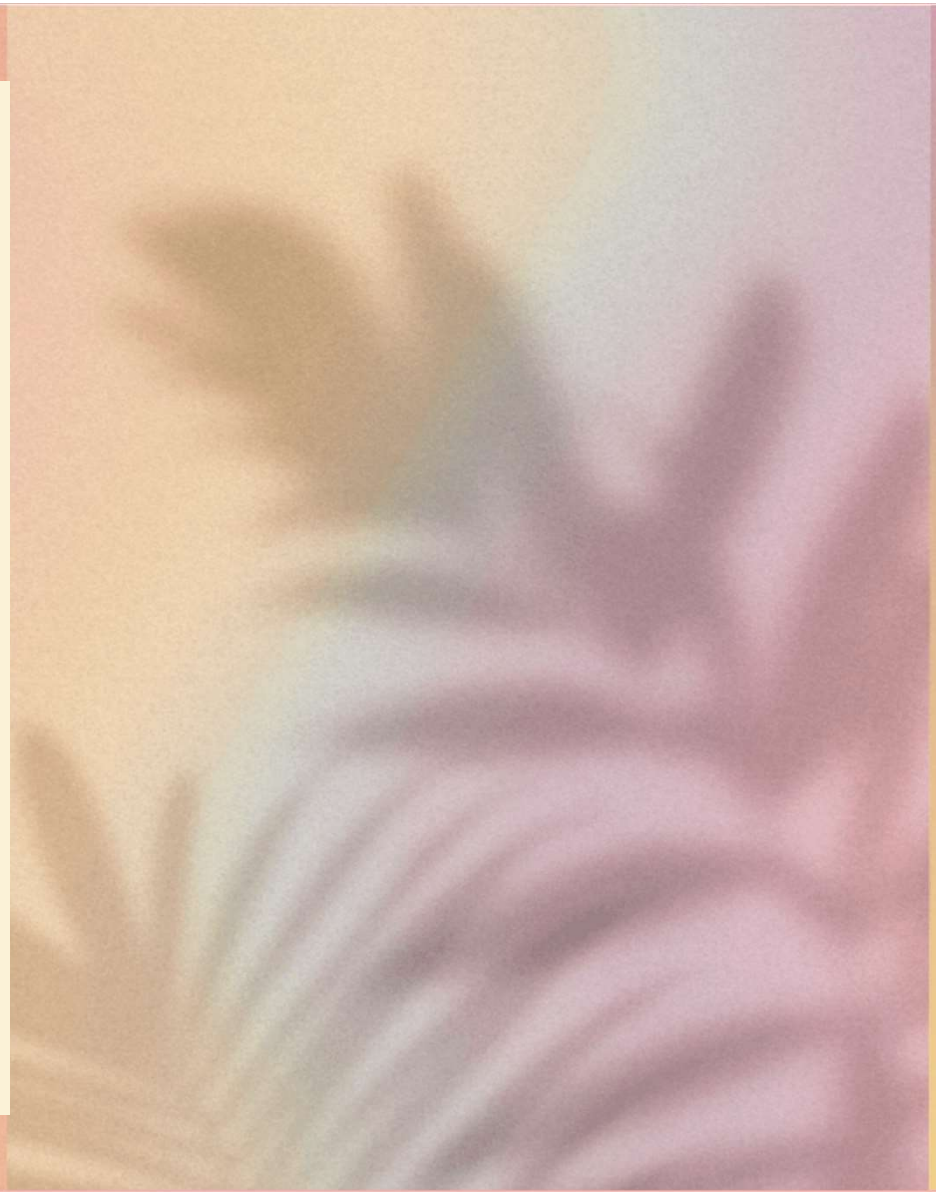
ISFAHAN UNIVERSITY OF MEDICAL SCIENCES
JUNE 2024

- PN should be used only when it is not possible to meet nutritional requirements via the GI tract for a prolonged time.
- Enteral nutrition has several physiologic advantages as compared with PN and generally has fewer complications.
- Changes in the gastrointestinal (GI) luminal contents, GI function, metabolic abnormalities, cholestasis, liver compromise, and blood stream infections were reported in PN.

- Rarely, the GI tract cannot be accessed, and all nutrients must be delivered via the parenteral route; this is known as **total parenteral nutrition (TPN)**.

- **TPN** is ***the last resort*** when oral intake, enteral feeding, and the combination of partial PN and enteral feeds are not possible.



INDICATIONS FOR PARENTERAL NUTRITION IN CHILDREN

Partially functioning gastrointestinal tract
Cannot meet nutritional requirements after maximizing enteral support
Burns
Multi-organ failure
Malabsorption
Short bowel syndrome
Chronic intractable diarrhea
Congenital small bowel malabsorptive syndromes such as congenital chloride diarrhea, tufting enteropathy, or microvillus inclusion disease
Pseudo-obstruction
Severe malnutrition with hypoproteinemia and bowel edema
Nonfunctional gastrointestinal tract
Paralytic ileus
Small bowel ischemia
Necrotizing enterocolitis
Gastrointestinal surgery
Gastroschisis, omphalocele, gastrointestinal atresias (parenteral nutrition is indicated until the enteral route is functional and accessible)

- PN is indicated for infants and children who are unable to be fed enterally if nutritional support is expected to be required for seven days or more.
- Well-nourished children or adolescents tolerate up to seven days without nutrition support
- Adults can tolerate 7 to 10 days without nutrition support
- PN should not be used for short periods of time, because the risks can outweigh benefits
- The appropriate time for initiating PN should be individualized and depends on individual patient characteristics.

WHEN EXTRA CAUTION SHOULD BE USED…..

- PN should only be used in patients who **are hemodynamically stable** and are **able to tolerate the necessary fluid**.
- PN should be used with **particular caution** for children with electrolyte imbalance, renal or hepatic compromise, metabolic acidosis, or alkalosis.
- **Acid-base and electrolyte abnormalities should be corrected prior to starting PN, or corrected by infusions through a separate intravenous line.**
- **PN should not be used to correct metabolic imbalances**.

CENTRAL AND PERIPHERAL VENOUS ACCESS

- PN can be administered through a peripheral or a central vein.
- Central venous access is defined as a catheter whose distal tip lies in the distal vena cava or right atrium
- To avoid cardiac tamponade, there is some evidence that the catheter tip should lie outside of the pericardial sac, especially in premature babies

CENTRAL AND PERIPHERAL VENOUS ACCESS

- The maximum osmolarity that can be delivered via a peripheral vein is **900 mOsm/L**
- The osmolarity of a PN solution equation:

$$\text{MOsm/L} = (\text{Grams amino acids/L} \times 10) + (\text{Gram's dextrose/L} \times 5) + ([\text{mEq Na} + \text{mEq K}] \times 2)/\text{L} + (\text{mEq Ca} \times 1.4)/\text{L}$$

- If an infant or child is likely to need parenteral nutritional support for **more than two weeks**, a central venous catheter should be placed

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- The osmolarity of a PN solution equation:

MOsm/L= (Grams amino acids/L×10) + (Gram's dextrose/L × 5) + ([mEq Na + mEq K] × 2)/L + (mEq Ca × 1.4)/L

- Given this osmolarity restriction, central venous access will be required to meet the child's full nutritional needs
- If an infant or child is to need parenteral nutritional support for more than two weeks, a central venous catheter should be placed

