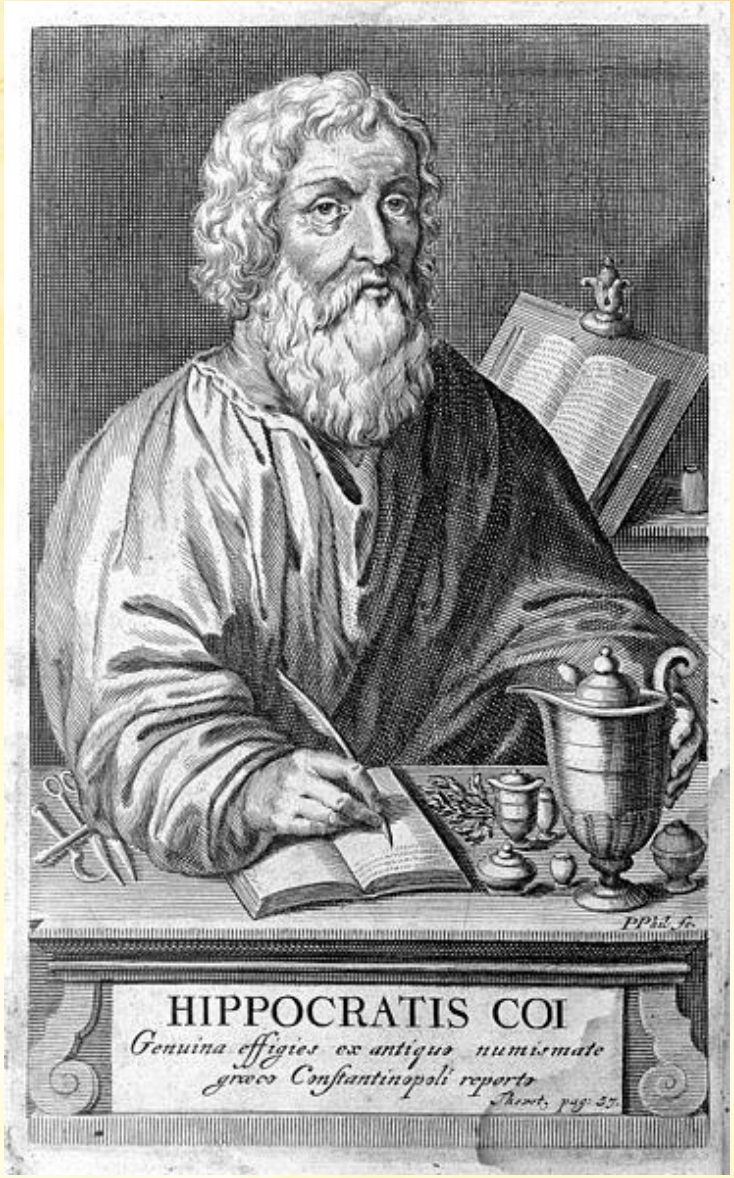
Nutritional Considerations in the ICU

奇美醫院

加護醫學部 蔡季倫



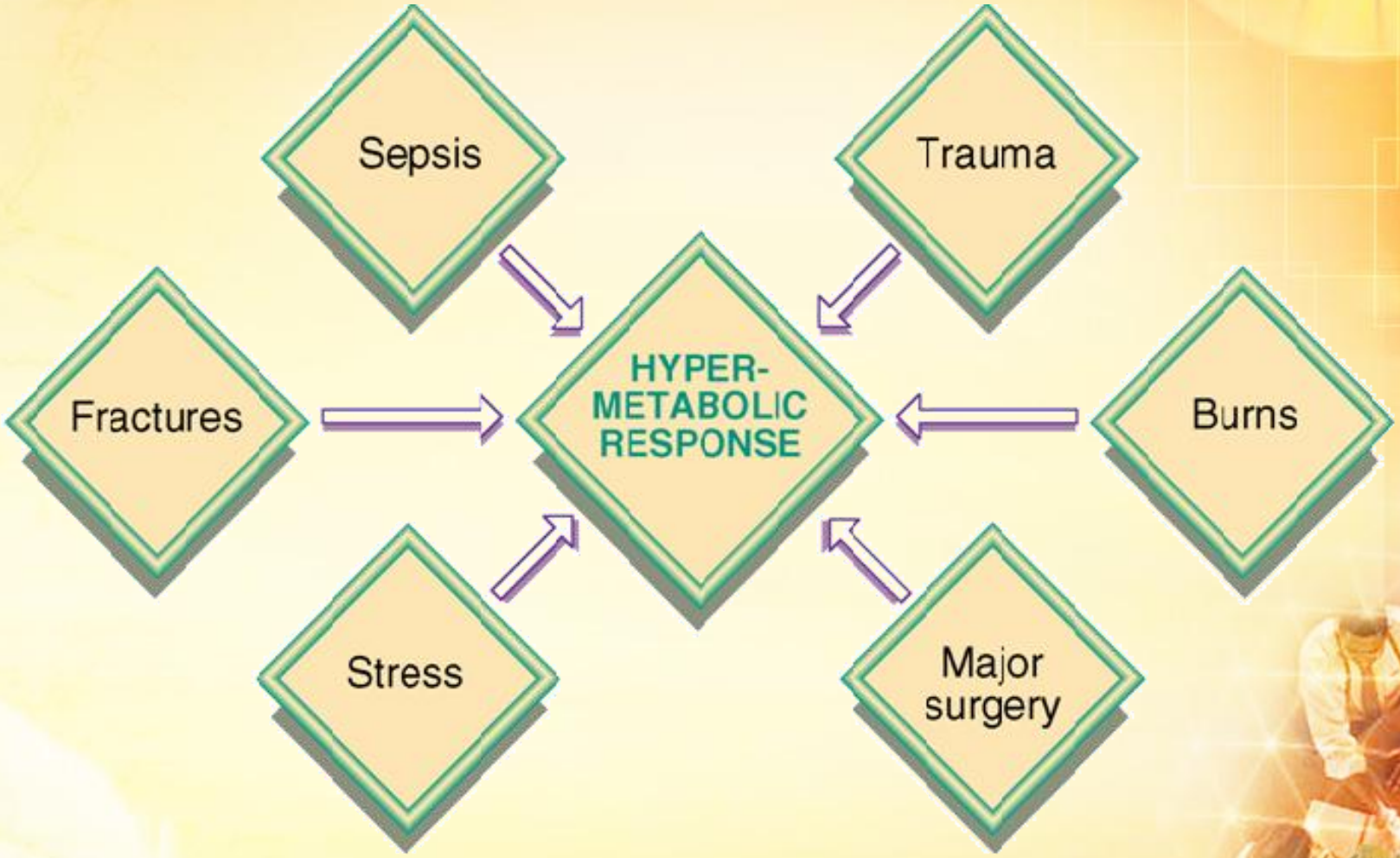
460 B.C. ~ 370 B.C.

'A slender and restricted diet is always dangerous in chronic and in acute diseases'

