

# Undernutrition in Children with Neurological Impairment

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## 1. Evaluation

### Antropometry:

- Weight (**W**), Height (**H**) and Body Mass Index (**BMI**) centiles and z-score BMI > 2 years of age; W, Length/Height (L/H) centiles and z-scores and cranial circumference (**CC**) < 2 years of age

- Table 1.1 Derivative equations for height in neurological impairment

Table 1.1

Author	Equation (H= height in cm)	Parameter
Stevenson	H = (4,35 x AL) + 21,8	Arm Length (AL) cm
	H = (3,26 x TL) + 30,8	Tibial Length (TL) cm
	H = (2,69 x KH) + 24,2	Knee Height (KH) cm
Chumlea	H = 40,54 + (2,22 x KH)	Knee Height (KH) cm
	Caucasic males	
	Afro- American Males	
	H = 43,21 + (2,15 x KH)	
	H = 46,59 + (2,02 x KH)	
Gauld	H = (4,605 x UL) + (1,308 x A) + 28,003	Ulnal Length (UL)
	Males	
	H = (4,459 x UL) + (1,315 x A) + 31,485	
	Females	

### Body Composition:

- Triceps skinfolds (centile and z-score)  
 - Mid Upper Arm Circumference (MUAC) and Mid-Arm-Muscle Circumference (MAMC) centiles and z-scores

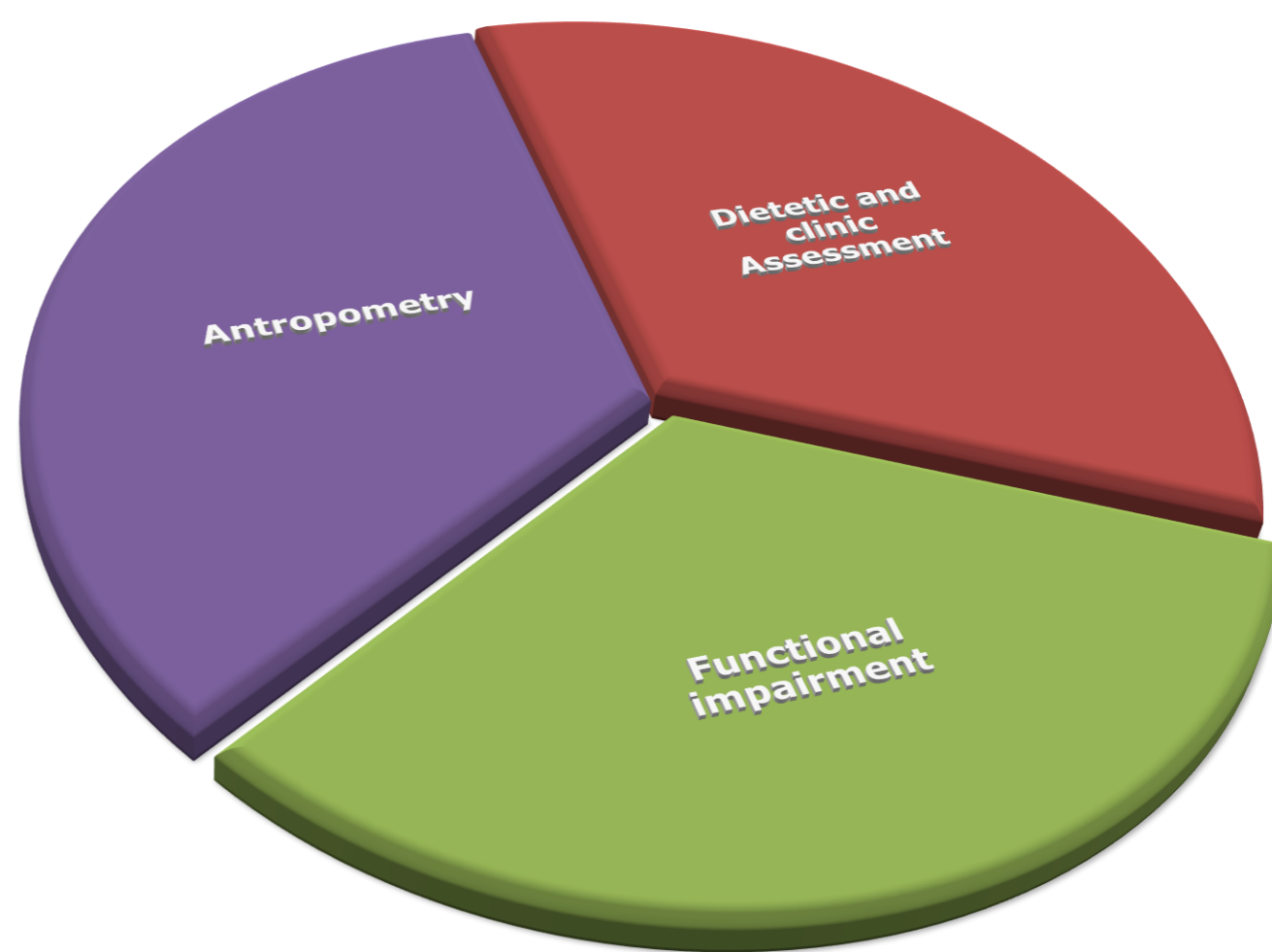
#### Red flags

1. Physical signs (eg decubitus skin and poor peripheral circulation)
2. Weight for age z score < - 2.
3. Triceps skinfold thickness < 10th centile for age and sex.
4. Mid-upper arm fat or muscle area < 10th percentile
5. Faltering weight and/or failure to thrive.

