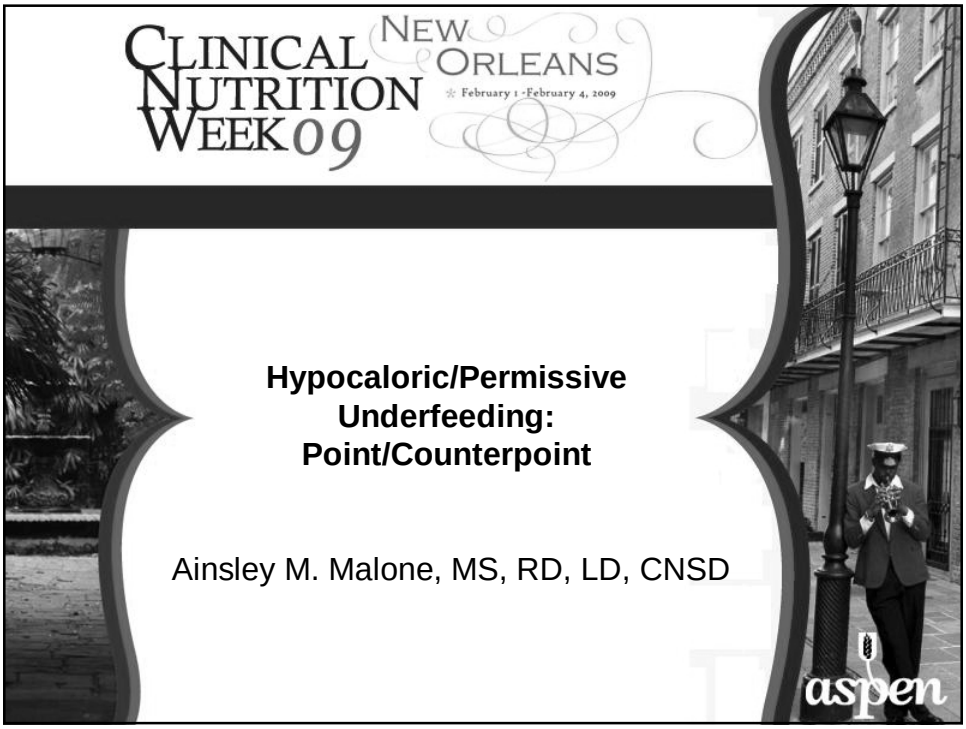
CLINICAL NUTRITION WEEK 09
NEW ORLEANS
February 1 - February 4, 2009
Hypocaloric/Permissive Underfeeding: Point/Counterpoint
Ainsley M. Malone, MS, RD, LD, CNSD
aspen

When Permissive Underfeeding/ Hypocaloric Feeding Regimens May Be Detrimental

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Hypocaloric Regimens vs. Permissive Underfeeding

Rationale for feeding strategies:

- Hypocaloric regimens – provision of high protein/low calorie intake to obese patients to maintain a positive nitrogen balance, avoid risks of overfeeding, and modestly reduce weight.
- Permissive underfeeding – based on the premise that short-term dietary restriction will limit pathologic processes while minimally impairing organ function.

Zaloga GP et al. New Horizons 1994;2:257-63.
Dickerson RN. Curr Opin Clin Nutr Metab Care 2005;8:189-96.

Feeding the Obese Patient

Historical methods for estimating the energy needs of hospitalized obese patients:

- Adjusted BW: IBW + 50% excess incorporated into HBE (Harris Benedict Equation)
  a. Females = 655 + (9.6 x Wt) + (1.7 x Ht) - (4.7 x A)*
  b. Males = 66 + (13.7 x Wt) + (5 x Ht) - (6.8 x A)*
  * Wt (kg), Ht (cm), A (yrs)
- HBE using average of actual BW and IBW x 1.3 stress factor
- HBE using IBW + 25% of excess

All predictive methods are often inaccurate and over-estimate energy needs

Feeding the Obese Patient

Hazards of overfeeding the critically ill obese patient

- Hyperglycemia and risk of infection
- Difficulty weaning from the ventilator
- Lipogenesis causing hepatic steatosis and hepatic dysfunction
- Pulmonary edema and CHF requiring fluid restriction

