Pediatric Nutrition Helpful Hints

Specialized nutrition for your most vulnerable patients.

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PEDIATRIC NUTRITION

CRITICAL CARE NUTRITION

NUTRITON IN THE NEUROLOGICALLY IMPAIRED CHILD

PEDIATRIC NUTRITION

PEDIATRIC NUTRITION

Baseline fluid requirements

1-10 kg	100 mL/kg
10-20 kg	1000 mL + 50 mL/kg for each kg above 10 kg
> 20 kg	1500 mL + 20 mL/kg for each kg above 20 kg

Daily fluid

Fluid needs based on above formula:

WEIGHT (kg)	DAILY FLUID REQUIREMENTS* (mL)	WEIGHT (kg)	DAILY FLUID REQUIREMENTS* (mL)
1	100	52	2140
2	200	54	2180
3	300	56	2220
4	400	58	2260
5	500	60	2300
6	600	62	2340
7	700	64	2380
8	800	66	2420
9	900	68	2460
10	1000	70	2500
12	1100	72	2540
14	1200	74	2580
16	1300	76	2620
18	1400	78	2660
20	1500	80	2700
22	1540	82	2740
24	1580	84	2780
26	1620	86	2820
28	1660	88	2860
30	1700	90	2900
32	1740	92	2940
34	1780	94	2980
36	1820	96	3020
38	1860	98	3060
40	1900	100	3100
42	1940	102	3140
44	1980	104	3180
46	2020	106	3220
48	2060	108	3260
50	2100	110	3300

*This number is only an estimate based on the above equation. Physician may determine actual individual fluid needs to be either lower or higher than this amount. Adapted from: Thomas EY. Fluid and Electrolytes. *The Harriet Lane Handbook*, Twentieth Edition. Elsevier Saunders 2015: 246-249

Initiation and Advancement of Enteral Feeds

(from A.S.P.E.N. Enteral Nutrition Practice Recommendations, 2009):

1. Beginning and advancing enteral feedings in pediatric patients is guided by clinical judgment and institutional practices in the absence of prospective controlled clinical trials.
2. Generally children are started on an isotonic formula at a rate of 1-2 mL/kg/h for smaller children and 1mL/kg/h for larger children over 35-40 kg.
3. The rate is advanced based on tolerance by the child with the goal of providing 25% of the total calorie needs on day 1.
4. Feedings are advanced to goal calories within 24-48 hours and then bolus feedings are started, if indicated.
5. Bolus feedings are given via gravity or over a longer period of time via an enteral feeding pump.
6. When the plan involves beginning with bolus feedings, a volume of 2.5-5 mL/kg can be given 5-8 times per day with gradual increases in this volume to decrease the number of feedings to closer to 5 times daily.
7. Bolus feedings can be given over shorter periods of time by gradually increasing the volume infused per hour.
8. At no time should a bolus feeding be given in a shorter period of time than a child would be expected to consume if given a bottle feeding.
9. Maximum volumes for continuous and bolus feedings are determined by the child's response to the regimen, weight gains, and overall GI status.
10. Bolus feedings may be started with 25% of the goal volume divided into the desired number of daily feedings.
11. Formula volume may be increased by 25% per day as tolerated, divided equally between feedings.
12. Pump-assisted feedings: A full-strength, isotonic formula can be started at 1-2 mL/kg/h and advanced by 0.5-1 mL/kg/h every 6-24 hours until the goal volume is achieved.
13. Preterm, critically ill, or malnourished children who have not been fed enterally for an extended period may require a lower initial volume of 0.5-1 mL/kg/hour.

Reference: Adapted from Bankhead R, et al. A.S.P.E.N. Enteral Nutrition Practice Recommendations. *JPEN J Parenter Enteral Nutr* 2009; 33; 122-167.

Growth velocity

AGE	WEIGHT (g/DAY)	LENGTH (cm/MO)
< 3 mo	25-35	2.6-3.5
3-6 mo	15-21	1.6-2.5
6-12 mo	10-13	1.2-1.7
1-3 yr	4-10	0.7-1.1
4-6 yr	5-8	0.5-0.8
7-10 yr	5-12	0.4-0.6

Adapted from Fomon SJ, Haschke F, et al. Body composition of reference children from birth to age 10 years. *Am J Clin Nutr* 1982;35:1169.

Catch-up growth requirements

$$\text{Catch-up growth Requirement (kcal/kg/d)} = \frac{\text{RDA calories for age (kcal/kg/d)} \times \text{Ideal weight for height (kg)}}{\text{Actual weight (kg)}}$$

$$\text{Protein requirement (g/kg/d)} = \frac{\text{RDA protein for age (g/kg/d)} \times \text{Ideal weight for height (kg)}}{\text{Actual weight (kg)}}$$

1. Plot the child's height and weight on the growth charts (WHO charts if child is 0-2 years, NCHS charts if child is over the age of 2)

2. Determine the child's recommended calories per kg for this child's age

3. Determine the ideal weight (50th percentile) for this child's height

4. Multiply the value obtained in (2) by the value obtained in (3)

5. Divide the value obtained in (4) by actual weight

For the protein equation, follow same steps, but in (2), substitute protein for calories.

