Highlights from
The 2009 Critical Care Nutrition Guidelines

Presented By:
Robert Martindale, MD, PhD
Stephen McClave, MD
Pamela Roberts, MD

Nestlé Breakfast Symposium (Feb 3, 2009)

Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient

Introduction

Stephen A. McClave, MD
Louisville, Kentucky

Joint ASPEN/SCCM Guidelines Committee

Steve McClave
Vince Vanek
Juan Ochoa
Lena Napolitano
Beth Taylor
Gail Cresci
Pam Roberts

Bob Martindale
Mary McCarthy
Introduction

- Basic Recommendations
  Not absolute requirements
  Do not project or guarantee outcome or mortality benefits
  Not a substitute for clinical judgment (takes precedent)

- Supportive evidence
  Current literature
  National, international guidelines
  Expert opinion
  Clinical practicality

- Target population
  Adult critically ill med and surg patients
  Expected to stay in ICU ≥ 2-3 days
  Not a homogeneous population

ASPEN 2002 Guidelines
Practice Guidelines

Critical Care: Critical Illness

1. Patients with critical illnesses are at nutrition risk and should undergo nutrition screening to identify those who require formal nutrition assessment with development of a nutrition care plan. (B)

2. SNS should be initiated when it is anticipated that critically ill patients will be unable to meet their nutrient needs orally for a period of 5–10 days. (B)

3. EN is the preferred route of feeding in critically ill patients requiring SNS. (B)

4. PN should be reserved for those patients requiring SNS in whom EN is not possible. (C)
Model for New Guidelines

Canadian Clinical Practice Guidelines

John Drover
Surgeon

Daren Heyland
Intensivist

Rupinder Dhaliwal
Research

Naomi Jones
Research

www.criticalcarenutrition.com

Model for New Guidelines

Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock

R. Phillip Dellinger, MD; Jean M. Carlet, MD; Henry Masur, MD; Henwieg Gerlach, MD, PhD; Thierry Calandra, MD; Jonathan Cohen, MD; Juan Gea-Banacloche, MD, PhD; Didier Keh, MD; John C. Marshall, MD; Margaret M. Parker, MD; Graham Ramsay, MD; Janice L. Zimmerman, MD; Jean-Louis Vincent, MD, PhD; Mitchell M. Levy, MD; for the Surviving Sepsis Campaign Management Guidelines Committee


CCM 2004;32:858-873
Model for New Guidelines
Surviving Sepsis

H. Steroids

1. Intravenous corticosteroids (hydrocortisone 200–300 mg/day, for 7 days in three or four divided doses or by continuous infusion) are recommended in patients with septic shock who, despite adequate fluid replacement, require vasopressor therapy to maintain adequate blood pressure.

Grade C

*Rationale.* One multiple-center, randomized, controlled trial (RCT) with patients in severe septic shock showed a significant shock reversal and reduction of mortality rate in patients with relative adrenal insufficiency (defined as post-adrenocorticotropic hormone [ACTH] cortisol increase ≤9 μg/dL) (39). Two additional smaller RCTs showed significant effects on shock reversal (40, 41). In the first study, patients had more severe septic shock (systolic blood pressure <90 mm Hg despite vasopressors) than in the latter two studies (systolic blood >90 mm Hg with vasopressors).

- Topic-driven
- Brevity
- Clarity
- Specificity
- Transparency
- Renewable
- Free access

Process

- Five year process beginning July 2004 (>45 reviewers)

Original manuscript (old style) Peer Review July 2005
Voluntary revision Survive Sepsis format
Guidelines Committee reorganized format (delay 1 yr)
Updated manuscript ASPEN Peer Review Mar 2007
ASPEN Board Review Aug 2007
SCCM Board and Peer Review Jan 2008
CCM Journal Peer Review Nov 2008

- Final Board Approval
ASPEN Board Jun 2008
SCCM Board Jan 26, 2009
Joint publication May 2009
Development of Guidelines

- List of recommendations compiled by Committee Experts
  Action statements

- PRCTs primary source of support
  Overall strength based on 2 things:
  Level of investigative studies
  Number of supportive studies
  Controversy in interpreting literature
  Resolved by consensus opinion
  Could result in down-grade

- Philosophy of this specific committee:
  Include patient care recommendations where sole basis was expert opinion
  Promote recommendations and conditions for use of PN where outcome benefit assured

Grading of Recommendations

Level of Evidence

I  Large, randomized trials; low risk of false-positive (alpha) error or false-negative (beta) error

II Small, randomized trials; moderate to high risk of alpha and/or beta error

III Non-randomized, contemporaneous controls

IV Non-randomized, historical controls

V Case series, uncontrolled studies, expert opinion

Adapted from Dellinger (CCM 2004;32:858-873)
Grading of Literature

- Definition of Large trial
  - Fulfill endpoint criteria per power analysis
  - Size > 100 subjects

- Use of Meta-Analysis
  - Organize information
  - Derive overall treatment effect
  - Not to grade recommendation

- Review papers, consensus statements = Expert opinion

- Grade based on level of evidence of individual studies

Grading of Recommendations

- Grade of Recommendation:
  - A  Supported by at least two level I investigations
  - B  Supported by one level I investigation
  - C  Supported by level II investigations only
  - D  Supported by at least two level III investigations
  - E  Supported by level IV or level V evidence

- Level of Evidence:
  - I  Large, randomized trials
  - II Small, randomized trials
  - III Non-randomized, contemporaneous controls
  - IV Non-randomized, historical controls
  - V  Case series, uncontrolled studies, expert opinion

Adapted from Dellinger (CCM 2004;32:858-873)
Conclusions

Don’t shoot the messenger...

CNW Breakfast Symposium: Critical Care Nutrition Guidelines

*Pamela R. Roberts, MD, FCCM, FCCP*
Professor & Division Chief of Critical Care
John A. Moffitt Endowed Chair
Department of Anesthesiology
University of Oklahoma Health Sciences
Oklahoma City, OK, USA

pamela-roberts@ouhsc.edu

Assessment Tools
Timing: Start Early
EN>PN
Hemodynamic Compromise
Bowel Sounds
Gastric or Small Bowel

C1-5. Dosing of Nutritional Support

Identify Goal
Give 50-65%, later advance
When to use Supplemental PN
Adequacy of Protein
Permissive Underfeeding in Obesity
Case: 23 y/o M s/p MVC

Previously healthy, he presented with traumatic brain injury, rib fractures, pulmonary contusions and 'bad' pelvic fractures. He was intubated at scene and was on mechanical ventilation. Initial shock responded to resuscitation and he was admitted to the ICU where he was transfused 2 units PRBCs. Orthopedic surgery was delayed due to respiratory failure and concern regarding head injury.

