Timing of Enteral and Parenteral Nutrition in the PICU

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Disclosures

Honorarium provided by Nutricia for this presentation

This does not pose a conflict of interest for this talk

The opinions reflected in this presentation are those of the speaker and independent of Nutricia North America

Objectives

- Review the evidence supporting early enteral nutrition to meet energy demands and improve patient outcomes
- Examine the risks of undernutrition during critical illness and its long-term implications on recovery and growth
- Highlight the role of energy and nutrient dense formulas in addressing the unique needs of infants in the PICU
- Share practical considerations and clinical examples for integrating these formulas (ENDF) into enteral feeding protocols

Nutrition Assessment of the Critically Ill Child - Considerations

Acute metabolic stress response

- Breakdown of adipose, glucose, muscle stores as energy substrate
- Further catabolism if adequate energy and protein not provided

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Nutrition Assessment of the Critically Ill Child - Considerations

Development of adipose stores and lean body mass

- Growth evaluation
- Adequacy of muscle bulk
- Presence of edema

Nutrition Assessment of the Critically Ill Child - Considerations

Increased protein needs

- High protein turnover, even above normal pediatric rate
- Increased protein losses: urinary, wounds

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Why is adequate nutrition support so crucial in this population?

Malnutrition

- Prevalence of malnutrition is reported to be higher in critically ill children compared to hospitalized children
- Malnourished patients have lower baseline nutrition stores to take on demand of critical illness
  - Increased risk of worsened outcomes and longer recovery
  - Priority should be given to initiating nutrition support and ensuring adequacy
- Acute malnutrition can develop with serial NPO status and overall inadequate energy and protein provision

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Long-term implications of under-nutrition

- Suboptimal intake associated with increased mortality, length of stay, and growth failure
- Catabolic state due to starvation, immobilization, stress and inflammation
  - Metabolism shifts to favor protein degradation over protein synthesis to allow for adequate amino acids for organ functions
- Cumulative energy and protein deficits result in need for catch up growth, but first must overcome increased needs for critical illness
- Adequate calories but inadequate protein?
  - Protein underfeeding exaggerates cumulative protein deficit
  - Inadequate protein and inadequate energy intake can result in growth failure

Nutrition Support in the PICU

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Timing of Nutrition Support

Feeding Modalities	Oral Diet, Enteral Nutrition, Parenteral Nutrition
Early Enteral Nutrition	24-48 hours of PICU admission Hemodynamic stability
Advancement to goal enteral nutrition, modifying intervention as needed based on tolerance and intake	Prevent cumulative negative protein balance – which can result in lean muscle mass, which is associated with poor outcomes in critically ill patients
Timely supplementation of TPN when unable to achieve enteral goals	

Benefits of Early Enteral Nutrition

↓
- Energy and protein deficits
- Number of day to goal feeds
- Infectious complications
- Ventilator days
- Length of stay

↑
- Maintains gut integrity
- Earlier achievement of anabolic state
- More cost effective compared to PN
- Ease of maintaining electrolytes and fluid balance

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Barriers to Enteral Nutrition

Barriers to Initiation

- Hemodynamic Instability
- Nonfunctional GI tract
- Surgical and medical procedures

Barriers to Adequacy

- Prolonged or recurrent NPO status
- Volume restriction
- Perceived intolerance
- Delayed initiation of failure to advance feeds when feasible

Enteral Feeding Goals

Energy & Protein Goals

Indirect calorimetry, when available

Estimated Basal Metabolic Rate: Schofield or FAO-WHO-UNU

ASPEN Protein Guidelines

Advancement/adequacy of intake

Initiate feeds within 24-48 hours of admission

Two-thirds of nutrition goal in the first week of critical illness

Advancement to goal energy provision

- Modification of feeds, supplemental TPN if unable to meet goals

Monitoring adequacy of intake, tolerance, physical exam

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Protein

- ASPEN guideline
- Additional protein for CRRT, ECMO, burns, increased protein losses
- Protein underfeeding can exaggerate cumulative protein deficit
- Protein requirements to achieve positive nitrogen balance may increase as severity of illness increases

