Liệu pháp dinh dưỡng tối ưu cho trẻ sinh non nhẹ cân
Từ khuyến cáo đến thực hành lâm sàng

BSCK2. Nguyễn Thanh Thiện
TK HSSS - BV Nhi Đồng 2

Dinh dưỡng cho trẻ sinh non nhẹ cân

- Vấn đề cơ bản quan trọng
- Liên quan đến sự phát triển, bệnh tật và di chứng
- Can thiệp dinh dưỡng sớm góp phần cải thiện tiên lượng thần kinh

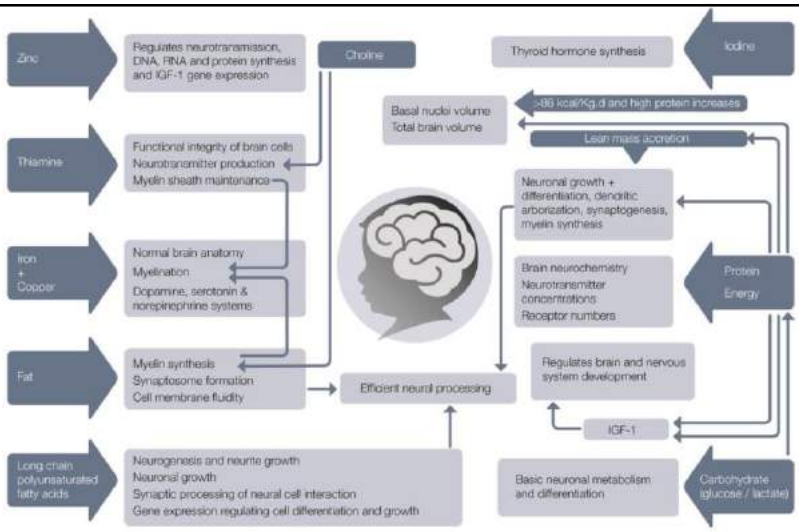
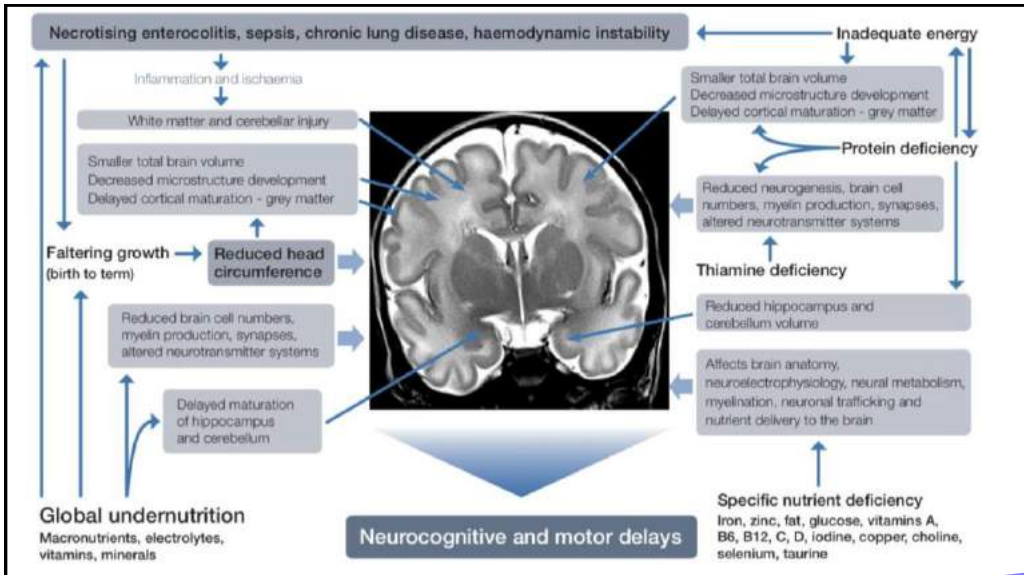


Figure 2. Nutrients needed for normal brain development.

Cormack BE et al (2019), *Nutrients*; 11(9):2029



Cormack BE et al (2019), *Nutrients*; 11(9):2029

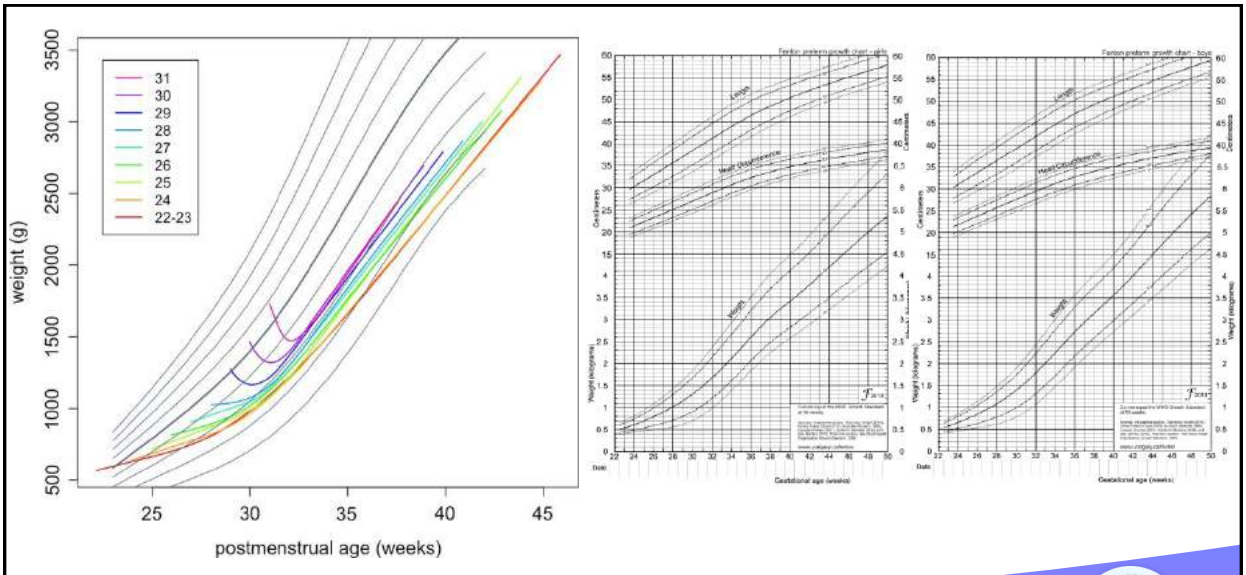
Trẻ non tháng

- Tam cá nguyệt cuối: thai phát triển nhanh nhất
- Sanh non → gián đoạn đột ngột nguồn cung cấp dinh dưỡng
- Cần phục hồi hoạt động chuyển hoá bào thai → Ngừa sụt cân, duy trì đà phát triển, đẩy mạnh bắt kịp tăng trưởng trong tử cung

