Enteral Nutrition in Critically Ill Children- What, When and How?

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Apollo Hospitals GROUP
touching lives

Nutritional status

- **Many children on admission to PICU are compromised nutritionally**
  - Chronic diseases
- **65% of congenital heart disease**

Varan. Arch Dis Childhood 1999; 81:49

- **24% of non-cardiac**

Pollack. JPEN. 1982; 6: 20

Our study, Indraprastha Apollo Hospital:

31% were stunted and 29% wasted in 0-5 age group

Nagrath, Ghosh-Jerath et al *(to be published)*

Malnutrition, Obesity and critical care

- More likely to develop multi-organ failure
- Physiologic instability
- Longer stay in ICU
- Longer duration of mechanical ventilation
- Increased morbidity and mortality

- **Worse outcomes, as in malnourished**

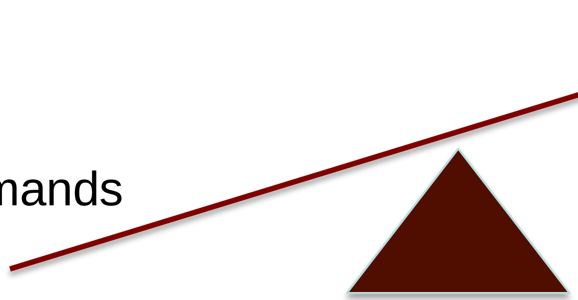
- **Increased incidence of**
  - Sepsis
  - ICU stay
  - Wound infection
  - Post-operative fistulae

Karlson. Obesity.2006; 14: 1931

Critical Illness and requirements

Reduced utilization

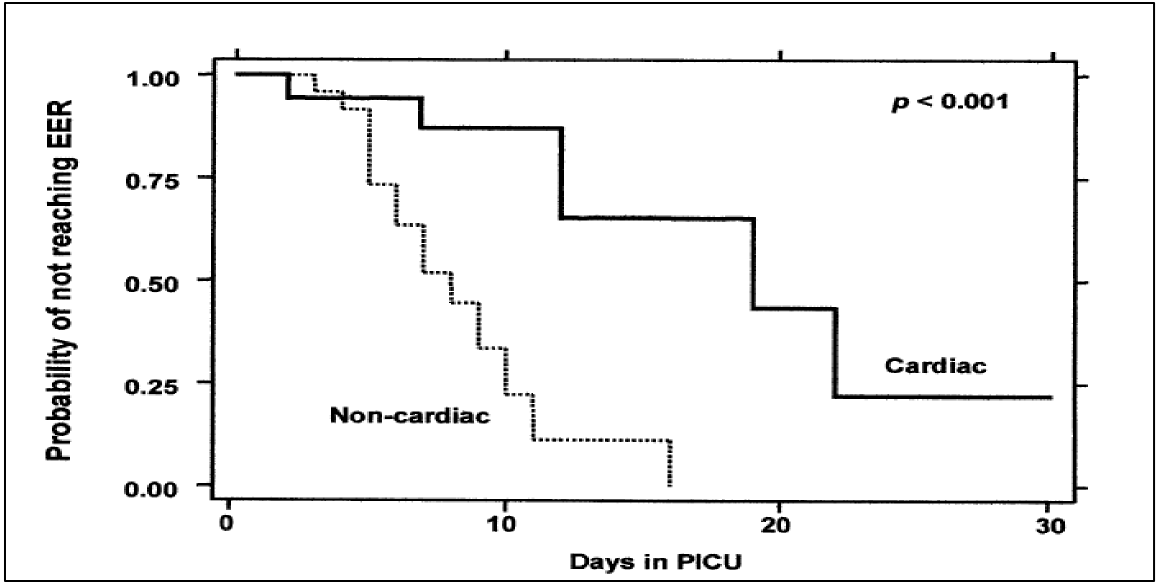
- Sedation
- Mech vent
- Muscle relaxation
- ↓ Insens water loss



Increased demands

- Fever
- Pain
- Shivering
- Resp distress

How good are we?



Probability of not reaching full energy requirements during PICU stay

Rogers. Nutrition.2003; 19: 865

Reasons?