CENTRAL AND PERIPHERAL VENOUS ACCESS

Percutaneous nontunneled central catheters

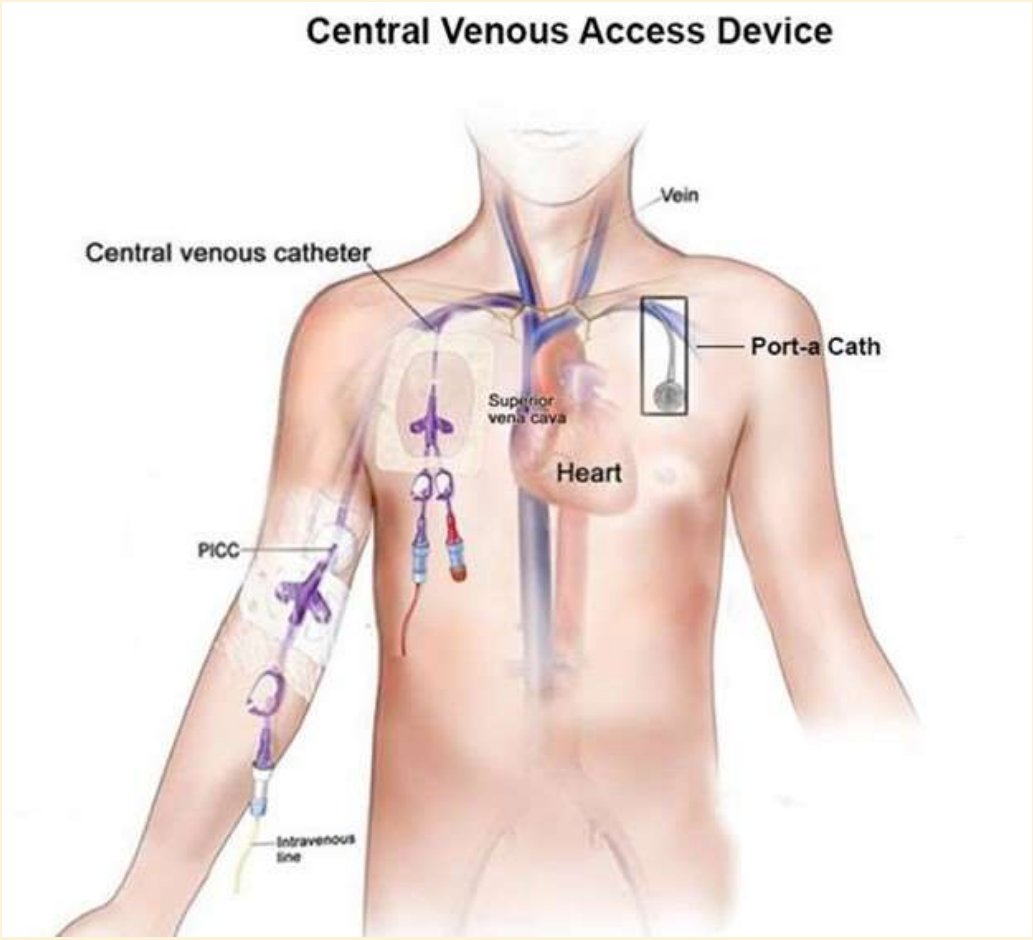
- This type of catheter is most appropriate for **short-term PN of one to two weeks**.
- These catheters are **easily** removed and can be replaced over a guide wire;
- however, they are associated with **a high infection rate** especially those placed via **the femoral vein**.

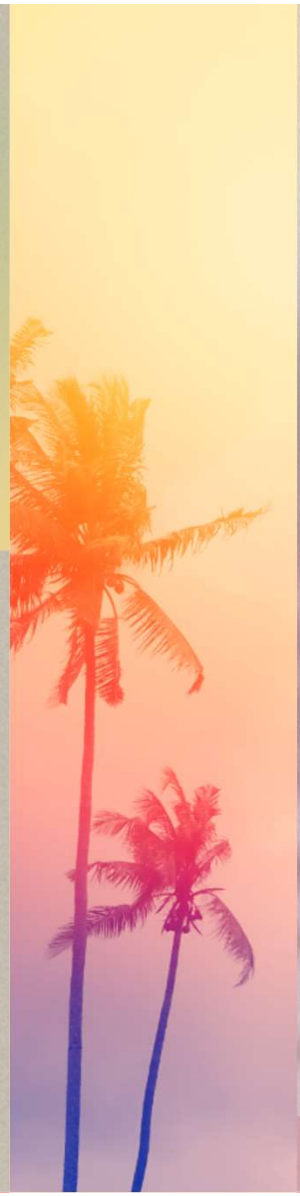
Tunneled cuffed central catheters

- These catheters are **placed surgically**
- This type of catheter is appropriate for **long-term PN** including home PN.

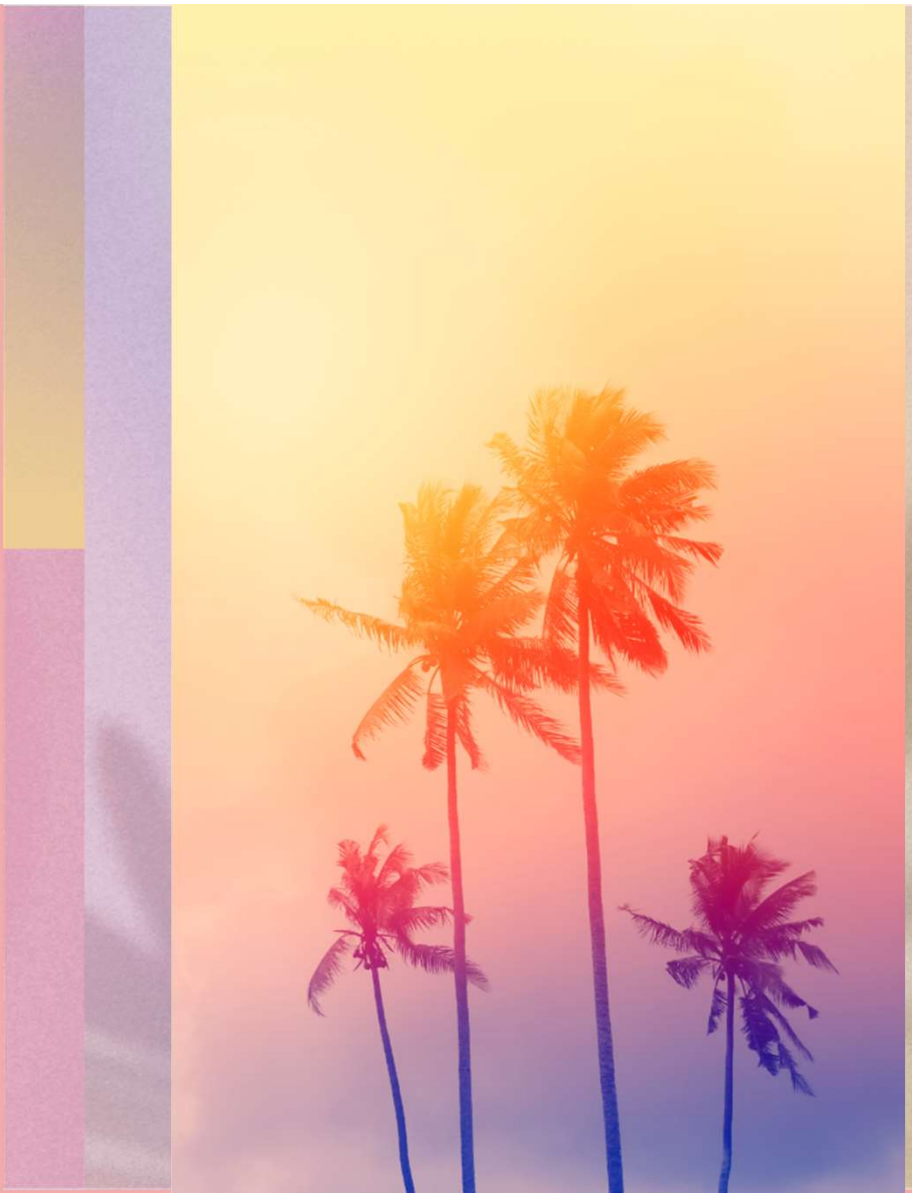
Peripherally inserted central catheters (PICC)

- These can be placed via any peripheral vein but are typically placed **via the antecubital vein**.
- PICC lines are appropriate for **medium-term use**, up to several months.
- The major advantage of PICC lines is the ease with which they can be inserted.
- Because of errors in estimates of insertion length, it is important to **confirm** central positioning of line.


