Nutrition in the critically-ill child

Basics and Beyond

Heraklion 2007

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Reduced nutritional reserves

• 43% - 88% of ICU patients
  – Giner et al, 1996; Barr et al, 2004

• 16% - 20% of critically ill children
  – Pollack et al, JPEN 1982

• Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients
Consensus conferences for nutrition of critically ill patients

• Accurate assessment of the REE is required in patients receiving nutritional support
  – to ensure that their energy needs are met
  – to avoid the complications associated with over- or underfeeding
Indirect calorimetry

1. Indirect calorimetry and other more sophisticated techniques (i.e. double labelled water) are
   1. rarely available to centres
   2. outside of research due to cost, time limitations, availability of designated staff

2. Efforts to measure caloric requirements are meaningless unless an equal effort is made to actually provide enough calories to match those requirements
Using IC studies have failed to show a rise in energy expenditure during the early postinjury period in infants or older children.

Individual patients data of repeat REE measurements

Compact modular metabolic monitors

- May overcome many of previously encountered problems
- Validation studies have indicated that it can be easily used in the clinical setting with adequate reproducibility and accuracy in ventilated critically ill adult patients
- Accuracy in children?

Singer P et al, Nutrition 2006: 22; 1077-86
Relation between normal and abnormal metabolic patterns and mortality

Case control relative risk of mortality: 6.48, 95% CI 0.7 - 54, p<.07

213 Adult ICU patients

- **Normometabolic**: 31%
- **Hypermetabolic**: 48%
- **Hypometabolic**: 21%
Metabolic status in critically ill children using PICU specific White equation

HYPOMETABOLIC

32.5%

60.0%

7.5%

REE / PEE PICU
WHITE Eq2 * 100
In the last few years, three sets of clinical practice guidelines have been published by various bodies interested in the optimal practice of nutrition support in ICU patients

- Have used evidence-based approaches
- Several controversies remain
- Practical aspects warrant further discussion
Guidelines 1st

- Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients
Guidelines 2nd

• Doig GS, Simpson F, the Australian and New Zealand Intensive Care Society Clinical Trials Group

• Evidence-based guidelines for nutritional support of the critically ill: results of a bi-national guideline development conference

• Carlton: Australian and New Zealand Intensive Care Society; 2005
Guidelines 3rd

- Kreymann KG, Berger MM, Deutz NE, et al
- ESPEN Guidelines on enteral nutrition: intensive care
- Clin Nutr 2006; 25:210–223
Enteral nutrition is preferred to parenteral nutrition unless there is a major gut condition which will delay commencement of enteral nutrition.

Nasogastric feeding should begin within 24 h, but if intolerance develops, promotility drugs (erythromycin or metoclopramide) or small bowel feeding should be attempted before resorting to supplementary parenteral nutrition.
Enteral Nutrition

- **Use EN** in patients who can be fed via the enteral route
- **Avoid additional parenteral nutrition** in patients who tolerate EN and can be fed approximately to the target values
- **There is no significant difference in the efficacy of jejunal versus gastric feeding**

*2006 ESPEN guidelines on enteral nutrition in intensive care:*
• Small bowel feeding tubes
  – are more expensive
  – appear to block more commonly
  – are not uncommonly inadvertently removed
  – can be difficult to place, delay in EN

Gastrointestinal complications in critically ill children with transpyloric enteral nutrition

Gastrointestinal complications

- Duodenal perforation
- NEC
- GIT bleeding
- Diarrhea
- Abdominal distension / GR

CONTRAINDICATION TO EN?

Hypermetabolic &/or malnourished: EN contraindicated >7-10 days?

Able to meet needs via oral route?

Oral diet.

Oral diet. No

EN

PN; reassess q 24-48 hrs re EN.

No PN; reassess q 24-48 hrs re EN.

Contraindication to gastric EN? (see purple box)

Gastric EN.

Postpyloric EN.

Planned abdominal surgery?

Intraoperative postpyloric feeding tube.

Short term: nasoduodenal tube.

Long term: feeding jejunostomy.

Short term: manual (see pink box), endoscopic, or fluoroscopic nasoduodenal feeding tube.

Long term: endoscopic or fluoroscopic gastrojejunostomy.

Absolute contraindications:
- Mechanical bowel obstruction
- Bowel ischemia

Relative contraindications:
- Hemodynamic instability
- Small bowel ileus
- Small bowel fistulae
- Bowel anastomosis

Contraindication to gastric EN:
1) Gastric residual volumes > threshold maximum (250 ml) despite prokinetics agents.
2) Chronic/acute gastroesophageal reflux.
3) High risk pulmonary aspiration (i.e. required to be cared for in prone or supine position).

Nasoduodenal Feeding Tubes Manual Placement Techniques:

Developed by J. Greenwood, RD, (Vancouver General Hospital) in collaboration with the CCCCPGC (1/1/07).
Type of nutritional support delivered

- Enteral: 55%
- Parenteral: 21%
- None: 15%
- Enteral & Parenteral: 9%

Death by parenteral nutrition

• Marik PE, Pinsky M
• Intensive Care Med. 2003; 29:867-9

Is parenteral nutrition guilty?

