Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient: ASPEN-SCCM 2017

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Learning Objectives

- To describe the association between nutritional status and outcomes
- To emphasize the importance of anthropometrics in the definition of malnutrition
- To understand the benefits of enteral nutrition and its association with good outcomes
- To recognize the importance of using algorithms in the provision of nutrition support

Nutrition Support Guidelines for the Critically Ill Child

- ASPEN / SCCM Collaboration
  - Nilesh M. Mehta
  - Heather E. Skillman
  - Sharon Y. Irving
  - Jorge A. Coss-Bu
  - Sarah Vermilyea
  - Elizabeth Anne Farrington
  - Liam McKeever
  - Amber M. Hall
  - Praveen S. Goday
  - Carol Braunschweig

Nutrition Support Guidelines for the Critically Ill Child

- A total of 2,032 citations were scanned for relevance related to pediatric nutritional support
- Data for critically ill pediatric patients (>1 mo and < 18 yr) with a length of stay greater than 2 or 3 days
- Children admitted to a pediatric intensive care unit (PICU), with a medical, surgical, and cardiac diagnosis.

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- After careful review,16 randomized controlled trials and 37 cohort studies appeared to answer 1 of the 8 pre-identified question groups for this guideline

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- The GRADE criteria (Grading of Recommendations, Assessment, Development, and Evaluation) was used to adjust the evidence grade based on assessment of the quality of study design and execution.

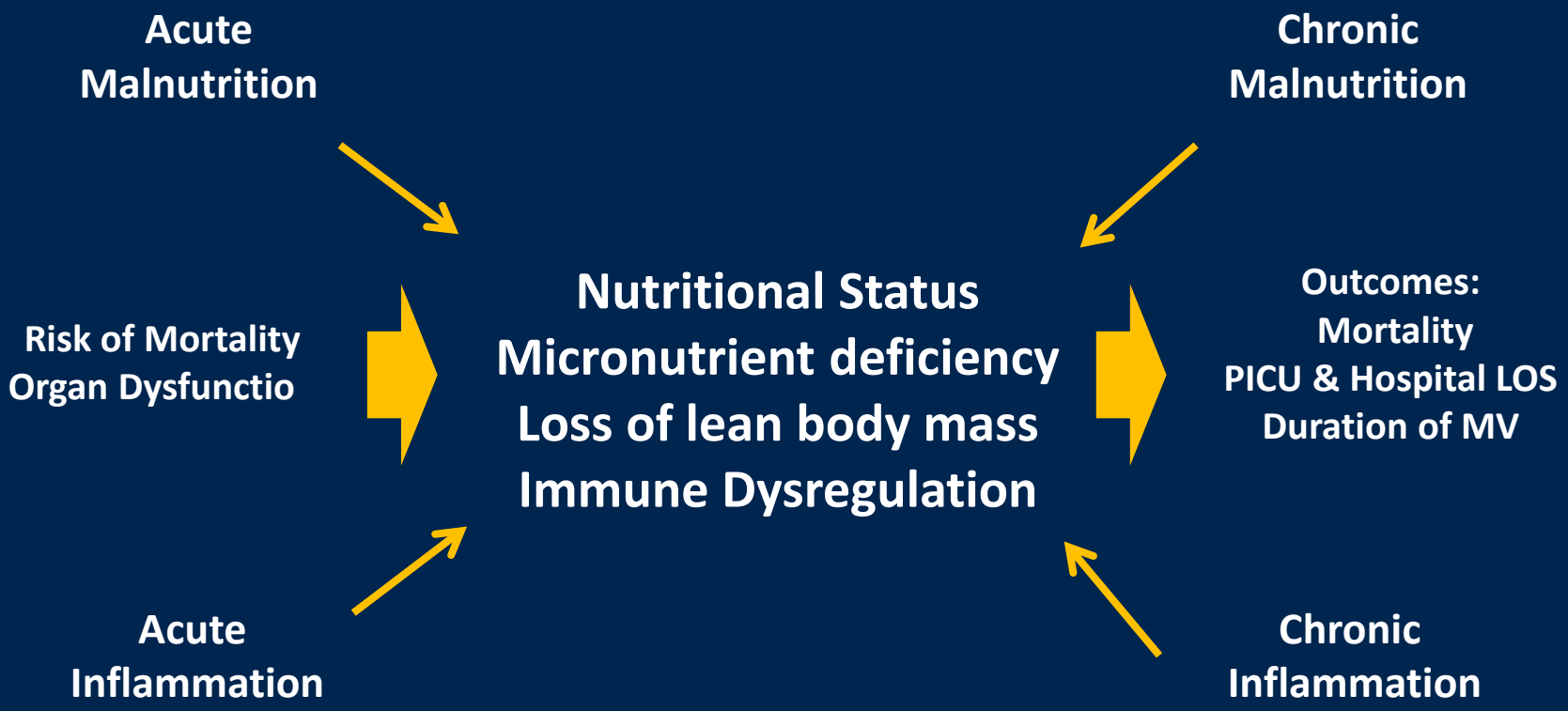
Nutrition Support Guidelines for the Critically Ill Child

Table 2. Language for Guidelines Recommendations.

Quality of Evidence	Weighing Risks vs Benefits	GRADE Recommendations	Clinical Guideline Statement
High to very low	Net benefits outweigh harms	Strong	We recommend.
High to very low	Trade-offs for patient are important	Weak	We suggest.
High to very low	Uncertain trade-offs	Further research needed	We cannot make a recommendation at this time.

GRADE, Grading of Recommendations, Assessment, Development, and Evaluation.

Nutritional Risk Assessment in PICU



Modified from Heyland Critical Care 2011

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	Quality of the evidence	GRADE recommendation
What is the impact of nutritional status on outcomes in the critically ill child?	Very low	Strong
What are the best practices to screen and identify patients with malnutrition or those at risk of nutrition deterioration in the PICU?	Very low	Strong

Pediatric Growth Charts

- Anthropometrics
  - WHO Growth Standard for 0 to 24 months
  - WHO Child Growth Standards (birth to age 5)
  - WHO Reference 2007 (ages 5 to 19)
  - CDC Growth calculator for 0 to 36 months
  - CDC Growth calculator for 2 to 20 years