Central Venous Access Device
Vein
Central venous catheter
Port-a Cath
Superior vena cava
Heart
PICC
Intravenous line



- For all catheters that are intended to end centrally, imaging is required to confirm tip position.
- Many centers are employing daily ethanol lock therapy in an attempt to decrease bloodstream infections.
- Typically, enough 70% ethanol to completely fill the catheter is instilled during a time when the catheter is not being used for PN.
- The ethanol is allowed to remain in the catheter for four hours and then removed.
- There is weak evidence that ethanol lock therapy reduces blood stream infections in PN associated liver disease and intestinal failure
- Ethanol lock therapy is associated with greater risk of thrombus and shortens the life of the catheter



STEPS FOR INITIATING PARENTERAL NUTRITION

1-NUTRITIONAL ASSESSMENT AND ANTHROPOMETRICS

- The most important components of a nutritional assessment are accurate measurements of weight and length or height.
- For infants 0 to 24 months, these are used to calculate weight for length
- For children 24 months and older, they are used to calculate body mass index (BMI).
- Using weight-for-height Z-scores or percentile in children younger than two years or BMI-for-age Z-scores or percentile in older children

Calculator: Body mass index (BMI) percentiles and Z-scores, females 2 to 20 years (CDC)

Contributors Disclosures Date

Calculator: Body mass index (BMI) percentiles and Z-scores, females 2 to 20 years (CDC)

Input

Age		yr
Height		cm
Weight		kg

Results

Important: Inputs must be complete to perform calculation.

BMI		kg/m^2
Z-score		
Percentile		

Decimal precision 1

Reset form

BMI FOR CHILDREN AND TEENS, AGE 2-20

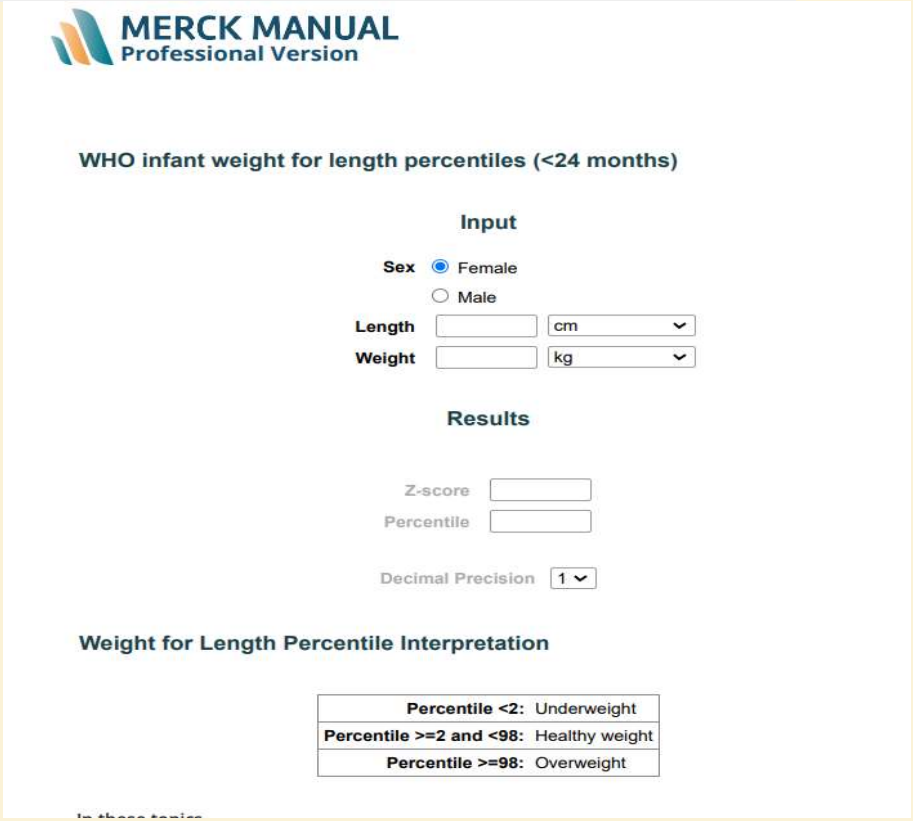
- +2<BMI Z-score<-2 is Normal Range

- For BMI≥30 OR BMI Z-score ≥ +2 OR BMI percentile ≥ 95% Considered Ideal Body Weight (IBW)

Category	Percentile Range
Underweight	<5%
Healthy weight	5% - 85%
At risk of overweight	85% - 95%
Overweight	>95%

Weight for Length Interpretation for infants 0 to 24 months

- +2< Z-score<-2 is Normal Range
- Percentile ≥ 2 and <98 is healthy



2-INITIATION AND MONITORING

- Prior to initiating PN, goals for fluids, energy, protein, carbohydrate, fat, electrolyte, mineral, and trace elements are set based on the patient's individual needs

- Anthropometric and laboratory measures must be obtained at baseline and repeated periodically after PN treatment is begun to monitor the patient and adjust the PN prescription as needed

- Any significant fluid and electrolyte disturbance should be corrected with separate intravenous fluids administered via separate venous access.

-

CONTINUED….

- If hypophosphatemia is present, it should be corrected before PN is initiated because the dextrose in the PN solution will cause an intracellular shift of phosphorus that will further decrease the serum phosphorus level.

- Similarly, children with malnutrition typically require phosphorus and calcium repletion in quantities that cannot be accommodated in a single PN solution, so additional venous access usually is required

Parameter	Suggested frequency	
	Initial/hospitalized	Follow-up/home
Growth		
Weight	Daily	Daily to monthly
Height	Weekly	Weekly to monthly
Head circumference	Weekly	Weekly to monthly
Triceps skin fold	Monthly	Monthly to annually
Mid-arm muscle circumference	Monthly	Monthly to annually

Serum*		
Electrolytes	Daily to weekly	Weekly to monthly
BUN, creatinine	Weekly	Monthly
Calcium, phosphorus, magnesium	Twice weekly	Weekly to monthly
Acid-base status (venous bicarbonate)	Until stable	Weekly to monthly
Albumin	Weekly	Weekly to monthly
Prealbumin ¶	Weekly	Monthly
Glucose	Daily to weekly	Weekly to monthly
Triglycerides	Daily while increasing lipid	Weekly to monthly
Liver function tests (AST, ALT, GGTP, and alkaline phosphatase)	Weekly	Weekly to monthly
CBC and differential	Weekly	Weekly to monthly
Platelets	Weekly	Weekly to monthly
PT, PTT, INR	Weekly	Weekly to monthly
TSH Δ	As indicated	Every 6 months
Iron indices ◊	As indicated	Biannually to annually
Trace elements §	As indicated	Biannually to annually
Fat-soluble vitamins ¥	As indicated	Biannually to annually
Carnitine	As indicated	As indicated
Ammonia	As indicated	Biannually to annually
Blood culture from central venous catheter	As indicated	Biannually to annually
CRP or ESR	As indicated	As indicated

3-FLUIDS REQUIREMENTS

- Parenteral fluid guidelines are based on **estimates of needs to maintain normal hydration** and adjusted for increased or decreased losses as necessary.
- **The Holliday-Segar method** is most commonly used to calculate maintenance needs
- Infants and children generally require **at least 115 mL of fluid per 100 kcal** of energy provided
- **Most patients can tolerate fluid administration at 30 to 50 percent above maintenance needs**

Daily Routine Maintenance Fluid	
1st 10kg of Bodyweight	100 mL/kg/day
2nd 10kg of Bodyweight	50 mL/kg/day
For each kg over 20kg of Bodyweight	20 mL/kg/day
Maximum: 2000mL for females, 2500mL for males	

4 – 2 – 1 Rule

	mL Requirements
< 10 kg	4 mL/kg/hr
10-20 kg	40 mL/hr + 2 mL/kg/hr for every kg between 10-20 kg
> 20 kg	60 mL/hr + 1 mL/kg/hr for every kg > 20 kg

- Be aware first 10 kg only give 96 mL/kg/day
- Why some slight differences between two methods

CONTINUED….

Many factors affect individual fluid requirements

- **Age**
- **Disease state:** cardiac disease, bronchopulmonary dysplasia, head trauma, renal failure
- **Hydration status :** GI losses should be measured and replaced separately from the PN prescription
- **Insensible water losses:** fever increases insensible losses by 5 mL/kg/day for each degree of temperature >38, extensive burns, low humidity, high respiratory rate,…

Volume of PN

- PN part of maintenance fluids
- PN total volume =

  (Total 24hr fluids – fluids from drips

  – intravenous fat emulsions – feeds)

4-ENERGY REQUIREMENTS

A practical approach to determining **Resting Energy Expenditure (REE)** is based on the patient's age and weight:

- Term infants <6 months – 85 to 105 kcal/kg/day
- ≥6 to 12 months – 80 to 100 kcal/kg/day
- ≥1 to 7 years – 75 to 90 kcal/kg/day
- ≥7 to 12 years – 50 to 75 kcal/kg/day
- ≥12 to 18 years – 30 to 50 kcal/kg/day

5-PROTEIN REQUIREMENTS

Targets for protein intake for pediatric patients with normal organ function for age are:

- Infants (1 to 12 months) – 2 to 3 g/kg/day
- Children (>10 kg, or age 1 to 10 years) – 1 to 2 g/kg/day
- Adolescents (11 to 17 years) – 0.8 to 1.5 g/kg/day

CONTINUED….

