What's New in Parenteral Nutrition?

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7 กรกฎาคม พ.ศ. 2559

What's New in Parenteral Nutrition?

Parenteral Nutrition (PN) Used in Critically ill Adults

- Early or Late ??
- Safety ??
- Intravenous lipid emulsions (IVFE) ??

OUTLINE

- **Overview of Nutrition Support**
- **Nutritional Support in ICU**
- **Role of PN in ICU**
- **Conclusions**

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- **Overview of Nutrition Support**
- Nutritional Support in ICU
- Role of PN in ICU
- Conclusions

Definition: Nutrition Support

- **"Nutrition Support"**[1]

  : Orally modified formulas *or* intravenous nutrition necessitated by inability to consume a general diet; administered to **malnourished individuals** who **cannot consume food in its original form**.

- **"Nutrition Therapy"**[2]

  : A component of **medical treatment** that includes **oral**, enteral, and parenteral nutrition.

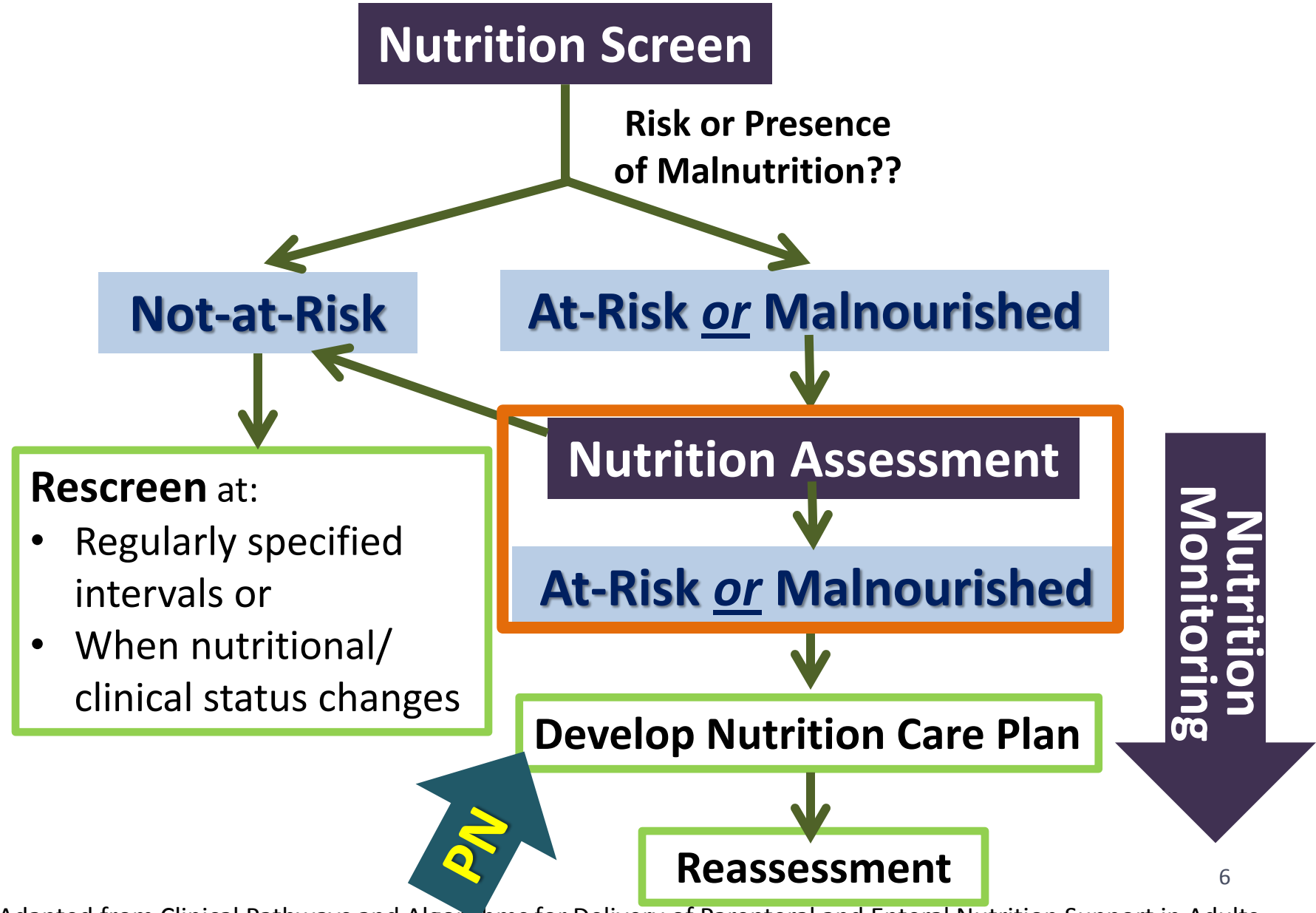
- **"Nutrition Support Therapy"**[2]

  : **Parenteral and/or enteral** nutrition.

[1]Mosby's Dictionary of Complementary and Alternative Medicine. (c) 2005, Elsevier.

[2] A.S.P.E.N. http://www.nutritioncare.org/Icontent.aspx?id=546

Algorithm for Delivery of Nutrition Support



Adapted from Clinical Pathways and Algorithms for Delivery of Parenteral and Enteral Nutrition Support in Adults. ASPEN; 1984:4.

Nutritional Assessment: Goals

1. Assessment of nutritional status
2. Medical problem(s)/disease(s)
3. Energy, macro/micronutrient and fluid requirements
4. Route of administration
5. Follow up

Nutritional Assessment: Goals

1. Assessment of nutritional status
2. Medical problem(s)/disease(s)
3. **Energy, macro/micronutrient and fluid requirements**
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5. Follow up

Major goals for Nutrition Prescription

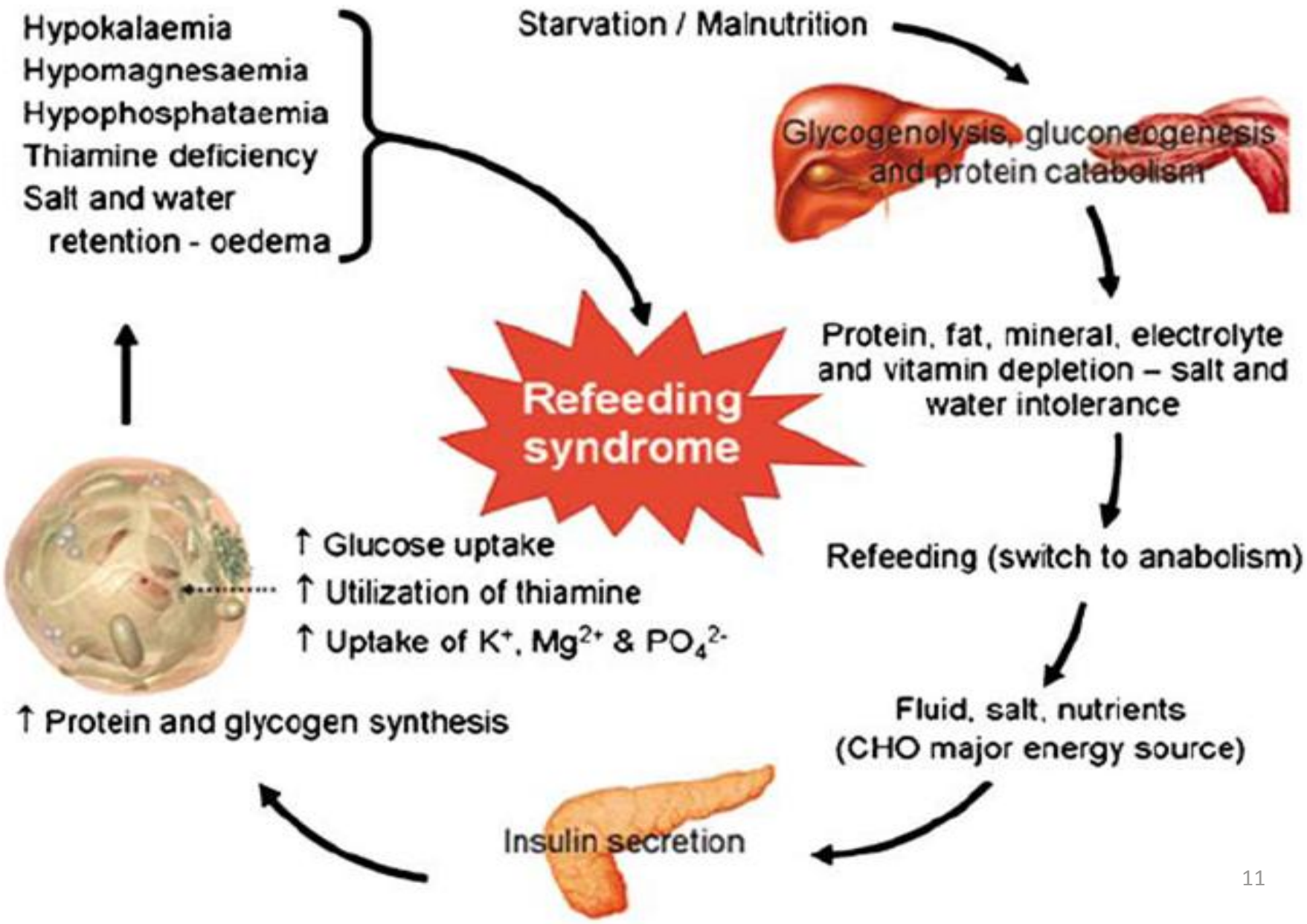
- Energy
- Protein
- Fluids

Daily Requirements

Daily Goals	Stable	Critical Care
Energy (Kcal/kg)	**30-35**	**(20-25) 25-30***

JPEN. 2009;33(3):277-316. Clinical Nutrition. 2009; 28:387–400. Nutr Clin Pract. 2005;20:468-73.
Heimburger DC, Ard JD (eds): Handbook of clinical nutrition, 4th ed, 2006.
*Crit Care Med. 2016;44(2):390-438. *J Parenter Enteral Nutr. 2016;40(2):159-211

