NUTRITIONAL SUPPORT OF THE TRAUMA PATIENT

Alan H. Tyroch, FACS, FCCM
Professor and Chair of Surgery
Trauma Medical Director
KEY POINTS

- Nutritional assessment on ICU admission
  - Energy requirements
  - Protein requirements

- Initiate enteral nutrition (EN) 24-48 hours after admission.
  - Reach goal < a week from admission (preferably much sooner)

- Take steps to reduce aspiration risk and improve tolerance to feeding.

- Do NOT use gastric residual volumes to monitor patients on EN.

FEED the GUT!
FEED the GUT!
FEED the GUT!
(I hate TPN!)
METABOLIC RESPONSE

In 1930, Sir David Cuthbertson divided the metabolic response to injury in humans into 'ebb' and 'flow' phases:

- INJURY
- EBB PHASE
- FLOW PHASE
- RECOVERY

**INJURY**
- Shock
- Catabolism
- Anabolism

**Days 1-2**
- Acute Phase
- Early Period

**Days 3-7**
- Acute Phase
- Late Period

- Late Phase
- Rehabilitation
- Or
- Chronic Phase

**Catabolism**

**Resting Metabolism (%)**

- Major Burn
- Major Trauma
- Minor Trauma
- Normal Range
- Starvation

**%REE**

- Major burns
- Sepsis/pancreatitis
- Skeletal trauma
- Elective surgery

- Normal range
- Starvation
NUTRITIONAL ASSESSMENT

Comorbid Conditions

Aspiration Risk

Function of GI Tract

DO NOT USE
Traditional Serum Markers
24-hour Urine Urea Nitrogen

BEST TEST
Indirect Calorimetry

POTENTIAL
CT Scan
Ultrasound
PATIENT ASSESSMENT

- Patient history
- Physical exam
- Anthropometrics
  - Height
  - Weight (ideal & dry)
  - BMI
- Usual labs
The NUTRIC Score is designed to quantify the risk of critically ill patients developing adverse events that may be modified by aggressive nutrition therapy. The score, of 0-10, is based on 6 variables that are explained below in Table 1. The scoring system is shown in Tables 2 and 3.

### Table 1: NUTRIC Score variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>50-75</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;75</td>
<td>2</td>
</tr>
<tr>
<td>APACHE II</td>
<td>&lt;15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>15-20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20-28</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;28</td>
<td>3</td>
</tr>
<tr>
<td>SOFA</td>
<td>&lt;6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>2</td>
</tr>
<tr>
<td>Number of Co-morbidities</td>
<td>0-1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;2</td>
<td>2</td>
</tr>
<tr>
<td>Days from hospital to ICU admission</td>
<td>0-1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;3</td>
<td>2</td>
</tr>
<tr>
<td>IL-6</td>
<td>&lt;100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;100</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;400</td>
<td>2</td>
</tr>
</tbody>
</table>

### Table 2: NUTRIC Score scoring system if IL-6 available

<table>
<thead>
<tr>
<th>Sum of points</th>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>High Score</td>
<td>Associated with worse clinical outcomes (mortality, ventilation); these patients are the most likely to benefit from aggressive nutrition therapy.</td>
</tr>
<tr>
<td>0-5</td>
<td>Low Score</td>
<td>These patients have a low mortality risk.</td>
</tr>
</tbody>
</table>

### Table 3: NUTRIC Score scoring system if no IL-6 available

<table>
<thead>
<tr>
<th>Sum of points</th>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-9</td>
<td>High Score</td>
<td>Associated with worse clinical outcomes (mortality, ventilation); these patients are the most likely to benefit from aggressive nutrition therapy.</td>
</tr>
<tr>
<td>0-4</td>
<td>Low Score</td>
<td>These patients have a low mortality risk.</td>
</tr>
</tbody>
</table>

### Nutritional status

<table>
<thead>
<tr>
<th>Score</th>
<th>Nutritional status</th>
<th>Disease/surgery severity</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
<td>Normal</td>
<td>&lt;70</td>
</tr>
<tr>
<td>1</td>
<td>Weight loss &gt;5%/3 months or Food intake &lt;75%</td>
<td>Includes chronic disease, hip fracture, cancer, minor surgery</td>
<td>≥70</td>
</tr>
<tr>
<td></td>
<td>Weight loss &gt;5%/2 months or Food intake &lt;50% or BMI 18.5-20.5</td>
<td>Includes major surgery, myocardial infarction, pneumonia, lymphoma, leukemia</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Weight loss &gt;5%/1 month (or &gt;15%/3 months) or Food intake &lt;25% or BMI &lt;18.5</td>
<td>Includes head trauma, transplantation, intensive care patients</td>
<td></td>
</tr>
</tbody>
</table>