TABLE 59.1 Estimated Protein and Energy Requirements to Achieve Fetal Growth

Weight (g)	Protein (g/kg/day)	Energy (kcal/kg/day)	Protein/Energy (g/100 kcal)
500–700	4.0	105	3.8
700–900	4.0	108	3.7
900–1200	4.0	119	3.4
1200–1500	3.9	125	3.1
1500–1800	3.6	128	2.8
1800–2200	3.4	131	2.6

Based on the factorial method (Ziegler EE. Meeting the nutritional needs of the low-birth-weight infant. *Ann Nutr Metab.* 2011;58[Suppl 1]:8–18).



Cole TJ et al, 2014, *Arch Dis Child Fetal Neonatal Ed*; 99(1):F34-40

TABLE 30.1 Estimated Maintenance Fluid Requirements

Birth weight (g)	DAILY FLUID REQUIREMENTS (mL/kg) Day 1	Day 2	Days 3–6	Day 7+
<750	100–140	120–160	140–200	140–160
750–1000	100–120	100–140	130–180	140–160
1000–1500	80–100	100–120	120–160	150
>1500	60–80	80–120	120–160	150

TABLE 69.1 Suggested Daily Parenteral Intakes for Extremely Low and Very Low Birth Weight Infants

Component (units/kg per day)	ELBW Day 0[a]	ELBW Transition[b]	ELBW Growing	VLBW Day 0[a]	VLBW Transition[b]	VLBW Growing
Energy (kcal)	40–50	70–80	90–100	40–50	60–70	90–100
Protein (g)	2.0–3.0	3.5	3.5–4.0	2.0–3.0	3.0–3.5	3.0–3.5
Glucose (g)	7–10	8–15	13–17	7–10	8–15	13–17
Fat (g)	2	2–3	3–4	2	2–3	3
Na (mEq)	0–1	2–4	3–7	0–1	2–4	3–5
Potassium (K) (mEq)	0	0–2	2–3	0	0–2	2–3
Chloride (mEq)	0–1	2–4	3–7	0–1	2–4	3–7
Calcium (mg)	20–60	60	60–80	20–60	60	60–80
Phosphorus (mg)	0	45–60	45–60	0	45–60	45–60
Magnesium (mg)	0	3.0–7.2	3.0–7.2	0	3.0–7.2	3.0–7.2

ELBW, Extremely low birth weight; *VLBW*, very low birth weight.
[a]Recommended parenteral intakes on the first day of life.
[b]Period of transition to physiologic and metabolic stability. For most premature neonates, this occurs between 2 and 7 days.

Table: Recommendations for carbohydrates

R 5.1	The amount of glucose to be provided by PN should be guided by [1] the balance between meeting energy needs and the risks of overfeeding/excess glucose load [2], phase of illness (acute, stable, recovery/growing) [3], macronutrient supply by enteral and parenteral nutrition, and [4] glucose administered outside enteral and parenteral nutrition, e.g. with medication (GPP, conditional recommendation)		
R 5.2	Excessive glucose intake should be avoided because it may be responsible for hyperglycemia (LoE 1−, RG A, strong recommendation), causes increased lipogenesis and fat tissue deposition together with subsequent liver steatosis and enhanced production of VLDL triglycerides by the liver (LOE 2+, RG B, strong recommendation), and may cause increased CO_2 production and minute ventilation (LoE 2+, RG B, strong recommendation)		
R 5.3	Glucose intake does not lower protein catabolism in the acute phase of critical illness (LoE 1−, RG A, strong recommendation)		
R 5.4	Recommended parenteral glucose supply in (pre)term newborns in mg/kg per min (g/kg per day) (LoE 2+, RG B, conditional		
		Day 1	Day 2 onwards
		Start with	Increase gradually over 2−3 days to
	Preterm newborn	4−8 (5.8−11.5)	Target 8−10 (11.5−14.4) Min 4 (5.8); max 12 (17.3)
	Term newborn	2.5−5 (3.6−7.2)	Target 5−10 (7.2−14.4) Min 2.5 (3.6); max 12 (17.3)
R 5.5	Newborns < 28 days of age, who have an episode of acute illness such as infection or sepsis, should temporarily receive the carbohydrate supply of day 1 (R5.4), guided by the blood glucose levels (GPP, conditional recommendation)		

ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Carbohydrates

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Table: Recommendations for amino acids in PN