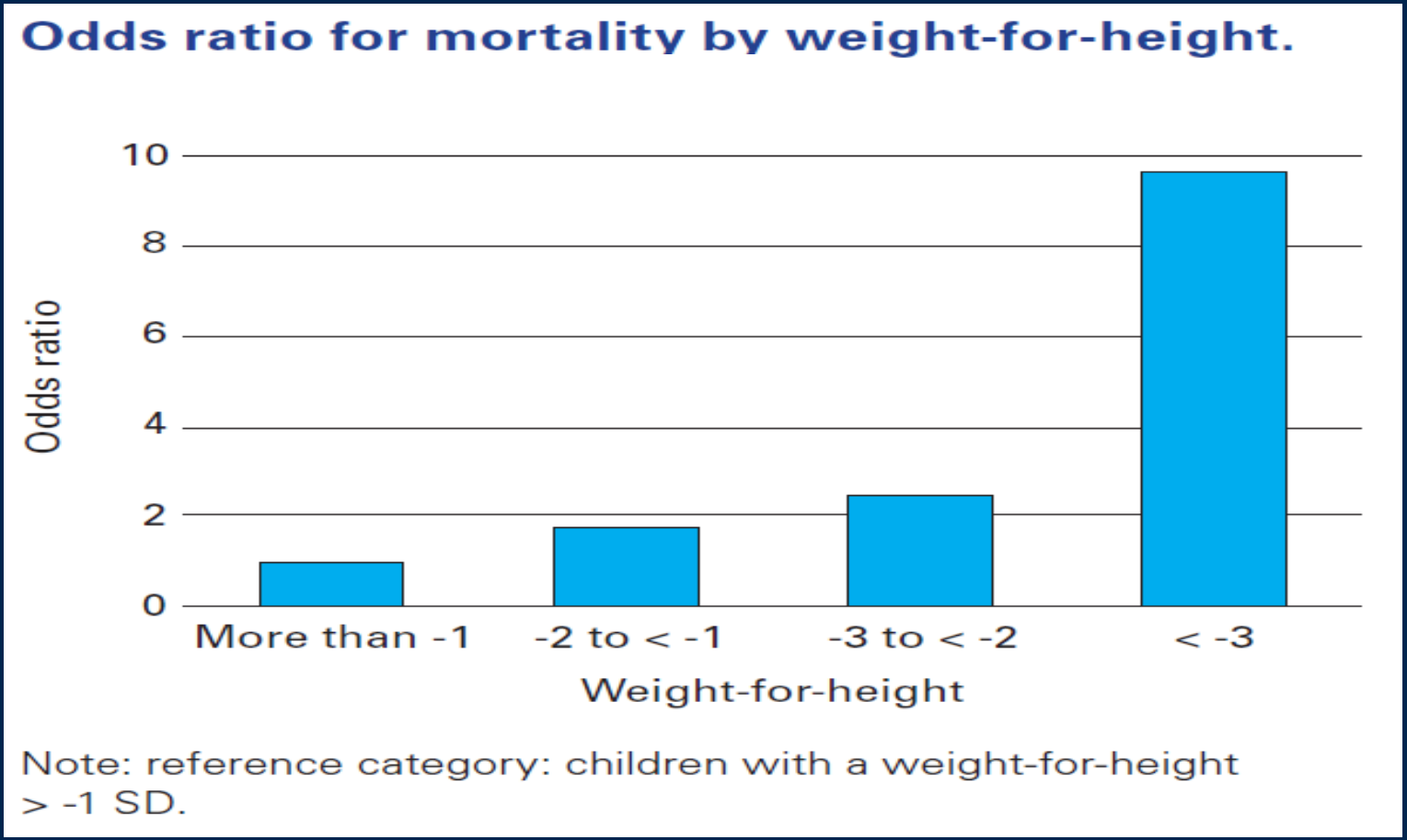
http://peditools.org/

Pediatric Malnutrition Anthropometric Criteria

Z Score BMI/WFL	Growth Percentiles	Waterlow Criteria (%)	Malnutrition Class
0		≥ 90	No risk
-1	2.4 – 15.9	< 90	Mild
-2	0.2 – 2.3	80 – 89.9	Moderate
-3	< 0.2	< 80	Severe

Beer, S. et al. *Nutr Clin Pract. 2015;30:609-624*

Malnutrition in Children Mortality Risk



Bull World Health Organ. 2010 Jan;88(1):39-48

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- Observational studies found association of malnutrition including obesity with bad outcomes
- Recommendation: Patients in the PICU should have detailed nutritional evaluation by 48hrs
- Observational studies recommend anthropometric evaluation of children on admission to PICU
- Implement validated screening methods to identify patients at risk of malnutrition
- High-risk patients are likely to benefit from early nutritional assessment and interventions

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	Quality of the evidence	GRADE recommendation
What is the recommended energy requirement for critically ill children?	Low	Weak
How should energy requirement be determined in the absence of IC?	Very low	Weak
What is the target energy intake in critically ill children?	Low	Weak

Nutrition Support Guidelines for the Critically Ill Child

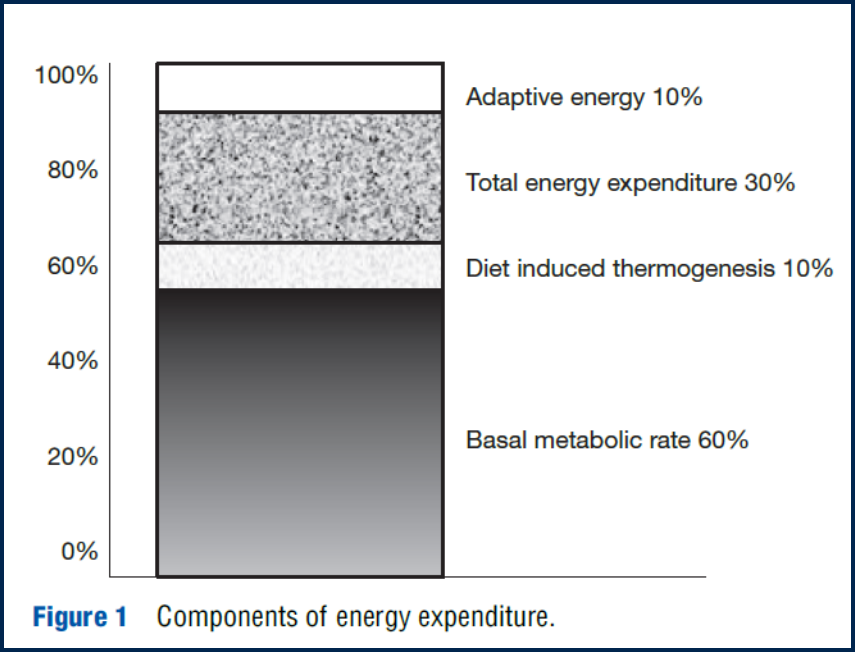
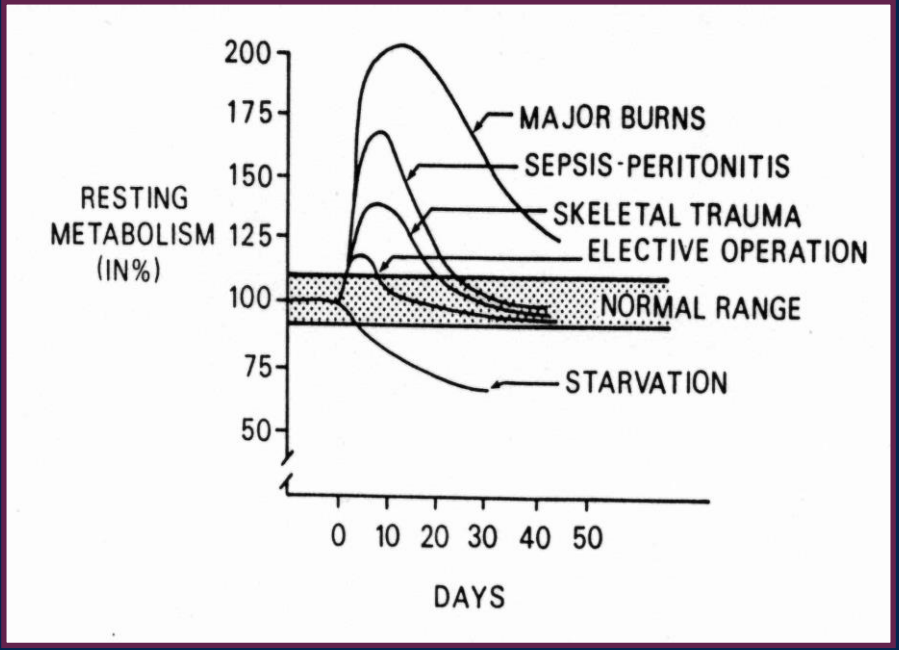