Pathogenesis of Refeeding Syndrome



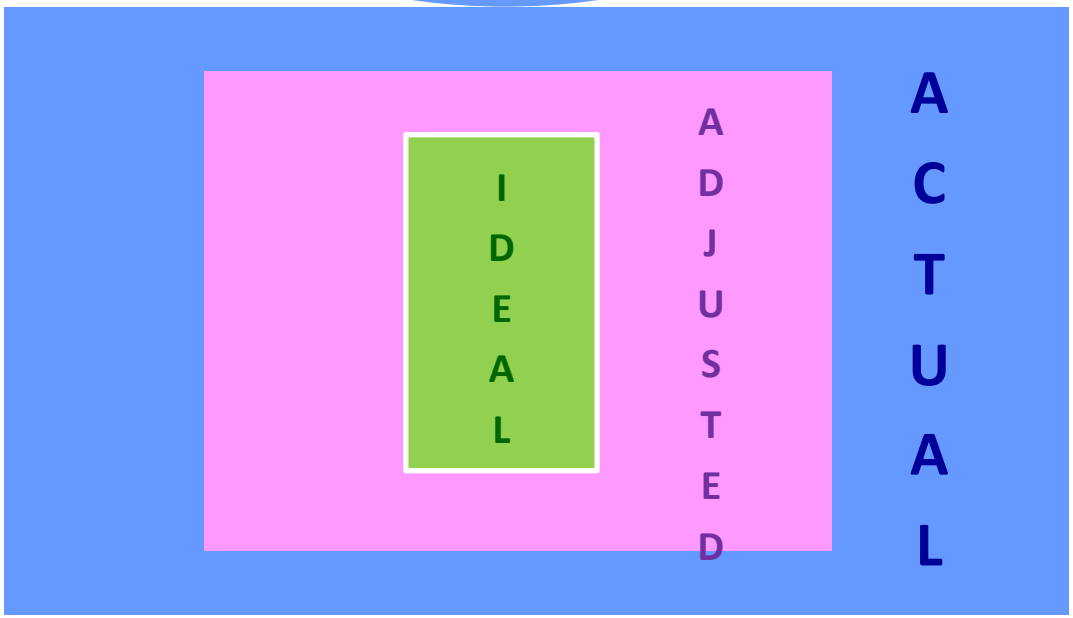
Daily Requirements

Daily Goals	Stable	Critical Care
Energy (Kcal/kg)	**30-35**	**(20-25) 25-30***
• Refeeding	• **10(5)- 20** Kcal/kg/day • **80%** BEE	

Heimburger DC, Ard JD (eds): Handbook of clinical nutrition, 4th ed, 2006.

*Crit Care Med. 2016;44(2):390-438. *J Parenter Enteral Nutr. 2016;40(2):159-211

Adjusted BW in "Obese Patients" (BMI ≥ 30 kg/m²)



■ = Actual weight

■ = Ideal weight (IBW)

■ = ***Adjusted weight***

= ■ + { 50 % (■ - ■)}

$$= \frac{\text{Actual weight} + \text{IBW}}{2}$$

Adjusted body weight

$$= IBW + [\ 0.5 \times (\ Actual\ BW - IBW\ )]$$

Where **IBW** is calculated as:

- ♂ = **Ht (in cm.) – 100 kg.**
- ♀ = **Ht (in cm.) – 105 kg.**

Heimburger DC, Ard JD (eds): Handbook of clinical nutrition, 4th ed, 2006.

Daily Requirements

Daily Goals	Stable	Critical Care
Energy (Kcal/kg)	**30-35**	**(20-25) 25-30***
• Refeeding	• **10(5) - 20** Kcal/kg/day • **80% BEE**	
• Obesity	**15-20 (adjusted BW)**	
	BMI 30-50*	• **11-14 (actual BW)**
	BMI > 50*	• **22-25 (IBW)**
Protein (g/kg)	**1.2-1.5(2)**	
• Obesity		BMI 30-40: ≥ **2 (IBW)** BMI >40: ≥ **2.5 (IBW)**
Fluids (mL/kg)	**30-35** mL (depending on comorbidities)	

JPEN. 2009;33(3):277-316. Clinical Nutrition. 2009; 28:387–400. Nutr Clin Pract. 2005;20:468-73. Heimburger DC, Ard JD (eds): Handbook of clinical nutrition, 4th ed, 2006.
*Crit Care Med. 2016;44(2):390-438. *J Parenter Enteral Nutr. 2016;40(2):159-211

Nutritional Assessment: Goals

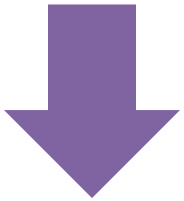
1. Assessment of nutritional status
2. Medical problem(s)/disease(s)
3. Energy, macro/micronutrient and fluid requirements
4. **Route of administration**
5. Follow up

The Basic Principle

" IF THE GUT WORKS, …USE IT "

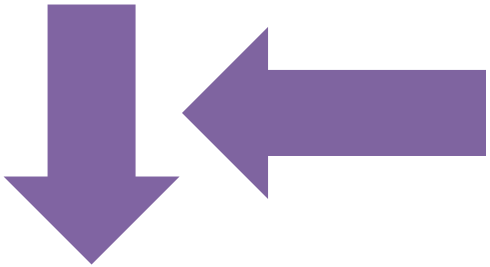
Route:

Oral diet



Oral supplements

Enteral nutrition (EN)



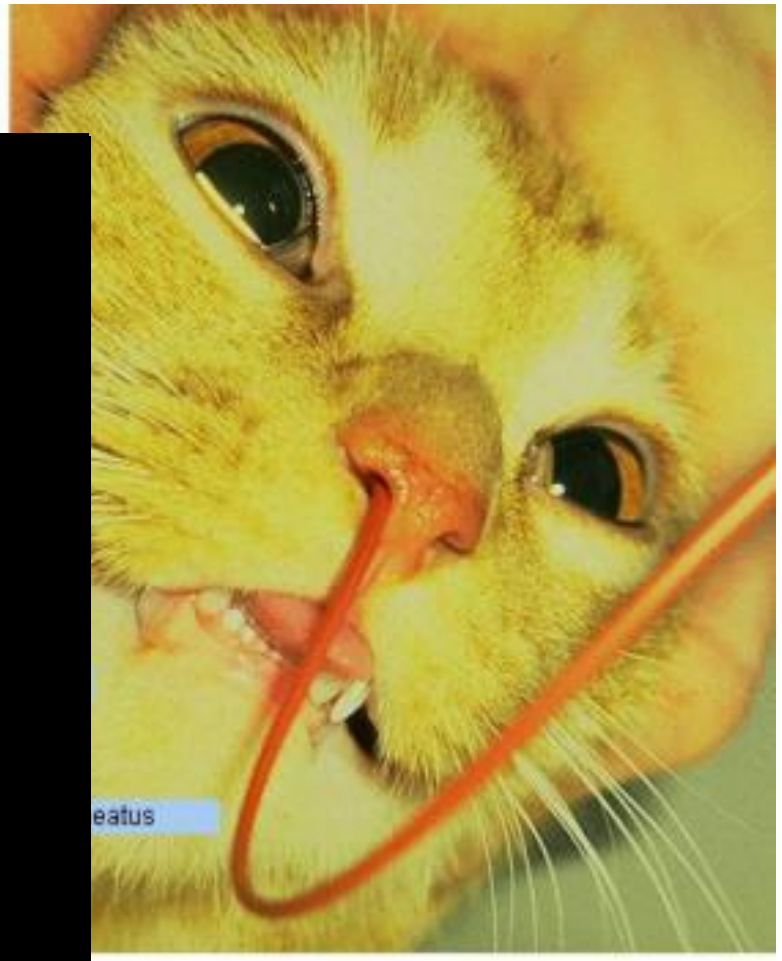
SPN = EN + PN

Parenteral nutrition (PN)

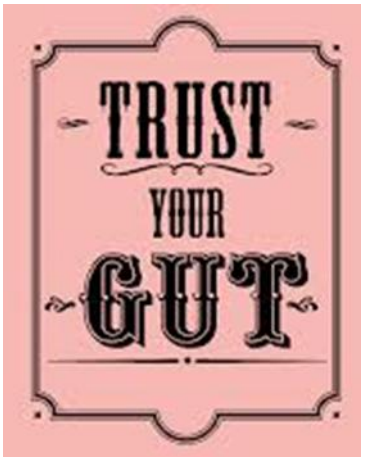
SPN = Supplemental parenteral nutrition

???

is the only absolute contraindication to enteral feeding



Feeding Approaches



Oral

Peripheral vein

Parenteral

Enteral

Tube

Central vein

" If the gut works, use it "

สรุป: เมื่อผู้ป่วยมีหรือเสี่ยงต่อภาวะ **malnutrition** จะต้อง ...

Plan for Nutritional Support

- **Nutritional Prescription**

  : How much ?

- **Route of Administration**

Route:

Oral diet

Oral supplements

Enteral nutrition (

Critically ill patients

SPN = EN + PN

Parenteral nutrition (PN)

SPN = Supplemental parenteral nutrition

IV Lipid Emulsions

Intravenous Lipid Emulsions (IVLEs)

- An essential **component of** parenteral nutrition (**PN**)
- Help to **prevent essential fatty acid deficiency** (EFAD)
- To **decrease** the **carbohydrate** calorie **load**
- Suitable for patients who need **fluid restriction**

Nutr Clin Pract. 2012; 27:150–192.