R 3.1	In preterm infants the amino acid supply should start on the first postnatal day with at least 1.5 g/kg/d to achieve an anabolic state. (LOE 1++, RG A, strong recommendation)
R 3.2	In preterm infants the parenteral amino acid intake from postnatal day 2 onwards should be between 2.5 g/kg/d and 3.5 g/kg/d and should be accompanied by non-protein intakes >65 kcal/kg/d and adequate micronutrient intakes. (LOE 1+, RG A, strong recommendation)
R 3.3	In preterm infants, parenteral amino acid intakes above 3.5 g/kg/d should only be administered as part of clinical trials (LOE 2+, RG 0, conditional recommendation)
R 3.4	A minimum amino acid intake of 1.5 g/kg/d should be administered to stable term infants to avoid a negative nitrogen balance while the maximum amino acid intake should not exceed 3.0 g/kg/d (LOE 1+, RG B, strong recommendation)
R 3.5	Withholding parenteral nutrition, including amino acids, for 1 week in critically ill term infants while providing micronutrients can be considered (LOE 1+, RG B, conditional recommendation)
R 3.6	A
R 3.7	W
R 3.8	In
R 3.9	W
R 3.10	Ar
R 3.11	W
	1+, RG B, conditional recommendation)
R 3.12	Bioavailable cysteine (50−75 mg/kg/d) should be administered to preterm neonates. Higher amounts do not improve outcomes (LOE 1+, RG B, conditional recommendation)
R 3.13	The lower limit of tyrosine intake should be at least 18 mg/kg per day in preterm infants. (LOE 2++, RG B, conditional recommendation)
R 3.14	The advisable tyrosine intake in term infants is 94 mg tyrosine/kg per day. (LOE 1+, RG B, conditional recommendation)
R 3.15	Glutamine should not be supplemented additionally in infants and children up to the age of two years. (LOE 1++, RG A, strong recommendation)
R 3.16	Taurine should be part of amino acid solutions for infants and children, although no firm recommendation can be made upon advisable lower or upper limits. (LOE 1−, RG B, conditional recommendation)
R 3.17	Arginine supplementation may be used for prevention of NEC in preterm infants (LOE: 1−, RG B, conditional recommendation)

ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Amino acids

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Amino acid đặc biệt

- Cysteine là cơ chất chính của glutathione (chức năng chống oxy hoá), duy trì khả năng oxy hoá khử và cân bằng nội môi Ca
- Tyrosin là tiền chất của dopamin
- Thiếu taurin làm tăng ứ mật ở sơ sinh
- Arginin là tiền chất của NO, thiếu Arginin có liên quan đến VRHT và cao áp phổi dai dẳng
- Glutamin có sẵn lượng lớn trong cơ thể người, cung cấp thêm glutamin có thể làm giảm nồng độ tyrosin và phenylalanin trong máu

Table 1 – Composition of commercially available parenteral amino acid solutions for infants <2y.

	Primene 10%, Baxter	TrophAmine 10%[†], B.Braun	Aminoven Infant 10%[‡], Fresenius Kabi	Vaminolact 6.5%, Fresenius Kabi	Aminosyn-PF 10%[¶], Hospira / ICU Medical
pH	5.5	5.5	5.5 – 6.0	5.2	5.5
Osmolality (mOsmol/L)	780	875	885	510	788
Total nitrogen (g/L)	15.0	15.5	14.9	9.3	15.2
Protein equivalent (g/L)	NA	97	NA	58	100
Essential amino acids (weight%)					
Histidine	3.8	4.8	4.8	3.2	3.1
Isoleucine	6.7	8.2	8.0	4.7	7.6
Leucine	10.0	14.0	13.0	10.7	12.0
Lysine	11.0[a]	8.2[a]	8.5[a]	8.6[a]	6.8[a]
Methionine	2.4	3.4	3.1	2.0	3.8
Phenylalanine	4.2	4.8	3.8	4.1	4.3
Threonine	3.7	4.2	4.4	5.5	5.1
Tryptophan	2.0	2.0	2.0	2.1	1.8
Valine	7.6	7.8	9.0	5.5	6.7
Subtotal	51.4	57.4	56.6	46.4	49.2
Semi-essential amino acids (weight%)					
Arginine	8.4	12.0	7.5	6.3	12.3
Cysteine	1.9	<0.16[a,c]	0.52[c]	1.5	0[c]
Glutamine	0	0	0	0	0
Glycine	4.0	3.6	4.2	3.2	3.9
Proline	3.0	6.8	9.7	8.6	8.1
Taurine[a]	0.6	0.25	0.4	0.5	0.7
Tyrosine	0.45	2.4[b]	4.2[b]	0.8	0.44
Subtotal	18.4	25.2	26.5	20.9	25.4
Non-essential amino acids (weight%)					
Alanine	8.0	5.4	9.3	9.6	7.0
Asparagine	0	0	0	0	0
Aspartic acid (aspartate)	6.0	3.2	0	6.3	5.3
Glutamic acid (glutamate)	10.0	5.0	0	10.9	8.2
Ornithine[a]	2.5[c]	0	0	0	0
Serine	4.0	3.8	7.7	5.8	5.0
Subtotal	30.5	17.4	17	32.6	25.5
Other (mmol/L)					
Acetate	0	97	59	0	46
Chloride	19	<3	0	0	0
Sodium	0	5	0	0	0
Malic acid (g/L)	NA	0	2.6	0	0

