Interprofessional Traumatology Conference
September 27th and 28th, 2012

Nutrition Therapy in Adult Trauma Patients

Lyne St-Laurent, p. dt.
MUHC-MGH
Key nutrients can modulate the stress response by influencing:
- inflammatory process
- immunity
- antioxidant defences

*Weissenfluh et al. NCP. 2006; 21:479*
Rationale for nutrition therapy

1. Prevent acute protein malnutrition which is associated with:
   - Worsening clinical outcome
   - ↑ rate of infections
   - Multiple organ dysfunction
   - Delayed wound healing
   - Prolonged mechanical ventilation
   - ↑ LOS and recovery
   - ↑ mortality

Rationale for nutrition therapy

2. Modulate immune response

3. Promote GI structure and function
   - Disuse
   - ICU treatments (narcotics, broad spectrum antibiotics, surgery) → further dysfunction
     - progressive ileus
     - ↑ permeability
     - ↓ gut associated lymphoid tissue function

   Impaired local and systemic defence mechanisms resulting in infection, sepsis and MOD

Todd et al. NCP. 2006; 21:421
Moore et al. NCP. 2009; 24:297
Gut: instigator and victim of multiple organ dysfunction

Shock
↓
Gut ischemia

Resuscitation
Laparotomy
ICU therapies
Disuse

↓ Blood flow
↓ Gastric emptying
Sm bowel ileus
↑ Colonization
↑ Permeability
↓ Immunity

Aspiration
Infections
Translocation
Toxins
MOD

Sepsis

Moore et al. NCP. 2009; 24: 297
Doig et al. Int Care Med. 2009; 35:2018
Nutrition therapy in adult trauma patients

1) Malnourished or not?
2) Which route to choose? EN vs PN
3) When to feed?
4) Gastric vs small bowel feeding?
5) How much to feed?
6) Which key nutrients to provide?
7) How to maximize efficiency and minimize risks?
8) How to monitor response?
Parameters of nutritional assessment

- Past medical history (including socio-economic profile)
- Physical exam
- Nutritional history
- Anthropometric measures
  - Height
  - Weight
- Laboratory data
  - Blood: albumin, prealbumin, CRP
- Subjective global assessment

Shenkin. Clinical chemistry. 2006; 52:2177
Ziegler. NEJM. 2009; 361:1088
Nutrition therapy recommendations are based on:

1) Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). 2009.

2) Canadian Clinical Practice Guidelines (CCPG) for nutrition support in mechanically ventilated, critically ill adult patients. 2009

- Basic recommendations
- Supportive evidence
- Target population
  - Critically ill (including trauma)
  - Expected ICU stay > 2-3 days

Mc Clave et al. JPEN. 2009; 33:277

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Enteral nutrition (EN) vs Parenteral nutrition (PN)

1) SCCM/ASPEN

EN is the preferred route of feeding over PN
- No difference in mortality
- No difference on number of ventilator days or LOS
- Significant reduction in infectious morbidity
  - pneumonia
  - specifically abdominal abscess in trauma (ATI > 15)

2) CCPG

Strongly recommend the use of EN over PN
- Based on 1 level I study and 12 level II studies (8 on trauma patients)
Nutrition therapy in open abdomen

- **Indications**
  - Damage control laparotomy (major hemorrhage, contamination)
  - Decompressive laparotomy (abdominal compartment syndrome)

- **Nutritional implications**
  - Significant fluid, electrolyte and protein losses from exposed viscera
  - Estimated protein loss from abdominal fluid: 2 g of nitrogen per litre

- **Nutrition therapy:** withholding EN has been a common practice but is not supported by the current available literature

- **Concerns regarding:**
  - Small bowel necrosis
  - Delay of abdominal fascial closure
  - Fistula formation
  - Bowel distension and potential aspiration

*Collier et al. JPEN. 2007; 31:410*
*Cheatham et al. Crit Care Med. 2007; 35:127*
*Dissanaike et al. J. Am Coll Surg. 2008; 207:690*
*Byrnes et al. Am. J. of Surgery. 2010; 199:359*
Nutrition therapy in open abdomen

Study by Collier et al (retrospective)