### Dietetic and Clinic Assessment

- **Adequate caloric, proteic, micronutrient and hydric intake** (include evaluation feeding time and needs dispercption by caregiver)  
 - **Increasing losses** (GERD with vomiting and regurgitation)  
 - **Altered Metabolism** (61 ± 15% basal metabolism with increasing on basis of spasticity, active mobility and fisiotherapy)  
 - **Non nutritional factors:** alteration of the hypothalamic-pituitary axis (and so linear growth decline, hemiplegic side < contralateral, absence of pubertal spurt), severity of disease (Gross Motor Function Classification System o GMFCS), motor patterns (Hypotonic, Athetoid, Dystonic, Spastic, Etc), associated Gastrointestinal symptoms (GastroEsophageal Reflux Disease, Oropharyngeal Dysphagia, constipation, airway aspiration)

Figura 1.1 Evaluation of undernutrition in children with Neurological Impairment (NI). In this pediatric population (NI) the prevalence of undernutrition is 29-46% and the prevalence of stunting is 23%



Romano JPGN 2017;65: 242-264

**Oropharyngeal dysfunction (OPD)** is defined by the presence of disturbances in one of more of the 3 phases of swallowing (oral, pharyngeal, and esophageal). In children with NI reported prevalence of 90%.

### For evaluation OPD:

- **feeding history** from early infancy (eg, problems in sucking and swallowing).
- **symptoms:** sialorrhea, coughing, multiple swallows, gurgly voice, wet breathing, gagging, and choking and alterations in appetite, feeding difficulties, and prolonged feeding times (feeding time between 3-6 h/day or > 30 minutes per feed foods). Many of these symptoms are associated with dysfunction in the pharyngeal phase of swallowing, more significant OPD, and poorer longterm prognosis
- **observation of meal times** with or without the use of standardized and validated scoring systems
- **Videofluoroscopy (VFS)** → to identify discoordinate pharyngeal motility and silent aspiration.
- **Others** (VFS + high-resolution esophageal manometry to identify specific defects, videomanometry when there is a high suspicion of an abnormal pharyngeal phase of swallowing but the VFS is normal or where it is difficult to differentiate between upper esophageal sphincter function and pharyngeal dysmotility, etc.)

## 2. Nutritional Work-up

Figura 2.1 choice of formula based on gastrointestinal function, access, age and comorbidity