BMI: body mass index. The Nutritional Risk Score (NRS) is calculated by adding 3 different components: nutritional status + disease/surgery severity + age. Only the more severe contribution to the overall score of each of these 3 elements is considered in the overall score.
ESPEN RECOMMENDATIONS

• Predicted ICU stay > 2 days.
• Mechanical ventilation
• Active infection
• Underfed > 5 days
• Presenting with a severe chronic disease

“Medical nutrition therapy shall be considered for all patients staying in the ICU, mainly for more than 48 hours.”
ASPIRATION RISKS

- Unable to protect airway
- Presence of a NGT
- Mechanical ventilation
- Age > 70
- Reduced level of consciousness
- Poor oral intake
- Inadequate RN/Patient ratio
- Supine position
- Neurologic deficits
- GERD
- Transport in/out of ICU
- Use of bolus feeding
NUTRITIONAL SUPPORT
Inadequacy

• < 50% of patients reach their target goal of energy intake.

• We provide only 60%-80% of energy requirements.

• Patients receive ~80% of what is prescribed.

• Feeding is held for too long and for inappropriate reasons
INITIATION OF NUTRITIONAL SUPPORT

• Calculate energy requirements: 25-30 kcal/kg/day

• Protein Provision: 1.2-2.0 g/kg/day (more for major trauma & burns)
  • ESPEN: 1.3 g/kg/day

• Start tube feeds at 20cc/hr and increase by 10cc/hr every 4-6 hours until goal (conservative approach)

• Provide free water at 30cc/kg (NS if TBI)
  • Enteral nutrition is ~85% water
SPECIAL POPULATIONS
Renal Failure

- Standard enteral formula

- Use dry weight for calculation

- Energy provision: 25-30 kcal/kg/day

- Protein provision: 1.2-2 g/kg actual body weight

- Hemodialysis or CRRT:
  - Increase protein to 2.5 g/kg/day
SPECIAL POPULATIONS
Hepatic Failure

- Use dry weight to determine energy and protein requirements in those with cirrhosis and hepatic failure.

- Avoid restricting protein.

- Standard enteral formula.
  - Branched-chain amino acid formulas had no effect on coma grade
RATIONAL OF ENTERAL VERSUS PARENTERAL NUTRITION

• Reduction of infectious morbidity:
  • Pneumonia
  • CAUTI
  • Abdominal abscess (trauma)

• Reduced ICU LOS.

• Minimal impact on mortality.
ENTERAL VERSUS PARENTERAL NUTRITION
Infectious Complications

**ASPEN**

**ESPEN**
INITIATION OF ENTERAL NUTRITION
(24 - 48 Hours)

RATIONALE
• Supports intestinal integrity.
• Stimulates intestinal blood flow.
• Induces release of trophic agents.
• Supports immunocytes.

KEY POINTS
• Presence of bowel sounds is NOT required.
• Do NOT wait for flatus or bowel movement.
EARLY VERSUS DELAYED ENTERAL NUTRITIONAL SUPPORT

