Are we creating survivors... or Victims?

Can We Change the Future By Optimizing Nutrition in ICU?

Paul Wischmeyer M.D., E.D.I.C.
Professor of Anesthesiology and Pediatrics
Associate Chair, Clinical and Translational Research
Director, Nutrition Therapy Service
University of Colorado School of Medicine
Mortality Related to Severe Sepsis and Septic Shock Among Critically Ill Patients in Australia and New Zealand, 2000-2012

Kirsi-Maija Kaukonen, MD, PhD, EDIC; Michael Bailey, PhD; Satoshi Suzuki, MD; David Pilcher, FCICM; Rinaldo Bellomo, MD, PhD

JAMA, Online March 18, 2014.

ICU Mortality

Decreasing

...over last 10 years!
In Critical Care...

Are We Winning Many Battles?

And...Losing the War!!
PYRRHIC VICTORY
Sometimes, success leads to tragedy
Pyrrhus of Epirus
Although Sepsis Deaths Fall By Half...
...Many More Patients to Rehab!
Improved Hospital Survival...But...

How many survive even a year?

JAMA, Online March 18, 2014
At 1 year following ICU admit...

What percentage of deaths occur after pts are “recovered” and discharged from ICU?

A. < 5%
B. 10%
C. 20%
D. 30%
E. > 40%
> 40% of Mortality at 12 Month Follow-up Occurs Post-ICU Discharge

Shiell AM, Griffiths RD et al Clinical Intensive Care 1990;1 (6): 256-262
Mortality Related to Severe Sepsis and Septic Shock Among Critically Ill Patients in Australia and New Zealand, 2000-2012

Kirsi-Maija Kaukonen, MD, PhD; Michael Bailey, PhD; Satoshi Suzuki, MD; David Pilcher, FCICM; Rinaldo Bellomo, MD, PhD

“Given low ICU mortality…

Quality of Life

…will become focus of future trials”
“Are we creating survivors... or Victims?”
What Do Our Patients Think About Their Quality of Life?
Melissa M. - 58 y.o Female with 3 d Hx of Influenza...
Evolves ARDS...
In ICU 3 weeks...

Acute Lung Injury / ARDS
• American-European consensus definition:
  – Acute onset after 'at risk' dx
  – Bilateral infiltrates on CXR
  – \( \text{PaO}_2 / \text{FiO}_2 \leq 300 \) (ALI)
  – \( \text{PaO}_2 / \text{FiO}_2 \leq 300 \) (ARDS)
  – \( \text{PaO}_2 / \text{FiO}_2 \leq 200 \)
  – No left atrial hypertension
• No evidence of CHF, or...
  – \( \text{P WEDGE} \leq 18 \text{ mm Hg} \)

58 yo with ARDS...

Tolerates 50% of EN goal

14 d Caloric Debt = ~20,000 kCals

Protein Delivery - 0.60 g/kg/d
58 yo with ARDS...

PN Never Started! (Admit BMI: 30)

Massive loss of lean muscle mass

Difficult to ween from ventilator-
Requires Trach...
58 yo with ARDS...

Discharged from ICU **23 days** post-admit to long term care unit...
Was she a success?
Is Quality of Life Where We Are Losing The ICU War?
We Must Be Winning MOST Battles in ICU... Right??
ICU Survivorship

Iwashyna  *Annals of Int Med* 2010; 153:204-5

Courtesy: Wes Ely M.D.
One-Year Outcomes in Survivors of the Acute Respiratory Distress Syndrome

Margaret S. Herridge, M.D., M.P.H., Angela M. Cheung, M.D., Ph.D., Catherine M. Tansey, M.Sc., Andrea Matte-Martyn, B.Sc., Natalia Diaz-Granados, B.Sc., Fatma Al-Saidi, M.D., Andrew B. Cooper, M.D., Cameron B. Guest, M.D., C. David Mazer, M.D., Sangeeta Mehta, M.D., Thomas E. Stewart, M.D., Aiala Barr, Ph.D., Deborah Cook, M.D., and Arthur S. Slutsky, M.D., for the Canadian Critical Care Trials Group
Physical Role Score (SF-36) Following ICU Discharge

<table>
<thead>
<tr>
<th>Time</th>
<th>Physical Role Score (Med)</th>
<th>Normal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
Post-Intensive Care Weakness Survivors....or VICTIMS??

50% pts Not Back At Work At 1 yr

33% pts Never Return To Work (including young pts)
Impaired QOL persists 5 years post-ICU
60-80% Functionally Impaired

Courtesy: Wes Ely M.D.
This is an EPIDEMIC
What Can We Do?...
...to start winning this war?
Why Are We Losing the Quality of Life War?
Critically Ill Patients Can Lose As Much As 1 kg of Lean Body Mass Daily!

Loss of lean body mass accelerates in critical illness

Weight change from pre-ICU status

Not Lean Mass Gain!.. Mostly Fat!
What can be done to end this epidemic?
POST-ICU Quality of Life...

Easy as ABC...
For Post-ICU QOL

**Awake and Breathing**
- Trial Daily

**Choose light sedation & avoid benzos**

**Delirium Monitoring & Management**

**Early Mobility & Exercise**

**Goal Directed Feeding & Early Adequate Protein**

**Gain Function & Grow Muscle**
Could This Be Due To Protein/Calorie Malnutrition?...

While in ICU/Hospital?...

Probably..
Nutrition must be the complete package...
Carbohydrate, Lipid, Electrolytes, Trace Elements, Protein
International ICU Nutrition Survey
We Underfeed For 2 Weeks...
When We Underfeed Enteral Calories...

We Massively Underfeed Protein!
Average Protein Delivery

0.6 g/kg/d

for 2 weeks in ICU!