AGE	PROTEIN NEEDS
0-2 years	2-3 g/kg
2-12 years	1.5 – 2 g/kg
>13 years	1.5 g/kg

Enteral Feeding Intervention

- Standard formulas for the general infant or pediatric patient should be carefully evaluated for adequacy of protein in the critically ill population
- Addition of protein modular when needed
- Concentration of formula
  - Standard infant formulas unlikely to meet ICU protein goals
- Utilizing higher protein formulas as available per formulary and as tolerated – consider addition of ICU protein formulas if applicable to population

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Benefits of Feeding Protocols

- Reduce variability in nutrition provision among patients
- Reduce avoidable deficits in energy intake
  - Initiate feeds early in eligible patients
  - Timely resumption of feeds and minimizing NPO status

Energy and Nutrient Dense Formula

- 30 kcal/fluid ounce to support high energy needs and fluid restriction
- 2.6 grams of protein/100 kcal
- Lower osmolarity (AAP suggests <400 mOsm/L)
- Well tolerated and supports growth
- Ready-to-feed sterile liquid
- Nutritionally complete
- Can be used to supplement breastmilk feeds

Energy and Nutrient Dense Formula in the PICU

Van Waardenburg, D., De Betue, C., & Joosten, K. (2008). Critically ill infants benefit from early administration of protein and energy-enriched formula: A randomized controlled trial. *Pediatrics*, 121(Supplement_2), S99-S100.

Objective: The study aimed to evaluate the impact of early administration of protein and energy-enriched formula on critically ill infants

Methodology: Double-blind, randomized controlled trial involving 20 critically ill infants with respiratory insufficiency. Participants were divided into two groups: one receiving protein and energy-enriched formula and the other receiving standard formula

Tolerance: Both formulas were well tolerated, with similar volumes of intake

- Nutritional Intake: Infants receiving the enriched formula had significantly higher protein and energy intake compared to those receiving the standard formula
- Metabolic Effects: The enriched formula improved energy balance and plasma amino acid profiles
- Trend towards increased nitrogen balance

Conclusion: Early administration of protein and energy-enriched formula is beneficial for critically ill infants, promoting better nutrient intake and metabolic stability without adverse effects

Incorporating ENDF into Feeding Protocols

- Utilization of higher protein formulas when appropriate to apply particular formulas to a protocol or algorithm
- Energy and nutrient dense formulas can be utilized for patients as early ICU formula option
  - Fluid restricted patients or those with baseline or acquired malnutrition
  - Ensure high protein provision with increased ICU protein needs
  - Supplemental formula option for breast milk when needed

Case Study

Energy- and Nutrient-Dense Formula Use in Infant with Bronchopulmonary Dysplasia

Case Study

HISTORY

BIRTH HISTORY

- 4-month-old, female with hx of NICU stay.

ADMISSION

- Admitted to PICU: BPD, PDA/ASD with concern for over-circulation

FEED HISTORY

- Transitional formula 22 kcal/oz at 150 mL/kg/day (110 kcal/kg/day)

Hx = history; NICU = neonatal intensive care unit; PICU = pediatric intensive care unit; BPD = bronchopulmonary dysplasia; PDA = patent ductus arteriosis; ASD = atrial septal defect; kcal = kilocalorie; oz = ounce; mL = milliliter; kg = kilogram;

Case Study

NUTRITION THERAPY TIMELINE

10/31: Admitted to PICU

11/1: Initial assessment: Goal to increase feeds to 145 mL/kg/day

11/2: Feeds initiated 24 hours later

11/3: Volume restricted to 75 mL/kg/day; goal to increase to 30 kcal/oz. Feeds increased to 24 kcal/oz at 75 mL/kg/day (60 kcal/kg/day) prior to hospital transfer

PICU = pediatric intensive care unit; mL = milliliter; kg = kilogram; kcal = kilocalorie; oz = ounce

Case Study

NUTRITION THERAPY TIMELINE

11/6: New assessment: meeting 40% of needs x 5 days; feeds advanced to 27 kcal/oz at 95 mL/kg/day

11/7: Fluid restriction of 95 mL/kg/day remains – feeds switched to ENDF

11/8: ENDF advanced to 110 mL/kg/day via continuous feeds (110 kcal/kg/day)

11/9: Feeds held for procedure; resumed at 110 mL/kg/day

Kcal = kilocalorie; oz = ounce; mL = milliliter; kg = kilogram; ENDF = energy- and nutrient-dense formula