- Failure to start feeding 44%
- Failure to increase feeds 31%
- Feed “Holds” 25%
    - Fasting for airway management/ procedures 21%
    - Gastro-intestinal intolerance 14%

Reid. Journal of Human Nutrition and Dietetics. 2006; 19: 13

Predictive equations to estimate REE

- Schofield
- FAO/WHO/UNU

- ~~White~~ Not validated in children < 2 months
- ~~Harris- Benedict~~ Not validated in children

Schofield equation

Age	Gender	Equation	
		W	WH
<3 years	M	59.48W - 30.33	0.167W + 1517.4H - 617.6
	F	58.29W - 31.05	16.252W + 1023.2H - 413.5
3–10 years	M	22.7W + 505	19.59W + 130.3H + 414.9
	F	20.3W + 486	16.97W + 161.8H + 371.2
10–18 years	M	17.7W+ 659	16.25W + 137.2H + 515.5
	F	13.4W+ 696	8.365W + 465H + 200

FAO/WHO/UNU

Name	Gender	Equation
<3 years	M	60.9W - 54
	F	61W - 51
3–10 years	M	22.7W + 495
	F	22.5W + 499
10–18 years	M	17.5W + 651
	F	12.2W + 746

Energy Requirements in critical Illness

- Energy :BMR + activity+ growth

- Initial protein intake: ***1.5g/kg/d***
- Carbohydrates: 60-70% of NPN
- Lipids: 30-40%of NPN.

Factors adding to REE

	Multiplication Factor
Maintenance	0.2
Activity	0.1-0.25
Fever	0.13/per °C >38 °C
Simple trauma	0.2
Multiple injuries	0.4
Burns	0.5-1
Sepsis	0.4
Growth	0.5

Q2B: How should energy requirement be determined in the absence of IC?

R2B: If IC measurement of resting energy expenditure is not feasible, we suggest that the Schofield or Food Agriculture Organization / World Health Organization / United Nations University equations may be used *without* the addition of stress factors to estimate energy expenditure. Multiple cohort studies have demonstrated that most published predictive equations are inaccurate and lead to unintended overfeeding or underfeeding. The Harris-Benedict equations and the RDAs, which are suggested by the dietary reference intakes, should not be used to determine energy requirements in critically ill children.

ASPEN Clinical guidelines. JPEN 2017. 41; 706-742

Watch out for

Potential signs of overfeeding

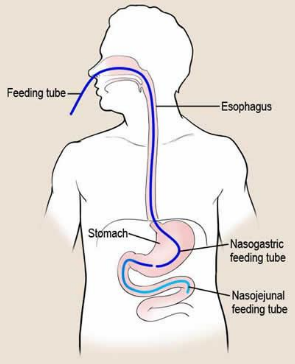
- Hyperglycemia
- hypertriglyceridemia,
- increased CO_2 production,
- increased arm circumference, and
- rapid or excessive weight gain

Potential signs of underfeeding

- weight loss,
- decreased arm circumference,
- malnutrition,
- prolonged dependency on mechanical ventilation, and
- increased length of PICU stay

Means of delivering nutrition

- Enteral (nasal, oral or percutaneous)
  - Gastric
  - Duodenal (trans-pyloric)
  - Jejunal (post-pyloric)
- Parenteral
- EN + PN



Recommendation…

Q4A: Is EN feasible in critically ill children?

R4A: On the basis of observational studies, we recommend EN as the preferred mode of nutrient delivery to the critically ill child. Observational studies support the feasibility of EN, which can be safely delivered to critically ill children with medical and surgical diagnoses and to those receiving vasoactive medications. Common barriers to EN in the PICU include delayed initiation, interruptions due to perceived intolerance, and prolonged fasting around procedures. On the basis of observational studies, we suggest that interruptions to EN be minimized in an effort to achieve nutrient delivery goals by the enteral route.

Q4B: What is the benefit of EN in this group?

R4B: Although the optimal dose of macronutrients is unclear, some amount of nutrient delivered as EN has been beneficial for gastrointestinal mucosal integrity and motility. Based on large cohort studies, early initiation of EN (within 24–48 h of PICU admission) and achievement of up to two-thirds of the nutrient goal in the first week of critical illness have been associated with improved clinical outcomes.

Gastric vs post-pyloric

- No real advantage of PP feeding in all cases
- PP feeding has a role in
  - Patients not tolerating gastric feeds
  - High risks of aspiration
- Dumping

- PP tube placement can be done at bedside
  - Does not need trip to Endoscopy / Fluoroscopy suites

Salasidis. CCM. 1998; 26: 1039

Intermittent vs Continuous

- Both equally effective
- Certain situations continuous feeding may help overcome feed intolerance

- Large volume post-pyloric feedings are better done as an infusion

Macronutrients

- Initial protein intake: 1.5g/kg/d
- Carbohydrates: 60-70% of NP Cals
- Lipids: 30-40%of NP Cals

Q3A: What is the minimum recommended protein requirement for critically ill children?