Guideline Protein: 1.2-2.0 g/kg/d
Energy Expenditure and Protein Requirements

Fürst P, Protein and amino acid metabolism: Composition of stressed and nonstressed states, In Cresci G (ed), Nutrition support for the critically ill patient, Taylor & Francis (CRC), Boca Raton, 2005 pg 29
Protein Delivery
(1.2-2.0 g/kg/day)
Optimizing energy and protein balance in the ICU

Peter J.M. Weijs\textsuperscript{a,b,c,d} and Paul E. Wischmeyer\textsuperscript{e}

Curr Opin Clin Nutr Metab Care 2013, 16:194–201

NO Benefit in Trials Giving

$< 1.0 \text{ g/kg/d}$ Protein

Such As: EPaNIC Trial
EDEN Trial
Arabi et al Trial
Optimizing energy and protein balance in the ICU

Peter J.M. Weijsa,b,c,d and Paul E. Wischmeyer e

Curr Opin Clin Nutr Metab Care 2013, 16:194–201

ALL Trials

> 1.0 g/kg/d

Protein Show Benefit!

Such As:

Early PN Trial, JAMA 2013
Swiss PN Trial, Lancet 2013
TICACOS Trial, ICM 2011
Optimizing energy and protein balance in the ICU

Peter J.M. Weijs\textsuperscript{a,b,c,d} and Paul E. Wischmeyer\textsuperscript{e}

Curr Opin Clin Nutr Metab Care 2013, 16:194–201

Protein is Most Vital Nutrient In ICU!

ESEPN and ASPEN Guidelines: Recommend: 1.2–2.0 g/kg/d
Extra-Protein Reduces Mortality!

Every additional 30 g/d protein given... Mortality decreased!

Alberda, C, Heyland D et al
Intensive Care Med. 35:1728-37. 2009
Has this already been shown in a multi-center RCT?
Trial of Omega-3 Fatty acid, Gamma-linolenic Acid and Antioxidant Supplementation in the Management of Acute Lung Injury (Omega)

Todd Rice, MD, MSc
Co-chair: NIH NHLBI EDEN-OMEGA
NHLBI ARDS Network of Investigators
Division of Allergy, Pulmonary and Critical Care
Vanderbilt University
OMEGA: 60-Day Mortality

- Omega: 26.6%
- Control: 16.3%
- FACTT conservative: 25.5%

P = 0.05
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>N-3/A-O Suppl (120mL)</th>
<th>Control (120mL)</th>
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<tbody>
<tr>
<td>Energy, cal</td>
<td>240</td>
<td>237</td>
</tr>
<tr>
<td>Osmolarity, kCal / mL</td>
<td>2.04</td>
<td>2.01</td>
</tr>
<tr>
<td>Protein, g</td>
<td>1.9</td>
<td>10</td>
</tr>
<tr>
<td>Carbohydrate, g</td>
<td>2.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Fat, g</td>
<td>22.3</td>
<td>11</td>
</tr>
<tr>
<td>EPA, g</td>
<td>3.42</td>
<td>0</td>
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<tr>
<td>DHA, g</td>
<td>1.70</td>
<td>0</td>
</tr>
<tr>
<td>GLA, g</td>
<td>2.96</td>
<td>0</td>
</tr>
<tr>
<td>Vitamin C, mg</td>
<td>500</td>
<td>38</td>
</tr>
<tr>
<td>All-natural Vitamin E, IU</td>
<td>220</td>
<td>6</td>
</tr>
<tr>
<td>B-carotene, mg</td>
<td>2.4</td>
<td>0</td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>12.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Selenium, ug</td>
<td>42.6</td>
<td>9</td>
</tr>
<tr>
<td>L-carnitine, mg</td>
<td>90</td>
<td>19</td>
</tr>
<tr>
<td>Taurine, mg</td>
<td>175</td>
<td>19</td>
</tr>
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</table>

Daily dosage = 2 Modules
Did 5 x Protein Reduce Mortality in Large RCT?
Increased Protein Delivery Reduces Risk of Death in ICU

- High protein & AA: 1.46 g/kg/d protein
- Medium protein & AA: 1.06 g/kg/d protein
- Low protein & AA: 0.80 g/kg/d protein

Log-rank test for trend: P < 0.01

Clinical Nutrition: 31; 462-468, 2012
The Problem is Kcal and Protein Delivery Are Linked...

What Happens When You Separate Them?
Clinical Outcomes Related to Protein Delivery in a Critically Ill Population: A Multicenter, Multinational Observation Study

Michele Nicolo, MS, RD, CNSC; Daren K. Heyland, MD, MSc, FRCPC; Jesse Chittams, MS; Therese Sammarco, BA; and Charlene Compher, PhD, RD, CNSC, LDN, FADA, FASPEN

Only > 80% of Protein Goals Reduces 60 d Mortality--(Not Reaching Energy Goals)
Independent of Energy Intake!
Optimizing energy and protein balance in the ICU

Peter J.M. Weijs a,b,c,d and Paul E. Wischmeyer e

Curr Opin Clin Nutr Metab Care 2013, 16:194–201

Protein is Most Vital Nutrient In ICU!

ESEPN and ASPEN Guidelines:
Recommend: 1.2-2.0 g/kg/d
“Are we creating survivors... or Victims?”
Can Early Protein/Calories Improve Quality of Life?
“Come Strong or Don’t Come At All”
Early PN Reduces Muscle Wasting in ICU

Legend: P-values from fully factorial repeated measures ANOVA: $p < 0.0001$ change over time, $p = 0.014$ difference between groups (0.16 grade per week). Grey shaded area represents test based 95% confidence interval from fully factorial repeated measures ANOVA analysis between groups. ICU: Intensive Care Unit. PN: parenteral nutrition.

Doig et al JAMA, Online: May, 2013
Improved Protein and Kcal Delivery in 1st ICU Week Improves Survival in Hi-Risk Pts

N= 475 Pts on Ventilator > 8 Days

Wie, Heyland et al. Crit Care Med, Online April, 2015
## Subgroup Analysis of the Effect of Nutritional Adequacy on SF-36 scores

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<td>142</td>
<td>2.5 (0.2, 4.9)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

N= 475 Pts on Ventilator > 8 Days

Wie, Heyland et al. Crit Care Med, Online April, 2015
“7.8 point change in Physical Function (PF) score is meaningful change in QoL*...”