78 patients with an open abdomen ≥ 4 days

<table>
<thead>
<tr>
<th>Variable</th>
<th>Inclusion group n=78</th>
<th>EEN n=43</th>
<th>LEN n=35</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator associated pneumonia</td>
<td>46 (59)</td>
<td>29 (67)</td>
<td>17 (49)</td>
<td></td>
</tr>
<tr>
<td>Empyema</td>
<td>4 (5)</td>
<td>3 (7)</td>
<td>1 (3)</td>
<td>.41</td>
</tr>
<tr>
<td>Bloodstream infections</td>
<td>28 (36)</td>
<td>13 (30)</td>
<td>15 (43)</td>
<td>.25</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>14 (18)</td>
<td>5 (12)</td>
<td>9 (26)</td>
<td>.10</td>
</tr>
<tr>
<td>Wound infection</td>
<td>11 (14)</td>
<td>6 (14)</td>
<td>5 (14)</td>
<td>.97</td>
</tr>
<tr>
<td>Wound cellulitis</td>
<td>4 (5)</td>
<td>1 (2)</td>
<td>3 (9)</td>
<td>.21</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>4 (5)</td>
<td>1 (2)</td>
<td>3 (9)</td>
<td>.21</td>
</tr>
</tbody>
</table>

Variables presented as number of patients of 78 and (%). EEN, early enteral feeding; LEN, late enteral feeding.

Collier et al. JPEN. 2007; 31:410
# Nutrition therapy in open abdomen

Study by Collier et al (retrospective)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Inclusion group n=78</th>
<th>EEN n=43</th>
<th>LEN n=35</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early fascial closure &lt; 8d</td>
<td>46 (63)</td>
<td>32 (74)</td>
<td>17 (49)</td>
<td>.02</td>
</tr>
<tr>
<td>Fistula formation</td>
<td>13 (17)</td>
<td>4 (9)</td>
<td>9 (26)</td>
<td>.05</td>
</tr>
<tr>
<td>Total hospital charges, $</td>
<td>194, 270 ± 128, 758</td>
<td>172, 283 ± 118,010</td>
<td>223, 349 ± 138, 324</td>
<td>.04</td>
</tr>
</tbody>
</table>

Variables presented as number of patients of 78 and (%). EEN, early enteral feeding; LEN, late enteral feeding.

*Collier et al. JPEN. 2007; 31:410*

*Ivatury. World J. Surg. 2009; 33:1150*
Nutrition therapy in open abdomen

Study by Dissanaike et al (prospective cohort study)
100 patients with an open abdomen

Results: no difference in:
- Time and rate of closure
- Duration of mechanical ventilation
- ICU and hospital LOS
- Multi organ dysfunction
- Mortality

Early EN: substantial decrease in rate of VAP
Limitation: gastric vs small bowel feeding?

Nutrition therapy in open abdomen

Study by Byrnes et al (retrospective)
23 abdominal trauma patients (ISS=30.9)

Route of EN: 50% surgical jejunostomies, 25% gastric, 25% post-pyloric

Results:
- Timing of fascial closure: EN → 7.08 days, No EN → 3.4 days
- Incidence of VAP: similar in both groups
- No anastomotic leak
- No EC fistula

Limitations:
- Small sample size
- Retrospective
- EN group: EN often started at ≥ day5

Nutrition therapy and hemodynamic instability

SCCM/ASPEN:
In the setting of hemodynamic compromise (high dose catecholamine agents, large volume fluid or blood product resuscitation) EN should be withheld until the patient is fully resuscitated and/or stable.