R 4.1	In paediatric patients, intravenous lipid emulsions (ILE) should be an integral part of parenteral nutrition (PN) either exclusive or complementary to enteral feeding. (LoE 1−, RG A, strong recommendation for)
R 4.2	In preterm infants, lipid emulsions can be started immediately after birth and no later than on day two of life and for those in whom enteral feeding has been withdrawn, they can be started at time of PN initiation. (LoE 1−, RG A, strong recommendation for)
R 4.3	In preterm and term infants, parenteral lipid intake should not exceed 4 g/kg/day. (LoE 4, GPP, conditional recommendation for)
R 4.4	In children, parenteral lipid intake should be limited to a maximum of 3 g/kg/day. (LoE 3−4, RG 0, conditional recommendation for)
R 4.5	In order to prevent essential fatty acids (EFA) deficiency in preterm infants a lipid emulsion dosage providing a minimum linoleic acid (LA) intake of 0.25 g/kg/day can be given. This lipid emulsion dosage ensures an adequate intake of linolenic acid (LNA) with all lipid emulsions currently registered for paediatric use. (LoE 2−, RG 0, strong recommendation for)
R 4.6	In order to prevent EFA deficiency in term infants and in children a lipid emulsion dosage providing a minimum LA intake of 0.1 g/kg/day can be given, which also provides an adequate intake of LNA with all ILEs currently registered for paediatric use. (LoE 3−4, RG 0, conditional recommendation for)
R 4.7	In preterm infants, newborns and older children on short term PN, pure soybean oil (SO) ILEs may provide less balanced nutrition than composite ILEs. For PN lasting longer than a few days, pure SO ILEs should no longer be used and composite ILEs with or without fish oil (FO) should be the first choice treatment (LoE 1−, RG A, conditional recommendation for)
R 4.8	In preterm infants, ILEs should be protected by validated light-protected tubing. (LoE 1−, RG B, strong recommendation for)
R 4.9	In infants and children, 20% ILEs should be the first choice treatment (LoE 1−, RG B, strong recommendation for)
R 4.10	In newborns including preterm infants, routine use of ILEs should be continuous over 24 h (LoE 2++, RG B, conditional recommendation for)
R 4.11	If cyclic PN is used, for example for home PN children, ILEs should usually be given over the same duration as the other PN components. (LoE 4, GPP, strong recommendation for)
R 4.12	In paediatric patients, heparin should not be given with lipid infusion on a routine basis. (LoE 3−4, GPP, conditional recommendation for)
R 4.13	Carnitine supplementation may be considered in paediatric patients expected to receive PN for more than 4 weeks or in premature infants on an individual basis (LoE 3
R 4.14	In critically ill paediatr ent. Available evidence rais ow to differentiate potent
R 4.15	In paediatric patients v nia are recommended. ILE requirements (LoE 4, G
R 4.16	Case reports have sugg ell-designed trials (LoE 3−4, GPP, conditional recommendation for)
R 4.17	In patients with severe unexplained thrombocytopaenia, serum triglyceride concentrations should be monitored and a reduction of parenteral lipid dosage may be considered. (LoE 3−4, GPP, conditional recommendation for)
R 4.18	As part of measures to reverse IFALD in paediatric patients, a discontinuation of SO ILE, a reduction of other ILE dosage and/or the use of composite ILE with FO, should be considered along with the treatment and management of other risk factors (LoE 2+, RG B, strong recommendation for)
R 4.19	The use of pure FO ILE is not recommended for general use in paediatric patients but may be used for short-term rescue treatment in patients with progression to severe IFALD, based on case reports. (LoE 3−4, GPP, conditional recommendation for)
R 4.20	Markers of liver integrity and function, and triglyceride concentrations in serum or plasma should be monitored regularly in patients receiving ILEs, and more frequently in cases with a marked risk for hyperlipidaemia (e.g. patients with high lipid or glucose dosage, sepsis, catabolism, extremely low birth weight infants) (LoE 2−, RG B, strong recommendation for)
R 4.21	Reduction of the dosage of ILEs can be considered if serum or plasma triglyceride concentrations during infusion exceed 3 mmol/L (265 mg/dL) in infants or 4.5 mmol/L (400 mg/dL) in older children (LoE 4, GPP, conditional recommendation for)

ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Lipids

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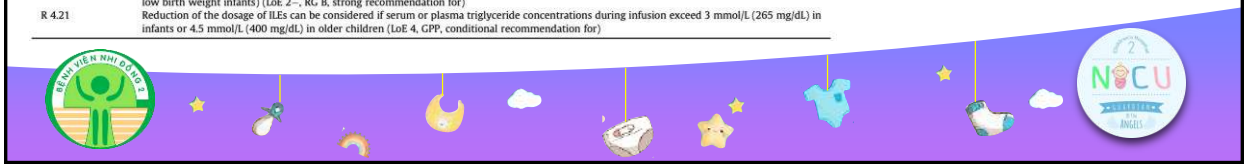

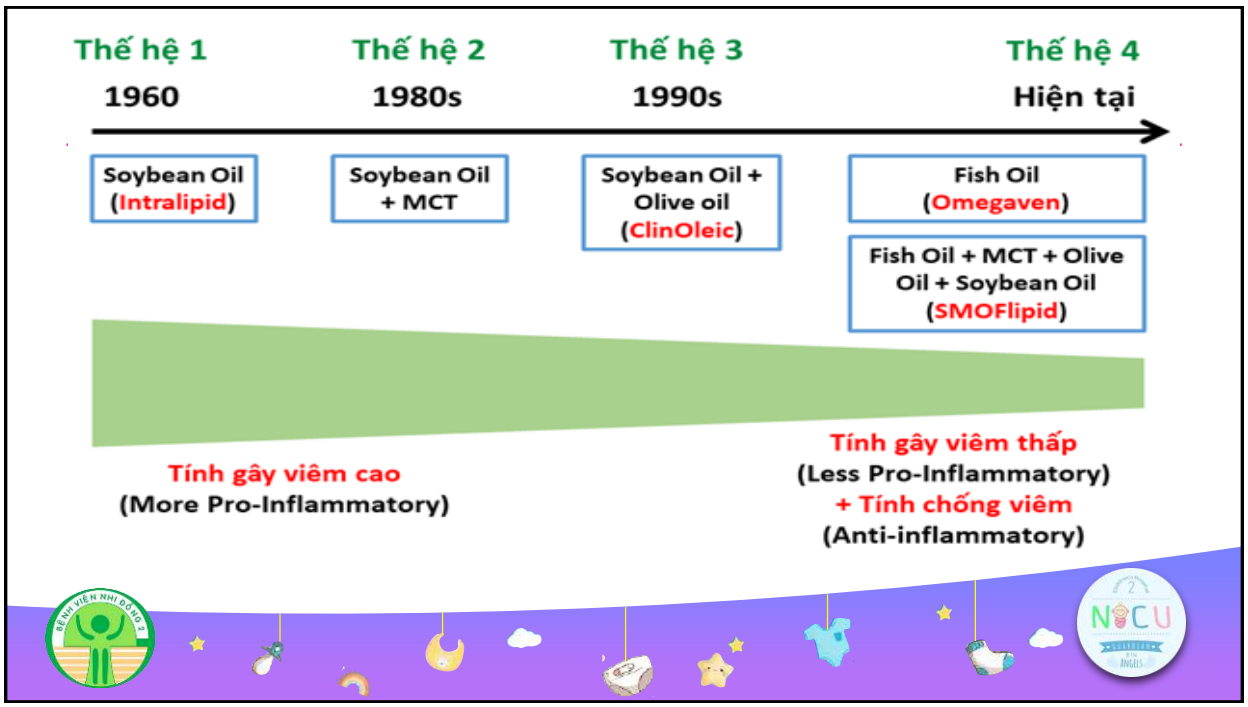

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ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Calcium, phosphorus and magnesium