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Case Study

Formula	Volume (mL/kg/day)	Energy kcal/kg/day)	Protein (grams/kg/day)
Transitional Formula 24 kcal/oz	75	60	1.6
Transitional Formula 27 kcal/oz	95	85	2.4
ENDF 30 kcal/oz	95	95	2.5
ENDF 30 kcal/oz	110	110	2.9

ENDF = energy- and nutrient-dense formula; mL = milliliter; kg = kilogram; kcal = kilocalorie

Case Study

NUTRITION THERAPY TIMELINE

11/10: Reassessment – caloric intake improving and tolerating feeds. Supplemental Vitamin D initiated at 200 IU/day. Meeting DRI for other vitamins/minerals

11/14: Patient tolerating goal feeds until extubation.
Fluid status improved; advanced back to standard fluid provision.

IU = international units; DRI = dietary reference intake

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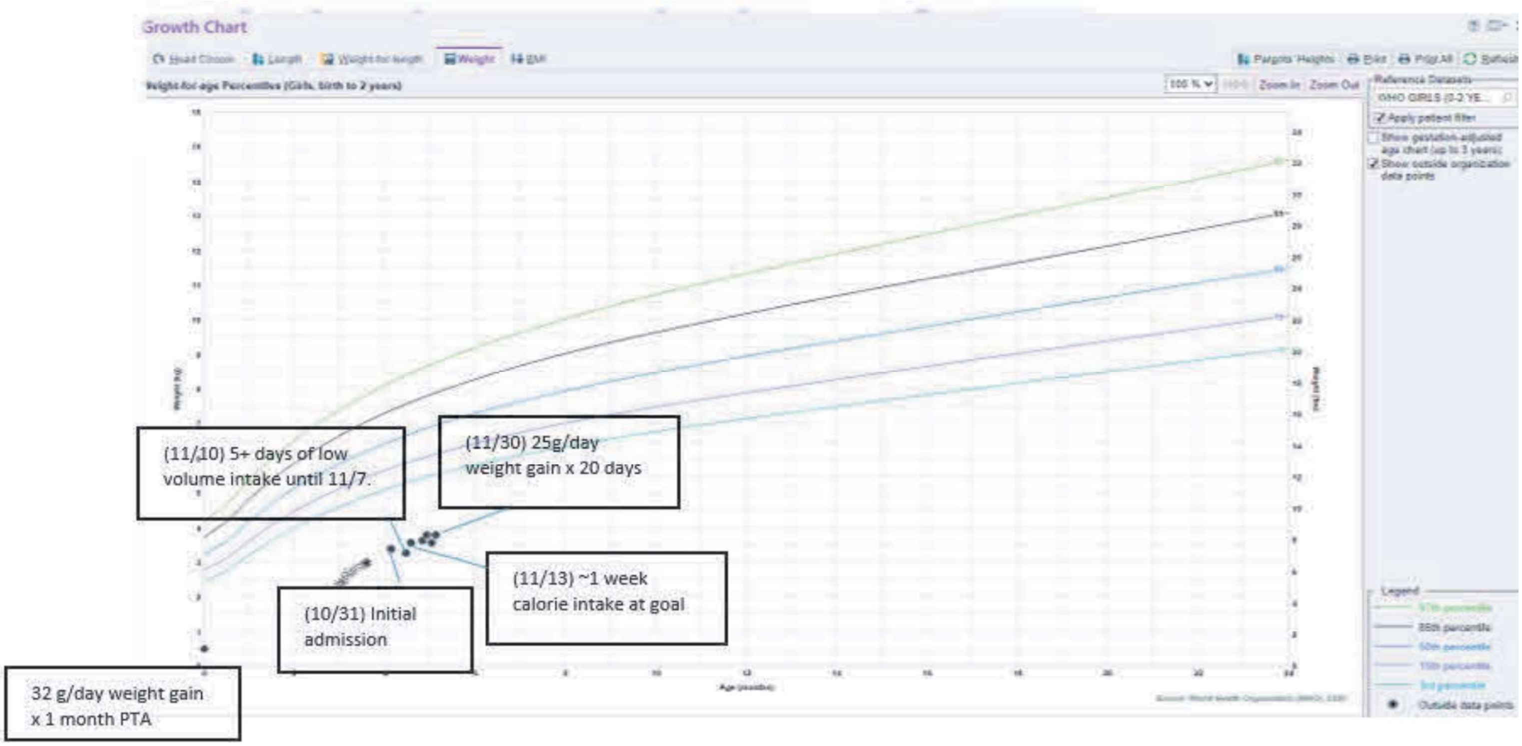