Feeding the Obese Patient

- Important concept: a positive nitrogen balance can be achieved by using a low protein/high caloric (LP/HC) intake, a medium protein intake/medium caloric (MP/MC) intake, or high protein/low caloric (HP/LC) intake.
- Marked differences in body composition occur with above three intakes:
  - LP/HC: increased body fat and water
  - MP/MC: maintain body fat and protein
  - HP/LC: increased body protein and decreased body fat

Figure 1. The influence of caloric and protein intake upon nitrogen balance in unstressed depleted patients

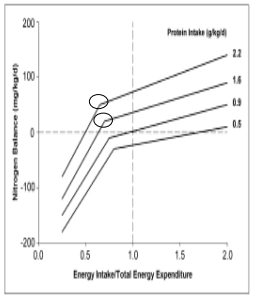
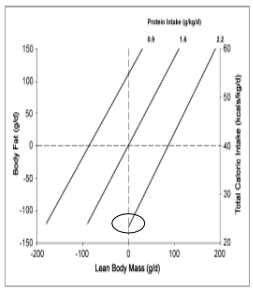


Figure 2. Body composition changes with varying parenteral calorie and protein intakes in a typical 60 kg surgical patient with 10% weight loss



Dickerson RN. Curr Opin Clin Nutr Metab Care 2005;8:189-196.

Support for HP/LC PN in Obesity

- Case series of 13 obese postoperative patients (208% ± 114% IBW)
- Exclusion criteria: renal or hepatic disease
- Nutrient regimens: ~50%MREE (881 kcal/day) as dextrose, 2.1 g/kg/d IBW
- Results: Significant increases in serum albumin, serum TIBC, + N_2 balance; complete tissue healing of wounds, abscess cavities, fistulae.

Dickerson RN et al. Am J Clin Nutr 1986;44:747-55.

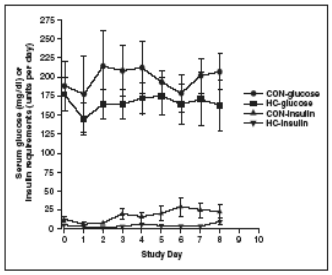
Support for HP/LC PN in Obesity

- Randomized, double-blind, prospective study of HP/LC vs. HP/HC PN administration in obese patients
- Inclusion criteria: > 130% IBW
- Exclusion criteria: renal/hepatic disease, adrenal disease, pediatrics, pregnancy
- Nutrient regimens: HP/LC = 2 IBW/22 IBW (n=16) vs. HP/HC = 2 IBW/36 IBW (n=14)
- No difference in N_2 balance, wt changes, nor albumin
- Significant difference in study days for which insulin was required among NIDDM HP/LC vs. HP/HC (3.2 vs. 8 d, $p<0.05$)

Choban PS, et al. Am J Clin Nutr 1997;66:546-550.

Figure 3. Daily mean serum glucose concentrations (upper graphs) and insulin requirements (lower graphs) from patients with type II diabetes mellitus

Choban PS, et al. Am J Clin Nutr 1997;66:546-550.



Five patients were given hypocaloric parenteral nutrition and four were given higher calorie parenteral nutrition. CON represents the higher calorie control group and HC represents the hypocaloric feeding group (see Table 1 for a summary of calorie and protein intakes for each group).

Published Studies of Hypocaloric Feeding in Obese Patients

Reference	N	Mean BMI	BMI > 35	BMI > 40
Burge	9	32.5	2 (22%)	0
Choban	26	35.6	7 (50%)	4 (28%)
Dickerson	13	44.5	8 (62%)	7 (54%)
Dickerson	28	41.3	18 (64%)	13 (46%)
Liu				
< 60 years	18	33.4		
> 60 years	12	31.1		

Choban PS, Dickerson RN. NCP 2005;20:480-487.

Feeding the Obese Patient

- Studies of hypocaloric, high-protein PN formulations in hospitalized obese patients have documented positive nitrogen balances with wound healing, better glucose control with less requirement for exogenous insulin and weight loss.
- One study using hypocaloric, high-protein EN showed a shorter ICU length of stay, decreased antibiotic days, and a trending decrease in number of ventilator days.