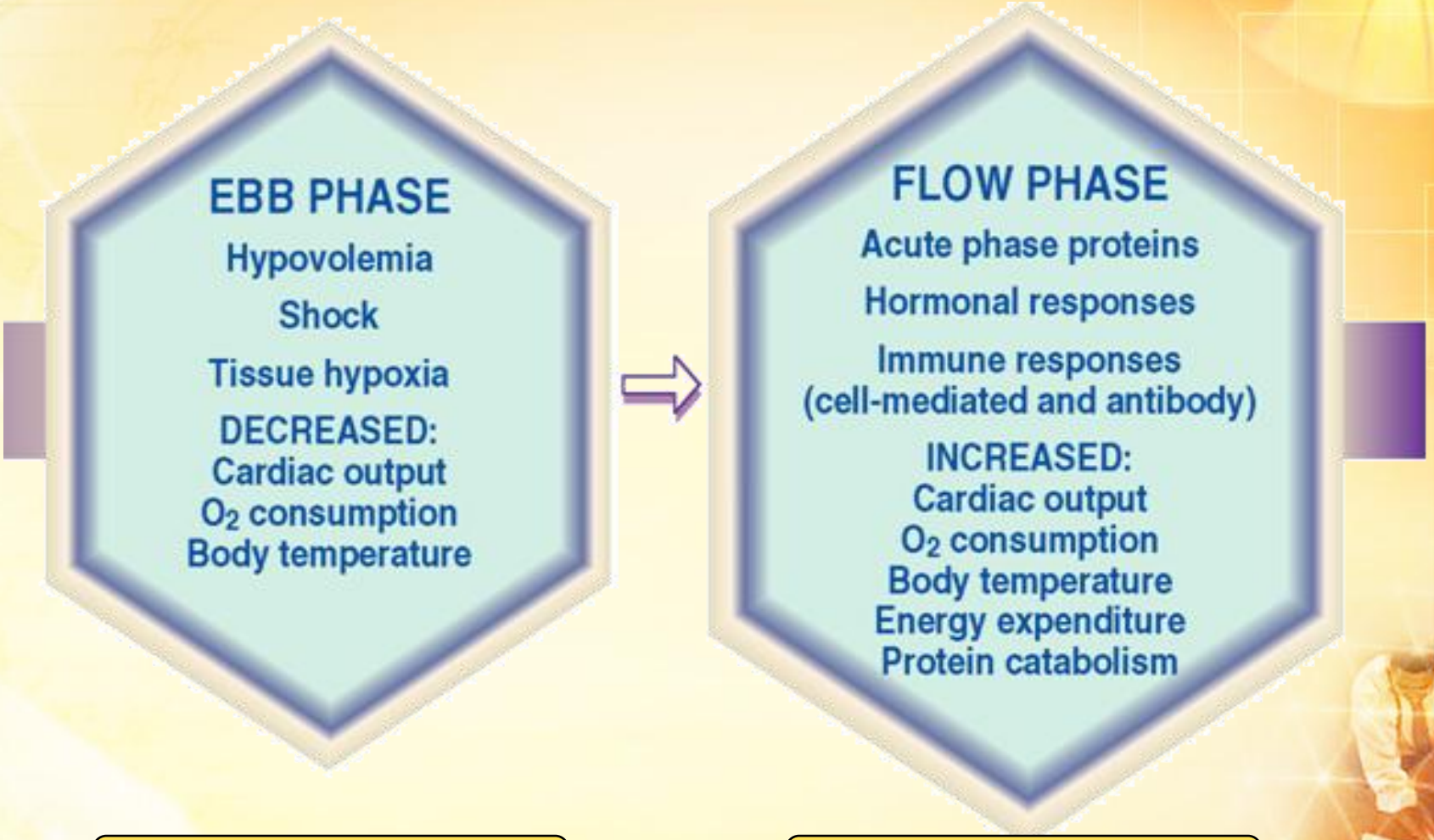
傳統台灣社會

您可曾想過您的病人”*吃飽沒*”？

加護病房的特徵 壓力


Sepsis
Trauma
Fractures
HYPER-
METABOLIC
RESPONSE
Burns
Stress
Major
surgery

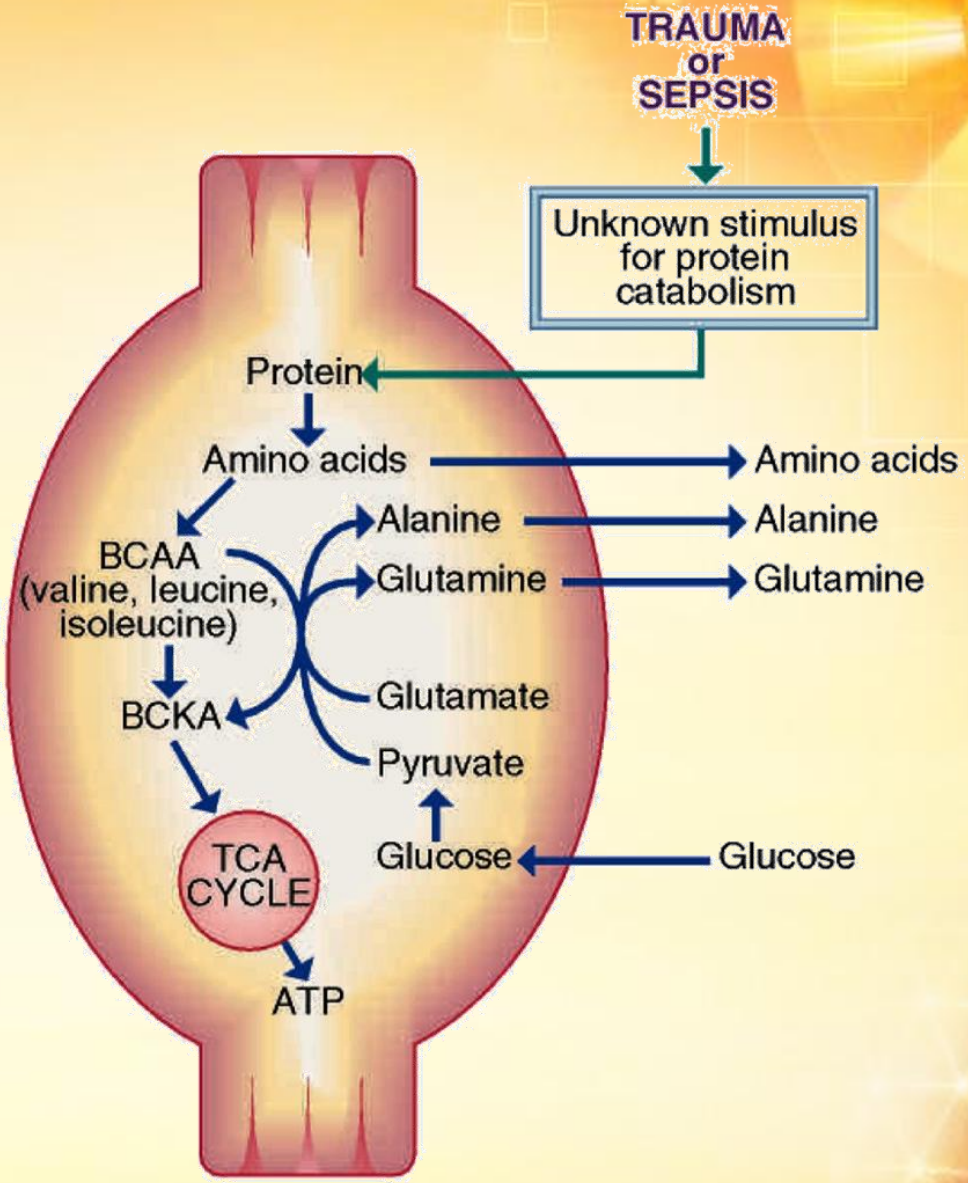
壓力下之生理病理變化：外傷為例



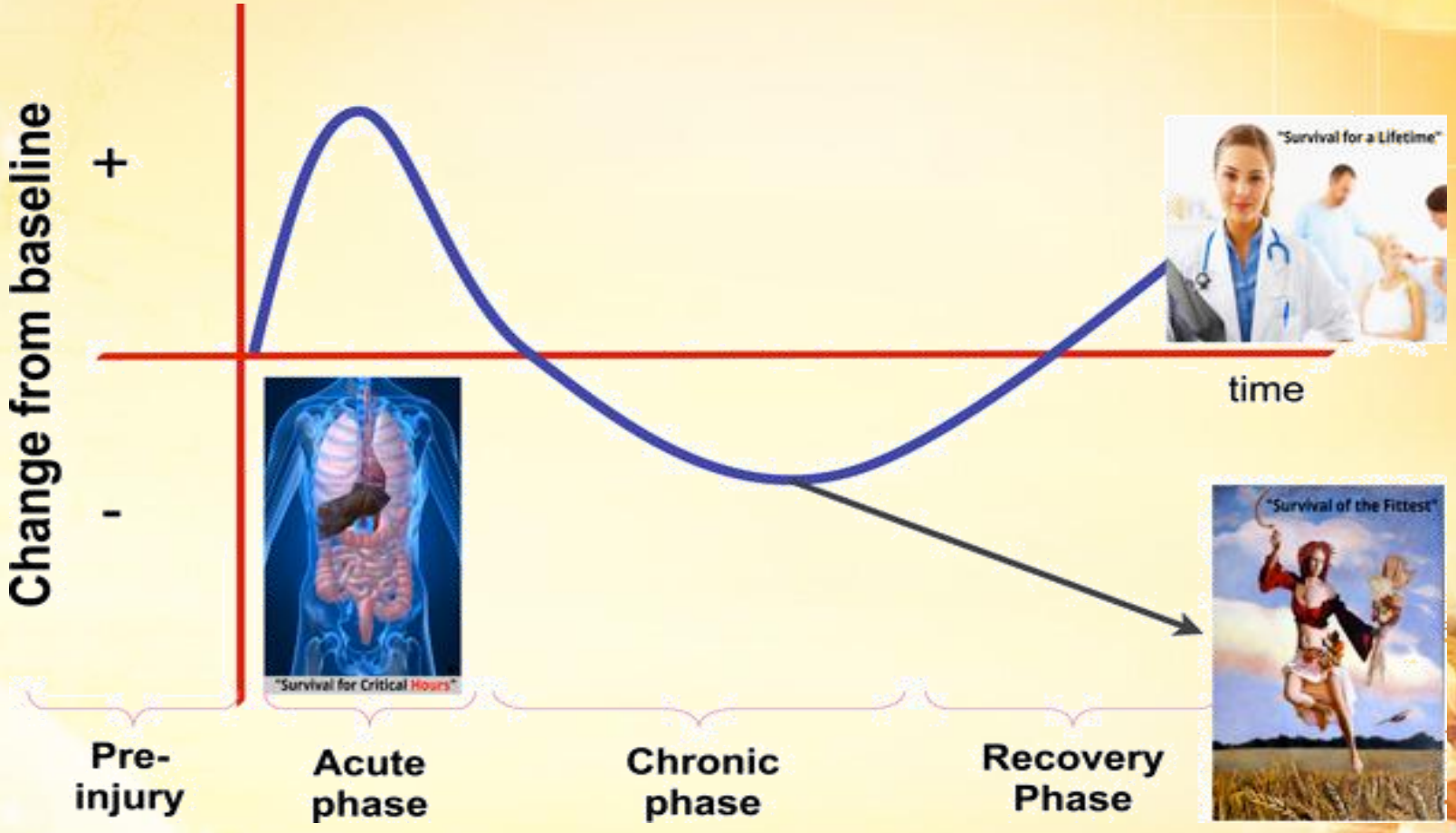
Metabolic rate↓

Metabolic rate ↑↑

Skeletal Muscle Proteolysis

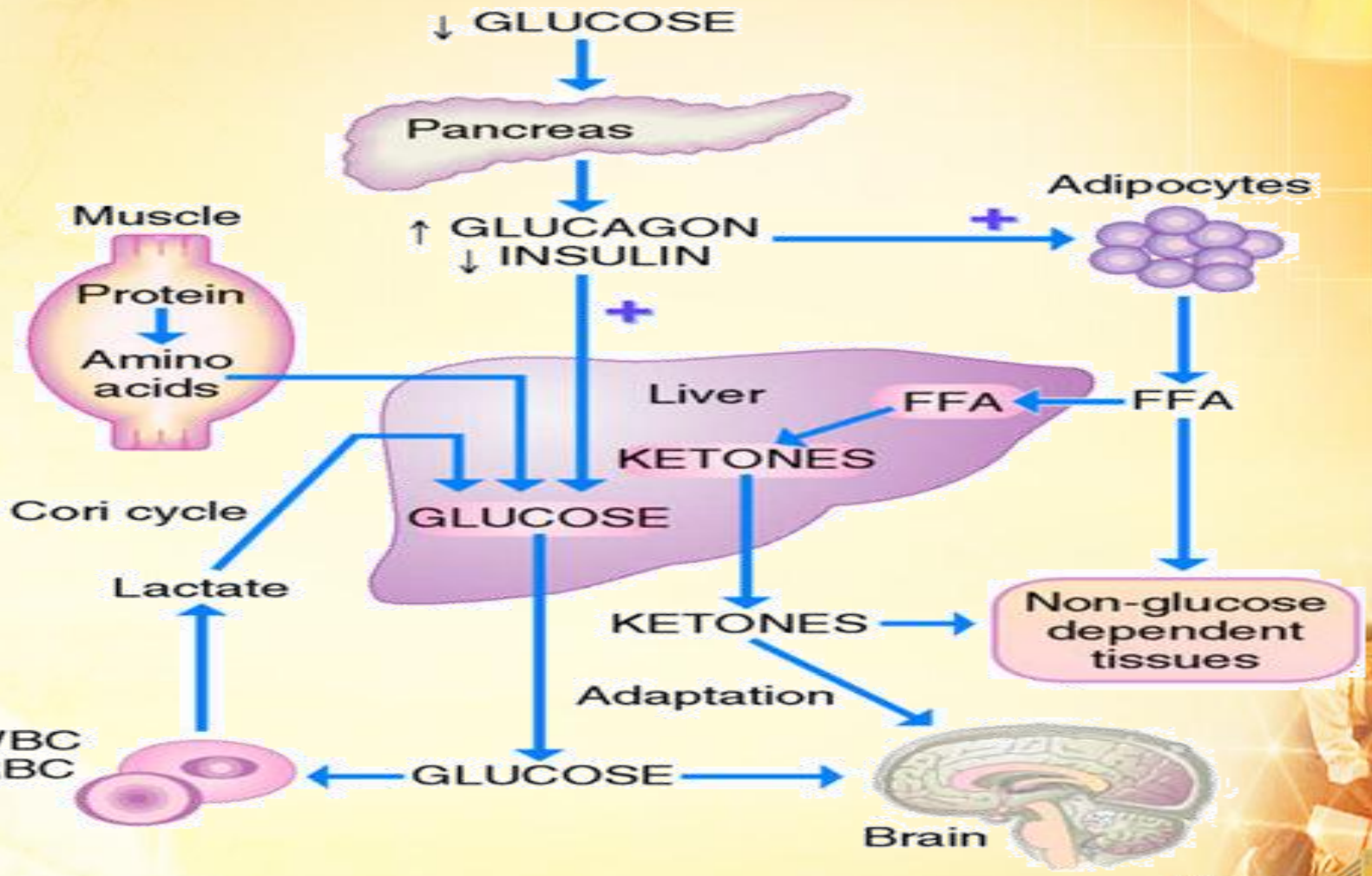


Phased Metabolic/Inflammatory Response to Critical Illness and Injury



Critical Care 2013; 17(Suppl 1):S7

飢餓下之生理病理變化



Why Nutrition Treatment is Important?

Critical Illness

- Anorexia
- Immobilization
- Inflammation
- Endocrine stress

- Iatrogenic NPO

Catabolic Response ↑

↓

Energy Debt

↓

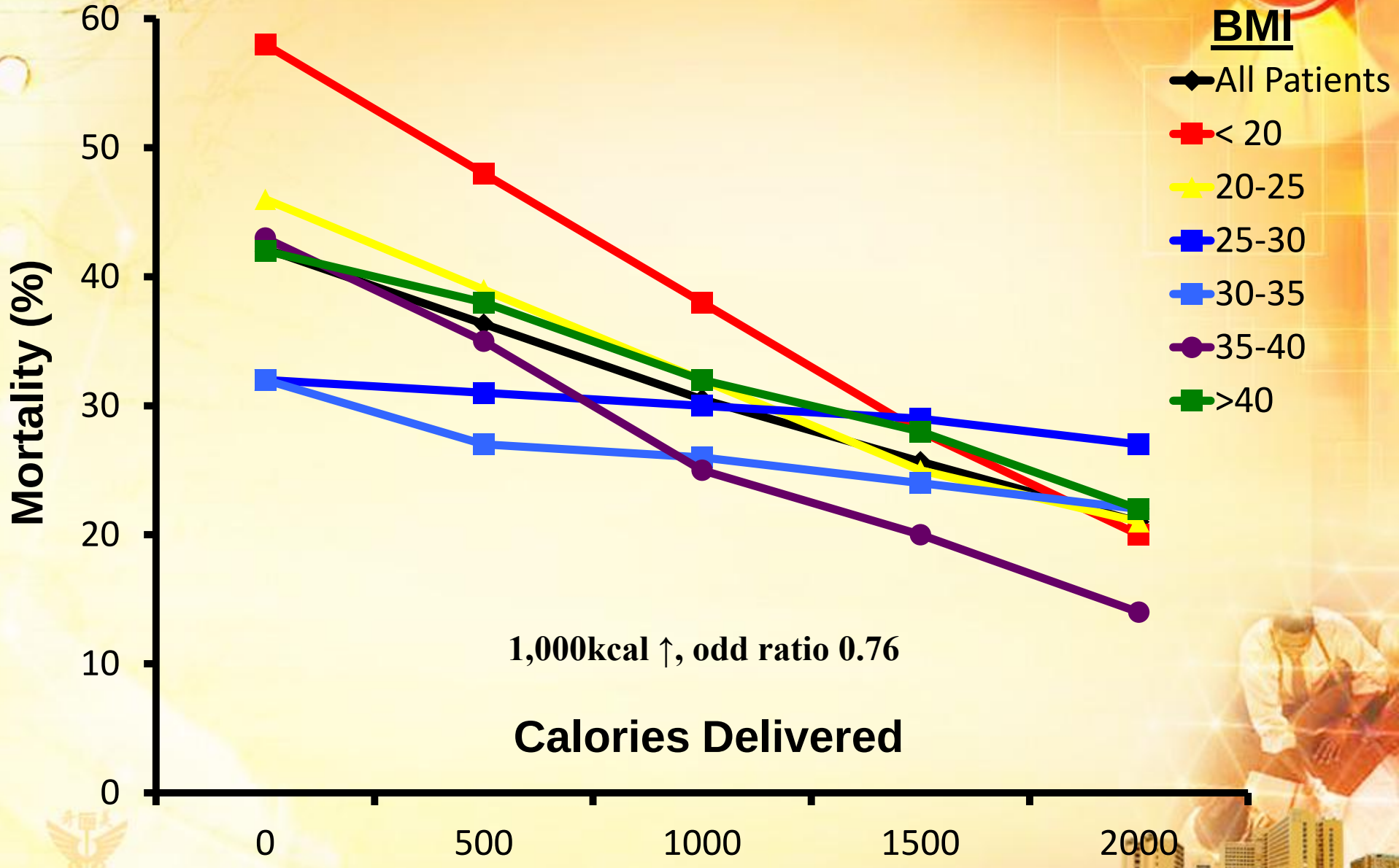
Lean Body Mass ↓

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

Intensive Care Med 2009; 35:1728–37

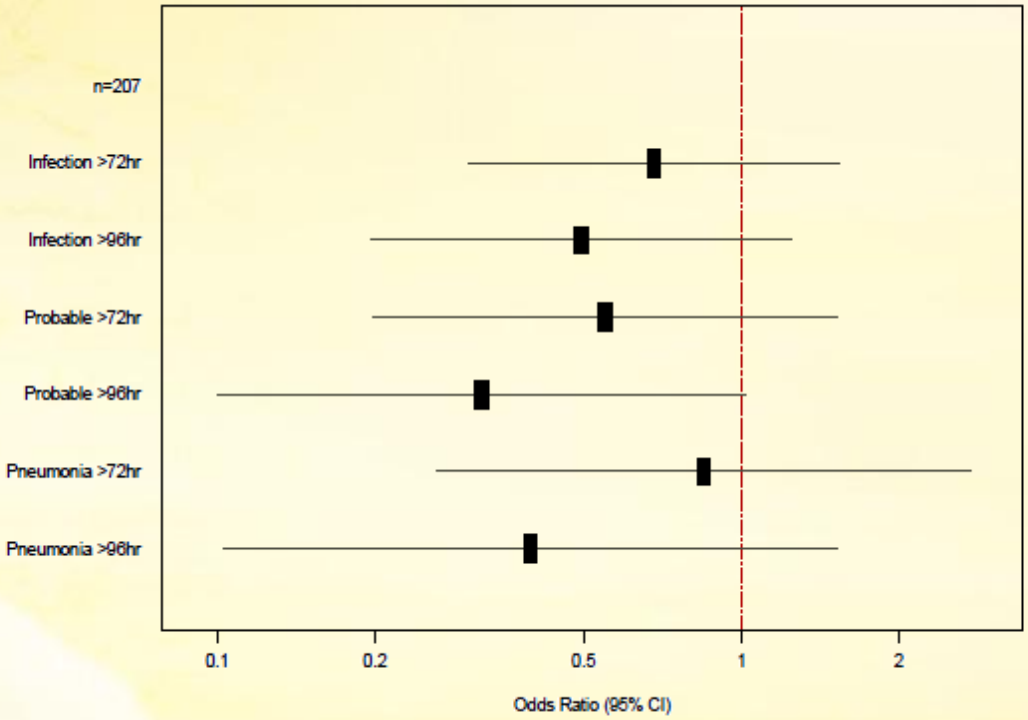
- Observational
- 137 ICUs from 37 countries over 5 continents
- 2,772 patients
  - Ventilated adult patients who remained in ICU >72 hours

Relationship of Caloric Intake, 60 day Mortality and BMI



The success of enteral nutrition and ICU-acquired infections: A multicenter observational study

Clinical Nutrition 30 (2011): 148-155



- Observational
- Multicenter
- 207 patients

  >72 hrs in ICU

for increase of 1000 cal/day, OR of infection at 28 days

Inadequate energy delivery during early critical illness correlates with increased risk of mortality in patients who survive at least seven days: A retrospective study

Clinical Nutrition 30 (2011): 209-214

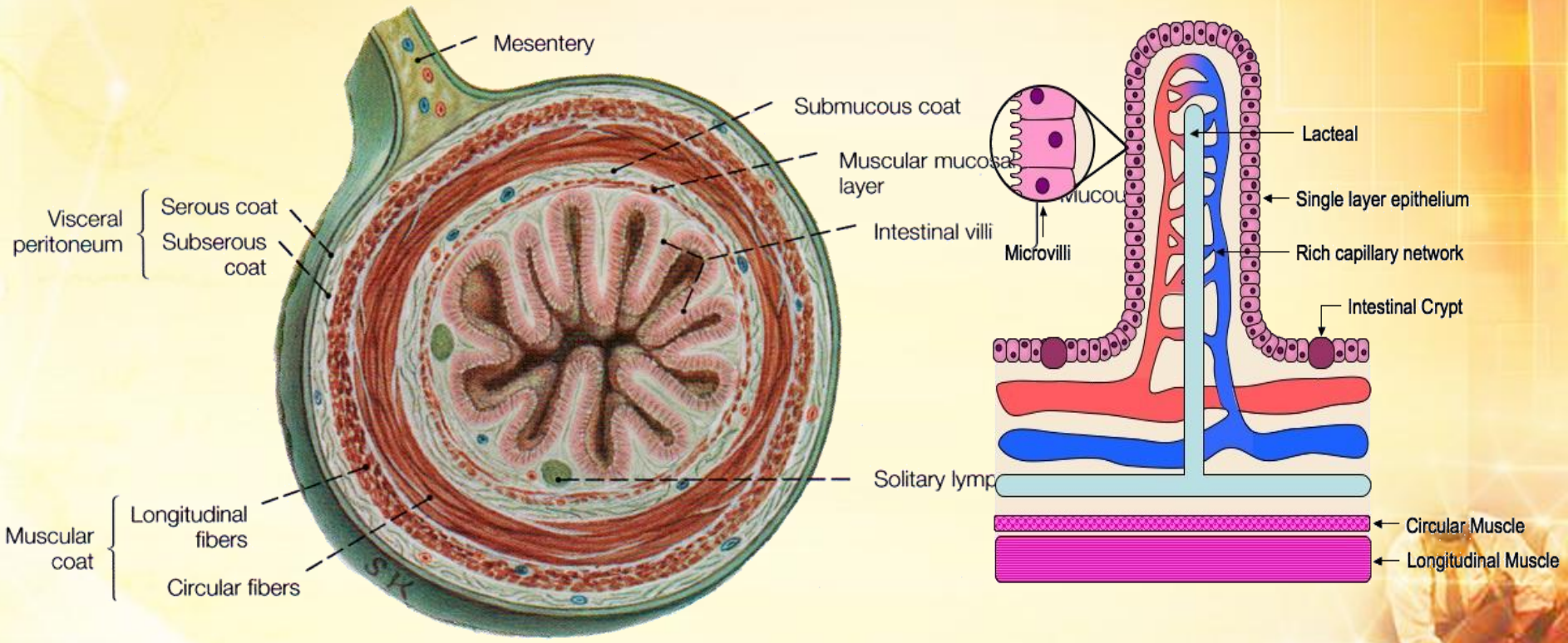
- Retrospective, Single medical ICU
- 295 patients
- High/Low Energy/Protein
  - 60% mean daily recommendation

Clinical outcomes	1st to 7th day			1st to 7th day		
	Low ED	High ED	P	Low PD	High PD	P
Length of Hospital stay	32.4 ± 22.7	38.6 ± 30.9	0.203	36.3 ± 31.5	37.9 ± 29.6	0.733
Length of ICU stay	14.4 ± 5.2	14.7 ± 5.5	0.746	14.7 ± 5.0	14.6 ± 5.5	0.942
Ventilator free time	3.0 ± 3.2	3.8 ± 4.0	0.291	3.2 ± 3.2	3.7 ± 4.1	0.482
ICU mortality	19 (42.2%)	41 (16.4%)	<0.001*	19 (41.3%)	41 (16.5%)	<0.001*

做善事 ≠ 做好事

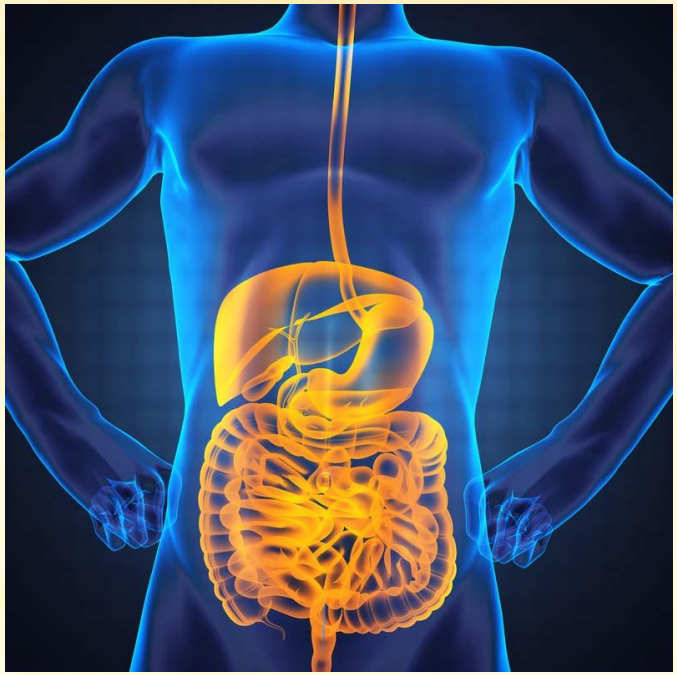
Enteral or Parenteral

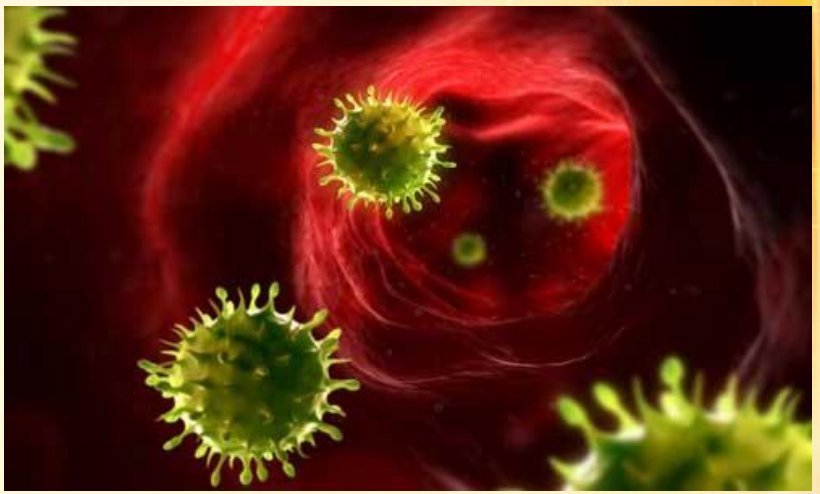
Small Bowel


Mesentery
Submucous coat
Muscular mucosae layer
Visceral peritoneum
Serous coat
Subserous coat
Intestinal villi
Solitary lymp
Muscular coat
Longitudinal fibers
Circular fibers
Lacteal
Single layer epithelium
Microvilli
Rich capillary network
Intestinal Crypt
Circular Muscle
Longitudinal Muscle