How do we assess his needs and initiate nutritional support?

Assessment Tools

A1. Traditional nutrition assessment tools are not validated in critical care (albumin, prealbumin, and anthropometry)

Before initiation of feedings, assessment should include evaluation of weight loss and intake prior to admission, level of disease severity, co-morbid conditions, and gastrointestinal tract function

Grade: E
Early Enteral Nutrition

A2. Nutrition support therapy in the form of enteral nutrition should be initiated in the critically ill patient who is unable to maintain volitional intake. Grade: C

Specific reasons for providing early EN:
- Maintain gut integrity
- Modulate stress and systemic immune responses
- Attenuate disease severity

Meta-analysis in GI surgery and surgical critical care
Patients who were given early post-op EN experienced significant reductions in infection, (RR=0.72), hospital length of stay (mean 0.84 days), and a trend toward reduced anastomotic dehiscence (RR=0.53), when compared to similar pts receiving no nutrition support therapy.

McClave SA et al. JPEN 2006; 30: 143-56
Meta-analysis of pts with surgery for compl of severe acute pancreatitis, those placed on EN one day post-op showed a trend toward reduced mortality compared to controls randomized to standard therapy.
Enteral Nutrition (EN)

A3. EN is the preferred route of feeding over parenteral nutrition (PN) for the critically ill patient who requires nutrition support therapy. Grade: B

35 EN vs PN studies referenced in guidelines

All six meta-analyses that compared EN vs PN showed significant reductions in infectious morbidity with EN

Few studies have found reduced mortality

Enteral Nutrition (EN)

A4. EN should be started within the first 24-48 hours after admission. Grade: C

The feedings should be advanced towards goal over the next 48-72 hours. Grade: E
Early Enteral Nutrition (EN)

A4. EN should be started within the first 24-48 hours after admission. Grade: C

Feedings started within 24-72 hrs, compared to feedings started later (after 72 hours), are associated with less gut permeability, diminished activation and release of inflammatory cytokines, and reduced systemic endotoxemia.

Heyland DK et al. (Canadian Critical Care Clinical Practice Guidelines Committee) JPEN 2003; 27: 355-373
Found trend toward reduced infectious morbidity and mortality

Significant reductions in infectious morbidity and hospital length of stay with early EN compared to delayed feedings

Case: 23 y/o M s/p MVC

In first 24 hours we started gastric tube feeds; over 48 hours we advanced him to about 60% of the estimated goal rate.

3 days after MVC he was slightly better and was cleared to go to OR for pelvic stabilization next day. In OR he had ‘problems’ and returned to ICU with worsened oxygenation and hypotension on vasopressors. Developed fever and leukocytosis. Cultures were sent and Abx started. We did not start EN that night, working to resuscitate and stabilize him.
Enteral Nutrition (EN)

A5. In the setting of hemodynamic compromise (patients requiring support including high dose catecholamines, alone or in combination with large volume fluid or blood product resuscitation to maintain cellular perfusion), EN should be withheld until the patient is resuscitated and/or stable.

Grade: E

Case: 23 y/o M s/p MVC

He improved and the next day we restarted gastric tube feeds even though we did not hear bowel sounds.

We monitored for intolerance and planned to advance his feeds over next 48 hours to his goal nutrition rate.
Enteral Nutrition (EN)

A6. In the ICU patient population, neither the presence nor absence of bowel sounds nor the passage of flatus and stool is required for the initiation of enteral feeding. **Grade: B**

Kozar RA et al. J Surg Res. 2002; 104: 70-75
ICU enteral feeding protocols were followed, rates of GI tolerance were in the range of 70-85%

Ten randomized clinical trials reported feasibility and safety of EN within the initial 36-48 hours of ICU admission.

Gastric or Small Bowel?

A7. Either gastric or small bowel feeding is acceptable in the ICU setting. Critically ill patients should be fed via an enteral access tube placed in the small bowel if at high risk for aspiration or after showing intolerance to gastric feeding. **Grade: C**

A7. Withholding of enteral feeding for repeated high gastric residual volumes alone may be sufficient reason to switch to small bowel feeding. **Grade: E**
Gastric or Small Bowel?

A7. Either gastric or small bowel feeding is acceptable in the ICU setting. Critically ill patients should be fed via an enteral access tube placed in the small bowel if at high risk for aspiration or after showing intolerance to gastric feeding. Grade: C

Three meta-analyses (Ho, Marik, Heyland) compared gastric with post-pyloric feeding in the ICU.

Only the Heyland meta-analysis (JPEN 2002) showed a significant reduction in ventilator-associated pneumonia with post-pyloric feeding (RR=0.76), but it was heavily influenced by one study by Taylor.

The two other meta-analyses showed no difference in pneumonia between gastric and post-pyloric feeding.

All of these Meta-analyses showed no significant difference in mortality between gastric and post-pyloric feeding.

Dosing of Enteral Nutrition

C1. The target goal of EN (defined by energy requirements) should be determined and clearly identified at the time of initiation of nutrition support therapy.

Grade: C
Dosing of Enteral Nutrition

C1. Energy requirements may be calculated by predictive equations or measured by indirect calorimetry. Predictive equations should be used with caution, as they provide a less accurate measure than indirect calorimetry in the individual patient. In the obese patient, the predictive equations are even more problematic without availability of indirect calorimetry. Grade: E

Dosing of Enteral Nutrition

C2. Efforts to provide 50-65% of goal calories should be made over the first week of hospitalization in order to achieve the clinical benefit of EN. Grade: C
Dosing of Enteral Nutrition

C3. If unable to meet energy requirements (100% of target goal calories) after 7 to 10 days by the enteral route alone, consider initiating supplemental PN. Grade: E

Initiating supplemental PN prior to this 7-10 day period in the patient already on EN, does not improve outcome and may be detrimental to the patient. Grade: C

Supplemental PN

Initially, EN is directed toward maintaining gut integrity, reducing oxidative stress, and modulating systemic immunity. Use of supplemental PN over the first 7-10 days adds cost and appears to provide no additional benefit.