Guidelines are used to estimate catch-up growth requirements; precise individual needs vary and are mediated by the medical status and diagnosis.

Adapted from KM Corrales and SL Utter, Failure to Thrive. In Samour PQ, Helm KK and Lang CE. *Handbook of Pediatric Nutrition*, 2nd ed. Aspen Publishers. 1999;406.

Estimated Energy Requirements (EER)

WHO[a] and Schofield[b]

EER (kcal/day) = Resting Energy Expenditure X Activity Factor X Stress Factor

Resting energy expenditure

AGE	GENDER	WHO[A]	SCHOFIELD[B]
0-3 yrs	Male	60.7W - 54	0.17W + 15.17H - 617.6
	Female	61W - 51	16.25W + 10.232H - 413.5
3-10 yrs	Male	22.7W + 495	19.6W + 1.303H + 414.9
	Female	22.5W + 499	16.97W + 1.618H + 371.2
10-18 yrs	Male	17.5W + 651	16.25W + 1.372H + 515.5
	Female	12.2W + 746	8.365W + 4.65H + 200.0

Note: W=Weight (kg); H=Height (cm)

A. WHO. Energy and Protein Requirements. WHO Tech Rep Ser no 724. Geneva; 1985.

B. Schofield WN. Predicting basal metabolic rate, new standards and review of previous work. *Hum Nutr Clin Nutr* 1985;39c(1s):5-42.

ACTIVITY FACTORS		STRESS FACTORS			
Paralyzed	1.0	Surgery	1.2-1.5	Burn	1.5-2.5
Confined to bed	1.1	Infection	1.2-1.6	Starvation	0.7
Ambulatory	1.2-1.3	Trauma	1.1-1.8	Growth Failure	1.5-2.0

From Nutrient Requirements. In Page CP, Hardin TC, Melnik G (eds): Nutritional Assessment and Support—a Primer, ed 2. Baltimore: Williams and Wilkins, 1994;32.

Dietary Reference Intakes (DRI)

EER (kcal/day) = Total Energy Expenditure + Energy Deposition

Infants and young children (ages 0-35 months)

AGE	EER
0-3 mos	(89W - 100) + 175
4-6 mos	(89W - 100) + 56
7-12 mos	(89W - 100) + 22
13-35 mos	(89W - 100) + 20

Children and adolescents (ages 3-18 years)

AGE	EER
Boys 3-8 yrs	88.5 - (61.9A + PA[26.7W + 903H])+20
9-18 yrs	88.5 - (61.9A + PA[26.7W + 903H])+25
Girls 3-8 yrs	135.3 - (30.8A + PA[10W + 934H])+20
9-18 yrs	135.3 - (30.8A + PA[10W + 934H])+25

Note: W= Weight (kg); H= Height (m); A= Age

Physical activity coefficients (PA), DRI (ages 3-18 years)

GENDER	SEDENTARY	LOW ACTIVE†	ACTIVE††	VERY ACTIVE†††
Boys	1.00	1.13	1.26	1.42
Girls	1.00	1.16	1.31	1.56

† (30-60 Mins. Daily moderate activity)
†† (60 Mins. Daily moderate activity)
††† (120 Mins. Daily moderate activity, or 60 mins. Moderate + 60 mins. Vigorous activity)

Estimates for overweight children

Total energy expenditure (TEE) for weight maintenance in overweight* children ages 3-18 years

GENDER	TEE (kcal/DAY)
Boys	114-50.9 x age (y) + PA x (19.5 x weight [kg] + 1161.4 x height [m])
Girls	389-41.2 x age (y) + PA x (15.0 x weight [kg] + 701.6 x height [m])

*Defined as BMI >95th %ile for age and sex

PA = physical activity coefficient

Physical activity coefficients (PAs) for overweight children ages 3-18 years

	PHYSICAL ACTIVITY LEVEL†			
GENDER	SEDENTARY	LOW ACTIVE	ACTIVE	VERY ACTIVE
Boys	1.00	1.12	1.24	1.45
Girls	1.00	1.18	1.35	1.60

†Physical activity level (PAL) is defined as the ratio of total energy expenditure to basal energy expenditure. PAL is determined from assessment of the amount of time the child or adolescent spends in moderate and vigorous play and work.

Food And Nutrition Board. Dietary Reference Intakes For Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids. Prepublication edition. Washington, DC: National Academies Press; 2005.