Early EN associated with non occlusive bowel necrosis → rare but highly lethal

Non specific signs of intestinal necrosis
- Abdominal pain and distension
- High NG output
- Fever and ↑ WBC
- Hypotension and shock

McClave et al. JPEN. 2009; 33:277
When to feed: cumulative energy debt

- Energy debt begins in the first several days after trauma
- That debt can’t be compensated by aggressive nutrition therapy
- Consequences of that debt:
  - Occurrence of ARDS
  - Pressure sores
  - ↑ total complication rate (including infections)
  - Longer ICU-LOS
  - More days on mechanical ventilation
- High risk patients:
  - Major TBI → + CT scan and GCS < 8
  - Major torso trauma → significant injury to 2 or more body regions
  - Major abdominal trauma → ATI > 18

McClave et al. NCP. 2009; 24:305
Todd et al. NCP. 2006; 21:421
When to feed: early vs late EN

1) SCCM/ASPEN

Enteral feeding should be started early within the first 24-48 hours following admission as soon as fluid resuscitation is completed and the patient is hemodynamically stable

- Attenuates the inflammatory cascade and subsequent hypermetabolic response
- Protects the intestinal mucosa integrity and function
- Improves wound healing

2) CCPG

Recommend early EN, within 24-48 hours following admission to ICU.

- Based on 14 level II studies (7 on trauma patients)

Mc Clave et al. JPEN. 2009; 33:277
When to feed: early vs late EN

Marik and Zaloga (meta analysis of 15 PRCT’s)
Early EN (within 36 hours of admission) vs late EN in 753 patients
(trauma, TBI and burns)

Results:
- Trend ↓ mortality
- Significant ↓ infectious complications (12/15 studies)
- No effect on ICU or hospital LOS

Limitation:
- Significant heterogeneity between studies

When to feed: early vs late EN

Doig et al. (meta analysis of 3 RCT’s)

- Determine treatment benefits of early EN provided within 24 hrs of injury or ICU adm.
  - 126 patients fed per NGT with a standard formula
  - ISS > 20 and up to 40

Results:

- Pneumonia: • reported in only 1 study • stat. significant reduction
- MOD: • reported in only 1 study • no difference in incidence
  • strong trend towards decreased severity
- Mortality: • stat significant reduction in hospital discharge mortality (1 study)
  • stat significant reduction in ICU discharge mortality (1 study)

Limitations:

- overall quality of studies was low
- trial size was small
- composition of EN formula, nutr. goals, use of supplemental PN in 1 study
Gastric vs small bowel feeding

- Either gastric or small bowel feeding is acceptable in the ICU setting.
- One benefit associated with post pyloric feeding is optimization of enteral feeding but there is no significant difference in clinical outcomes such as:
  - ICU – LOS
  - Hospital – LOS
  - Pneumonia
  - Mortality
  - Ventilator days
- Feeding TBI patients in the stomach can be challenging, particularly in the acute phases of illness:
  - Suppressed vagal nerve activity 2° to ↑ ICP
  - Meds (sedatives, opioids)

Taylor et al. JPEN. 2010; 34:21
Cook et al. NCP. 2008; 23:608
Gastric vs small bowel feeding

CCPG:

- Routine use of small bowel feeding if feasible (fluoroscopy/endoscopy)
- If difficult logistically, small bowel feeding should be considered for:
  - Patients at high risk for intolerance
    - Ex.: on paralytic agent
  - Patients at risk of regurgitation and aspiration
    - Ex.: supine position
- If not feasible, small bowel feeding should be considered for patients who repeatedly demonstrate intolerance to gastric feeding

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How much to feed: Energy requirements

- Indirect calorimetry: gold standard
- Predictive equations:
  - PENN State equation is recommended
  - Accurate in 77% of trauma patients

Mifflin (0.96) + Tmax (167) + Ve (31) - 6212

Where Mifflin:

♂ 10 (w) + 6.25 (h) – 5 (a) +5
♀ 10 (w) + 6.25 (h) – 5 (a) -161

T = temperature  w = weight (kg)  a = age
Ve = minute ventilation  h = height (cm)

Frankenfield et al. JPEN. 2009; 33:27
How much to feed: factors affecting metabolic rate

1) No correlation between ISS/APACHE score and metabolic rate
   - Degree of inflammatory response more important than extent of tissue injury as a determinant of hypermetabolism

2) TBI
   - GCS $\leq$ 5 $\rightarrow$ basal metabolic rate $\times$ 168% (posturing response)
   - GCS $\geq$ 8 $\rightarrow$ basal metabolic rate $\times$ 150% (awareness and agitation)
   - GCS = 6-7 $\rightarrow$ basal metabolic rate $\times$ 129%