Gut is the Motor of Sepsis

Arch. Surg. 1986; 121: 196-208

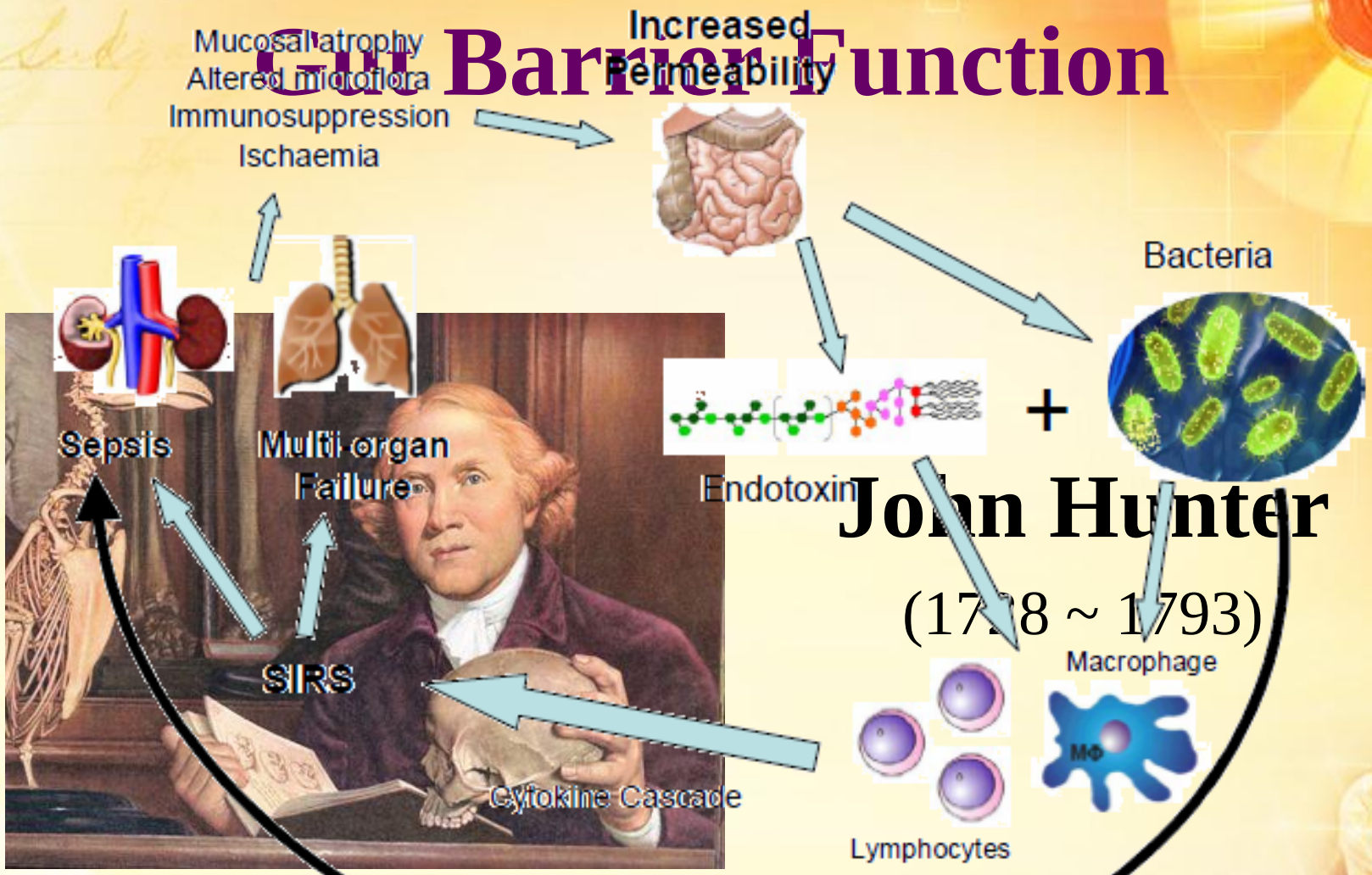




Gut-Derived Sepsis

Surgeon 2012; 10: 350-356

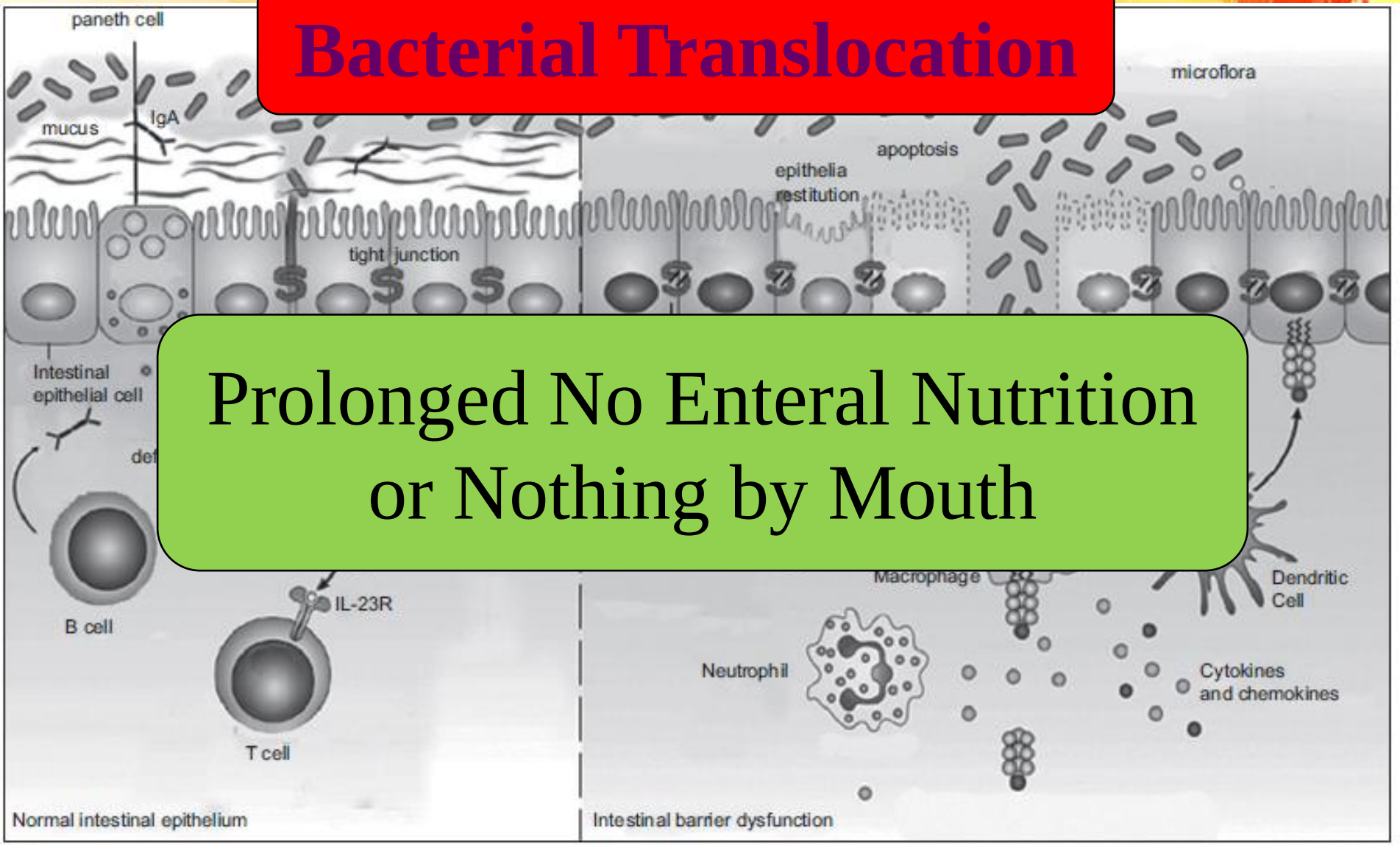
Gut Barrier Function



John Hunter

(1728 ~ 1793)

Bacterial Translocation



Prolonged No Enteral Nutrition or Nothing by Mouth

Ann Gastroenterol 2015;28(2):1-14

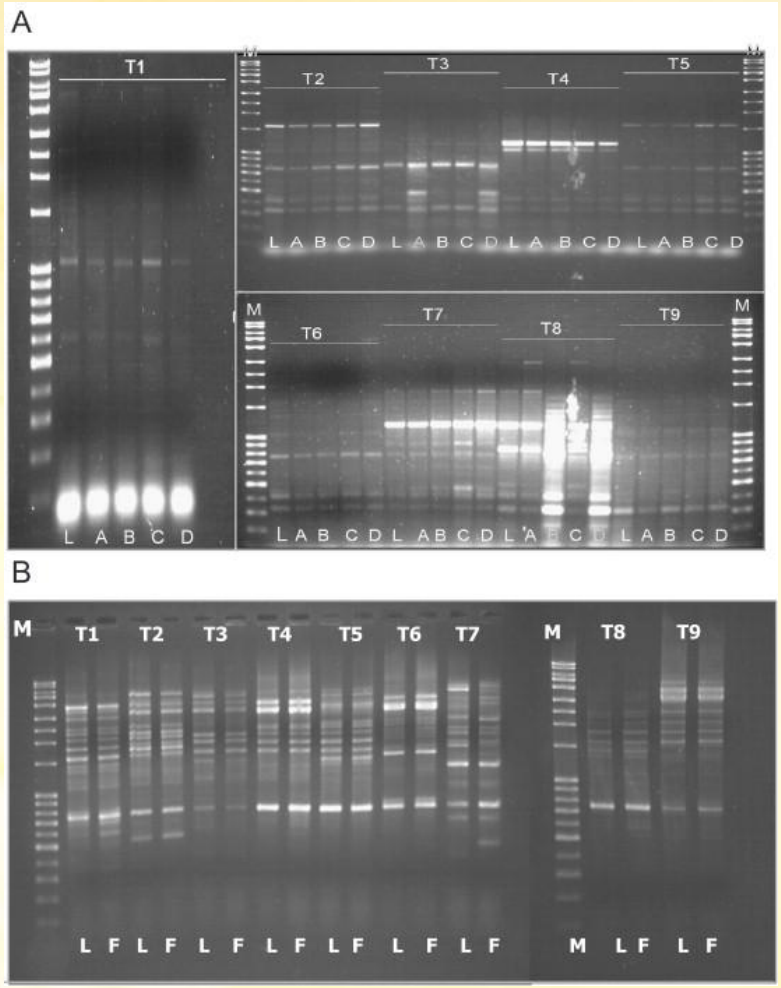
NAINR. 2003;3(2)

Sepsis After Coronary Bypass Grafting: Evidence for Loss of the Gut Mucosal Barrier

Ann Thorac Surg 1991;52:514-7

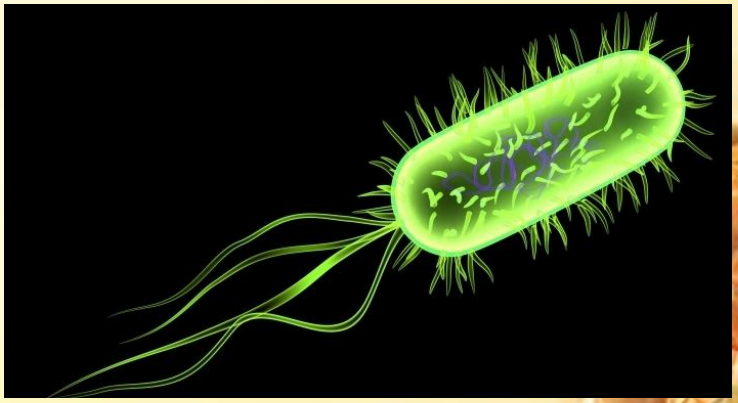
- 55 episodes of sepsis in 329 patients following coronary artery re-vascularization
- **75%** caused by gram negative ***enteric*** bacteria

Commensal bacteria do translocate across the intestinal barrier in surgical patients



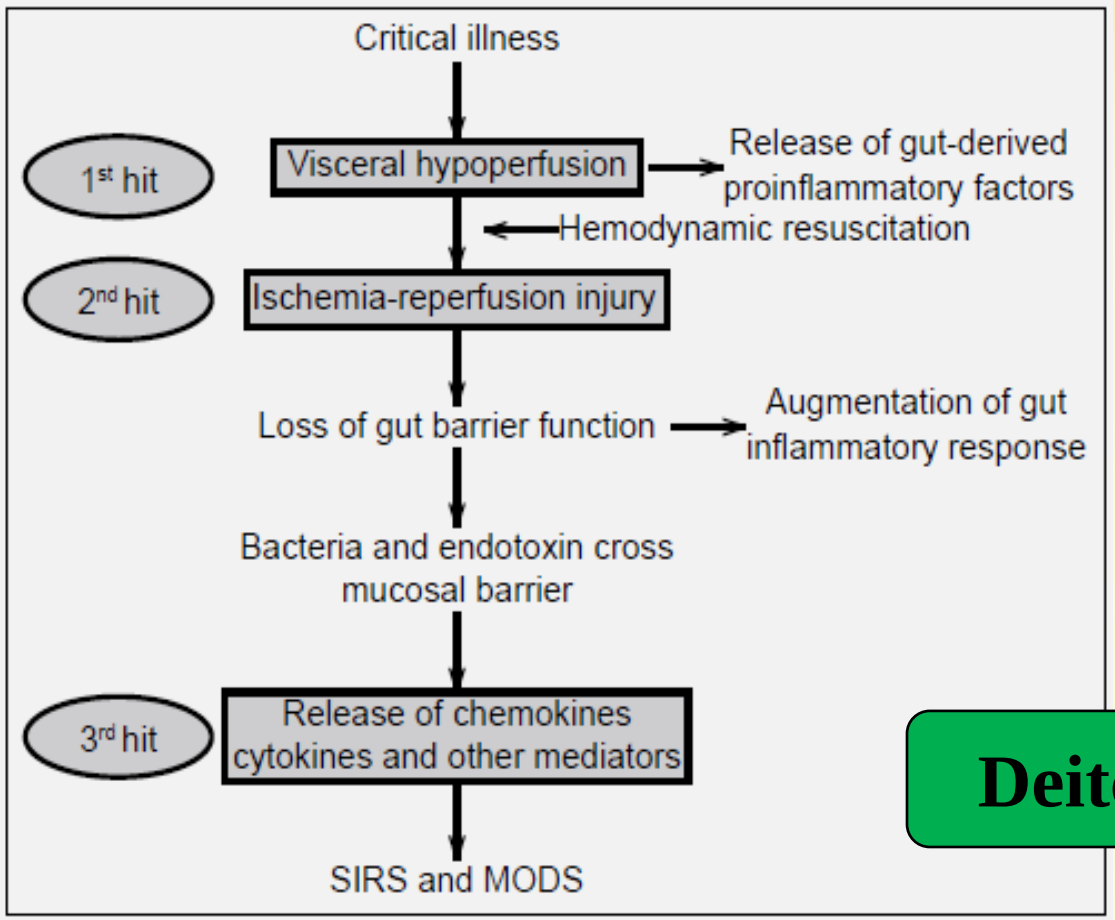
Clin Nutrit 2007; 26(2):208-215

- 98 colonic resection
- MLN & faecal samples
- DNA fingerprints (9/98)

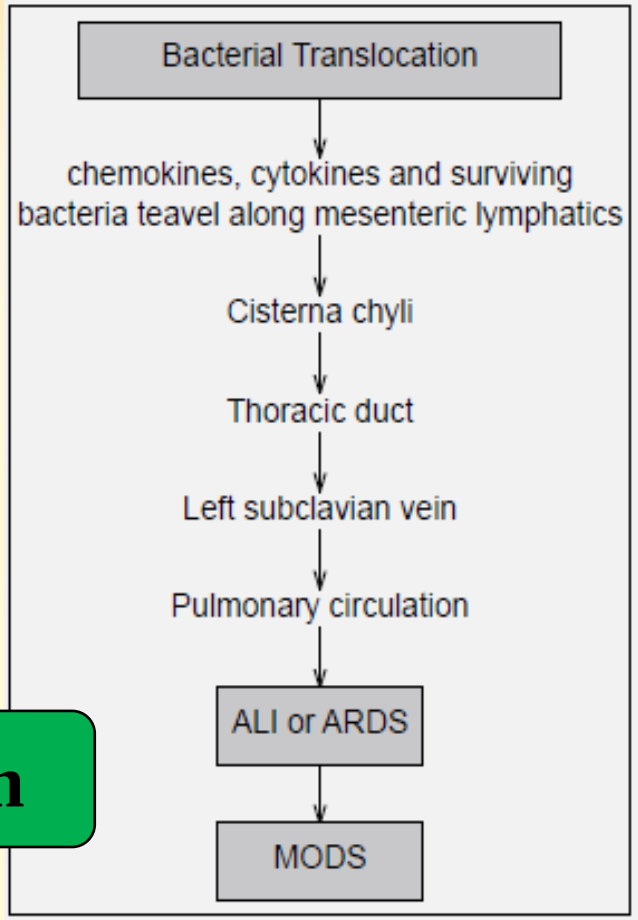


3-Hit Hypothesis

"**Gut Lymph**" Theory



Deitch



Surgery 2002; 131: 241-244

Front Biosci 2006;11:520-8

Gut Injury → Permeability ↑

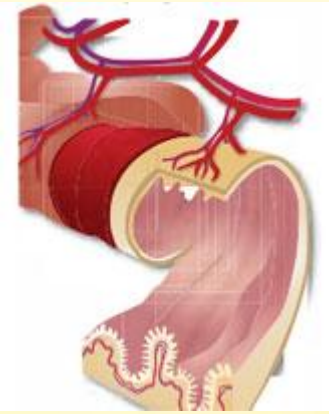
- Citrulline
- Intestinal bacterial DNA
- Scintigraphy of labeled bacteria

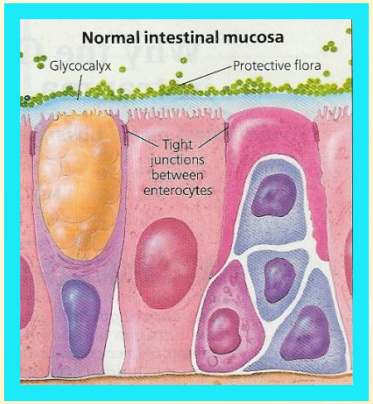
- D-lactate
- Glutathione S-transferase (GST)
- Intestinal fatty acid binding protein (iFABP)

Ann Gastroenterol 2015;28(2):1-14

Why Enteral Nutrition is Preferred?

