DOES IN WITH THE GOOD EQUAL OUT WITH THE BAD? APPLICATION OF NUTRITION SUPPORT RESEARCH

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- I am not advocating for any particular device or manufacturer
- All photographs used with written permission

Objectives

- Describe incidence and risks of malnutrition in the hospitalized patient in the PICU
- Discuss available methodologies to determine nutrition needs in the PICU population
- Describe challenges and current best practices in nutrient delivery in the critically ill child

Pediatric Malnutrition

- “an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients that may negatively affect growth, development and other relevant outcomes” (p. 478)
- Domains of chronicity, etiology, mechanisms of nutrient imbalance, severity of malnutrition and impact on outcomes
- Emphasis on etiology of malnutrition as a primary driver for nutrition support

(Mehta et al., 2013)

Epidemiology of the Problem

- More than 30% children requiring mechanical ventilation were severely malnourished upon admission to the PICU (Nilesh M. Mehta et al., 2012)
  - BMI Z score > 2 (13.2%) or < 2 (17.1%)
- Inadequate delivery of nutrition during hospitalization results in cumulative energy (kcal/kg/day) and/or protein (grams/kg/day) deficits which contribute to delayed recovery (Mehta et al., 2012; Mikhailov et al., 2014)

Epidemiology of the Problem

- Cohort study of children ages 3.9 to 63.3 months admitted to the PICU over a 2 year period (n=385) (de Souza Menezes, Leite, & Koch Nogueira, 2012).
  - 46% (n=175) were malnourished on admission, assoc with longer duration of MV (p=0.003)
- Only 35% of energy needs and 0% of protein needs were met for AKI/renal failure vs 55% and 19% in those without
  - Likely due to fluid restrictions and reluctance to provide needed protein in patients with kidney injury

(Kyle, Akcan-Arikan, Orellana, & Coss-Bu, 2013).

A.S.P.E.N. Nutrition Support Recommendations for the Critically Ill Child

- Nutrition screening for all patients
- Energy expenditure should be assessed throughout course of illness
- Insufficient data to make standard recommendation for macronutrient intake, total or composition

(Mehta, Compher, et al., 2009)

A.S.P.E.N. Nutrition Support Recommendations for the Critically Ill Child

- EN preferred mode of nutrition delivery
- Routine use of immunonutrition not recommended
- Specialized Nutrition Support Teams and aggressive feeding protocols may enhance delivery of EN, minimizing use of PN and decreasing nutritional deficits

(Mehta, Compher, et al., 2009)

Measuring Energy Needs

- Best practice – Indirect Calorimetry (IC)
- Calculates a respiratory quotient (RQ), the ratio of CO_2 elimination to oxygen uptake, partly determined by endogenous substrate use
- Target is 0.87
  - higher increased CHO burden
  - lower increased fat burden
- Can direct nutrition therapy for not only energy needs, but composition

(Dokken M, Rustoen T & Stubhaug A., 2013)

Measuring Energy Needs

- Challenges of IC
  - Often not tolerated by critically ill patients
  - Use on infants < 10kg
- Alternatives
  - RDA
  - Standardized equations
    - Many available, with modifications employed account for REE variation in the PICU environment

(Dokken M, Rustoen T & Stubhaug A., 2013; Mehta NM, 2009; Irving, SY, et. al., 2009)

Measuring Energy Needs

- Re-assess every 3-4 days
- Early inflammatory phase associated with catabolism, lower energy but higher protein needs
  - Biomarkers??
- Convalescent phase is anabolic with increased energy needs along with adequate protein
- <u>When unable to achieve target daily energy and protein, supplementation to target protein while sacrificing calorie intake may still confer an outcome benefit for the patient</u>

(Larsen, 2012; Larsen et al., 2012)

Impact of EN on Outcomes in the PICU

- Mean (SD) attainment of target nutrition via EN was 38% (34) for energy and 43% (44) for protein
- Higher levels of EN (66.6% compared to 33.3%) resulted in a lower mortality rate (OR 0.27 [0.11-0.67], p = .002)
- Subjects receiving parenteral nutrition had a higher mortality rate (OR 2.61 [1.3 – 5.3], p = .008)
- Analyses controlled for hospital site and severity of illness

(Mehta et al., 2012)