Growth:

Z-scores and percentiles

Z-SCORE	PERCENTILE
3	99.8%
2	97.7%
1	84.1%
0	50%
–1	15.9%
–2	2.3%
–3	0.1%

Degree of malnutrition and z-scores

DEGREE	Z-SCORE
Mild or at risk for malnutrition	<–1
Moderate	–2 to –3
Severe	<–3

Mehta N et al. *JPEN*. 2013:37(4):460-481

Chronicity of Malnutrition

Acute (Wasting)	< 3 months duration
Chronic (Stunting)	≥ 3 months duration

Mehta N et al. *JPEN*. 2013:37(4):460-481

Calorie and protein requirements, RDA

CATEGORY	AGE (YEARS)	kcal/kg	PROTEIN g/kg
Infants	0.0-0.5	108	2.2
	0.5-1.0	98	1.6
Children	1-3	102	1.2
	4-6	90	1.1
	7-10	70	1.0
Males	11-14	55	1.0
	15-18	45	0.9
	19-24	40	0.8
Females	11-14	47	1.0
	15-18	40	0.8
	19-24	38	0.8

Recommended Dietary Allowances, 10th ed, National Academy of Sciences, National Academy Press 1989; 33-36.

Dietary Reference Intakes for Total Protein by Life Stage Group:

AGES 1-18 YEARS				
DRI Values (g/kg/day)				
	EAR[a]		RDA[b]	
	MALES	FEMALES	MALES	FEMALES
1 through 3 years	0.87	0.87	1.05 (13)[c]	1.05 (13)
4 through 8 years	0.76	0.76	0.95 (19)	0.95 (19)
9 through 13 years	0.76	0.76	0.95 (34)	0.95 (34)
14 through 18 years	0.73	0.71	0.85 (52)	0.85 (46)

[a]EAR = Estimated Average Requirement. An EAR is the average daily nutrient intake level estimated to meet the requirements of half of the healthy individuals in a group.

[b]RDA = Recommended Dietary Allowance. An RDA is the average daily dietary intake level sufficient to meet the nutrient requirements of nearly all (97-98%) healthy individuals in a group.

[c]Values in parentheses ( ) are examples of the total g/day of protein calculated from g/kg/day times the reference weights in Part I, "Introduction to the Dietary Reference Intakes", Table 1 in: Dietary Reference Intakes, The Essential Guide to Nutrient Requirements. National Academy of Sciences, 2006.

Source: This table is derived from the DRI report: see **http://nap.edu**

EQUATIONS TO ESTIMATE ENERGY REQUIREMENT: AGES 0-18 YEARS		
Infants and Young Children Estimated Energy Requirement (kcal/day) = Total Energy Expenditure + Energy Deposition		
0-3 months		EER[a] = (89 x weight [kg] – 100) + 175
4-6 months		EER = (89 x weight [kg] – 100) + 56
7-12 months		EER = (89 x weight [kg] – 100) + 22
13-35 months		EER = (89 x weight [kg] – 100) + 20
Children and Adolescents 3-18 years Estimated Energy Requirement (kcal/day) = Total Energy Expenditure + Energy Deposition		
BOYS	3-8 yrs	EER = 88.5 – (61.9 x age [y]) + PA[b] x [(26.7 x weight [kg])] + (903 x height [m]) + 20
	9-18 yrs	EER = 88.5 – (61.9 x age [y]) + PA x [(26.7 x weight [kg])] + (903 x height [m]) + 25
GIRLS	3-8 yrs	EER = 135.3 – (30.8 x age [y]) + PA x [(10.0 x weight [kg])] + (934 x height [m]) + 20
	9-18 yrs	EER = 135.3 – (30.8 x age [y]) + PA x [(10.0 x weight [kg])] + (934 x height [m]) + 25

NOTE: These equations provide an estimate of energy requirement. Relative body weight (i.e., loss, stable, gain) is the preferred indicator of energy adequacy.
[a]**EER** = Estimated Energy Requirement
[b]**PA** = Physical Activity Coefficient
Source: This table is derived from the DRI report: see **http://nap.edu**

Body Mass Index (BMI)

BMI is recommended as a routine screening tool for overweight children and adolescents[1]

Procedure:

1. Obtain standing height for children ages 2 to 20 with a stadiometer
2. Record weight to the nearest 1⁄2 ounce or 0.01 kg[2]
3. Calculate **BMI**[3]

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height (m)}^2} \quad \textbf{or} \quad \text{BMI} = \left[\frac{\text{weight (lb)}}{\text{height (in)}^2}\right] \times 703$$

4. For children ages 2 to 20, plot BMI using the BMI growth chart appropriate for gender[4]

Recommended BMI-for-age cutoffs[5,6]:

1. ≥ 95th percentile is considered "obese"
2. 85th to 95th percentile is considered "overweight"
3. < 5th percentile is considered "underweight"