Figure 1 Components of energy expenditure.

Coss-Bu J.A. & Mehta N.M. (2016) Energy Metabolism



Long CI. *JPEN* 1979;3:452

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Nutrition Support Guidelines for the Critically Ill Child

Targeted Indirect Calorimetry in PICU

- Underweight (BMI < 5th percentile for age), at risk of overweight (BMI > 85th percentile for age) or overweight (BMI > 95th percentile for age)
- Children with > 10% weight gain or loss during ICU stay
- Failure to consistently meet prescribed caloric goals
- Failure to wean, or need to escalate respiratory support
- Need for muscle relaxants for > 7 days
- Neurologic trauma (traumatic, hypoxic and/or ischemic) with evidence of dysautonomia
- Oncologic diagnoses (including children with stem cell or bone marrow transplant)
- Children with thermal injury
- Children requiring mechanical ventilator support for > 7 days
- Children suspected to be severely hypermetabolic (status epilepticus, hyperthermia, systemic inflammatory response syndrome, dysautonomic storms, etc) or hypometabolic (hypothermia, hypothyroidism, pentobarbital or midazolam coma, etc.)
- Any patient with ICU LOS > 4 weeks may benefit from IC to assess adequacy of nutrient intake.

Mehta N. JPEN 2009

Is Indirect Calorimetry a Necessity or a Luxury in the Pediatric Intensive Care Unit?

Ursula G. Kyle, MS, RD/LD, FADA; Ana Arriaza, BS; Monica Esposito, BS; and Jorge A. Coss-Bu, MD

IC was indicated in 72.0% (108/150) of patients (n=150) during PICU days 1-7.

One-third of patients met ≥2 indications for IC.

Three of 4 patients were candidates for IC per A.S.P.E.N. guidelines.

PICUs might have to prioritize performing IC in patients who are <2 years of age, malnourished (underweight/overweight) on admission, or PICU stay of >5 days.

Future studies should determine the cost-benefit ratios of performing IC in PICU patients.

Kyle UG. JPEN 2012

Nutrition Support Guidelines for the Critically Ill Child

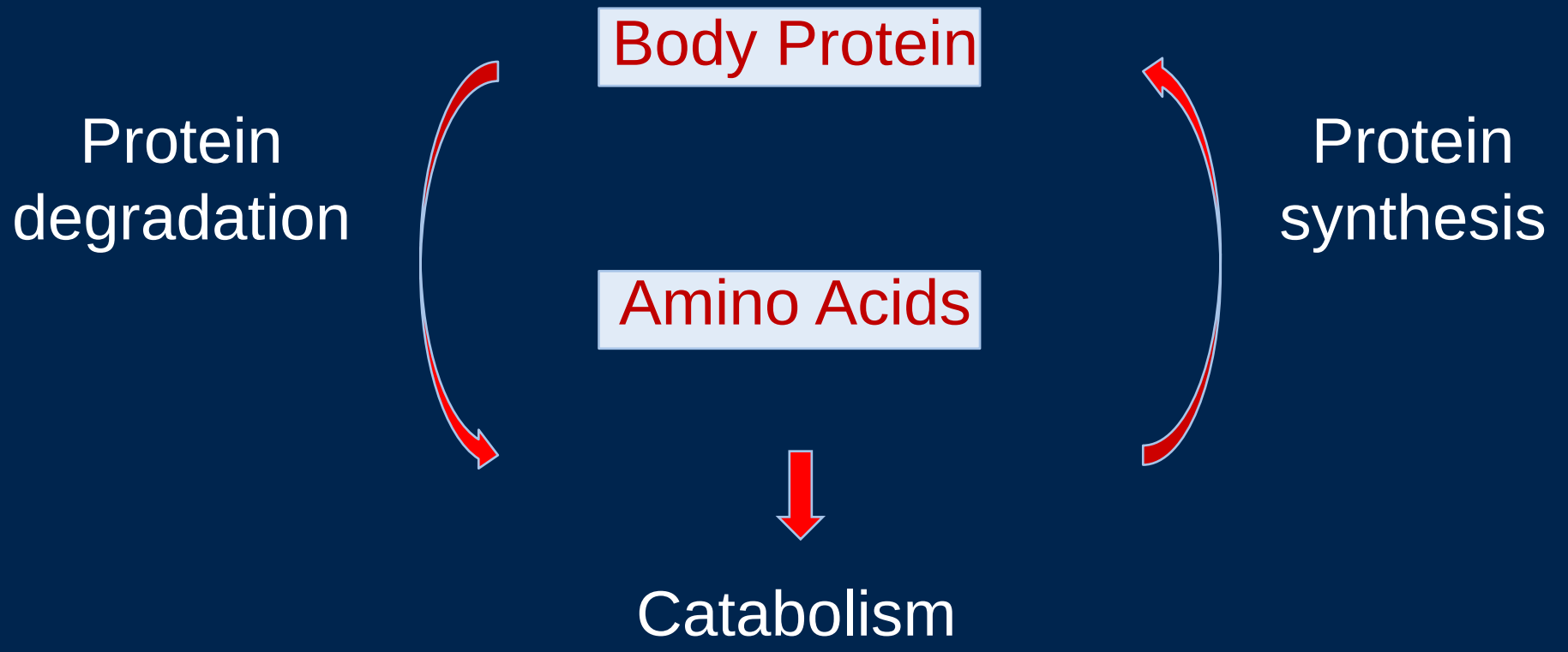
- Observational studies suggest that MEE by IC to determine energy needs and guide prescription
- If IC is not available using equations: Schofield, WHO, predictive equations are not accurate.
- The Harris-Benedict equation and the RDA should not be used to determine energy needs
- Observational studies suggest achieving delivery of at least 2/3 of the prescription by day 7