Thus... for every 25% increase in kcals/d delivered a clinically meaningful change in QoL occurs...

*ANZICs Trials Group, BMJ open 2014;4(5):e004966
How you feed in the 1st week in ICU...

Changes Pts QoL Months Later!!

Wie, Heyland et al. Crit Care Med, Online April, 2015
**Increased Protein Improves Physical Function Post-ICU!**

**REDOX STUDY**
First 364 pts w/ SF-36 Score at 3 m

<table>
<thead>
<tr>
<th></th>
<th>Model Estimate (CI)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>(B) Increased protein intake (30 g/d)</strong></td>
<td></td>
</tr>
<tr>
<td>PHYSICAL FUNCTIONING (PF) at 3 m</td>
<td>2.9 (-0.7, 6.6)</td>
<td>P=0.11</td>
</tr>
<tr>
<td>ROLE PHYSICAL (RP) at 3 m</td>
<td>4.4 (0.7, 8.1)</td>
<td>P=0.02</td>
</tr>
<tr>
<td>STD PHYSICAL COMPONENT SCALE (PCS) at 3 m</td>
<td>1.9 (0.5, 3.2)</td>
<td>P=0.007</td>
</tr>
</tbody>
</table>

Presented at ASPEN, 2014
Promote Protein Provision!

...and good nutrition will follow...?
We All Underfeed Protein Enterally!!
Supplement PN Early in At-risk Patients?!?

Failing EN at 2-3 d?
All Malnourished!
How Do We Put This Data Into Practice?

And what do new ASPEN/SCCM Guidelines say?
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...

Peritonitis and SIRS in ED...
Nutritional Status

BMI 23, Weight 50 kg

Weight: Lost 6 kg over last month due to frequent “belly ache”

Albumen - 2.2
Past Medical History

- Hypertension
- Type II Diabetes
- Mild CHF
- Significant Peripheral Vascular Disease
Nutritional Evaluation?
Which factor is Most sensitive for evaluating pt’s acute nutritional risk in ICU or hospital?

A. BMI  
B. Albumin  
C. Risk for poor PO intake over week  
D. > 10% recent weight loss  
E. Pre-Albumin
Which factor is Most sensitive for evaluating pt’s acute nutritional risk in ICU or hospital?

A. BMI
B. Albumin
C. Risk for poor PO intake over week
D. > 10% recent weight loss
E. Pre-Albumin
Definition of Malnutrition

Loss of >10% of USUAL body weight
Problem of Surgical Malnutrition
65% Pts Undergoing GI Surgery are Malnourished
Low Pre-Op Albumin Predicts Mortality in Surgery!

1.5 million patient NSQIP database can’t be wrong...
Complications from GI Oncology Surgery

>70% of malnourished pts have complications

Curr Opin in Anesthes, 24; 2011
<table>
<thead>
<tr>
<th>Variable</th>
<th>All patients</th>
<th>Age 18-69</th>
<th>Age 70+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funct. Status</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ASA class</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dissem. CA</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Albumen &lt; 3.5</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Sepsis</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>DNR Order</td>
<td>6</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>BMI</td>
<td>7</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Creat&gt;1.2</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>WorkRVU</td>
<td>9</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Ascites</td>
<td>10</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Courtesy of C. Gajdos and UCH SOARES grp
Nutritional Status

Only Modifiable Risk Factor!

We Can Effect Pre-Operatively to Reduce Mortality...
Michelle W. - 63 yr. old with Diverticulitis for colonic resection...

Albumen 2.2  >10% wght loss in 1 m
Michelle W. - 63 yr. old with Diverticulitis for colonic resection...

Should we cancel surgery?
Michelle W. - 63 yr. old with Diverticulitis for colonic resection...

Give Pre-op Nutrition x 1 wk?
Michelle W. - 63 yr. old with Diverticulitis for colonic resection...

Unfortunately Pre-Op Nutrition Not Given...
ESPEN Surgical Guidelines
Malnourished Patients

7-14 d of pre-op EN
(Grade A)

EN not tolerated:
7-10 d preop TPN
(Grade A)
Post-Op Day 1 Patient is in SICU awake and alert

Should she be fed?
Question

After GI Surgery, patients have reduced **Mortality** with initiation of feeding on post-op day 1?

A. True

B. False
Question

After GI Surgery, patients have reduced **Mortality** with initiation of feeding on post-op day 1? 

A. True

B. False
Early Feeding In GI Surgery

Cochrane Review
Early vs Late Post-OP Nutrition

No Difference In:
- Pnemonia
- Wound dehiscence
- Vomiting

Early Feeding Reduces Death In GI Surgery

Do I need to tell you anymore ??

This works !
What is the Optimal Nutrition Assessment Technique in Post-Op ICU Patients?

A. BMI
B. Albumin
C. NRS Score
D. Nutric Score
E. C and D
F. All of the Above
What is the Optimal Nutrition Assessment Technique in Post-Op ICU Patients?

A. BMI
B. Albumin
C. NRS Score
D. Nutric Score
E. C and D
F. All of the Above
What do the new ASPEN/SCCM Guidelines Say?
We suggest determination of nutrition risk (e.g.- NRS-2002 or Nutric Score) be performed on all post-op pts in ICU.

Traditional “visceral protein levels” (serum albumin, prealbumin and transferrin concentrations) should NOT be used as markers of nutrition status.

(Expert Consensus)
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...

NRS Score??
1. Is BMI < 20.5?
2. Has the pt lost weight in last 3 months?
3. Has the pt had a reduced dietary intake in the last week?
4. Is the pt severely ill (in ICU)?

