Nutrition Support of Hospitalized Patients

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Dr. D. R. Duerksen
Associate Professor of Medicine
University of Manitoba
Objectives

- Know the prevalence of malnutrition.
- Understand optimal methods and limitations of nutrition assessment and rationale for timing of nutrition support.
- Know the benefits of enteral vs parenteral nutrition using acute pancreatitis as example
- Understand the influence of BMI on need for nutrition support
- Prevent complications of nutrition support
  - Refeeding syndrome
  - Hyperglycemia
Case

- 48 year old woman
  - Multiple medical problems
    - SLE – quiescent
    - Autoimmune hemolytic anemia – on prednisone
    - Seizure disorder
    - Bladder Ca
      - Cystectomy and ileal conduit 6 months ago
    - Hx of DVT/PE – on warfarin
Case

- Admitted with leg cellulitis
  - Started on IV antibiotics
- Significant weight loss over the past 6 months
  - UBWt 75 kg    admitting wt 63 kg
    - Nausea since surgery, poor appetite
    - Recurrent intermittent emesis
Case

- Labs
- Hb 118  WBC 16  L shift
- Lytes – normal
- Urea 16  Cr 231
- Albumin 18
- LFTs normal
Question

- What is the best way to assess nutrition status?
- When should nutrition support be started?
- How should nutrition support be started?
Nutrition Assessment

- What is the best method of nutritional assessment?
Nutrition Assessment

- Subjective Global Assessment
  - Nutrition assessment based on Hx and Px
  - Validated to be reproducible and predictive of hospital associated morbidity.
  - Originally validated in patients undergoing elective surgery.
  - JAMA physical exam series.
Subjective Global Assessment

A. History
1. Weight change
   Overall weight loss in past 6 months: kg ____________%
   Change in past 2 weeks:
   Increase
   No change
   Decrease

2. Dietary intake change (relative to normal)
   No change.
   Change ________ type:
   duration = # ________ weeks.
   suboptimal solid diet.
   hypocaloric liquids.
   full liquid diet.
   starvation.

3. Gastrointestinal symptoms (that persisted for > 2 weeks)
   ________ none, ________ nausea, ________ vomiting, ________ diarrhea,

4. Functional capacity
   ________ No dysfunction (e.g., full capacity)
   Dysfunction ________ duration = # ________ weeks.
   type: ________ working suboptimally
   ambulatory
   bedridden.

5. Disease and its relation to nutritional requirements
   Primary diagnosis (specify) ________
   Metabolic demand (stress): ________ no stress, ________ low stress,
   ________ moderate stress ________ high stress.

B. Physical (for each trait specify: O = normal, 1+ = mild or moderate, 2+ = severe).
   ________ loss of subcutaneous fat (triceps, chest)
   ________ muscle wasting (quadriiceps, deltoids)
   ________ edema
   ________ sacral edema.
   ________ ascites

SGA rating (select one)
   ________ A = Well nourished
   ________ B = Moderately malnourished
   C = Severely malnourished
SGA Rating

_____ A = Well Nourished
_____ B = Moderately Malnourished
_____ C = Severely Malnourished
Classification In SGA

A. Well Nourished

No history or physical findings associated with malnutrition.

Improving findings of malnutrition.
How to Perform an SGA

B. Moderately Malnourished

Weight Loss

5-10 % of usual body weight unintentional weight loss.

Physical Exam

Mild signs of malnutrition on physical exam.
How to Perform an SGA

C. Severely Malnourished

Weight Loss

>10 % of usual body weight
unintentional weight loss.