1. Barlow, SE and Dietz, wh. Obesity evaluation and treatment: expert committee recommendations. *Journal of Pediatrics* 1998; 102(3):e29.
2. U.S. Department of Health and Human Services. Accurately Weighing & Measuring: Technique: http://depts.Washington.Edu/growth/module5/text/intro.htm. Accessed August 29, 2005.
3. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL. Indices of relative weight and obesity. *Journal of Chronic Disease* 1972; 25:329-343.
4. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC Growth Charts for the United States: Methods and Development. National Center for Health Statistics. Vital Health Statitistics 2002;11(246).
5. Himes, JH and Deitz, WH. Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. *AmericanJournal of Clinical Nutrition* 1994;59:307-316.
6. American Medical Association. Expert Committee Recommendations on the Assessment, Prevention, and Treatment of Child and Adolescent Overweight and Obesity. June 6, 2007. http://www.Ama-assn.Org/ama1/pub/upload/mm/433/ped_obesity_recs.pdf. Accessed:July 20, 2007.

Enteral Feeding Troubleshooting

Gastrointestinal

COMPLICATION	POSSIBLE CAUSE	MANAGEMENT/PREVENTION
Aspiration pneumonia	Aspiration of feedings Emesis	Confirm tube placement prior to administration of feeds
	Displacement or migration	Elevate head 30 to 45 degrees
	Supine position during feeds	
	Gastroesophageal reflux	
	Presence of nasogastric tube preventing complete closure of esophagus	Tube placement into the duodenum
	Delayed gastric emptying	Use of prokinetics or formula change
Bloating/ cramps/gas	Air in tubing	Remove as much air as possible when setting up feeding
Diarrhea	Bacterial contamination of formula	Proper storage, preparation and administration of feeds
		Change feeding bag daily
		Limit hang time of formulas to 8-12 hours for commercially manufactured products
		Undiluted, ready to feed products minimize risk
	Food allergies	Consider changing formula
	Hyperosmolar formulas	Consider an isotonic formula
	Too rapid infusion	Slow rate of infusion
	Low fiber intake	Consider a fiber-containing formula
	Fat malabsorption	Consider changing formula to product with partial MCT content
	Medications (antibiotics, antacids, sorbitol, magnesium, antineoplastic agents)	
Dumping syndrome	Cold formula	Administer formula at room temperature
Vomiting	Rapid feeding	Slow rate of feeding
	Hyperosmolar formulas	Consider changing to isotonic formula
	Delayed gastric emptying	Consider transpyloric route for feeding
		Consider continuous infusion
		Elevate head of bed 45 degrees during feeding
		Check residuals prior to feeding
		Consider prokinetics
	Obstruction	Discontinue feeding
	Too rapid advancement of volume or concentration	Return to previously tolerated strength and volume, and advance more slowly

Enteral Feeding Troubleshooting

Mechanical

COMPLICATION	POSSIBLE CAUSE	MANAGEMENT/PREVENTION
Clogged tube	Inadequate flushing	Flush tube before and after aspirating residuals, after bolus feedings, and every 4-8 hours during continuous feeds
	Inadequate crushing of medications	Dissolve crushed tablets in warm water
	Formula and medication residue	Flush tube before and after medication administration; avoid mixing formula with medication
	Kinking of the feeding tube	Replace feeding tube
	Highly viscous fiber-rich formulas	
Tube displacement	Coughing Vomiting Inadvertent dislodgement Removal of tube by patient	Replace the tube

Metabolic

COMPLICATION	POSSIBLE CAUSE	MANAGEMENT/PREVENTION
Dehydration	Inadequate free water	Monitor I's and O's Monitor hydration status of patient routinely
	Hyperosmolar feedings	Assess renal solute load of formula
Overhydration	Excessive fluid administration	Advance feeds slowly
	Too rapid refeeding or patients with moderate to severe PEM	Allow a 5-7 day period to meet nutritional goals
Electrolyte imbalance	Formula components	Evaluate electrolyte adequacy of specific formula and appropriateness of formula dilution
	Medical condition/ diagnosis	Monitor electrolytes, phosphorus, BUN, creatinine, glucose
Failure to achieve weight gain	Inadequate nutrient intake	Evaluate adequacy of nutrient intake Perform routine nutritional assessments

Adapted From Cox JH, ed. *Nutrition Manual for At-Risk Infants and Toddlers*. Chicago: Precept Press;1997.

