Chapter 141

Nutrition in ICU: An Overview

Ketan K Mehta

A slender and restricted diet is always dangerous in chronic and in acute diseases.
—Hippocrates 400 BC

To feed or not to feed the critically ill patient? Is that the right question?

**BASIS OF NUTRITIONAL SUPPORT**

Stress, acute illness, surgery or trauma produces major changes in the metabolic milieu of the body such as
- Changes in substrate utilization
- Altered substance synthesis rates
- Hypermetabolism
- Catabolism.

Consequently, there is loss of lean and fat body mass—a process that has been termed as “autocannibalism”.

Factors favoring the development of malnutrition and negative nitrogen balance in the critically ill patients are:
- Poor intake of food
- Prolonged bed rest
- Changes in substrate utilization
- Stress
- Hypermetabolism
- Exogenous steroids
- Immobility
- Surgery.

**Consequences of Malnutrition**

- Increased morbidity and mortality
- Prolonged hospital stay
- Impaired tissue function and wound healing
- Defective muscle function, reduced respiratory and cardiac function
- Immunosuppression, increased risk of infection
- Critically ill patients lose around 2% per day muscle protein.

**Goals of Nutritional Support**

- Reduce or abolish the negative nitrogen balance (catabolic state)
- Prevent malnutrition
- Improve clinical outcomes, e.g. mortality, infections.

**ISSUES IN NUTRITION**

Nutrition as a treatment (therapy)/intervention versus nutritional support for “prevention of malnutrition.”

**Aspects of Nutritional Support**

- Early versus late nutrition
  - Early: Nutritional support initiated within 36 hours of admission
  - Late: Nutritional support initiated after 3–5 days
- Enteral versus parenteral nutrition
  - Enteral: Oral, nasoenteric, percutaneous endoscopic gastrostomy (PEG), jejunostomy
  - Parenteral: Central line = carbohydrates and proteins, peripheral lines = fats
- Standard versus specialized nutrition
  - Standard feeds: Jevity®
  - Specialized feeds: Glutamine-enriched supplements.

**WHAT GUIDELINES ARE AVAILABLE?**

- Canadian Critical Care Network 2003/2007: Clinical practice guidelines

**NASOGASTRIC ROUTE PROBLEMS**

- Risk of microaspiration in intensive care unit (ICU)
- Risk of displacement
- High gastric aspirates with opioids, sepsis and electrolyte imbalances
- Reaching goals uncommon
- Percutaneous endoscopic gastrostomy/gastrostomy feeding for long-term, i.e. more than 4 weeks

**NUTRITIONAL CARE PLAN**

Flow chart 1 shows nutritional care plan.

**NUTRITIONAL REQUIREMENTS**

**What is Sufficient Energy Intake?**

In sepsis and trauma, the total energy expenditure (TEE) of critically ill patients rise from 30 kcal/kg/day in the first week to 50–60 kcal/kg/day in the second week. American College of Chest Physicians (ACCP) guidelines recommending 25 kcal/kg/day as caloric content of nutrition for the critically ill patients.
Section 19

- Energy needs are calculated on the basis of basal energy expenditure (BEE)
- The BEE is the amount of energy required to perform metabolic functions at rest and is influenced by both body size and illness
- Basal energy expenditure classically is estimated by the Harris-Benedict equation:
  - For men, BEE = 66.5 + (13.75 × weight in kg) + (5.003 × height in cm) - (6.775 × age in years)
  - For women, BEE = 655.1 + (9.563 × weight in kg) + (1.850 × height in cm) - (4.676 × age in years)
- Add stress factor 1.2–2 times.

Energy Requirements per Day
- Energy: 25–30 kcal/kg
- Water: 30 ml/kg (1 ml per kcal)
- Carbohydrate: 55–70% of total energy, more than 100 g per day (minimum) to avoid ketosis.
- Fat: 15–30% of total energy
  - Saturated fat: 1/3 of total fat (0–10% of total energy)
- Protein: 10–15% of total energy.

COMPLICATIONS OF ENTERAL NUTRITION
- Aspiration can be reduced by continuous feeds and checking for gastric residue. Diarrhea due to:
  - Gastric hypersecretion
  - Lactose intolerance
  - Altered bowel flora
  - Hyperosmolar feeding
  - Malabsorption
- Mechanical problems due to
  - Tube dislodgment
  - Malposition
  - Blocked tubes.

CONTRAINDICATIONS TO ENTERAL FEEDING
- Bowel obstruction
- Paralytic ileus
- Intestinal ischemia
- Clinical shock.

COMPLICATIONS OF TOTAL PARENTERAL NUTRITION
- Catheter-related sepsis: 3.5% increase in catheter-related bloodstream infection (CRBSI) in a meta-analysis compared to EN
- Catheter malposition leading to

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- Pneumothorax
- Hydrothorax
- Arterial puncture
- Metabolic disorders
  - Hyperglycemia
  - Hypoglycemia if total parenteral nutrition (TPN) is abruptly stopped
  - Increased CO₂ production and increased O₂ consumption if infusion rates beyond 4 ml/kg/min.
  - Hypomagnesemia, hypophosphatemia if not supplemented
- Fatty liver.

EARLY VERSUS LATE ENTERAL NUTRITION
- Early enteral nutrition defined as nutrition supplementation within 36 hours of admission or surgery
- Delayed or late enteral nutrition defined as nutrition supplementation implemented after 36 hours of admission or surgery.
- Various studies have concluded that early enteral nutrition reduces infectious complications and hospital length of stay.
- Outcomes of numerous randomized clinical trials (RCTs) have concluded that parenteral nutrition may increase complication rates, with no effect on mortality.
- Table 1 shows summary of analysis on nutrition.