Nutrition Support Guidelines for the Critically Ill Child

	Quality of the evidence	GRADE recommendation
What is the minimum recommended protein requirement for critically ill children?	Moderate	Strong
What is the optimal protein delivery strategy in the PICU?	Moderate	Weak
How should protein delivery goals be determined in critically ill children?	Moderate	Strong

Nutrition Support Guidelines for the Critically Ill Child

Catabolism of Proteins and Amino Acids



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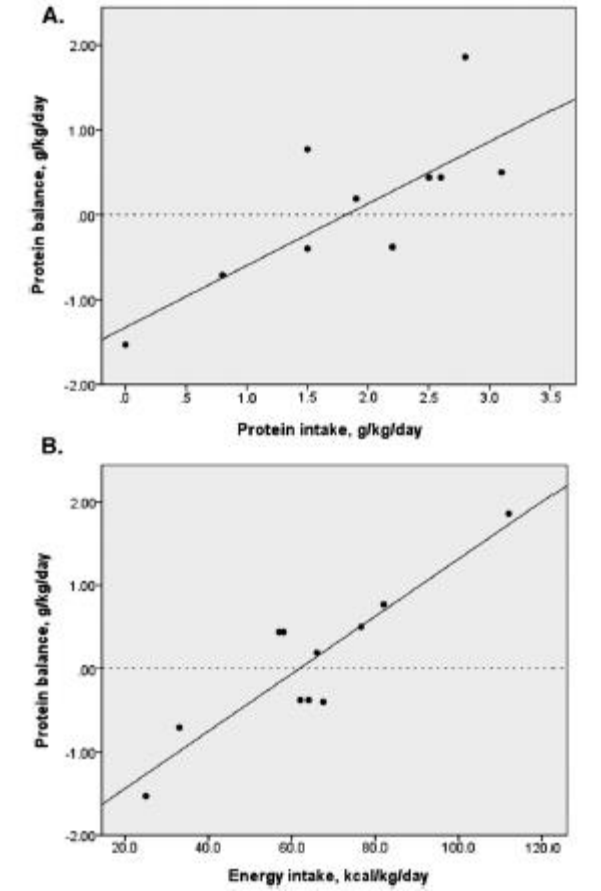

Bechard L. J Pediatr 2012

Protein Requirements of the Critically Ill Pediatric Patient

Jorge A. Coss-Bu, MD[1,2]; Jill Hamilton-Reeves, PhD, RD, CSO[3]; Jayshil J. Patel, MD[4]; Claudia R. Morris, MD[5]; and Ryan T. Hurt, MD, PhD[6]

Age category 0-2 years: on Enteral Nutrition
Protein balance was positive in children who received protein intakes of ~ 3 g/kg/day

Age category 2-13 years: on Enteral Nutrition
Children who received enteral nutrition had positive protein balance with protein intakes of at least 2 g/kg/day

Age category 2-13 years: on Parenteral Nutrition
Children who received parenteral nutrition had negative protein balance with protein intakes of ~ 2 g/kg/day

Age category 13-18 years: on Parenteral Nutrition
Children who received parenteral nutrition had a positive protein balance with protein intake of ~ 3 g/kg/day

Coss-BU JA. Nutr Clin Pract. 2017

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Protein intake and outcomes in critically ill children

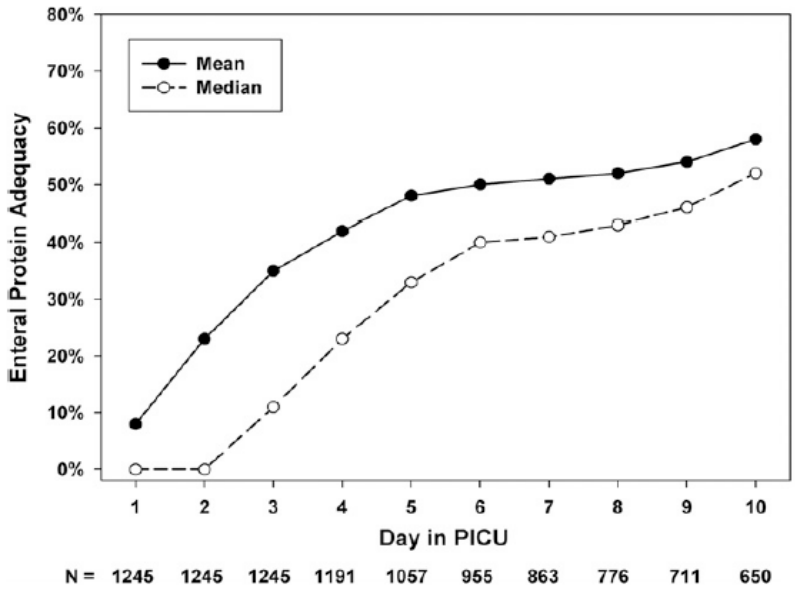
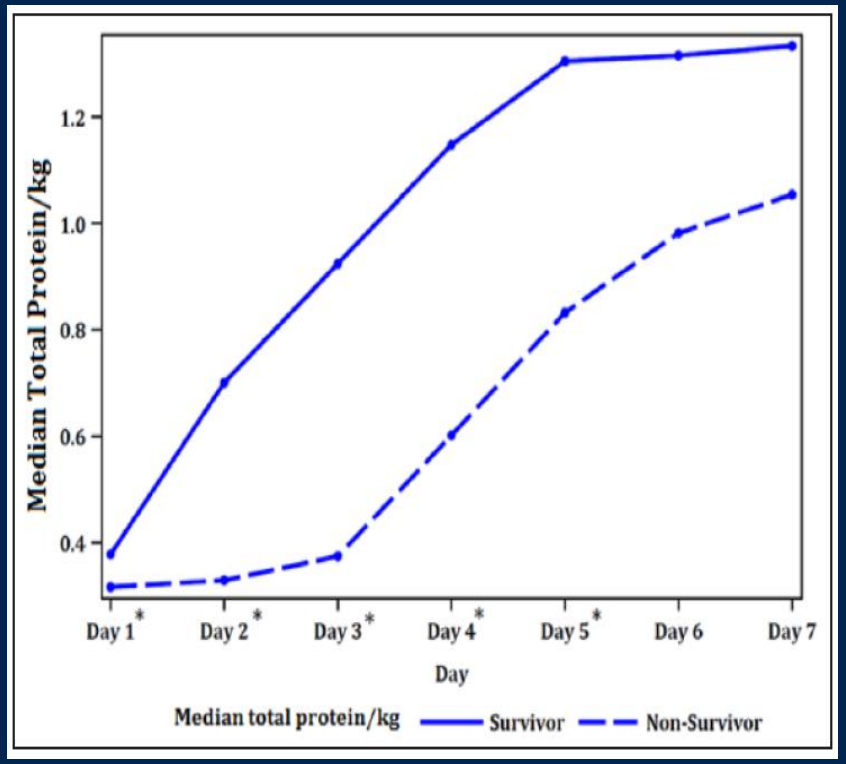


FIGURE 1 Daily cumulative protein intake adequacy in relation to the day since admission to the PICU in mechanically ventilated children (n = 1245). Adequacy = amount delivered ÷ goal prescribed × 100. Mean protein prescribed in this cohort was 1.9 g/kg per day. PICU, pediatric intensive care unit.