Adapted from Diamanti 2023  
 Front Nutr Mar 22:10:1087603

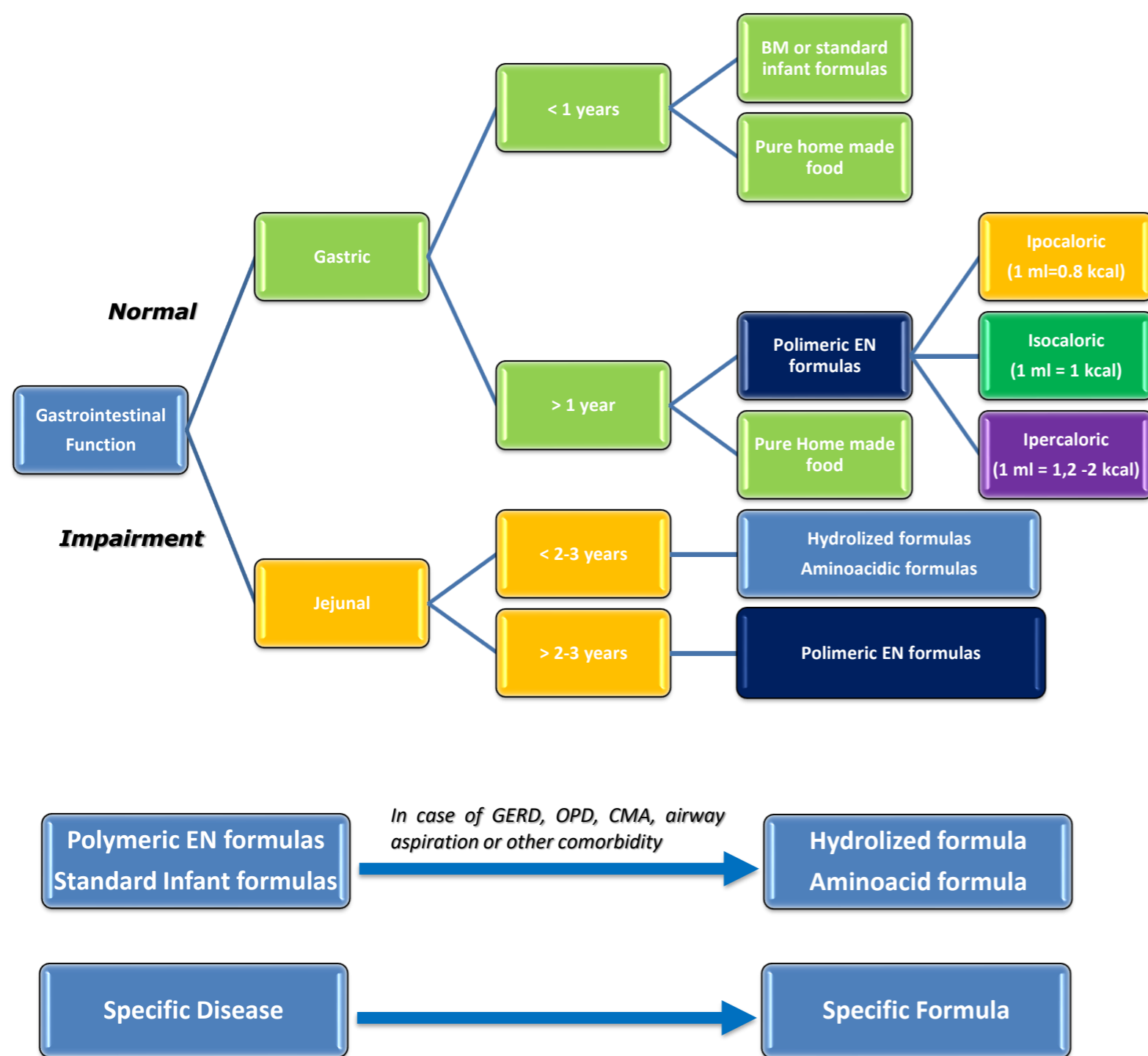


Figura 2.1. EN: Enteral Nutrition, GERD Gastro Esophageal Reflux Disease; OPD: Oro Pharyngeal Dysphagia; CMA: Cow's Milk Allergy

## 3. Caloric and hydric target

### Calculating energy needs of neurologically impaired patients

Paediatr Child Health. 2009 Jul-Aug; 14(6): 395-401.

#### 1. Krick method (32)

- Kcal/day = (BMR × muscle tone factor × activity factor) + growth factor  
 BMR (kcal/day) = Body surface area (m<sup>2</sup>) × standard metabolic rate (kcal/m<sup>2</sup>/h) × 24 h  
 Muscle tone factor: 0.9 if decreased, 1.0 if normal, 1.1 if increased  
 Activity factor: 1.15 if bedridden, 1.2 if dependant, 1.25 if crawling, 1.3 if ambulatory  
 Growth factor: 5 kcal/g of desired weight gain

#### 2. Height-based method (73)

- 14.7 cal/cm in children without motor dysfunction  
 13.9 cal/cm in ambulatory patients with motor dysfunction  
 11.1 cal/cm in nonambulatory patients

#### 3. Resting energy expenditure-based method (29)

- 1.1 × measured resting energy expenditure

Table 3.1. Krick method for energy requirements in children with neurological impairment (NI) (BMR + correction factors). The total daily caloric intake (kcal/day) was calculated by multiplying the Basal Metabolic Rate (BMR) value by the correction coefficients that take into account the tone muscle, level of physical activity and weight recovery desired

Kcal/day = BMR × Tone Factor <sup>o</sup> × Activity Factor <sup>∞</sup> + growth factor(s)# (mean is 79,4 kcal ± 20,9 body weight)	
*BMR (kcal/die)	Body surface area x standard Metabolic Rate x 24 hours
<sup>o</sup> Tone factors	Hypertonia - multiply by 1,1 (add 10%) Hypotonia - multiply by 0,9 (subtract 10%)
<sup>∞</sup> Activity factors	Bedridden - multiply 1,15 Wheelchair dependent - multiply by 1,2 Crawling - multiply by 1,25 Ambulatory - multiply by 1,3
#Growth factor(s)	Normal - add 31 kcal/day for 5 g/day weight gain Catch-up - add 150 kcal/day for 30 g/day weight gain

Table 3.2. The hydric intake, is possible calculate alternatively with the Holiday formula and Segar reported here.

Weight	mL/Kg/d	mL/Kg/h
<b>A: the first 10 Kg</b>	100	4
<b>B: weight between 10 and 20 Kg</b>	+ 50 mL/extra Kg/d	+ 2 mL/extra Kg/h
<b>C: weight above 20 Kg</b>	+ 25 mL/extra Kg/d	+ 1 mL/extra Kg/h
<b>Sum total requirements</b>	A + B + C	A + B + C