If yes to ANY above...go to Screen 2
If no...repeat q week
## NRS Score

<table>
<thead>
<tr>
<th>Impaired nutritional status</th>
<th>Severity of disease (≈ increase in requirements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent Score 0</td>
<td>Normal nutritional status</td>
</tr>
<tr>
<td>Absent Score 0</td>
<td>Normal nutritional requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild-1</th>
<th>Hip Fx, DM, COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt Loss &gt; 5% in 3 m</td>
<td>Mild-1</td>
</tr>
<tr>
<td>Food Intake:50-75% in last wk</td>
<td>Abd Surg, Stroke, Pneumonia, Heme Malignancy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moder-2</th>
<th>Severe-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt Loss &gt; 5% in 2 m</td>
<td>Severe-3</td>
</tr>
<tr>
<td>or BMI 18.5-20.5 +</td>
<td>Head Inj, BMT, ICU</td>
</tr>
<tr>
<td>Food Intake:25-60% in last wk</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severe-3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt Loss &gt; 5% in 1 m</td>
<td></td>
</tr>
<tr>
<td>or BMI &lt; 18.5 +</td>
<td></td>
</tr>
<tr>
<td>Food Intake:0-25% in last wk</td>
<td></td>
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Score: +

Age

- if ≥70 years: add 1 to total score above
- = age-adjusted total score

**ESPEN Guidelines for Nutrition Screening**

Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...

NRS Score = 5 (High Nutrition Risk)
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...
Post-Op Day 1 in ICU

Tube Feeds Started...

Trophic or Feed to Goal?
Question

In this patient, how would you plan for tube feeding...

A. Trophic only for first 5 days
B. Trophic only for 1st week
C. Advance to goal over first 24-48 hours
D. Advance to goal over first 3-4 days
Question
In this patient, how would you plan for tube feeding...

A. Trophic only for first 5 days
B. Trophic only for 1st week
C. Advance to goal over first 24-48 hours
D. Advance to goal over first 3-4 days
Why?...
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...

Albumen 2.2  NRS=5
What do the new ASPEN/SCCM Guidelines Say?
2016 ASPEN/SCCM Guidelines

Patients at high nutrition risk (NRS 2002 score >5 or Nutric score >6) or severely malnourished:

Should be advanced towards goal as quickly as tolerated over 24-48 h.

(Expert Consensus)
The only pt group where trophic feeds over 1st wk should be considered:

ARDs/ALI
MV > 72h
Patients
Either trophic OR full nutrition by EN is appropriate for pts with ARDS or ALI and those expected with duration of mech. vent. > 72 h:

These two feeding strategies have similar patient outcomes over first week of hospitalization

Quality of Evidence: High
But Remember....

If Pt ends up on vent > 8 days...
Improved Nutrition Delivery in 1st Week in ICU Improves Survival...

N = 475 Pts on Ventilator > 8 Days

Wie, Heyland et al. Crit Care Med, Online April, 2015
**Improved Nutrition in First Week in MICU Improves Quality of Life**

Subgroup Analysis of the Effect of Nutritional Adequacy on SF-36 scores

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N= 475 Pts on Ventilator > 8 Days

Wie, Heyland et al. Crit Care Med, Online April, 2015
Very Hard to predict who will be on MV > 3 d, but less then 8 d...

...as trophic feeding has no benefit over full feeding...

Why take risk??
How you feed in the 1st week in ICU...

Changes Pts QoL Months Later!!

Wie, Heyland et al. Crit Care Med, Online April, 2015
Despite Overwhelming Evidence Supporting it’s use...

EN not started....

Pt NPO > 2 d...
Should TPN be started now?

A. Yes

B. No
Should TPN be started now?

A. Yes

B. No
What do the new ASPEN/SCCM Guidelines Say?
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...
In pts at high nutrition risk (NRS 2002 $\geq 5$ or Nutric score $\geq 6$) or found to be severely malnourished:

When EN is not feasible, we suggest initiating exclusive PN as soon as possible following ICU admission.

(Expert Consensus)
ESPEN Guidelines for PN in ICU

**ALL Pts** not expected to be on EN/oral within 3 d should start TPN w/in 24 to 48 h (C)

**ALL Pts** receiving less than goal EN after 2 d should be considered for supplementary PN (C)
Despite Evidence Supporting it’s use...

EN and/or PN not started....

Pt NPO > 3 d...
Post-Op Day 3

- Increased abdominal pain
- White cell count: 31.1
- Zosyn started
Post-Op Day 4

- BP 60/40 and patient with delerium

- Transfer to ICU... Levophed and fluids started

- Respiratory system: Lungs Clear
<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>135</td>
</tr>
<tr>
<td>K</td>
<td>2.7</td>
</tr>
<tr>
<td>Cl</td>
<td>103</td>
</tr>
<tr>
<td>HCO₃</td>
<td>10</td>
</tr>
<tr>
<td>BUN</td>
<td>10</td>
</tr>
<tr>
<td>Creat</td>
<td>1.0</td>
</tr>
<tr>
<td>Ca</td>
<td>7.8</td>
</tr>
<tr>
<td>Mg</td>
<td>1.9</td>
</tr>
<tr>
<td>PO₄</td>
<td>2.9</td>
</tr>
<tr>
<td>Lactate</td>
<td>9.8</td>
</tr>
<tr>
<td>Hb</td>
<td>9.4</td>
</tr>
<tr>
<td>WBC</td>
<td>30.6</td>
</tr>
<tr>
<td>Plts</td>
<td>442</td>
</tr>
<tr>
<td>Neut</td>
<td>24.8</td>
</tr>
<tr>
<td>APTT</td>
<td>26.1-N</td>
</tr>
<tr>
<td>INR</td>
<td>1.2-N</td>
</tr>
<tr>
<td>LFTs</td>
<td>wnl</td>
</tr>
<tr>
<td>Trop I</td>
<td>0.03</td>
</tr>
<tr>
<td>Dig</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Arterial Blood Gases

pH
PaCO2
PaO2
Base Excess
HCO3
SaO2
FiO2

7.38
21
69
-12
12
93%
0.3
Further Work-Up

- CT Abdomen
  - Bowel wall thickening (small bowel)
  - Diffuse Pneumatosis
  - Poor vascular flow in SMA
  - Intra-abdominal free fluid and free air
**Laparotomy**