Home Delivery Carton Calculator for Nestlé Enteral Nutrition Formulas

Use this calculator to determine each patient's weekly or monthly enteral product needs for home delivery based on volume of formula ordered per day

TOTAL DAILY VOL. (mL/d)	CARTONS/DAY	CASES/WEEK	CASES/MONTH
500	2.0	0.6	2.6
550	2.2	0.6	2.8
600	2.4	0.7	3.0
650	2.6	0.8	3.3
700	2.8	0.8	3.5
750	3.0	0.9	3.8
800	3.2	0.9	4.0
850	3.4	1.0	4.3
900	3.6	1.1	4.5
950	3.8	1.1	4.8
1000	4.0	1.2	5.0
1050	4.2	1.2	5.3
1100	4.4	1.3	5.5
1150	4.6	1.3	5.8
1200	4.8	1.4	6.0
1250	5.0	1.5	6.3
1300	5.2	1.5	6.5
1350	5.4	1.6	6.8
1400	5.6	1.6	7.0
1450	5.8	1.7	7.3
1500	6.0	1.8	7.5
1550	6.2	1.8	7.8
1600	6.4	1.9	8.0
1650	6.6	1.9	8.3
1700	6.8	2.0	8.5
1750	7.0	2.0	8.8
1800	7.2	2.1	9.0
1850	7.4	2.2	9.3
1900	7.6	2.2	9.5
1950	7.8	2.3	9.8
2000	8.0	2.3	10.0
2050	8.2	2.4	10.3
2100	8.4	2.5	10.5

CRITICAL CARE NUTRITION

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Nutritional Assessment of the Critically Ill Child

ELEMENTS OF CRITICAL CARE ENTERAL NUTRITION (EN) PRACTICE BUNDLE

1. Nutritional assessment on admission
2. Caloric goal (measured by energy expenditure or estimate)
3. Early enteral nutrition (within 24 hours of admission)
4. Head of bed elevation (≥30 degrees)
5. Daily checklist for enteral nutrition status/protocolized EN advancement

Mehta NM. Approach to enteral feeding in the PICU. *Nutrition in Clinical Practice* 2009;24(3):384.

Equation For Assessing Energy Requirements of Ventilated, Critically Ill Children

EE = [(17 x age in mo) + (48 x wt kg) + (292 x body temp °C) – 9677] x 0.239

White MS, Sheperd RW, McEniery JA. Energy expenditure in 100 ventilated, critically ill children: improving the accuracy of predictive equations. *Crit Care Med* 2000;28(7):2307–12.

MEASUREMENT OF ENERGY EXPENDITURE:

Indirect calorimetry:

IC uses a metabolic cart to measure the amount of oxygen consumed and carbon dioxide exhaled to determine resting energy expenditure. This often provides the respiratory quotient (RQ) which may help determine substrate utilization (fat, protein, mixed, carbohydrate or fat synthesis). Patients that are spontaneously breathing are often measured under a hood which creates a seal to trap all oxygen inhaled and carbon dioxide exhaled. Ventilated patients or patients with tracheostomies may also be tested, as long as there are no inspiratory or expiratory air leaks and the patient is not on high frequency ventilation of FIO_2 of >60%.

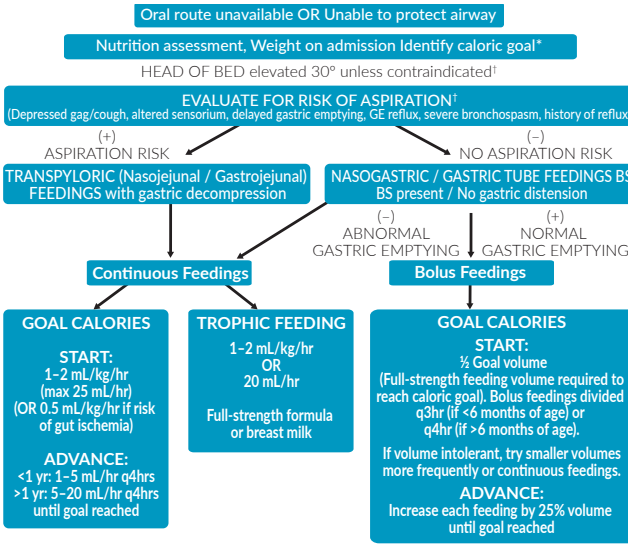
Ireton-Jones CS. Estimating Energy Requirements. *Nutritional Considerations in the Intensive Care Unit*. ASPEN; Kendall Hunt Publishing, Dubuque:2002.

Indirect calorimetry provides REE and a measure of substrate utilization as reflected in the RQ:

RQ <0.85	**indicates underfeeding**
RQ 0.85-1.0	**indicates adequate feeding**
RQ >1.0	**indicates overfeeding**

Ista E, Joosten K. Nutritional Assessment and Enteral Support of Critically Ill Children. *Crit Care Nurs Clin N Am* 2005;17(4):385–93.

Enteral Nutrition Support Algorithm



ENTERAL FEEDING INTOLERANCE

Gastric residual volumes (GRV) recorded prior to each bolus feed or q4hrs in patients on continuous gastric feedings with abdominal discomfort, distention or emesis.

If GRV >150 mL; or 5 mL/kg, or >½ volume of previous feeding; or >total 2 hourly infusion rate in patients on continuous feeding – hold feedings and repeat GRV after 2 hrs. If repeat GRV is elevated, hold feedings and monitor GRV at 4 hrs.