Dickerson RL. NCP 2004;19:245-54.

Feeding the Obese Patient

- Proposed indications for hypocaloric, high-protein feedings include:
  - BMI > 30 kg/m^2 or actual BW > 150% IBW
- Regimen goals: 22 total kcal/kg of IBW and 2 g/kg protein of IBW
- Contraindications to use of hypocaloric, high-protein feedings include:
  - Advanced renal disease without CRRT
  - Hepatic encephalopathy with end stage liver disease
- Use cautiously in patients with history of diabetic ketoacidosis or significant hypoglycemia

Consequences of Hypocaloric & Permissive Underfeeding

- Glucose control – No change (only demonstrated improvement in obese patients)
- Increased septic risk (pneumonia, bacteremia) – Villet S et al. and Rubinson L et al.
- Prolonged length of mechanical ventilation – Casadei E et al.
- Negative nitrogen balance and protein catabolism – McCowen KC et al.
- Increased overall complications – Villet S. et al.

Berger MM, Chiolero RL. Curr Opin Crit Care 2007;13:180-186

Negative Impact of Hypocaloric Feeding in ICU Patients

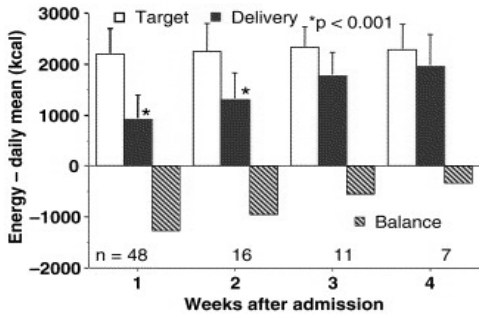
- Prospective observational study in ICU patients (> 5 days)
- Exclusion criteria: major thermal injury
- Indications for early EN (i.e., within 48 hr): multiple injury, major GI surgery for tumor, pre-existing malnutrition
- EN titrated to goal over 4 days; PN used when EN contraindicated
- REE was measured with indirect calorimetry; target set at 1.3 x REE or 30 kcal/kg/d (when not measured)
- Energy balance = energy delivery — energy target

Villet S et al. Clin Nutr 2005;24:502-509.

Negative Impact of Hypocaloric Feeding in ICU Patients

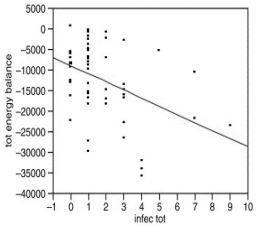
- 48 patients (age 57±16 yr) with ICU LOS of ~ 2 wks were evaluated
- MV lasted 11 ± 8 days, 30-day mortality 38%
- Feedings (EN/PN) were started within 3.1 ± 2.2 days after admission
- Mean REE = 1700 ± 325 kcal/d, resulting in a mean target = 2210 ±500 kcal/day (29 ± 7 kcal/kg/d)
- Energy balance decreased from -1270 kcal/day during 1st week to -625 kcal/day during 4th week

Villet S et al. Clin Nutr 2005;24:502-509.



Progression of energy deficit over 4-week study period

Villet S, et al. Clin Nutr 2005;24:502-509.



Variables	F	p
LOS	25.18	<0.001
Complic	15.15	<0.001
Infections	9.14	<0.005
Antibx days	17.48	<0.001
Start of NS	17.17	<0.001
MV days	17.12	<0.001

Villet S, et al. Clin Nutr 2005;24:502-509.

Negative Impact of Hypocaloric Feeding in ICU Patients

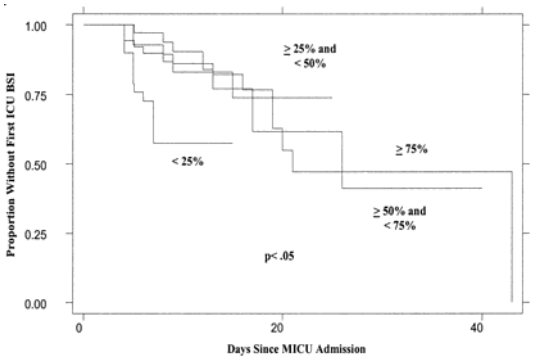
- Prospective cohort study in academic MICU
- Entry criteria: 138 patients who were NPO ≥ 96 hours after MICU admission
- Exclusion criteria: MICU stay ≤ 96 hr, DNR, postop monitoring only
- Patients group into quartiles (<25%, 25-49%, 50-74%, ≥75%) based on 25 kcal/kg/d or 27.5 kcal/kg/d (for SIRS)
- Outcome parameters: nosocomial BSI categorized as primary or secondary

Rubinson L et al. Crit Care Med 2004;32:350-357.

