Nutrition in ICU

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A. Nutrition Assessment

A nutrition risk **indicator** nutrition therapy

- Nutritional risk screening [NRS 2002]
- NUTRIC score

- All patients admitted to the ICU for whom volitional intake is anticipated to be insufficient.
- High nutrition risk identifies those patients most likely to benefit from early EN therapy.

Tools, Components, Surrogate markers

- Nutrition assessment include:
- evaluation of **comorbid** conditions
- function of the gastrointestinal (**GI**) tract
- and risk of **aspiration**

- We suggest not using traditional nutrition indicators or surrogate markers, as they are not validated in critical care.

best method for determining energy needs in the critically ill adult patient

- indirect calorimetry (IC)

- in the absence of IC:
  - published predictive equation
  - a simplistic weight-based equation (25–30 kcal/kg/d) be used to determine energy requirements. (See section Q for obesity)

Whether measured by IC or estimated by predictive equations:

- energy expenditure should be **reevaluated more than once per week**
- strategies to optimize **energy** and **protein** intake

Should protein provision be monitored independently from energy provision in critically ill adult patients?

- In the critical care setting, protein appears to be the most important macronutrient for:
- healing **wounds**
- supporting **immune** function
- maintaining **lean body mass**.

- For most critically ill patients, protein requirements are proportionately higher than energy requirements

- **Weight-based equations** (eg, 1.2–2.0 g/kg/d) may be used to monitor adequacy of protein provision

- Serum protein markers (albumin, prealbumin, transferrin, CRP) are **not validated** for determining adequacy of protein

B. Initiate EN

benefit of early EN in critically ill adult patients compared with withholding or delaying

- nutrition support therapy in the form of **early EN** be initiated within **24–48 hours** in the critically ill patient who is unable to maintain volitional intake.

benefit of early EN in critically ill adult patients compared with withholding or delaying

- EN supports:

- integrity of the gut by maintaining **tight junctions** between the intraepithelial cells

- stimulating **blood flow**

- and inducing the release of **trophic endogenous agents** (eg, cholecystokinin, gastrin, bombesin, and bile salts)

EN maintains structural integrity by:

- maintaining villous height

- supporting the mass of secretory **IgA** producing immunocytes (**B cells and plasma cells**) that compose the gut-associated lymphoid tissue (GALT) and in turn contribute to mucosal-associated lymphoid tissue at distant sites such as the **lungs**, **liver**, and **kidneys**.

Outcome difference between the use of EN or PN

- We suggest the use of **EN over PN** in critically ill patients who require nutrition support therapy.

GI dysfunction in the ICU setting

- occurs in 30%–70% of patients
- the diagnosis
- premorbid condition
- ventilation mode
- medications
- and metabolic state.

Is the clinical evidence of contractility (bowel sounds, flatus) required prior to initiating EN in critically ill adult patients?

- **Obvious** signs of contractility should **not** be required prior to initiation of EN.

preferred level of infusion of EN within the GI

- In most critically ill patients, it is acceptable to initiate EN in the stomach.

- level of infusion be **diverted lower** in the GI tract in those critically ill patients at high risk for **aspiration** or those who have shown **intolerance** to gastric EN.

EN safety during hemodynamic instability

- In the setting of hemodynamic compromise or instability;
- EN should be withheld until the patient is fully resuscitated

and/or

- Stable

- Initiation/reinitiating of EN may be considered with caution in patients undergoing withdrawal of vasopressor support.

C. Dosing of EN

What population of patients in the ICU setting does not require nutrition support therapy over the first week of hospitalization?

- patients who are at **low nutrition risk** with **normal baseline nutrition** status and low disease severity (eg, NRS 2002 ≤3 or NUTRIC score ≤5) who cannot maintain volitional intake do not require specialized nutrition therapy **over the first week** of hospitalization in the ICU.

For which population of patients in the ICU setting is it appropriate to provide trophic EN over the first week of hospitalization?

trophic or full nutrition by EN is appropriate for patients with:

- acute respiratory distress syndrome (ARDS) / acute lung injury (ALI) and those expected to have a duration of mechanical ventilation ≥72 hours,
- as these 2 strategies of feeding have **similar** patient outcomes over the first week of hospitalization.

initial trophic EN

- (defined as 10–20 kcal/h or up to 500 kcal/d) for up to 6 days resulted in a **lower incidence of GI intolerance** over the first week of hospitalization in the ICU **than full EN**

- What population of patients in the ICU requires full EN (as close as possible to target nutrition goals) beginning in the first week of hospitalization?