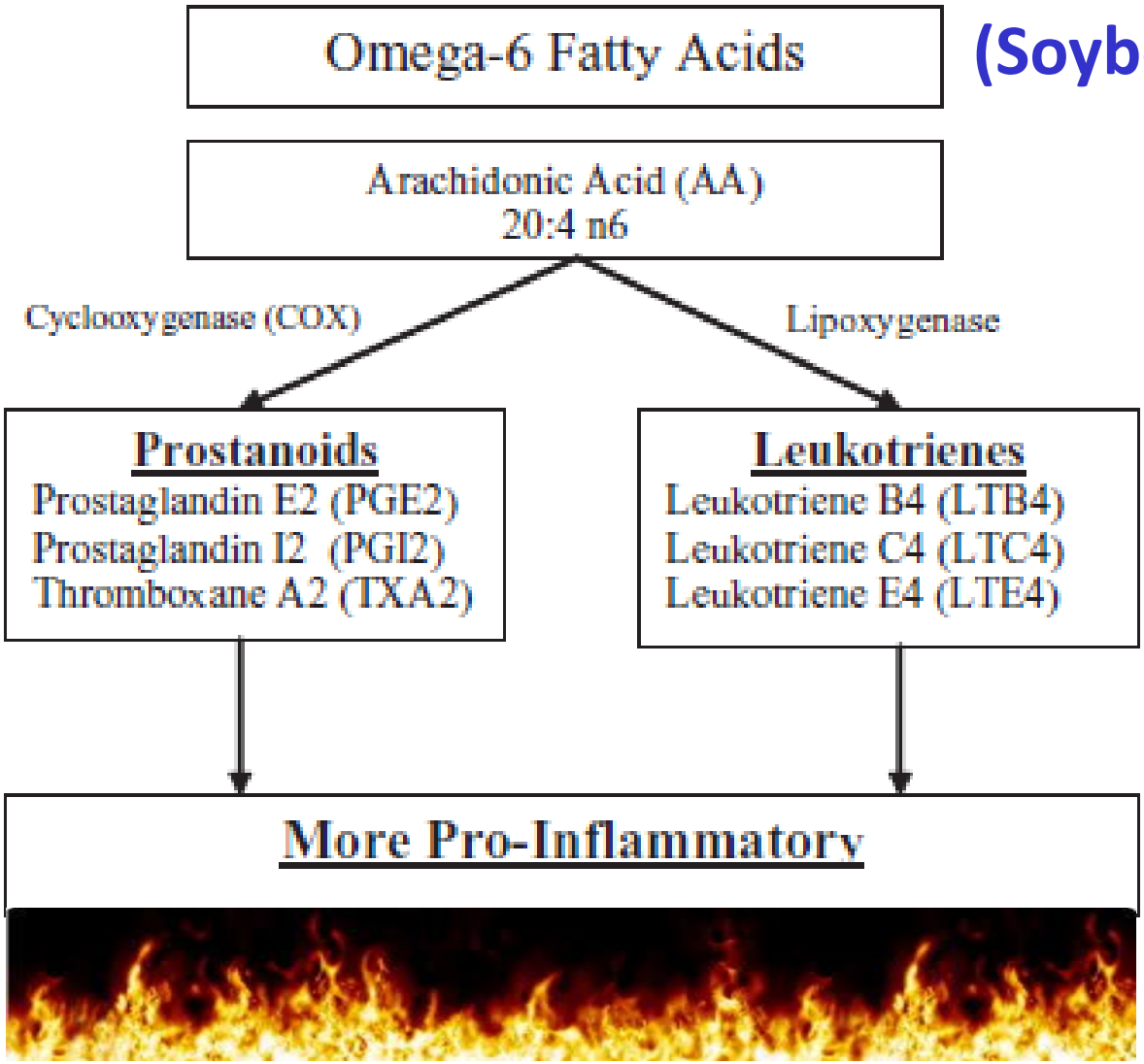
Evolution of Lipid Emulsions

1961- S-oybean oil

(พ.ศ. 2504)

ω-6 fatty acids

Relative pro-inflammatory Eicosanoids from metabolites of ω-6 Fatty Acids



(Soybean oil, LCT)

Nutr Clin Pract. 2012;27(2):150-92.

Evolution of Lipid Emulsions

Alternative IVLEs

Most recent:
S + M + O + F- ish oil

1996- O- live oil + soybean oil
(พ.ศ. 2539)

1984- M-CT – LCT
(coconut + soybean oil)
(พ.ศ. 2527)

1961- S-oybean oil
(พ.ศ. 2504)

Still continues to be safe & reliable (50 years)

ω-3
ω-9
MCT
ω-6

Reproduction from a slide courtesy from Fresenius Kabi.

Potential Benefits of Alternative IVLEs

- Less pro-**inflammatory effects**
- Less **immune** suppression
- Improved **antioxidant** defenses

" No studies showed worse outcomes for alternative IVLEs compared with soybean oil-based IVLEs "

World Rev Nutr Diet. 2015;112:163–171.

Eicosanoids from metabolites of ω-6 and ω-3 Fatty Acids

ω-6 Fatty Acids

Arachidonic Acid (AA)
20:4 n6

Cyclooxygenase (COX) | Lipoxygenase

Prostanoids
Prostaglandin E2 (PGE2)
Prostaglandin I2 (PGI2)
Thromboxane A2 (TXA2)

Leukotrienes
Leukotriene B4 (LTB4)
Leukotriene C4 (LTC4)
Leukotriene E4 (LTE4)

Pro-inflammatory

ω-3 Fatty Acids

Eicosapentaenoic Acid (EPA)
20:5 n3

Cyclooxygenase (COX) | Lipoxygenase

Prostanoids
Prostaglandin E3 (PGE3)
Prostaglandin I3 (PGI3)
Thromboxane A3 (TXA3)

Leukotrienes
Leukotriene B5 (LTB5)
Leukotriene C5 (LTC5)
Leukotriene E5 (LTE5)

Anti-inflammatory

Nutr Clin Pract. 2012;27(2):150-92.

A.S.P.E.N. Position Paper: Clinical Role for Alternative Intravenous Fat Emulsions

Novel Nutrient Task Force, Intravenous Fat Emulsions Workgroup; and the
American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Board of Directors

Conclusions:

- **Alternative IVLEs are safe and effective.**
- **They should be made available in the United States of America.**

A.S.P.E.N .=The American Society for Parenteral and Enteral Nutrition

Nutr Clin Pract. 2012;27(2):150-92.

Intravenous Lipids in Intensive Care

Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition*

Robert G. Martindale, MD, PhD; Stephen A. McClave, MD; Vincent W. Vanek, MD; Mary McCarthy, RN, PhD; Pamela Roberts, MD; Beth Taylor, RD; Juan B. Ochoa, MD; Lena Napolitano, MD; Gail Cresci, RD; American College of Critical Care Medicine; the A.S.P.E.N. Board of Directors

2009

When Indicated, Maximize Efficacy of PN

- **In the first week of hospitalization in the ICU, when PN is required and EN is not feasible, patients should be given a parenteral formulation without soy-based lipids (Grade D).**

Crit Care Med. 2009;37(5):1757-61.

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 (A.S.P.E.N.) 2016

H. When Indicated, Maximize Efficacy of PN

H3a. We suggest withholding or limiting SO-based IVFE during the first week following initiation of PN in the critically ill patient to a maximum of 100 g/week (often divided into 2 doses/week) if there is concern for essential fatty acid deficiency.

Crit Care Med. 2016;44(2):390-438. J Parenter Enteral Nutr. 2016;40(2):159-211

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 (A.S.P.E.N.) 2016

H. When Indicated, Maximize Efficacy of PN

H3b. Alternative IVFEs may provide outcome benefit over soy-based IVFEs; however, we cannot make a recommendation at this time due to lack of availability of these products in the United States. When these alternative IVFEs (SMOF [soybean oil, MCT, olive oil, and fish oil emulsion], MCT, OO, and FO) become available in the United States, based on expert opinion, we suggest that their use be considered in the critically ill patient who is an appropriate candidate for PN.

Crit Care Med. 2016;44(2):390-438. J Parenter Enteral Nutr. 2016;40(2):159-211

Canadian Nutrition Clinical Practice Guidelines for ICU: 2013 →2015

Topic	Number of new RCTs	Recommendation compared to 2013				2015 Recommendation	2013 Recommendation
		same	upgraded	downgraded	n/a (new section)		

- When PN with IV lipids is indicated, IV lipids that reduce the load of omega-6 fatty acids soybean oil emulsion should be considered.
- However, there are insufficient data to make a recommendation on the type of IV lipids to be used in critically ill patients.

Intravenous Lipids in Intensive Care

ESPEN Guidelines on Parenteral Nutrition: Surgery

M. Braga [a], O. Ljungqvist [b], P. Soeters [c], K. Fearon [d], A. Weimann [e], F. Bozzetti [f]

- **The optimal parenteral nutrition regimen for critically ill surgical patients should probably include supplemental n-3 fatty acids. [grade C]**

ESPEN = The European Society for Clinical Nutrition and Metabolism

Clin Nutr. 2009;28(4):378-86.

Intravenous Lipids in Intensive Care

ESPEN Guidelines on Parenteral Nutrition: Intensive care

Pierre Singer[a], Mette M. Berger[b], Greet Van den Berghe[c], Gianni Biolo[d], Ph
Alastair Forbes[f], Richard Griffiths[g], Georg Kreyman[h], Xavier Leverve[i], Clau

- **Addition of EPA and DHA** to lipid emulsions has demonstrable effects on **cell membranes** and **inflammatory processes.**
- **Fish oil-enriched lipid emulsions** probably **decrease length of stay** in critically ill patients. (Grade B)

ESPEN = The European Society for Clinical Nutrition and Metabolism

Clin Nutr. 2009;28(4):387-400.

OUTLINE

- Overview of Nutrition Support
- **Nutritional Support in ICU**
- Role of PN in ICU
- Conclusions

What is the Smartest Way of Nutritional Support in ICU?

" Early Enteral Nutrition"

How Early?

"Within 24-48 hours"

Intensive Care Med. 2009;35:2018-2017. Injury. 2011;42:50-56. N Engl Med. 2011;365:506-517. JAMA. 2012;307:795-803. Crit Care Med. 2016;44(2):390-438. J Parenter Enteral Nutr. 2016;40(2):159-211.

Problems with EN in ICU Practice

- **Fears** about precipitating bowel ischemia the patients with shock
- **EN intolerance**: high GRVs, aspiration, ileus, diarrhea, opiates, pain medications, vasopressors
- **Inappropriate cessation** of enteral feedings
- **Poor adherence to feeding protocols**

Inadequate Calorie and Protein Provision

GRV = gastric residual volume

Problems with EN in ICU Practice

- EN is the preferred route of nutritional support in, but it is frequently associated with **underfeeding**, especially in critically ill patients.

Crit Care Med. 1999;27:1252-6. Am J Crit Care. 2005;14:222-31. Nutr Support Serv. 1986;6:44-7.
Crit Care Nurse. 2003;23:49-57. Crit Care Med. 2000;28:1742-6. J Am Diet Assoc .2007;107:458-65.

- The **average energy** from EN provided to critically ill patients is between **50 - 95%** of requirements.

Crit Care Med. 2001;29:8-12. Nutrition. 2005;21:786-92. Chest. 2003;124:297-305.
Crit Care Med. 2004;32:350-7. Intensive Care Med .2008;34:1054-9.

- The **average protein** intake with enteral feeding ranges from **38 - 82%** of requirements.

Crit Care. 2005;9:R218-25. J Hum Nutr Diet. 2006;19:13-22. Crit Care Med. 1999;27:2525-31.

Problems with EN in ICU Practice

- **EN**: Physicians **prescribed a daily mean volume** that was **65.6% of the requirements**, but only **78.1% of the volume prescribed was infused** in critically ill patients in a medical ICU and coronary care unit (CCU)[1]
- The **adequacy of enteral nutritiona**l intake is **associated with** nutritional support practice provided by **health care providers** rather than with patients' characteristics [2,3]

[1]Crit Care Med. 1999;27:1252-6.
[2]Chest. 2003;124:297-305.
[3]Crit Care Med. 2004;32:350-7.

Route:

Oral diet

Oral supplements

Enteral nutrition (

Critically ill patients

SPN = EN + PN

Parenteral nutrition (PN)

SPN = Supplemental parenteral nutrition

When to Start PN/SPN ??