Small study in burn patients, EN supplemented with PN was associated with increased mortality (63% vs 26%) when compared respectively to hypocaloric EN alone.

Trauma pts fed some EN also treated with early PN had a greater risk of nosocomial infections. Mortality tended to be higher with EN + PN vs EN alone.
Protein

C4. Ongoing assessment of adequacy of protein provision should be performed. The use of additional modular protein supplements is a common practice, as standard enteral formulations tend to have a high non-protein calorie to nitrogen ratio. In patients with BMI<30, protein requirements should be in the range of 1.2-2.0 g/kg actual body wt per day, and may likely be even higher in burn or multi-trauma patients. Grade: E

Obesity and Critical Illness

C5. In the critically ill obese patient, permissive underfeeding or hypocaloric feeding with EN is recommended. For obesity with BMI>30, the goal of the EN regimen should not exceed 60-70% of target energy requirements or 11-14 kcal/kg actual body wt/day (or 22-25 kcal/kg ideal body wt/d) Grade: D
Obesity and Critical Illness

Protein should be provided in a range ≥ 2.0 gm/kg ideal body wt/d for Class I and II patients (BMI 30-40), and ≥ 2.5 gm/kg ideal body wt/d for Class III (BMI > 40).

Grade: D

Thank you
Critical Care Guidelines
Section D: Monitor Tolerance

• D1. In the ICU setting, evidence of bowel motility (resolution of clinical ileus) is not required in order to initiate EN in the ICU. (Grade: E)

• D2. Patients should be monitored for tolerance of EN (determined by patient complaints of pain and/or distention, physical exam, passage of flatus and stool, abdominal radiographs). (Grade: E)

• Inappropriate cessation of EN should be avoided. (Grade: E)

• Holding EN for gastric residual volumes <500 mL in the absence of other signs of intolerance should be avoided. (Grade: B)

• Making the patient nil per os (NPO) surrounding the time of diagnostic tests or procedures should be minimized to prevent inadequate delivery of nutrients and prolonged periods of ileus. Ileus may be propagated by NPO status. (Grade: C)
### Table 8. Randomized Studies Evaluating Lower versus Higher “Cut-Off Values” for Gastric Residual Volumes (GRVs).

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Groups By GRVs</th>
<th>% Goal Kcal Infused</th>
<th>Pneumonia</th>
<th>Aspiration</th>
<th>GI Intolerance</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kortbeek 1999&lt;sup&gt;19&lt;/sup&gt; Level II</td>
<td>Trauma, Head Injury (n=82)</td>
<td>150/50 mL, 200 mL, 100/50 mL, 200 mL, 150/50 mL, 200 mL</td>
<td>36% 59%&lt;sup&gt;*&lt;/sup&gt;</td>
<td>26/41 (63%)</td>
<td>18/41 (44%)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Pinilla 2001&lt;sup&gt;14&lt;/sup&gt; Level II</td>
<td>ICU (n=80)</td>
<td>150 mL, 250 mL</td>
<td>70 ± 25% 76 ± 18%</td>
<td>0/36 (0%)</td>
<td>1/44 (2%)</td>
<td>NR</td>
<td>21/36 (58%) 20/44 (45%)</td>
</tr>
<tr>
<td>McClave 2005&lt;sup&gt;13&lt;/sup&gt; Level II</td>
<td>ICU (n=40)</td>
<td>200 mL, 400 mL</td>
<td>77.0 ± 21.2% 77.8 ± 32.5%</td>
<td>NR</td>
<td>21.6 ± 25.6% 22.6 ± 25.0%</td>
<td>35.0 ± 27.3% 27.8 ± 25.0%</td>
<td></td>
</tr>
<tr>
<td>Montejo 2008&lt;sup&gt;12&lt;/sup&gt; Level I</td>
<td>ICU (n=329)</td>
<td>200 mL, 500 mL</td>
<td>82.8 ± 1.7% 89.6 ± 1.8%&lt;sup&gt;†&lt;/sup&gt;</td>
<td>46/169 (27%) 45/160 (28%)</td>
<td>NR</td>
<td>107/169 (64%) 76/160 (48%)&lt;sup&gt;*&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

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**Gastric Residuals: Controversial?**

- ADA Guidelines 2008 > 250 cc
- CCPG > 250 cc
- ESPEN Guidelines 2006 not addressed
- ASPEN / SCCM >500 cc
Critical Care Guidelines
Section D: Monitor Tolerance

• D3. Use of enteral feeding protocols increases the overall percentage of goal calories provided and should be implemented. (Grade: C)

• Rationale: Use of ICU or nurse-driven protocols which define goal infusion rate, designate more rapid startups, and provide specific orders for handling gastric residual volumes, frequency of flushes, and conditions or problems under which feeding may be adjusted or stopped, have been shown to be successful in increasing the overall percentage of goal calories provided23,76,133,135,153,154

• Note of caution:
• JAMA Dec 2008:300;2731-2741, Doig GS
  • Randomized 27 ICU’s with or without intensive guideline educational interventions focused to change practice
  • No change in M and M
  • Why?

47

Critical Care Guidelines
Section D: Monitor Tolerance

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• Note of caution:
• JAMA Dec 2008:300;2731-2741, Doig GS
  • Randomized 27 ICU’s with or without intensive guideline educational interventions focused to change practice
  • No change in M and M
  • Why?
• Both groups fed early and relatively effectively
• 95% started feeding within 16 hours

• Take home message should not be the Nutrition Guidelines makes no outcome difference!!

Doig GS; JAMA Dec 2008;300:2731-2741.

