Contents

CHAPTER 1

Nutrition for Preterm and Beyond

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PRETERM AND LOW BIRTH WEIGHT INFANTS

Recent advances in the nutritional care for the preterm neonate have led to better survival and improved awareness regarding the importance of nutritional support. In the early weeks of life, when gastrointestinal motility is still not well established, enteral feed tolerance may be difficult and challenging. The growth velocity is higher in preterm than in term babies. Premature infants have high nutritional demands and poor nutrient stores.

Preterm growth charts should be used for these infants. The Fenton preterm growth chart is one of the most commonly used charts.

Prematurity is often discussed with respect to the birth weight and gestational age, as shown in **Box 1.**

BOX 1: Classification of prematurity categorized as per birthweight and gestational age.

Classifications

Maturity by gestational age
- Preterm: <37 weeks
- Term: 37–42 weeks
- Post-term: >42 weeks

Birth weight
- Low birth weight (LBW): <2,500 g
- Very low birth weight: <1,500 g
- Extremely low birth weight: <1,000 g

Birth weight for gestational age
- Intrauterine growth retardation: Weight < 3rd percentile
- Small for gestational age (SGA): Weight < 10th percentile
- Asymmetric SGA: Weight only < 10th percentile
- Symmetric SGA: Weight, length, head circumference < 10th percentile
- Appropriate for gestational age: Weight 10th–90th percentile
- Large for gestational age: Weight > 90th percentile

Feeding of Preterm Infants

Adequate nutrition is essential for optimal growth, resistance to infection, optimal neurologic and cognitive development. Providing adequate nutrition to preterm infants is challenging because of several problems. These problems include immaturity of bowel function, inability to suck and swallow, high risk of necrotizing enterocolitis (NEC), other illnesses that may interfere with adequate enteral feeding[1]. **Flowchart 1** depicts the nutrient requirements for preterm infants.

Parenteral Nutrition

Goals to achieve while starting of parenteral feeding.

- The majority of premature infants will start with the initiation of parenteral nutrition which should provide recommended fluid and nutrient estimates until enteral feeds can be established **(Table 1)**.
- Parenteral nutrition for premature infants should begin in the first 24–48 hours of

Flowchart 1: Nutrient requirements for preterm infants.[2]

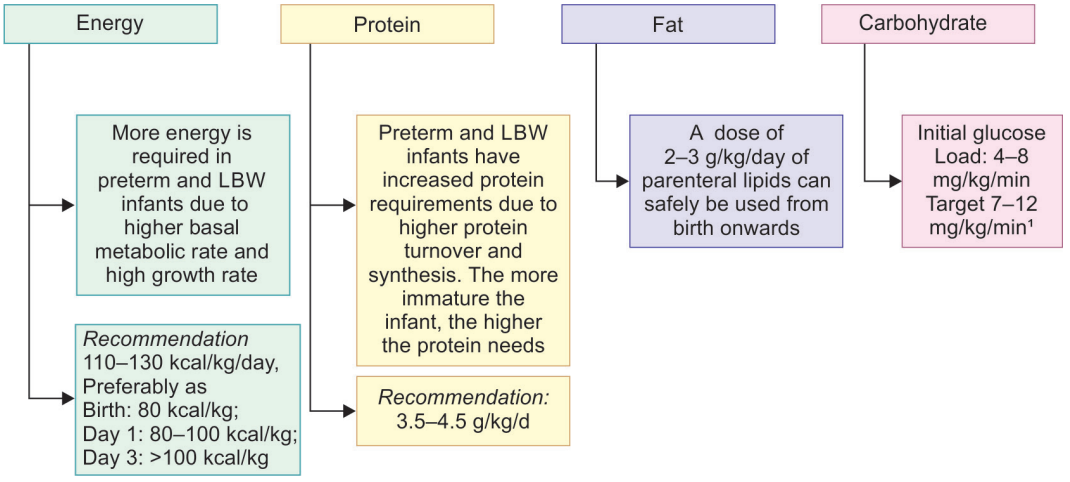

TABLE 1: Parenteral nutrition in premature infants.[3]