SUPPLEMENTED NUTRITION

Immunonutrition/Pharmaconutrition
- “Disease-modulating” nutrients
- Attenuate metabolic response
- Prevent oxidant stress
- Favorably modulate immune response
- Probiotics to alter gut environment
- Keep blood glucose less than 8 mmol/L
- Reduces infections and organ failures.

Immune Enhanced Diets

Glutamine
- It can prevent or ameliorate the gastrointestinal mucosal atrophy seen during prolonged parenteral nutrition and may help the gastrointestinal mucosa heal more promptly after damage by either radiotherapy or chemotherapy. But there are insufficient data to support the use of glutamine in the critically ill. Enteral glutamine supplementation may be of benefit in trauma and burns patients.
**Nutrition**

### TABLE 1 | A summary of analysis on nutrition

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Early vs. late EN</th>
<th>TPN vs. Standard</th>
<th>Early EN vs. PN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 RCT, n = 753</td>
<td>26 RCT, n = 2,211</td>
<td>30 RCT, n = 2,430</td>
</tr>
<tr>
<td>Mortality</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Infectious complication</td>
<td>Reduced with early nutrition 19% vs. 41%</td>
<td>All complications—trend for increase with TPN 7.9% increase of complications with PN</td>
<td>4.9% increase with PN</td>
</tr>
<tr>
<td>Non-infectious complications</td>
<td>No difference 33% vs. 38%</td>
<td>Not reported</td>
<td>4.9% increase with PN</td>
</tr>
<tr>
<td>Technical complications</td>
<td>Not reported</td>
<td>Not reported</td>
<td>No differences in complications</td>
</tr>
<tr>
<td>Diarrheal episodes</td>
<td>Not reported</td>
<td>Not reported</td>
<td>8.7% increase with EN</td>
</tr>
<tr>
<td>Hospital length of stay</td>
<td>Reduced by 22 days with early EN</td>
<td>Not reported</td>
<td>1–2 days increased with PN</td>
</tr>
</tbody>
</table>

**Abbreviations:** EN, Enteral nutrition; RCT, Randomized controlled trial; PN, Parenteral nutrition; TPN, Total parenteral nutrition

### TABLE 2 | Complication rates of immune enhanced diets (Supplemented nutrition)

<table>
<thead>
<tr>
<th></th>
<th>Elective Surgery</th>
<th>Critically Ill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Septic</td>
</tr>
<tr>
<td>Arginine</td>
<td>Benefit</td>
<td>No benefit</td>
</tr>
<tr>
<td>Glutamine</td>
<td>Possible Benefit</td>
<td>PN Beneficial</td>
</tr>
<tr>
<td>Omega 3 FFA</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Anti-oxidants</td>
<td>—</td>
<td>Consider</td>
</tr>
</tbody>
</table>

**Abbreviations:** EN, Enteral nutrition; PN, Parenteral nutrition

**Potential beneficial effects of glutamine:**
- Enhanced insulin sensitivity
- Decreased free radical availability (anti-inflammatory action)
- Preserved cellular energetic (increases ATP content)
- Preservation of muscle mass (anti-catabolic effect)
- Reduced translocation of enteric bacteria or endotoxins (maintenance of intestinal mucosal barrier)
- Attenuation of inflammatory cytokines
- Maintenance of lymphocyte function (reduction of infectious complications)

There has been modest reduction in mortality/infections in nine studies of glutamine-supplemented parenteral nutrition. There has been improvement in morbidity and mortality in two studies of enteral glutamine in burns and trauma patients. So, Canadian Critical Care Nutrition (CCCN) recommends enteral glutamine for burns and trauma, and IV glutamine to be given with parenteral nutrition.

**Probiotics**
These are live microorganisms which administered in adequate amounts confer a health benefit on the host biocological control. They supply viable beneficial bacteria or a substrate which enhances specific beneficial bacteria, instead of trying to eliminate the pathogen.

Critical illness causes virulence of gut bacteria and treatment worsens gut function.

**Potential beneficial effects of probiotics:**
- Inhibit growth of pathogenic enteric bacteria
- Block epithelial invasion by pathogens
- Eliminate pathogenic toxins
- Improve mucosal barrier function
- Enhance T-cell and macrophage function
- Reduce production of tumor necrosis factor (TNF) and NF-κB.

**Arginine**
Deficiency state leads to immunosuppression, decreased Th2 cell function, free radical formation, abnormal microperfusion and abnormal wound healing.

Arginine-supplemented parenteral nutrition showed an increased ability to synthesize acute phase proteins when challenged with sepsis; but no effect on mortality or infectious complications.

**Fish Oils**
Only one study in acute respiratory distress syndrome (ARDS) patients but it cannot extrapolate to all critically ill patients. Patients with ARDS fed with gamma linolenic acid (GLA), eicosapentaenoic acid (EPA) and antioxidants had a reduction in pulmonary neutrophils, improvement in oxygenation, decrease in ventilator days and decrease in ICU and hospital days (Table 2).

**CONCLUSION**
In conclusion, nutritional problems are common in the critically ill patients. It occurs in about 35% of patients. Malnutrition impacts on mortality and other outcomes, nearly a threefold increase in mortality and a longer hospital stay. But it is interesting to note that the provision of nutritional support either by means of enteral nutrition or total parenteral nutrition does not impact on mortality. Early enteral nutrition significantly reduces complication rates and it may decrease infectious complication rates and reduce hospital length of stay. Increased incidence of complications and infections has been observed with parenteral nutrition and late enteral nutrition.
BIBLIOGRAPHY