Impact of EN on Outcomes in the PICU

- Retrospective study of 8 PICUs (n=5105) compared those on MV who did and did not achieve early EN (25% goal calories within 48 hours of admission)
- 27.1% (mean) of subjects (range 15.6%-45.1%) achieved early EN
- Those achieving EN had lower mortality
  - (odds ratio 0.51; 95% CI 0.34-0.76; p =.001)
  - Adjusted for age, severity of illness, clinical site, and propensity score (Mikhailov et al., 2014)

Barriers to Delivery of Adequate EN

- Hemodynamic instability
- Feeding intolerance
- Feeding interruptions
- Variation in feeding practices/lack of feeding protocols

Barriers – Hemodynamic Instability

- Hemodynamic instability
  - Hypoxia, ischemia or both
  - Compensatory vasoconstriction shunts blood away from GI tract and skin toward the heart, lungs and brain
  - Gut vulnerable to alterations in motility, secretion, digestion, and absorption.
  - Concomitant fluid restriction

(Mentec et al., 2001).

Barriers – EN During Vasopressor Infusion

- Feeding tolerance evaluated during administration of vasopressors adult ICU patients (n=259)
  - Overall tolerance of EN 74.9%
- Adult ICU patients (n=1174) 2 groups:
  - those given EN within 48 hours of starting MV (n=707) and those who did not (n=467)
  - Those receiving early EN had lower ICU (p=.003) and hospital mortality (p=< .001)
- **Greatest benefit of early EN was seen in those who received multiple vasopressor agents**

Mancl and Muzevich (2013)
(Khalid, Doshi, & DiGiovine, 2010)

Barriers – EN During Vasopressor Infusion

- Feeding intolerance evaluated in PICU patients (n=339) on vasoactive medications who were fed vs not fed, comparing incidence of adverse GI events
- Increased incidence of adverse GI events, e.g. emesis, diarrhea, abdominal distension, GI bleeding noted in fed group
- **The fed group had lower risk of mortality [6.9% vs 15.9%; OR 0.39 (0.18-0.84;p<.01)]**
- Consistent with the findings of Mancl, et al (2013), patients can tolerate EN while on vasopressor support with the advantages of EN maintained

(Panchal et al., 2013).

Barriers – Feeding Intolerance

- Lack of consensus on measures/thresholds
  - Emesis
  - Gastric Residual Volumes
  - Abdominal Distension
  - Diarrhea
  - Abdominal Pain
  - Constipation

Barriers – Feeding Interruptions

- Avoidable/Unavoidable
- 28 day observational PICU study
  - 58% interruptions avoidable
    - 3x more likely to receive PN
- Feeding tube issues
  - Placement issues
    - Radiologic confirmation current best practice
  - Unplanned tube or dysfunction
- Recommend protocols to minimize interruptions

(Mehta et al., 2010)

Barriers - Variation in Feeding Practices/Lack of Feeding Protocols

- Higher caloric formula advancement protocol for post op CHD infants
  - Improved delivery of target energy 98% vs 78% in control (p=.01), weight gain vs *LOSS* (p<.03)
  - Shorter hospital LOS 5 vs 6 days (p<.05)
- Continuous NG protocol initiated for post Stage 1 Palliation in HLHS infants
  - Shorter duration of PN (p = .03) & time to goal feeds (p=/01)
  - no incidence of NEC in the intervention group compared to 11% in the control

(Pillo-Blocka, Adatia, Sharieff, McCrindle, & Zlotkin, 2004
(Braudis et al., 2009)

Barriers - Variation in Feeding Practices/Lack of Feeding Protocols

- Numerous studies demonstrate improved delivery of EN with implementation protocol in PICU
- Varied protocols
- No best feeding approach yet defined
- Early RD documentation in MR of EER improves higher daily intake

(Petrillo-Albarano, Pettignano, Asfaw, & Easley,
(Tume, Latten, & Darbyshire, 2010)
(Horn & Chaboyer, 2003)
(Brown, Forbes, Vitale, & Tirodker, 2012)
(Wakeham, et. al., 2013)