Mortality

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Early EN Events</th>
<th>Delayed/None Events</th>
<th>Weight</th>
<th>M-H, Random, 95% CI Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagar 1979</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>Not estimable 1979</td>
</tr>
<tr>
<td>Moore 1986</td>
<td>1</td>
<td>2</td>
<td>2.3%</td>
<td>0.49 [0.05, 5.07] 1986</td>
</tr>
<tr>
<td>Chiarelli 1990</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>Not estimable 1990</td>
</tr>
<tr>
<td>Schroeder 1991</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>Not estimable 1991</td>
</tr>
<tr>
<td>Eyer 1993</td>
<td>2</td>
<td>19</td>
<td>3.7%</td>
<td>1.00 [0.16, 6.39] 1993</td>
</tr>
<tr>
<td>Beier-Holgersen 1996</td>
<td>2</td>
<td>30</td>
<td>4</td>
<td>0.50 [0.10, 2.53] 1996</td>
</tr>
<tr>
<td>Carr 1996</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>0.33 [0.01, 7.55] 1996</td>
</tr>
<tr>
<td>Chuntrasakul 1996</td>
<td>1</td>
<td>21</td>
<td>3</td>
<td>0.27 [0.03, 2.37] 1996</td>
</tr>
<tr>
<td>Watters 1997</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>Not estimable 1997</td>
</tr>
<tr>
<td>Singh 1998</td>
<td>4</td>
<td>21</td>
<td>4</td>
<td>0.82% [0.33, 3.66] 1998</td>
</tr>
<tr>
<td>Kompan 1999</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>0.15 [0.01, 7.55] 1999</td>
</tr>
<tr>
<td>Minard 2000</td>
<td>1</td>
<td>12</td>
<td>4</td>
<td>0.31 [0.04, 2.44] 2000</td>
</tr>
<tr>
<td>Pupelis 2000</td>
<td>1</td>
<td>11</td>
<td>5</td>
<td>0.33 [0.04, 2.45] 2000</td>
</tr>
<tr>
<td>Pupelis 2001</td>
<td>1</td>
<td>30</td>
<td>7</td>
<td>0.14 [0.02, 1.09] 2001</td>
</tr>
<tr>
<td>Dvorak 2004</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>Not estimable 2004</td>
</tr>
<tr>
<td>Kompan 2004</td>
<td>0</td>
<td>27</td>
<td>1</td>
<td>0.31 [0.01, 7.28] 2004</td>
</tr>
<tr>
<td>Peck 2004</td>
<td>4</td>
<td>14</td>
<td>5</td>
<td>0.74 [0.25, 2.18] 2004</td>
</tr>
<tr>
<td>Mahotra 2004</td>
<td>12</td>
<td>100</td>
<td>16</td>
<td>0.75 [0.37, 1.50] 2004</td>
</tr>
<tr>
<td>Nguyen 2005</td>
<td>6</td>
<td>14</td>
<td>6</td>
<td>1.00 [0.43, 2.35] 2008</td>
</tr>
<tr>
<td>Moses 2009</td>
<td>3</td>
<td>29</td>
<td>3</td>
<td>1.03 [0.23, 4.71] 2009</td>
</tr>
<tr>
<td>Chourdakis 2012</td>
<td>3</td>
<td>34</td>
<td>2</td>
<td>1.10 [0.20, 6.12] 2012</td>
</tr>
</tbody>
</table>

Total (95% CI) 469 467 100.0% 0.70 [0.49, 1.00]

Total events 41 66

Heterogeneity: Tau² = 0.00, Chi² = 7.23, df = 15 (P = 0.99); I² = 0%

Test for overall effect: Z = 1.97 (P = 0.05)
<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Early EN</th>
<th>Delayed/None</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagar 1979</td>
<td>3</td>
<td>15</td>
<td>15</td>
<td>0.60 [0.17, 2.07] 1979</td>
</tr>
<tr>
<td>Moore 1986</td>
<td>3</td>
<td>32</td>
<td>9</td>
<td>0.32 [0.10, 1.08] 1986</td>
</tr>
<tr>
<td>Schroeder 1991</td>
<td>1</td>
<td>16</td>
<td>0</td>
<td>3.00 [0.13, 68.57] 1991</td>
</tr>
<tr>
<td>Carr 1996</td>
<td>0</td>
<td>14</td>
<td>3</td>
<td>0.14 [0.01, 2.53] 1996</td>
</tr>
<tr>
<td>Beiler-Holgersen 1996</td>
<td>2</td>
<td>30</td>
<td>14</td>
<td>0.14 [0.04, 0.57] 1996</td>
</tr>
<tr>
<td>Singh 1998</td>
<td>7</td>
<td>21</td>
<td>12</td>
<td>0.61 [0.30, 1.25] 1998</td>
</tr>
<tr>
<td>Minard 2000</td>
<td>6</td>
<td>12</td>
<td>7</td>
<td>1.07 [0.49, 2.34] 2000</td>
</tr>
<tr>
<td>Malhotra 2004</td>
<td>54</td>
<td>100</td>
<td>67</td>
<td>0.81 [0.64, 1.01] 2004</td>
</tr>
<tr>
<td>Kompan 2004</td>
<td>9</td>
<td>27</td>
<td>16</td>
<td>0.52 [0.26, 0.96] 2004</td>
</tr>
<tr>
<td>Peck 2004</td>
<td>12</td>
<td>14</td>
<td>11</td>
<td>1.01 [0.74, 1.39] 2004</td>
</tr>
<tr>
<td>Nguyen 2008</td>
<td>3</td>
<td>14</td>
<td>6</td>
<td>0.50 [0.15, 1.61] 2008</td>
</tr>
<tr>
<td>Moses 2009</td>
<td>17</td>
<td>29</td>
<td>19</td>
<td>0.93 [0.61, 1.39] 2009</td>
</tr>
<tr>
<td>Chourdakis 2012</td>
<td>13</td>
<td>34</td>
<td>12</td>
<td>0.80 [0.44, 1.44] 2012</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>358</td>
<td>350</td>
<td>100.0%</td>
<td>0.74 [0.58, 0.93]</td>
</tr>
<tr>
<td>Total events</td>
<td>130</td>
<td>181</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $I^2 = 39\%$.
SMALL BOWEL VERSUS GASTRIC FEEDINGS