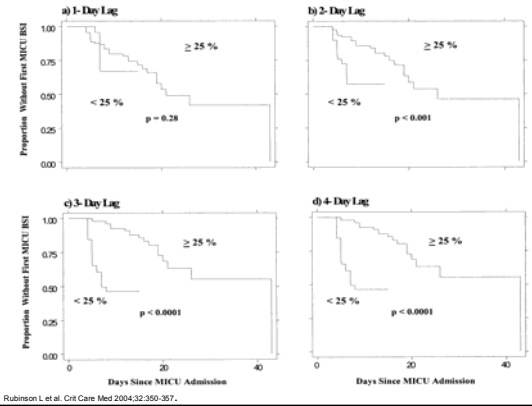
Table 1. Baseline patient characteristics by level of nutritional support

Characteristic	All Study Patients (n = 138)
% ACCP recommended caloric intake received	49.3 ± 29.2
Comorbidities, n (%)	
Diabetes mellitus	31 (22.5)
Chronic renal insufficiency	30 (21.7)
AIDS	30 (21.7)
Cirrhosis	20 (14.5)
Severe COPD	7 (5.1)
Reason for admission, n (%)	
Respiratory failure	77 (55.8)
Circulatory failure	19 (13.8)
Encephalopathy	19 (13.8)
Cardiac arrest	16 (11.6)
Other	7 (5.1)
SAPS II*	52.5 ± 15.4
Age, yrs	52.6 ± 16.4
Gender, n (%), female	64 (46.4)
Source of MICU admission, n (%)	
Emergency department	69 (50.0)
Non-ICU acute care unit	69 (50.0)
Serum albumin at MICU admission, g/dL	2.7 ± 0.7
BMI, kg/m^2	
Number of hospital days prior to MICU admission	3.2 ± 6.6
Mechanically ventilated during study period, n (%)	127 (92.0)

Rubinson L et al. Crit Care Med 2004;32:350-357.



Rubinson L et al. Crit Care Med 2004;32:350-357.



Rubinson L et al. Crit Care Med 2004;32:350-357.

Negative Impact of Hypocaloric Feeding in ICU Patients

- Caloric intake of < 25% of ACCP recommendations (< 6 kcal/kg/day) is associated with increased risk of nosocomial BSI in MICU patients
- As the lag period increased from 2 – 4 days, the association with risk of BSI increased in strength
- Patients who received ≥ 25% of ACCP recommendations exhibited 73% hazard reduction [95% CI, 32-89%] for BSI vs. those who received < 25%.
- Limitation: patients NOT tolerating ≥ 25% may be most ill patients at a higher risk for BSI

Rubinson L et al. Crit Care Med 2004;32:350-357.

Negative Impact of Hypocaloric Feeding in ICU Patients

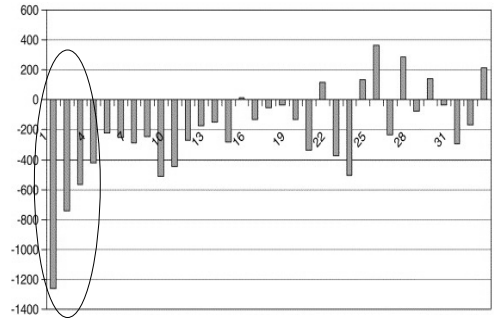
- Prospective cohort in university-affiliated tertiary hospital
- Entry criteria: 50 patients requiring ≥ 96 hr of MV
- Exclusion criteria: FiO_2 ≥ 60%, air leaks, chest tubes, hemodynamic instability, < 18 years old
- Indirect calorimetry performed 6 days/week
- Energy balance calculated as MEE – calories provided (EN, PN, IVFs)
- Primary outcome measures: mortality
- Secondary outcome measures: days of MV, organ dysfunction (renal, hepatic, CV), severe sepsis, & septic shock

Dvir D et al. Clin Nutr 2006;25:37-44.