- Ischemic small bowel
- Small bowel resection leaving 160 cm viable jejunum
- Remainder of bowel well perfused
- Admitted to ICU
- It’s hospital day 5......
Arrival In ICU

- Blood pressure 90/40 on levophed/dobutamine
- On Ventilator...
- CVP 11
- MV O2 sat- 77%

Weight 54 kg....BMI 22
Can We Predict Nutrition Risk With An ICU-Specific Score?
A Conceptual Model for Nutrition Risk Assessment in the Critically Ill

**Nutrition Status**
- Micronutrient levels
- Immune markers
- Muscle mass

**Starvation**
- Acute: Reduced po intake
  - Pre ICU hospital stay
- Chronic: Recent weight loss
  - BMI?

**Inflammation**
- Acute: IL-6
  - CRP
  - PCT
- Chronic: Comorbid illness

**NUTRIC Score?**
Development of NUTrition Risk in Critically Ill Score (NUTRIC Score)

Table 4 Proposed nutrition scoring system

<table>
<thead>
<tr>
<th>Variables in NUTRIC Score</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−&lt; 75</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≥75</td>
<td>2</td>
</tr>
<tr>
<td>APACHE II</td>
<td>&lt; 15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>15−&lt; 20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20−28</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>≥28</td>
<td>3</td>
</tr>
<tr>
<td>SOFA</td>
<td>&lt; 6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6−&lt; 10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≥10</td>
<td>2</td>
</tr>
<tr>
<td># Co-morbidities</td>
<td>0−1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2+</td>
<td>1</td>
</tr>
<tr>
<td>Days from hospital to ICU admit</td>
<td>0−&lt; 1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1+</td>
<td>1</td>
</tr>
</tbody>
</table>

NUTRIC score discriminative performance

<table>
<thead>
<tr>
<th></th>
<th>In sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUC</td>
<td>0.783</td>
</tr>
<tr>
<td>Gen R-Squared</td>
<td>0.169</td>
</tr>
<tr>
<td>Gen Max-rescaled R-Squared</td>
<td>0.256</td>
</tr>
</tbody>
</table>

BMI, CRP, PCT, weight loss, and oral intake excluded as not significantly associated with mortality or inclusion did not improve fit of final model
Validation of NUTrition Risk in the Critically ill Score (NUTRIC Score)

Interaction between NUTRIC Score and nutritional adequacy (n=211)*

P value for the interaction = 0.01

Heyland D et al, Crit Care, 15:R268, 2011
Who Will Benefit From Aggressive Nutrition Delivery?

Pre-Injury Malnutrition

High Nutric Score (>5) ?

(Excluding IL-6)
Interpreting NUTrition Risk in Critically Ill Score? (NUTRIC Score)

**Nutric Score: 5-9**

High Nutritional Risk!

Start EN at admit - goal over 24-48 h

If not on EN on ICU Day 1:

Start PN Day 1

If not at Goal EN 48 h post-ICU admit:

Start PN ASAP
What Is Our Pts Nutric Score?

**Table 4 Proposed nutrition scoring system**

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</tr>
</tbody>
</table>

The proposed nutrition scoring system includes variables such as age, APACHE II, SOFA, number of co-morbidities, and days from hospital to ICU admit, each with a specified range and corresponding points. The discriminative performance of the NUTRIC score is evaluated using AUC, Gen R-Squared, and Gen Max-rescaled R-Squared.
What Is Our Pts Nutric Score?

Nutric Score

= 6

High Nutrition Risk!
What should nutrition plan be?

A. Start something now

B. Wait 1-2 more days to start anything

C. Wait 3-5 more days, perhaps she’ll be extubated and can eat on her own
What should nutrition plan be?

A. Start something now

B. Wait 1-2 more days to start anything

C. Wait 3-5 more days, perhaps she’ll be extubated and can eat on her own
How would you provide nutrition?

A. EN only - Trying to achieve goal needs
B. EN only – Trophic feeds only
C. TPN – Only
D. TPN with Trophic EN
How would you provide nutrition?

A. EN only - Trying to achieve goal needs

B. EN only – Trophic feeds only

C. TPN – Only

D. TPN with Trophic EN
Does Parenteral Nutrition (TPN) lead to increased risk of infection in ICU pts?

A. Yes

B. No
Does Parenteral Nutrition (TPN) lead to increased risk of infection in ICU pts?

A. Yes
B. No
Three New Large Randomized Trials Show....

TPN Does Not Increase Infection Risk in 2017!

Doig et al. JAMA, 2013
Heidegger et al, Lancet, 2013
CALORIES Trial, NEJM, 2014
TPN No Longer Related To Infection in 2017!

- No Longer “Hyperalimentation”
- We Now Control Hyperglycemia
- Sterile TPN Compounding Centers
- No Hospital TPN Compounding!
- Better Central Line Care

Improved Lipids?
How many calories would you give this patient to start?

A. < 15 kcal/kg/d
B. 15-20 kcal/kg/d
C. 20-25 kcal/kg/d
D. 25-30 kcal/kg/d
How many calories would you give this patient to start?

A. $ < 15 \text{ kcal/kg/d}$
B. $15-20 \text{ kcal/kg/d}$
C. $20-25 \text{ kcal/kg/d}$
D. $25-30 \text{ kcal/kg/d}$
Is There Another Source of “Calories” in Acute Phase We Are Forgetting!?!
What Happens to Metabolism in Acute Phase?
Catabolic Response to Stress and Injury

Adapted from: Anesthesiology 2015; 123:1455-72

Body Can Generate 50-75% of Pts Glucose Requirements!
During Acute Phase...