Critical Care Guidelines
Section D: Monitor Tolerance

• D4. Patients placed on EN should be assessed for risk of aspiration. (Grade: E)
• Steps to reduce risk of aspiration should be employed.
• (Grade: E)
  – The following measures have been shown to reduce risk of aspiration:
    – In all intubated ICU patients receiving EN, the head of the bed should be elevated 30-45º. (Grade: C)
    – For high risk patients or those shown to be intolerant to gastric feeding, delivery of EN should be switched to continuous infusion. (Grade: D)
    – Agents to promote motility such as prokinetic drugs (metoclopramide and erythromycin) or narcotic antagonists (naloxone and alvimopan) should be initiated where clinically feasible. (Grade: C)
    – Diverting the level of feeding by post-pyloric tube placement should be considered. (Grade: C)
    – Use of chlorhexidine mouthwash twice a day should be considered to reduce risk of ventilator-associated pneumonia. (Grade: C)
Table 11. Randomized studies with vs without motility agents in critically ill patients

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Groups</th>
<th>ICU Mortality</th>
<th>Pneumonia</th>
<th>Nutritional Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yavagal 2000</td>
<td>ICU (n=305)</td>
<td>Metoclopramide 10 mg NG Placebo</td>
<td>73/131 (56%)</td>
<td>22/131 (17%)</td>
<td>NR</td>
</tr>
<tr>
<td>Berne 2002</td>
<td>Trauma (n=48)</td>
<td>Emycin 250 mg IV q 8 hrs Placebo</td>
<td>2/32 (6%)</td>
<td>13/32 (40%)</td>
<td>EN tolerated at 48 hrs 58% EN tolerated during study 65% 59%</td>
</tr>
<tr>
<td>Meissner 2003</td>
<td>ICU (n=84)</td>
<td>Naloxone 8 mg q 6 hrs NG Placebo</td>
<td>6/38 (16%)</td>
<td>13/38 (34%)</td>
<td>Mean GRV 54 mL, 129 mL Volume EN delivered at 3 D better in Naloxone (trend)</td>
</tr>
</tbody>
</table>

NOTE: 1. Data now available to consider the peripheral opiate blockers in preop setting
2. Wischmeyer study Emycin vs Metoclopromide: JPEN 2008: Emycin slightly better

Gastric vs Jejunal Feeding

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal yr</th>
<th>Study pop N</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>JPEN 1992</td>
<td>Gas v Jej n=17</td>
<td>No difference in aspiration</td>
</tr>
<tr>
<td>Montecalvo</td>
<td>CCM 1992</td>
<td>Gas v Jej</td>
<td>Jejunal: Goal faster</td>
</tr>
<tr>
<td>Kortbeek</td>
<td>J Trauma 1999</td>
<td>Gas v Jej n=80</td>
<td>Jejunal: Goal faster</td>
</tr>
<tr>
<td>Kearns</td>
<td>CCM 2000</td>
<td>Gas v Jej VAP n=44</td>
<td>Jejunal: Goal faster no change VAP</td>
</tr>
<tr>
<td>Heyland</td>
<td>CCM 2001</td>
<td>Gas v Jej n=33</td>
<td>Gastric more aspiration</td>
</tr>
<tr>
<td>Montiejo</td>
<td>CCM 2002</td>
<td>MRPCT</td>
<td>Jejunal: decrease complications</td>
</tr>
<tr>
<td>Neumann</td>
<td>CCM 2002</td>
<td>Pro descriptive n=60</td>
<td>Gastric: goal faster, No increase aspiration</td>
</tr>
<tr>
<td>Davies</td>
<td>CCM 2002</td>
<td>RCT n=73</td>
<td>Jejunal better tolerance decrease need for TPN</td>
</tr>
<tr>
<td>Meert</td>
<td>Chest 2004</td>
<td>RCT n=74 PEDS</td>
<td>Jejunal greater goal no change in aspiration</td>
</tr>
<tr>
<td>Methany</td>
<td>CCM 2006</td>
<td>Pros descriptive n=360</td>
<td>Gastric increases aspiration pneumonia</td>
</tr>
</tbody>
</table>
• D5. Blue food coloring and glucose oxidase strips, as surrogate markers for aspiration, should not be used in the critical care setting. (Grade: E)

• D6. Development of diarrhea associated with enteral tube feedings warrants further evaluation for etiology. (Grade: E)

• 55% of ICU patients will at one time have loose to liquid stools
• Antibiotic associated diarrhea in 25% of patients on antibiotics, in ICU >60%
• C. difficile common and becoming more aggressive
Classic techniques to rationalize our endogenous “bias”

- Deny the story
- Alleges bias – “the trial was not representative”
- Quibble on the details – “selection bias, sample size, poor choice of controls, heterogeneous populations”
- Shift the goalposts – “the trial will not work in all subpopulations etc”
- Use anecdotal reports – turn to basic science theory of mechanistic studies, post ad hoc analyses
- Only when all else fails admit the truth - but only when very convenient

2009 Critical Care Guidelines

- E1. Immune-modulating enteral formulations (supplemented with agents such as arginine, glutamine, nucleic acid, omega-3 fatty acids, and anti-oxidants) should be used for the appropriate patient population (major elective surgery, trauma, burns, head and neck cancer, and critically ill patients on mechanical ventilation), being cautious in patients with severe sepsis.
  - (For surgical ICU patients Grade: A)
  - (For medical ICU patients Grade: B).
- ICU patients not meeting criteria for immune-modulating formulations should receive standard enteral formulations.
  - (Grade: B)

- 6 Level 1 studies
- 15 Level 2 studies
## Immune, Inflammation, and Metabolism Modulating Nutrition: Meta-Analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th># of Pts</th>
<th>Studies</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heys</td>
<td>Ann Surg 1999</td>
<td>1009</td>
<td>11</td>
<td>Dec infection</td>
</tr>
<tr>
<td>Beale</td>
<td>CCM 1999</td>
<td>1482</td>
<td>12</td>
<td>Dec infection Dec ventilator</td>
</tr>
<tr>
<td>Heyland</td>
<td>JAMA 2001</td>
<td>2419</td>
<td>22</td>
<td>Dec infection Dec LOS</td>
</tr>
<tr>
<td>Montejo</td>
<td>Clin Nutr 2003</td>
<td>1270</td>
<td>26</td>
<td>Dec infection Decrease vent Dec Increase LOS</td>
</tr>
<tr>
<td>Waitzberg</td>
<td>WJS 2006</td>
<td>2305</td>
<td>17</td>
<td>Dec infection Dec LOS</td>
</tr>
</tbody>
</table>
### Differences in ICU "Clinical Practice Guidelines"

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Immune Modulating Formulations in all ICU’s</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Immune Modulating in Surgery / Trauma</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Metabolic Routes of Arginine

![Metabolic Routes of Arginine Diagram]
Arginine “Controls” in the Cell

- Transport into cell
  - ATB⁺, CAT 1, CAT 2, system y⁺
- Enzyme substrate
  - NOS (eNOS, nNOS, iNOS)
  - Arginase 1 or 2
  - Arg-gly amidinotransferase
  - Arg decarboxylase
- Production of endogenous iNOS inhibitors
  - Dimethylarginine (ADMA)
- Competition for arginine with other pathways
  - Acute phase protein synthesis
  - Substrate availability
- Other metabolic / cellular mechanisms
  - Binding to hemoglobin / myoglobin
  - Feedback inhibition (proven mechanism in astrocyte)
  - Extensive compartmentalization, co-localization
- Arginine (Citrulline) is beneficial in the surgical population