3) Medications can reduce metabolic rate

Frankenfield. NCP. 2006; 21:430
Frankenfield et al. JADA. 2007; 107:1552
How much to feed: effects of medications

- Consider energy provided by Propofol
  - Solubilized in soybean oil
  - Provides 1.1 kcal/ml

<table>
<thead>
<tr>
<th>Medication/treatment</th>
<th>Δ in energy expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedation (Fentanyl)</td>
<td>↓ 22-27%</td>
</tr>
<tr>
<td>Paralytic agent (Rocuronium)</td>
<td>↓ 11-33%</td>
</tr>
<tr>
<td>Barbiturate</td>
<td>↓ 30%</td>
</tr>
<tr>
<td>Cooling body temperature</td>
<td>↓ 18%</td>
</tr>
</tbody>
</table>

Frankenfield. NCP. 2006; 21:430
Dickerson et al. JADA. 2005; 105:835
Cook et al. NCP. 2008; 23:608
How much to feed: protein requirements

- Protein is the most important macronutrient for:
  - Wound healing
  - Supporting immune function
  - Maintaining lean body mass

- No storage ability for protein → we use muscle
- Increased loss through wounds (Ex.: open abdomen)
- Requirements: BMI < 30: 1.2-2.0 g/kg actual body weight
- Ongoing assessment of adequacy of protein provision should be performed: nitrogen balance
- The use of additional modular protein supplements is sometimes necessary

Mc Clave et al. JPEN. 2009; 33:277
How much to feed: energy and protein needs in obese patients

SCCM/ASPEN

- In the critically ill obese patient, hypocaloric feeding with EN is recommended
- For all classes of obesity (BMI > 30), the goal of EN regimen should not exceed 60-70% of target energy requirements or 11-14 kcal/kg actual weight
- Achieving some degree of weight loss may increase insulin sensitivity and reduce risk of comorbidities
- Protein requirements:
  - BMI=30-40 → ≥ 2.0 g/kg ideal body weight
  - BMI = > 40 → ≥ 2.5 g/kg ideal body weight

McClave et al. JPEN. 2009; 33:277
Dickerson. Curr Opin Clin Nutr Metab Care. 2005; 8:189
Impact of obesity in the critically ill trauma patient

Study by Bochicchio et al. (prospective data collection)
1167 trauma patients admitted to ICU over a 2 year period → 5.3% obese patient (BMI ≥ 30)
Mean ISS = 24.5
Preadmission: ↑ incidence of HTN, DM and COPD in obese patients
Conclusion: obesity was found to be an independent predictor for overall outcomes, LOS and mortality

Impact of obesity in the critically ill trauma patient

<table>
<thead>
<tr>
<th>Table 1. Outcomes Risk Factors and Variables Stratified by Obesity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes</strong></td>
</tr>
<tr>
<td>Risk factors</td>
</tr>
<tr>
<td>No. of patients</td>
</tr>
<tr>
<td>Men, n</td>
</tr>
<tr>
<td>Women, n</td>
</tr>
<tr>
<td>ISS</td>
</tr>
<tr>
<td>TRISS</td>
</tr>
<tr>
<td>RTS</td>
</tr>
<tr>
<td>Age (y)</td>
</tr>
<tr>
<td>Ventilator (d)</td>
</tr>
<tr>
<td>Central line (d)</td>
</tr>
<tr>
<td>Foley catheter (d)</td>
</tr>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>No. of patients</td>
</tr>
<tr>
<td>HLOS (d)</td>
</tr>
<tr>
<td>ILOS (d)</td>
</tr>
<tr>
<td>Infections, no. of patients (%)</td>
</tr>
<tr>
<td>In-house mortality, no. of patients (%)</td>
</tr>
</tbody>
</table>

Data reported as mean ± SD except where otherwise indicated. HLOS, hospital length of stay; ILOS, ICU length of stay; ISS, Injury Severity Score; RTS, Revised Trauma Score.

Impact of obesity in the critically ill trauma patient

Figure 1. Percentage of infections by site of infection. Obese versus nonobese. GU, genitourinary infections; Resp, respiratory infections.

