Clinical nutrition strategies in the management of the critically ill patient
Critical care situation patterns

resuscitation → flow

resuscitation → flow x n

admission discharge

admission discharge
Critical care situation patterns

Critical care → effects on nutrition

Body composition changes:
- protein loss
- carbohydrate loss
- fat loss
- fluid imbalance
- electrolyte imbalance
- trace element changes

Organ changes:
- dysfunction
- failure

More organs affected →
- more morbidity
- higher mortality

Inflammation factors
- stress factors, hormones
- wound healing, repair
- function priorities
Critical care management: phases

Phase 1: resuscitation
- cardiovascular
- pulmonary

Microcirculation
- airway
- fluids
- medication
- other intervention(s)

Unstable
- Cellular function

Phase 2: build up / maintenance
- stable

? nutrition
Critical care → effects on nutrition

Body composition changes:
- protein loss
- carbohydrate loss
- fat loss
- fluid imbalance
- electrolyte imbalance
- trace element changes

Organ changes:
- dysfunction
- failure

More organs affected →
- more morbidity
- higher mortality

NUTRITION MANAGEMENT

- inflammation factors
- stress factors, hormones
- wound healing, repair
- function priorities
Strategies in critical care management

Know the nutritional status/ risk level to give accurate nutrient requirements

Correct the imbalances

Deliver all requirements through the most appropriate route

Make sure adequate intake is achieved

Readjust mgt as soon as there is need

Use special substrates

Body composition changes
- protein loss
- carbohydrate loss
- fat loss
- fluid imbalance
- electrolyte imbalance
- trace element changes

Organ changes:
- dysfunction
- failure

More organs affected →
- more morbidity
- higher mortality

inflammation factors
stress factors, hormones
wound healing, repair
function priorities
To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient

**STRATEGY #1: KNOW THE NUTRITIONAL STATUS & RISK LEVEL OF THE PATIENT**
Initial requirement: nutritional status/risk assessment

• Patients with critical illnesses are at nutrition risk and should undergo nutrition screening to identify those who require formal nutrition assessment with development of a nutrition care plan. (B)

Nutrition assessment / risk level form

- Simplified form
- Uses validated tool: Subjective Global Assessment
- Incorporates Body Mass Index, serum albumin, Total Lymphocyte Count
- Scoring system

Validation of nutritional assessment tool

• Modified SGA
• Done in private (2) and government (2) hospitals
  – Sensitivity = 93%
  – Specificity = 52%
  – Positive Predictive Value = 93%

<table>
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<tr>
<th>Assessment Tool</th>
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Nutritional assessment predicts complications

Nutrition risk assessment predicts morbidity and mortality in surgical patients while in the hospital.

Clinical Nutrition Process

1. Admission
2. Patient Screening
   - Not at Risk
   - At Risk
      - Patient Assessment
         - Development of Nutrition Care Plan
            - Implementation of Nutrition Care Plan
               - Patient Monitoring
                  - Goals Achieved
                  - Progressing Towards Goals
                     - Termination of Therapy
               - Evaluation of Care Setting
                  - In Patient Care No Longer Required
                     - Discharge Planning

ASPEN Board of Directors – Standards of nutrition support for hospitalized patients (1995)
To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient

STRATEGY #2: AIM FOR ADEQUATE INTAKE AS EARLY AS POSSIBLE
Nutrition intake and infection(s)

Nutritional status & mortality

Malnutrition is associated with increasing mortality even after discharge

How much calories?

Usual: 20-25 kcal/kg/day
Very sick: 15-20 kcal/kg/day


Calorie requirement

• Not obese:
  – With actual weight: 20-25 kcal/kg body weight
  – This is usually appropriate with geriatric patients, cancer patients with cachexia, patients on prolonged NPO

• Obese: use ideal body weight
  – 20-25 kcal/kg IBW
Protein requirements

• Basal (REE): 0.8 gm/kg/day
• Stressed: 1 – 1.2 gm/kg/day
• Severely stressed: 1.5 – 2 gm/kg/day
• With renal function problems: 0.6-0.8 gm/kg/day
• Protein should be 20% of the total computed calorie requirement during stress (when dealing with deficiency states)
Other requirements

• Non-protein calorie = Total calories – Protein calories
  – usually 50% carbohydrate and 50% fat
  – glucose control → 40% carbohydrate and 60% fat
  – Key monitoring variable = blood glucose

• Vitamins – daily
  – Water soluble
  – Fat soluble

• Trace elements - daily
Permissive underfeeding?