- Once the protein target is determined, the caloric content of the amino acid solution is calculated as a component of the total energy input
- PN solutions formulated with crystalline amino acids provide 4 kcal/g
- Available concentrations of stock solutions range from 3 percent to 15 percent, with 10 percent most frequently used

6-FAT REQUIREMENTS

- Between 20 and 50 percent of energy needs in PN are provided as fat, in the form of an intravenous lipid emulsion (ILE).
- ILE is initially prescribed to provide fat at 0.5 to 1 g/kg/day ,can be advanced to 3 g/kg/day (or 2 g/kg/day for older children)
- A rare syndrome including acute respiratory distress, metabolic acidosis, and death has been associated with rapid ILE infusions, especially in infants
- This risk is minimized by gradual advancement to target rates and intermittent monitoring of triglycerides

CONTINUED….

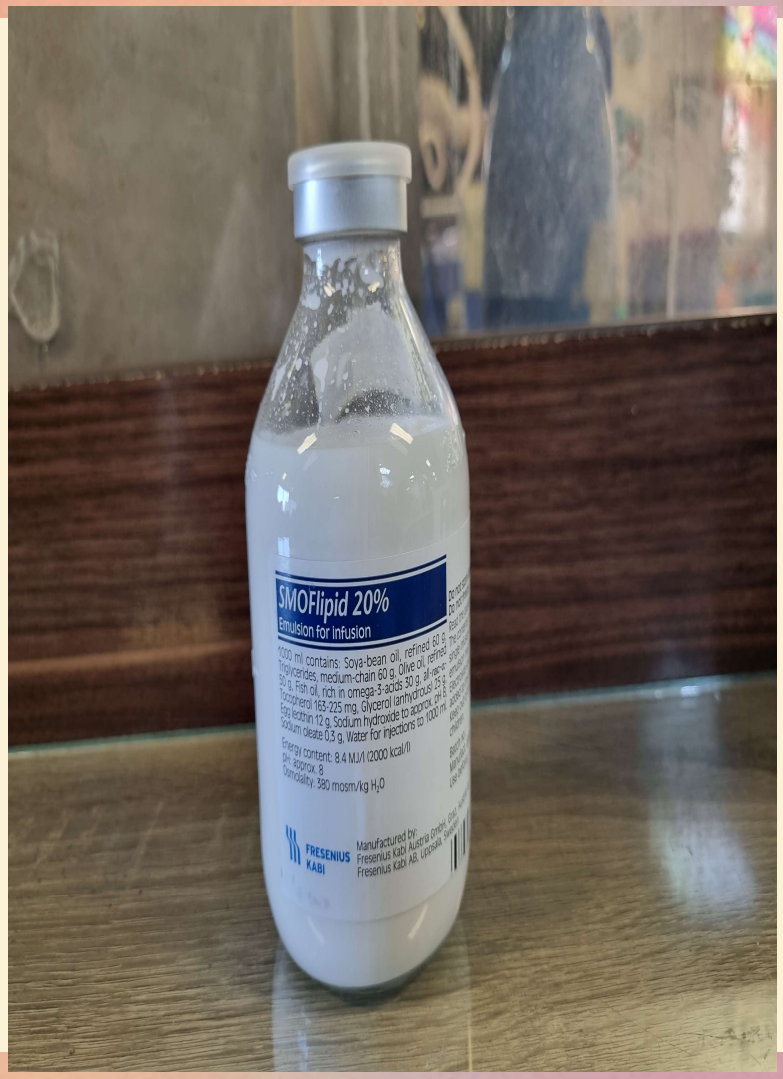
- The total calories supplied by fat are calculated using the factor 10 kcals/gram of lipid, or 2 kcal/mL for a 20 percent ILE.
- ILE are sources of essential fatty acids (EFAs; primarily linoleic and linolenic acids)
- Carnitine is not present in PN solutions, yet it is necessary for transport and metabolism of long-chain fatty acids.
- Carnitine supplements should be added to PN for patients on PN longer than two months, at a dose of 2 to 5 mg/kg/day.

CONTINUED….

- **Soybean oil-based lipid emulsions** rich in omega-6 fatty acids, which have the advantage of supplying EFAs, but may be associated with increased inflammation and liver injury, especially in infants on total parenteral nutrition
- **Fish oil-based lipid emulsion (Omegaven),** contain omega-3 fatty acids, which have anti-inflammatory properties, but provides minimal amounts of EFA

- **A mixed soybean, medium-chain triglyceride, olive, and fish oil lipid emulsion(SMOFLipid),** has been developed and suggests that it may delay progression of liver injury


SMOFlipid 20%
Emulsion for infusion
1000 ml contains: Soya-bean oil, refined 60 g, Triglycerides, medium-chain 60 g, Olive oil, refined 50 g, Fish oil, rich in omega-3-acids 30 g, all-rac-α-Tocopherol 163-225 mg, Glycerol (anhydrous) 25 g, Egg lecithin 12 g, Sodium hydroxide to approx. pH 8, Sodium oleate 0,3 g, Water for injections to 1000 ml
Energy content: 8.4 MJ/l (2000 kcal/l)
pH: approx. 8
Osmolality: 380 mosm/kg H_2O
FRESENIUS KABI
Manufactured by:
Fresenius Kabi Austria GmbH,
Fresenius Kabi AB, Uppsala,


SMOFlipid 20%
Emulsion for infusion
FRESENIUS KABI

CONTINUED….

- Maximum rate should not exceed 0.1 g/kg/hour.
- Duration of infusion is from 12 to 24 hours, depending on clinical situation.
- Triglyceride levels as high as 100 to 150 mg/dL are well tolerated.
- Dose of ILE should be reduced if the triglyceride levels are consistently in excess of 150 mg/dL
- If triglycerides > 200mg/dL, then hold lipids for 4 hours, and recheck. If triglycerides remain elevated, consider decreasing intravenous lipid emulsion rate

6-CARBOHYDRATES REQUIREMENTS

- Glucose is the only source of carbohydrate in PN and provides 40 to 60 percent of total calories
- It is provided in a monohydrous form (dextrose monohydrate), which has a caloric concentration of 3.4 kcal/g
- Glucose is available in stock solutions of 5 to 70 percent, as dextrose monohydrate
- Concentrations greater than 12.5 percent must not be used in a peripheral vein, because the high osmolarity can damage veins.
- Central lines can accommodate a maximum concentration of 25 percent glucose.

CONTINUED….

- Energy from carbohydrates =Total energy needs – Energy from protein – Energy from fats
- Grams glucose = Energy (kcals) from carbohydrates ÷ 3.4 kcal/g
- Glucose infusion rate (GIR) should also be calculated, to ensure that the hourly carbohydrate dose is in an appropriate range
- Calculate Dextrose Percent after mixing and making solution

Calculation of the glucose infusion rate for parenteral nutrition

1. Calculate grams of glucose in the parenteral nutrition prescription	Energy (kcals) from carbohydrates ÷ 3.4 kcal/g = g glucose
2. Convert to milligrams of glucose	G glucose × 1000 = mg glucose
3. Calculate milligrams of glucose per kilogram	Mg glucose ÷ body weight (kg) = mg glucose/kg
4. Calculate milligrams of glucose per kilogram per minute = **GIR**	Mg glucose/kg ÷ minutes of infusion = mg glucose/kg/minute (where minutes of infusion = 1440 if infusion is continuous over 24 hours)

CONTINUED….

- **Adequate quantities of glucose are important** because at glucose infusions <2 mg/kg/min, body fat is mobilized for energy and ketosis occurs.

- It is also important to avoid excessive glucose; an excessive GIR can cause **hyperglycemia**, **hyperosmolarity**, and **osmotic diuresis**.
- Excessive glucose can increase the risk of **hepatic steatosis**

CONTINUED….

- A healthy child can tolerate a GIR of 12 to 14 mg/kg/min, but an ill or malnourished child may not.