Physical Exam

Severe signs of malnutrition on physical exam.
Case

- SGA - C
How useful is serum albumin as a measure of nutrition status?
# Visceral Proteins

<table>
<thead>
<tr>
<th>PROTEIN</th>
<th>HALF LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>14-20 days</td>
</tr>
<tr>
<td>Transferrin</td>
<td>8-10 days</td>
</tr>
<tr>
<td>Prealbumin</td>
<td>2-3 days</td>
</tr>
<tr>
<td>Retinol Binding</td>
<td>12 hours</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
</tr>
</tbody>
</table>
Distribution of Albumin

- Total body pool of albumin ~ 350 grams
- 40% intravascular
- 60% extravascular (most in the skin)
- ~14 grams (4%) of albumin is produced and degraded daily.
- Liver can produce 2-3x this amount.
- There is an equilibration between intravascular and extravascular albumin.
Acute Phase Response

- Metabolic and immune response to host injury (trauma, infectious, autoimmune).
  - Increased adrenalin, cortisol, glucagon
  - Cytokines: IL1, IL6, TNF
  - Increased WBC
- Increase in acute phase response proteins
  - Antibodies, complement, CRP, fibrinogen
Negative Acute Phase Reactants

- Albumin
- Prealbumin
- Transferrin
- Retinol Binding Protein
Albumin and the ‘Stressed State’

- Albumin levels fall for the following reasons:
  - Decreased synthesis.
  - Increased breakdown.
  - A large shift in the albumin exchange from the intravascular to the extravascular compartment.
    - due to increased vascular permeability.
A 35 year old woman with a refractory eating disorder is admitted to hospital with weight loss. Height 5’2” Weight 29 kg BMI 11.7 kg/m²

On physical examination she has significant muscle wasting. She is not dehydrated.

Her albumin is
a) 12    b) 22    c) 31    d) 38
Case

A 65 year old man is admitted to hospital with a severe pneumonia and pneumoccal septicemia. Because of respiratory failure and septic shock, he is admitted to the intensive care unit. Prior to his hospitalization, he was well and had not lost any weight. His labs on ICU Day # 2 are:

- Albumin 34 Prealbumin .20
- Albumin 19 Prealbumin .20
- Albumin 19 Prealbumin .05
- Albumin 19 Prealbumin .20
What is the prevalence of malnutrition in hospitalized patients?
Prevalence of Malnutrition in Hospitalized Patients

- Hospitalized General Medical Patients
  - 40-65% prevalence of malnutrition
    - Weinsier AJCN 1979; Nabor AJCN 1997; Singh Nutrition 2005

- Hospitalized General Surgical Patients
  - ~50% prevalence of malnutrition

- The prevalence of malnutrition of hospitalized patients has not changed in the past 30 years.
Prevalence of Malnutrition

- St. Boniface General Hospital
  - 68 medical patients
  - SGA-A  Well nourished  31%
  - SGA-B  Moderately malnourished  39%
  - SGA-C  Severely malnourished  30%
Some hospitals in Canada perform nutrition screening on admitted patients to determine who is most ‘at risk’.

**MUST tool**
- BMI (< 20)
- Unintentional weight loss (> 5 %)
- Acute disease (no intake > 5 d)
Nutrition Risk of Hospitalized Patients

- MUST

4 community hospitals in Winnipeg

- Medicine Patients – 45 % ‘at risk’
- Surgical Patients – 22.5 % ‘at risk’
When should nutrition support be started in hospitalized patients?

- When would you start 48 y.o. with cellulitis?
Case

- A 63 year old man undergoes an anterior resection for rectal cancer. He had not lost any weight prior to surgery and has no other medical problems.

- He develops a post operative ileus.

- When would you start post op nutrition support?
  
a) day 3  b) day 5  c) day 7  d) day 10  e) day 14
A 72 year old man is admitted with dyspnea and a community acquired pneumonia.

She has a history of Parkinson’s disease and has a gradual increase in difficulty with swallowing.

She has lost ~ 10 kg over past 6 months (usual wt 84 kg). Calorie counts on the 3rd hospital day show she is ingesting ~ 500-600 kcal/day. She has moderately severe muscle wasting.