If abdominal distension, (abdominal girth increased for 2 consecutive measurements) or abdominal discomfort or emesis x2 – hold feedings for 4 hrs and reassess.

CONSTIPATION

(for age >1 month/non-neutropenic)
NO STOOL AFTER 48 HOURS OF EN

Day 1: Prune juice
Day 2: Glycerin supp.

Docusate
(<3 yrs: PO 10 mg BID)
(3–6 yrs: PO 20 mg BID)
(6–12 yrs: PO 50 mg BID)
(≥12 yrs: PO 100 mg BID)

Senna (discontinue after 2 normal stools)
(1 mo–2 yrs: PO 2.5 mL BID)
(2–5 yrs: PO 3.75 mL BID)
(5–12 yrs: PO 7.5 mL BID)
(≥12 yrs: PO 1 Tab BID)

Fleet Enema (for age >2 yrs)
Pediatric Fleet enema: 2–12 yrs (66 mL/bottle) 1 enema
Adult Fleet enema: ≥12 yrs

DIARRHEA (>4 loose stools/24 hrs)

Discontinue laxatives (senna) and stool softeners (docusate)

Discontinue any sorbitol-containing medication

Review osmolarity of formula

Consider withdrawal from opiates

Consider change in formula, or hold tube feedings until diarrhea resolves

Stool viral studies / *Clostridia (C.) difficile*

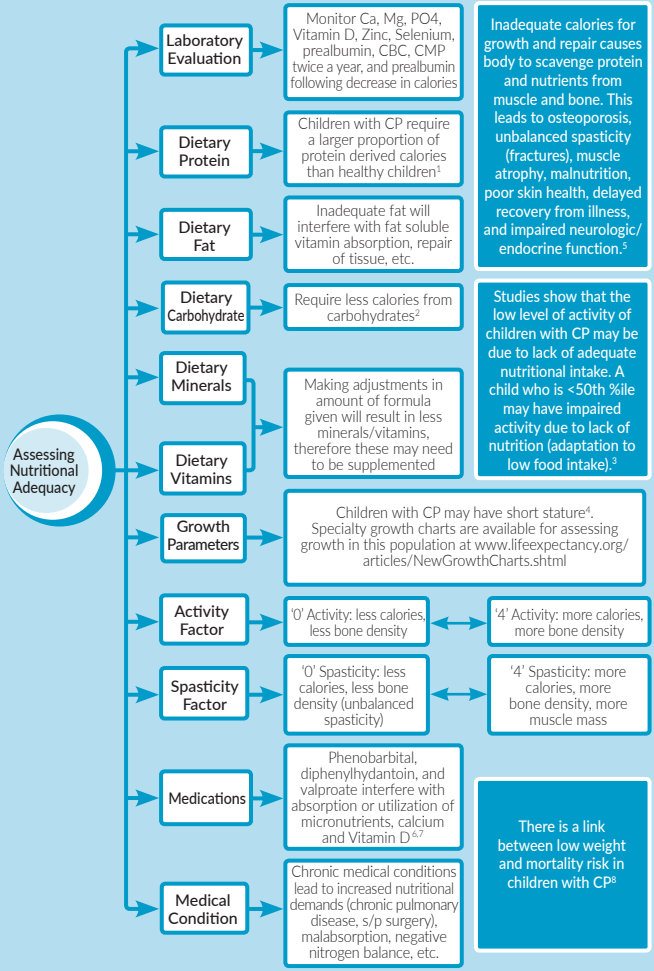
Stool *C. difficile* toxin and culture (if on antimicrobials)

Adapted from: Mehta NM. Approach to enteral feeding in the PICU. *Nutr Clin Pract* 2009;24(3):379. © 2009 American Society for Parenteral and Enteral Nutrition. Reprinted by permission of SAGE Publications.

*Rogers EJ et al. Barriers to adequate nutrition in critically ill children. *Nutrition* 2003;19:865–8.
†Heyland DK et al. Total parenteral nutrition in the critically ill patient: a meta-analysis. *JAMA* 1998;280:2013–19.

NUTRITION – NEUROLOGICALLY IMPAIRED CHILD

NUTRITIONAL ASSESSMENT IN CHILDREN WITH CEREBRAL PALSY



Adapted from Brannan D., The Children's Center, 2010. Used with permission.