- Glucose should be initiated in an incremental fashion while monitoring for hyperglycemia (blood glucose >200 mg/dL) and glucosuria.

Macronutrient guidelines for initiation and advancement of parenteral nutrition in children

Age group	Carbohydrate/dextrose *	Protein/amino acid ¶	Fat/lipid
<1 year	▪ Initial – 6 to 8 mg/kg/min ▪ Goal – 10 to 14 mg/kg/min	▪ Initial – 2 to 3 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 3 g/kg/day	▪ Initial – 0.5 to 1 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 3 g/kg/day
1 to 10 years	▪ Initial – 10 to 12.5% ▪ Daily increase – 5% increments (maximum 15 mg/kg/min)	▪ Initial – 1 to 2 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 2.5 to 3 g/kg/day	▪ Initial – 1 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 3 g/kg/day
>10 years	▪ Initial – 10 to 15% ▪ Daily increase – 5% increments (maximum 8.5 mg/kg/min)	▪ Initial – 1 to 1.5 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 1.5 to 2 g/kg/day	▪ Initial – 1 g/kg/day ▪ Daily increase – 1 g/kg/day ▪ Maximum – 2.5 g/kg/day

* Carbohydrate intake is given as the glucose infusion rate (GIR), in mg/kg/minute. Refer to topic text for explanation of how to calculate the GIR.

¶ Starting protein intake at the low end of the range and then advancing is generally recommended. This is out of caution because there is no good evidence suggesting the need to limit initial protein to less than calculated needs.


50 mL Single dose vial
Rx only
20% DEXTROSE
Injection,USP
10g in 50mL (0.2g/mL)
Each mL contains:
Dextrose anhydrous 0.2g,
Water for injection
Solution for intravenous use
Store at 20°c to 25°c


10%


50 mL
50% Dextrose
Injection, USP
25 grams/50 mL

7-ELECTROLYTES REQUIREMENTS

Daily electrolyte and mineral requirements for parenteral nutrition in pediatric patients

Electrolyte	Preterm neonates	Infants/children	Adolescent
Sodium	2 to 5 mEq/kg (2 to 5 mmol/kg)	2 to 5 mEq/kg (2 to 5 mmol/kg)	1 to 2 mEq/kg (1 to 2 mmol/kg)
Potassium	2 to 4 mEq/kg (2 to 4 mmol/kg)	2 to 4 mEq/kg (2 to 4 mmol/kg)	1 to 2 mEq/kg (1 to 2 mmol/kg)
Calcium*	2 to 4 mEq/kg (1 to 2 mmol/kg)¶	0.5 to 4 mEq/kg (0.25 to 2 mmol/kg)¶	10 to 20 mEq (5 to 10 mmol)¶
Phosphorus*	1 to 2 mmol/kg	0.5 to 2 mmol/kg	10 to 40 mmol
Magnesium	0.3 to 0.5 mEq/kg (0.15 to 0.25 mmol/kg)	0.3 to 0.5 mEq/kg (0.15 to 0.25 mmol/kg)	10 to 30 mEq (5 to 15 mmol)

SODIUM

- Calculate 30-150 meq/l for sodium in maintain fluid by Nacl 5%

- 1 mL 0f Nacl 5%= 0.8 meq Na
- 2-5 meq/kg/day
- 2.5-6.25 cc/kg/day

- Check daily requirement

POTASSIUM

- Calculate 20 meq/l for potassium in maintain fluid by Kcl 15%

- 1 mL 0f kcl 15%= 2 meq K
- 2-4 meq/kg/day
- 1-2cc/kg/day

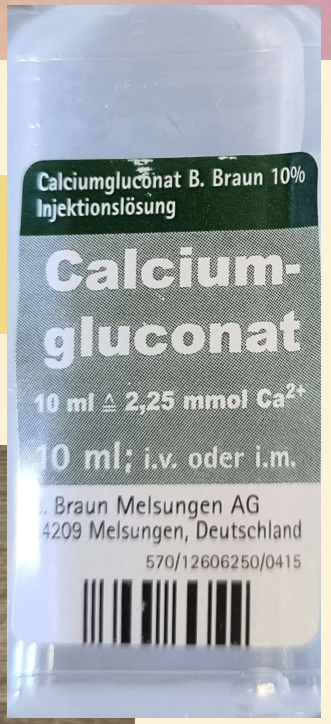
- Check daily requirement

CALCIUM

Calcium gluconate 10%:

- Conversions: 1 mEq elemental calcium (20 mg) = 0.5 mmol = 215 mg calcium gluconate salt= 2 ml

- **0.5-4 meq/kg/day**
- **1-8 cc/kg /day**
- **Maximum dose in each injection:10cc=5meq=2.2mmol**
- **Maximum dose/day :60 cc**

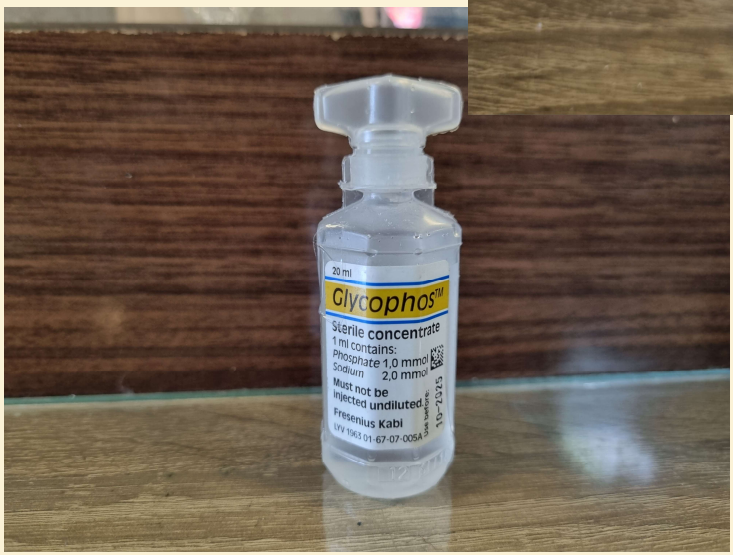


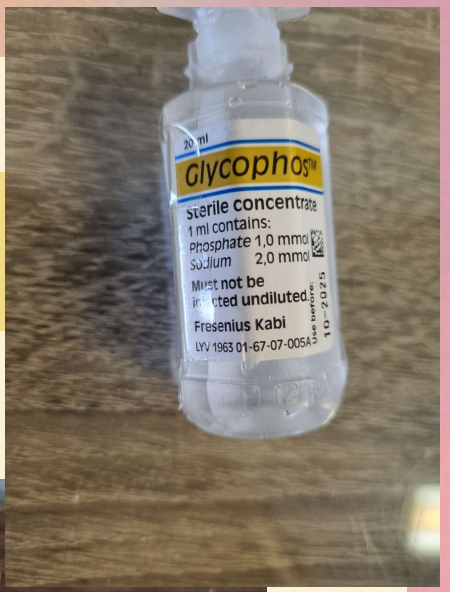
PHOSPHORUS

Glycophos

- 1ml=1 mmol
- 0.5- 2 mmol/kg/day
- 0.5-2 cc/kg/day

- Infuse rate< 7mmol /h





MAGNESIUM

Magnesium sulfate 50%

- 1ml=4 meq
- 0.3- 0.5 meq/kg/day
- 0.07-0.12 cc/kg/day

- Infuse rate< 8meq/h

OTHER POINTS…..

- Iron is not added to PN solutions.
- It must be administered orally, intramuscularly or intravenously.
-
- Iron status should be monitored every three to four months while on PN, by measuring hemoglobin, hematocrit, and iron indices(eg, serum iron, total iron binding capacity, ferritin, and/or soluble transferrin receptor levels)

OTHER POINTS…..