When would you intervene nutritionally?
  a) Day 3  b) Day 5  c) Day 7  d) Day 10  e) Day 14
Timing of nutrition support

- There are no randomized controlled studies that answer this question.
  - Recommendations are based on extrapolation of physiology/clinical observations
Timing of Nutritional Support

- ASPEN GUIDELINES 2001
  - Death from protein energy malnutrition occurs within 60-70 days of total starvation in normal weight adults.
  - Functional deficits are evident in normal weight adults who voluntarily restrict food for \( \sim 15 \) days.
  - Critically ill patients are catabolic and depletion of nutrient stores occurs more rapidly.
Timing of Nutritional Support

- ASPEN GUIDELINES
  - Total starvation for < 2-3 days results mainly in glycogen and water losses.
  - Most investigators consider 7 days of limited nutrient intake the limit before nutritional support is initiated.
  - The baseline nutritional status and degree of physiologic stress influences the length of time patients are observed before nutrition support is initiated.
Timing of Nutritional Support

- Factors that influence decision to initiate nutrition support
  - Length of time NPO/inadequate oral intake.
  - Baseline Nutritional Status
  - Catabolic Stress.
  - Estimation of the recovery time of GI tract.
Timing of Nutritional Support

In hospitalized patients with mild metabolic stress:

- Severely malnourished patient
  - Initiate nutritional support within 2-3 days

- Mildly malnourished patient
  - Initiate nutritional support in ~ 5-7 days

- Patient not malnourished
  - Initiate nutritional support in 7-10 days
Case

- 34 year old woman with Crohn’s disease and ileal stricture refractory to medical therapy. She has lost ~ 5% usual body weight over the past 2 months.
- She is scheduled for surgery and ileal resection.

Should she receive preoperative nutrition support?
Relevance of baseline nutrition status to starting nutrition support

- Nutritional Assessment is important in predicting patients appropriate for pre-operative nutritional support.
Pre-Operative TPN

- 395 Patients
- Multi-Center Study
- Randomized to pre-operative TPN for 7-10 days or no support.
- Pre-operative Nutritional Assessment
  - SGA
  - Nutrition Risk Index
Nutritional Risk Index

NRI = (1.489 x serum albumin (g/L)) + 41.7 x (present weight/usual weight)

Interpretation

> 100 not malnourished
97.5-100 mild malnutrition
83.5-97.5 moderate malnutrition
<83.5 severe malnutrition
# Pre-op VA Study - Results

<table>
<thead>
<tr>
<th></th>
<th>TPN (192)</th>
<th>Control (203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRI</td>
<td>92.3</td>
<td>93.8</td>
</tr>
<tr>
<td>SGA borderline</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>SGA Mild</td>
<td>62</td>
<td>53</td>
</tr>
<tr>
<td>SGA Severe</td>
<td>15</td>
<td>9</td>
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### Major Infectious Complications

<table>
<thead>
<tr>
<th></th>
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<th>Mild</th>
<th>Severe</th>
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<tbody>
<tr>
<td>TPN</td>
<td>12.2</td>
<td>15.2</td>
<td>12.9</td>
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<tr>
<td>Control</td>
<td>4.0</td>
<td>6.6</td>
<td>10.5</td>
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</table>
## Major Non-Infectious Complications

<table>
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<tr>
<th></th>
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<th>Mild</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPN</td>
<td>14.3</td>
<td>16.1</td>
<td>22.6</td>
</tr>
<tr>
<td>Control</td>
<td>16.0</td>
<td>22.6</td>
<td>42.1</td>
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</table>
# Preoperative TPN

**NEJM, 1991**

<table>
<thead>
<tr>
<th>Total Patients</th>
<th>Glucose (%)</th>
<th>Infections (%)</th>
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</thead>
<tbody>
<tr>
<td>TPN 192</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Control 203</td>
<td>1.5</td>
<td>6.4</td>
</tr>
</tbody>
</table>
Timing of Nutrition Support

- Is early nutrition support (within 24-48 h of admission) associated with improved outcomes?
Timing of Nutrition Support