- patients who are at high nutrition risk (eg, NRS 2002 ≥5 or NUTRIC score ≥5, without interleukin 6)

OR

- severely malnourished
- should be advanced toward goal as quickly as tolerated over 24–48 hours while monitoring for refeeding syndrome

How soon should target nutrition goals be reached in these patients?

- Efforts to provide >80% of estimated or calculated goal energy and protein within 48–72 hours should be made to achieve the clinical benefit of EN over the first week of hospitalization.

low- to moderate-risk patients

Trophic feeds (usually defined as 10–20 mL/h or 10–20 kcal/h) may be sufficient to:

- prevent mucosal atrophy
- and maintain gut integrity

high-risk patients

- >50%–65% of goal energy may be required to prevent:

 increases in intestinal permeability

 and systemic infection

in **burn** and **bone marrow transplant** patients,

 to promote faster return of cognitive function in **head injury** patients,

 and to reduce mortality in **high-risk hospitalized** patients.

protein & clinical outcomes

- sufficient (high-dose) protein should be provided.
- Protein requirements are expected to be in the range of 1.2–2.0 g/kg **actual body weight** per day.
- and may likely be even higher in **burn** or **multiple trauma** patients.

D. Monitoring Tolerance and Adequacy of EN

- (NPO) should be minimized to limit propagation of ileus and to prevent inadequate nutrient delivery.

GI intolerance definition

- vomiting,
- abdominal distention,
- complaints of discomfort,
- high NG output, high GRV,
- diarrhea,
- reduced passage of flatus and stool,
- or abnormal abdominal radiographs

Question: Should GRVs be used as a marker for aspiration to monitor ICU patients receiving EN?

- D2a. We suggest that GRVs not be used as part of routine care to monitor ICU patients receiving EN.
- D2b. We suggest that, for those ICUs where GRVs are still utilized, holding EN for GRVs <500 mL in the absence of other signs of intolerance (see section D1) should be **avoided.**
- GRVs do **not correlate** with incidences of pneumonia, regurgitation, or aspiration.

Question: Should EN feeding protocols be used in the adult ICU setting?

- D3a. We recommend that enteral feeding protocols be designed and implemented to increase the overall percentage of goal calories provided.
- D3b. Based on expert consensus, we suggest that use of a volume-based feeding protocol or a top-down multistrategy protocol be considered.

aspiration risk measurments

- presence of a nasoenteric enteral access device
- mechanical ventilation,
- age >70 years,
- reduced level of consciousness,
- poor oral care,
- inadequate nurse:patient ratio,
- supine positioning,
- neurologic deficits,
- gastroesophageal reflux,
- transport out of the ICU,
- and use of bolus intermittent EN

- Pneumonia and bacterial colonization of the upper respiratory tree is more closely associated with aspiration of contaminated oropharyngeal secretions than regurgitation and aspiration of **contaminated gastric contents**

patients at high risk for aspiration

- diverting the level of feeding by postpyloric enteral access device placement in patients deemed to be at high risk for aspiration

- high-risk patients or those shown to be intolerant to bolus gastric EN, delivery of EN should be switched to continuous infusion.

patients at high risk for aspiration

- agents to promote motility, such as prokinetic medications (metoclopramide or erythromycin), be initiated where clinically feasible

- In all intubated ICU patients receiving EN, the head of the bed should be elevated 30°–45° and use of chlorhexidine mouthwash twice a day should be considered.

- How should diarrhea associated with EN be assessed in the adult critically ill population?

- EN not be automatically interrupted for diarrhea but rather that feeds be continued while evaluating the etiology of diarrhea in an ICU patient to determine appropriate treatment.

- E. Selection of Appropriate Enteral Formulation

Which formula should be used when initiating EN in the critically ill patient?

- For the majority of patients in an ICU setting, a standard polymeric isotonic or near isotonic 1- to 1.5-kcal/mL formula is appropriate and will be well tolerated.

- We suggest avoiding the routine use of all specialty formulas in critically ill patients in a MICU and disease-specific formulas in the SICU.

- no clear benefit to patient outcome has been shown in the literature for the routine use of specialty formulas in a general ICU setting, including:
- Diabetes
- (pulmonary, renal, hepatic),
- semielemental
- elemental
- immune modulating:

Use of immune-modulating formulas has shown no outcome benefits over standard EN formulas in a MICU setting

- The rationale for pulmonary formulas (high fat to carbohydrate to reduce respiratory quotient) has been shown to be erroneous (effect seen only with overfeeding), and their high content of omega-6 fatty acid may drive inflammatory processes.