- Iodine is generally not included in PN; it is not provided in most trace element solutions or added to the PN

- Children for whom PN is their sole source of nutrition should undergo periodic monitoring of iodine status by checking serum thyroid-stimulating hormone (TSH) every six months.
- If serum TSH is elevated, then iodine status can be evaluated by measurement of either 24-hour urinary iodine or spot urinary iodine

8-VITAMINS REQUIREMENTS

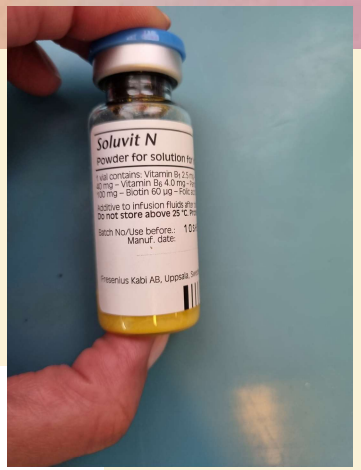
- Multivitamins should be routinely included in the PN prescription
- Pediatric preparations are commercially available in each country

Intravenous multivitamin preparation for pediatric use

	Each 5 mL solution contains:
Vitamin C (ascorbic acid)	80 mg
Vitamin A (palmitate)	2300 IU
Vitamin D (cholecalciferol)	400 IU
Vitamin B1 (thiamine)	1.2 mg
Vitamin B2 (riboflavin)	1.4 mg
Vitamin B6 (pyridoxine)	1 mg
Niacinamide	17 mg
Dexpanthenol	5 mg
Vitamin E	7 IU
Vitamin K1 (phytonadione)	0.2 mg
Folic acid	140 mcg
Biotin	20 mcg
Vitamin B12 (cyanocobalamin)	1 mcg

- Infant <6m=2 Ml
- <40 kg=5 Ml
- >40kg=10 Ml

- **<10 kg: 1cc/kg/day**
- **>10 kg:10cc /day**



Soluvit N

Powder for solution for infusion

1 vial contains: Vitamin B_1 2.5 mg – Vitamin B_2 3.6 mg – Nicotinamide 40 mg – Vitamin B_6 4.0 mg – Pantothenic acid 15.0 mg – Vitamin C 100 mg – Biotin 60 µg – Folic acid 0.4 mg – Vitamin B_{12} 5.0 µg.

Additive to infusion fluids after dissolution. See package insert.
Do not store above 25 °C. Protect from light.

Batch No/Use before:
Manuf. date:

330 6098

Fresenius Kabi AB, Uppsala, Sweden

Vitamin K

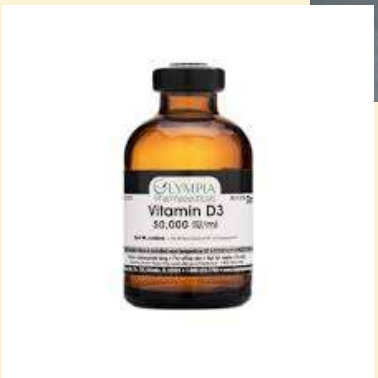
- Infant:10-20 mcg/kg/day
- Children:200 mcg/day

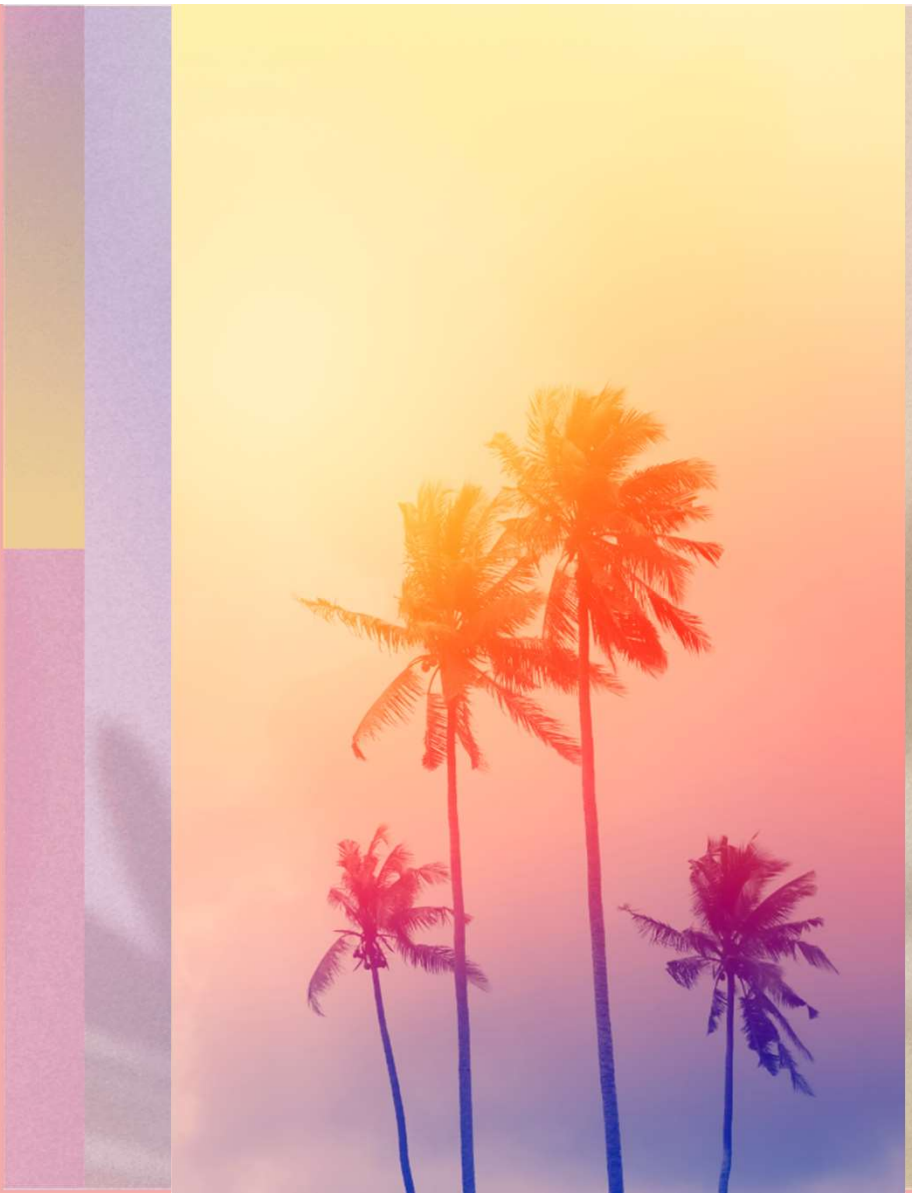
Vitamin A

- Infant: 200-500 IU/kg/day-IM
- Children:2500 IU/day-IM

Vitamin D

- 400 IU/day
- 50000 IU/Stat-IM





HOW TO ORDER

EXAMPLE...

Example:

A 3-year-old male requires parenteral nutrition (PN). The anticipated duration of nil per os (NPO) is >7 days. A peripherally inserted central catheter (PICC) is in place. Baseline labs were completed and are normal. The child's current weight is 14 kg. The nutritional goal is an age-appropriate weight gain of 4 to 10 g/day.

Refer to the relevant sections of the topic review on parenteral nutrition in children for the equations used in the calculations below.

1. Calculate fluid needs:

100 mL/kg × 10 kg = 1000 mL for the first 10 kg of weight

50 mL/kg × 4 kg = 200 mL for the next 4 kg of weight

1200 mL/day (rate per 24 hours: 1200 ÷ 24 = 50 mL/hr)

2. Calculate estimated energy needs:

14 kg × 85 kcal/kg = 1190 total kcals/day

3. Calculate protein needs:

14 kg × 3 g/kg = 42 g protein/day (42 g × 4 kcal/g = 168 kcal)

4. Calculate calories from fat:

14 kg × 2.5 g/kg = 35 g fat/day (35 g × 10 kcal/g = 350 kcal)

5. Calculate carbohydrate (CHO) needs:

1190 total calories – 168 kcal as protein – 350 kcal as fat

1190 – 518 = 672 calories to come from CHO (56% of total calories)

672 kcal ÷ 3.4 kcal/g of CHO = 198 g of CHO

6. Calculate glucose infusion rate (GIR):

GIR = 198 g CHO × 1000 mg/g = 198,000 mg CHO/day

198,000 mg ÷ 14 kg = 14,143 mg CHO/kg

14,143 mg/kg ÷ 1440 minutes/day = 9.8 mg/kg/min

GIR = 9.8 mg/kg/min

7. Final Contains :

a. Amino acid 10% → $\frac{10gr}{100cc} = \frac{42gr}{a.a}$ → **a.a = 420cc**

b. Intralipid 20% → $\frac{20gr}{100cc} = \frac{35gr}{IL}$ → **IL = 175cc**

c. Dextrose : 1200cc − (420cc + 175cc) = 605cc

198gr Dextrose → DW 10% → $\frac{10gr}{100cc} = \frac{15gr}{150cc}$

→ DW 50% → $\frac{50gr}{100cc} = \frac{183gr}{366cc}$

Final Volume For Macro = 420cc + 175cc + 150cc + 366cc = **1111cc**

d. Electrolytes and vitamins :