Critical Care Guidelines
Section E: Selection of Appropriate Enteral Formulation

- E2. Patients with ARDS and severe acute lung injury (ALI) should be placed on an enteral formulation characterized by an anti-inflammatory lipid profile (i.e., omega-3 fish oils, borage oil) and antioxidants.
  - (Grade: A)
Critical Care Guidelines
Section E: Selection of Appropriate Enteral Formulation

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<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Study Groups</th>
<th>Mortality</th>
<th>LOS days Mean ± SD</th>
<th>Ventilator days Mean ± SD</th>
<th>New Organ Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadek 1999&lt;sup&gt;207&lt;/sup&gt; Level I</td>
<td>ARDS ICU (n = 146)</td>
<td>FO/BO/AOX vs Standard EN</td>
<td>11/70 (16%) ICU 19/76 (25%) ICU</td>
<td>11.0 ± 0.9 ICU * 14.8 ± 1.3 ICU 27.9 ± 2.1 Hosp 31.1 ± 2.4 Hosp</td>
<td>9.6 ± 0.9 * 13.2 ± 1.4</td>
<td>7/70 (10%) * 19/76 (25)</td>
</tr>
<tr>
<td>Singer 2006&lt;sup&gt;208&lt;/sup&gt; Level I</td>
<td>ARDS and ALI (n =100)</td>
<td>FO/BO/AOX vs Standard EN</td>
<td>14/46 (30%)* at 28d 26/48 (53%) at 28d</td>
<td>13.5 ± 11.8 ICU 15.6 ± 11.8 ICU</td>
<td>12.1 ± 11.3 14.7 ± 12.0</td>
<td>NR</td>
</tr>
<tr>
<td>Pontes-Arruda 2006&lt;sup&gt;209&lt;/sup&gt; Level I</td>
<td>Severe Sepsis ICU (n=165)</td>
<td>FO/BO/AOX vs Standard EN</td>
<td>26/83 (31%)* at 28d 38/82 (46%) at 28d</td>
<td>17.2 ± 4.9 ICU * 23.4 ± 3.5 ICU</td>
<td>14.6 ± 4.3 * 22.2 ± 5.1</td>
<td>32/83 (38%) * 66/82 (81%)</td>
</tr>
</tbody>
</table>

• E3. To receive optimal therapeutic benefit from the immune-modulating formulations, at least 50-65% of goal energy requirements should be delivered. (Grade: C)
Critical Care Guidelines
Section E: Selection of Appropriate Enteral Formulation

• E3. To receive optimal therapeutic benefit from the immune-modulating formulations, at least 50-65% of goal energy requirements should be delivered. (Grade: C)
  - The exact quantity is the question and consequently the C rating
    » Supported by level 2 data only
  - Human studies of “dose” response of therapeutic agents are lacking.

• E4. If there is evidence of diarrhea, soluble fiber-containing or small peptide formulations may be utilized. (Grade: E)

Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient

B. When to Use PN
G. How to Maximize Efficacy

Stephen A. McClave, MD
Louisville, Kentucky
B1. When to Use Parenteral Nutrition

1st
EN (not feasible)

2nd
STD Rx

3rd
PN

- If early EN is not feasible or available over the first 7 days following admission to the ICU, no nutrition support therapy (Standard therapy) should be provided. (Grade: C)

- In the patient who was previously healthy prior to critical illness with no evidence of protein-calorie malnutrition, use of PN should be reserved and initiated only after the first 7 days of hospitalization (when EN is not available). (Grade: E)

B1. When to Use Parenteral Nutrition

Rationale: STD Rx, No PN x 7 days (EN not feasible)

Most controversial in entire guidelines
Based on 2 meta-analyses PN vs Standard Rx
Interpret carefully per patient care

Braunschweig (7 studies) STD vs PN ¹
STD ↓ Infection 23% (RR=0.77, p<0.05)
↓ Overall complications 13% (RR=0.87) Trend

Heyland (4 studies) PN vs STD ²
PN ↑ Mortality 78% (RR=1.78, p<0.05)
↑ Overall complications 140% (RR=2.40) Trend

¹ Braunschweig (AJCN 2001;74:534) ² Heyland (JAMA 1998;280:2013)
**B1. When to Use Parenteral Nutrition**

**Rationale:** After 7 days STD Rx, initiate PN (EN not feasible)

- **Increased duration of illness, priorities reverse**
  - **Sandstrom** – After 14 days \(^1\)
    - STD  \(\uparrow\) mortality (21%) vs. PN (2%), \(p<0.05\)
    - \(\uparrow\) hosp LOS (36.3d) vs. PN (23.4d), \(p<0.05\)
  - **Braunschweig** – recommended PN after 7-10 days \(^2\)
  - **Heyland** – recommended PN after 14 days \(^3\)
  - **Guidelines Committee** – recommended PN after 7 days

---

B2. When to Use Parenteral Nutrition

1st 2nd 3rd

EN (not feasible) PN STD Rx

- If there is evidence of protein-energy malnutrition (PEM) on admission and EN is not feasible, it is appropriate to initiate PN as soon as possible following admission and adequate resuscitation. (Grade: C)

Braunschweig STD vs PN in PEM ²
- STD ↑ Mortality 200% (RR=3.0, p<0.05)
- ↑ Infection 17% (RR=1.17, Trend)

Heyland PN vs STD in PEM ¹
- PN ↓ Overall complications by 48%
  (RR=0.52, p<0.05)

Presence of PEM reverses priorities
- Defined by recent weight loss >10% ABW, or <90% IBW

¹ Braunschweig (AJCN 2001;74:534)  ² Heyland (JAMA 1998;280:2013)
B3. When to Use Parenteral Nutrition

- If a patient is expected to undergo major upper GI surgery and EN is not feasible, PN should be provided under very specific conditions.