- Do immune-modulating enteral formulations have an impact on clinical outcomes for the critically ill patient regardless of the ICU setting?
- immune-modulating enteral formulations (arginine with other agents, including eicosapentaenoic acid [EPA], docosahexaenoic acid [DHA], glutamine, and nucleic acid)
- **should not be used routinely** in the MICU. Consideration for these formulations should be reserved for patients with TBI and perioperative patients in the SICU

- Should EN formulas with fish oils (FOs), borage oil, and antioxidants be used in patients with ALI or ARDS?

- We cannot make a recommendation at this time regarding the routine use of an enteral formulation characterized by an anti-inflammatory lipid profile (e.g. omega-3 FOs, borage oil) and antioxidants in patients with ARDS and severe ALI, given conflicting data.

what are the indications, if any, for enteral formulations containing soluble fiber or small peptides?

- a commercial mixed fiber formula not be used routinely in the adult critically ill patient prophylactically to promote bowel regularity or prevent diarrhea
- considering use of a commercial mixed fiber-containing formulation if there is evidence of persistent diarrhea. We suggest avoiding both soluble and insoluble fiber in patients at high risk for **bowel ischemia** or severe dysmotility.
- We suggest considering use of small peptide formulations in the patient with persistent diarrhea, with suspected malabsorption or lack of response to fiber.

F. Adjunctive Therapy

- How should diarrhea associated with EN be assessed in the adult critically ill population?

- EN not be automatically interrupted for diarrhea but rather that feeds be continued while evaluating the etiology of diarrhea in an ICU patient to determine appropriate treatment.

Definition of diarrhea

- 2–3 liquid stools per day or >250 g of liquid stool per day.

The following factors may contribute to acute diarrhea:

- type and amount of fiber in formula
- osmolality of formula
- delivery mode
- EN contamination
- Medications
- infectious etiologies, including Clostridium difficile

Medications contribute to acute diarrhea

- Antibiotics
- proton-pump inhibitors
- Prokinetics
- glucose lowering agents
- nonsteroidal antiinflammatory drugs
- selective serotonin reuptake inhibitors
- laxatives, and sorbitol-containing preparations

- An attempt should be made to distinguish infectious diarrhea from osmotic diarrhea

- a fermentable soluble fiber additive (eg, fructooligossaccharides [FOSs], inulin) be considered for routine use in all hemodynamically stable MICU/SICU patients placed on a standard enteral formulation.

- We suggest that 10–20 g of a fermentable soluble fiber supplement be given in divided doses over 24 hours as adjunctive therapy if there is evidence of diarrhea.

role or harm of probiotic administration in critically illness

- We cannot make a recommendation for the routine use of probiotics across the general population of ICU patients
- There appears to be some beneficial effect of certain probiotic species (primarily **Lactobacillus GG**) in decreasing the incidence of **overall infectious complications and VAP**
- Studied probiotics may be considered for use in selective patient populations (eg, liver transplantation, trauma, pancreatectomy) colitis, and antibiotic-associated diarrhea

role or harm of probiotic administration in critically illness

- cases of fungemia in ICU patients associated with the use of Saccaromyces boulardii

- **worsened** clinical outcomes in **severe pancreatitis** patients

antioxidants and trace minerals

- F3. We suggest that a combination of antioxidant vitamins and trace minerals in **doses reported to be safe in critically ill** patients be provided to those patients who **require specialized nutrition therapy**.

- Antioxidant vitamins (including vitamins E and C [ascorbic acid])
- and trace minerals (including selenium, zinc, and copper)
- may improve patient outcome, especially in burns, trauma, and critical illness requiring mechanical ventilation

- Renal function should be considered when supplementing vitamins and trace elements.

enteral glutamine

- supplemental enteral glutamine not be added to an EN regimen routinely in critically ill patients.

G. When to Use PN

patient at low nutrition risk

- We suggest that, in the patient **at low nutrition risk** (eg, NRS 2002 ≤3 or NUTRIC score ≤5), exclusive PN be withheld over the first 7 days following ICU admission if the patient cannot maintain volitional intake and if early EN is not feasible.

- Patients who have a diagnosis that makes them **PN dependent (**eg, short bowel) should continue their PN upon admission to the ICU unless bacteremia is suspected

patient at high nutrition risk?