Nacl 5% → 5cc/kg → 70cc

kcl 15% → 1 cc/kg → 15cc

Glycophose → 1cc/kg → 7cc

magnesium sulfate 50% → .1 cc/kg → .7cc (1cc)

Soluvit N : 10cc

calcium glucanate : 10% → 1 cc/kg → 10cc

Final volume = 1111cc + 113cc = 1224cc

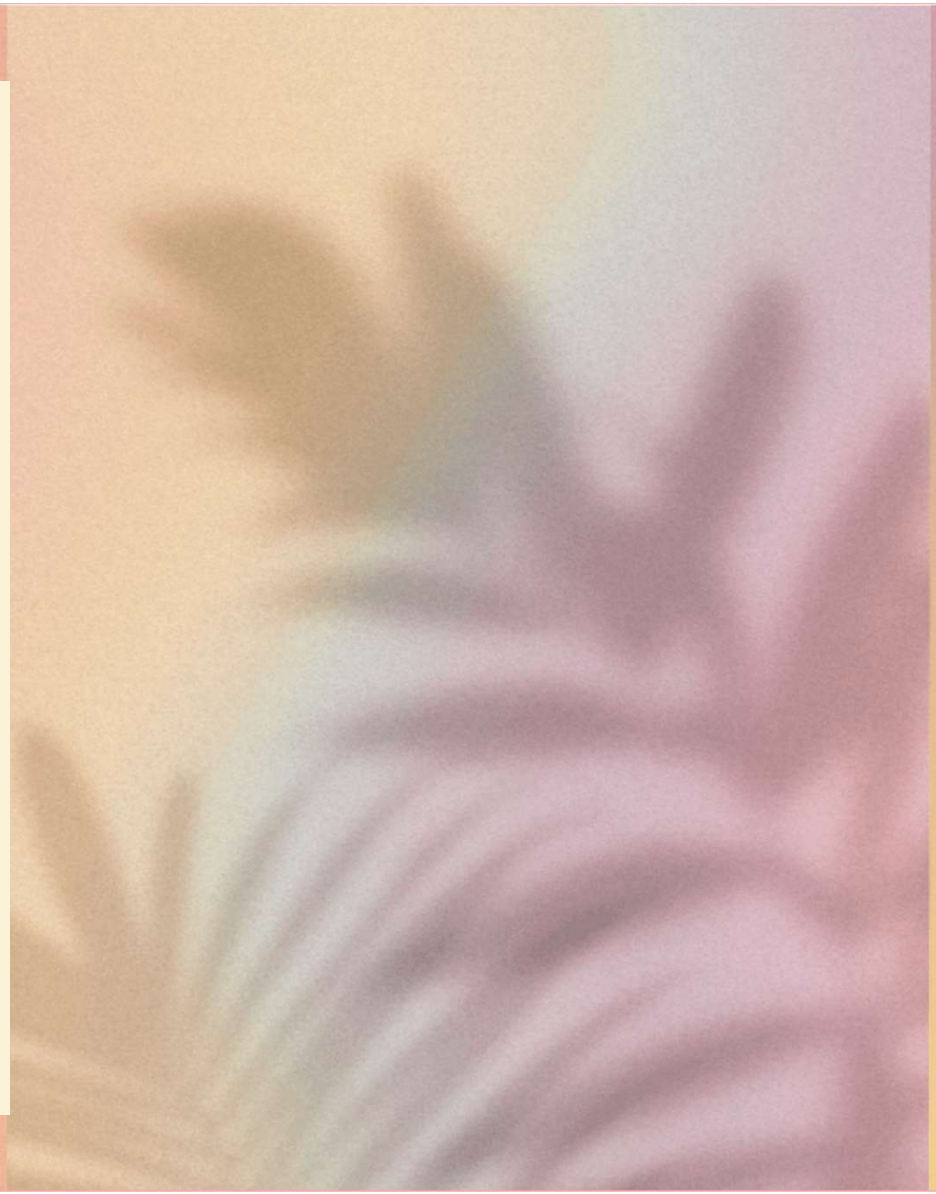
8. Final concentration :

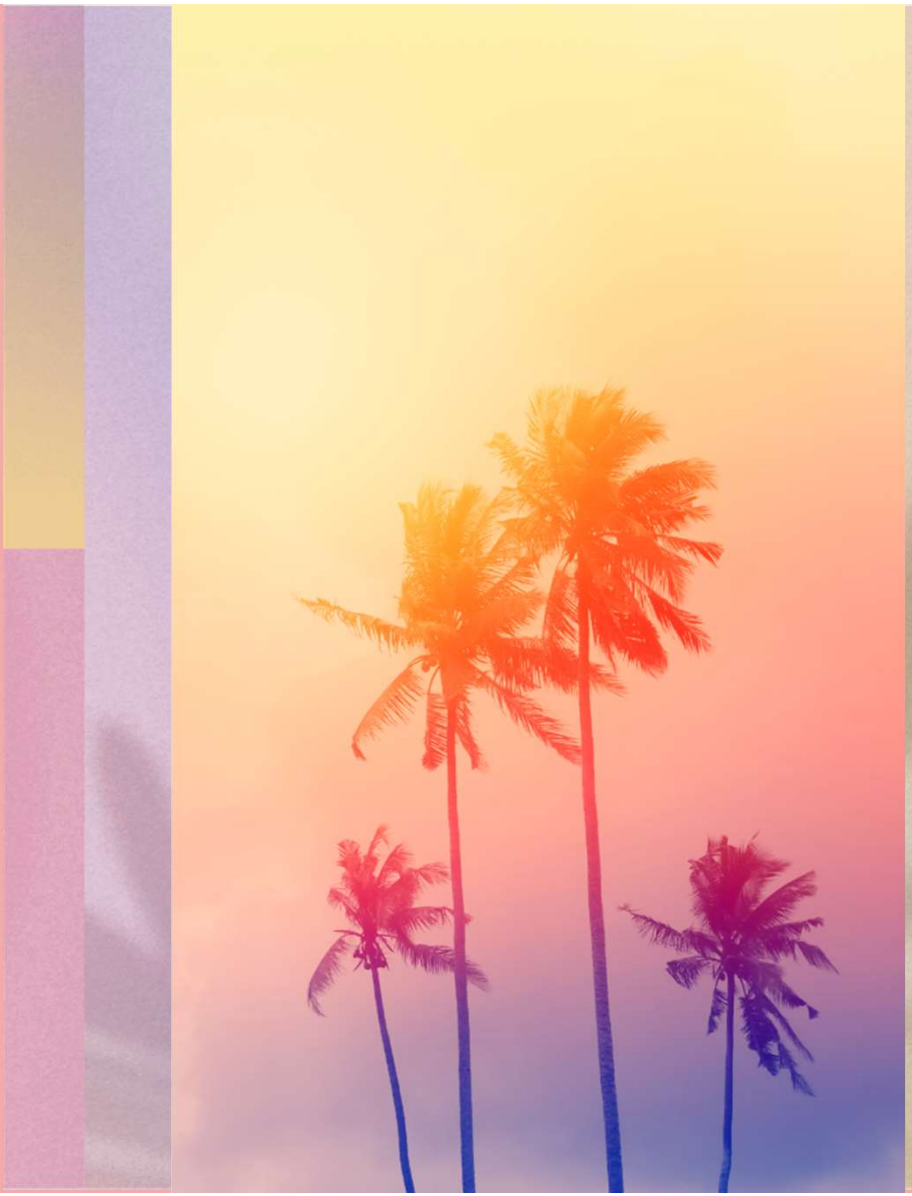
$$a.a = \frac{42\,gr}{1224\,cc} = \frac{3.4}{100\,cc} \quad 3.4\%$$

$$FL = \frac{35\,gr}{1224\,cc} = \frac{2.8}{100\,cc} \quad 2.8\%$$

$$Dw = \frac{198\,gr}{1224\,cc} = \frac{16.2}{100} \quad 16.2\%$$

- Any Problem in Order?
- Osmolarity ?