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R 8.1	In infants, children and adolescents on PN appropriate amounts of Ca, P and Mg should be provided to ensure optimal growth and bone mineralization (GPP, strong recommendation)
R 8.2	The mineral accretion of the fetus, healthy infant, child, and adolescent may be used as a reference for Ca, P and Mg provision (GPP, conditional recommendation)
R 8.3	In the individual infant appropriate PN should provide a simultaneous slight surplus of Ca, P, and Mg to ensure optimal tissue and bone mineral accretion (GPP, conditional recommendation)
R 8.4	Ca infusion may be used for prevention and treatment of early neonatal hypocalcaemia that is common and generally not associated with obvious clinical problems such as tetany (GPP, conditional recommendation)
R 8.5	In preterm infants on PN who were exposed to maternal Mg therapy, Mg intakes need to be adapted to postnatal blood concentrations (LoE 2, RG B, conditional recommendation)
R 8.6	Acidic solutions packaged in glass vials, such as calcium gluconate, are contaminated with aluminum and should not be used in PN (LoE 3, RG D, strong recommendation)
R 8.7	It is recommended to use organic Ca and P salts for compounding of PN solutions to prevent precipitation (GPP, strong recommendation)
R 8.8	The adequacy of Ca and P intakes in preterm infants can be adjusted until both start being excreted simultaneously with low urine concentrations (>1 mmol/L) indicative of a slight surplus (extrapolated evidence derived from enteral nutrition LoE 2+ studies, RG B, conditional recommendation)
R 8.9	The recommended parenteral intake for calcium, phosphorus, and magnesium intake in newborns and children on parenteral nutrition in mmol (mg)/kg/d is as follows (LoE 2, 3 and 4, RG D, conditional recommendation)

Age	Ca mmol (mg)/kg/d	P mmol (mg)/kg/d	Mg mmol (mg)/kg/d
Preterm infants during the first days of life	0.8–2.0 (32–80)	1.0–2.0 (31–62)	0.1–0.2 (2.5–5.0)
Growing Premature	1.6–3.5 (64–140)	1.6–3.5 (50–108)	0.2–0.3 (5.0–7.5) infants
0–6 m*	0.8–1.5 (30–60)	0.7–1.3 (20–40)	0.1–0.2 (2.4–5)
7–12 m	0.5 (20)	0.5 (15)	0.15 (4)
1–18 y	0.25–0.4 (10–16)	0.2–0.7 (6–22)	0.1 (2.4)

*Includes term newborns.

R 8.10	In preterm infants with intrauterine growth restriction on PN careful monitoring of the plasma phosphate concentration within the first days of life is required to prevent severe hypophosphataemia that can result in muscle weakness, respiratory failure, cardiac dysfunction, and death (LoE 3, RG D, strong recommendation)
R 8.11	In preterm infants on early PN during the first days of life lower Ca, P and Mg intakes are recommended than in growing stable preterm infants (Table 1) (LoE 2, RG B, conditional recommendation)
R 8.12	In early PN when calcium and phosphorus intakes are low (Table 1) and protein and energy are optimized it is recommended to use a molar Ca:P ratio below 1 (0.8–1.0) to reduce the incidence of early postnatal hypercalcaemia and hypophosphataemia (LoE 2, RG B, strong recommendation)
R 8.13	In infants and children on PN regular monitoring of the individual alkaline phosphatase, Ca, P and Mg serum concentrations and Ca and P urine concentrations is required (Extrapolated evidence from LoE 2 and 3 studies, RG D, strong recommendation)
R 8.14	In infants and children on long term PN the risk of metabolic bone disease requires periodic monitoring of Ca, P, vitamin D and bone mineral status (LoE 2 + and 3, RG D, strong recommendation)

Ca & P

- Growpone 10% (0.22 mmol/ml), Phosphorus Aguettant (0.66 mmol/ml)
- Giai đoạn đầu: Tỉ lệ Ca/P ~ 0.8-1

  → 4 ml/kg Growpone (0.88 mmol/kg)

  1.5 ml/kg Phosphorus Aguettant (1 mmol/kg)
- Giai đoạn tăng tưởng:Tỉ lệ Ca/P ~ 1.3

  → 12 ml/kg Growpone (2.6 mmol/kg)

  3 ml/kg Phosphorus Aguettant (2 mmol/kg)