- G2.in the patient determined to be at high nutrition risk (eg, **NRS 2002 ≥5 or NUTRIC score ≥5**) or severely malnourished, when EN is not feasible, we suggest initiating exclusive PN **as soon as possible** following ICU admission.

optimal timing for initiating supplemental PN

in patients at **<u>either low or high nutrition risk</u>**:

- 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

H. When Indicated, Maximize Efficacy of PN

strategies to improve PN efficacy

- the use of protocols and nutrition support teams to help incorporate strategies to maximize efficacy and reduce associated risk of PN.

Management of PN should include attention to:

- rate of advancement of feeding
- glycemic control
- electrolyte monitoring
- and repletion (evidence of refeeding)
- duration of PN
- and transition to EN as feasible.

- Attention to refeeding syndrome is especially important for the patient with risk factors:
- alcoholism
- weight loss
- low body mass index [BMI]
- prolonged periods NPO.

- Although refeeding syndrome can occur with EN, the risk is higher with initiation of PN.

- In those patients, advancement of feeding should be slower, taking 3–4 days to reach goal. Use of protocols and nutrition support teams have been shown to decrease PN-associated complications

- Question: In the appropriate candidate for PN (high risk or severely malnourished), should the dose be adjusted over the first week of hospitalization in the ICU?

- H2. We suggest that hypocaloric PN dosing (≤20 kcal/ kg/d or 80% of estimated energy needs) with adequate protein (≥1.2 g protein/kg/d) be considered in appropriate patients (high risk or severely malnourished) requiring PN, initially over the first week of hospitalization in the ICU.

- **soy-based IV fat** emulsions (IVFEs) in the first week VS

alternative IVFEs (ie, medium-chain triglycerides [MCTs], olive oil [OO], FO, mixture of oils) ?

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/wk (often divided into 2 doses/wk) if there is concern for essential fatty acid deficiency.

- H3b. Alternative (SMOF [soybean oil, MCT, olive oil, and fish oil emulsion], MCT, OO, and FO) IVFEs may provide outcome benefit over soy-based IVFEs

- Question: Is there an advantage to using standardized commercially available PN (premixed PN) versus compounded PN admixtures?

- H4. Based on expert consensus, use of standardized commercially available PN versus compounded PN admixtures in the ICU patient **has no advantage in terms of clinical outcomes.**

The desired target blood glucose range in adult ICU patients

- H5. We recommend a target blood glucose range of **140 or 150–180** mg/dL for the **general ICU population**; ranges for specific patient populations (postcardiovascular surgery, head trauma) may differ and are beyond the scope of this guideline.

- **For specific patient populations (eg, postcardiovascular surgery, head trauma), we defer to SCCM published guidelines on glycemic control.**

- We suggest that a **BG ≥ 150 mg/dL triggers initiation of insulin** therapy for most patients admitted to an ICU with the diagnoses of ischemic stroke, **intraparenchymal hemorrhage**, aneurysmal subarachnoid hemorrhage, or **TBI**.

- titrated to achieve BG values absolutely < 180 mg/dL with minimal BG excursions <**100** mg/dL, to minimize the adverse effects of hyperglycemia.

- Hypoglycemia carries specific risks for the normal brain and a greater risk for the injured brain .
- Severe hypoglycemia (SH) can produce or **exacerbate:**

focal neurological deficits,

encephalopathy,

seizures or status epilepticus,

permanent cognitive dysfunction,

and death.

- Further, tight GC may induce regional neuroglycopenia in **TBI**

- Question: Should parenteral glutamine be used in the adult ICU patient?
- H6. We recommend that parenteral glutamine supplementation not be used routinely in the critical care setting.

I. Pulmonary Failure

optimal carbohydrate/fat ratio for pulmonary failure

- specialty high-fat/low-carbohydrate formulations designed to manipulate the respiratory quotient and reduce CO2 production not be used in ICU patients with acute respiratory failure.

- lowering CO2 production only in the ICU patient who is being overfed

- **avoid total energy provision** that exceeds energy requirements, as **CO2 production increases significantly with lipogenesis.**

- Rapid infusion of IVFE (especially SO based),

regardless of the total amount, should be avoided in patients with severe pulmonary failure

- Question: Does use of energy-dense EN formulas to restrict fluid administration benefit the adult ICU patient with acute respiratory failure?
- I2. Based on expert consensus, we suggest that fluidrestricted energy-dense EN formulations be considered for patients with acute respiratory failure (especially if in a state of volume overload).

- **Fluid accumulation**, **pulmonary edema**, and **renal failure** are common in patients with acute respiratory failure and have been associated with poor clinical outcomes.
- It is therefore suggested that a fluid-restricted energy-dense nutrient formulation (1.5–2 kcal/mL)

- Question: Should serum phosphate concentrations be monitored when EN or PN is initiated in the ICU patient with respiratory failure?