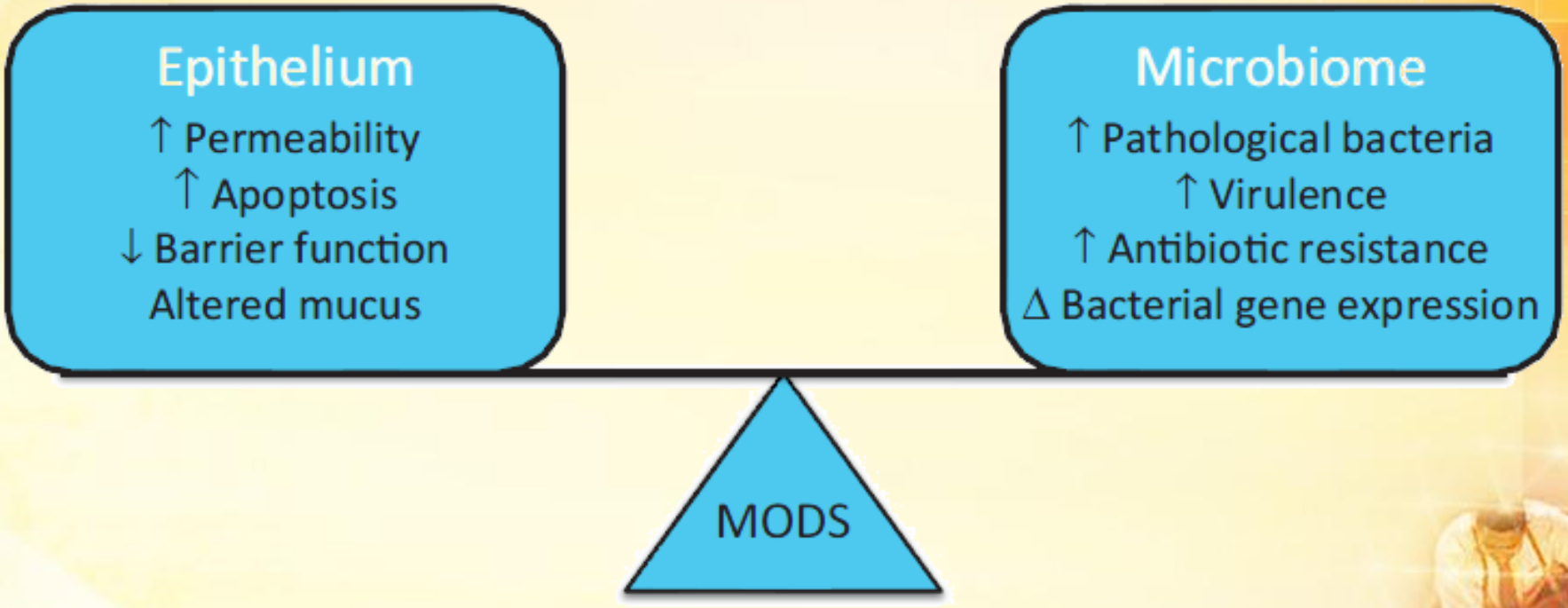
- Maintains GI tract function and integrity
- Stimulates GI contractility and trophic substance release
- Supports gut- and mucosal- associated lymphoid tissues
- Preserves gut microbiota
- Prevents parenteral nutrition-associated infective and metabolic morbidities





Nutr Clin Pract 2009;24:305-15

"If the gut works, use it."



Trends in Mol Med 2014; 20(4): 214-23

When is the Best Timing?

Enteral nutrition is considered as a "lower priority" in ICU than interventions for hemodynamic problems

Effects of Early Enteral Feeding on the Outcome of Critically Ill Mechanically Ventilated Medical Patients

- Retros
- Multi-
- 4,049 ventila
- "Early hours 63%)

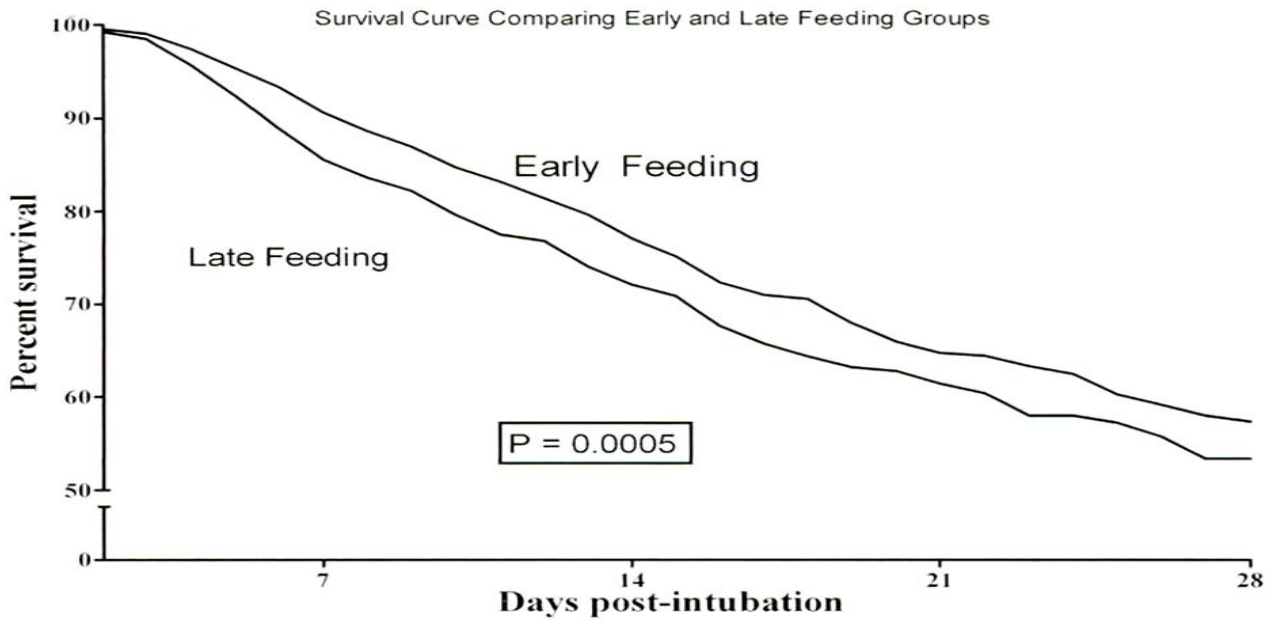


FIGURE 4. Kaplan-Meier estimates of survival among 2,537 critically ill medical patients in early feeding group and 1,512 patients in the late feeding group. Early feeding was associated with a significantly higher rate of survival (p = 0.0005 by the log-rank test).

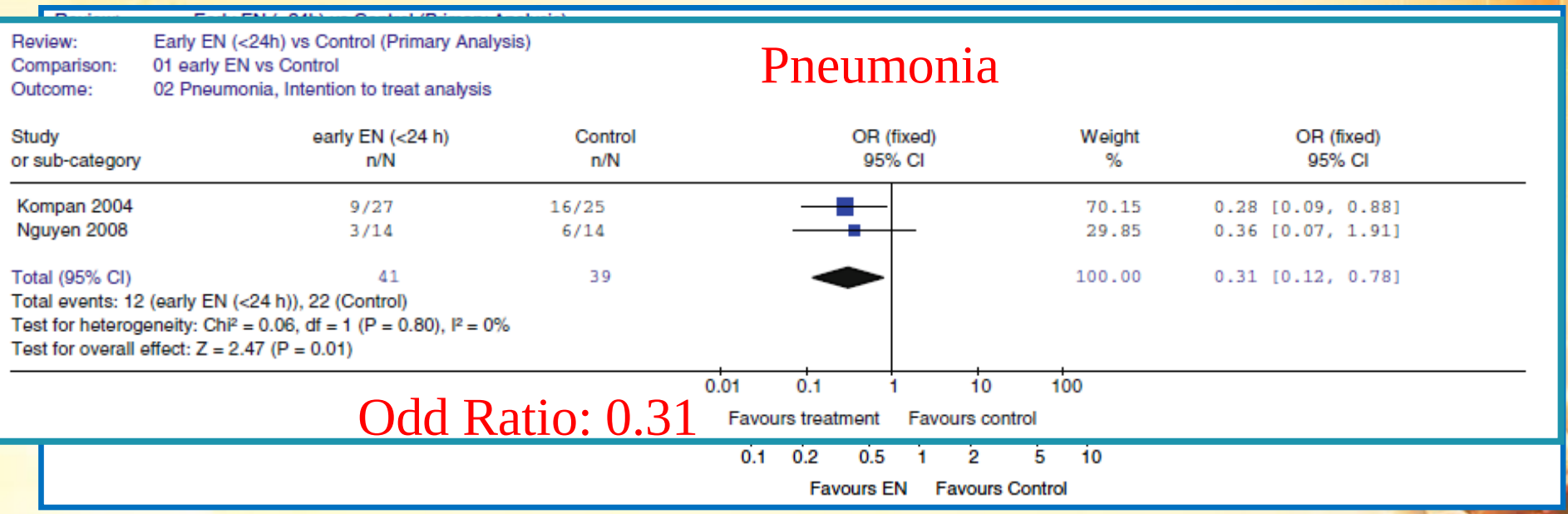
67

Early
Late

More evident in sickest group

Early enteral nutrition, provided within 24 h of injury or intensive care unit admission, significantly reduces mortality in critically ill patients: a meta-analysis of randomised controlled trials

Intensive Care Med 2009; 35:2018–27



- Meta-analysis; 6 RCTs; 234 p’ts

Early Enteral Nutrition

- ***24–48*** hours after admission
(ESPEN, Canadian Critical Care Guidelines)
- ***24–72*** hours after admission
(SCCM/ASPEN)
- ***24*** hours after admission
(Australian Guidelines)

Clin Nutr 2006;25:224-244.

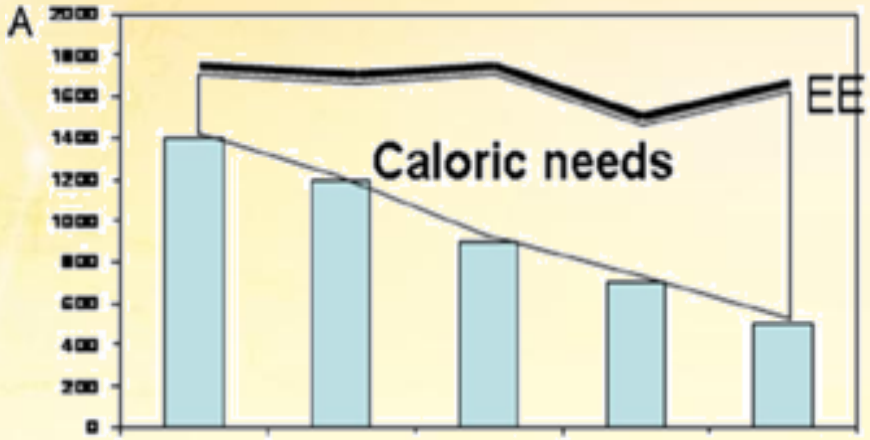
JPEN 2003;27:355-373.

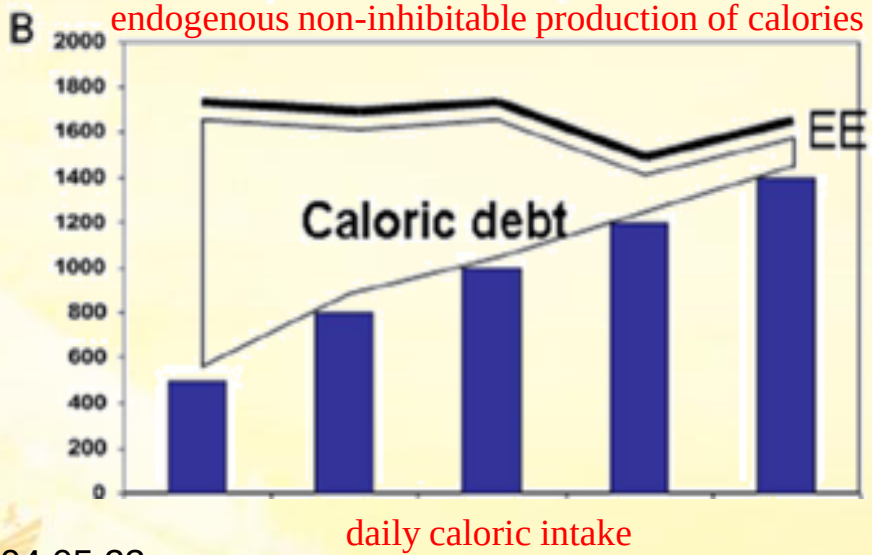
JPEN 2009;33:277-316.

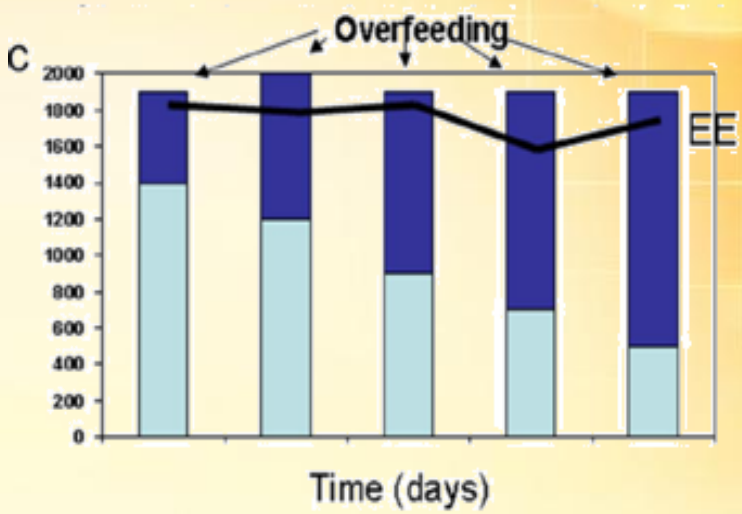
JAMA 2008;300:2731-2741

Early and Adequate EN is Best for the Patient!