R 9.1	Infants and children receiving PN should receive parenteral vitamins (LoE 4, RG 0, strong recommendation)
R 9.2	Whenever possible water and lipid soluble vitamins should be added to the lipid emulsion or a mixture containing lipids to increase vitamin stability. (LoE 4, RG 0, strong recommendation)
R 9.3	Vitamins should be administered daily, if possible. Lipid-soluble vitamins should be given simultaneously to lipid emulsions; an exception is vitamin K, which can be given weekly. Intermittent substitution twice or three times a week has a hypothetical risk of adverse effects from transient high levels. (LoE 4, RG 0, strong recommendation)
R 9.4	Optimal doses and infusion conditions for vitamins in infants and children have not been established. Vitamins should be given in doses mentioned in Table 1 of this chapter. However, these are based mainly on expert opinion. (GPP, conditional recommendation)
R 9.5	Routine monitoring of vitamin concentrations (except of vitamin D) is not recommended because of lack of evidence for adequate benefits. In patients on long-term PN (weeks) monitoring may be needed based on clinical indications. (LoE 4, RG 0, conditional recommendation)
R 9.6	Preterm infants on PN should receive 700–1500 IU/kg/day (or 227–455 ug/kg/day) of vitamin A, term infants 150–300 ug/kg/day (or 2300 IU (697 ug)/day), and older children 150 ug/day. (LoE 3, RG 0, strong recommendation)
R 9.7	There are substantial losses of vitamin A when given with a water-soluble solution; therefore, parenteral lipid soluble vitamins should be given with the lipid emulsion whenever possible. (LoE 3, RG 0, strong recommendation)
R 9.8	Preterm infants on PN should receive 200–1000 IU/day (or 80–400 IU/kg/day) of vitamin D, term infants up to 12 months of age 400 IU/day (or 40–150 IU/kg/day), and older children 400–600 IU/day. (LoE 3, RG 0, strong recommendation)
R 9.9	Paediatric patients receiving long-term PN should be monitored periodically for vitamin D deficiency. In patients with 25 (OH) vitamin D serum concentrations <50 nmol/L, additional supplementation with vitamin D should be provided. (LoE 3, RG 0, strong recommendation)
R 9.10	Oral supplementation of vitamin D should be considered in patients on partial PN as well as during weaning from parenteral nutrition. (LoE 3, RG 0, strong recommendation)
R 9.11	The total dose of vitamin E should be ≤11 mg/day for infants and children below 11 years, when new fat emulsions containing LC-PUFAs and vitamin E are given. (LoE 2+, RG B, strong recommendation)
R 9.12	For preterm infants, the total dose of vitamin E should be between 2.8 and 3.5 mg/kg/day, but should not exceed 11 mg/day. (LoE 2+, RG B, strong recommendation)
R 9.13	To properly assess vitamin E status, the ratio between serum vitamin E/total serum lipids should be used. (GPP, conditional recommendation)
R 9.14	Preterm and term infants up to 12 months of age on PN should receive 10 ug/kg/day, and older children 200 ug/day of vitamin K. (LoE 3, RG 0, strong recommendation)
R 9.15	Classical coagulation tests can be used in low-risk infants for indirect evaluation of vitamin K status, but are not specific to vitamin K deficiency. (LoE 3, RG 0, conditional recommendation)
R 9.16	Undercarboxylated Serum Vitamin K-Dependent Proteins (PIVKA-II) seem to be a useful biomarker of subclinical vitamin K deficiency for at-risk patient groups and should be used when locally available. (LoE 3, RG 0, conditional recommendation)
R 9.17	Newborns who are unable to take oral vitamin K or whose mothers have taken medications that interfere with vitamin K metabolism should follow a specific supplementation protocol, according to local policy. (LoE 4, RG 0, strong recommendation)
R 9.18	Preterm and term infants up to 12 months of age on PN should receive 15–25 mg/kg/day, and older children 80 mg/day of vitamin C. (LoE 3, RG 0, strong recommendation)
R 9.19	Preterm and term infants up to 12 months of age on PN should receive 0.35–0.50 mg/kg/day, and older children 1.2 mg/day of thiamine. (GPP, conditional recommendation)
R 9.20	Preterm and term infants up to 12 months of age on PN should receive 0.15–0.2 mg/kg/day, and older children 1.4 mg/day of riboflavin. (GPP, conditional recommendation)
R 9.21	Preterm and term infants up to 12 months of age on PN should receive 0.15–0.2 mg/kg/day, and older children 1.0 mg/day of pyridoxine. (GPP, conditional recommendation)
R 9.22	Preterm and term infants up to 12 months of age on PN should receive 0.3 ug/kg/day, and older children 1 ug/day of cobalamin. (GPP, conditional recommendation)
R 9.23	Preterm and term infants up to 12 months of age on PN should receive 4–6.8 mg/kg/day, and older children 17 mg/day of niacin. (GPP, conditional recommendation)
R 9.24	Preterm and term infants up to 12 months of age on PN should receive 2.5 mg/kg/day, and older children 5 mg/day of pantothenic acid. (GPP, conditional recommendation)
R 9.25	Preterm and term infants up to 12 months of age on PN should receive 5–8 ug/kg/day, and older children 20 ug/day of biotin. (GPP, conditional recommendation)
R 9.26	Preterm and term infants up to 12 months of age on PN should receive 56 µg/kg/day and older children 140 µg/day of folic acid. The adequacy of current recommendations needs to be confirmed. (LoE 3, RG 0, strong recommendation)

Table 1
Recommended doses for parenteral supply of fat soluble and water soluble vitamins for preterm infants, infants and children.

	Preterm infants	Infants − 12 months	Children and adolescents 1−18 years
Vitamin A[a]	700−1500 IU/kg/d (227−455 ug/kg/d)	150−300 ug/kg/d or 2300 IU/d (697 ug/d)	150 ug/d
Vitamin D[b]	200−1000 IU/d or 80−400 IU/kg/d	400 IU/d or 40−150 IU/kg/d	400−600 IU/d
Vitamin E[c]	2.8−3.5 mg/kg/d or 2.8−3.5 IU/kg/d	2.8−3.5 mg/kg/d or 2.8−3.5 IU/kg/d	11 mg/d or 11 IU/d
Vitamin K	10 ug/kg/d (recommended, but currently not possible)[d]	10 ug/kg/d (recommended, but currently not possible)[d]	200 ug/d
Vitamin C	15−25 mg/kg/d	15−25 mg/kg/d	80 mg/d
Thiamine	0.35−0.50 mg/kg/d	0.35−0.50 mg/kg/d	1.2 mg/d
Riboflavin	0.15−0.2 mg/kg/d	0.15−0.2 mg/kg/d	1.4 mg/d
Pyridoxine	0.15−0.2 mg/kg/d	0.15−0.2 mg/kg/d	1.0 mg/d
Niacin	4−6.8 mg/kg/d	4−6.8 mg/kg/d	17 mg/d
Vitamin B12	0.3 ug/kg/d	0.3 ug/kg/d	1 ug/d
Pantothenic acid	2.5 mg/kg/d	2.5 mg/kg/d	5 mg/d
Biotin	5-8 ug/kg/d	5-8 ug/kg/d	20 ug/d
Folic acid	56 µg/kg/d	56 µg/kg/d	140 µg/d

List of parenteral multivitamin products available on the European and American market (in alphabetical order).