Body Can Generate
50-75% of Kcals Needs from Endogenous Sources!

Catabolic Response to Stress and Injury

Body Can Generate 50-75% of Pts Glucose Requirements!

Is Significant Exogenous Glucose Kcal Delivery Needed?

Early Protein Delivery Essential Due to Catabolism!
Protein-energy nutrition in the ICU is the power couple: A hypothesis forming analysis  Clinical Nutrition, In Press, 2016

Taku Oshima a,1, Nicolaas E. Deutz b,2, Gordon Doig c,3, Paul E. Wischmeyer d, Claude Pichard e,*

Conceptual Transitions of Utilization of Energy Supply in Illness

<table>
<thead>
<tr>
<th>Phase of Critical Illness</th>
<th>Acute</th>
<th>Chonic</th>
<th>Post Acute</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utilization of Energy Source</strong></td>
<td>Endogenous</td>
<td>Exogenous</td>
<td></td>
</tr>
</tbody>
</table>


Please cite this article in press as: Oshima T, et al., Protein-energy nutrition in the ICU is the power couple: A hypothesis forming analysis, Clinical Nutrition (2015), http://dx.doi.org/10.1016/j.clnu.2015.10.016

Corresponding author. Tel.: & E-mail addresses:

Medical innovations during the last 2 decades have allowed intensive care units (ICUs) to treat critically ill patients that only patients receiving a protein delivery of greater than 1 g/kg/day had a reduced mortality, regardless of adequate energy provision. Despite the technical difficulties, the strategy has been accompanied by remarkable progress in critical care medicine, demonstrating improved outcomes compared to historical controls. However, there is ongoing debate about the optimal delivery of energy and protein to critically ill patients.

The impact of amino acids on kidney function, Doig et al. demonstrated that the renal function of patients with acute kidney injury was improved by the provision of amino acids. A high proportion of patients with acute kidney injury in ICU, intensive care unit; EN, enteral nutrition; PN, parenteral nutrition; EE, energy expenditure.

Despite the technical difficulties, the strategy has been accompanied by remarkable progress in critical care medicine, demonstrating improved outcomes compared to historical controls. However, there is ongoing debate about the optimal delivery of energy and protein to critically ill patients.
Targeted Nutrition Delivery in Critical Illness

Kcal/kg/day

Protein Delivery

ICU Admit

Total Kcal Delivery in Well Nourished Pt

Activity/Rehab Increases

Acute phase (0-5 d Post ICU-admit)
Chronic phase (5+ days Post ICU-admit)
Recovery Phase (Post-ICU Discharge)
What do the new ASPEN/SCCM Guidelines Say?
We suggest hypocaloric PN (≤ 20 kcal/kg/day or 80% of estimated energy needs) with adequate protein (≥ 1.2 g protein/kg/day) be considered in pts requiring PN, over first ICU week.

[Quality of Evidence: Low]
2016 ASPEN/SCCM Guidelines

In Early Sepsis:

Suggest provision of trophic feeds (defined as 10-20 kcal/h- up to 500 kcal/d) for initial phase of sepsis, advance as tolerated after 24-48 h to > 80% of target energy over first week

(Expert Consensus)
How much protein would you give this patient?

A. 0.5-1.0 g/kg/d
B. 1.0-1.25 g/kg/d
C. 1.2-2.0 g/kg/d
D. > 2.0 g/kg/d
How much protein would you give this patient?

A. 0.5-1.0 g/kg/d
B. 1.0-1.25 g/kg/d
C. 1.2-2.0 g/kg/d
D. > 2.0 g/kg/d
In Early Sepsis:

Suggest provision of trophic feeds (defined as 10-20 kcal/h - up to 500 kcal/d) for initial phase of sepsis, advance as tolerated after 24-48 h to > 80% of target energy over first week.

We suggest delivery of 1.2 to 2 g protein/kg/d

(Expert Consensus)
Does This Sound Familiar?
Targeted Nutrition Delivery in Critical Illness


Kcal/kg/day

Protein Delivery

ICU Admit

Total Kcal Delivery in Well Nourished Pt

Activity/Rehab Increases

Acute phase (0-5 d Post ICU-admit)

Chronic phase (5+ days Post ICU-admit)

Recovery Phase (Post-ICU Discharge)
We All Underfeed Enterally!!
Use Enteral Protein Supplements!
Supplement with PN Early!
ICU Day 6

- Pt weans off vasopressors...
- EN advanced to goal...
Should Gastric Residuals Be Followed?
Would You Follow Gastric Residuals on This Patient?

A. Yes

B. No
Would You Follow Gastric Residuals on This Patient?

A. Yes

B. No?
What do the new ASPEN/SCCM Guidelines Say?
We suggest GRVs not be used as part of routine care to monitor ICU pts on EN.

[Quality of Evidence: Low]
Michelle W. - 63 y.o. with perforated diverticulitis for exploratory lap...
63 yo in ICU Recovered From Shock...

Started on Oral Nutrition...

Will she eat enough on her own?

Not Likely!!
Does evidence support pts receiving Oral Nutrition Supplements vs. Oral intake alone to improve outcome (including mortality) on floor and post-discharge?

A. Yes

B. No
Does evidence support pts receiving Oral Nutrition Supplements vs. Oral intake alone to improve outcome (including mortality) on floor and post-discharge?

A. Yes
B. No
63 yo in ICU Recovered From Shock...

Started on Oral Nutrition...

- High Protein Oral Supplement?
- HMB?
- Propranolol?
- Oxandrolone?
Role for ORAL Nutrition Supplements? (ONS)
ONS Reduces Hospital Mortality

OR 0.61 [95% CI 0.48–0.78], p < 0.001

Meta-analysis of 11 trials, n = 1965;

Stratton et al, 2003
ONS Reduces Hospital Complications

Control: 41% Complications
ONS: 18% Complications

OR 0.31; 95% CI 0.17–0.56, \( p < 0.001 \)

Meta-analysis of 7 trials, \( n = 384 \)

Stratton et al, 2003
Oral Nutrition Supplements

- Reduce Hospital LOS
- Reduce Hospital Readmission
Reduced Hospital Costs!
Mainly Small Trials...