• Acceptable to initiate enteral nutrition in the stomach.
  • ASPEN: Yes
  • ESPEN: Yes

• No difference, to include:
  • LOS
  • Mortality
  • Nutrient delivery
  • Pneumonia
SMALL BOWEL VERSUS GASTRIC FEEDINGS
Nutritional Efficiency

**ASPEN**

**ESPEN**
### SMALL BOWEL VERSUS GASTRIC FEEDINGS

Pneumonia

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Small Bowel</th>
<th></th>
<th>Gastric</th>
<th></th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montecalvo, 1992</td>
<td>4</td>
<td>19</td>
<td>6</td>
<td>19</td>
<td>3.9%</td>
<td>0.67 [0.22, 1.99]</td>
<td></td>
</tr>
<tr>
<td>Kortbeek, 1999</td>
<td>10</td>
<td>37</td>
<td>18</td>
<td>43</td>
<td>10.4%</td>
<td>0.65 [0.34, 1.22]</td>
<td></td>
</tr>
<tr>
<td>Taylor, 1999</td>
<td>18</td>
<td>41</td>
<td>26</td>
<td>41</td>
<td>20.6%</td>
<td>0.69 [0.46, 1.05]</td>
<td></td>
</tr>
<tr>
<td>Keams, 2000</td>
<td>4</td>
<td>21</td>
<td>3</td>
<td>23</td>
<td>2.5%</td>
<td>1.46 [0.37, 5.78]</td>
<td></td>
</tr>
<tr>
<td>Minard, 2000</td>
<td>6</td>
<td>12</td>
<td>7</td>
<td>15</td>
<td>7.2%</td>
<td>1.07 [0.49, 2.34]</td>
<td></td>
</tr>
<tr>
<td>Day, 2001</td>
<td>0</td>
<td>14</td>
<td>2</td>
<td>11</td>
<td>0.6%</td>
<td>0.16 [0.01, 3.03]</td>
<td></td>
</tr>
<tr>
<td>Davies, 2002</td>
<td>2</td>
<td>31</td>
<td>1</td>
<td>35</td>
<td>0.9%</td>
<td>2.26 [0.22, 23.71]</td>
<td></td>
</tr>
<tr>
<td>Montefio, 2002</td>
<td>16</td>
<td>50</td>
<td>20</td>
<td>51</td>
<td>14.2%</td>
<td>0.82 [0.48, 1.39]</td>
<td></td>
</tr>
<tr>
<td>Hsu, 2009</td>
<td>5</td>
<td>59</td>
<td>15</td>
<td>62</td>
<td>5.1%</td>
<td>0.35 [0.14, 0.90]</td>
<td></td>
</tr>
<tr>
<td>White, 2010</td>
<td>11</td>
<td>57</td>
<td>5</td>
<td>51</td>
<td>4.7%</td>
<td>1.97 [0.73, 5.28]</td>
<td></td>
</tr>
<tr>
<td>Acosta-Escribano, 2010</td>
<td>16</td>
<td>50</td>
<td>31</td>
<td>54</td>
<td>17.5%</td>
<td>0.56 [0.35, 0.89]</td>
<td></td>
</tr>
<tr>
<td>Davies, 2012</td>
<td>18</td>
<td>91</td>
<td>19</td>
<td>89</td>
<td>12.4%</td>
<td>0.93 [0.52, 1.65]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>482</strong></td>
<td><strong>494</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
<td><strong>0.75 [0.60, 0.93]</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total events**: 110