1. Taylor SB, Sheldon JE. Caloric requirements of a spastic immobile cerebral palsy patient: A case report. *Arch Phys Med Rehabil* 1995;76:281–3. **2.** Bandini LG et al. Body composition and energy expenditure in adolescents with cerebral palsy or myelodysplasia. *Pediatr Res* 1991;29:70–7. **3.** Stallings VA et al. Energy expenditure of children and adolescents with severe disabilities: a cerebral palsy model. *Am J Clin Nutr* 1996;64:627–34. **4.** Samson-Fang L, Stevenson RD. Linear growth velocity in children with cerebral palsy. *Dev Med Child Neur* 1998;40:689–92. **5.** Samson-Fang L, Stevenson RD. Identification of malnutrition in children with cerebral palsy: poor performance of weight-for-height centiles. *Dev Med Child Neur* 2000;42:162–8. **6.** Hahn TJ. Bone complications of anticonvulsants. *Drugs* 1976;12:201–11. **7.** Hahn TJ et al. Phenobarbitol-induced alterations in vitamin D metabolism. *J Clin Invest* 1972;51:741–8. **8.** Brooks J, Day SM, Shavelle RM, Strauss DJ (2011). *Pediatrics*, 128; e299; (DOI 10.1542/peds.2010-2801).

NUTRITIONAL ASSESSMENT

Feeding History and Skills for Children with Neurological Impairment or Developmental Delays
ITEMS TO CONSIDER:
Developmental status
Neurologic status
Physical activity
Mobility
Feeding history
Diet history
4-day diet diary, include fluids
4-day physical activity diary
Supplemental feedings, including oral feedings, tube feedings, vitamins, and minerals
Herbal supplements
Feeding difficulties in the past
Length of time to complete a meal
Swallowing difficulties
Choking
Recurrent pneumonia
Pain when eating
Vomiting
Difficulty with textures or thickness of solids or liquids
Current use of occupational therapy/physical therapy/ speech therapy
Developmental stimulation activities
School programs
Nutritional status
Caregiver's willingness to consider tube feedings
Stooling history
Surgery history

Ekvall S, Ekvall V. Nutrition Support for Children with Developmental Disabilities. In: Baker SS, Baker RD, Davis AM, eds. Pediatric Nutrition Support. Jones & Bartlett, 2007:360.

NUTRITIONAL ASSESSMENT

Indications for Nutrition Intervention	
FACTORS TO LOOK FOR:	
Primary therapy for oromotor feeding difficulties	
Supportive therapy	
Preoperative nutritional rehabilitation	
Drug nutrient interactions	
Vitamin D	Folic acid
Abnormalities of specific laboratory tests	
Anemia	Prolonged prothrombin time
Hypoalbuminemia	Depressed alkaline phosphatase
Serum mineral deficiencie	Lactose intolerance
Serum vitamin deficiencies	
Complications of neurologic disorders	
Malnutrition	Obesity
Growth failure	

Indications for Enteral Tube Placement
Nutritional
Inability to meet daily fluid requirement
Inability to meet daily nutrient requirements by the oral route
Moderate/severe wasting (<80% weight-for-height)
Moderate/severe linear stunting (<90% height-for-age)
Neurologic
Orofacial abnormalities associated with swallowing difficulties
Gastroesophageal reflux unresponsive to medications
Recurrent complications of swallowing difficulties (aspiration, pneumonia, esophagitis)

Ekvall S, Ekvall V. Nutrition Support for Children with Developmental Disabilities. In: Baker SS, Baker RD, Davis AM, eds. Pediatric Nutrition Support. Jones & Bartlett, 2007:363.

Energy Requirements in Children with Developmental Disabilities

CLINICAL CONDITION	CALORIE REQUIREMENT
Cerebral Palsy (age 5–11 yrs)	13.9 kcal/cm height with mild to moderate activity 11.1 kcal/cm height with severe physical restrictions
Athetoid Cerebral Palsy	up to 6000 kcal/d (adolescence)
Down Syndrome Boys (age 5–12 yrs) Girls (age 5–12 yrs)	 16.1 kcal/cm height 14.3 kcal/cm height
Myelomeningocele (Spina Bifida)	9–11 kcal/cm height for maintenance 7 kcal/cm for weight loss approximately 50% RDA for age after infancy
Prader-Willi Syndrome	10–11 kcal/cm height for maintenance 8.5 kcal/cm height for weight loss

1. Protein requirements – May be met by providing DRI for age
2. Fluid requirements – Attention to fluid needs is critical in these patients because many do not have, or cannot express, a thirst sensation
3. Formula choice guideline – If weight age is ≤ 13 years, use pediatric formula; if weight age is > 13 years, may use adult formula

Ekvall SW, Bandini L, Ekvall V: Obesity. In Ekvall SW (ed): Pediatric Nutrition in Chronic Diseases and Developmental Disorders, Oxford University Press, 1993;168.

Davis A. Pediatrics. In: Contemporary Nutrition Support Practice; 1998, Ch 26;356.

Determination of Energy Needs: Krick Method

kcal/day = BMR x (muscle tone factor x activity factor) + growth factor
BMR = body surface area (m^2) x standard metabolic rate (kcal/m^2/h) x 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 dependent, 1.25 if crawling, 1.3 if ambulatory
Growth factor: 5 kcal/g of desired weight gain

Krick J. A proposed formula for calculating energy needs of children with cerebral palsy. *Dev Med Child Neurol* 1992;34:481–7.