- Conditions for which there is evidence of improved outcome with early nutrition support
  - Trauma (critically ill)
  - Burns
  - Acute Pancreatitis
  - Upper GI tract surgery
Case

- 23 year old woman
  - PMHx
    - Obesity
    - 2 pregnancies, 1 stillbirth
    - Biliary Colic
      - Mild increase in LFTs
      - U/S – gallstones, mildly dilated CBD
Case

- ERCP
  - Sphincterotomy
    - Removal of small CBD stone
  
  - Post procedure (1 hour)
    - Abdominal pain
    - Given morphine
      - Pain settled and patient discharged home
Case

- 12 hours later came to ER with abdominal pain, N+V
  - Na 137, K 4.5, Cl 101, TCO2 17
  - Urea 8.7, Cr 79, Glucose 19.4
  - Lipase 1792

- Admitted to medical ward
Case

- Day 2 Post ERCP
  - TCO2 15
  - Respiratory Failure
    - Transferred to ICM
      - Intubated
      - NG tube – 1.5 liters over 24 h
  - CT Scan Abdomen
    - Bilateral pleural effusions
    - Extensive pancreatic necrosis
    - Ascites
- Abdomen
  - Distended ++
  - Active bowel sounds
  - No BM in first 24 h ICM

- Usual Body Weight – 104 kg
- Day 3 post admission – 117 kg
- Height – 168 cm
<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 5</th>
<th>Day 7</th>
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<tbody>
<tr>
<td>Alb</td>
<td>36</td>
<td>29</td>
<td>21</td>
<td>18</td>
<td>16</td>
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<tr>
<td>Lipase</td>
<td>2240</td>
<td>1698</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Gluc</td>
<td>19.4</td>
<td>18.1</td>
<td>21.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hb</td>
<td>158</td>
<td>129</td>
<td>115</td>
<td></td>
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</table>
When would you initiate nutrition support?

Should this be provided enterally or parenterally?
Benefits of Enteral Nutrition

- Maintain gut function and mass
- Maintain gut integrity
- Maintain splanchnic blood flow
- Improve immunocompetence
- Blunt hypermetabolism
- Maintain normal gut flora
- Improve substrate utilization
- Reduce cost, complications
Benefits of Enteral Nutrition

- Diseases for which there is clinical evidence for benefits of enteral nutrition
  - Burns
  - Trauma
  - Pancreatitis

- Physiologic Benefits
  - Blunt hypermetabolism
  - Improve immunocompetence
Meta-analysis of PN vs EN in patients with acute pancreatitis

- 6 studies; 263 participants
- EN decreased infections
  - .45 (.26-.78)
- EN reduced LOS
  - Mean reduction 2.9 days
- No significant differences in mortality or non-infectious complications.

Marik BMJ 2004
Effect of enteral nutrition on pancreatitis
Case

- Patient started on EN on Day 3
  - SBFT, Elemental formula
  - By day 6 up to 55 cc/h 1.5 kcal/cc
    - Extra protein (120 g/day)
  - Tolerated well
    - Has been on EN for past 2 weeks
    - Still ventilated in ICU
Are there hospitalized patients who are at increased nutritional risk?

- Obese? Low BMI?
Effect of obesity on intensive care morbidity and mortality: A meta-analysis

- Obese (BMI > 30) vs Non obese (BMI < 30)
- 14 studies inclusion criteria, 15,347 patients

Akinnusi et al CCM 2008
Obesity and Critically Ill

Results

- Intensive care unit mortality
  - No difference overall
- Duration of mechanical ventilation
  - Longer in obese – 1.48 days
- Intensive care unit stay
  - Longer in obese – 1.08 days
Subgroup analysis

- Increased in-hospital mortality in non-obese
- Increase mortality in non-obese vs obese (BMI 30-39)
- No difference in mortality between obese and morbid obese (BMI > 40)
International point prevalence survey of nutrition therapies in ICUs