Mehta, NM. Am J Clin Nutr 2015



Wong, J. JPEN 2016

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- Based on RCTs and observational studies: we recommend a minimum protein intake of 1.5 g/kg/d
- In Infants and younger children the optimal protein intake may be much higher
- One observational study found and association of higher protein intake with lower 60-d mortality
- Protein provision should be early. RDA is not recommended to guide prescription in PICU

Nutrition Support Guidelines for the Critically Ill Child

	Quality of the evidence	GRADE recommendation
Is EN feasible in critically ill children?	Low	Strong
What is the benefit of EN in this group?	Low	Weak

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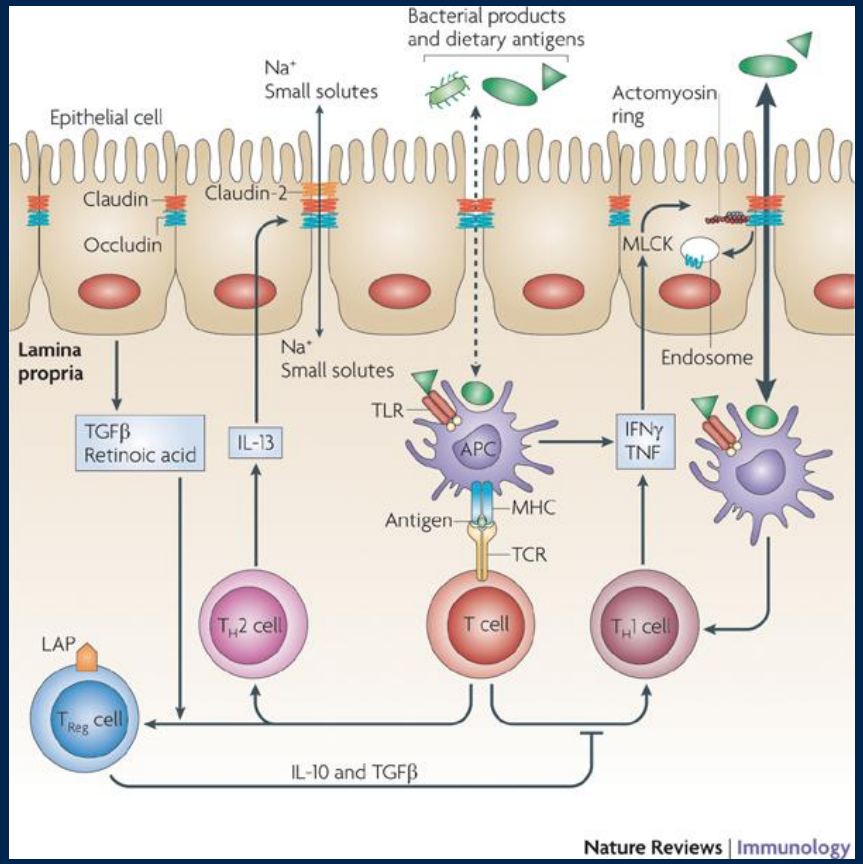


Gut Barrier

- Physical Barrier
  - Gut Microbiota
  - Intestinal Mucus
  - Epithelial Cells
- Functional Barrier
  - Gut Associated lymphoid tissue or "GALT"

Turner J. Nat Rev Immunol, 2009

Nutrition Support Guidelines for the Critically Ill Child

- Benefits of Enteral Nutrition: Evidence from clinical studies
  - Preservation of gut integrity
  - Favorable mucosal immunity
  - Improved nutritional indices
  - Lower infection rates
  - Decreased costs

Gramlich L et al. Nutrition 2004

Nutrition Support Guidelines for the Critically Ill Child

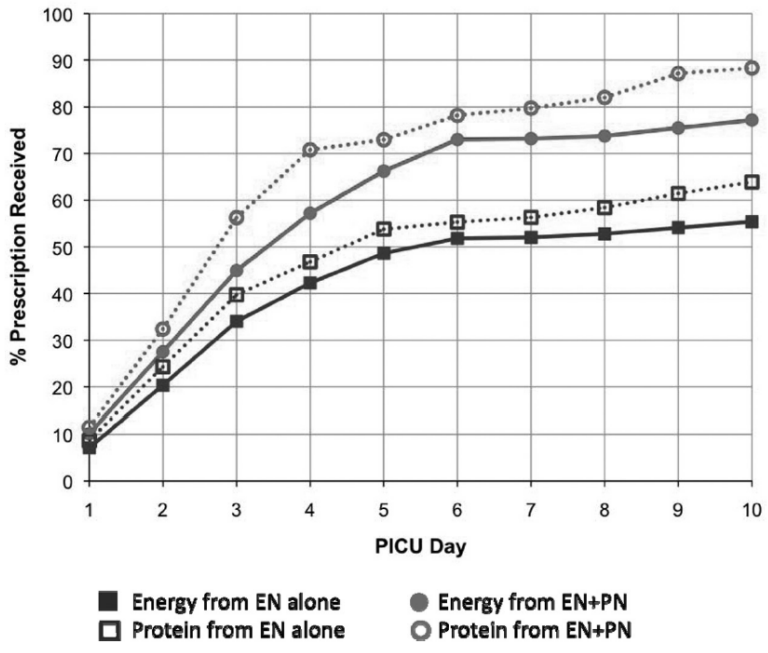
- Observational studies recommend EN as the preferred mode of nutrient delivery in PICU
- Observational studies support the feasibility of EN and can be safely delivered to children with medical and surgical diagnosis, including those receiving vasoactive medications.
- Common barriers to EN in PICU include: 1) delayed initiation, 2) interruptions, 3) Long fastings

Nutrition Support Guidelines for the Critically Ill Child

Nutritional practices and their relationship to clinical outcomes in critically ill children—An international multicenter cohort study*

Nilesh M. Mehta, MD; Lori J. Bechard, MEd, RD, LDN; Naomi Cahill, RD, MSc; Miao Wang, MSc; Andrew Day, MSc; Christopher P. Duggan, MD, MPH; Daren K. Heyland, MD, MSc

Crit Care Med 2012; 40:2204–2211



- A higher percentage of goal energy intake via enteral nutrition route was significantly associated with lower 60-day mortality.