Fluid requirements		
Preterm neonate:	>1,500 g:	60–160 mL/kg
	1,000–1,500 g:	70–180 mL/kg
	<1,000 g:	80–180 mL/kg
Vitamins		
Vitamin A: 400–1,000 µg/kg/day		Vitamin D: 800–1,000 IU/kg/day
Vitamin C: 11–46 mg/kg/day		Thiamine: 140–300 µg/kg/day
Riboflavin: 200–400 µg/kg/day		Niacin: 380–5,500 µg/kg/day
Vitamin E: 2.8–3.5 IU/kg/day		Vitamin B_{12}: 0.2 µg/kg/day
Pyridoxine: 0.15–0.2 mg/kg/day		Pantothenic acid: 2.5 mg/kg/day
Biotin: 5–8 µg/kg/day		Folic acid: 56 µg/kg/day
Minerals and trace elements		
Iron: 200–250 µg/kg/day	Calcium: 60–90 mg/kg/day	Phosphorus: 31–62 mg/kg/day
Magnesium: 2.5–5.0 mg/kg/day	Iodine: 1–10 µg/kg/day	Zinc: 400–450 µg/kg/day
Selenium: 7 µg/kg/day	Copper: 40 µg/kg/day	Manganese: ≤1 µg/kg/day
Additives		
Na: 2–4 mEq/kg/day		
K: 2–4 mEq/kg/day		
Cl: 2–3 mEq/kg/day		

life, once urine output is established and electrolyte is stable.

- Parenteral nutrient intake may be built up over a number of days; glucose and fat tolerance need to be monitored carefully with blood glucose and plasma triglyceride measurements.
- Complications associated with use of parenteral nutrition include glucose intolerance, bloodstream infection resulting from central venous catheter-related sepsis, cholestasis and hypertriglyceridemia.
- Parenteral nutrition should follow recommended fluid and nutrient estimates.

Enteral Nutrition

The gestational age of the infant will affect the decision to feed orally or by tube feeding since suck, swallow and breathe coordination do not develop until 32–34 weeks' gestation. Feed advancement is often based on birth weight **(Table 2)**.

Human Milk Fortifier

The nutritional composition of expressed breast milk (EBM) can be insufficient to meet the requirement of preterm babies. Human milk fortifier (HMF) can be added to EBM. HMF contains protein, fat, carbohydrate, sodium, calcium, phosphorus, zinc and vitamins.

Discharge Planning

Very low birth weight or small for gestational age infants at birth are at risk. Infants with a history of poor feeding skills, who were on long-term parenteral nutrition, or who have had a complicated medical course or nutritional deficits are also at risk and should have routine follow-up visits after discharge.

The infant should be fed orally, but in certain medical conditions cases, tube feeding may be initiated, based on the medical condition and parental readiness.

Human milk fortifiers are not recommended for home use because of their high concentration of protein and minerals. Infants not on breast milk should be on preterm transition formulas for home. These feed formulations can be started close to time of discharge. Preterm formulas provide a higher concentration of protein, vitamins and minerals than term infant formulas.

TABLE 2: Enteral nutrition: feeding advancement and goals.[2,3]

Energy
- 110–130 kcal/kg/day
- 150–160 kcal/kg

(in bronchopulmonary dysplasia, small for gestational age infants)

Protein
- 3.0–4.0 gm/kg/day

Calcium: 120–140 mg/kg/day
Phosphorus: 60–90 mg/kg/day

Multivitamin
- Preterm infants receiving breast milk exclusively should receive multivitamin supplementation

Birth weight (g)	*Initial volume (mL/kg/day)*	*Volume increase (mL/kg/day)*
<800	10	10–20
800–1,000	10–20	10–20
1,001–1,250	20	20–30
1,251–1,500	30	30
1,501–1,800	30–40	30–40
1,801–2,500	40	40–50
>2,500	50	50

NUTRITION CARE OF THE PEDIATRIC PATIENT

Introduction

Covering over a span of 18 years, childhood is one of the most intense stages in a person's lifetime. The time covered by childhood in one's life is vast that can be categorized into different phases of life such as infancy, preschool and early school-going phase, later childhood years and adolescence. With the global estimates of malnutrition skyrocketing (22% of children under the age of 5 in the world are stunted and 6.7% of children under the age of 5 are wasted) and India not faring any better (34.7% and 17.3% of children in India are stunted and wasted, respectively) as of 2020, it is essential that due importance be given to pediatric nutrition.[4,5]

Growth and development during childhood is significant and adequate nutrition is essential for every child's survival. With malnutrition so prevalent in our country, it is important that a clear distinction be made between growth and development.

Figure 1 shows the difference between growth and development, where the former is quantitative, the latter is both quantitative and qualitative.

A severe deviation from normal growth and development is what causes malnutrition in children. Although malnutrition is commonly associated with undernutrition the term also includes overnutrition and micronutrient deficiencies.

During infancy, rapid gains in weight and length are normal. However, persistence of rapid weight gains while going into adolescence is a predictor of progression to obesity. This reinforces effective pediatric nutrition support, by providing accurate assessment of nutritional status and ensuring appropriate nutrients are provided to optimize growth.

A poorly balanced diet can impact several important developmental milestones in children.

Weight Velocity

The age-dependent changes in velocity that characterize postnatal growth can be shown using weight velocity charts. The weight velocity charts can be accessed from the WHO website.

Some important developmental milestones while measuring the weight velocity are given in **Figure 2**.