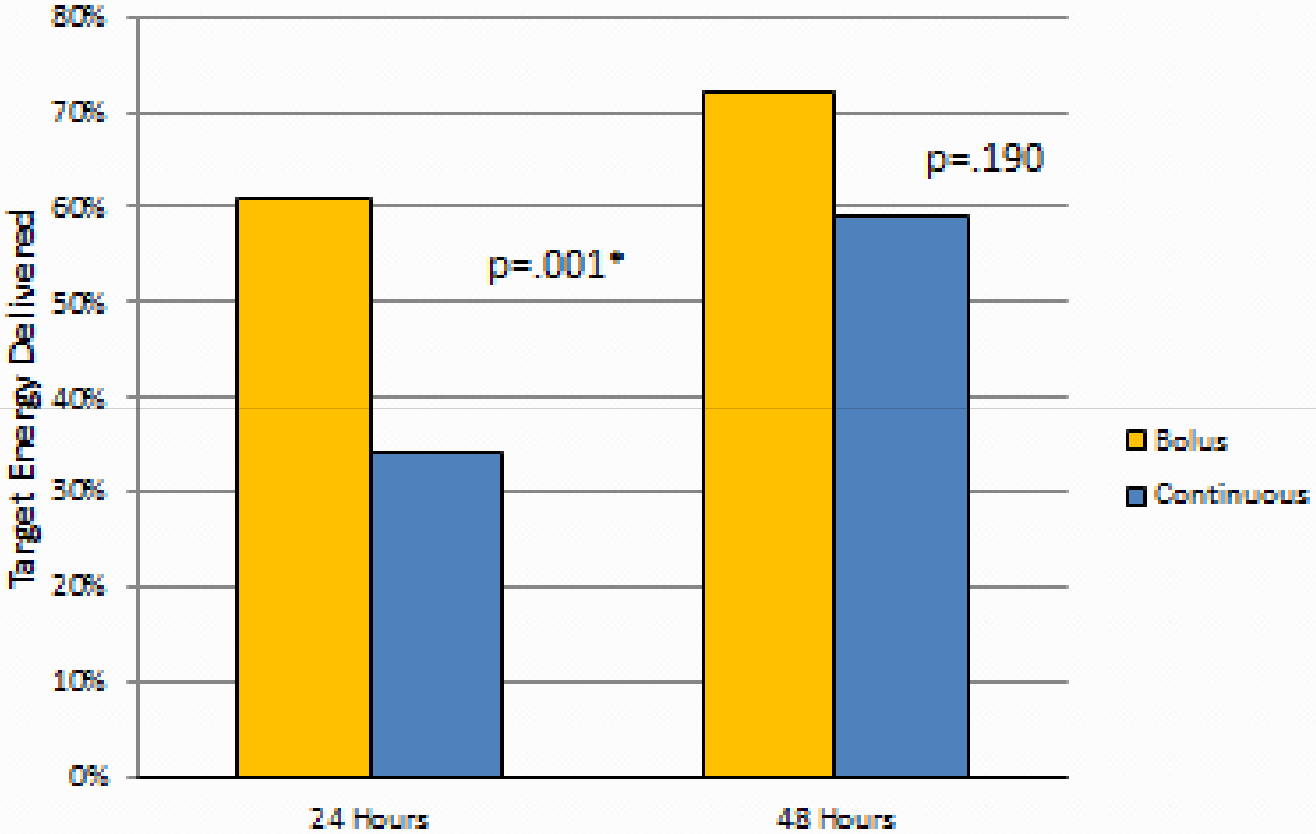
Continuous vs Bolus

- Adult studies (5) show ***NO*** increased pulmonary risk occurred with bolus feeding (Chen et al., 2006)
  - All demonstrate same or increased delivery of prescribed nutrition (Chen et al., 2006; Rhoney et al., 2002)
- Increased protein synthesis in muscles of different fiber types and visceral tissues in the bolus fed group compared to the continuously fed group ($p<.05$)
  - (El-Kadi et al., 2013)