Sex: M/F (*n*)	33/17
Age (years)	59±18
BMI (kg/m^2)	26.85±5.23
APACHE II	23.1±7.7
Reason for admission:	*No. of patients*
Surgery patients	18
Patients with multiple trauma or burns	11
Medical patients	21

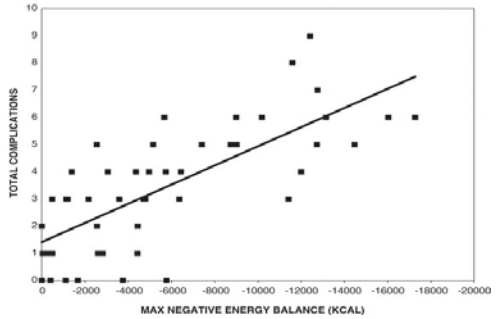
Patient baseline characteristics.

Dvir D et al. Clin Nutr 2006;25:37-44.



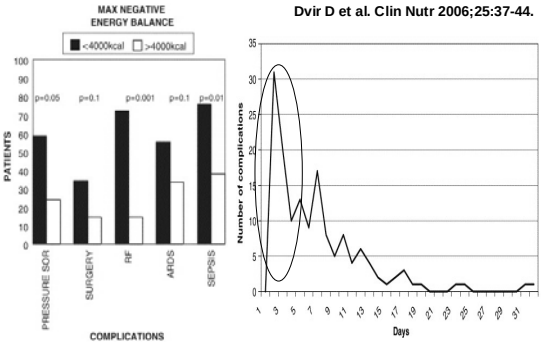
Daily mean energy balance (in kcal) in relation to time (days)

Dvir D et al. Clin Nutr 2006;25:37-44.



Correlation between total complications & maximum negative energy balance

Dvir D et al. Clin Nutr 2006;25:37-44.



Dvir D et al. Clin Nutr 2006;25:37-44.

Complications > or < 4000 kcal

Complications vs. time

What is the Optimal Amount of Energy & Protein Intake?

- Prospective, randomized, controlled, nonblinded trial
- University-affiliated teaching hospital with NST
- Inclusion criteria: requiring PN for ≥ 5 days, based upon ASPEN criteria
- Exclusion criteria: severely underweight (< 50 kg), home PN, requiring specific preoperative PN regimen
- Regimens: hypocaloric (1L of 70 g protein, 1000 kcal) or weight-based (25 kcal/kg & 1.5 g protein/kg); dry weight or adjusted weight if > 130% IBW [IBW + (actual – IBW)0.25].
- Outcome measures: rate of hyperglycemia, pneumonia, CRBSI, wound infection, SIRS

McCowen KC et al. Crit Care Med 2000;28:3606-3611.

Characteristics	Hypocaloric Patients (n = 21)	Control Patients (n = 19)
Gender (% male)	57	53
Age (yrs)		
(mean ± SD)	57.5 ± 14.9	56.6 ± 20.4
(range)	27–79	25–81
Weight (kg)	75	78
Feeding weight (kg)	67	69
BMI (kg/m²) (mean ± SD)	27.6 ± 8.1	25.7 ± 6.2
No. with obesity		
(BMI ≥ 30)	4	2
(BMI ≥ 40)	0	2
No. with diabetes	5	2
Baseline albumin, g/dL (mean ± SD)	2.5 ± 0.7	2.4 ± 0.6
No. with albumin <3.0 g/dL	11/13	11/15
No. with albumin <3.5 g/dL	12/13	14/15
No. with baseline fever	8	6
hypothermia	0	0
elevated WBC or band forms	4	5
No. with APACHE below 10th percentile	6 of 8	5 of 8

Diagnosis	Hypocaloric	Control
Cardiovascular surgery/postoperative ileus	3	3
Bowel perforation/fistula	5	3
Acute pancreatitis	0	1
Medical illness with ileus	4	2
Bowel surgery/postoperative ileus	3	6
Inflammatory bowel disease/bowel rest	1	2
Chylous ascites	0	1
Liver transplant/postoperative ileus	0	1