HOW TO DELIVER

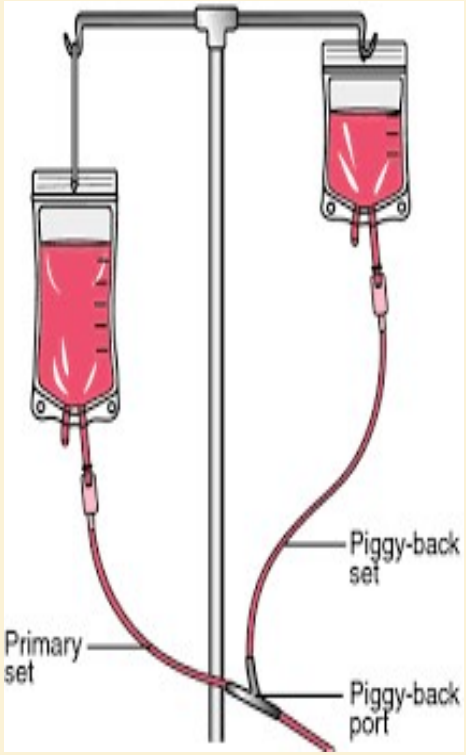
System for Delivery

- 2 in 1
  - AA + Dextrose
  - Piggybacked (PB) fat emulsion daily, intermittent, or optional
  - Better stability and compatibility
  - Improved visual inspection
  - Filter 0.2 micron
- Total Nutrient Admixture (TNA) or 3 in 1
  - AA + Dextrose + fat emulsion all in one bag
  - Single bag – decreased nursing time, decrease touch contamination and easier administration for home patient
  - Better fat utilization
  - Filter 1.2 micron

Admixture Types

2-in-1

3-in-1 (TNA)



Final Order :

1- Dw10% : 100 cc + Dw50% 44 cc + V0 cc Nacl 0%
+ 10 cc Kcl 10% + 10 cc Ca gluconate 10% +
1 cc Magnesium sulfate 50% + V cc glycophose
+ 10 cc Sulovit N / IV infusion / 24h

2. Intralipid 20% : 175 cc / IV infusin / 12h

3. Amp vit D, 50/000 IU / IM / Stat

4. Amp vit A, 50/000 IU / 1/3 vial / IM / weekly
(17,500 IU)
(2500 X 7d)

5. Amp vit K, 1.4 mg / IV / weekly
(200 x 7d)

Automated Compounding Devices

Pinnacle TPN Management System
B. Braun Medical Inc.

Multi-Chamber bags

- Promote extended stability
- Separate IVFE from rest of PN
- At the time of administration, seal/clamp is opened to mix contents
- MVI and trace elements added prior to infusion
- Advantages – Lower risk for infections, less compounding time, commercially available
- Disadvantages- Preset concentration limits customization

ashp

SOME OTHER POINTS…..

- Add vitamins to PN bag immediately prior to use

- Item Cause instability:
- Final concentration of AA< 3.5-4%
- Final concentration of IL< 2%
- Final concentration of dextrose< 10%

- **Beyond use Dating:**
- < 30h in air room
- <7 day in 2-8$_{0c}$

CYCLING

- The term "cycling" is used when the PN solution is infused at a higher rate for less than 24 hours, followed by several hours without a PN infusion
- Cycling can be initiated when a patient has been stable on PN for at least one week.
- Generally the time off PN is increased and the infusion rate is increased to compensate, so that the total daily volume of PN is unchanged

- For children, time off of the pump allows them freedom of movement and the ability to participate in activities
- For infants and toddlers, freedom of movement is important as they develop large motor skills.
- Cycling off of PN may allow children to experience hunger, which is helpful when transitioning to oral feeds.
- Cycling allows the rise and fall of hormones associated with meals.
- Continuous infusion of glucose can be associated with high levels of insulin secretion.

- Cycling requires careful planning and monitoring because sudden discontinuation of a high glucose infusion can cause hypoglycemia, especially in children younger than three years of age

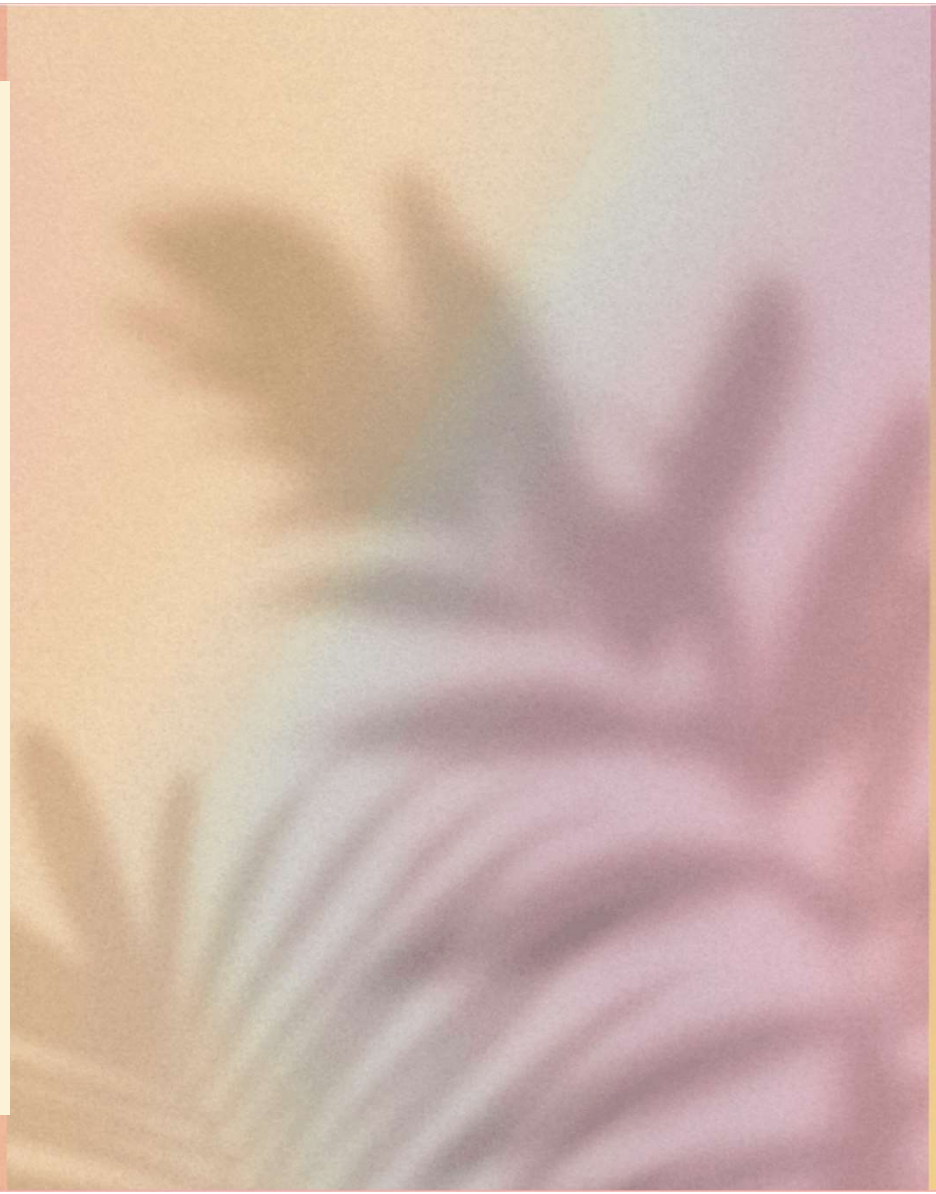
- Blood glucose levels should be closely monitored when implementing a cycling regimen.

- To prevent hypoglycemia, the rate of PN delivery should be tapered during the final one to two hours of the infusion.

- A standard practice is to decrease the infusion rate to one-half for an hour and then one-half again for a second hour, prior to stopping the infusion entirely

REFERENCES:

- Up to date.2024
- Standardized competencies for parenteral nutrition order review and parenteral nutrition preparation, including compounding: the ASPEN model. Nutrition in clinical practice. 2016 Aug;31(4):548-55.
- Balint J, Bobo E, Corkins MR, Kuhn J, Plogsted S, Yaworski JA, editors. The ASPEN pediatric nutrition support core curriculum. American Society for Parenteral and Enteral Nutrition; 2015.




THANK YOU


Thank You!