Limited Data in Large Scale Trials and Elderly Medicare Population

New Data for ONS...

Adults With Any Primary Diagnosis...

\[ n = 724,000 \]

ONS patient episodes studied

ONS Improves Outcome...

Reduced Hospital LOS

21%

ONS Reduces Costs...

Reduced Hospital Cost

21.6%

Every $1 spent on ONS...

Saves $522.63 in hospital costs

Conclusions

Use of ONS in hospitalized pts:

Improves clinical outcomes and reduces costs
Is “Right” Nutrition Enough to Win the War?
July, 2014...
August 4th, 2014...
Emergent Small Bowel Obstruction with Marked Bowel Edema and Rising Lactate...
In SICU for fear of bowel ischemia...
Hospitalized 23 days on PN....

Ileus x 21 days...vomiting daily
But...calories/lipids limited due to soy-lipid cholestasis!
20 kg weight loss in 17 d... on TPN...

Unable to walk down the block without being SOB...
Could not pick up my own child...
When inflammation is acute and of severe degree, we propose the term "acute disease- or injury-related malnutrition." Examples of this syndrome include major infection, burns, trauma or closed head injury.

Figure 1 illustrates the theoretical relationship of these malnutrition syndromes with nutritional status (lean body mass).

**Acknowledgments**

GL Jensen and A Forbes served as co-chairs of the International Guideline Committee. All authors listed on the title page participated in meetings and follow up discussions that culminated in development of this manuscript. The original consensus manuscript draft was written by GL Jensen, J Mirtallo, and C Compher, and then all authors participated in editing and final revisions.

**Calorie Delivery Alone Won’t Stop LBM Loss in ICU!**

Disease-related Malnutrition

- **Chronic Dz Malnutrition**
- **Chronic Dz Malnutrition + Nutrition Support**

**Acute (ICU) Malnutrition**

- **Acute (ICU) Malnutrition + Nutrition Support**

Jensen et al, JPEN, 34:156-159, 2010
Can’t build a house without bricks...

Protein is Fundamental...
Evolving to Survive Critical Illness and “Function Again” is Superhuman!
We Are NOT Evolved For This!

Nutrition alone not enough...

“Survival of the Fittest”

Awake and Breathing Coordination

Choose light sedation & avoid benzos

Delirium Monitoring & Management

Early Mobility & Exercise

Feeding & Early Adequate Protein

Gain Function & Grow Muscle
Can We Learn From Elite Athletes...

“Train Smart. Eat Right. Sleep 10 Hours a Day.”

...To help our pts?
Take “Right” Anabolic Performance Enhancing Agents!?
IF STEROIDS ARE ILLEGAL FOR ATHLETES
THEN PHOTOSHOP SHOULD BE ILLEGAL FOR MODELS
Can we “pump you up” in ICU?

Beta-Blockers

HMB

Testosterone

Growth Hormone
A Role For Beta-Blockers?

To Maintain Lean Body Mass....

And...Improve Outcome?
Hypermetabolism in Critical Illness...

BURN, SEPSIS?

Plasma Catecholamines stimulate

β1 and β2 Receptors

Heart Rate↑
Energy Expend.↑
Muscle Protein↓
Insulin Resist.↑

Hyperdynamic Circulation
Increased Cardiac Work

Muscle Catabolism

Hyperglycemia

Increases 10-fold for up to 2 years post-injury or ICU!
...Is Attenuated By Beta-Blockers

Plasma Catecholamines

stimulate

β1 and β2 Receptors

Increases 10-fold!

BURN, SEPSIS?

Beta-Blocker

Heart Rate ↓

Energy Expend. ↓

Muscle Protein ↑

Insulin Resist. ↓

Improved Cardiac Work

Attenuated Muscle Catabolism

Attenuated Hyperglycemia
Propranolol Reduces REE...

...and Increases Muscle Mass

40% Reduction in Mortality With B-blocker in Septic Shock!
Can we “pump you up” in ICU?

- Beta-Blockers
- HMB
- Testosterone
- Growth Hormone
HMB-Containing ONS Reduces Death at 90 d Post-Hospital Discharge

78 Center, RCT, n=652 pts

Kaplan-Meier Survival Curve:
Mortality

HP-HMB ONS
Placebo

p = 0.013

Days postdischarge

Clinical Nutrition, Online First, 1/2016
<table>
<thead>
<tr>
<th>Time</th>
<th>Pre-injury</th>
<th>Acute phase</th>
<th>Chronic phase</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Exercise</td>
<td>- Arginine</td>
<td>- Calorizes</td>
<td>- Calories/Protein</td>
</tr>
<tr>
<td>Pre-op</td>
<td>Arginine</td>
<td>- Creatine</td>
<td>- Protein</td>
<td>- Oxandrolone</td>
</tr>
<tr>
<td>Glucose</td>
<td>Creatine</td>
<td>- Pre-op</td>
<td>- Lower</td>
<td>- B-Blocker</td>
</tr>
<tr>
<td>Loading</td>
<td>Glucose</td>
<td>- Non-protein</td>
<td>Kcals?</td>
<td>- B-Blocker</td>
</tr>
<tr>
<td></td>
<td>Loading</td>
<td>- B-Blocker</td>
<td>- No Potent</td>
<td>- Oxandrolone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anabolics's</td>
<td>- HMB/Creatine</td>
<td>- HMB/Creatine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Vitamin D</td>
<td>- GH?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- GLN-if no AKI or AKI on CRRT?</td>
<td>Exercise/PT</td>
</tr>
</tbody>
</table>

**Metabolic Cart Measures for Energy Needs Weekly**

- Sepsis
- Trauma
- Surgery

**Survival for Critical Hours**
What Does “ICU Recovery” Look Like For Me?
Over 1 yr...

4000-5000 kcal/d

2.0 g/kg/d protein
Is it Possible We Have Known This Since 1945?