- we suggest that serum phosphate concentrations should be monitored closely and phosphate replaced appropriately when needed.
- moderate hypophosphatemia serum phosphorus concentrations ≤2.2 mg/dL
- and severe hypophosphatemia <1.5 g/dL

- Phosphate is essential for the synthesis of ATP (adenosine triphosphate) and 2,3-DPG (2,3-diphosphoglycerate),both of which are **critical for normal diaphragmatic contractility** and **optimal pulmonary function**

Renal Failure

acute kidney injury (AKI), energy and protein

- ICU patients with acute renal failure (ARF) or AKI be placed on a standard enteral formulation.
- and that standard ICU recommendations for **protein (1.2–2 g/kg actual body weight per day**) and energy (25–30 kcal/kg/d) provision should be followed.

- If significant **electrolyte abnormalities** develop, a specialty formulation designed for renal failure (with appropriate electrolyte profile) may be considered.

acute kidney injury (AKI), energy and protein

- **usual body weight for normal weight** patients
- and **ideal body weight for obese** and critically ill patients

- Question: In adult critically ill patients with AKI receiving hemodialysis or CRRT, what are appropriate targets for protein intake to support increased nitrogen losses?

- J2. We recommend that patients receiving **frequent hemodialysis or CRRT receive** increased protein, **up to a maximum of 2.5 g/kg/d.**
- Protein should not be restricted in patients with renal insufficiency as a means to avoid or delay initiating dialysis therapy.

- Lean body mass catabolism inferred from protein catabolic rate values is 1.4–1.8 g/kg/d in patients with AKI on CRRT

Hepatic Failure

- Question: Should energy and protein requirements be determined similarly in critically ill patients with hepatic failure as in those without hepatic failure?

- we suggest a **dry weight or usual weight** be used instead of actual weight in patients with cirrhosis and hepatic failure,
- due to complications of ascites, intravascular volume depletion, edema, portal hypertension, and hypoalbuminemia. We suggest that nutrition regimens **avoid restricting protein** in patients with liver failure, using the **same recommendations as for other critically ill patients**

- Question: What is the appropriate route of nutrition delivery in patients with hepatic failure?

- K2. Based on expert consensus, we suggest that **EN** be used preferentially when providing nutrition therapy in ICU patients with acute and/or chronic liver disease.

- **Long-term PN** can be associated with **hepatic complications**

- **Encephalopathy** occurs in patients with liver dysfunction due to complex multifactorial processes involving:
- products of protein metabolism
- and is worsened by:
- inflammation,
- infection,
- and oxidative stress.

- Question: Is a disease-specific enteral formulation needed for critically ill patients with liver disease?

- K3. **standard enteral formulations** be used in ICU patients with acute and chronic liver disease.
- There is no evidence of further benefit of branched-chain amino acid (BCAA) formulations on coma grade in the ICU patient with encephalopathy who is already receiving first-line therapy with luminal-acting antibiotics and lactulose.

Acute Pancreatitis

- Question: Does disease severity in acute pancreatitis influence decisions to provide specialized nutrition therapy?

- L1a. Based on expert consensus, we suggest that the initial nutrition assessment in acute pancreatitis evaluate disease severity to direct nutrition therapy.

- Since disease severity may change quickly, we suggest frequent reassessment of feeding tolerance and need for specialized nutrition therapy.

- Moderately severe acute pancreatitis is defined by transient organ failure lasting <48 hours and local complications
- pain, nausea, vomiting, and normalization of pancreatic enzymes

- Question: Do patients with mild acute pancreatitis need specialized nutrition therapy?

- We suggest not providing specialized nutrition therapy to patients with mild acute pancreatitis.
- instead advancing to an oral diet as tolerated.

- If an unexpected complication develops or there is failure to advance to oral diet **within 7 days, then specialized nutrition** therapy should be considered.
-

- Question: **Which patients require specialized nutrition** therapy early after admission for acute pancreatitis?

- We suggest that patients with moderate to severe acute pancreatitis should have a naso-/oroenteric tube placed and **EN started at a trophic rate** and advanced to goal as fluid volume resuscitation is completed (**within 24–48 hours of admission**)

- Failure to initiate EN therapy for >72–96 hours deterioration of nutrition status and its inherent complications.