Which key nutrients to provide: glutamine

Rationale for its use:

- Glutamine deficiency occurs precipitously after injury
- Preferred fuel for enterocytes → maintenance of intestinal mucosal barrier → reduction in translocation of enteric bacteria

CCPG: Enteral glutamine should be considered in burn and trauma patients
Based on 2 level I and 7 level II studies

- May be associated with a reduction in infectious complications in trauma
- Associated with a significant reduction in hospital LOS in trauma

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Taylor. JPEN. 2010; 34:21
Which key nutrients to provide: glutamine

SCCM/ASPEN:
The addition of enteral glutamine to an EN regimen (not containing glutamine) should be considered in burn, trauma and mixed ICU patients.

Based on 1 level I and 6 level II studies

Study by Houdjik et al. (blinded, randomized, controlled study)

- 80 trauma patients with ISS ≥ 20
- Glutamine given for at least 5 days
- Iso-caloric and iso-nitrogenous
- Significant reduction in pneumonia, bacteremia and sepsis

Houdjik et al. Lancet. 1998; 352:772
Which key nutrients to provide: antioxidants

- Most studied: vitamin C, selenium, zinc, vitamin E, beta-carotene

- Rationale for their use:
  - Oxidative stress is increased in critically ill patients and contributes to organ dysfunction
  - Increase of oxidative stress is associated with depletion of the stores of antioxidants
  - Trauma is characterized by extensive losses of biologic fluids (wounds, drain, fistulas, etc)

Berger. NCP. 2006; 21:438
Which key nutrients to provide: antioxidants

SCCM/ASPEN:
A combination of antioxidant vitamins and trace minerals (specifically including selenium) should be provided to all critically ill patients receiving specialized nutrition therapy.

Issues:
- Various nutrients, doses, combinations included in studies
- Possible toxicity

CCPG:
The use of supplemental combined vitamins and trace elements should be considered.
Based on 3 level I and 13 level II studies

Mc Clave et al. JPEN. 2009; 33:277
www.criticalcarenutrition.com
Which key nutrients to provide: antioxidants

Study by Nathens et al. (prospective, randomized)
Early administration of antioxidants after trauma (595 patients)

- Antioxidants: 3 g vit C IV vs no antioxidants
  3000 IU vit E enterally
- Supplementation for 28 days

Figure 3. Kaplan-Meier estimates of the risk of pulmonary morbidity (ARDS or pneumonia) among 301 patients receiving antioxidant supplementation and 294 patients receiving standard care. There is a suggestion that antioxidant supplementation might be associated with a lower likelihood of pulmonary morbidity ($P = .2$ by the log-rank test). Solid line: no antioxidant supplementation; dashed line: antioxidant supplementation.

Figure 4. Kaplan-Meier estimates of the risk of multiple organ failure among 301 patients receiving antioxidant supplementation and 294 patients receiving standard care. Treatment with antioxidant supplementation was associated with a significant reduction in the risk of developing multiple organ failure ($P = .04$ by the log-rank test). Solid line: no antioxidant supplementation; dashed line: antioxidant supplementation.

Which key nutrients to provide: antioxidants

Study by Nathens et al.

Limitations:
- Young trauma not critically ill (ISS=20/APACHE-14)
- Selenium not included in supplements

Which key nutrients to provide: antioxidants

Study by Collier et al. (cohort study)
High dose antioxidant protocol in acute trauma (4294 patients with ISS=21)

- Antioxidants: 3 g vit C IV vs no antioxidants
  - 3000 IU vit E enterally
  - 200 µg selenium IV
- Supplementation for 7 days

Results:
- No difference in ventilator days
- Decreased in hospital and ICU-LOS (by 1 day)
- Significant decrease in mortality with antioxidant supplementation (6.1% vs 8.5%)

Limitations:
- Not a randomized study
- Changes in ICU protocols (glucose control, VAP prevention)

Strengths:
- Large sample size
- Relatively homogenous population

*Collier et al. JPEN. 2008; 32:384*
Study by Berger et al (PRCT, double blind)

Early antioxidant effect on clinical evolution and organ function after cardiac surgery, major trauma (ISS > 9) and severe SAH