Estimation of Stature from Segmental Measures

ESTIMATION OF STATURE IN CENTIMETERS	
Age 0–12[1]	(4.35 x UAL) + 21.8 (3.26 x TL) + 30.8 (2.68 x KH) + 24.2
Age 6–18[2]	White male: (2.22 x KH) + 40.54 AA male: (2.18 x KH) + 39.60 White female: (2.15 x KH) + 43.21 AA female: (2.02 x KH) + 46.59

UAL = upper arm length TL = tibia length KH = knee height

1. North American Growth in Cerebral Palsy Project at http://www.healthsystem.virginia.edu.
2. Chumlea WC, Guo SS, Steinbaugh ML. Prediction of stature from knee height for black and white adults and children with application to mobility-impaired or handicapped persons. *J Am Diet Assoc* 1994;94(12):1385–8.

Diagnostic Tools in Dysphagia Evaluation
Careful history
Physical examination (especially neurologic examination)
Barium swallow
Modified barium swallow (videofluoroscopy)
Esophageal manometry
Esophageal pH monitoring
Endoscopic evaluation (hypopharynx or esophageal)

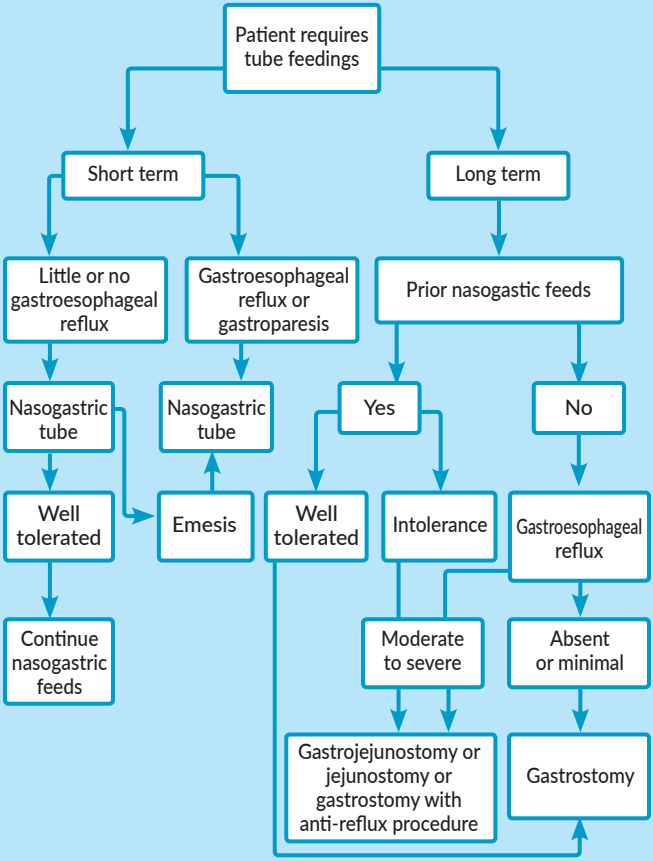
Major Patient Risk Factors for Aspiration
Previous episode of aspiration
Decreased level of consciousness
Neuromuscular diseases and structural abnormalities of the aerodigestive tract
Endotracheal intubation
Vomiting
Persistently elevated gastric residual volumes
Need for prolonged supine positioning of the patient

DeLegge MH. Enteral nutrition and the neurologic diseases. In: Rolandelli RH. Enteral and Tube Feeding, eds. 4th ed. Elsevier, Inc., 2005, p. 410.

Approach to Nutrition Support in Children with Developmental Disabilities
Route of tube feeding
Nasogastric
Gastrostomy
Jejunostomy
Method of formula administration
Continuous drip
Intermittent bolus
Combined continuous nighttime and intermittent daytime bolus
Amount of nutrients
Individualize energy based on ideal body weight for chronologic age (10^{th}–25^{th} percentile) in the malnourished child
Individualize energy based on multiples (1.0–1.2) of the resting metabolic rate in obese children
Source of nutrition supplement
Polymeric formula specific for children
Whey based formula for children with emesis

Ekvall S, Ekvall V. Nutrition Support for Children with Developmental Disabilities. In: Baker SS, Baker RD, Davis AM, eds. Pediatric Nutrition Support. Jones & Bartlett, 2007:364.

DECISION TREE FOR ENTERAL ACCESS



Adapted from: Marchand V. Enteral Nutrition Tube Feedings. In: Baker SS, Baker RD, Davis AM, eds. Pediatric Nutrition Support. Jones & Bartlett, 2007:252.

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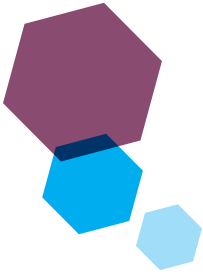

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