- Question: Which is the most appropriate formula to use when initiating early EN in the patient with moderate to severe acute pancreatitis?
- standard polymeric formula to initiate EN in the patient with severe acute pancreatitis.
- immune-enhancing formulation currently insufficient to recommend:

- 3 small RCTs comparing

2 with arginine and FO, 1 with FO alone with a standard enteral formula suggested additional outcome benefits

- Question: Should patients with severe acute pancreatitis receive EN or PN?
- use of EN over PN in patients with severe acute pancreatitis who require nutrition therapy.
- use of EN compared with PN reduced infectious morbidity

Route of feeding in pancreatitis

- by either the gastric or jejunal route, as there is **no difference** in tolerance or clinical outcomes between these 2 levels of infusion

Strategies In intolerance to EN in severe acute pancreatitis?

- diverting the level of infusion of **EN more distally in the GI** tract

- changing from a standard polymeric formula to one that contains **small peptides and MCTs**
- or to one that is a nearly **fat-free elemental formulation**
- and switching from **bolus to continuous** infusion

- A variety of probiotic organisms were used in these trials. In the **absence of a commercial product**, a recommendation for a specific dose and type of organism cannot be made at this time.

- a large multicenter Dutch trial showed **increased mortality, MOF, and need for surgical intervention** (18 vs 10%; $P < .05$) in aggressive prebiotic and probiotic (6 strains of Lactobacillus and Bifidobacter at >1010 CFU/L) therapy delivered directly into the jejunum, compared with controls given prebiotic therapy only.

- Question: When is it appropriate to use PN in patients with severe acute pancreatitis?

- In severe acute pancreatitis, when EN is not feasible, use of PN should be considered **after 1 week** from the onset of the pancreatitis episode.

M. Surgical Subsets

Trauma

- Question: Does the nutrition therapy approach for the trauma patient differ from that for other critically ill patients?

- similar to other critically ill patients, **early** enteral feeding with a **high protein polymeric diet** be initiated in the immediate posttrauma period (within 24–48 hours of injury) once the patient is **hemodynamically stable**.

- The metabolic response to trauma is associated with **dramatic changes in metabolism**, with utilization of lean body tissue to serve as gluconeogenic substrates and to support immune and repair functions.
- progressive loss of skeletal muscle

- physical unloading of muscle with inactivity, bed rest, and immobility is associated with decreasing muscle protein synthesis, mediated by multiple mechanisms, including
- **calcium-dependent proteolysis, ATP-dependent proteolysis, lysosomal proteolysis, and free radical oxidative activation.**

- These physiologic processes lead to **deterioration of lean body mass** in trauma and are compounded by the difficulty in providing nutrition therapy.
- Depending on the extent of the trauma, these patients may have **prolonged stays** in the ICU and should undergo timely nutrition **reassessment**

- Resting energy expenditure (REE) **peaks over 4–5 days** but continues to remain high for 9–12 days (with some elevation in energy expenditure persisting for over 21 days).

- **Approximately 16% of total body protein is lost in the first 21 days, with 67% of that protein loss coming from skeletal muscle alone**
- Energy goals should be in the range of **20–35** kcal/kg/d

- Question: Should **immune-modulation formulas** be used routinely to improve outcomes in a patient with severe trauma?

- immune-modulating formulations containing arginine and FO be **considered in patients with severe trauma**.

Traumatic Brain Injury

TBI

- similar to other critically ill patients, early enteral feeding be initiated in the immediate posttrauma period (within 24–48 hours of injury) once the patient is hemodynamically stable

- early nutrition therapy (within 24–72 hours of injury) compared with those fed late (within 3–5 days of injury), **regardless of route**

- Critically ill patients with TBI often have other injuries and organ damage, making them a heterogeneous population.
- In addition to the inconsistency of individual pathophysiologic **immune and metabolic responses to trauma**, the variability in management will alter metabolic demands.

- Brain Trauma Foundation showed a significant relationship between the amount of early nutrition therapy provided and the risk of death

- Optimal energy and protein intake following TBI predicted the mortality risk after 2 weeks, with a 30%–40% decrease in mortality for every 10-kcal/kg/d increase in energy intake, achieving a plateau at approximately **25 kcal/kg/d.**

- Energy requirements are primarily influenced by the method of management of TBI. Actual measured **energy expenditure can range from 100%–200%** of baseline-predicted REE, depending on variables such as use of paralytics and/or coma-inducing agents in early management.

- Protein requirements may be in the range of **1.5–2.5 g/kg/d**

immune-modulating formulas in TBI

- Suggested use of either arginine-containing immune-modulating formulations or EPA/DHA supplement with standard enteral formula in patients with TBI.