- 200 patients → 102 (antioxidants), 98 (control)
- Received EN first (PN used only when EN contraindicated)
- IV supplementation for 5 days:
  - selenium - 270 µg
  - zinc -30 mg
  - vitamin C – 1.1 g
  - B1 – 100 mg
  
  Double – loading dose on days 1 and 2

Results:

- No difference between groups for AKI, pneumonia, mortality
- Antioxidant group:
  - Trend towards ↓ length of mechanical ventilation and ICU – LOS
  - Shorter hospital LOS (significant in trauma)
  - ↓ CRP (significant blunting of inflammation)

Limitations: heterogeneity in trauma patients  

Maximizing efficiency and minimizing risks of EN

1) Enteral feeding protocol
   - Use of a protocol increases the overall percentage of goal calories
   - Goal infusion rate
   - Handling of gastric residuals, etc

2) EN interruptions
   - The time period that a patient is made NPO prior to, during and immediately following the time of diagnostic tests or procedures should be minimized to prevent inadequate delivery of nutrients and prolonged periods of ileus.
     - Cessation of feeding occurs in > 85% of patients for an average of 20% of the infusion time
     - Available in > 65% of occasions
     - Reasons for cessation
       - 1/3 intolerance (only ½ is true intolerance)
       - 1/3 NPO from midnight for OR, tests, extubation
       - 1/3 elevated gastric residuals + tube displacement

Mc Clave et al. JPEN. 2009; 33:277
Btaiche et al. NCP. 2010; 25:32
Taylor. JPE N. 2010; 34:21
Maximizing efficiency and minimizing risks of EN

3) Aspiration risk

Steps to reduce risks of aspiration should be employed:

- HOB should be at 30 to 45°
  - Can reduce incidence of pneumonia from 23% to 5% (supine vs semi-recumbent position)
- Agents to promote motility such as prokinetic drugs should be initiated when clinically feasible
- Diverting to post-pyloric feeding should be considered
- Use of chlorhexidine mouthwash BID should be considered to reduce risks of VAP

McClave et al. JPEN. 2009; 33:277
Btaiche et al. NCP. 2010; 25:32
Taylor. JPEN. 2010; 34:21
Maximizing efficiency and minimizing risks of EN

Gastric residuals:

- Holding EN for gastric residual volumes < 500 ml in the absence of other signs of intolerance should be avoided

Prokinetic agents:

1) Metoclopramide

- Stimulates gastric and duodenal motility
- Dose recommended: 10 mg IV q 6 h
- Reduced efficacy after 3 days
- Ineffective in severe TBI (especially when elevated ICP)
- Can cause extrapyramidal effects in TBI (dyskinesia)
Maximizing efficiency and minimizing risks of EN

Prokinetic agents:

2) Erythromycin
   - Acts as a motilin agonist, stimulates antral contractions
   - Dose: 250 mg IV q 6 h
   - Reduced efficacy after 3-4 days (↑ risk of tachyphylaxis in TBI)
   - Potential induction of bacterial resistance

3) Combination of metoclopramide and erythromycin
   - Greater benefit and less tachyphylaxis than monotherapy

Dickerson et al. JPEN. 2009; 33:646
Nguyen et al. Crit Care Med. 2007; 35:2561
Taylor. JPEN. 2010; 34:21
Fraser et al. NCP. 2010; 25:26
Maximizing efficiency and minimizing risks of EN

Study by Morgan et al (retrospective observational study)
Factors causing interrupted delivery of EN in trauma ICU patients

- 56 patients
- Data collected for maximum duration of 1 week

<table>
<thead>
<tr>
<th>Enteral nutrient intake</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Caloric goal, kcal/kg</td>
<td>30</td>
</tr>
<tr>
<td>Protein goal, g/kg</td>
<td>2.0</td>
</tr>
<tr>
<td>Route of delivery, %</td>
<td></td>
</tr>
<tr>
<td>Gastric</td>
<td>80</td>
</tr>
<tr>
<td>Jejunal</td>
<td>20</td>
</tr>
<tr>
<td>Amount of EN received, % of prescribed</td>
<td>67</td>
</tr>
</tbody>
</table>