Guidelines	Recommendations
ASPEN 2009	When **EN is not feasible or available**: • **Without** previous *malnutrition: PN should be reserved and initiated only **after the first 7 days** of hospitalization when EN is not available. ***(Grade: E)*** • **With *malnutrition** on admission: **initiate PN as soon as possible** following adequate resuscitation. ***(Grade: C)***
ESPEN 2009	All patients receiving **EN less than** their **target**ed enteral feeding **after 2 days** should be considered for supplementary PN. ***(Grade: C)***

ASPEN = The American Society for Parenteral and Enteral Nutrition
ESPEN = The European Society for Clinical Nutrition and Metabolism

[1]JPEN. 2009;33(3):277-316.
[2]Clinical Nutrition. 2009; 28:387–400.

When SPN ????

I. Timing	II. Calories from EN
• May depend on **nutritional status** of the patients	• < 50- 60* % of target energy and protein requirement

- Indirect calorimetry *or*
- Predictive equations

*Crit Care Med. 2016;44(2):390-438.

*J Parenter Enteral Nutr. 2016;40(2):159-211

SPN = Supplemental parenteral nutrition

Clinical Guidelines

A.S.P.E.N. 2016

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 (A.S.P.E.N.)

Stephen A. McClave, MD[1*]; Beth E. Taylor, RD, DCN[2*]; Robert G. Martindale, MD, PhD[3]; Malissa M. Warren, RD[4]; Debbie R. Johnson, RN, MS[5]; Carol Braunschweig, RD, PhD[6]; Mary S. McCarthy, RN, PhD[7]; Evangelia Davanos, PharmD[8]; Todd W. Rice, MD, MSc[9]; Gail A. Cresci, RD, PhD[10]; Jane M. Gervasio, PharmD[11]; Gordon S. Sacks, PharmD[12]; Pamela R. Roberts, MD[13]; Charlene Compher, RD, PhD[14]; and the Society of Critical Care Medicine[†] and the American Society for Parenteral and Enteral Nutrition[†]

Crit Care Med. 2016;44(2):390-438.
J Parenter Enteral Nutr. 2016;40(2):159-211

Clinical Nutrition (2005) 24, 502–509

ELSEVIER

Clinical Nutrition

http://intl.elsevierhealth.com/journals/clnu

ORIGINAL ARTICLE

Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients

Stéphane Villet[a], René L. Chiolero[b], Marc D. Bollmann[b], Jean-Pierre Revelly[b], Marie-Christine Cayeux RN[b], Jacques Delarue[c], Mette M. Berger[b,*]

- Prospective observational study
- Surgical ICU; N = 48 (mean LOS = 15 days)
- Energy balance at weeks 1, 2, 3, and 4

Clinical Nutrition. 2005;24:502-9.

Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients

Results:

1. Time to feeding

(A) Patients	*N*	Days
All	48	3.1±2.2 (3)
Trauma	10	3.8±0.7 (3.5)
Cardiac surgery	13	3.4±0.6 (3)
Respiratory failure	7	2.7±0.9 (2.5)
Gastro-intestinal	3	1.7±1.3 (2)
Sepsis	3	2.5±1.6 (2.5)
Transplantation	4	3.0±1.2 (3)
Other	8	2.9±0.8 (1)

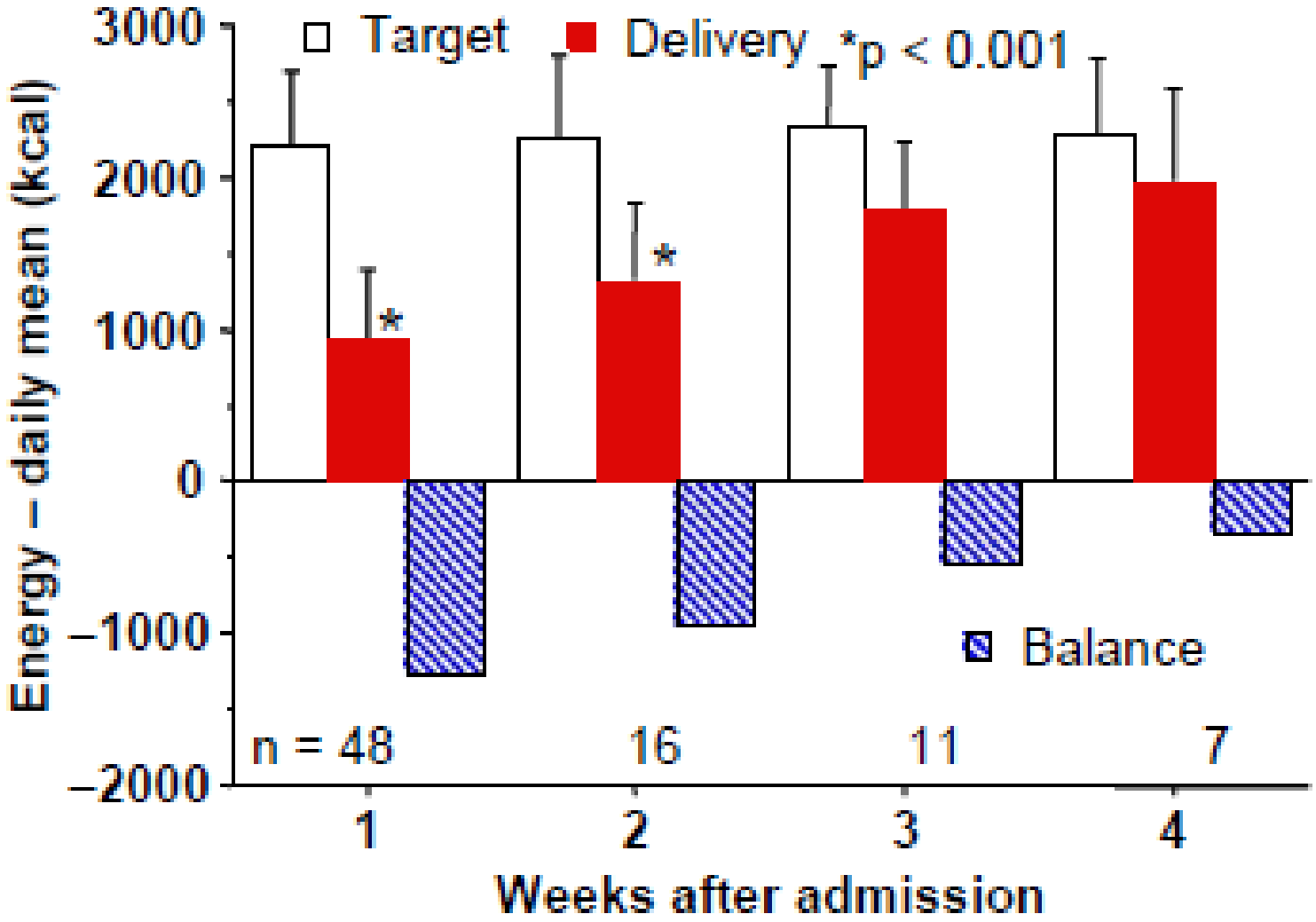
2. Energy delivery

(B) Routes	Days	Energy delivery
No feeding*	101 (4/3/1.75)	345±410 (225)
Oral Feeding	18	805±490 (880)
Enteral†	433	1365±770 (1320)‡
Combined§	81	2160±650 (2175)‡
Parenteral	36	1915±625 (1710)‡

Results as mean±SD (median).
*As defined: days without oral or artificial feeding.
†Enteral feeding includes 416 with pure enteral and 17 days with transition to oral feeding.
‡$P<0.0001$ between enteral and either parenteral or combined nutrition.
§Combined = combination of EN and PN.

Clinical Nutrition. 2005;24:502-9.

Progression of energy delivery compared to energy target over 4 weeks: the figure shows that energy delivery increases with time, reducing daily deficit.



Negative impact of hypocaloric feeding and energy balance on clinical outcome in ICU patients

Relationship between complications and cumulated energy deficit

Variables	*P*
Length of stay	0.0001
Complications	0.0003
Infections	0.0042
Days on antibiotics	0.0003
Start of nutrition	0.0002
Days of mechanical ventilation	0.0002

At 1 week: Cumulated energy balance was between -12,600 ± 10,520 kcal.

Clinical Nutrition. 2005;24:502-9.

Intensive Care Med (2009) 35:1728–1737
DOI 10.1007/s00134-009-1567-4

ORIGINAL

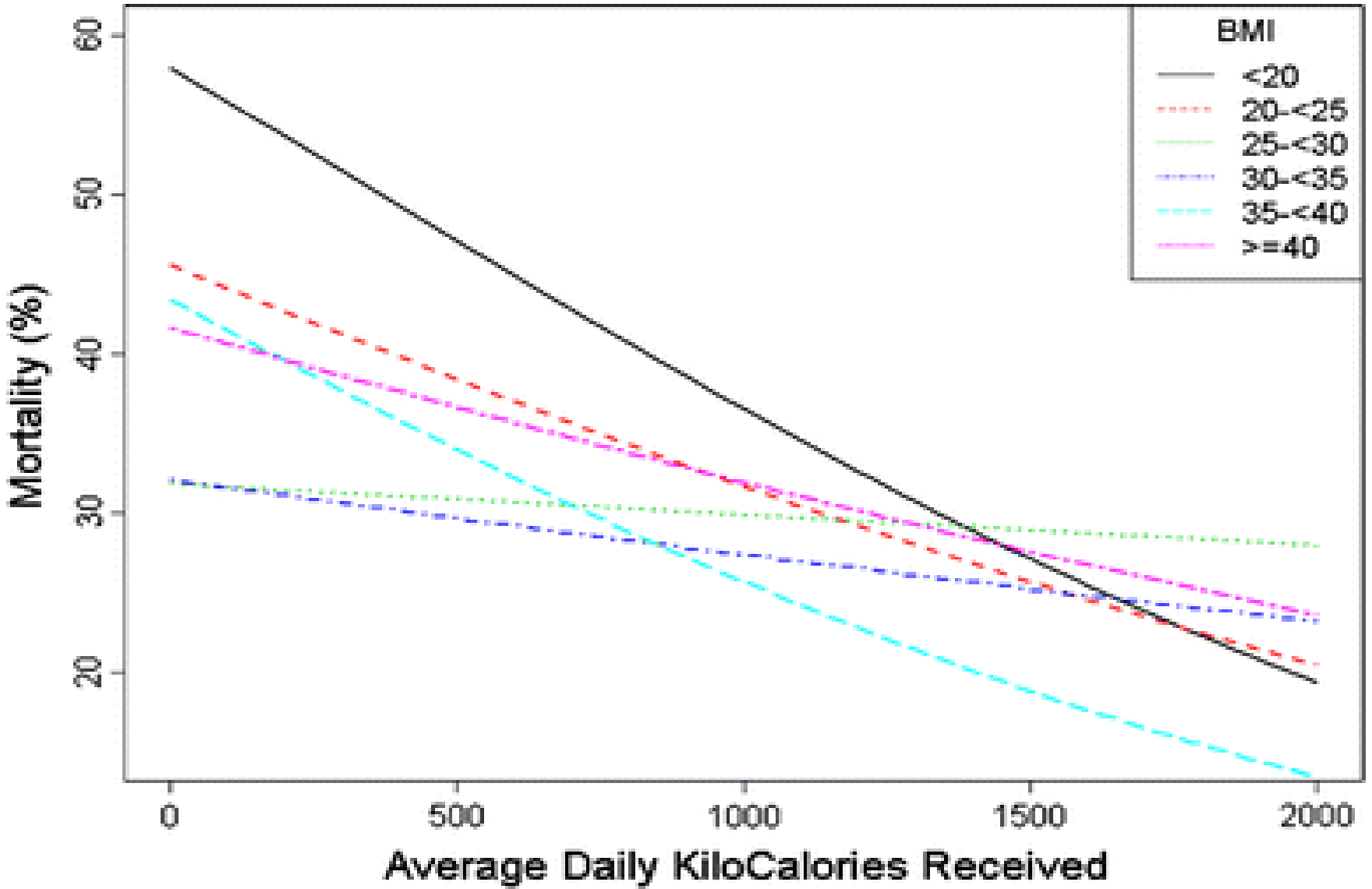
Cathy Alberda
Leah Gramlich
Naomi Jones
Khursheed Jeejeebhoy
Andrew G. Day
Rupinder Dhaliwal
Daren K. Heyland