Open abdomen protein/energy needs

- we suggest providing an additional 15–30 g of protein per liter of exudate lost for patients with OA.
- Energy needs should be determined **as for other ICU patients** (see section A).

Burns

- mode of nutrition support to feed burn patients:
- EN should be provided to burn patients whose GI tracts are functional and for whom volitional intake is inadequate to meet estimated energy needs.

- PN should be reserved for those burn patients for whom EN is not feasible or not tolerated.

Burns

- energy requirements in BURN
- we suggest that IC be used when available to assess energy needs in burn patients with weekly repeated measures.

Burns

- optimal quantity of protein to for large burns requiring ICU care:

- we suggest that patients with burn injury should receive protein in the range of 1.5–2 g/kg/d.

Burns

- When should nutrition support be initiated?
- we suggest very early initiation of EN (if possible, within 4–6 hours of injury) in a patient with burn injury.

Sepsis

- Are patients with severe sepsis candidates for early EN therapy?
- Initiating EN within 24-48 hours of resuscitation or when hemodynamic stability is reached
- (defined as adequate perfusion pressure, stable doses of vasoactive drugs, stabilized or decreasing levels of lactate and metabolic acidosis, and mean arterial pressure .60 mm Hg)
- **is associated with improved outcomes**

Sepsis

- Question: Should exclusive or supplemental PN added to EN providing <60% of goal be used in the acute phase of severe sepsis or septic shock?

- N2. We suggest **not using** exclusive PN or supplemental PN in conjunction with EN early in the acute phase of severe sepsis or septic shock, regardless of patients' degree of nutrition risk.

micronutrient supplementation in sepsis

- We cannot make a recommendation regarding **selenium**, **zinc**, and **antioxidant** supplementation in sepsis at this time due to conflicting studies.

micronutrient supplementation in sepsis

- Specifically, plasma **selenium** has been shown to be depressed in sepsis

- Selenium is believed to be one of the most potent antioxidant agents in clinical settings (as well as zinc, ascorbic acid, vitamin E, and beta-carotene).

micronutrient supplementation in sepsis

- The recommended optimal acute selenium dose for critically ill patients may range between **500–750** mcg/d, with ideal duration of supplementation being **1–3 weeks** depending on severity of disease

- **the protein and energy requirements for septic patients in the acute phase of management**

- We suggest the provision of trophic feeding (defined as 10–20 kcal/h or up to 500 kcal/d) for the initial phase of sepsis, advancing as tolerated after 24–48 hours **to >80% of target energy goal over the first week.**

- We suggest delivery **of 1.2–2 g protein/kg/d**.

- immune or metabolic-modulating enteral formulations (arginine with other agents, including EPA, DHA, glutamine, and nucleic acid) in sepsis?

- We suggest that immune-modulating formulas not be used routinely in patients with severe sepsis.

Arginine

- Theoretically, in septic critically ill patient who is hemodynamically unstable increasing nitric oxide production, and causing greater hemodynamic instability and organ dysfunction.

- clinical trials reported no such adverse events.
- In fact, arginine may provide benefit in sepsis by promoting perfusion of tissues and increasing cardiac output.

- Formula containing **FO**, **arginine**, and **nucleic acids**, reduced mortality, bacteremia and nosocomial infection

- formulation of glutamine, antioxidants, trace elements, and butyrate (but no arginine) compared with use of a standard enteral formula **faster recovery** in organ function

immune-enhancing enteral formula

- early prior to severe sepsis, an immune-enhancing enteral formula with **omega-3** fatty acids, **gamma linolenic acid**, and **antioxidants** reduced the development of organ dysfunctions, although it did not improve mortality or LOS

O. Postoperative Major Surgery (SICU Admission Expected)

- Question: nutrition risk indicator or traditional markers of nutrition assessment?
- we suggest that determination of nutrition risk (eg, NRS 2002 or NUTRIC score) be performed on all postoperative patients in the ICU
- and that traditional visceral protein levels (serum albumin, prealbumin, and transferrin concentrations) **should not be used as markers of nutrition status.**

O. Postoperative Major Surgery (SICU Admission Expected)

- Question: Should immune-modulating formulas be used routinely to improve outcomes in a postoperative patient?
- **We suggest the routine use** of an immune-modulating formula (containing both **arginine and fish oils**) in the SICU for the postoperative patient who requires EN therapy.

- We suggest enteral feeding for many patients in difficult postoperative situations such as prolonged ileus, intestinal anastomosis, OA, and need of vasopressors for hemodynamic support. Each case should be individualized based on perceived safety and clinical judgment.