Morgan et al. NCP. 2004; 19:511
Maximizing efficiency and minimizing risks of EN

Study by Morgan et al.
Reasons for temporary discontinuation of EN

Cut-off for gastric residuals < 150 ml

- Reasons for low % of GI intolerance:
  - Aggressive use of prokinetic agent
  - ↑ HOB
  - Periodic use of jejunostomy feeding (significant ↑ in EN delivery)

*Figure 2. Reasons for temporary discontinuation of enteral feeding. Two hundred twenty-two total occurrences derived from 56 multiple trauma patients.*

*Morgan et al. NCP. 2004; 19:511*
Maximizing efficiency and minimizing risks of PN

1) Dose of PN / permissive underfeeding
   - Use permissive underfeeding initially – 80 % of goal calories
     - Not applicable for PN > 10 days or for malnourished critically ill
   - Benefit:
     - Reduce incidence of hyperglycemia
     - Reduce incidence of infections

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Maximizing efficiency and minimizing risks of PN

2) Use of lipids

**SCCM/ASPEN**

During the first week, if PN is required, should be without soy based lipids (omega 6)

Very controversial:

- Omega 6 fatty acids are immunosuppressive
- PN without lipids may exacerbate hyperglycemia

**CCPG**

Withholding lipids rich in soybean oil should be considered:

- Patients not malnourished
- Tolerating some EN
- PN < 10 days

May decrease LOS and duration of mechanical ventilation in trauma patients

Significantly reduces infectious complications

*Mc Clave et al. JPEN. 2009; 33:277*

*Ziegler. NEJM. 2009; 361:1088*

*www.criticalcarenutrition.com*
Maximizing efficiency and minimizing risks of PN

2) Use of lipids (first 10 days)

<table>
<thead>
<tr>
<th>Battistella’s study</th>
<th>57 trauma patients (ISS=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PN (lipid)</td>
</tr>
<tr>
<td>NP calories/kg IBW</td>
<td>28.0</td>
</tr>
<tr>
<td>Hospital LOS (days)</td>
<td>39</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
<td>29</td>
</tr>
<tr>
<td>Duration mechanical ventilation (days)</td>
<td>27</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>73.3%</td>
</tr>
</tbody>
</table>

Battistella. J. Trauma. 1997; 43:52
Use of PN in trauma patients

Study by Rhee et al (retrospective study)
Decreased use of PN in a Trauma ICU

- 2964 patients admitted during the 6 year period (2000 → 2005)
- 15.6% of patients received PN

Rhee et al. J Trauma. 2007; 63:1215
Use of PN in trauma patients

**Fig. 2.** Average start day and duration of TPN use.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average start day for TPN</th>
<th>Average TPN duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>4.4 ± 3.2</td>
<td>13.8 ± 18.7</td>
</tr>
<tr>
<td>2001</td>
<td>4.2 ± 3.8</td>
<td>10.3 ± 13.6</td>
</tr>
<tr>
<td>2002</td>
<td>4.8 ± 4.3</td>
<td>10.0 ± 12.9</td>
</tr>
<tr>
<td>2003</td>
<td>5.6 ± 5.8</td>
<td>14.5 ± 35.5</td>
</tr>
<tr>
<td>2004</td>
<td>8.3 ± 7.7</td>
<td>14.6 ± 25.6</td>
</tr>
<tr>
<td>2005</td>
<td>12.4 ± 8.3</td>
<td>13.5 ± 20.5</td>
</tr>
</tbody>
</table>

Rhee et al. J Trauma. 2007; 63:1215

Rhee et al. J Trauma. 2007; 63:1215
Use of PN in trauma patients

Difference in complication rates between the 2 groups may be attributed to changes in practice: • Resuscitation technique • Ventilator management • VAP management • Tighter glycemic control, etc

Rhee et al. J. Trauma. 2007; 63:1215
Use of PN in critically ill trauma patients

Study by Sena et al (retrospective cohort study from 8 trauma centers)

Early supplementation of PN in critically ill trauma patients → effect on infectious complications