According to the child growth standards set by the World Health Organization (WHO), the velocity standards for weight are presented in **Table 3**.

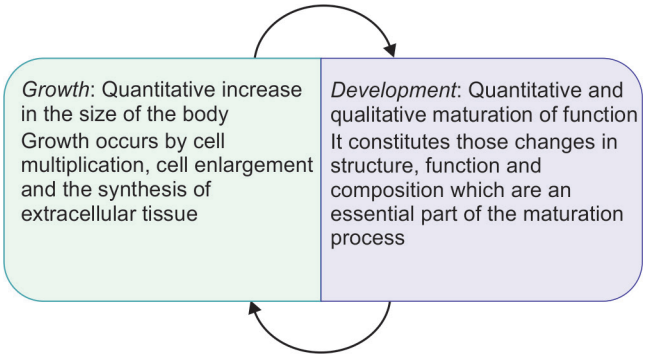

Fig. 1: Difference between growth and development.

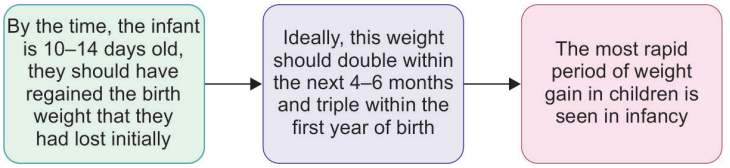

Fig. 2: Developmental milestones while measuring weight velocity.

TABLE 3: Weight velocity standards as per WHO.

Age group	*Increments*
Birth to 12 months	1 month increment
Birth to 24 months	2 to 6 month increment
Birth to 60 days	Depends on birth weight

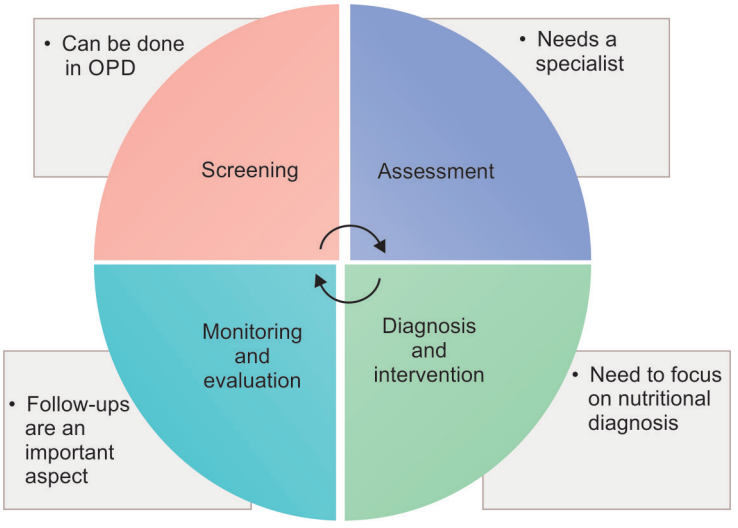

Fig. 3: Nutrition care process and its components.

Nutrition Care Process in Pediatrics

A systematic approach to providing high-quality nutrition care to patients is called the Nutrition Care Process (NCP). Nutrition assessment, nutrition diagnosis, nutrition intervention and nutrition monitoring/evaluation are the four main steps in the NCP model. **Figure 3,** shows the Nutrition care process and its components. This helps us in identifying any possible causes of abnormal nutrition status, collecting any information to develop an appropriate nutrition care plan and to evaluate the effectiveness of the nutrition care plan.[8]

Nutritional Screening

What can be described as a precursor of nutrition assessment, nutrition screening identifies those who are at risk of being malnourished and are susceptible to diseases. The subjective data related to diet and associated lifestyle behavior, information regarding body weight, medical history and other anthropometric data are collected during the screening process. The purpose of a nutritional screening is to provide a snapshot of the dietary factors of interest, define nutritional education goals, guide

recommendations for dietary supplements and identify the need to refer a patient to a registered dietitian for consultation.

The different aspects of nutrition screening and assessment have been shown in **Figure 4**.

Tools Used for Nutrition Screening

There are several tools specific to pediatric patients that are commonly used for the process of nutrition screening as shown in **Table 4**.[9,10]

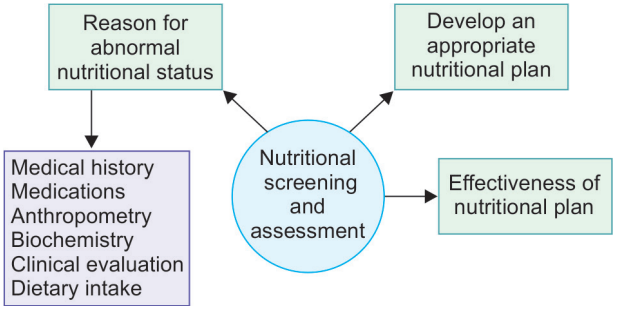

Fig. 4: Different aspects of nutrition screening and assessment.