Case Study

CLINICAL OUTCOMES:

- Following 5 days of limited intake, ENDF bridged patient and improved caloric intake through fluid restriction until goal volume achieved again.
- Goal concentration provided at goal volume during and after ICU stay
- Feeds well tolerated in critically ill infant

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Conclusions

- Early nutrition support within the first 24-48 hours of admission to the Pediatric Intensive Care Unit (PICU) is associated with better clinical outcomes, including reduced infection rates, shorter hospital stays, and lower mortality
- Critically ill children are at high risk of malnutrition due to increased energy expenditure and decreased nutrient intake. Early intervention helps prevent nutritional deterioration, which can negatively impact recovery
- Early nutrition support helps in preserving muscle mass, which is crucial for recovery, especially in children with respiratory failure who are prone to muscle atrophy
- Studies have shown that critically ill infants receiving energy-dense formulas exhibit better growth and recovery rates, including improved weight gain and muscle mass

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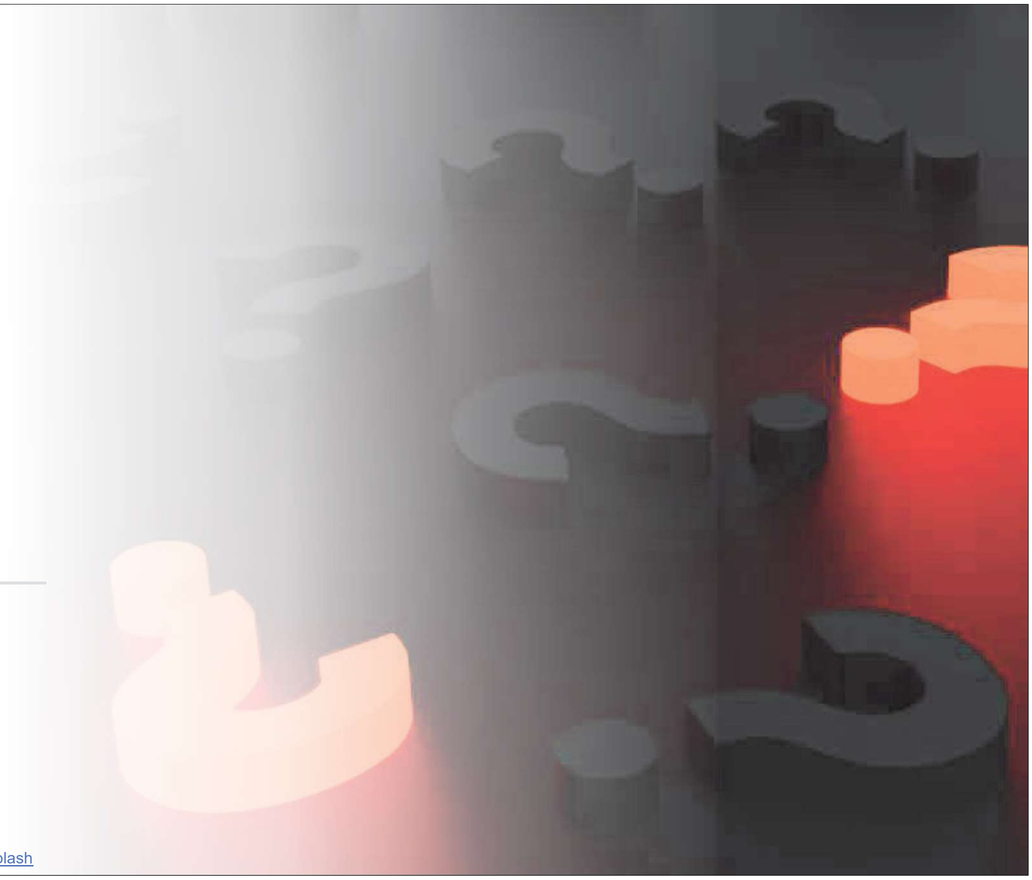
Questions?



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