Energy Requirement







Very over time

Predictive equation: fails in *80%*

Parenter Enteral Nutr 2013;37:705-713

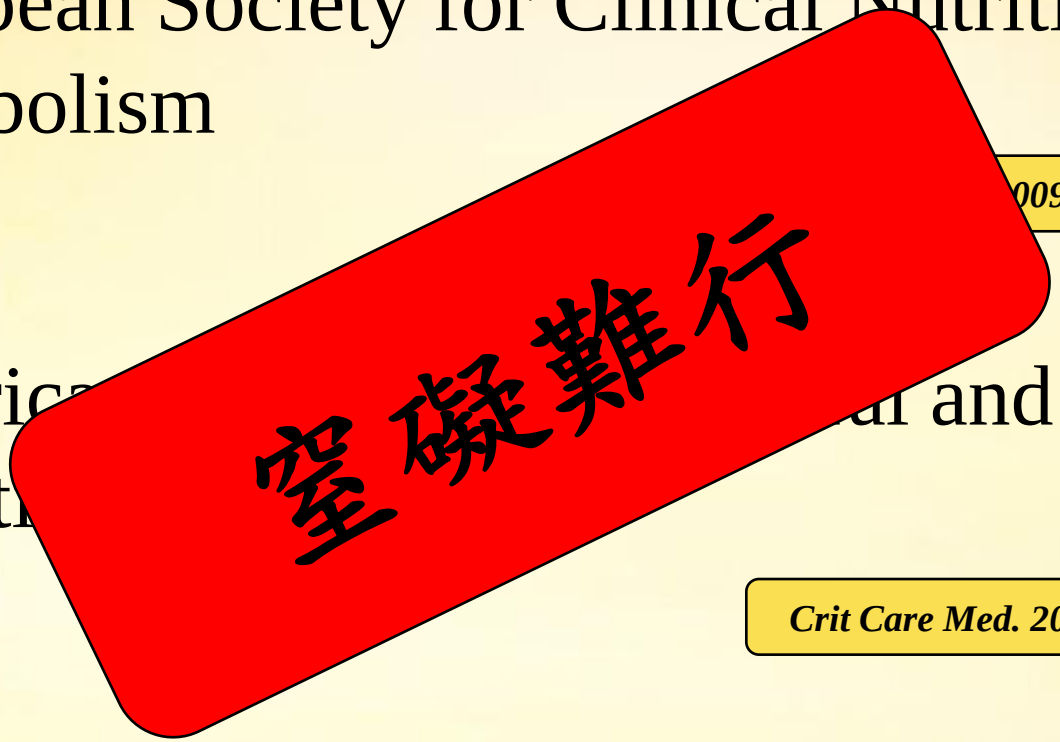
Indirect Calorimetry

- European Society for Clinical Nutrition and Metabolism

  009;28:387-400

- Americ… …al and Enteral Nutriti…

  Crit Care Med. 2009;37:1757-61



Rule of Thumb

ESPEN

- **EN**
  - Acute phase:
    - 20~25 kcal/kg/d
  - Recovery phase:
    - 25~30 kcal/kg/d
  - Severe undernutriton:
    - 25~30 kcal/kg/d
- **PN**
  - 25~30 kcal/kg/d

Clin Nutr 2006;25:210-223

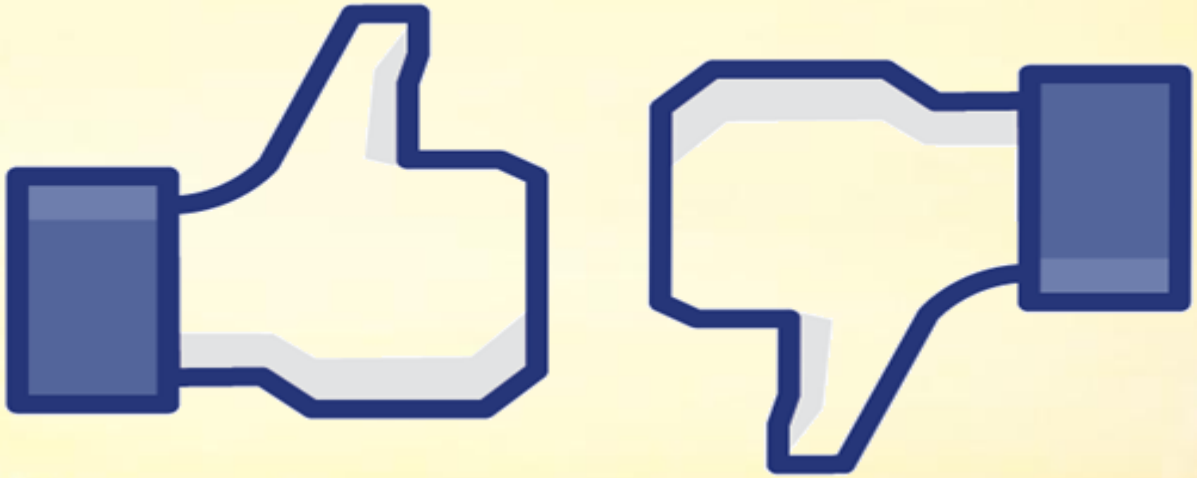
ASPEN

- **Goal**
  - 25-30 kcal/kg/d
  - Predictive equation
  - Indirect calorimetry
  - > 55 ~ 60% of requirement

J Parenter Enteral Nutr 2009;33:277-316

Matching Energy Expenditure

- Accelerated muscle catabolism
- Caloric debt and poor outcome
- Endogenous production of glucose
- Autophagy suppression



Tight Calorie Control Study (TICACOS)

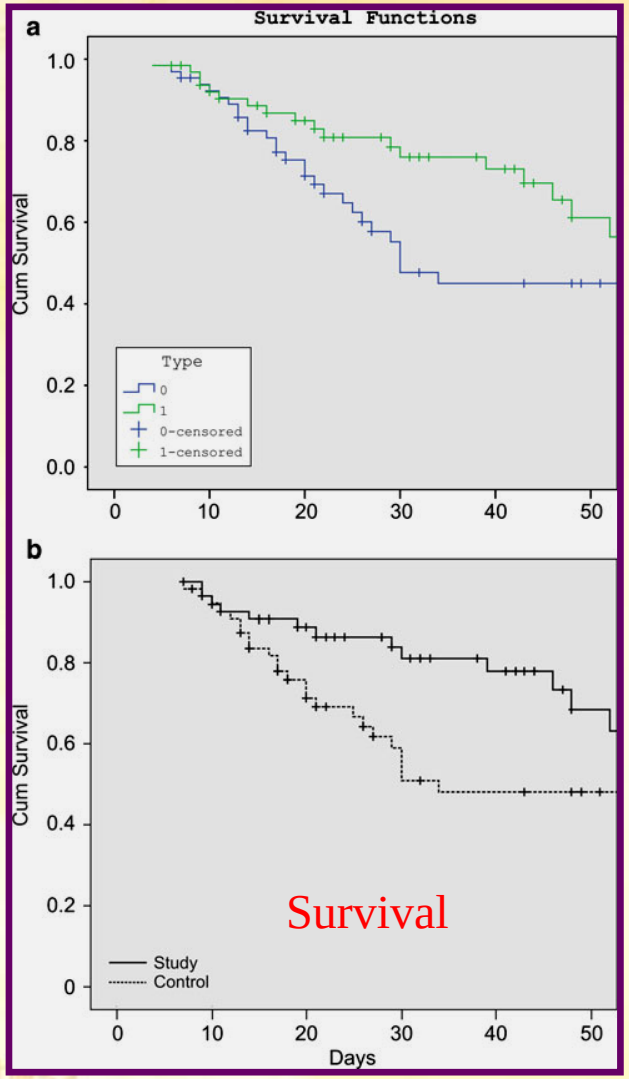
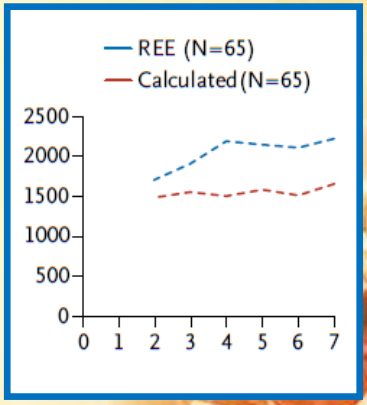


Table 4 Secondary outcomes for all patients ($n = 130$). Infectious complications are expressed in absolute numbers and percentage between brackets

Variable	Study group ($n = 65$)	Control group ($n = 65$)	p value
ICU mortality (%)	24.60%	26.20%	1.0
Duration ventilation (days)			
Mean	16.1 ± 14.7	10.5 ± 8.3	0.03
Median (range)	12.5 (1–82)	9 (1–33)	
Duration ICU stay (days)			
Mean	17.2 ± 14.6	11.7 ± 8.4	0.04
Median (range)	14 (1–84)	10 (0.5–35)	
Duration hospital stay (days)			
Mean	33.8 ± 22.9	31.8 ± 27.3	0.33
Median (range)	29 (4–101)	21 (4–142)	
Infectious complications (n)	37	20	0.05
VAP (%)	18 (27.7%)	9 (13.8%)	0.08
Bacteremia (%)	13 (20.0%)	8 (12.3%)	0.33
Urinary tract infections (%)	0	1 (1.5%)	1.0
Wound infections (%)	5 (7.7%)	1 (1.5%)	0.21
Abdominal infections (%)	1 (1.5%)	1 (1.5%)	1.0
New pressure ulcers (%)	26 (40.0%)	20 (30.8%)	0.34
Unplanned surgery and surgical complications (%)	4 (6.2%)	3 (4.6%)	1.0
Renal impairment[a] & requirement	14 (21.6%)	10 (15.4%)	0.49

- RCT, 1 ICU
- Ventilated
- Calorimetry vs 25 kcal/kg/d
- 130 p’ts



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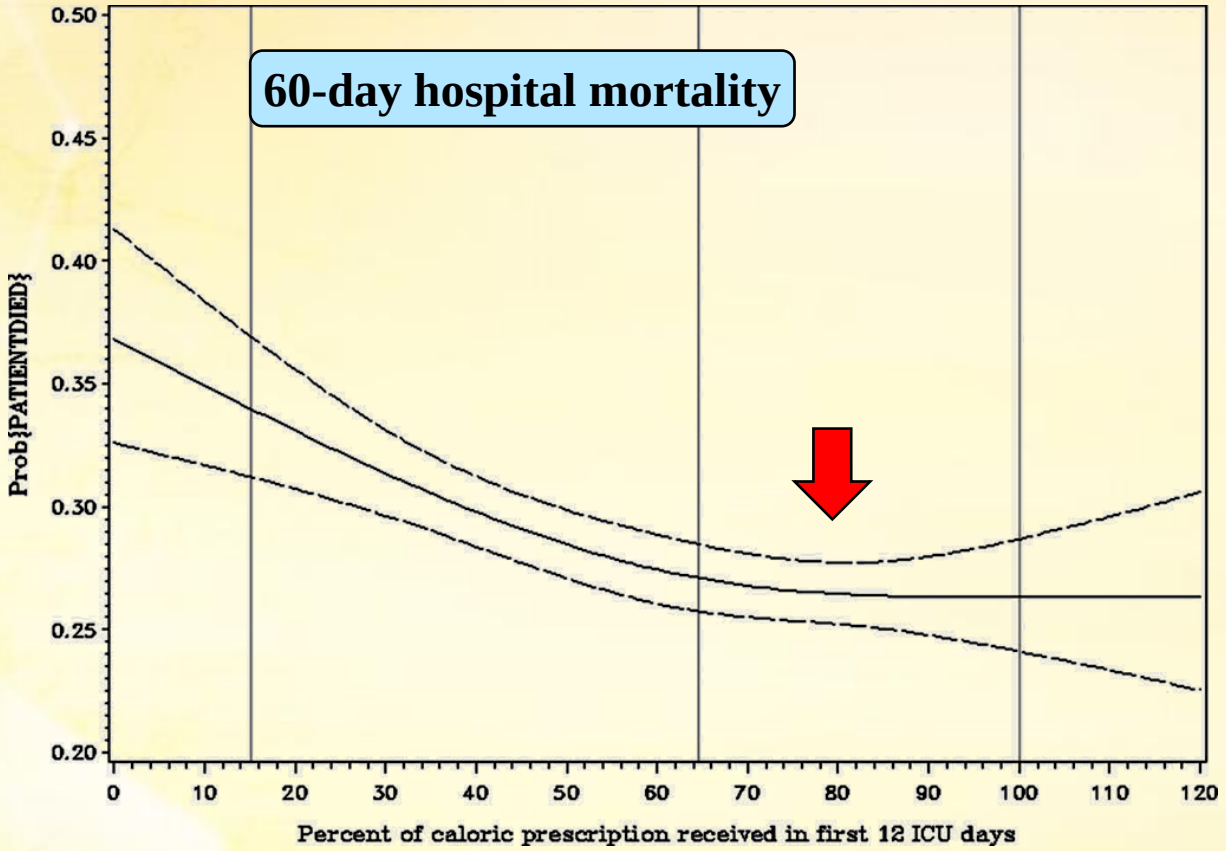
Intensive Care Med 2011; 37:601–9

Optimal Amount of Calories



- Observational
- 352 ICUs
- 33 Countries
- 7,872 ventilated p'ts (at least 96 hrs)

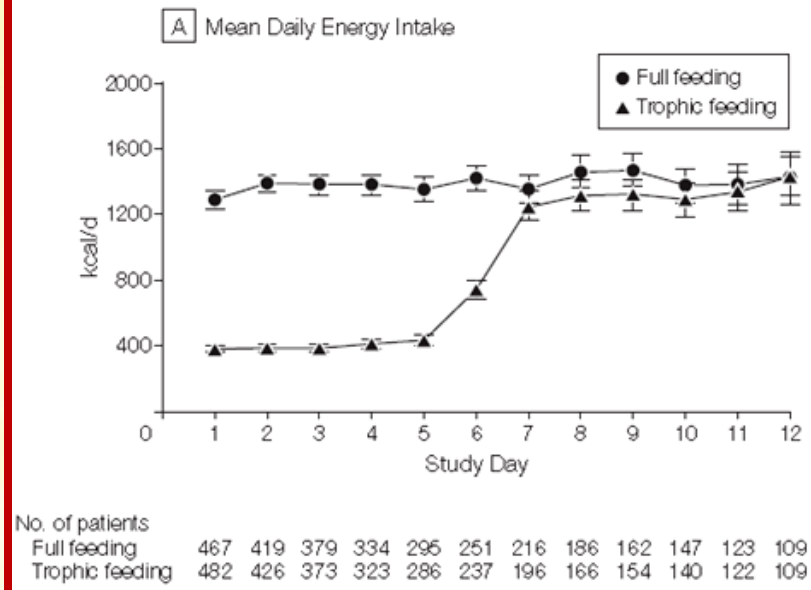
Crit Care Med. 2011;39:2619-26

Initial Trophic vs Full Enteral Feeding in Patients With Acute Lung Injury

The **EDEN** Randomized Trial

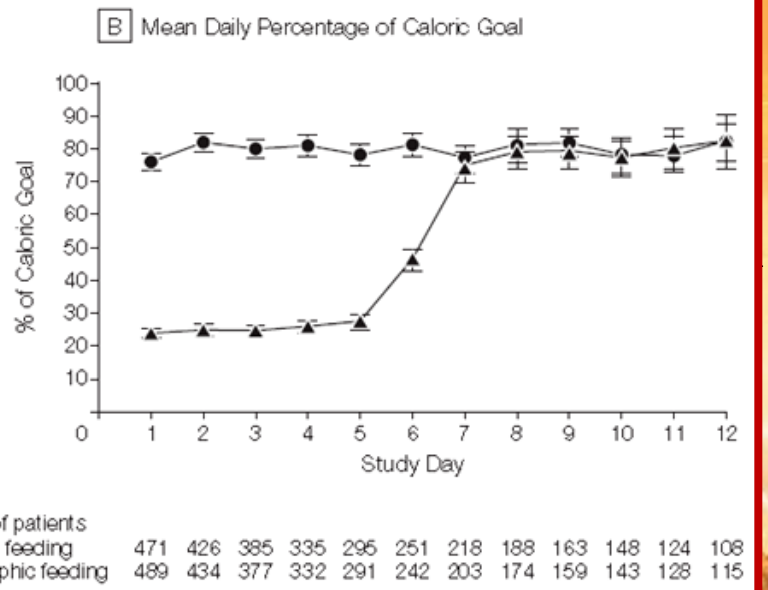
- 1,000 relatively young

Figure 4. Daily Energy Intake and Daily Percentage of Goal Enteral Feedings



No. of patients

Full feeding	467	419	379	334	295	251	216	186	162	147	123	109
Trophic feeding	482	426	373	323	286	237	196	166	154	140	122	109



No. of patients

Full feeding	471	426	385	335	295	251	218	188	163	148	124	108
Trophic feeding	489	434	377	332	291	242	203	174	159	143	128	115

- 10~20 ml/hr, 12h RGV

JAMA 2012 ; 307:795–803

Initial Trophic vs Full Enteral Feeding in Patients With Acute Lung Injury

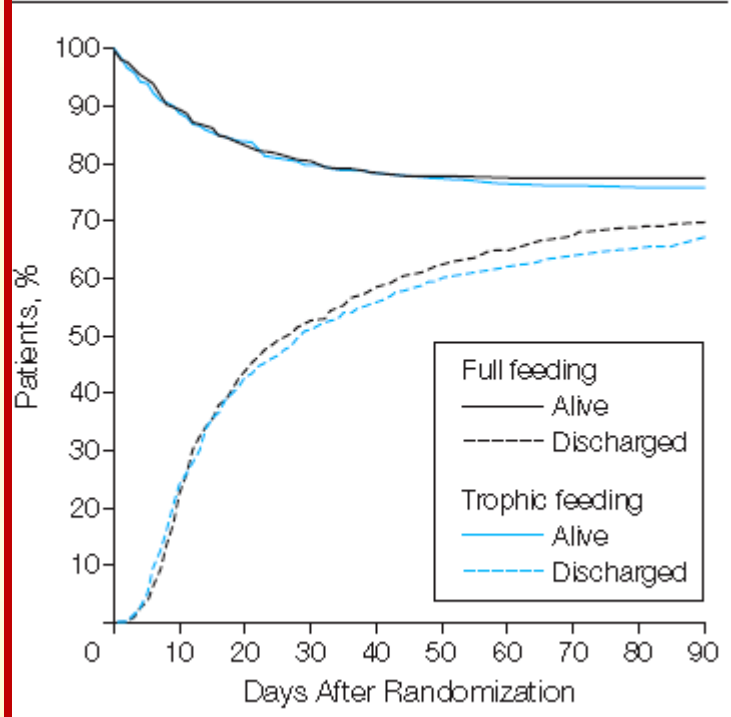
The **EDEN** Randomized Trial

Table 2. Clinical Outcomes

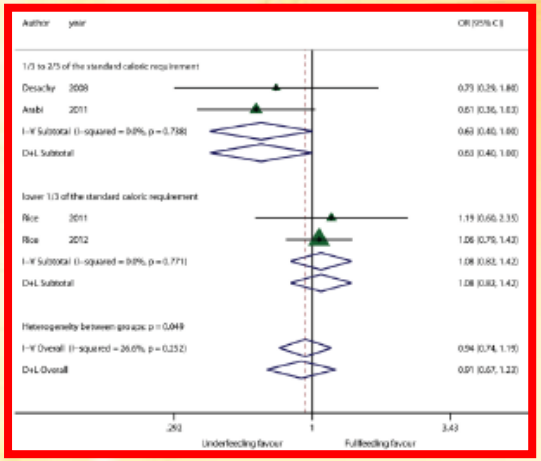
Outcome	Trophic Feeding (n = 508)	Full Feeding (n = 492)	*P* Value
Ventilator-free days, No. (95% CI)	14.9 (13.9-15.8)	15.0 (14.1-15.9)	.89
Failure-free days, No. (95% CI)			
Cardiovascular	19.1 (18.2-20.0)	18.9 (18.1-19.8)	.75
Renal	20.0 (19.0-20/9)	19.4 (18.4-20.5)	.43
Hepatic	22.0 (21.2-22.9)	22.6 (21.8-23.5)	.37
Coagulation	22.3 (21.4-23.1)	23.1 (22.3-23.9)	.16
ICU-free days, No. (95% CI)	14.4 (13.5-15.3)	14.7 (13.8-15.6)	.67
60-d mortality, No. (%) [95% CI]	118 (23.2) [19.6-26.9]	109 (22.2) [18.5-25.8]	.77
Development of infections, No. (%) [95% CI]			
VAP	37 (7.3) [5.0-9.5]	33 (6.7) [4.5-8.9]	.72
Clostridium difficile colitis	15 (3.0) [1.5-4.4]	13 (2.6) [1.2-4.1]	.77
Bacteremia, No. (%)	59 (11.6) [8.8-14.4]	46 (9.3) [6.8-11.9]	.24

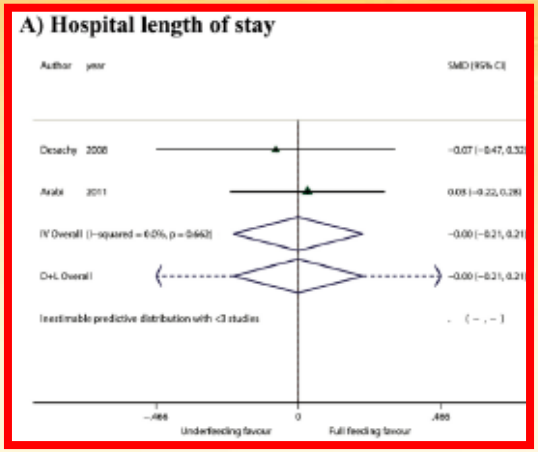
Abbreviations: ICU, intensive care unit; VAP, ventilator-associated pneumonia.