• Intensive Care Med. 2003; 29: 1861-4
Is PN really that risky in ICU?
Can it all be done by EN?

• PN remains a valuable yet challenging weapon in the presence of gastrointestinal feed intolerance or failure

• Real life in biology and in ICU is neither black nor white

2006 ESPEN guidelines on enteral nutrition in intensive care: Grade C

- No general amount can be recommended as EN therapy has to be adjusted to the progression/ course of the disease and to gut tolerance
No significant difference in REE between diagnostic groups

Regarding the short-term mortality, REE showed opposite trends between survivor and non-survivors. Reference line represents mean PBMR.
Exogenous energy supply: REE: same target?

• During the **acute and initial phase of critical illness**: in excess of 20–25 kcal/kg **BW/day** may be associated with a less favourable outcome.

• During the **anabolic recovery phase**, the aim should be to provide 25–30 kcal/kg **BW/day** to support the anabolic reconstitution.

*2006 ESPEN guidelines on enteral nutrition in intensive care: Grade C*
If target not reached?

• If these target values are not reached supplementary parenteral nutrition should be given

• In patients with severe undernutrition—or a chronic catabolic disease — target values should be met fully using supplementary PN if necessary

2006 ESPEN guidelines on enteral nutrition in intensive care: Grade C
A large proportion of feeding delays are attributable to avoidable causes

- Adequate nutritional support remains an elusive goal for many patients
- Intakes of between 50 and 70% of target are commonplace

Underfeeding 50.3% of days

Reasons

1. Failing to start feeding (43.3%)
2. Failing to increase feeds according to the protocol (31.8%)
3. Stopping feeds for prolonged periods (24.8%)
   - Fasting for airway management procedures (21%)
   - Gastrointestinal intolerance (14%)

Reid C. Journal of Human Nutrition & Dietetics 2006; 19: 13
Intolerance in adult ICUs

• Lower cut-off values (150–250 mL) have often been criticized because they can result in premature cessation of feeds and significant underfeeding

• When protocols using 200 mL or 400 mL to define intolerance were compared, there was no difference in the frequency of regurgitation or aspiration

Lin & Van Citters, 1997, McClave et al., 2005
• Narcotic agents
  – Reassess and reduce to minimal effective dose
• Hypokalemia
  – Correct in timely manner
• **General intervention: Do not stop feeds;** follow enteral feeding guideline
• Initiate IV metoclopramide (0.15 mg/kg)
• If no response after 4 doses, place a nasoduodenal feeding tube
ICU patients receiving NG feeding in whom GI intolerance develops should have a small bowel feeding tube placed

- **CONCURRENT GASTRIC DECOMPRESSION:** If gastric stasis is present, place a decompression tube to allow for gastric decompression
- **PATIENT POSITIONING:** Unless contraindicated, elevate the head of bed 45°.
- **EARLY TEN** is better than late, not increased complications, achieved earlier nutrition 24-48 h (0.5-1 ml/kg/hr and every 4h)

*Sánchez C. Nutrition 2007; 23: 16-22*
Energy intake in PICU

Percentage of days

Underfed 28%
Overfed 12%
Adequately fed 60%

Studies in critically ill patients

• Short enteral fasting (7 days), causes gut mucosal atrophy, expressed as a decrease in villus height and crypt depth, when compared to controls

• Loss of gastrointestinal mucosal integrity is reversed by the institution of EN
The ratio of energy intake to energy expenditure per admission day over the course of the study period

*\( p < .001 \)

Nitrogen balances on days 1 and 5 of a protocol of early enteral nutrition in 71 critically ill children.

Mean CHI, indicative of somatic protein status at the beginning and the end of a protocol of early enteral nutrition in critically ill children.
2006 ESPEN guidelines on enteral nutrition in intensive care: grade C

- Whole protein formulae are appropriate in most patients because no clinical advantage of peptide based formulae could be
Major methodological problems in studies in intensive care patients

1. Type of immune-modulating nutrition implies a formula enriched with several “functional” substrates

- Glutamine, arginine, nucleotides, antioxidants and ω-3 fatty acids
- The observed effects cannot, therefore be ascribed to one single substrate
2. They do not refer to homogenous populations

- **Vary widely** in terms of:
  - Diagnosis
  - Severity of disease
  - Metabolic derangements
  - Therapeutic procedures
  - Gastrointestinal function

- **Which concentrations, doses, groups?**
Immune-modulating formulae are superior to standard enteral formulae

- in elective upper GI surgical patients
- in patients with a mild sepsis (APACHE II<15)
- in patients with trauma
- in patients with ARDS (formulae containing ω-3 fatty acids and antioxidants)

2006 ESPEN guidelines on enteral nutrition in intensive care: Grade A & B
Mortality, LOS and LOMV in critically ill children

**Immunonutrition**

**Control**

- Days: 0-1000
- Cumulative: 301, 192
- LOS PICU: 247, 180

**Immunonutrition**

- Days: 0-1000
- Cumulative: 301, 192
- LOS PICU: 247, 180

**Legend**

- Blue: Mech Vent
- Green: LOS PICU

Percent of patients surviving (Su) in critically ill children.
WHEN THE ENTERAL ROUTE IS AVAILABLE

USE IT!