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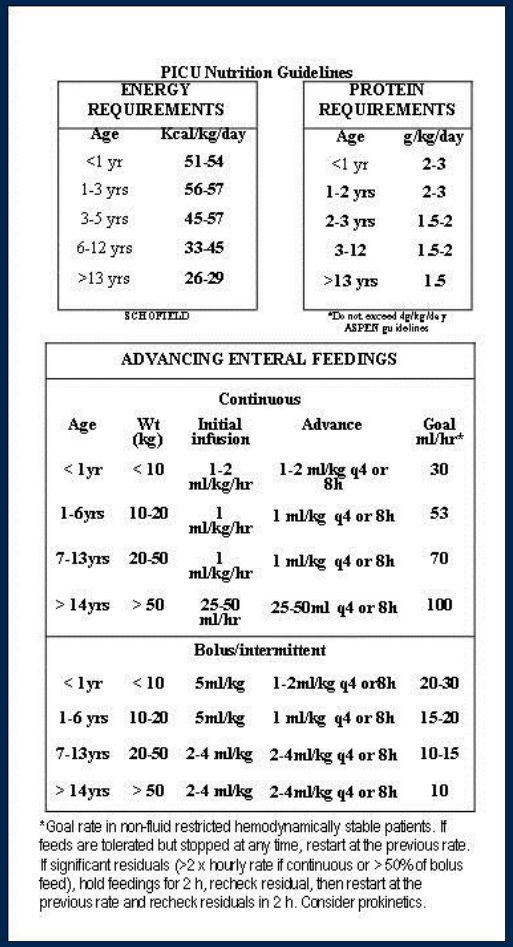
- Observational studies suggest that interruptions to EN should be minimized
- Some amount of EN is beneficial for gastrointestinal mucosal integrity and motility
- Large cohort studies found an association of early EN (24-48 hr.) and improved clinical outcomes

Nutrition Support Guidelines for the Critically Ill Child

	Quality of the evidence	GRADE recommendation
What is the optimum method for advancing EN in the PICU population?	Low	Weak
What is the role of a nutrition support team or a dedicated dietitian in optimizing nutrition therapy?	Low	Weak

Nutrition Support Guidelines for the Critically Ill Child



PICU Nutrition Guidelines

ENERGY REQUIREMENTS	
Age	Kcal/kg/day
<1 yr	51-54
1-3 yrs	56-57
3-5 yrs	45-57
6-12 yrs	33-45
>13 yrs	26-29

SCHOFIELD

PROTEIN REQUIREMENTS	
Age	g/kg/day
<1 yr	2-3
1-2 yrs	2-3
2-3 yrs	1.5-2
3-12	1.5-2
>13 yrs	1.5

*Do not exceed dg/kg/day ASPEN guidelines

ADVANCING ENTERAL FEEDINGS

Continuous

Age	Wt (kg)	Initial infusion	Advance	Goal ml/hr*
< 1yr	< 10	1-2 ml/kg/hr	1-2 ml/kg q4 or 8h	30
1-6yrs	10-20	1 ml/kg/hr	1 ml/kg q4 or 8h	53
7-13yrs	20-50	1 ml/kg/hr	1 ml/kg q4 or 8h	70
> 14yrs	> 50	25-50 ml/hr	25-50ml q4 or 8h	100

Bolus/intermittent

< 1yr	< 10	5ml/kg	1-2ml/kg q4 or8h	20-30
1-6 yrs	10-20	5ml/kg	1 ml/kg q4 or 8h	15-20
7-13yrs	20-50	2-4 ml/kg	2-4ml/kg q4 or 8h	10-15
> 14yrs	> 50	2-4 ml/kg	2-4ml/kg q4 or 8h	10

*Goal rate in non-fluid restricted hemodynamically stable patients. If feeds are tolerated but stopped at any time, restart at the previous rate. If significant residuals (>2 x hourly rate if continuous or > 50% of bolus feed), hold feedings for 2 h, recheck residual, then restart at the previous rate and recheck residuals in 2 h. Consider prokinetics.

Texas Children's Hospital Nutrition Support Guidelines

Goals of Nutrition Care

- To meet 50% of energy requirements by 48 hours and 100% by days 3-5 based on Schofield, depending on course of the disease.
- To meet 50% of protein requirements based on ASPEN 2009 guidelines by 48 hours and 100% by days 3-5.

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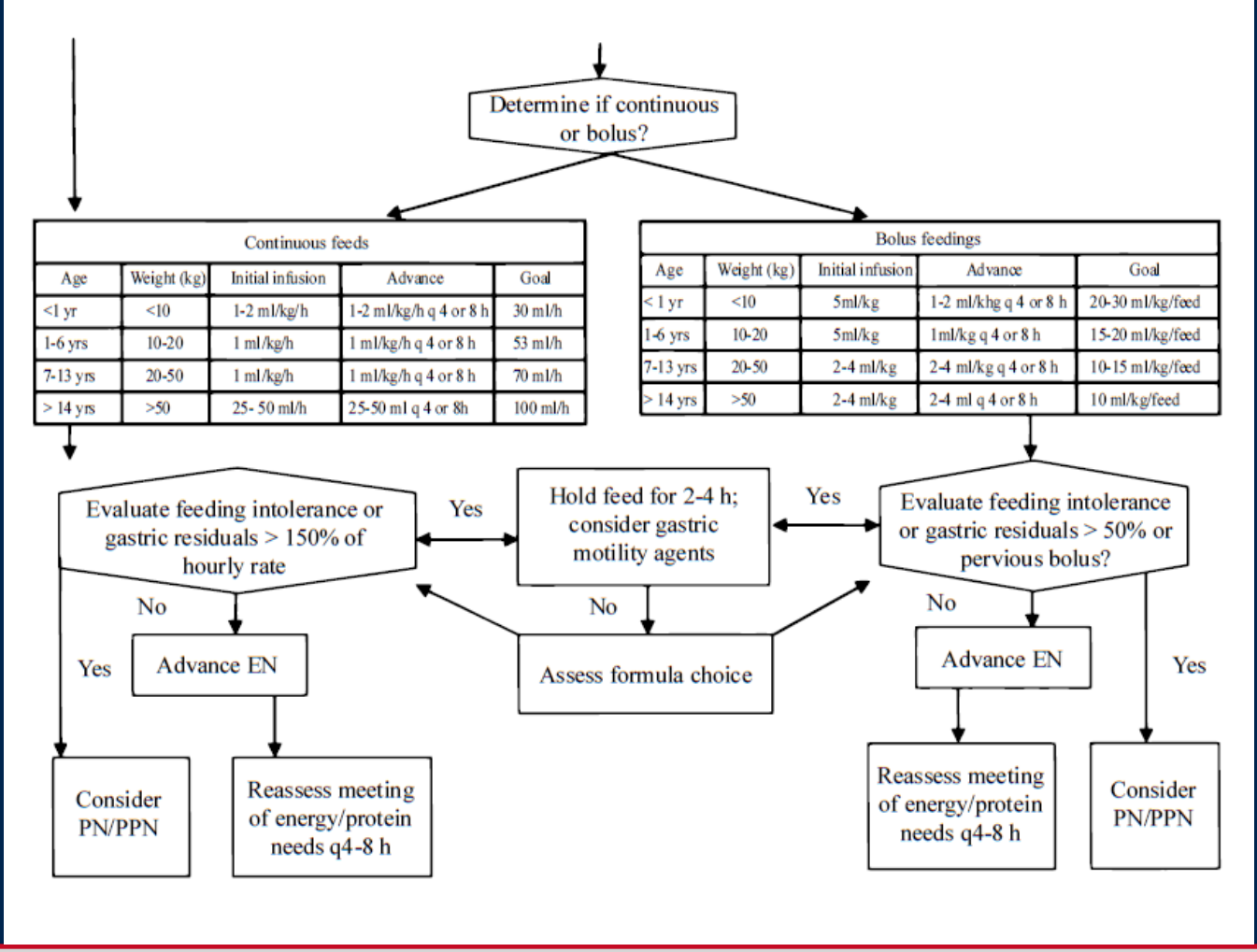