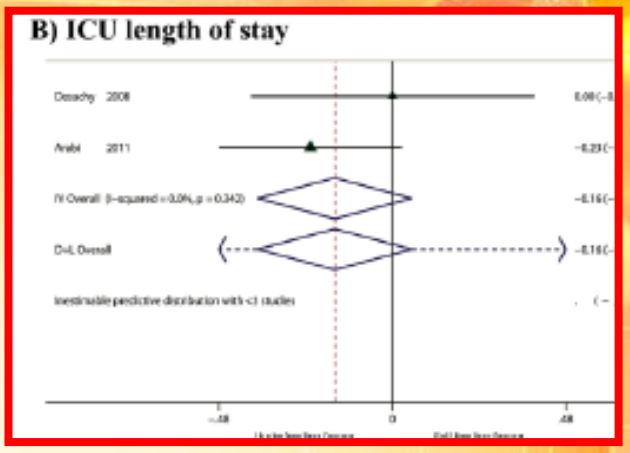
Figure 3. Survival and Hospital Discharge



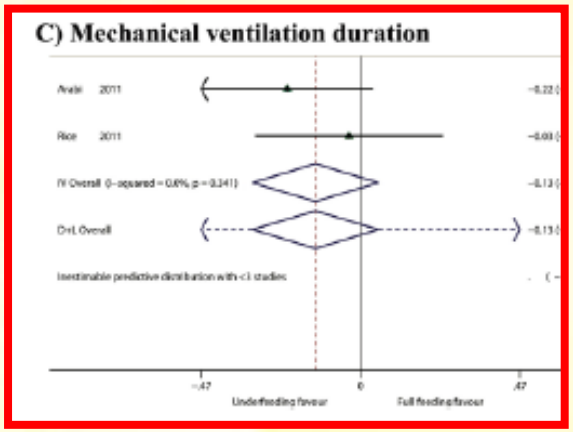
JAMA (2012) 307:795–803

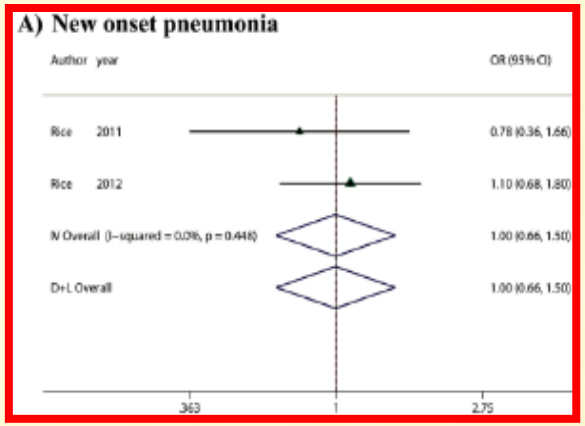


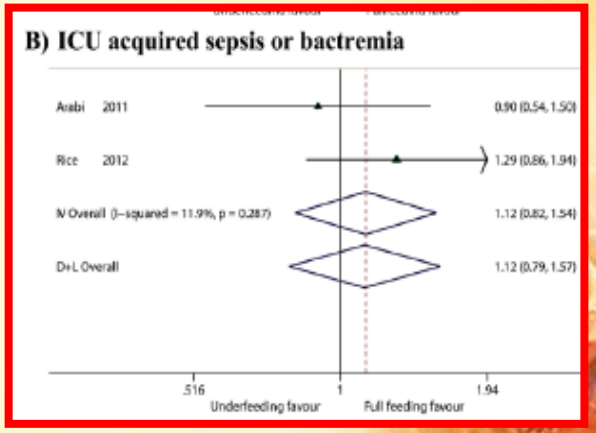




Trophic Feeding
Permissive Under-caloric Feeding







J Parenter Enteral Nutr. 2015;39:291-300

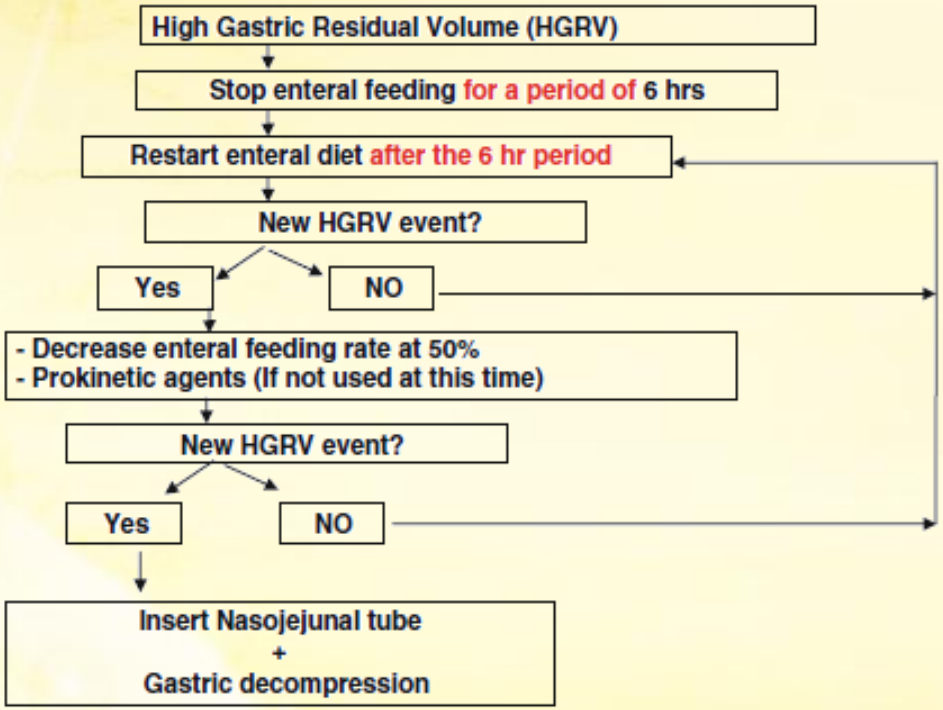
The Key Point is GI Intolerance

In My Daily Practice…

Gastric residual volume during enteral nutrition in ICU patients: the REGANE study

GRV 500 ml vs. 200 ml

Intensive Care Med (2010) 36:1386–93



- RCT
- 28 ICUs
- 329 ventilated p'ts
- Metoclopramide (10 mg every 8 h) x III days
- 1st EN day: GRV q6h
- 2nd EN day: GRV q8h
- 3rd EN day: GRV qd

Gastric residual volume during enteral nutrition in ICU patients: the REGANE study

GRV 500 ml vs. 200 ml

Intensive Care Med (2010) 36:1386–93

Table 3 Gastrointestinal complications

	Control (GRV: 200)	Study (GRV: 500)	*P*
Patients	165	157	
Patients with gastrointestinal complications	105 (63.6%)	75 (47.8%)	0.004
Patients with HGRV	70 (42.4%)	42 (26.8%)	0.003
Patients with abdominal distension	18 (10.9%)	16 (10.2%)	0.83
Patients with diarrhea	33 (20.0%)	31 (19.7%)	0.95
Patients with vomiting	24 (14.5%)	17 (10.8%)	0.31
Patients with regurgitation	12 (7.3%)	8 (5.1%)	0.41
Patients with aspiration	0	1 (0.6%)	0.48

GRV gastric residual volume, *HGRV* high gastric residual volume

Table 4 Outcome variables

	Control (GRV: 200)	Study (GRV: 500)	*P*
Mechanical ventilation (days)	14.7 ± 13.1	15.6 ± 13.6	0.36
ICU stay (days)	19.8 ± 15.8	20.7 ± 16.2	0.50
Pneumonia[a]	27.3%	28.0%	0.88
Ventilator-free days	5.1 ± 6.4	5.1 ± 8.0	0.28
SOFA day 5	6.3 ± 3.3	6.2 ± 3.2	0.48
SOFA day 10	5.0 ± 3.2	5.3 ± 3.0	0.75
ICU mortality[a]	15.7%	19.8%	0.28
Hospital mortality[a]	33.6%	33.9%	0.53

Values are expressed as percentage or mean ± SD
GRV gastric residual volume
[a] Percentage of patients

RCT; 28 ICUs; 329 ventilated p’ts

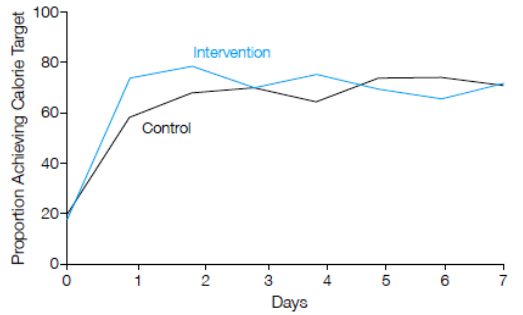
Effect of Not Monitoring Residual Gastric Volume on Risk of Ventilator-Associated Pneumonia in Adults Receiving Mechanical Ventilation and Early Enteral Feeding

A Randomized Controlled Trial

JAMA 2013; 309:249–56

Figure 3. Proportions of Patients Who Achieved Their Calorie Target During the First Week in the Groups With (Control) and Without (Intervention) Residual Gastric Volume Monitoring

Target achieved



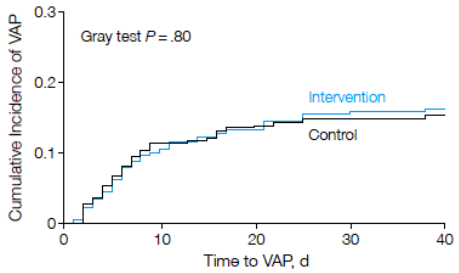
No. of patients

Intervention	227	222	206	184	153	141	119	103
Control	222	220	212	193	166	142	132	113

The data are those in the modified intention-to-treat analysis. The per-protocol analysis produced similar results.

Figure 2. Development of Ventilator-Associated Pneumonia in the Groups With (Control) and Without (Intervention) Residual Gastric Volume Measurement

VAP



No. at risk

Intervention	227	73	20	7	2
Control	222	80	21	8	5

Cumulative incidence of ventilator-associated pneumonia (VAP) in both groups in the modified intention-to-treat analysis. For the analysis of time from randomization to VAP, death was handled as a competing risk. Results were similar in the per-protocol analysis.

6h RGV 250 ml vs. Regurgitation/Vomiting

RCT; 9 ICUs; 452 ventilated p’ts

Prokinetics

- Effect: Erythromycin ＞ Metoclopramide
- Clinical outcome: same

Crit Care Med (2007) 35:483–9
J Parentr Enteral Nutr (2008) 32; 412-9

Post-pyloric Feeding

- ***No*** conclusive results in clinical outcome

Crit Care Med (2012) 40:2342–8
Intensive Care Med (2010) 36; 1532-9

The Timing for Parenteral Nutrition

Early vs. Late Parenteral Nutrition (EPaNIC trial)

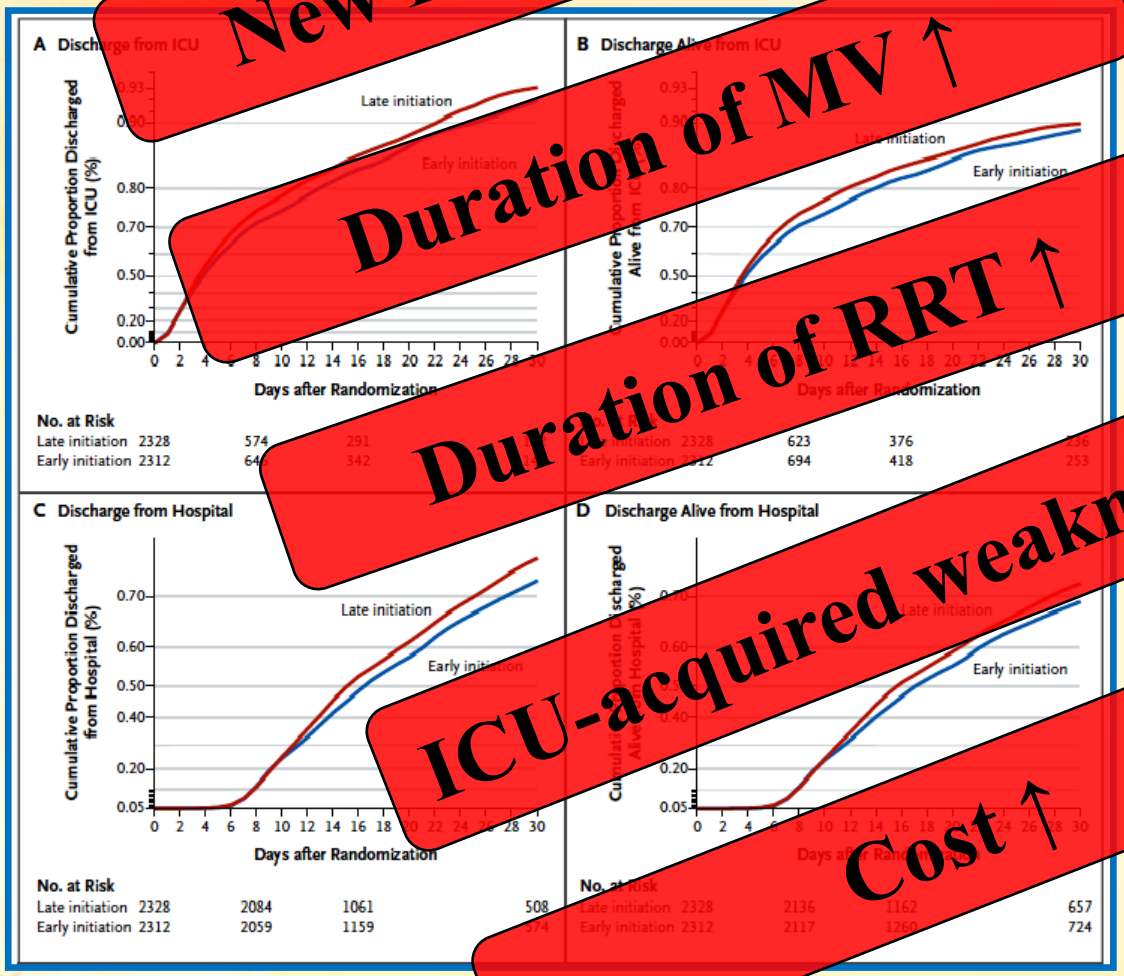
New ICU infection ↑

Duration of MV ↑

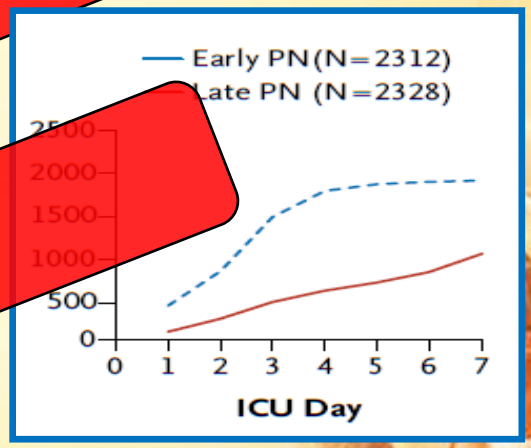
Duration of RRT ↑

ICU-acquired weakness ↑

Cost ↑



- Large RCT
- 4,640 p'ts
- ***Early***
  - iv glucose 2 days (D1: 400kcal, D2:800kcal)
  - All-in-one from D3



Late: ↑6.3% likelihood

N Engl J Med 2011;365:506-17

Supplemental Parenteral Nutrition (SPN study)