The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study

- **Objective**: To examine the relationship between the **amount of energy and protein** administered **and clinical outcomes**, and the extent to which pre-morbid nutritional status (BMI) influenced this relationship
- **167 ICUs** across **21 countries**/ **N = 2,772**
- **Mechanically ventilated** patients

Intensive Care Med. 2009;35(10):1728-37.

The relationship between increasing calories/day and 60-day mortality by BMI



Route:

Oral diet

Oral supplements

Enteral nutrition (

Critically ill patients

- Calories
- Protein

SPN = EN + PN

Parenteral nutrition (PN)

SPN = Supplemental parenteral nutrition

OUTLINE

- Overview of Nutrition Support
- Nutritional Support in ICU

SPN

- **Role of PN in ICU**
- Conclusions

Supplemental Parenteral Nutrition (SPN)

- = EN + PN
- EN → → + PN

** ***when EN is insufficient to cover caloric needs*** **

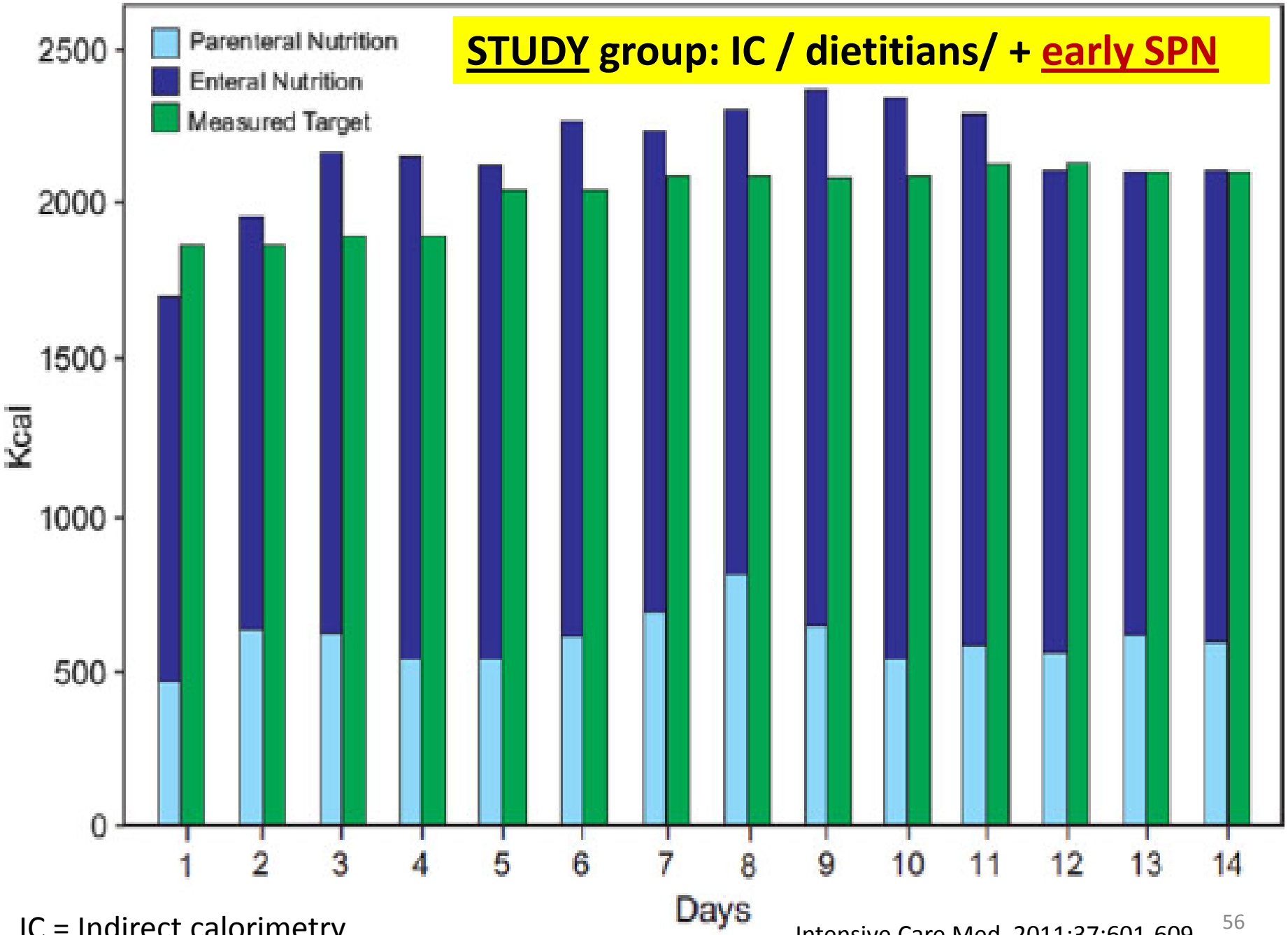
Intensive Care Med (2011) 37:601–609
DOI 10.1007/s00134-011-2146-z

ORIGINAL

Pierre Singer
Ronit Anbar
Jonathan Cohen
Haim Shapiro
Michal Shalita-Chesner
Shaul Lev
Elad Grozovski
Miryam Theilla
Sigal Frishman
Zecharia Madar

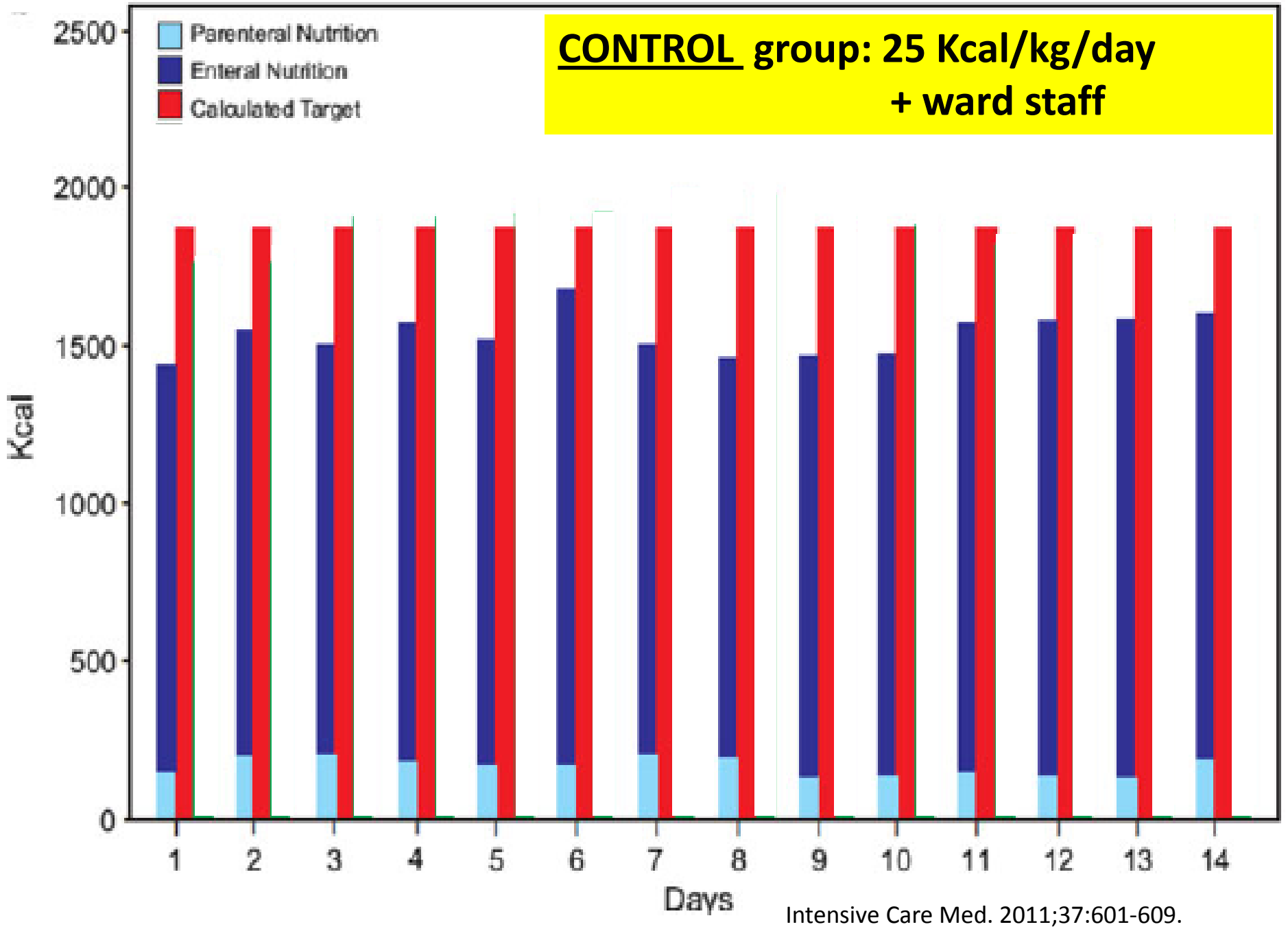
The tight calorie control study (TICACOS): a prospective, randomized, controlled pilot study of nutritional support in critically ill patients

- Prospective, randomized, single-center, pilot clinical trial
- **Adult general ICU**: N 112 **with mechanical ventilator** (56/56)
- **PURPOSE**: To determine whether nutritional support guided by repeated measurements of resting energy requirements using **indirect calorimetry (STUDY GROUP)** improves the **hospital mortality** of critically ill patients, compared to a weight-based formula using **25 Kcal/kg/day (CONTROL GROUP)**
- **STUDY GROUP**: **Dietitian / + SPN** to **reach target within 24 hrs**
- **CONTROL GROUP**: **Ward staff**



IC = Indirect calorimetry

Intensive Care Med. 2011;37:601-609.