Product (Distributor)	Vial volume	Content per vial												
		A (IU)	D (IU)	E (IU)	K (ug)	B1 (mg)	B2 (mg)	B3 (mg)	B5 (mg)	B6 (mg)	B12 (ug)	C (mg)	Biotin (ug)	FA (ug)
Adult														
Cernevit (Baxter)	5 mL	3500	220	11.2	0	3.5	4.1	46	17.3	4.5	6	125	69	414
Infuvite Adult (Baxter)	10 mL	3300	200	10	150	6	3.6	40	15	6	5	200	60	600
M.V.I.-12 (Hospira)	10 mL	3300	200	10	0	6	3.6	40	15	6	5	200	60	600
M.V.I. Adult (Hospira)	10 mL	3300	200	10	150	6	3.6	40	15	6	5	200	60	600
Pabrinex: ampule no.1	5 mL	0	0	0	0	250	4	0	0	50	0	0	0	0
(Archimedes Pharma)	10 mL	0	0	0	0	500	8	0	0	100	0	0	0	0
Pabrinex: ampule no.2	5 mL	0	0	0	0	0	0	160	0	0	0	500	0	0
(Archimedes Pharma)	10 mL	0	0	0	0	0	0	320	0	0	0	1000	0	0
Solivito N (Fresenius Kabi)	10 mL	0	0	0	0	2.5	3.6	40	15	4	5	100	60	400
Soluvit N (Fresenius Kabi)	10 mL	0	0	0	0	3.2	3.6	40	15	4	5	100	60	400
Vitamin B-Complex 100 (Bioniche Pharma)	1 mL	0	0	0	0	100	2	100	2	2	0	0	0	0
Vitalipid N Adult (Fresenius Kabi)	10 mL	3300	200	10	150	0	0	0	0	0	0	0	0	0
Paediatric														
Infuvite PEDiatric (Baxter)	5 mL	2300	400	7	200	1.2	1.4	17	5	1	1	80	20	140
M.V.I. Pediatric (Hospira)	5 mL	2300	400	7	200	1.2	1.4	17	5	1	1	80	20	140
Vitalipid N Infant (Fresenius Kabi)	10 mL	2300	400	7	200	0	0	0	0	0	0	0	0	0

Yếu tố vi lượng

- Chiếm < 0.01% tổng trọng lượng cơ thể, cơ thể không tự tổng hợp được
- Hoạt động như một mạng lưới
- Vai trò kết hợp trong các phản ứng chuyển hóa, chống oxy hóa, nội tiết, miễn dịch
- Vi lượng nhưng vai trò lớn trong các chức năng sống còn
- Biểu hiện không đặc hiệu, dễ bị bỏ qua

YẾU TỐ VI LƯỢNG	Vai trò	Dấu hiệu LS của thiếu hụt	Dấu hiệu LS của ngộ độc
Cu	Thải loại gốc tự do, giúp bảo vệ màng TB khỏi tổn thương oxy hoá; cần thiết cho chức năng phù hợp của các cơ quan và quá trình chuyển hoá	Thiếu máu nhược sắc không đáp ứng với điều trị Fe, giảm 3 dòng TB, kém lành vết thương, loãng xương, gãy xương	Xơ gan; tổn thương thận; là chất tiền oxy hoá gây tổn thương oxy hoá cho TB và mô
Se	Thải loại bỏ gốc tự do, chống oxy hoá; giảm nguy cơ nhiễm trùng huyết; đóng vai trò chuyển hoá hormon tuyến giáp	Rối loại cơ tim; rối loạn cơ vân; HC to; bất thường giường móng; giả bạch tạng; chậm phát triển; rụng tóc	Chất tiền oxy hoá gây tổn thương oxy hoá cho TB và mô
Zn	Đồng yếu tố > 300 enzyme chứa kim loại, quan trọng cho quá trình tăng trưởng, biệt hoá TB, chuyển hoá protein, CH, lipid, đóng vai trò trong cấu trực hormon, phát triển đường tiêu hoá, chức năng miễn dịch, yếu tố phiên mã di truyền	Chậm tăng trưởng; sụt cân; kém phát triển; viêm da quanh miệng; viêm lưỡi; tăng khả năng nhiễm trùng; tiêu chảy	Ức chế sự hấp thu của Cu và Fe; buồn nôn; nôn; đau; co rút cơ; tiêu chảy
Mn	Đồng yếu tố cho một số enzyme, như superoxide dismutase, pyruvate carboxylase	Ảnh hưởng đến sự hình thành mucopolysaccharide và lipopolysaccharide; suy giảm phát triển cơ vân và thất điều (mô hình ĐV)	Gây tình trạng suy giảm catecholamin trung tâm của hệ TKTW; mất ngủ; đau đầu; lo lắng; cử động tay nhanh; mất phối hợp (giống bệnh Parkinson)
Cr	Quan trọng đối với chuyển hoá chất dinh dưỡng đa lượng; tăng cường hoạt động của insulin, quan trọng trong quá trình tổng hợp yếu tố dung nạp Glucose, đồng yếu tố trong hoạt động của insulin	Tăng đường huyết kháng insulin; bất dung nạp Glucose; sụt cân; nồng độ acid béo tự do trong huyết tương cao	Giảm độ lọc cầu thận; tổn thương ống thận; tăng creatinin
Mo	Cần cho 3 hệ thống enzyme: xanthin dehydrogenase,oxidase, aldehyde oxidase, sulfite oxidase	Các triệu chứng tim mạch và TK (bao gồm cả nhịp tim nhanh và hôn mê); lượng sulfate và urate trong máu cao	Không có dữ liệu độc ở người; ở động vật ghi nhận tiêu chảy, chậm tăng trưởng, vô sinh, CNLS thấp, bệnh gout, độc tố ảnh hưởng phổi, thận, gan
I	Thành phần chính của hormon tuyến giáp điều hoà các phản ứng sinh hoá trọng yếu trong chuyển hoá năng lượng và protein; cần thiết cho tăng trưởng, phát triển, trưởng thành	Suy giáp; chậm tăng trưởng; chậm phát triển TK; đần độn (suy giáp bẩm sinh); bướu cổ goiter	Cường giáp; tăng tiết nước bọt, kích ứng đường tiêu hoá, tổn thương da dạng mụn trứng cá; ngộ độc lâu dài: bướu cổ goiter, suy giáp, phù niêm

Finch C.W. (2015), Nutrition in Clinical Practice, 30: 44-58

	ESPGHAN (2018)		ASPEN (2020)	
	Non tháng	Đủ tháng	Non tháng	Đủ tháng
Cr	--	--	--	0.2
Cu	40	20	40	20
Fe	200 -250	50 -100	200-250	50-100
I	1-10	1	1-10	1
Mn	≤ 1	≤ 1	1	1
Mo	1	0.25	1	0.25
Se	7	2-3	7	2-3
Zn	400 - 500	250	400-500	50-250

M. Domellof et al. (2018), Clinical Nutrition; 37: 2354-2359
Hardy G et al. (2020) *JPEN J Parenter Enteral Nutr.*;44 Suppl 2:S5-S23.