Lancet 2013;381:385-93

Eligible EN, but not reach the goal

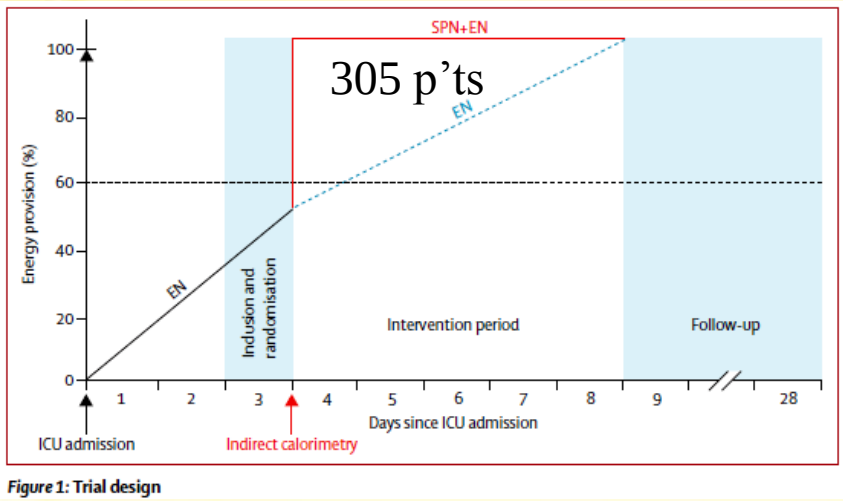


Figure 1: Trial design

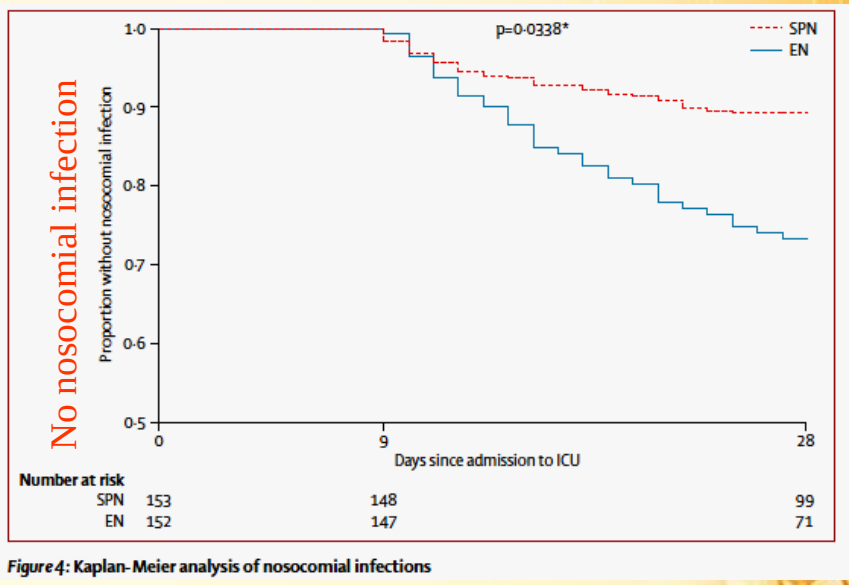
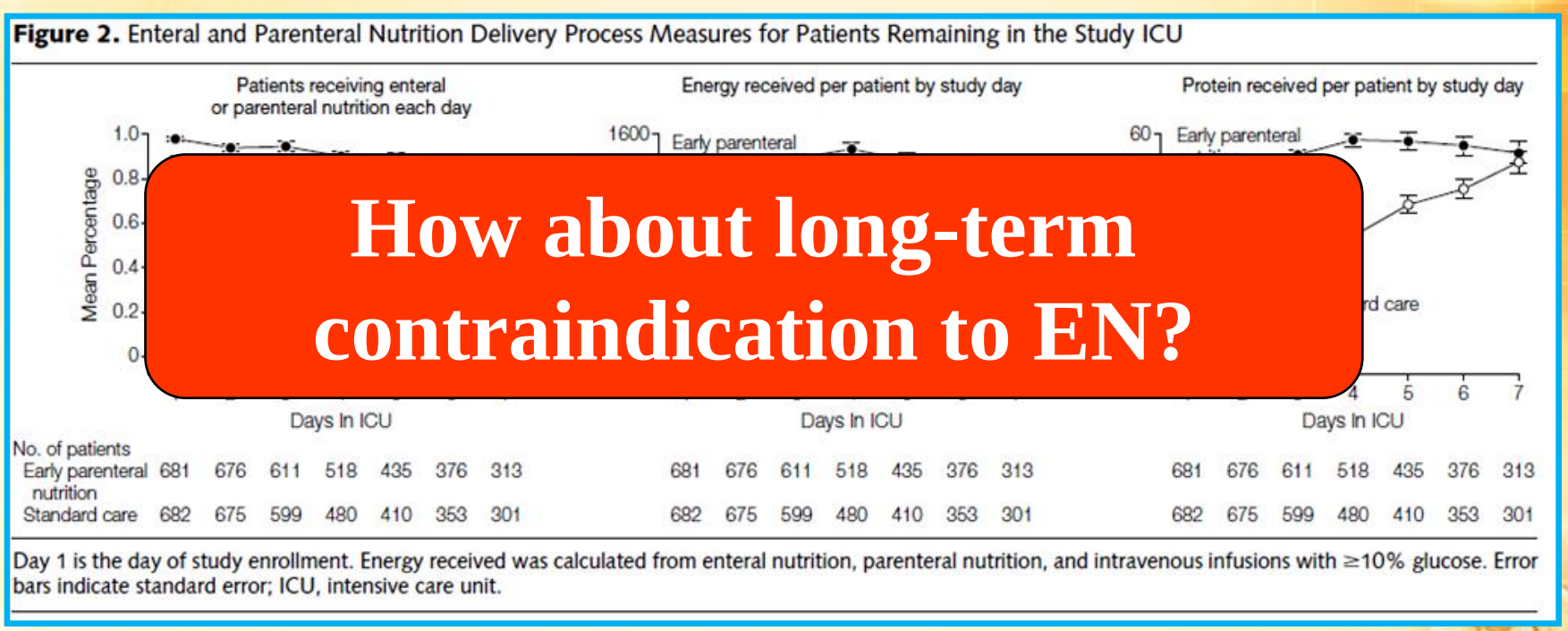


Figure 4: Kaplan-Meier analysis of nosocomial infections

No increased risk of infection

No clinical benefit (ventilator duration)

Early Parenteral Nutrition in Critically Ill Patients With Short-term Relative Contraindications to Early Enteral Nutrition A Randomized Controlled Trial



How about long-term contraindication to EN?

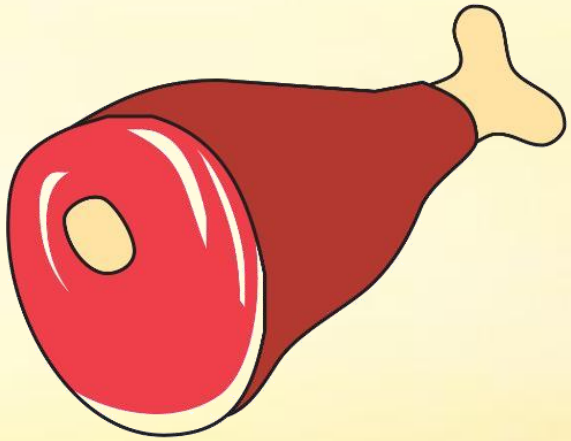
RCT; 31 ICUs, 1,372 p'ts

60-day mortality, LOS －, duration of mechanical ventilation ↓

JAMA 2013; 309:2130-8

Protein Requirement

- Achieve muscular synthesis rate
- Synthesis of acute phase response protein
- Cysteine (glutathione synthesis)
- Prevention of glutamine depletion



Optimal Protein

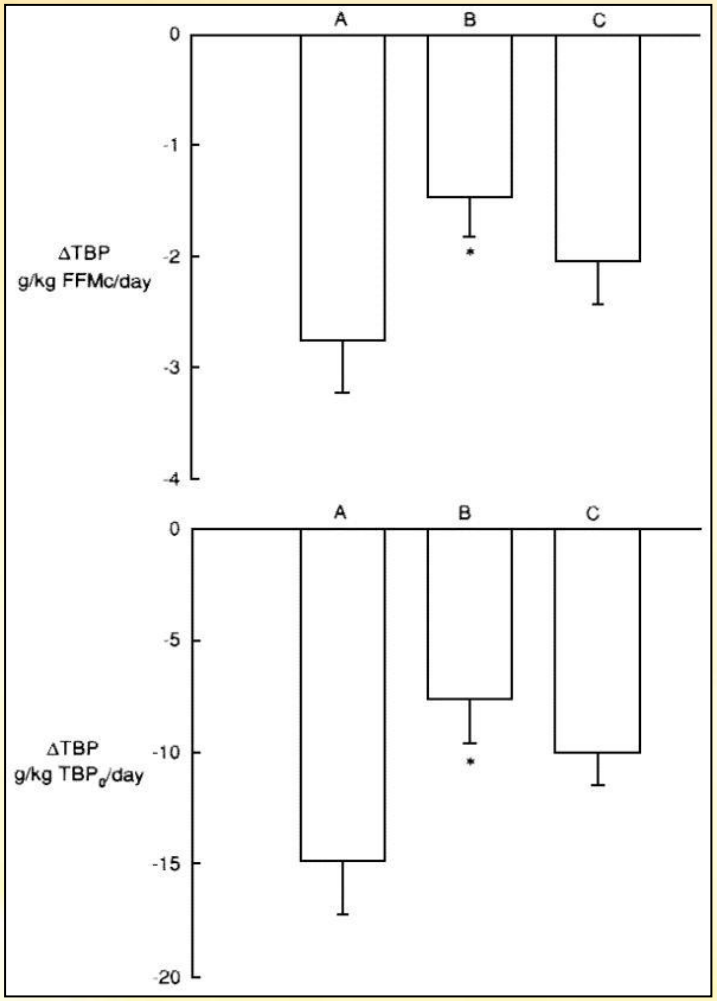


Figure 3 . Top: Daily changes in total body protein (Delta TBP) divided by corrected fat-free mass that occurred over the 10-day study period in critically ill patients grouped according to average protein intake. Bottom: Daily Delta TBP divided by day 0 measured TBP (TBP0) that occurred over the 10-day study period in critically ill patients grouped according to average protein intake. (Group A, 1.14 +/- 0.13 g/kg/day; group B, 1.47 +/- 0.11 g/kg/day; group C, 1.86 +/- 0.14 g/kg/day.) Error bars are SEM. *Significant difference from group A

1.5g/kg/d

Crit Care Med (1998); 26:1529-35

EPaNIC

Less is better

Micronutrients

- Zinc
- Selenium
- Copper
- Vitamins C, E, B

- Preexisting malnutrition
- Severity of illness
- Therapeutic side effect

Re-feeding

- Hypophophatemia
- Hypokalemia
- Hypomagnesemia

- Thiamine ↓

- Sodium & water retention

- Feed slowly
- Close monitoring & supplement

Over-feeding

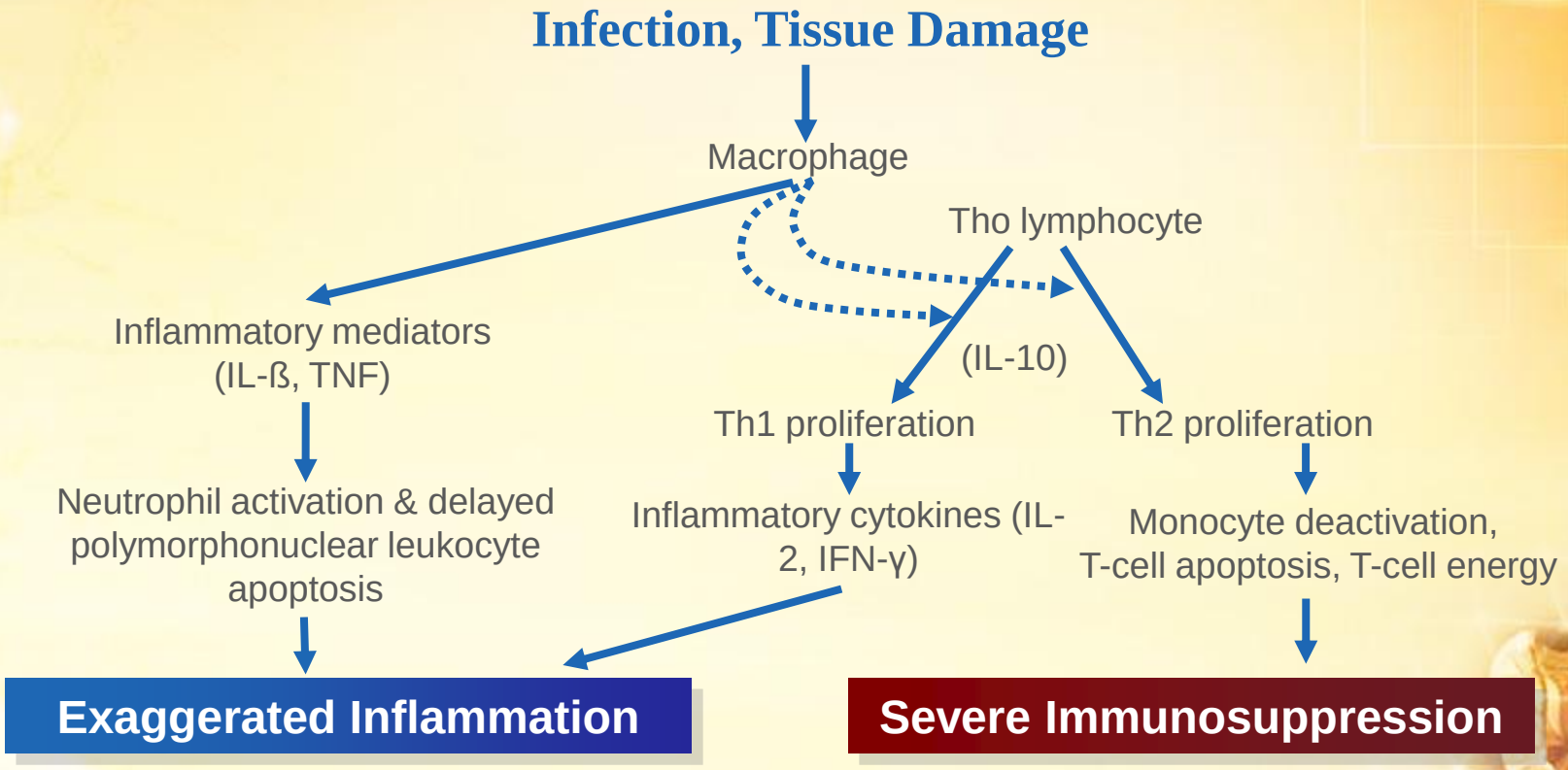
- Re-feeding syndrome
- High dose of protein
  - Azotemia, hypertonic dehydration, metabolic acidosis
- High dose of glucose
  - Hyperglycemia, hypertriglyceridemia, hepatic steatosis, hypercapnia

Pharmaco-nutrition

- Macronutrients
  - Omega-3 fatty acids, glutamine, arginine
- Micronutrients
  - Vitamins A, C, E, Selenium, Zinc

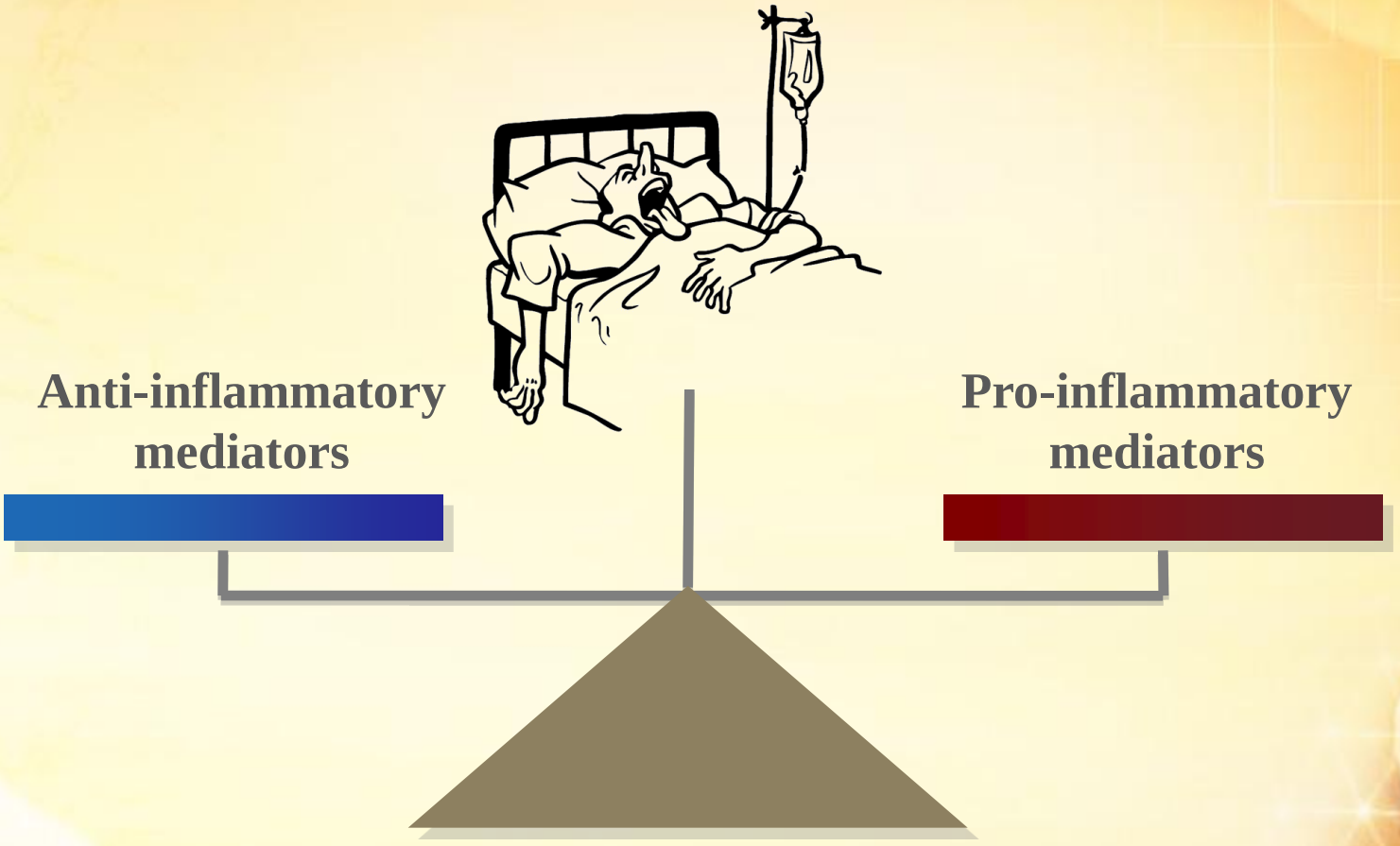
- Immuno-nutrition, Immune-modulating, immune-enriched diets