- 5 continents, 2902 mechanically ventilated patients, in ICU for at least 72 h
  - At least 3 days of nutrition support
  - Mean nutrition therapy (EN and PN) over max of 12 days
## Nutrition Support, Obesity and Critically Ill

<table>
<thead>
<tr>
<th>BMI (range)</th>
<th>&lt;20</th>
<th>20&lt;25</th>
<th>25&lt;30</th>
<th>30&lt;40</th>
<th>&gt;40</th>
<th>27.5 (12.5-102)</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>301</td>
<td>983</td>
<td>854</td>
<td>584</td>
<td>180</td>
<td>2902</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>50.8</td>
<td>65.9</td>
<td>79.7</td>
<td>94.9</td>
<td>135.1</td>
<td>78.5 (30.0-310.5)</td>
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<tr>
<td>Mortality % (60 days)</td>
<td>35.8</td>
<td>30.5</td>
<td>28.2</td>
<td>25.8</td>
<td>28.9</td>
<td>29.3</td>
</tr>
<tr>
<td>Energy Received (Kcal) Kcal/kg</td>
<td>888</td>
<td>874</td>
<td>932</td>
<td>867</td>
<td>940</td>
<td>895</td>
</tr>
<tr>
<td></td>
<td>17.7</td>
<td>13.4</td>
<td>11.7</td>
<td>9.2</td>
<td>7.3</td>
<td>12.1</td>
</tr>
<tr>
<td>Protein Received (g) g/kg</td>
<td>39.8</td>
<td>39</td>
<td>40.8</td>
<td>39.7</td>
<td>42.7</td>
<td>40</td>
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<tr>
<td></td>
<td>0.8</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
<td>0.5</td>
</tr>
</tbody>
</table>
## Nutrition Support, Obesity and Critically Ill

<table>
<thead>
<tr>
<th>Energy Prescribed (Kcal) Kcal/kg</th>
<th>1564</th>
<th>1722</th>
<th>1896</th>
<th>1857</th>
<th>1942</th>
<th>1798</th>
<th>&lt;0.0001</th>
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<tbody>
<tr>
<td></td>
<td>31.0</td>
<td>26.2</td>
<td>23.9</td>
<td>19.6</td>
<td>15.3</td>
<td>24</td>
<td>&lt;0.0001</td>
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</table>

<table>
<thead>
<tr>
<th>Protein Prescribed (g) g/kg</th>
<th>70</th>
<th>81.4</th>
<th>91.2</th>
<th>95.2</th>
<th>102.1</th>
<th>87.2</th>
<th>&lt;0.0001</th>
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<tbody>
<tr>
<td></td>
<td>1.4</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
<td>0.8</td>
<td>1.2</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Morning Blood Glucose (mmol/l)</th>
<th>7.2</th>
<th>7.2</th>
<th>7.3</th>
<th>7.6</th>
<th>7.5</th>
<th>7.3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin Received/kg (units/kg)</td>
<td>0.63</td>
<td>0.62</td>
<td>0.62</td>
<td>0.61</td>
<td>0.62</td>
<td>0.62</td>
<td>0.998</td>
</tr>
</tbody>
</table>
Summary

- In this point prevalence study, average nutrition therapy was significantly lower than what is frequently prescribed.
- Nutrition support (calories and protein) appears to be most important in underweight critically ill patients.

Prospective studies are needed to define optimal ‘dose’ of nutrition support.
What are the complications of nutrition support?
Refeeding Syndrome

- Physiology of Starved Individual
  - decreased insulin secretion
  - increased insulin sensitivity
  - loss of lean body mass
  - loss of cardiac muscle mass
  - hypometabolic
  - avid sodium and water retention
Pathophysiology of Refeeding Syndrome

- CHO
  - stimulates insulin
    - cellular shifts of K, Mg, PO4
  - stimulates anabolic response
    - cellular shifts of K, Mg, PO4
  - sympathetic nervous system stimulated
  - Avid sodium retention
    - precipitate CHF
    - precipitate arrhythmias (with electrolyte disturbances)
  - relative thiamine deficiency
Morbidity of Refeeding Syndrome

- **Hypophosphatemia**
  - paralysis, confusion, lethargy, CHF, arrhythmias, hemolytic anemia, resp. failure.