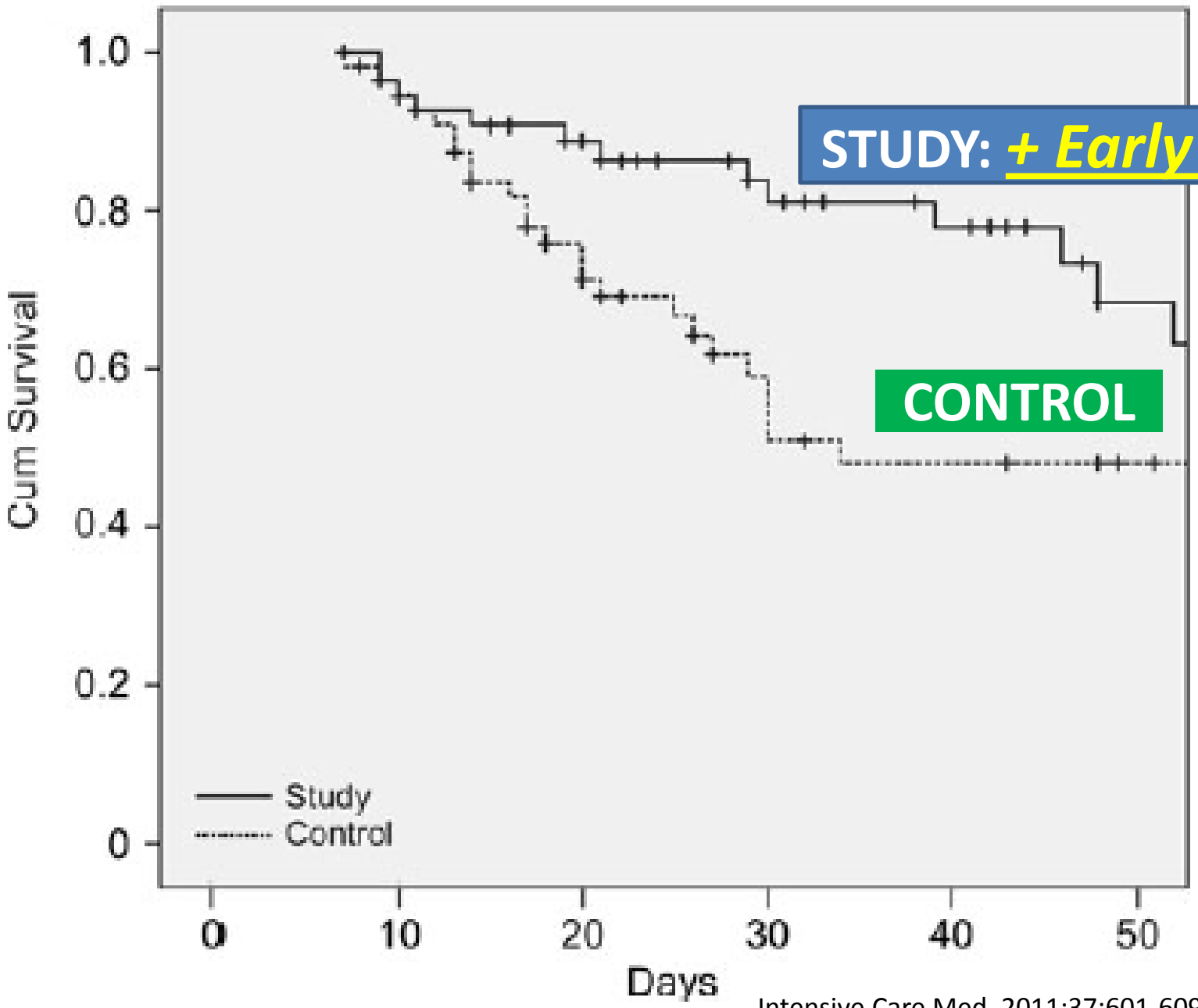
Intensive Care Med. 2011;37:601-609.

- IC
- Dietitian
- + SPN

- 25 Kcal/kg/day
- Ward staff

Parameter	Study group ($n = 56$)		Control group ($n = 56$)	p
Mean REE (kcal/day)	1,976 ± 468		1,838 ± 468	0.6
Mean energy delivered/day (kcal/day)	2,086 ± 460	>	1,480 ± 356	0.01
Mean enterally delivered energy/day (kcal/day)	1,515 ± 756		1,316 ± 456	0.09
Mean parenterally delivered energy/day (kcal/day)	571 ± 754	>	164 ± 294	0.001
Route of administration (n)				
Enteral	34		48	
Parenteral	3		1	
Enteral and parenteral	19		7	
Mean protein delivered/day (g/day)	76 ± 16	>	53 ± 16	0.001
Mean daily energy balance (kcal)	186 ± 206	>	−312 ± 481	0.001
Cumulative energy balance (kcal)	2,008 ± 2,177	>	−3,550 ± 4,591	0.01
Maximum negative energy balance (kcal)	15.7 ± 883	<	−3,895 ± 4,144	0.01
Daily mean blood glucose (mg/dL)	119.6 ± 21.8		127.3 ± 33.7	0.82

REE resting energy expenditure, *kcal* kilocalories; ***SPN,*** Supplemental parenteral nutrition



Intensive Care Med. 2011;37:601-609.

Intensive Care Med (2011) 37:601–609
DOI 10.1007/s00134-011-2146-z

ORIGINAL

Pierre Singer
Ronit Anbar
Jonathan Cohen
Haim Shapiro
Michal Shalita-Chesner
Shaul Lev
Elad Grozovski
Miryam Theilla
Sigal Frishman
Zecharia Madar

The tight calorie control study (TICACOS): a prospective, randomized, controlled pilot study of nutritional support in critically ill patients

Conclusions: Actively supervised nutritional intervention and **providing** near **target energy requirements based on repeated IC** was achievable **in** a general **ICU** and may be associated with **lower hospital mortality**.

Comparison the inflammatory effects of early supplemental parenteral nutrition plus enteral nutrition versus enteral nutrition alone in critically ill patients

[1]Abrishami R., [2]Ahmadi A., [1]Abdollahi M., [1]Moosivand A., [1]Khalili H., [2]Najafi A., [1]Gholami K., [1, 3]Hamishehkar H., [4]Peivandi Yazdi A., [*1]Mojtahedzadeh M.

- Single center (teaching hospital) RCT; Iran
- N = 20 mixed ICU pts with SIRS and APACHE score > 10
- Day 0, 3, and 7:
  - Inflammatory indices: **IL-6**
  - Pre-albumin
- Objectives: To compare **inflammatory parameters** of EN and EN+PN regimens during the first week of nutritional support in the ICU

DARU. 2010;18(2):103-6.

Comparison the inflammatory effects of early supplemental parenteral nutrition plus enteral nutrition versus enteral nutrition alone in critically ill patients

- **Supplemental PN** = 250 x 3.4 = 850 Kcal

  = 50% dextrose 500 mL

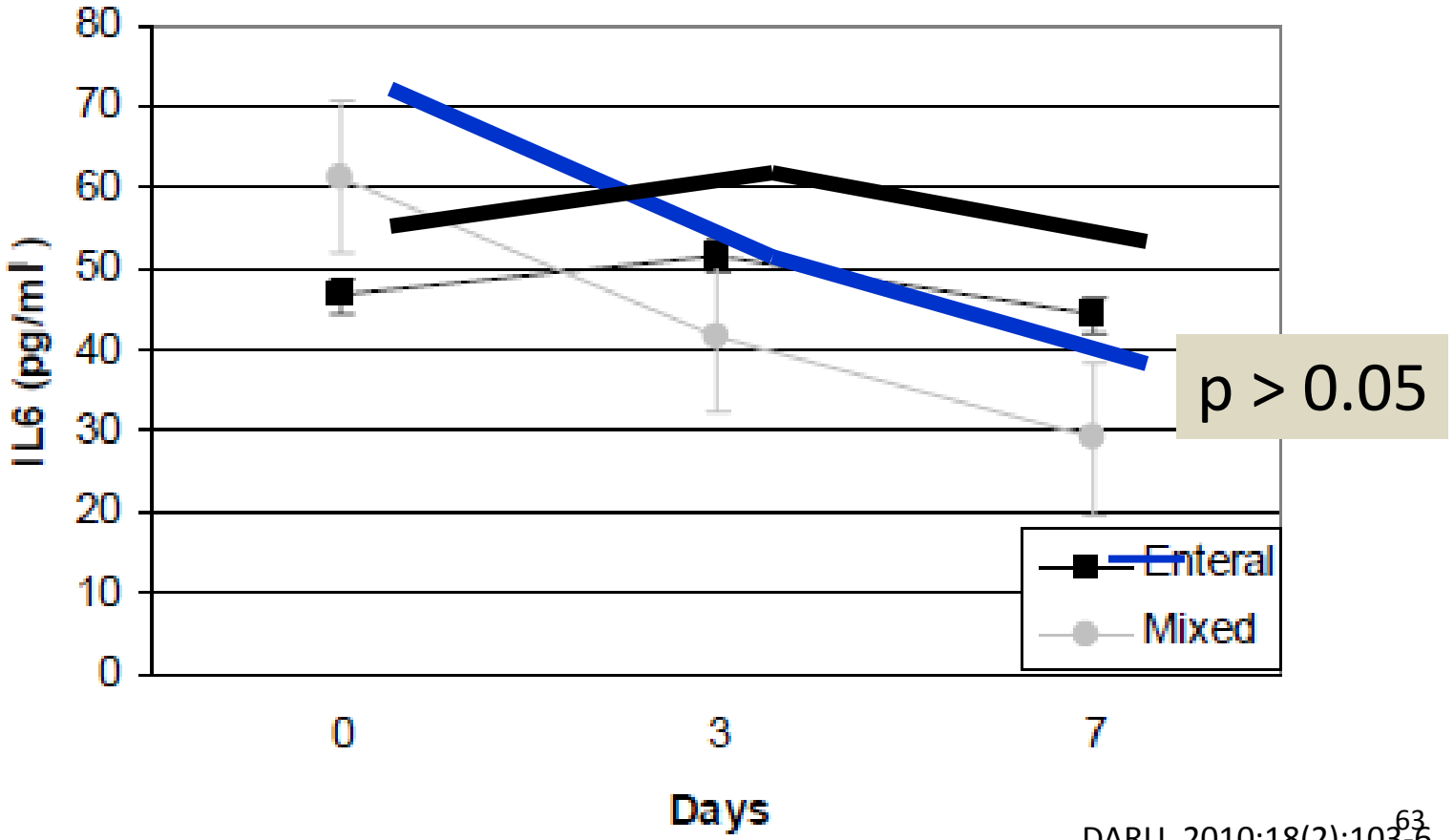
  \+ 10% amino acid solution 500 mL = 50 x 4 = 200 Kcal

∴ PN calories = 1,050 Kcal w/ volume 1,000 mL

DARU. 2010;18(2):103-6.