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- Observational studies suggest the use of a stepwise algorithmic approach to advance EN
- The stepwise approach must include bedside support to guide the process of EN delivery
- Observational studies suggest that a nutrition support team, including a dedicated dietitian be available on the PICU team, to facilitate timely nutritional assessment and optimal EN delivery

Nutrition Support Guidelines for the Critically Ill Child

	Quality of the evidence	GRADE recommendation
What is the best site for EN delivery: gastric or small bowel??	Low	Weak
When should EN be initiated?	Low	Weak

Nutrition Support Guidelines for the Critically Ill Child

Horn, D; 2003 RCT[a]	45 pts.; continuous (n=22) vs. intermittent (n=23)	NS[b]: stool volume, diarrhea, vomiting, use of prokinetics
Horn, D; 2004 RCT	45 pts.; continuous (n=22) vs. intermittent (n=23)	NS: volume of formula (ml/kg/d) or GRV/kg[c] in 72 hrs.
Meert, K; 2004 RCT	74 pts MV[d]; gastric (n=32) vs. small bowel (n=42, then 30)	NS: Percentage of aspiration or feeding intolerance
Sanchez, C; 2007 Prospective	526 pts. on transpyloric feeds; early < 24 h. (n=202), late > 24 h (n=324), 10 y study	Early group: Less days in SPN[e] (0.2 vs. 0.9 days); and abdominal distention (3.5% vs. 7.8%)

[a] RCT: Randomized controlled trial; [b] Non-significant; [c] GRV: Gastric residual volume; [d] MV: Mechanical ventilation; [e] SPN: Supplemental parenteral nutrition

Nutrition Support Guidelines for the Critically Ill Child

- Existing data are insufficient to make universal recommendations regarding the optimal EN route
- Observational studies suggest the gastric route be the preferred site for EN
- The post-pyloric or small intestinal site may be used in patients intolerant to gastric feeding
- Existing data are insufficient to make recommendations regarding the use of continuous vs intermittent gastric feeding

Nutrition Support Guidelines for the Critically Ill Child

	Quality of the evidence	GRADE recommendation
What is the indication for and optimal timing of PN in critically ill children?	Moderate	Strong
What is the role of PN as a supplement to inadequate EN?	Low	Weak

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

MARCH 24, 2016 VOL. 374 NO. 12

Early versus Late Parenteral Nutrition in Critically Ill Children

Tom Fivez, M.D., Dorian Kerklaan, M.D., Dieter Mesotten, M.D., Ph.D., Sascha Verbruggen, M.D., Ph.D., Pieter J. Wouters, M.Sc., Ilse Vanhorebeek, Ph.D., Yves Debaveye, M.D., Ph.D., Dirk Vlasselaers, M.D., Ph.D., Lars Desmet, M.D., Michael P. Casaer, M.D., Ph.D., Gonzalo Garcia Guerra, M.D., Jan Hanot, M.D., Ari Joffe, M.D., Dick Tibboel, M.D., Ph.D., Koen Joosten, M.D., Ph.D., and Greet Van den Berghe, M.D., Ph.D.

- Single large randomized control trial
- Three-center RCT (PEPaNIC)
- 723 patients receiving early PN (within 24 hours)
- 717 patients receiving late PN (day 8)
- Inclusion criteria
- Expected ICU stay ≥ 24 hours
- Moderate to high risk of malnutrition (≥ 2 on STRONGkids)

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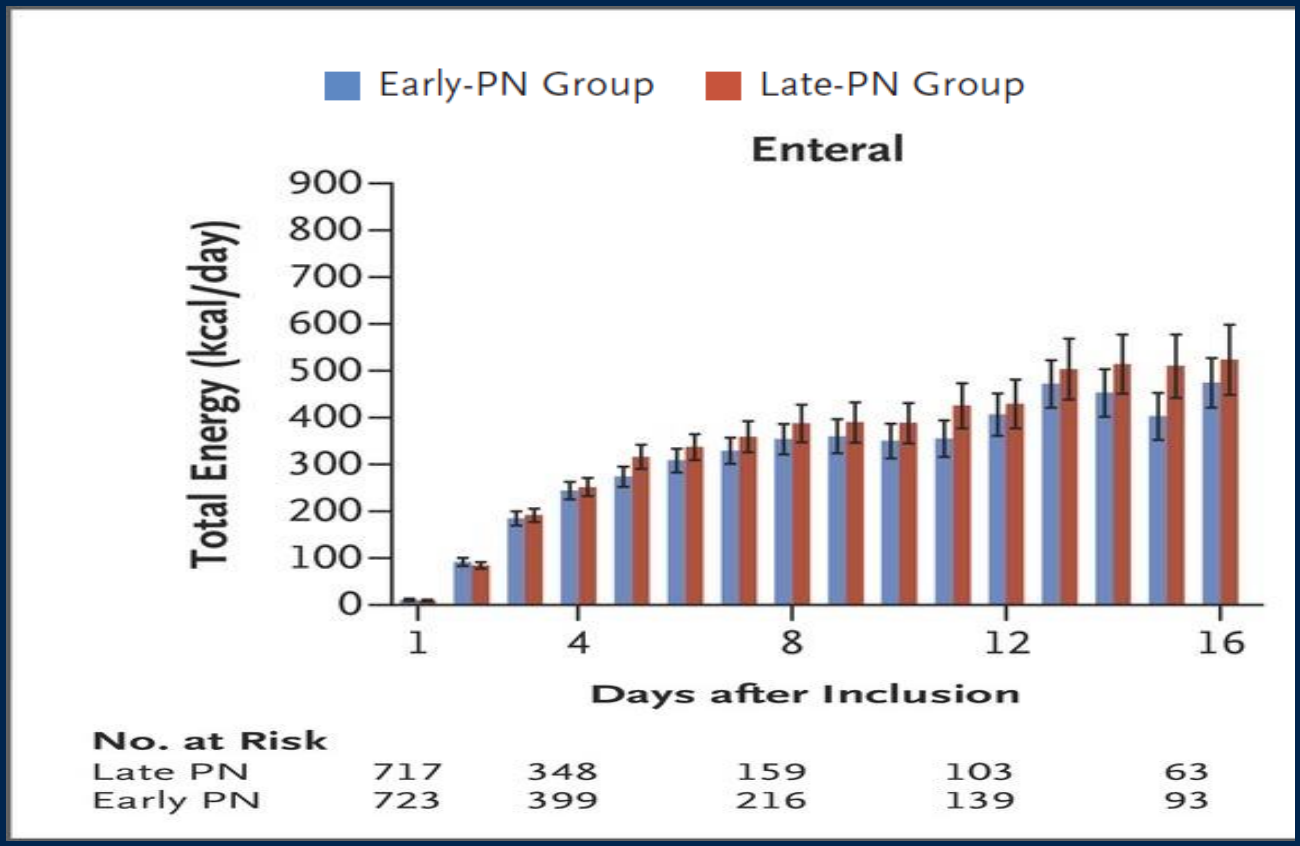