Rationale:

- Major surgery pts (esophag, gastric, panc, abd re-op) show most consistent PN benefit, esp if PEM present
- Heyland STD vs PN in surg pts
  - STD ↑ overall complications 140% (RR=2.40, p<0.05)
  - No effect on mortality
  - Benefits seen PN provided preOP for ≥ 7-10 days, then postop
B3. When to Use Parenteral Nutrition

- If the patient is malnourished, PN should be initiated 5 to 7 days pre-operatively and continued into the post-operative period. (Grade: B)

- PN should not be initiated in the immediate post-operative period, but should be delayed for 5-7 days (should EN continue not to be feasible). (Grade: B)

- PN therapy provided for a duration of less than 7 days would be expected to have no outcome benefit and may result in increased risk to the patient. Thus, PN should be initiated only if the duration of therapy is anticipated to be >7 days. (Grade: B)
B3. When to Use Parenteral Nutrition

Rationale: For PEM, Delay Surg, PN 7-10 d, then postop
For Postop only, hold PN 5-7 days

Comparison of systematic reviews:

Detsky ¹ PN vs STD (7/14 studies PN ≥ 7d)
Pos treatment effect only 1 study ³
Overall meta-analysis negative

Klein ² PN vs STD (13/13 studies PN ≥ 7d)
6/13 Studies showed pos treatment effect
Pooled meta-analysis 10% ↓ in infection by PN

PN Benefit lost if provided only post op - PN vs STD
Klein 9 studies post op PN ↑ complic 10% vs STD ²
Recommended holding PN 5-10d post op

³ Muller (Lancet 1982;1:68)

G1. Maximize Efficacy of PN

- If EN not available or feasible, the need for PN therapy should be evaluated (see recommendations B1, B2, B3, C3). (Grade: C)  If the patient is deemed to be a candidate for PN, steps to maximize efficacy (regarding dose, content, monitoring, and choice of supplemental additives) should be used. (Grade: C)

Rationale - Appropriate candidates for PN:

1. Previously well nourished ICU pt after 7d hosp
   (EN not feasible, goals not met by EN alone)
2. Malnourished PEM ICU pt on admission (EN not feasible)
3. Major surgery pt malnourished being evaluated preop
   (EN not feasible thru perioperative period)

Identify appropriate candidate, maximize PN efficacy
G2. Maximize Efficacy of PN

- In ICU pts on PN, permissive underfeeding should be considered, at least initially. 80% of requirements should serve as goal or dose of PN. (Grade: C)

- As patient stabilizes, PN may be increased to meet requirements. (Grade: E)

- For obese patients (BMI ≥ 30), the dose of PN with regard to protein and caloric provision should follow the same recommendations given for EN in recommendation C5. (Grade: D)

---

G2. Maximize Efficacy of PN
Rationale: Permissive PN underfeeding at 80% requirements

Permissive underfeeding at 80% goal requirements
- Avoids risk from overfeeding
- May improve outcome

Two studies Low dose vs Regular dose PN

<table>
<thead>
<tr>
<th></th>
<th>Hypocaloric</th>
<th>Eucaloric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahrens (n=40) ¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperglycemia</td>
<td>25%</td>
<td>70% *</td>
</tr>
<tr>
<td>Battistella (n=57) ²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>48%</td>
<td>73% *</td>
</tr>
<tr>
<td>Blood stream inf</td>
<td>19%</td>
<td>43% *</td>
</tr>
<tr>
<td>ICU LOS</td>
<td>18d</td>
<td>29d *</td>
</tr>
<tr>
<td>Hosp LOS</td>
<td>27d</td>
<td>39d *</td>
</tr>
<tr>
<td>Durat MV</td>
<td>15d</td>
<td>27d *</td>
</tr>
</tbody>
</table>

¹ CCM 2005;33:2507  ² J Trauma 1997;43:52
G3. Maximize Efficacy of PN

- In the first ICU week, when PN is required and EN is not feasible, patients should be given PN without Ω-6 soy-based lipids. (Grade: D)

Very controversial
Soy-based Ω-6 PN lipids immunosuppressive
Main support one Level II study
(Battistella – also hypocaloric)
Studies done prior to Van den Berghe glucose control trials
Full dose PN w/o lipids might exacerbate hyperglycemia
Grade C (2 Level II studies) down-graded to D

Battistella (J Trauma 1997;43:52)

G3. Maximize Efficacy of PN
Rationale: First week, provide PN without soy-based lipids

Comparison: Ω1 lipids vs no lipids (parenteral)

<table>
<thead>
<tr>
<th>Study</th>
<th>no lipids</th>
<th>lipids</th>
<th>RR (95% CI)</th>
<th>Weight</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battistella</td>
<td>13/37</td>
<td>22/30</td>
<td></td>
<td>76.2</td>
<td></td>
</tr>
<tr>
<td>McGovern</td>
<td>6/31</td>
<td>10/19</td>
<td></td>
<td>23.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19/66</td>
<td>32/49</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test for heterogeneity: chi-square=9.12, df=1, p=0.08
Test for overall effect: z=-2.34, p=0.02

PN/No Lipids vs PN/Lipids
Signif reduction infection by 37%
(RR=0.63, p=0.02)

Heyland (JPEN 2003;27:355)
A protocol should be in place to promote moderately strict glucose control (range of 110-150 mg/dL). (Grade: B)

Van den Berghe studies (* p<0.05)

<table>
<thead>
<tr>
<th>Study</th>
<th>ICU Mort (n)</th>
<th>ICU Mort 3d</th>
<th>ICU Mort &gt;3d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SICU</td>
<td>1548</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td>Convent Control</td>
<td>8% *</td>
<td>11% *</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>ICU Mort (n)</th>
<th>ICU Mort 3d</th>
<th>ICU Mort &gt;3d</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICU</td>
<td>1200</td>
<td>3.9%</td>
<td>43%</td>
</tr>
<tr>
<td>Convent Control</td>
<td>2.8% *</td>
<td>52% *</td>
<td></td>
</tr>
</tbody>
</table>

Van den Berghe (1) NEJM 2001;345:1359, (2) NEJM 2006;354:449

Prieser Unpublished Study ¹

Hyperglycemia

<table>
<thead>
<tr>
<th>Control</th>
<th>Range</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight</td>
<td>80-110 mg/dL</td>
<td>9.8% *</td>
</tr>
<tr>
<td>Mod</td>
<td>140-180 mg/dL</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

(Mortality higher in pts with hypoglycemia)

Committee recommended range 110-150 mg/dL

Devos (Curr Opin Clin Nutr Metab Care 2007;10:206)
G5. Maximize Efficacy of PN

- When PN used in the critical care setting, consideration should be given to supplementation with parenteral glutamine. (Grade: C)