- BMR is not markedly increased in most critical care patient (except in burns)
- The mean REE in sedated and ventilated patients is approximately 1500 kcal/day
- Energy intake as glucose in excess of need causes increased CO2 production and fatty liver
- Hyperglycemia increases the risk of infectious complications and mortality

Permissive underfeeding = Using appropriate values as required by the nutritional status and disease severity of the patient
Implications for adequate intake

• Consistent intake $\rightarrow$ better outcome
• Use of feeding pathways $\rightarrow$ better intake
• Requires accurate monitoring of intake
Consistent intake $\rightarrow$ better outcome

Feeding pathway → better intake

Can the GIT be used?

Yes

Oral

“inadequate intake”

< 75% intake

No

Parenteral nutrition

Short term

“Inability to use the GIT”

Long term

Peripheral PN

Central PN

Parenteral nutrition

More than 3-4 weeks

More than 3-4 weeks

No

NGT

Nasoduodenal or nasojejunal

Yes

Gastrostomy

Jejunostomy

How do we measure intake?

• Calorie count form
• Somebody is trained to perform it accurately
• Nutrition support team (NST) – best people to do this procedure
The calorie count form

Procedures:
1. Fluid intake is recorded
2. Fluid output is recorded and the fluid balance determined (%)
3. Calorie balance is computed (actual and % of computed)
4. Protein balance is computed (actual and % of computed)
The team performs the calorie count and fluid balance

The fluid, calorie, and protein intake are recorded and adequacy of intake is recorded in the patient’s chart
# The summary

## NUTRIENT MONITORING FORM

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<th>Date And Shift</th>
<th>Nutrient Source</th>
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NST and energy intake

Sioson MS, Inciong JF, Reyes MCS, Navarrete DI, Llido L. Nutrition support team supervision improves intake of critical care patients in a private tertiary care hospital in the Philippines: report from years 2000 to 2006; PENS A 2007 poster presentation
HEMODYNAMIC STABILITY INFLUENCES NUTRITION DELIVERY
When can you start nutrition?

Phase 1: resuscitation
- airway
- fluids
- medication
- other intervention(s)

Microcirculation
- cardiovascular
- pulmonary

Unstable → Cellular function → stable

Phase 2: build up / maintenance

? nutrition
When can you start nutrition?

• Hemodynamically stable
  – What are the criteria?
    • Blood pressure
    • Blood gases
    • Who decides?
  – End point: microcirculation perfusion status
    • Pulse oximeter?
    • Special devices?
To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient

STRATEGY #3: IN UNSTABLE STATUS
PN MAY BE THE BETTER OPTION
Feeding strategies

PN indicated:
• in the setting of hemodynamic compromise, EN should be withheld until the patient is fully resuscitated and/or stable
• with Protein Calorie Malnutrition (PCM): start PN on admission
• Initial feeding goal = 50% of requirement

SCCM and ASPEN: Critcare Med 2009; 37(5)
Unstable status $\rightarrow$ pathway

- Can the GIT be used?
  - Yes
  - Oral
  - $< 75\%$ intake
    - No
      - NGT
      - Nasoduodenal or nasojejunal
    - Yes
      - Gastrostomy
      - Jejunostomy
  - Tube feed
    - More than 3-4 weeks
      - No
        - Parenteral nutrition
          - Short term
            - Peripheral PN
          - Long term
            - Central PN
      - Yes

"Inability to use the GIT"

Parenteral nutrition

- Ultimate goal: ≥ 75% of computed
  - Total calories: 25-35 kcal/kg/day
  - Total protein: 1-2 gm/kg/day
  - Complete electrolytes, vitamins, trace elements
  - Nutraceuticals:
    - Glutamine: 0.3-0.5 gm/kg of the total protein requirement
    - Fish oils (EPA, DHA)
Parenteral nutrition

Macronutrients:
- protein
- fat
- carbohydrate

Micronutrients:
- vitamins
  - water soluble
  - fat soluble
- trace elements
- electrolytes

Nutraceuticals:
- glutamine
- fish oils
- antioxidants
- arginine

Complete Food

Special Diet / Specialized Nutrition Therapy
Why “Three in One”?  

• Optimal utilization of calories  
• Minimizes metabolic complications  
  – reduced volume load  
  – reduced CO2 production  
  – avoidance of hyperglycemia  
  – less fat synthesis  
• Permits peripheral administration
Parenteral nutrition

Intravenous:
• macronutrients
• micronutrients
• nutraceuticals

Safe delivery:
• aseptic technique
• dedicated line
• infusion pump

NUTRIFLEX series
The “All in One” approach

CARBO + OTHER (1%)

PROTEIN (12%)
FAT (15%)

WATER (72%)

STARVATION

PROTEIN (6%)
FAT (23%)

WATER (70%)

CRITICAL CARE

glucose ← protein ← lipid

water + Electrolytes

vitamins trace elements

Soluvit-N Vitalipid-N Addamel-N

smoflipid omegaven dipeptiven

novamin kabiven
When to give parenteral nutrition

- **Total NPO**
  - PN
  - Usually the 1500 to 1900 kcal bags will suffice

- **Tube fed**
  - Unable to reach 70% of computed requirements
  - Give parenteral nutrition intermittently (usually the lower calorie content like 1000 kcal bags)

- **Oral - No appetite in spite of stimulants**
  - PN for 1-2 days 1000 kcal bag
  - Once appetite perks up, shift to oral supplements

Always add vitamins, trace elements, appropriate electrolytes
Enteral or parenteral nutrition?