Immune Response



Curr Opin Clin Nutr Metab Care 2003;6:223-228

Immune Response to Injury/Illness



Am J Surg 1999;178:564-9

Arginine

- NO-like
- Up-regulation of NO
  - Hemodynamic instability
  - Immunologic dysfunction
  - Non-specific cytotoxicity

Not Use in Critical Ill

- A RCT, non-critical
  - Postoperative infection↓, hospital stay↓

Gastroenterology 2002; 122:1763-70

- Meta-analysis 32 RCTs
  - Pre-op 5 days (+ fish oil)
  - Postoperative complication ↓

J Am Coll Surg 2011;212:385-99

Glutamine

- Gut barrier
- Lymphocyte function
- Glutathione synthesis
- Preserve lean body mass
- Antioxidant

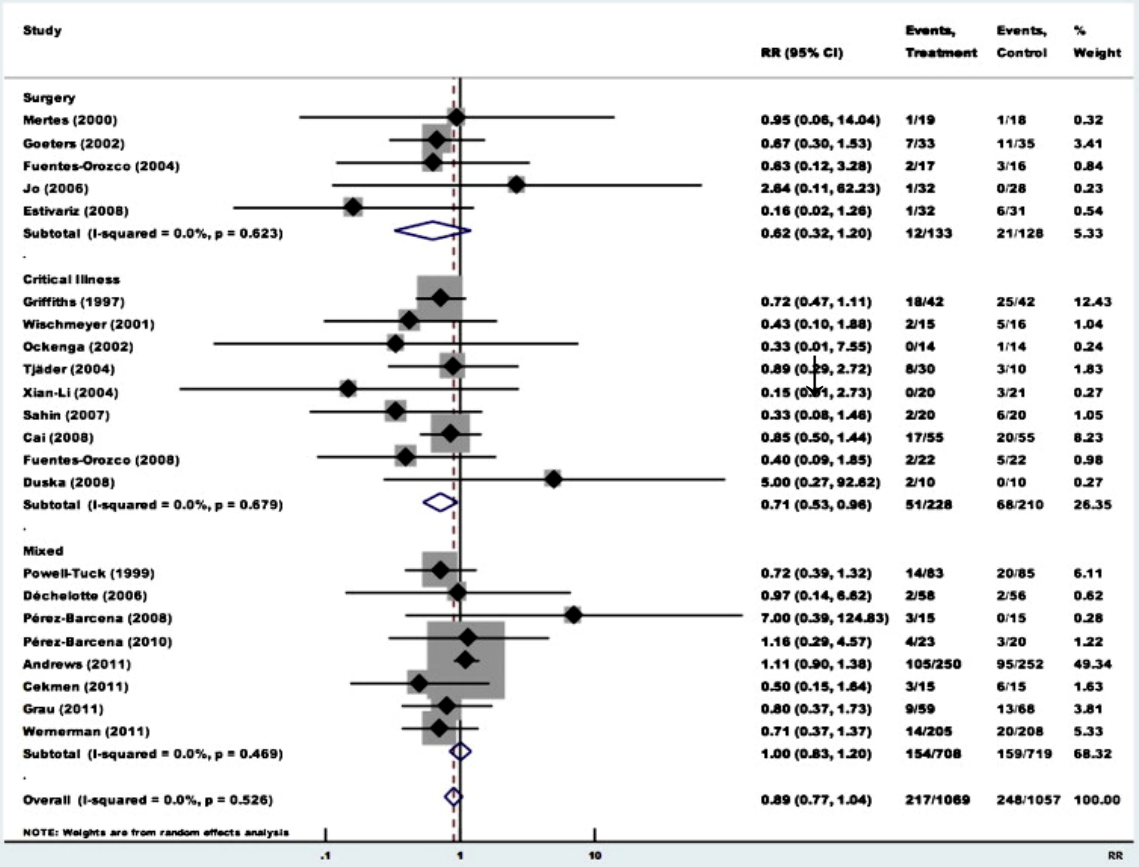
- Low level associated with increased mortality

Intensive care Med. 2001;27:84-90

- Enteral glutamine reduces infections

Lancet 1998; 352:772-6
Crit Care Med 2003; 31:2444-9

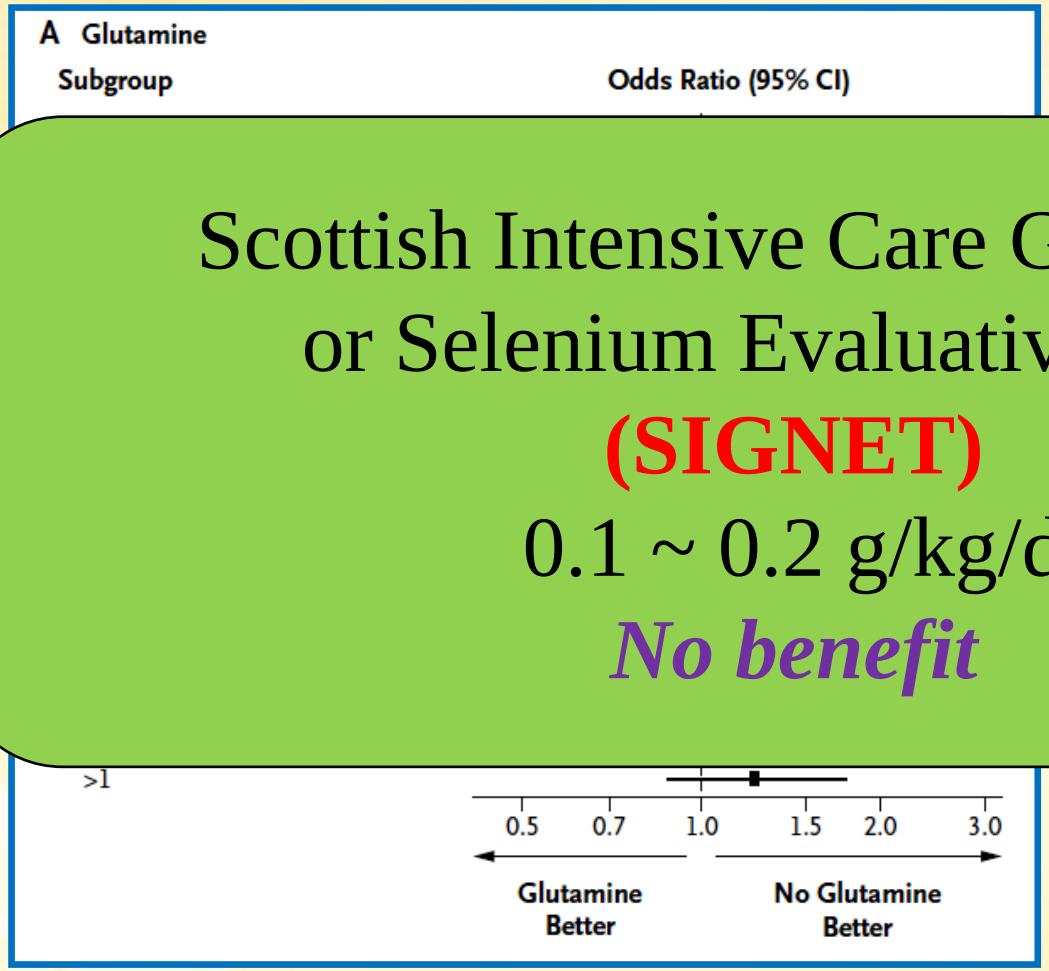
Parenteral Glutamine



- Infection ↓
- Hospital stay ↓
- Mortality ↓

Clin Nutr 2013;32:213-23

Reducing Deaths due to Oxidative Stress (REDOXS)



- RCT

Scottish Intensive Care Glutamine or Selenium Evaluative Trial

(SIGNET)

0.1 ~ 0.2 g/kg/d

No benefit

BMJ 2011)342:d1542

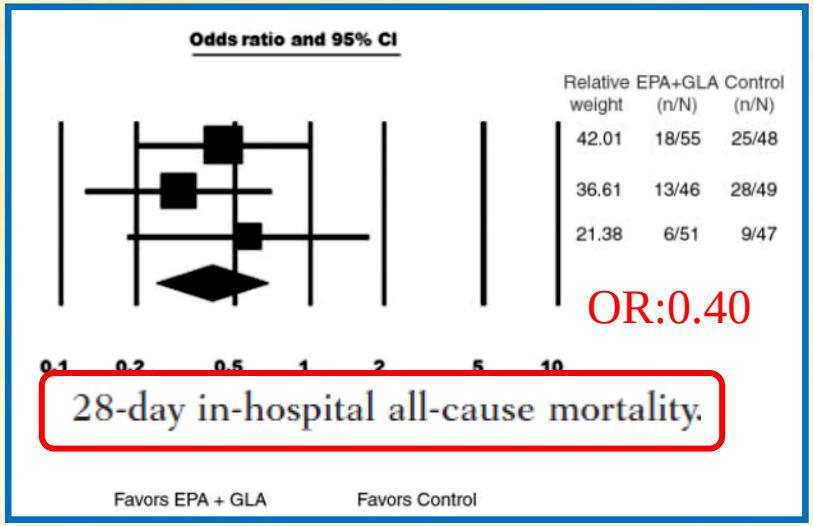
e ↑

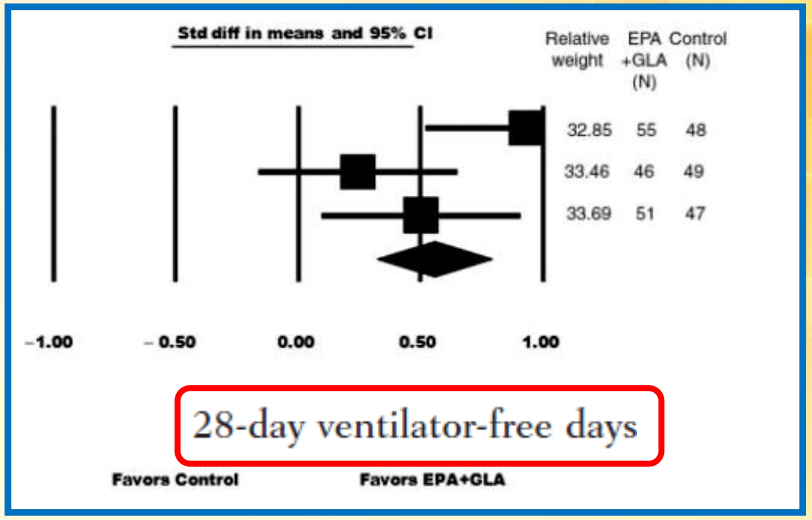
N Engl J Med 2013;368:1489-97

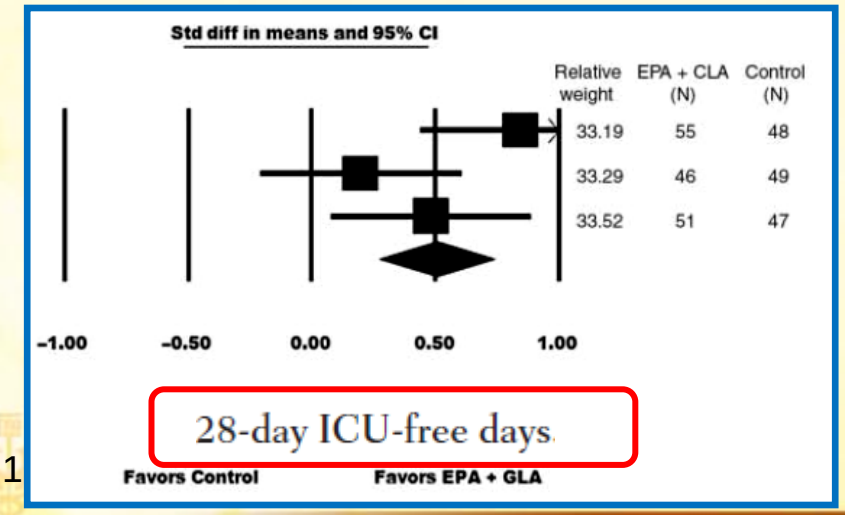
Omega-3 Fatty Acid

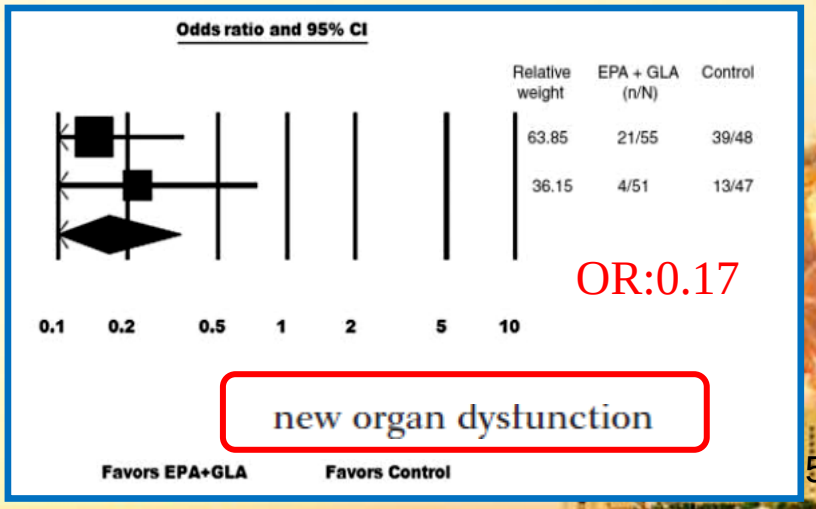
3 RCTs, 411 in ALI/ARDS

J Parenter Enteral Nutr 2008; 32:596-605









Soybean v.s. Olive Oil in PN

Table 2. Mortality and hospital complications in patients treated with soybean oil– and olive oil–based parenteral nutrition

	All	Soybean Oil Parenteral Nutrition	Olive Oil Parenteral Nutrition	*p*
Deaths during hospital stay, n (%)	13 (13)	8 (16.3)	5 (9.8)	.38
Acute renal failure, n (%)	22 (22)	13 (26.5)	9 (17.6)	.34
Infectious complications				
Any infection, n (%)	50 (50)	21 (42.8)	29 (56.8)	.16
Pneumonia, n (%)	12 (12)	5 (10.2)	7 (13.7)	.76
Urinary tract infection, n (%)	12 (12)	7 (14.3)	7 (13.7)	>.99
Bacteremia	22 (22)	11 (22.4)	11 (21.5)	.92
Wound infection, n (%)	15 (15)	4 (8.1)	11 (21.5)	.09
Cardiac complications				
Acute myocardial infarction, n (%)	2 (2)	0 (0)	2 (3.9)	.50
Congestive heart failure, n (%)	3 (3)	1 (2.04)	2 (3.9)	>.99
Cardiac arrhythmia, n (%)	11 (11)	5 (10.2)	6 (11.7)	>.99

RCT, 100 mixed ICU p’ts, PN

Crit Care Med 2012; 40(5):1792-98

Prebiotics, Probiotics, Synbiotics

- Probiotics (益生菌)
  - Live microorganisms, confer a health benefit on the host
- Prebiotics (益菌生)
  - Basically food for probiotics
  - Inulin, carbohydrate fiber (oligosaccharides)
- Synbiotics
  - Contains probiotics and prebiotics

How to Monitor: Big Challenge

- Secondary infections
- Muscle atrophy & weakness
- Respiratory insufficiency
- Delayed wound healing
- Prolonged catabolism

Table 2 Areas of consensus (ICU patients with a more than 4-day length of stay)

	Consensus
Early enteral feeding	Consider in each patient without absolute contraindication; prevents mucosal atrophy
Risks of overfeeding	Early phase
Estimation of energy expenditure	Requires indirect calorimetry – cannot be predicted by equations
Arginine	Not recommended in sepsis; beneficial in perioperative patients outside the ICU
Vitamins, trace elements	Mandatory, in nutritional doses; particularly true in parenteral nutrition

Table 1 Areas of uncertainty – opposing views

Topic/area	One viewpoint	Opposing view
Optimal caloric intake	Early match of EE.	Less than EE during the early phase.
Supplemental PN	When EN provision is less than 60% in early course of ICU stay not contraindicated.	Not before day 8 in patients with a body mass index of at least 17.
Optimal protein intake	Equal to nitrogen losses, up to 1.5 g/kg per day.	Less than nitrogen losses.
Re-feeding syndrome	Slowly increase nutritional support to prevent re-feeding syndrome consequences even if this results in increased energy deficit.	Early nutritional support improves outcome also in malnourished patients; re-feeding syndrome consequences should be monitored and immediately treated if necessary.
Role of indirect calorimetry	Yes (patients staying more than 4 days).	No.
Autophagy	Provision of nutrients should be reduced so as not to reduce autophagy capacity as early nutrients provoke a phenotype of suppressed autophagy in human and animal experiments, with functional consequences that impair recovery.	Although experimentally autophagy may be reduced in early critical illness, pharmacological autophagy activation remains to be tested clinically.
Antioxidants	Supplement in case of low levels of antioxidants.	Use pharmacological dosages.
Glutamine	In all patients on PN.	High-dose glutamine increases mortality in critically ill patients, regardless of route of administration.
Omega-3 lipid formulations	Use continuous enteral administration and avoid bolus administration.	Not beneficial in acute respiratory distress syndrome.
High-dose selenium 800 to 4,000 μg/day	High-dose trials (1,000 μg) show greater improvement than low-dose trials.	Potential for toxicity. In selenium-replete populations, 800 to 1,000 μg may be ineffective.
Probiotics	Safe. Avoid use in pancreatitis patients with multiple organ dysfunction syndrome.	May be harmful in ICU patients when given post-pyloric with fiber.
Monitoring GRV	Accept GRV of 250 up to 500 mL per 6 hours.	Abandon GRV monitoring in medical patients and consider in surgical patients.

EE, energy expenditure; EN, enteral nutrition; GRV, gastric residual volume; PN, parenteral nutrition.

謝謝聆聽