Hỗn hợp vi chất trong dinh dưỡng tĩnh mạch

- Thường không chứa Mo, Fe (Fe được bổ sung riêng)
- Nên được cung cấp sớm trong những ngày đầu trong dinh dưỡng tĩnh mạch ở trẻ sinh non
- Nếu bệnh gan tắc mật: giảm lượng Cu, Mn
- Nếu suy thận, giảm Se

	Junimin	ESPGHAN / ASPEN	
		Non tháng	Đủ tháng
Cu	20	40	20
I	1	1-10	1
Mn	0.5	≤ 1	1
Se	2	7	2-3
Zn	100	400	250
Liều (ml/kg)	1	2	1

Fluid $^{ml}/_{kg}$ /day	1st day 70-90 2nd day 90-110 3rd day 110-130 4th day 130-150 5th day 160-180 After: 140-160
Glucose $^{mg}/_{kg}$ /min ($^{g}/_{kg}$ /day)	Day 1: start with 4-8 (5.8-11.5) Day 2 onwards: increase gradually over 2-3 days: target to 8-10 (11.5-14.4) min 4 (5.8); max 12 (17.3)
Amino acids $^{g}/_{kg}$ /day	First day: at least 1.5 Onwards: 2.5-3.5
Lipids $^{g}/_{kg}$ /day	Minimum of 0.25 Up to 4
Sodium (Na) $^{mmol}/_{kg}$ /day	Days 1-2: 0-2 (3) Day 3: 0-5 (7) Day 4 and after, until stable growth is established: 2-5 (7) After stable growth is established: 3-5 (7)
Potasium (K) $^{mmol}/_{kg}$ /day	Days 1-3: 0-3 Days 4-5: 2-3 After, until stable growth is established: 1-3 After stable growth is established: 2-5
Chlorine (Cl) $^{mmol}/_{kg}$ /day	Days 1-3: 0-3 After, until stable growth is established: 2-5 After stable growth is established: 3-5
Calcium (Ca) $^{mmol(mg)}/_{kg}$ /day	During the first days: 0.8-2.0 (32-80) After stable growth: 1.6-3.5 (64-140)
Phosphorus (P) $^{mmol(mg)}/_{kg}$ /day	During the first days: 1.0-2.0 (31-62) After stable growth: 1.6-3.5 (50-108)
Magnesium (Mg) $^{mmol(mg)}/_{kg}$ /day	During the first days: 0.1-0.2 (2.5-5) After stable growth: 0.2-0.3 (5.0-7.5)

Iron	200-250 $^{\mu g}/_{kg}$ /day
Zinc	400-500 $^{\mu g}/_{kg}$ /day
Copper	40 $^{\mu g}/_{kg}$ /day
Iodine	1-10 $^{\mu g}/_{kg}$ /day
Selenium	7 $^{\mu g}/_{kg}$ /day
Manganese	≤1 $^{\mu g}/_{kg}$ /day
Molybdenum	1 $^{\mu g}/_{kg}$ /day
Chromium	-
Vitamin A	700-1500 $^{IU}/_{kg}$ /day (227-455 $^{\mu g}/_{kg}$ /day)
Vitamin D	200-1000 $^{IU}/_{day}$ or 80-400 $^{IU}/_{kg}$ /day
Vitamin E	2.8 – 3.5 $^{mg}/_{kg}$ /day or 2.8 – 3.5 $^{IU}/_{kg}$ /day
Vitamin K	10 $^{\mu g}/_{kg}$ /day
Vitamin C	15-25 $^{mg}/_{kg}$ /day
Thiamine	0.35-0.50 $^{mg}/_{kg}$ /day
Riboflavin	0.15-0.2 $^{mg}/_{kg}$ /day
Pyridoxine	0.15-0.2 $^{mg}/_{kg}$ /day
Niacin	4-6.8 $^{mg}/_{kg}$ /day
Vitamin B12	0.3 $^{\mu g}/_{kg}$ /day
Pantothenic acid	2.5 $^{mg}/_{kg}$ /day
Biotin	5-8 $^{\mu g}/_{kg}$ /day
Folic acid	56 $^{\mu g}/_{kg}$ /day

Theo dõi

- Cân mỗi ngày
- Đo chiều dài, vòng đầu mỗi tuần
- Các XN (bảng)

Parameter	Frequency
Weight	Daily
Length and OFC	Weekly
Serum glucose	1×/shift during week 1, then daily
Serum Na, K, Cl, BUN, Ca, P, Mg, hematocrit	2–3×/week during week 1, then weekly
Alkaline phosphatase, ALT (SGPT), GGT, fractionated bilirubin	Weekly

ALT, Alanine aminotransferase; *BUN*, blood urea nitrogen; *GGT*, gamma-glutamyl transferase; *OFC*, occipitofrontal circumference; *SGPT*, serum glutamate-pyruvate aminotransferase.

Thông điệp

- Dinh dưỡng cho trẻ sơ sinh là vấn đề quan trọng cơ bản
- Cần dinh dưỡng đầy đủ, tối ưu cho sự phát triển của trẻ
- Theo dõi quá trình tăng trưởng nhằm can thiệp dinh dưỡng kịp thời và phù hợp