- **Hypokalemia**
  - as above. Constipation, ileus, polyuria, polydipsia

- **Hypomagnesemia**
  - as above. Abdominal pain, diarrhea, constipation

- **Hyperglycemia**

- **Thiamine Deficiency**
Refeeding Syndrome

- Fatal Outcomes Have Been Reported
  - case 1 - 500 grams of dextrose over 24 h.
  - case 2 - 750 grams of dextrose over 24 h.

Weinsier et al AJCN 1981
Mortality Related to Refeeding
(Weinsier et al AJCN 1981)

Clinical Findings:
- Chest pain
- ST segment on EKG
- Hypotension
- Arrhythmias
- ARDS

Blood Glucose (mg/dl):
- Admission: 100
- Peak: 700
- 9/19: 300
- 9/20: 100

Serum Phosphorus (mg/dl):
- Admission: 3.0
- Peak: 5.0
- 9/19: 4.0
- 9/20: 2.0

TPN Glucose Infusion (g/m/24h):
- 8/18: 500
- 8/19: 250
- 8/20: 150
- 8/21: 250

28 y.o. WF
Wt.: 23 kg
40% IBW
Dx: Malabsorption Syndrome
Died 9/9:
Cardiopulmonary failure
Management of Refeeding Syndrome

- Identify patient at risk
  - any patient with significant weight loss
    - > 10% of body weight
    - fasting for >10-14 days with moderate stress
  - occurs with any modality of feeding - enteral or parenteral.
  - occurs in renal failure patients as well.
Management of Refeeding Syndrome

- Limit initial dextrose to 1.5-2 g/kg.
  - Don’t increase dextrose until K, PO4, Mg stable
- Even if serum levels normal, supplement K, PO4, Mg.
- Limit initial sodium infusion to 40-80 mmol/d and fluid to 1-1.5 L/day
- Monitor blood levels of K, Glu, PO4, Mg daily
- In severe risk, supplemental thiamine.
Hyperglycemia

Clinical Studies give indirect evidence that hyperglycemia may be related to increased susceptibility to infection.

- Pre-op TPN (Buzby, NEJM 1991)
- Enteral vs Parenteral (Moore, Ann Surg 1992)
- TPN in Acute Pancreatitis (Grant, WJ Surg 1994)
Glucose control and the Inflammatory Response

- Hyperglycemia impairs host defence
  - Neutrophil activity
    - Decreased chemotaxis
    - Decreased phagocytosis
    - Decreased bacterial killing
Glucose control and the Inflammatory Response

- Hyperglycemia causes a pro-inflammatory state
  - Increases NF$_{κ}$B
  - Increases reactive oxygen species
Hyperglycemia and Dextrose Infusion

<table>
<thead>
<tr>
<th>Rosmarin NCP 1996</th>
<th>4.0 mg/kg/min</th>
<th>4.1-5.0 mg/kg/min</th>
<th>&gt;5.0 mg/kg/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ Glucose</td>
<td>0</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>N Glucose</td>
<td>19</td>
<td>41</td>
<td>19</td>
</tr>
</tbody>
</table>
Glucose Control in ICUs

- Intensive (80-110) vs Conventional (>215) Glucose Control
  - Vandenberg (surgical)* mortality benefit
  - Vandendenberg (medical)
  - Brunkhorst
  - Nice Sugar * mortality risk

Need to balance risk of hypoglycemia with tight glycemic control
Hyperglycemia and TPN

- Increase dextrose slowly
  - Start with 100-150 g/day
- Use insulin if glucose > 9-10.
  - As infusion; may be added to TPN
- Limit total dextrose to 4-6 g/kg/24h