TABLE 4: Different tools available for nutrition screening and assessment.

S.No.	*Screening tool*	*Tool description or target population*
1	Scored Patient-Generated Subjective Global Assessment (PG-SGA)	Useful for oncology and other chronic catabolic condition
2	Pediatric Nutrition Screening Tool (PNST)	Hospitalized pediatric patients
3	Screening Tool Risk on Nutritional Status and Growth (STRONGkids)	Screening tool for risk on nutritional status and growth
4	Pediatric Yorkhill Malnutrition Score (PYMS)	To ensure the early detection of hospitalized children at nutrition risk
5	Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP)	Developed for hospitalized children aged 2–17 years; allows for repeated screening
6	STAMP (Mod) Screening Tool for the Assessment of Malnutrition in Pediatrics-Modified [STAMP (Mod)]	Modified version of STAMP (above) for children in the outpatient setting
7	Electronic Kids Dietary Index (E-Kindex)	For children in the community
8	Integrated Management of Childhood Illness (IMCI)	Designed by WHO to be used by health workers in developing countries
9	Nutrition Risk Screening Tool for Children and Adolescents with Cystic Fibrosis (NRST-CF)	Developed for children with cystic fibrosis in the inpatient or outpatient setting
10	Nutrition Screening Tool for Every Preschooler (NutriSTEP)	A community-based, parent-administered tool for preschool children
11	Nutrition Screening Tool for Every Preschooler-Toddler (NutriSTEP-Toddler)	Modified version of NutriSTEP (above); a community-based, parent-administered tool for toddlers (18–35 months)
12	Pediatric Nutrition Risk Score (PNRS)	Developed for hospitalized children > 1 month of age at risk of acute malnutrition
13	Pediatric Nutrition Screening Tool (PNST)	Developed to improve simplicity of nutrition screening in hospitalized children
14	Pediatric Malnutrition Screening Tool (PMST)	Modified version of STAMP for hospitalized children aged < 2–17 years; screens for both under and overnutrition
15	Nutrition Screening Tool for Childhood Cancer (SCAN)	Developed for children with a cancer diagnosis

Nutrition Assessment

Nutritional assessment is the systematic process of collecting and interpreting information in order to make decisions about the nature and cause of nutrition-related health issues that affect an individual. It involves the identification and quantification of nutritional deficits. A person's nutritional status reflects the balance between supply and demand and the consequences of any imbalance in their body. This step also includes reassessment for comparing and re-evaluating data from the previous interaction to the next and collection of new data that may lead to new or revised nutrition diagnoses. The ABCD of nutrition assessment includes anthropometry, biochemical, clinical and dietary analysis.

Anthropometry

A quantitative measurement of the muscle, bone and adipose tissue used to assess the composition of the body is called the anthropometric measurement.[11,12]

Some of the pediatric anthropometric measurements include:

- Height
- Weight
- Head circumference
- Skinfold measurement
- Mid-upper arm circumference (MUAC). The grade of malnutrition using MUAC z-score is shown in **Table 5**.

Confirming malnutrition: Depending on the above measurements, with the help of growth standards/reference charts, several anthropometric indices are made in order to confirm the presence of malnutrition in a person.[13]

TABLE 5: Assessing the grade of malnutrition using MUAC z-score.

MUAC z-score	*Grade of malnutrition*
1–1.9	Mild malnutrition
2–2.9	Moderate malnutrition
3 or greater	Severe malnutrition

1. *Height-for-age*: It compares a child's height/length with a healthy reference child of the same age.
2. *Weight-for-age*: It reflects acute and chronic undernutrition.
3. *Weight-for-height*: It helps to understand the degree of wasting.
4. *Body mass index (BMI)-for-age*: In children, BMI is age and sex specific because the amount of fat varies with age and between boys and girls. This index is specifically used in children above the age of 5.
5. *Z-score/standard*: Z-score is a tool used to quantify standard deviations (SDs) from population mean value. Z score is also helpful in quantifying and to track the indicators that are below the 5th or which lie above 95th percentile. (The percentile is the rank position of an individual on a given reference distribution, stated in terms of what percentage of the group the individual equals or exceeds). A z-score of 0 is at the apex of the curve and is the same as a 50th percentile, a z-score of ± 1.0 plots at the 15th or 85th percentiles, respectively and a z-score of ± 2 plots at roughly the 3rd or 97th percentiles.

$$\text{Z-score} = \frac{(\text{Observed value}) - (\text{Median reference value})}{\text{Standard deviation}}$$

Growth charts: Growth standards represent the description of physiological growth for children who live under optimal environmental conditions, receiving optimal nutrition, health care and show desirable