- GI inadequate
  - Clinically certain on GI function
    - TPN (1)
      - Reached 80% of computed requirement: 91.8%
      - Failed to reach 80%: 8.2%
  - Clinically uncertain on GI function

- GI adequate
  - Randomized
    - TPN (3)
      - Reached 80% of computed requirement: 94.7%
      - Failed to reach 80%: 6.3%
  - Clinically certain on GI function
    - EN (2)
      - Reached 80% of computed requirement: 68%
      - Failed to reach 80%: 32%

Woodcock NP et al, Enteral vs parenteral nutrition: a pragmatic study; Nutrition 2001; 17: 1-12
When can you start nutrition?

Phase 1: resuscitation

- airway
- fluids
- medication
- procedures

cardiovascular

pulmonary

Microcirculation

Unstable

Cellular function

stable

Phase 2: build up / maintenance

? nutrition
To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient

STRATEGY #4: WHEN STABLE START ENTERAL NUTRITION
Stable status → pathway

Can the GIT be used?

- Yes
  - Oral
    - "inadequate intake"
    - < 75% intake
      - Short term
        - Parenteral nutrition
        - Long term
          - Peripheral PN
          - Central PN
      - More than 3-4 weeks
        - No
          - NGT
            - Nasoduodenal or nasojejunal
        - Yes
          - Gastrostomy
          - Jejunostomy

Feeding strategies

Early EN

- should be started within 24-48 hours and advanced towards goal over the next 48-72 hours

SCCM and ASPEN: Critcare Med 2009; 37(5)

EN = Enteral Nutrition
Why Early EN?

- **Rationale:**
  - Cytokine cascade → SIRS (due to critically ill state)
  - Absence of gut stimulation → gut atrophy
  - Changes in gut integrity begins within 6 hours
  - ↓ mucosal integrity → Higher incidence of infection/sepsis

- **Window of opportunity: 24 to 48 hrs.**

EN = Enteral Nutrition

McClave, J Clin Gastro, Sept 2002
Peng, Burns, 2001
Chiarelli, Am J Clin Nutr, 1990
Cerra, Surgery, 1988; Eyer, Trauma, 1993
Why Early EN?

Early Enteral Nutrition in Critically Ill Patients With a High-Protein Diet Enriched with Arginine, Fiber, and Antioxidants Compared With a Standard High-Protein Diet. The Effect on Nosocomial Infections and Outcome

Early EN

• Early EN vs. early PN? → meta-analysis
  – No difference in treatment effect on mortality
    • PN → increases in:
      – infective complications (7.9%, p = .001)
      – catheter-related blood stream infections (3.5%, p = .003)
      – noninfective complications (4.9%, p = .04)
      – hospital LOS (1.2 days, p = .004)
    • EN → increases in:
      – diarrheal episodes (8.7%, p = .001)


EN = Enteral Nutrition       PN = Parenteral Nutrition
## Enteral nutrition in critically ill

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<tr>
<th>Author</th>
<th>Journal/ Yr</th>
<th>% Patients Reaching Goal</th>
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<td>McClave</td>
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<td>J Surg Res 02</td>
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<tr>
<td>Umali</td>
<td>Nutr 06</td>
<td>38%</td>
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</table>
Gut dysfunction/failure = ?prognosis

- Deranged motility
- Intestinal hypoperfusion / bowel ischemia
- Reduced exocrine / pancreatic function

SIGNS / SYMPTOMS:
- gastric reflux
- aspiration
- nausea / vomiting
- gastric residuals
- abdominal distention / cramps
- diarrhea
- malabsorption
Gut dysfunction/failure → suggestions

• Gastric RESIDUALS:
  – Check first the tip location if in “normal” place:
    • 50 to 100 ml in 2 to 3 hrs: DO NOT put on NPO, continue feeding, slower rate
    • 150 to 250 in 2 to 4 hrs: STOP and observe for 3 to 4 hrs, if resolves resume feeding, but with lesser volume and slower rate
    • 300 to 400 ml: STOP feeding, observe for at least 4 to 6 hrs, if persistent → NPO, then parenteral nutrition

• Use elemental or semi-elemental formula

• Use enteral pump
Feeding approaches

• With oral intake → feed → calorie count
  – Inadequate intake → recommend tube feed
  – REFUSES → parenteral nutrition supplement

• No oral intake
  – NGT → when no signs of gut dysfunction/ failure → feed
  – Enteral nutrition → calorie count → if inadequate → give supplemental parenteral nutrition

• Gut failure → parenteral nutrition
Bacterial contamination in standard tube feeds

To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient

STRATEGY #5: GLUCOSE CONTROL
Glucose control

Strict glucose control with insulin

NICE-SUGAR STUDY:

Intensive insulin therapy significantly increased the risk of hypoglycemia and conferred no overall mortality benefit among critically ill patients.