Comparison the inflammatory effects of early supplemental parenteral nutrition plus enteral nutrition versus enteral nutrition alone in critically ill patients

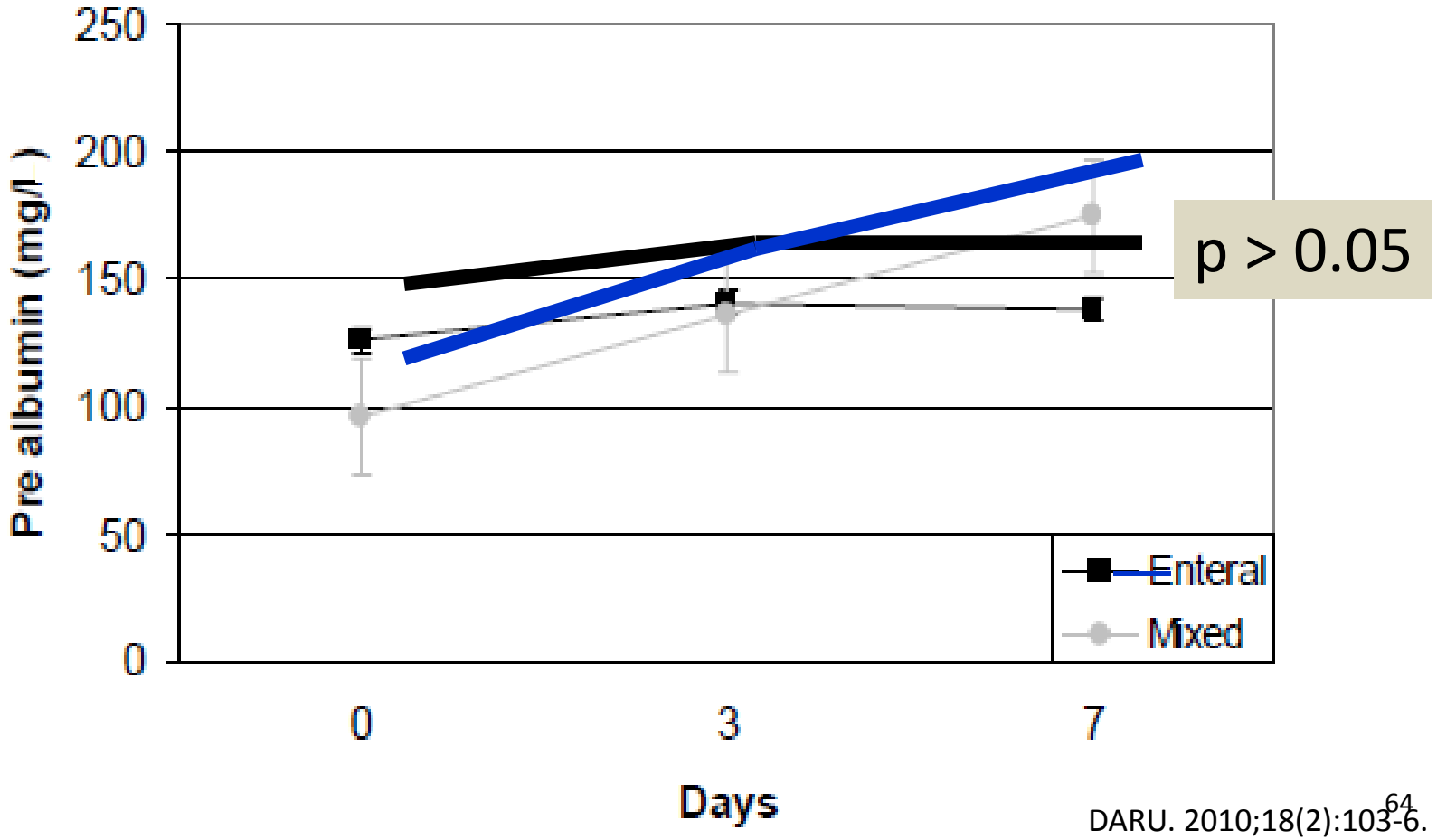
Results: Differences in mean IL-6 levels between groups were not significant



DARU. 2010;18(2):103-6.

Comparison the inflammatory effects of early supplemental parenteral nutrition plus enteral nutrition versus enteral nutrition alone in critically ill patients

Results: Differences in **mean serum pre-albumin** between groups were **not significant**



DARU. 2010;18(2):103-6.

Comparison the inflammatory effects of early supplemental parenteral nutrition plus enteral nutrition versus enteral nutrition alone in critically ill patients

- Mean length of hospitalization were not different
- **OMEGA score**: Higher score in EN+PN group
  → **higher nursing workload** (30 mins more)

CONCLUSION

No difference was found between EN and EN+PN regimens in regard to effects on inflammatory responses. Severity of illness may not change with these regimens. Nursing workload increases with implementation of supplemental PN. Until sufficient data from large randomized clinical trials is available using EN with parenteral supplementation is not recommended.

DARU. 2010;18(2):103-6.

Optimisation of energy provision with supplemental parenteral nutrition in critically ill patients: a randomised controlled clinical trial

- **Objective**: Individually optimized energy provision by **SPN for 5 days after day 3 of ICU** admission **(early PN)** could improve clinical outcome for whom EN alone is insufficient.
- **Primary outcome**: **Nosocomial infection** at D8 and D28
- **Population**: Severely ill patients on **day 3 of ICU** admission + **received EN < 60% of energy target** (**N = 305**)

Lancet. 2013;381:385-93.

Optimisation of energy provision with supplemental parenteral nutrition in critically ill patients: a randomised controlled clinical trial

Only 65% done

- **Energy targets**: at Day 3
  - Indirect calorimetry (IC)
  - If not possible, set targets as:
    - —♀: 25 kcal/kg IBW/day
    - —♂: 30 kcal/kg IBW/day
- **Intervention**: Day 4-7 (4 days)

  EN (n =152) vs. SPN (n = 153)

Lancet. 2013;381:385-93.

Optimisation of energy provision with supplemental parenteral nutrition in critically ill patients: a randomised controlled clinical trial

**** Early PN ดีกว่า ****

Findings		EN n = 152		SPN (EN+PN) n = 153
Mean **energy** delivery between D 4-8		20 kcal/kg per day (77% of target)	<	28 kcal/kg per day (103% of target)
Mean **protein** delivery between D 4-8		0.8 g/kg/day	<	1.2 g/kg/day
Nosocomial infection between D 9 - 28		58/152 (38%)	>	41/153 (27%)
		Hazard ratio 0·65, 95% CI 0·43–0·97; p=0·0338		

SPN group had a **lower** mean number of **nosocomial infections** per patient (−0.42 [−0.79 to −0.05]; p=0.0248).

Lancet. 2013;381:385-93.

Optimisation of energy provision with supplemental parenteral nutrition in critically ill patients: a randomised controlled clinical trial

✓ did not increase

- **Interpretation:** Individually optimized energy supplementation with **SPN** starting 4 days after ICU admission ~~could reduce~~ **nosocomial infections** and should be considered as a **strategy to improve clinical outcome** in patients in the **ICU** for whom **EN is insufficient**

Lancet. 2013;381:385-93.

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 OCTOBER 30, 2014 VOL. 371 NO. 18

Trial of the Route of Early Nutritional Support in Critically Ill Adults

Sheila E. Harvey, Ph.D., Francesca Parrott, M.Sci., David A. Harrison, Ph.D., Danielle E. Bear, M.Res., Ella Segaran, M.Sc., Richard Beale, M.B., B.S., Geoff Bellingan, M.D., Richard Leonard, M.B., B.Chir., Michael G. Mythen, M.D., and Kathryn M. Rowan, Ph.D., for the CALORIES Trial Investigators*

- N =2,400
- Early nutritional support: EN vs. PN

CONCLUSIONS

We found no significant difference in 30-day mortality associated with the route of delivery of early nutritional support in critically ill adults.

N Engl J Med. 2014:371(18):1673-84.

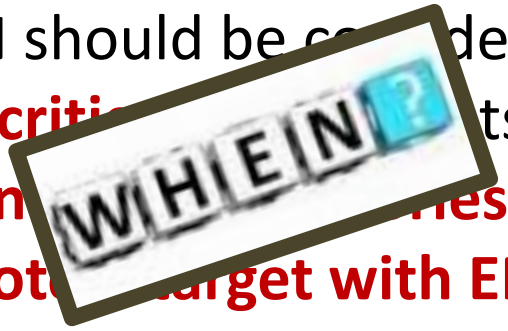
Evolution of PN Concept

Past

- PN was associated with ↑**infectious complications and mortality** in ICU patients
- 1980s: **Hyperalimentation**
  - ✓Impaired immunity
  - ✓↑CO2 production
  - ✓Organ dysfunction

Present

- **Not that Bad** !!!!!!
- Goal-directed nutrition strategies
  - ✓ Safe
  - ✓ Improved quality of IVFE
  - ✓ Better IC, line care and glucose control
- PN should be co[illegible]dered in in **criti[illegible]ts who can[illegible]ies and prot[illegible]arget with EN alone**



IVEF = intravenous lipid emulsion; IC = infectious control

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

" EPaNIC "

Early versus Late Parenteral Nutrition in Critically Ill Adults

- Prospective, randomized, controlled, parallel-group multicenter (7) trial
- **Critically ill adults** in the ICU who were **nutritionally at risk but** who were **not chronically malnourished**
- **** Early EN ****

+ Early PN	V S.	+ Late PN
• European guideline		• American and Canadian guidelines
• Start PN on D3		• Start PN on D8
• n = 2,312		• n = 2,328

N Engl J Med. 2011. 365;6:506-17.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

"EPaNIC"

Early versus Late Parenteral Nutrition in Critically Ill Adults

Early EN +

Early PN		Late PN
• n = 2,312		• n = 2,328
• D1: **20% glucose** solution (TC = 400 Kcal) • D2: **20% glucose** solution (TC = 800 Kcal) • ** **D3: + 3-in-1 PN at 100% of caloric goal**	***V S.***	• **5% glucose** solution • ** **Withhold PN for 1 week**

N Engl J Med. 2011. 365;6:506-17.