Nutrient	Average Per Day		Average Per Day at Goal	
	Hypocaloric	Control	Hypocaloric	Control
Protein g	70 ± 0.2*	80 ± 13	72 ± 7*	92 ± 15
Protein g/kg	1.1 ± 0.2*	1.3 ± 0.2	1.1 ± 0.2*	1.4 ± 0.2
Dextrose g	187 ± 26*	225 ± 41	213 ± 36*	273 ± 50
Dextrose g/kg	2.9 ± 0.6*	3.3 ± 0.8	3.0 ± 0.7*	4.0 ± 0.8
Fat g	0.7 ± 3*	8 ± 8	1.4 ± 7*	14 ± 15
Fat g/kg	0.01 ± 0.06*	0.1 ± 0.1	0.03 ± 0.12*	0.21 ± 0.22
Kcal	913 ± 90*	1192 ± 212	999 ± 149*	1410 ± 224
Kcal/kg	14 ± 3*	18 ± 4	15 ± 3*	21 ± 4

*$p < .01$ for all comparisons with control group.

Infections	Hypocaloric	Control
No. of patients infected	6	10
Total no. of infections	7	11
Venous catheter infection	4	4
Pneumonia	2	3
Wound infection	1	4
Abdominal collection	0	0

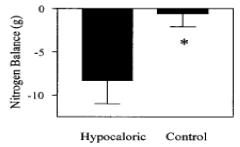
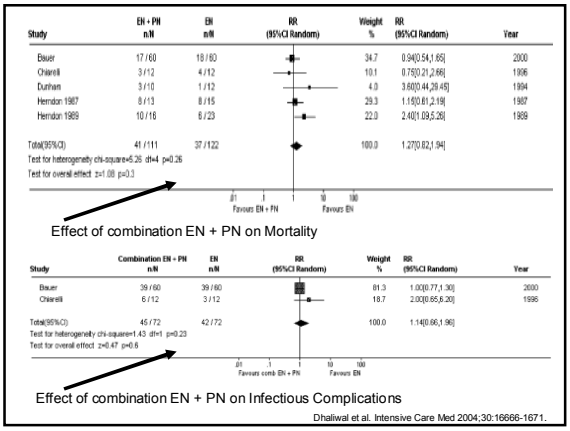


Figure 2. *Nitrogen balance* measured after 5 days of TPN, mean ± standard error. *$p < .03$ for the difference between the *hypocaloric* and *control* groups.

Optimal Energy Intake

- Systematic review comparing combination EN + PN vs. EN alone to optimize nutritional intake in critically ill patients
- Databases searched included Medline, Embase, CINAHL, Cochrane Library from 1980 – 2003)
- Included studies if were randomized clinical trials in ICU comparing combination EN + PN vs. EN alone.
- Only 5 studies found to meet inclusion criteria; methodological scores ranged from 6 – 12 (maximal score: 14)

Dhaliwal et al. Intensive Care Med 2004;30:16666-1671.



Effect of combination EN + PN on Mortality

Effect of combination EN + PN on Infectious Complications

Dhaliwal et al. Intensive Care Med 2004;30:16666-1671.

Optimal Energy Intake

- Starting PN with EN in critically ill patients with intact GI tracts who are not malnourished has no added benefit in terms of reducing mortality, infectious complications, days of mechanical ventilation, and length of stay.
- Three of four studies reporting effects on nutritional intake demonstrate that combination EN + PN delivers more calories than EN alone.

Dhaliwal et al. Intensive Care Med 2004;30:16666-1671.

Conclusions

- Provision of hypocaloric, high-protein regimens to obese patients can result in clinical benefits (i.e., positive nitrogen balances with wound healing, better glucose control and weight loss).
- Permissive underfeeding critically ill patients at ≤ 25% of ACCP recommendations and creating an energy debt within the first week can be associated with increased complications.
- Energy AND protein intake interactions MUST be considered in feeding strategies.
- Based upon the McCowen study in non-critically ill patients, a minimum of 1.3 g protein/kg must be provided with 20 kcal/kg to prevent severe protein catabolism.