However, this therapy may be beneficial to patients admitted to a surgical ICU.

Glucose control: some maneuvers

- **EN**
  - Use disease specific formula
  - Formulation: higher percentage of fat in the non-protein calorie component (50% - 70%)

- **PN**
  - Formulation: higher percentage of fat in the non-protein calorie component (50% - 70%)

EN = Enteral Nutrition  PN = Parenteral Nutrition
STRATEGY #6: AVOID REFEEDING / STRICT FLUID MANAGEMENT

To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient
Refeeding syndrome

- **Why?** Electrolyte alterations are frequently present in “at risk” hospitalized patients (especially malnourished) before starting artificial nutrition.

- **How?** In these patients electrolyte derangements can be triggered by starting artificial nutrition.

- **When?** Usually occurs on the 3rd to 4th day of artificial nutrition.

Refeeding: key abnormalities

- **Sodium and water retention** → fluid overload, edema, heart failure
- **Hypophosphatemia** → ventilatory failure, rhabdomyolysis
- **Hypokalemia** → cardiac arrhythmia, ventilatory failure, rhabdomyolysis, ileus
- **Hypomagnesemia** → cardiac arrhythmia, rhabdomyolysis
- **Vitamin deficits (thiamine)** → encephalopathy, lactic acidosis

E. Fiaccadori. Fluids and electrolytes. PN Workshop 2009, Kuala Lumpur, Malaysia
To avoid refeeding

If severely malnourished, geriatric (>70 yrs), or low intake for several days →

• Check electrolytes before EN or PN delivery

• For patients with low or low normal electrolyte values, add more of these electrolytes either in the EN or PN

• Deliver PN or EN slowly → start with 800 to 1000 kcal/day gradually increasing in the next 3 to 5 days until goals are reached

EN = Enteral Nutrition       PN = Parenteral Nutrition
Strict fluid management

- Avoid “+” fluid balances that are accumulating
- Concentrate formula if possible:
  - EN → 1.5 kcal/ml to 2 kcal/ml
  - PN → concentrate in smaller volume
- Use infusion pumps for delivery
STRATEGY #7: IMPLEMENT PHARMACONUTRITION

To preserve/sustain cellular structure and provide energy to achieve optimum function in the critical care patient
What is pharmaconutrition?

• Definition: nutrients that have specific metabolic or therapeutic effects when given above their usual dosage
• Previous names: nutraceuticals, immunonutrients
• What are examples of pharmaconutrition?
  – Glutamine
  – Fish oils
  – Antioxidants
  – Arginine
Glutamine (parenteral/enteral)

- Low glutamine independent of mortality
- Doubled mortality
  - Gln < 0.42 mmol/L
  - p = 0.013

## Glutamine & mortality

**Comparison:** mortality  
**Outcome:** glutamine vs. control

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<td><strong>100</strong></td>
<td><strong>0.79 (0.59, 1.04)</strong></td>
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Jiang Hua, *The clinical efficacy of glutamine: evidence from systematic review and clinical trials; FA, Singapore; 11/01/03*
EPA, antioxidants (enteral)

EPA, antioxidants, zinc, selenium

Calaguas MJ, Moog FLJ, Gaerlan AD, Saniel MV, & Llido LO. Department of Radiation Oncology, St. Luke’s Medical Center, Metro-Manila, Philippines

- EPA
- high fat low carbo
- MCT
- high protein
- Zn, Se
- antioxidants
- high fiber
Lipid emulsions (parenteral)

Mayer K. Reduced immune modulation by balanced lipid emulsions. Br J Nutr 2003
Antioxidants

Randomized prospective trial of antioxidant supplementation in critically ill surgical patients


Randomized prospective trial of antioxidant supplementation in critically ill surgical patients
IN SUMMARY
To improve nutrition in critical care

1. Know the nutritional status/risk level
2. Aim for adequate intake as early as possible
3. If unstable, PN may be the best option
4. When stable, start EN, try “early EN”
5. Achieve glucose control
6. Avoid refeeding / strict fluid management
7. Use pharmaconutrition