Results: Safety and Primary Outcome

LATE

EARLY

Variable	Late-Initiation Group (N=2328)		Early-Initiation Group (N=2312)	P Value
Safety outcome				
Vital status — no. (%)				
Discharged live from ICU within 8 days	1750 (75.2)	>	1658 (71.7)	0.007
Death				
In ICU	141 (6.1)		146 (6.3)	0.76
In hospital	242 (10.4)		251 (10.9)	0.63
Within 90 days after enrollment†	257 (11.2)		255 (11.2)	1.00
Nutrition-related complication — no. (%)	423 (18.2)		434 (18.8)	0.62
Hypoglycemia during intervention — no. (%)‡	81 (3.5)	>	45 (1.9)	0.001
Primary outcome				
Duration of stay in ICU§				
Median (interquartile range) — days	3 (2–7)		4 (2–9)	0.02
Duration >3 days — no. (%)	1117 (48.0)	<	1185 (51.3)	0.02
Hazard ratio (95% CI) for time to discharge alive from ICU	1.06 (1.00–1.13)			0.04

N Engl J Med. 2011. 365;6:506-17.

Results: Secondary Outcomes

Variable	Late-Initiation Group (N=2328)		Early-Initiation Group (N=2312)	P Value
Secondary outcome	LATE		EARLY	
New infection — no. (%)				
Any	531 (22.8)	<	605 (26.2)	0.008
Airway or lung	381 (16.4)		447 (19.3)	0.009
Bloodstream	142 (6.1)		174 (7.5)	0.05
Wound	64 (2.7)		98 (4.2)	0.006
Urinary tract	60 (2.6)		72 (3.1)	0.28
Inflammation				
Median peak C-reactive protein level during ICU stay (interquartile range) — mg/liter	190.6 (100.8–263.2)		159.7 (84.3–243.5)	<0.001
Mechanical ventilation				
Median duration (interquartile range) — days	2 (1–5)		2 (1–5)	0.02
Duration >2 days — no. (%)	846 (36.3)		930 (40.2)	0.006
Hazard ratio (95% CI) for time to definitive weaning from ventilation	1.06 (0.99–1.12)			0.07
Tracheostomy — no. (%)	134 (5.8)		162 (7.0)	0.08

N Engl J Med. 2011. 365;6:506-17.

Result Summary: Secondary Outcomes

Parameters	Early EN +	
	Early PN	Late PN
Mortality	No significant difference	
Fewer ICU infection	☹	☺ * but higher degree of acute inflammation*
Shorter duration of MV	☹	☺
Shorter duration of RRT	☹	☺
Shorter ICU stay	☹	☺ * but slightly increase in hypoglycemic episode *
Shorter hospital stay	☹	☺
Reduced health care cost	☹	☺

N Engl J Med. 2011. 365;6:506-17.

EPaNIC Trial Conclusion

(** Late PN ดีกว่า **)

In conclusion, the early initiation of parenteral nutrition to supplement insufficient enteral nutrition during the first week after ICU admission in severely ill patients at risk for malnutrition appears to be inferior to the strategy of withholding parenteral nutrition until day 8 while providing vitamins, trace elements, and minerals. Late parenteral nutrition was associated with fewer infections, enhanced recovery, and lower health care costs.

N Engl J Med. 2011. 365;6:506-17.

Considerations of EPaNIC Trial

(** Late PN ดีกว่า **)

- 61% elective heart surgery

  ?? Need nutrition support ??

- 50% stayed in ICU < 3 days

N Engl J Med. 2011. 365;6:506-17.

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ORIGINAL ARTICLE

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Early versus Late Parenteral Nutrition in Critically Ill Adults

Early EN +

Early PN		Late PN
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Considerations of EPaNIC Trial

(** Late PN ดีกว่า **)

- 61% elective heart surgery

  ?? Need nutrition support ??

- 50% stayed in ICU < 3 days

- **Early PN group**:

  Early hypertonic glucose load →

  hyperglycemia → poorer outcome??

N Engl J Med. 2011. 365;6:506-17.

CRITICAL CARE

Early versus late parenteral nutrition in ICU patients: cost analysis of the EPaNIC trial

Simon Vanderheyden[1†], Michael P Casaer[1†], ... Thomas De ...
Pieter J Wouters[1], Jocelijn Coenegra... Alexand...
Jasperina Dubois[7], Greet Van den Berghe ...

****Late PN ดีกว่า**

Conclusions: The **increased costs by early PN** were **mainly pharmacy-related** and explained by higher expenditures for PN **and anti-infective agents**.

The use of **Early-PN in critically ill** patients can thus **not be recommended for both clinical (no benefit) and cost-related reasons.**

Crit Care. 2012;25;16(3):R96.

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- N =2,400
- Early nutritional support: EN vs. PN

CONCLUSIONS

We found no significant difference in 30-day mortality associated with the route of delivery of early nutritional support in critically ill adults.

N Engl J Med. 2014:371(18):1673-84.

Different recommendations on PN initiation in ICU

: 24 hrs → 7 days

JPEN. 2003;27(5):355-73.
Crit Care Med. 2009;37(5):1757-61.
Crit Care Med. 2010;38(2):395-401.

ELSEVIER

Contents lists available at ScienceDirect

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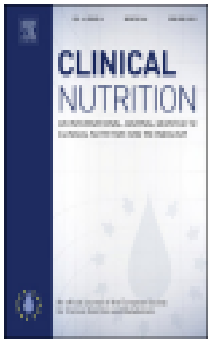

Review

Clinical Nutrition. Aug 2015;34(4):565-71.

Nutrition therapy in critically ill patients- a review of current evidence for clinicians

Emma Ridley [a, b, *], Dashiell Gantner [a, c, d], Vincent Pellegrino [c]

Parenteral Nutrition (PN):

When to Start PN

Although the **conflicting recommendations**, it appears sensible to **consider PN when EN cannot be delivered** at all in patients who:

1. **Malnourished (regardless of duration)**. PN should be commenced as early as possible if EN is contraindicated.
2. In **surgical patients** who have **impaired GI function** (pre- or postop) which would prevent oral or EN being commenced within 5-7 days.
3. In **critically ill patients** whom **EN or oral nutrition is contraindicated or not expected** to commence **within 3 days**.

Clinical Nutrition. Aug 2015;34(4):565-71.

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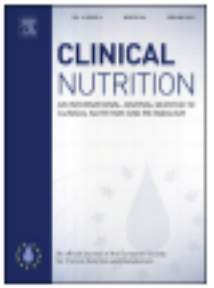

Review

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Emma Ridley [a, b, *], Dashiell Gantner [a, c, d], Vincent Pellegrino [c]

Supplemental PN (SPN):

- Relatively **new concept**
- SPN should be considered in ICU **when EN is insufficient for more than 2 days** to prevent energy and protein deficiency : as recommended by ESPEN 2009

[ESPEN guideline on PN: intensive care. Clin Nutr. 2009;28(4):387-400.]

Clinical Guidelines

A.S.P.E.N. 2016

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 (A.S.P.E.N.)

Stephen A. McClave, MD[1*]; Beth E. Taylor, RD, DCN[2*]; Robert G. Martindale, MD, PhD[3]; Malissa M. Warren, RD[4]; Debbie R. Johnson, RN, MS[5]; Carol Braunschweig, RD, PhD[6]; Mary S. McCarthy, RN, PhD[7]; Evangelia Davanos, PharmD[8]; Todd W. Rice, MD, MSc[9]; Gail A. Cresci, RD, PhD[10]; Jane M. Gervasio, PharmD[11]; Gordon S. Sacks, PharmD[12]; Pamela R. Roberts, MD[13]; Charlene Compher, RD, PhD[14]; and the Society of Critical Care Medicine[†] and the American Society for Parenteral and Enteral Nutrition[†]

Crit Care Med. 2016;44(2):390-438.
J Parenter Enteral Nutr. 2016;40(2):159-211

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 (A.S.P.E.N.) 2016

G. When to Use PN

G3. We recommend that, in patients at either low or high nutrition risk, use of supplemental PN be considered after 7–10 days if unable to meet > 60% of energy and protein requirements by the enteral route alone.

Initiating supplemental PN prior to this 7- to 10-day period in critically ill patients on some EN does not improve outcomes and may be detrimental to the patient.

Crit Care Med. 2016;44(2):390-438. J Parenter Enteral Nutr. 2016;40(2):159-211

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 (A.S.P.E.N.) 2016

H. When Indicated, Maximize Efficacy of PN

H1. Based on expert consensus, we suggest the use of protocols and nutrition support teams to help incorporate strategies to maximize efficacy and reduce associated risk of PN.

Crit Care Med. 2016;44(2):390-438. J Parenter Enteral Nutr. 2016;40(2):159-211

OUTLINE

- Overview of Nutrition Support
- Nutritional Support in ICU
- Role of PN in ICU
- **Conclusions**

Conclusions: Benefit of PN

: To easily meet calories and protein target
**** regardless of GI function****

How to maximize efficacy and minimize complications of PN:

1) **Always + EN when possible** (SPN is better than PN alone)
2) As GI tolerance improves: **↑ EN and ↓ PN**
3) Use **PN** for the **shortest** possible **duration**
4) Mode: complete **all-in-one bag** is preferred

(ESPEN 2009: Grade B)

Conclusions

- **EN support is always the preferred route** as compared to PN
- The **optimum timing of PN initiation in critically ill adults** in whom caloric targets cannot be met by EN alone is still **controversial but tend to be beneficial**
- **Combination of PN with EN** constitutes a strategy to **prevent nutritional deficit, but** can **easily cause overfeeding**

Conclusions

- Understanding the **barriers for enteral nutrition is essential** for health care providers to optimize nutritional support
- **SPN** could be the optimal modality to provide the calculated **energy targets** if this **cannot be reached by EN alone**
- **Appropriate use of PN can minimize risk of its complications** to the patients.

Conclusions

- **In severely ill patients**, route of energy delivery may not affect patient outcome, and delivering **enough energy and substrate** to hypercatabolic critically ill patients **may be more important**. Higher demands of these patients must be matched with an appropriate supply

What's New in Parenteral Nutrition?

Parenteral Nutrition (PN) Used in Critically ill Adults

- Early or Late ??
- Safety ?? Yes
- Intravenous lipid emulsions (IVFE) ??

Alternative IVFE

QUESTIONS ???