Continuous vs Bolus
ACH PICU Nutrition Research

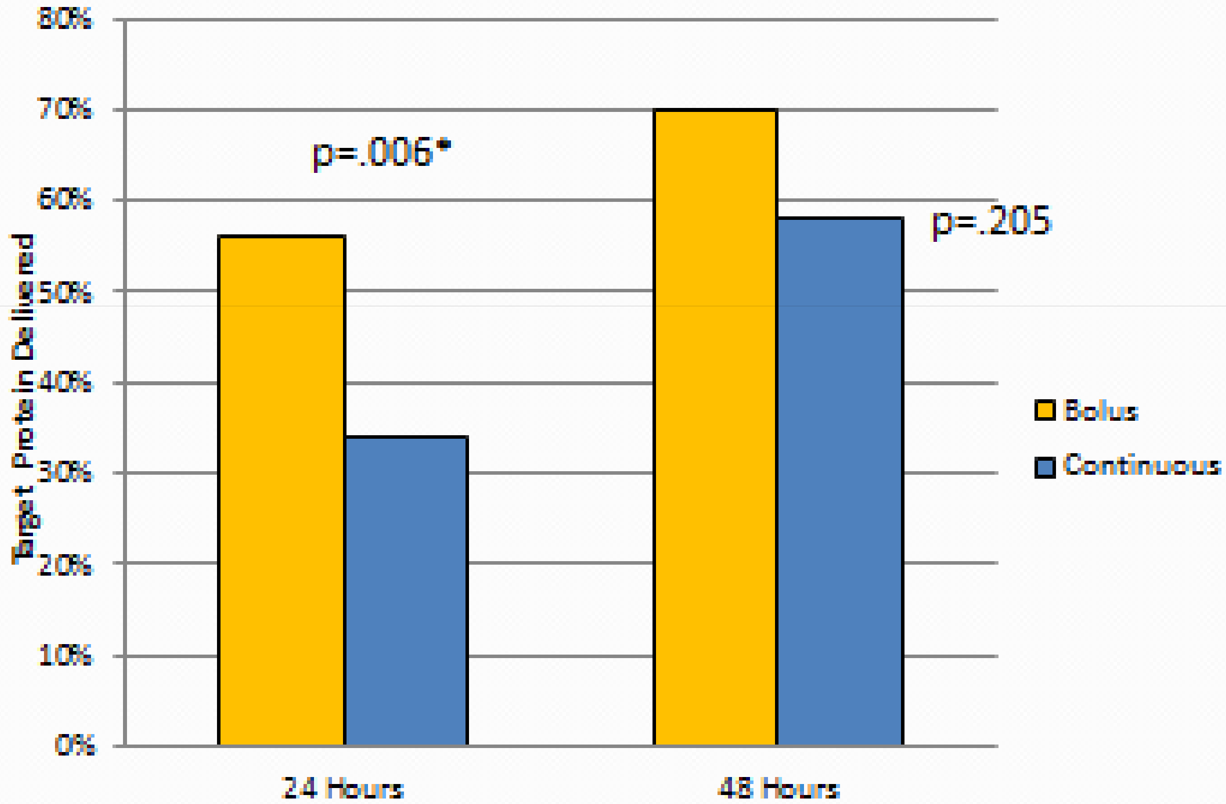
- COBO Study
- Compare continuous (CGF) vs. bolus (BGF) NG feeding approaches time to reach goal feeds, cumulative energy/protein deficits, intolerance events and feeding interruptions
- Mechanically ventilated infants and children 1 month corrected gestational age through 12 years of age.

More Energy Delivered in GF-B Group



24 and 48hr group n; B-GF 11/10, C-GF 14/10

More Protein Delivered in GF-B Group



24 and 48h group n; B-GF 11/10, C-GF 14/10

Changing the Paradigm

- From Nutrition Support
  - Preserve lean body mass
  - Avoid metabolic complications
- To Nutrition Therapy
  - Attenuate the metabolic response
  - Down-regulate inflammation
  - Reverse loss of lean body mass
  - Prevent oxidative stress
  - Immunomodulation
    - Micronutrient specific

Translation to Practice

- Recommendations
  - Use indirect calorimetry when possible
  - Enteral as default approach unless contraindicated
  - Avoid PN for 5-7 days except in special cases
  - Protocolized approach, regardless of setting
    - Include intolerance criteria
    - Minimize interruptions
  - Individualized NT care plan with interdisciplinary team

Directions for Future Research

- Defining feeding intolerance measures and thresholds that predict risk of adverse events
- Defining best feeding protocols
- Minimizing Interruptions
- Improved techniques to measure energy needs on an interval basis

Directions for Future Research

- Biomarkers to demarcate catabolic/inflammatory transition to anabolic/healing state
- Prospective evaluation of post-pyloric vs continuous gastric versus bolus gastric feeding
- EN for the patient with non-invasive ventilation
  - High flow nasal cannula
  - NIV
  - BiPAP

Thank You!!

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