1st part: 567 patients (early PN = within 7 days post-injury)

- 17% - early PN (ISS = 34 – more severe abd. injuries and more open abdomen)
- 83% - ∅ early PN (ISS = 27)

Use of PN in critically ill trauma patients

Table 2. Infectious and Noninfectious Outcomes in Study Cohort (n = 567)

<table>
<thead>
<tr>
<th>Complications</th>
<th>No early PN (n = 472)</th>
<th>Early PN (n = 95)</th>
<th>Adjusted OR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Late infectious</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nosocomial infection (excluding SSI)</td>
<td>128</td>
<td>27</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>68</td>
<td>14</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>BSI</td>
<td>38</td>
<td>8</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>Catheter-related BSI</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>39</td>
<td>8</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>SSI</td>
<td>47</td>
<td>10</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Noninfectious</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late ARDS (onset after 7 d)</td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Late thromboembolic (onset after 7 d)</td>
<td>29</td>
<td>6</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Death</td>
<td>38</td>
<td>8</td>
<td>22</td>
<td>23</td>
</tr>
</tbody>
</table>

Associated p values are based upon adjusted odds ratio.
BSI, bloodstream infection; OR, odds ratio; PN, parenteral nutrition; SSI, surgical site infection.

Use of PN in critically ill trauma patients

2nd part: 249 patients (EN tolerant $\rightarrow \geq 1000$ kcal/day for at least 1 day during 1st 7 days)

- 87% - early EN tolerant (NG vs small bowel)
- 13% - early EN tolerant + PN

Use of PN in critically ill trauma patients

Figure 2. Daily total and enteral caloric intake adjusted for body weight. (A) Daily total calories. (B) Daily enteral calories.
Use of PN in critically ill trauma patients

Table 4. Infectious and Noninfectious Outcomes in Enteral-Tolerant Group

<table>
<thead>
<tr>
<th>Complications</th>
<th>Early EN only (n = 217)</th>
<th>Early EN + PN (n = 32)</th>
<th>Adjusted OR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Late infectious</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nosocomial infection (excluding SSI)</td>
<td>92</td>
<td>42</td>
<td>22</td>
<td>69</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>55</td>
<td>25</td>
<td>12</td>
<td>38</td>
</tr>
<tr>
<td>BSI</td>
<td>24</td>
<td>11</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>Catheter-related BSI</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>24</td>
<td>11</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>SSI</td>
<td>31</td>
<td>14</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Noninfectious</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late ARDS (onset after 7 d)</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Late thromboembolic (onset after 7 d)</td>
<td>15</td>
<td>7</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Death</td>
<td>18</td>
<td>8</td>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

Associated p values are based upon adjusted odds ratio.
BSI, bloodstream infection; EN, enteral nutrition; OR, odds ratio; PN, parenteral nutrition; SSI, surgical site infection.

Use of PN in critically ill trauma patients

Conclusion:

1. PN support, when commenced during the first post injury week along with a moderate amount of enteral calories, does not provide measurable clinical benefit and is associated with an increase in risk of nosocomial, particularly bloodstream, infections.

2. There seems to be a protective effect of EN on gut mucosal function and immunity.

3. The increased infection rate may be secondary to the increased kcal intake especially from lipids which are known to be immunosuppressive.

Monitoring adequacy of nutrition therapy

1. Physical exam
2. Reassessment of nutritional needs
3. Weight
4. Nitrogen balance
   - 24 hours urine collection for urea
   - Open abdomen: estimate loss of 2 g nitrogen per litre of abdominal fluid output
5. Serum protein markers
   - Albumin
   - Prealbumin
   - C-reactive protein

There are not validated for determining adequacy of protein provision in the critical care setting.

Shenkin. Clinical Chemistry. 2006; 52:2177
Jose et al. J. of Trauma. 2010; 68:1425
Take home message

1. If the gut works, use it!
2. Feed early
3. It is safe to feed in the stomach
4. Do not overfeed! Especially when obesity is present
5. Consider glutamine as adjunctive therapy
6. Antioxidants, especially selenium, are promising
7. Maximize delivery of EN and prevent aspiration
8. If use PN, avoid overfeeding