**Benefit:**
- Gut integrity
- Heat shock proteins (MOFS)
- Anti-Oxidant (SIRS)

Studies done with GLN dipeptide
Dose 0.5 gm/Kg/d
Not available in North America

L-GLN limited by instability and poor solubility (100 ml water per 2gm GLN)

---

G5. Maximize Efficacy of PN

**Rationale:** Add parenteral glutamine to PN in ICU

Individual studies PN/GLN vs PN alone (Level II)

- ↓ Infectious complications (23% vs 75%)*
- ↓ Hosp LOS (12d vs 23d)*
- ↓ Mortality at 6 mos (33% vs. 60%)*

Meta-Analysis (9 studies)

- Mortality ↓ 33% (RR=0.67, p=0.01)
- Infection ↓ 25% (RR=0.75, p=0.08)

* p<0.05

**G6. Maximize Efficacy of PN**

In patients on PN, periodically repeat efforts to initiate EN. As tolerance improves, volume of EN increases, amount of PN decreases. Stop PN when > 60% of target requirements are met by the EN.  *(Grade: E)*

**Rationale**

Avoid overfeeding
Transition feeds – D/C PN at 60% goal calories

---

**Comparison to Other Guidelines**

<table>
<thead>
<tr>
<th>B1. STD &gt;&gt; PN first 7d</th>
<th>agree</th>
<th>disagree</th>
<th>NC</th>
<th>disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2. PN&gt;STD if PEM first 7d</td>
<td>NC</td>
<td>agree</td>
<td>NC</td>
<td>agree</td>
</tr>
<tr>
<td>B3. Surg PN preop 7-10d</td>
<td>NC</td>
<td>agree*</td>
<td>NC</td>
<td>NC</td>
</tr>
</tbody>
</table>

* (would delay, don’t specify postop alone)
NC = Not commented on directly

3. ADA EAL  
4. JAMA 2008;300:2731
### Comparison to Other Guidelines

<table>
<thead>
<tr>
<th>CPGs¹</th>
<th>ESPEN²</th>
<th>ADA³</th>
<th>AusNZ⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1. PN Candidate, max Rx</td>
<td>NC</td>
<td>agree++</td>
<td>NC</td>
</tr>
<tr>
<td>G2. Permissive PN underRx</td>
<td>agree*</td>
<td>disagree</td>
<td>NC</td>
</tr>
<tr>
<td>G3. PN no lipids first 7d</td>
<td>agree*</td>
<td>NC #</td>
<td>NC</td>
</tr>
<tr>
<td>G4. Moderate glucose Rx</td>
<td>agree+</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>G5. Glutamine with PN</td>
<td>agree</td>
<td>agree</td>
<td>NC</td>
</tr>
<tr>
<td>G6. Transition PN to EN at 60%</td>
<td>NC</td>
<td>agree</td>
<td>NC</td>
</tr>
</tbody>
</table>

++ Candidate if not at Max EN  * If not malnourished  # Other lipids  + Tight control  ** Transition at 80%  NC = Not commented on


### Conclusions

- PN has important role in ICU
- Select appropriate candidates
- Steps to maximize efficacy
F1. Administration of probiotic agents has been shown to improve outcome (most consistently by decreasing infection) in specific critically ill patient populations involving transplantation, major abdominal surgery, and severe trauma. (Grade C)

No recommendation can currently be made for use of probiotics in the general ICU population due to a lack of consistent outcome effect. It appears that each species may have different effects and variable impact on patient outcome, making it difficult to make broad categorical recommendations. Similarly, no recommendation can currently be made for use of probiotics in patients with severe acute necrotizing pancreatitis, based on the disparity of evidence in the literature and the heterogeneity of the bacterial strains utilized.
## Differences in ICU “Clinical Practice Guidelines”

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Probiotics in the ICU</td>
<td>No Rec</td>
<td>Yes</td>
<td>Variable</td>
<td>Variable</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## Critical Care Guidelines

### Section F: Adjunctive Therapy

- F2. A combination of antioxidant vitamins and trace minerals (specifically including selenium) should be provided to all critically ill patients receiving specialized nutrition therapy.
  
  (Grade: B)
Critical Care Guidelines
Section F: Adjunctive Therapy

• F2. A combination of antioxidant vitamins and trace minerals (specifically including selenium) should be provided to all critically ill patients receiving specialized nutrition therapy. (Grade: B)

• **Rationale:** Anti-oxidant vitamins (including vitamins E and ascorbic acid) and trace minerals (including selenium, zinc, and copper) may improve patient outcome, especially in burns, trauma, and critical illness requiring mechanical ventilation.\(^{230,231}\). A meta-analysis aggregating data from studies evaluating various combinations of antioxidant vitamins and trace elements showed a significant reduction in mortality with their use (RR=0.65, 95% CI 0.44-0.97, p=0.03)\(^{232}\). Parenteral selenium, the single anti-oxidant most likely to improve outcome\(^{233,234}\), has shown a trend toward reducing mortality in patients with sepsis or septic shock (RR=0.59, 95% CI 0.32-1.08, p=0.08)\(^{232}\). Additional studies to delineate compatibility, optimal dosage, route, and optimal combination of anti-oxidants are needed. Renal function should be considered when supplementing vitamins and trace elements.

• **Note:** Collier BR JPEN 2008 not included: reported mortality benefit in trauma ICU patients

---

“Impact of high-dose antioxidants on outcomes in acutely injured patients”

• Influence of high dose antioxidant protocol in acute trauma
  • Retrospective cohort
  • Prospective protocol
    – Vit C 1000 mg Q 8h, Vit E 1000 IU Q 8h, Se 200µgm QD X 7 days
    – 4279 patients
      – (2258 with antioxidant, 2021 without supplements)

• **Results:**
  • No difference in ventilator days
  • Hospital LOS and ICU LOS were decreased
  • Mortality significantly lower in the antioxidant group (6.0% vs 8.6%) 30% relative risk reduction

• Collier BR, et al JPEN 2008
• F3. The addition of enteral glutamine to an EN regimen (not already containing supplemental glutamine) should be considered in burn, trauma, and mixed ICU patients. (Grade: B)

The “controversy” of enteral vs parenteral glutamine:
“Most agree” that parenteral glutamine superior to enteral glutamine