R3A: On the basis of evidence from RCTs and as supported by observational cohort studies, we recommend a minimum protein intake of 1.5 g/kg/d. Protein intake higher than this threshold has been shown to prevent cumulative negative protein balance in RCTs. In critically ill infants and young children, the optimal protein intake required to attain a positive protein balance may be much higher than this minimum threshold. Negative protein balance may result in loss of lean muscle mass, which has been associated with poor outcomes in critically ill patients. Based on a large observational study, higher protein intake may be associated with lower 60-d mortality in mechanically ventilated children.

Proteins

Age	A.S.P.E.N. recommendations
0–2 years	2–3 g/kg/day
2–13 years	1.5–2 g/kg/day
13–18 years	1.5 g/kg/day

- Whey vs Casein
- Requirements are age dependent
- Minimum 1.5 g/kg/day
- Maintaining positive balance an important goal

Age of Children (Years)	Body Weight (kg)	Energy (Kcal/d)	Protein (gm/d)	Fat(gm/d)	Calcium (mg/d)	Iron (mg/d)	Zinc (mg/d)
1-3	12.9	1060	16.7	27.0	600.0	9.0	5.0
4-6	18.0	1350	20.1	25.0	600.0	13.0	7.0
7-9	25.1	1690	29.5	30.0	600.0	16.0	8.0

Carbohydrate metabolism

Glucose intolerance and insulin resistance can result from hormonal and metabolic challenges

–Hyperglycaemia and hypoglycaemia

In critically ill children, carbohydrate is utilised poorly, and fat is preferentially used for oxidation

During the metabolic response, carbohydrate turnover is increased, with a significant increase in glucose oxidation and gluconeogenesis

Glucose (availability and production) is a priority of nutrition

Fat sources and types

Short chain fatty acids (SCFA)	• 2–4 carbons in length • Fermentation product of prebiotics, energy source for the gut wall
Medium chain triglycerides (MCT)	• 6–12 carbons in length • Do not require bile salts or pancreatic lipase for digestion → more rapidly digested and absorbed than LCT • Rapid source of energy
Long chain triglycerides (LCT)	• >14 carbons in length • Major energy source in diet • Essential fatty acids are LCT • Ensure absorption of fat-soluble vitamins
Fish oil	• Supplies long-chain fatty acids with strong anti-inflammatory properties (EPA and DHA)

Types of formula

Polymeric (intact protein/standard formula)	• Provide 1–2 kcal/mL, may or may not contain fibre • Require that patients can absorb intact macronutrients
Semi-elemental (peptide-based/ hydrolysed)	• Provide 1–1.5 kcal/mL • Contain pre-digested macronutrients (such as small peptides and MCT), making it easier for a partially dysfunctional GI tract to absorb them
Elemental (amino acid-based)	• Provide 1–1.5 kcal/mL • Contain 100% free amino acids with variable amount of MCT, making it easier for a severely impaired GI tract to absorb them
Modular	• Vary in energy content • Contain single macronutrients (protein, glucose polymers, or lipids)
Disease-specific	• Vary in protein, carbohydrate, lipid and vitamin and mineral content • For patients with disease-specific conditions such as renal impairment, hepatic disease, diabetes, and pulmonary disease, etc.

Formula for specific conditions

Metabolic

PKU, MSUD-specific feeds are available

Renal

Low-to-moderate protein, low phosphate and potassium (pre-dialysis)

Moderate-to-high protein, low phosphate, normal potassium (on dialysis)

Liver

80% MCT, whole protein

50% MCT, hydrolysed protein

Chylothorax

High proportion of fat as MCT

What do we do?

- Discuss nutrition each day on each patient
  - Very easy to overlook
- Set targets for the day
- Plan for planned “off feed” times
- Reassess

- Proactive post-pyloric feeding if gastric tolerance is poor

Role of Nutrition Support Team

- Specialized teams
- Aggressive feeding protocols
  - Improve delivery of EN
  - Shorten time to goal EN
  - Reduce need of PN

ASPEN Clinical guidelines.JPEN 2009. 33; 260

Summary

- Each patient is an individual
- Enteral route is the preferred route
- Aggressive approach to establish feeds has better outcomes
- Parenteral nutrition can be used to compliment and optimize nutrition
- Nutrition support team has an important role to play