No mortality difference between the groups

<u>The late PN group</u>

Lower rate of acquisition of a new infection
Shorter stay in the PICU
Shorter duration of mechanical ventilation
Lower need for renal-replacement therapy

Fivez, T. NEJM 2016

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Limitations of the study

- Only 22% of patients in the late PN group in the PICU by day 8
- The prevalence of severe malnutrition likely was low
- Many children were receiving significant EN by day 4
- Different glycemic control protocols in each centers
- Non-standard definitions of acquired infections
- Presence of indwelling devices not reported
- New vs. infection present at baseline?

Fivez, T. NEJM 2016

Nutrition Support Guidelines for the Critically Ill Child

- Based on a single RCT, we do not recommend the initiation of PN within 24 hr. of PICU admission
- In children tolerating EN, we suggest stepwise advancement of nutrient delivery by enteral route
- Based on current evidence, the role of supplemental PN to reach a caloric goal, is not know

Nutrition Support Guidelines for the Critically Ill Child

- The time when PN should be initiated to supplement EN is also unknown
- Based on a single RCT, supplemental PN should be delayed until 1 week after PICU admission in patients with normal baseline nutritional status and low risk of nutritional deterioration
- PN supplementation: children unable to receive EN, or malnourished pts., or unable to advance EN

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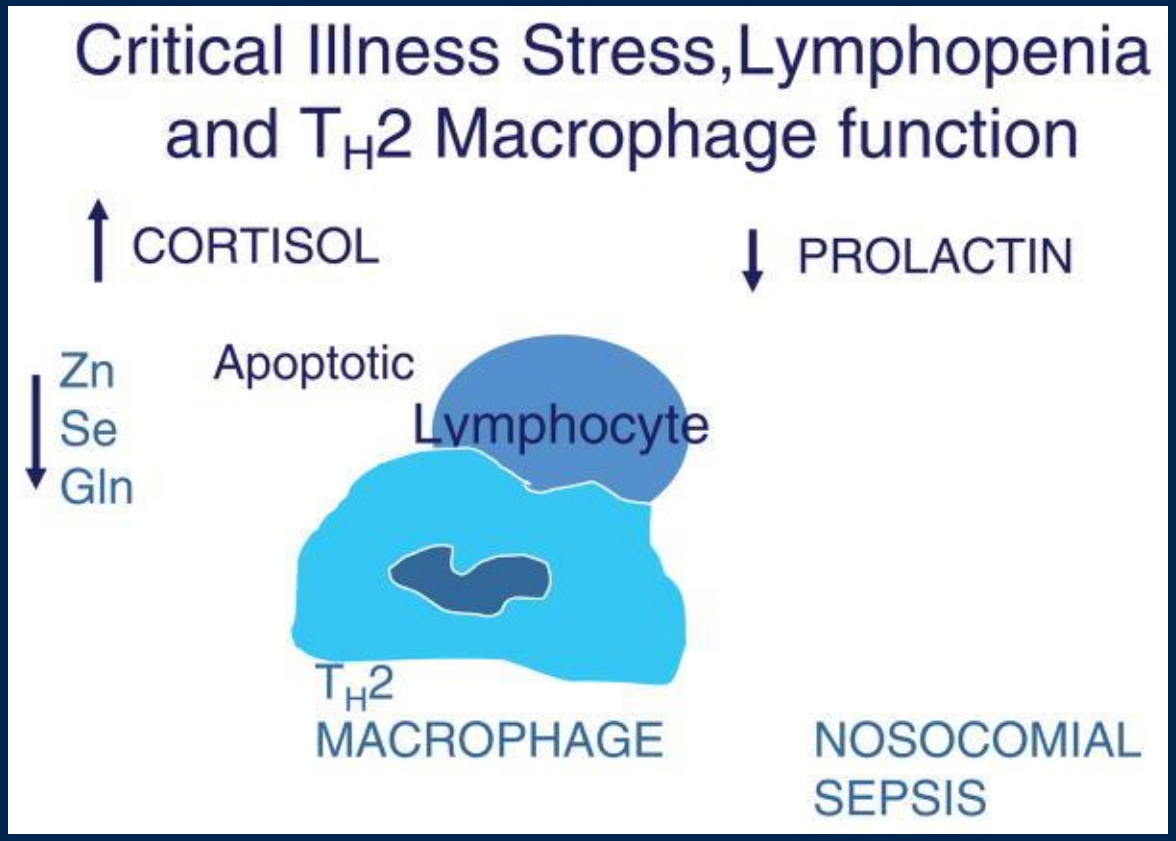
	Quality of the evidence	GRADE recommendation
What is the role of immunonutrition in critically ill children?	Moderate	Strong

- Based on evidence, we do not recommend the use of immunonutrition in critically ill children

Nutrition Support Guidelines for the Critically Ill Child



Carcillo J. JPEN 2009

Nutrition Support Guidelines for the Critically Ill Child

- Conclusions
  - The guidelines reiterate the importance of nutrition assessment—particularly, the detection of malnourished patients who are most vulnerable and therefore potentially may benefit from timely nutrition intervention.
  - There is a need for renewed focus on accurate estimation of energy needs and attention to cumulative energy imbalance. IC must be used to guide energy prescriptions, where feasible, and cautious use of estimating equations and increased surveillance for unintended caloric underfeeding and overfeeding are recommended

Nutrition Support Guidelines for the Critically Ill Child

- Conclusions
  - Optimal protein dose and its correlation with clinical outcomes is an area of great interest. The optimal route and timing of nutrient delivery are areas of intense debate and investigations.
  - EN remains the preferred route for nutrient delivery. Several strategies to optimize EN during critical illness have emerged.
  - The role of supplemental PN has been highlighted, and a delayed approach appears to be beneficial.
  - Immunonutrition cannot be currently recommended.

Nutrition-related resources and tools are available from Nestlé Nutrition Institute: www.nestlenutrition-institute.org

Visit the New and improved MyCE site at MyCEeducation.com

Offering CE to dietitians and nurses

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