• Recommendation F3 based on 6 level 2 and 1 level 1 study
  • The level 1 study showed no benefit
  • 2 of 6 level 2 studies showing benefit
    – Garrel 2003 mortality benefit in burn patients
    – Houdijk 1998 decrease infections in trauma
Glutamine: CC Guidelines

<table>
<thead>
<tr>
<th></th>
<th>Canadian 07</th>
<th>ASPEN 09</th>
<th>SCCM 09</th>
<th>ESPEN 06</th>
<th>ADA 08</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>YES Grade B</td>
<td>YES Grade B</td>
<td>YES Grade A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

Critical Care Guidelines
Section F: Adjunctive Therapy

- F4. Soluble fiber may be beneficial for the fully resuscitated, hemodynamically stable critically ill patient receiving EN who develops diarrhea. Insoluble fiber should be avoided in all critically ill patients. Both soluble and insoluble fiber should be avoided in patients at high risk for bowel ischemia or severe dysmotility. (Grade: C)
Critical Care Guidelines
Section F: Adjunctive Therapy

• F4. Soluble fiber may be beneficial for the fully resuscitated, hemodynamically stable critically ill patient receiving EN who develops diarrhea. Insoluble fiber should be avoided in all critically ill patients. Both soluble and insoluble fiber should be avoided in patients at high risk for bowel ischemia or severe dysmotility. (Grade: C)

• Rationale: Three small level II studies using soluble partially hydrolyzed guar gum demonstrated a significant decrease in the incidence of diarrhea in patients receiving EN. However, no differences in days of mechanical ventilation, ICU, length of stay or MODS have been reported. Insoluble fiber has not been shown to decrease the incidence of diarrhea in the ICU patient. Cases of bowel obstruction in surgical and trauma patients provided enteral formulations containing insoluble fiber have been reported.

Additional rationale for supplying soluble fiber which is not in guidelines is the SCFA production via fermentation by bacteria, multiple benefits of SCFA (animal models).

Critical Care Guidelines
Section H: Pulmonary Failure

• H1. Specialty high lipid low carbohydrate formulations designed to manipulate the respiratory quotient and reduce CO₂ production are not recommended for routine use in ICU patients with acute respiratory failure. (Grade: E)

  (This is not to be confused with the recommendation E2 for ARDS/ALI)

• H2. Fluid-restricted calorically dense formulations should be considered for patients with acute respiratory failure. (Grade: E)

• H3. Serum phosphate levels should be monitored closely, and replaced appropriately when needed. (Grade: E)
Critical Care Guidelines
Section I: Renal Failure

• I1. ICU patients with acute renal failure (ARF) or Acute Kidney Injury (AKI) should be placed on standard enteral formulations, and standard ICU recommendations for protein and calorie provision should be followed. If significant electrolyte abnormalities exit or develop, a specialty formulation designed for renal failure (with appropriate electrolyte profile) may be considered. (Grade: E)

• Key here is that we should not restrict protein !!!

Critical Care Guidelines
Section I: Renal Failure

• I2. Patients receiving hemodialysis or continuous renal replacement therapy (CRRT) should receive increased protein, up to a maximum of 2.5 gms/kg/day. Protein should not be restricted in patients with renal insufficiency as a means to avoid or delay initiation of dialysis therapy. (Grade: C)

• Rationale: There is an approximate amino acid loss of 10-15 gms/day during CRRT. Providing less than 1 gm protein/kg/day of protein may result in increased nitrogen deficits for patients on hemodialysis or CRRT. Patients undergoing CRRT should receive formulations with 1.5 – 2.0 grams protein /kg/day. At least one randomized prospective trial has suggested an intake of 2.5 gm/kg/day is necessary to achieve positive nitrogen balance in this patient population.

Grade: C
Critical Care Guidelines
Section J: Hepatic Failure

• J1. Traditional assessment tools should be used with caution in patients with cirrhosis and hepatic failure, as these tools are less accurate and less reliable due to complications of ascites, intravascular volume depletion, edema, portal hypertension, and hypoalbuminemia. (Grade: E)

• J2. Enteral nutrition (EN) is the preferred route of nutrition therapy in ICU patients with acute and/or chronic liver disease. Nutrition regimens should avoid restricting protein in patients with liver failure. (Grade: E)
Critical Care Guidelines
Section J: Hepatic Failure

- J3. Standard enteral formulations should be used in ICU patients with acute and chronic liver disease. The branched chain amino acid formulations (BCAA) should be reserved for the rare encephalopathic patient who is refractory to standard therapy with luminal acting antibiotics and lactulose. (Grade: C)

Critical Care Guidelines
Section K: Acute Pancreatitis

- K1. On admission, patients with acute pancreatitis should be evaluated for disease severity. (Grade: E) Patients with severe acute pancreatitis should have a nasoenteric tube placed and EN initiated as soon as fluid volume resuscitation is complete. (Grade: C)

- K2. Patients with mild to moderate acute pancreatitis do not require nutrition support therapy (unless an unexpected complication develops or there is failure to advance to oral diet within seven days). (Grade: C)
K3. Patients with severe acute pancreatitis may be fed enterally by the gastric or jejunal route. (Grade: C)

This is somewhat counter to the standard “belief” that feeding the stomach will exacerbate the pancreatitis, or be unsuccessful.

Two Level 2 PR studies compared gastric vs jejunal feeding in severe pancreatitis.

- Results – no difference in level of infusion
- Two patients in Eatock\(^1\) study and one in Kumar\(^2\) required d/c for increased pain and intolerance with gastric feeding

Critical Care Guidelines
Section K: Acute Pancreatitis

• K4. Tolerance to EN in patients with severe acute pancreatitis may be enhanced by the following measures:
  – Minimizing the period of ileus after admission by early initiation of EN. (Grade: D)
  – Displacing the level of infusion of EN more distally in the GI tract. (Grade: C)
  – Changing the content of the EN delivered from intact protein to small peptides, and long chain fatty acids to medium-chain triglycerides or a nearly fat-free elemental formulation. (Grade: E)
  – Switching from bolus to continuous infusion. (Grade: C)

• K5. For the patient with severe acute pancreatitis, when EN is not feasible, use of PN should be considered. (Grade: C) PN should not be initiated until after the first five days of hospitalization. (Grade: E)
• L1. Specialized nutrition therapy is not obligatory in cases of futile care or end-of-life situations. The decision to provide nutrition therapy should be based on effective patient/family communication, realistic goals, and respect for patient autonomy. (Grade: E)