Heterogeneity: $\tau^2 = 0.02$; $\chi^2 = 12.33$, df = 11 ($P = 0.34$); $I^2 = 11\%$

Test for overall effect: $Z = 2.56$ ($P = 0.01$)
Do not start in the setting of hemodynamic compromise or instability.

- Hypotensive (MAP < 50mm Hg)
- Vasopresors are being initiated
- Escalating doses of vasopressors are required for hemodynamic instability

EN may be started if vasopressor support is being withdrawn, but watch for abdominal distention, increased residuals or worsening metabolic acidosis or rising base deficit.
IS ENTERAL NUTRITION SAFE WITH HEMODYNAMIC INSTABILITY?

ESPIN

- Uncontrolled shock
- Uncontrolled hypoxemia and acidosis
- Uncontrolled UGI hemorrhage
- Gastric aspirate > 500cc/6hr
- Intestinal ischemia
- Intestinal obstruction
- Abdominal compartment syndrome
- High-output fistula without distal feeding access
GASTRIC RESIDUALS

• Gastric residuals should **NOT** be used as part of routine care.

• Residuals do **NOT** correlate with:
  • Pneumonia
  • Regurgitation
  • Aspiration

• If you must check, hold EN if gastric residual is > **500cc** in the absence of other signs of intolerance.

  **ASPEN**: Do not check residuals.
  **ESPEN**: Suggest hold EN if > 500cc/6hrs.
DAILY VOLUME GOAL
Nurse-Driven

• Use volume-based feeding protocols in which 24-hour daily volumes are targeted instead of simply hourly rates.

• This allows the RN to increase feeding rates to make up for lost volume.

EMPOWER THE NURSES!
Continue enteral nutrition until one hour prior to surgery on ventilated patients except for the following procedures (hold for 8 hours):

- Tracheostomy
- Laparotomy
- Spine surgery
- Oral maxillofacial procedures
- If patient will be placed in prone position
- Thoracotomy, especially if patient is to be placed in lateral position or if there is need to change to a double-lumen tube.
TUBE PLACEMENT

- CXR is the gold standard
- Capnometry is an adjunct
- Auscultation is of minimal value (dangerous)
DIARRHEA

- Do NOT stop enteral feeds.
  - If necessary, reduce rate.

- Review medication list (most likely source), including IV antibiotics.

- Rule-out infectious etiology (*C. diff*).

- Significant reduction in diarrhea with continuous vs. bolus feeding.

![Graph showing comparison of continuous vs. intermittent feeding in diarrhea reduction](image-url)
Help! My tube is clogged!

- Prevention is the best key
- Irrigate with ~25cc of water every 4-6 hrs and before & after Rxs.
- If clogged, do this:
  - Push back and forth with a 60cc syringe containing warm water.
  - If that does not work, let the warm water sit for ~20 minutes
- Sorry! Coke, Pepsi, Gingerale or meat tenderizer really do not work even though many think otherwise. Carbonation may make matters worse.
- Pancrease (Not enteric coated)
  - Viokase
TARGETED GLUCOSE RANGE

• SCCM: 150-180 mg/dl
• ASPEN: 140-180 mg/dl
• ESPEN: 150-180 mg/dl

Glucose > 200 is NOT OK!
Consider insulin drip
PERCUTANEOUS GASTROSTOMY PEARLS

• Literature supports use within 4 hours. No joke!
  • ASPEN: Yes
  • ESPEN: Yes

• Restart EN at same rate prior to stopping for procedure.

• If concern for patient pulling PEG out, place an abdominal binder.

• Don’t place bumper too tight to the skin.
OPEN GASTROSTOMY, G-J & J TUBES

- Moss tube
- MIC tube
- Foley
- Feeding jejunostomy tube

**Pearls**

- Always use water or saline for the balloon; NEVER use air.
- Can’t check residuals via a J-tube.
- If the tube fall out, immediately replace with a Foley catheter before tract closes.