WILL YOU Starve THAT They BE BETTER FED?
Minnesota Starvation Experiment

Baseline
3200 kcal/d
x 3 months

Starvation
1800 kcal/d
0.75 g/kg/d protein
(Low Protein Diet)
x 6 months

Plan to lose
1 kg/week

Physiological and Metabolic Testing Throughout Study
All men develop significant edema from protein malnutrition...

Lose all interest in sex...

Depression, Anxiety, Neurologic Deficits...
Average Starting Weight
152.7 pounds
(70 kg)

Average End Weight
115 pounds
(52 kg)
Minnesota Starvation Experiment

Baseline
3200 kcal/d
x 3 months

Starvation
1800 kcal/d
0.75 g/kg/d protein
(Low Protein Diet)
x 6 months

Recovery
↓ kcal/d
x 3 months

Physiological and Metabolic Testing Throughout Study
Regaining Weight and LBM Much Harder Than Expected!
Increased Calories

Grp 1- ↑ 400 kcal/d
   (2200 kcal/d)

Grp 2- ↑ 800 kcal/d
   (2600 kcal/d)

Grp 3- ↑ 1200 kcal/d
   (3000 kcal/d)

Grp 4- ↑ 1600 kcal/d
   (3400 kcal/d)
Most continued to lose weight...

Virtually none regained weight!
Raised All Groups by 800 Kcal/d More!

Grp 1- $\uparrow$ 1200 kcal/d  
(3000 kcal/d)

Grp 2- $\uparrow$ 1600 kcal/d  
(3400 kcal/d)

Grp 3- $\uparrow$ 2000 kcal/d  
(3800 kcal/d)

Grp 4- $\uparrow$ 2400 kcal/d  
(4200 kcal/d)
12 men stayed for 2 more months eating ad lib...

“Men would take in average of 5000 kcal/d with some taking in as much 11,500 kcal/d”
Recovery to normal weight took 6 months - 2 years for most all men.

No appreciable long term effects noted!
“Enough food must be supplied to allow tissues destroyed during starvation to be rebuilt...

...Our experiments show that in man NO appreciable rehabilitation can take place on a diet of 2000 kcal/d...

...The proper level is more then 4000 kcal/d daily for some months.”
What Does “ICU Recovery” Look Like For Me?
Over 1 yr...

BCAA’s
Fish Oil
Vit D.
HMB
Creatine
DHEA
And Exercise...!

“Train Smart.
Eat Right.
Sleep 10 Hours a Day.”
How Many of Our Patients Will Know What it Takes to “Recover”?
Who Will Teach Them?
“Creating Survivors...
...not Victims!
Sometimes, success leads to tragedy
Getting Pts Out of ICU is... NOT ENOUGH!
In Critical Care...

Winning battle against sepsis?

And...Losing the War on QoL!!!
Why Do We Do Critical Care At All?
“Are we creating survivors... or Victims?”
ICU Pts Get Far Less Energy and Protein Then In “Minnesota Starvation Study”!

Led to Say Were Starving Healthy Hypermetabolic ICU Pt?
Minnesota Starvation Study:
1800 kcal/d
0.75-0.8 g/kg/protein

ICU Patients for 12 days
1034 kcal/d
0.6 g/kg/protein
POST-ICU Quality of Life... Easy as ABC...

Awake and Breathing Coordination

Choose light sedation & avoid benzos

Delirium Monitoring & Management

Early Mobility & Exercise

Feeding & Early Adequate Protein

Gain Function & Grow Muscle
Targeted Nutrition Delivery in Critical Illness

Kcal/kg/day

Protein Delivery

ICU Admit

Protein (g/kg/d)

Severely Malnourished?

Total Kcal Delivery in Well Nourished Pt

Acute phase
(0-5 d Post ICU-admit)

Chronic phase
(5+ days Post ICU-admit)

Recovery Phase
(Post-ICU Discharge)

Activity/Rehab Increases
SPN/EN Goal: 25 kcal/Kg/d in Acute Phase?

Identify High Malnutrition Risk Patients!

- Weight Loss > 10%
- NUTRIC Score > 5
- NRS > 5
- Low BMI < 20

Start PN or Supplemental PN On ICU
Admit When Resuscitated!
Tailoring Metabolic and Nutrition Therapy in ICU: The Future?

- Exercise
- Arginine
- Creatine
- Pre-op
- Glucose Loading

Pre-injury

Acute phase

Chronic phase

Recovery

Treatment

Exercise Physiology Testing For Targeted Rehab.

Metabolic Cart Measures for Energy Needs Weekly

Could C12/13 Mass Spectroscopy Breath Test Determine Transitions???

Survival for Critical Hours™

Survival for a Lifetime

Sepsis

Trauma

Surgery

Treatment

- Protein/Lower Non-protein Kcals?
- B-Blocker
- No Potent Anabolics's

- Calories/Protein
- Oxandrolone
- B-Blocker
- HMB/Creatine
- Vitamin D
- GLN-if no AKI or AKI on CRRT?

Exercise/Physical Therapy

Treatment

- Calories/Protein
- Propranolol
- Oxandrolone
- HMB/Creatine
- GH?

Exercise/PT
A Proposal - How To Feed ICU/Trauma Patients?

**Acute Phase**
- EN if able...SPN in Malnourished Early!
- Goal EN and/or PN:
  - 15-20 kcal/kg/d
  - (1.2-2.0 g/kg/d protein)
  - (Lower non-protein kcal)

**Chronic Phase**
- EN + PN to Goal...
- Goal EN+SPN:
  - 25-30 kcal/kg/d
  - (1.5-2.0 g/kg/d protein)

**Recovery Phase**
Increase Kcals With Activity
- (1.5-2.0 g/kg/d protein)
“Train Smart. Eat Right. Sleep 10 Hours a Day.”