- Question: When should PN be used in the postoperative ICU patient?
- we suggest that, for the patient who has undergone major upper GI surgery and EN is not feasible, PN should be initiated (**only if the duration of therapy is anticipated to be ≥7 days).**

- **Unless** the patient is at high nutrition risk, PN should not be started in the immediate postoperative period but should be delayed for 5–7 days.

- Question: Is advancing to a **clear-liquid** diet required as the first volitional intake in the postoperative ICU patient?

- we suggest that, upon advancing the diet postoperatively, patients be allowed solid food as tolerated and that **clear liquids are not required as the first meal.**

P. Chronically Critically Ill

- we suggest that chronically critically ill patients (defined as those with persistent organ dysfunction requiring **ICU LOS >21 days**) be managed with aggressive high-protein EN therapy and, when feasible, that a resistance exercise program be used.

Q. Obesity in Critical Illness

Q. Obesity in Critical Illness

- we suggest that early EN start within 24–48 hours of admission to the ICU for obese patients who cannot sustain volitional intake.

Q. Obesity in Critical Illness

- the nutrition assessment in the obese ICU patient should focus on
- determining **actual**, **usual**, and **ideal** weight.
- **BMI** should be calculated,
- **class of obesity** identified,
- and, if possible, **waist circumference** measured.

- **Use of adjusted body weight is not recommended**

Q. Obesity in Critical Illness

- Biomarkers of metabolic syndrome should be evaluated, which include:

serum glucose,

triglyceride,

and cholesterol concentrations

Attention to blood pressure

Q. Obesity in Critical Illness

emerging comorbidities, including:

- diabetes
- hyperlipidemia,
- obstructive sleep apnea
- restrictive lung disease
- cardiomyopathy with congestive heart failure
- hypertension
- thrombogenesis,
- abnormal liver enzymes to suggest fatty liver disease.

- An assessment of the level of inflammation should be done by looking at :
- CRP
- Erythrocyte sedimentation rate
- evidence of SIRS

- These factors represent additional comorbidities that make

complications resulting from nutrition therapy e.g. volume overload, hyperglycemia

- Question: What factors on assessment identify obese patients in the ICU to be at high risk?
- central adiposity,
- metabolic syndrome,
- sarcopenia,
- BMI >40,
- SIRS,
- other comorbidities that correlate with higher obesity-related risk for cardiovascular disease and mortality.

- we suggest that highprotein **hypocaloric** feeding be implemented in the care of obese ICU patients to:
- preserve lean body mass,
- mobilize adipose stores,
- and minimize the metabolic complications of overfeeding.

- for all classes of obesity, the goal of the EN regimen should not exceed 65%–70% of target energy requirements as measured by IC.
- If IC is unavailable, we suggest using the weight-based equation

11–14 kcal/kg actual body weight per day for patients with BMI in the range of 30–50

- and 22–25 kcal/kg ideal body weight per day for patients with BMI >50.

- We suggest that protein should be provided in a range from 2.0 g/kg ideal body weight per day for patients with BMI of 30–40

- up to 2.5 g/kg ideal body weight per day for patients with BMI ≥40.

- we suggest that, if available, an enteral formula

with low caloric density and a **reduced NPC:N** be used in the adult obese ICU patient.

- Question: Does the obese ICU patient with a history of bariatric surgery or other malabsorptive condition require any additional supplementation of micronutrients when starting nutrition therapy?

- supplemental thiamine prior to initiating dextrose-containing IV fluids or nutrition therapy.
- calcium
- thiamin
- vitamin B12
- fat soluble vitamins (A, D, E, K)
- and folate
- along with the trace minerals **iron**, **selenium**, **zinc**, and **copper**, should
- be considered.

Nutrition Therapy End-of-Life Situations

- What is the role of artificial nutrition and hydration (ANH) in end-of-life situations?

- we suggest that ANH is not obligatory in cases of futile care or end-of-life situations. The decision to provide ANH should be based on evidence, best practices, clinical experience and judgment; effective communication with the patient, family, and/or authorized surrogate decision maker; and respect for patient autonomy and dignity

Thank you

- intralipid
- **Essential Fatty Acid Deficiency**
- When Intralipid® is administered to correct essential fatty acid deficiency, **eight to ten percent of the caloric input** should be supplied by Intralipid® in order to provide adequate amounts of linoleic and linolenic acids. When EFAD occurs together with stress, the amount of Intralipid® needed to correct the deficiency may be increased.

- The initial infusion rate of the intralipid in adults should be 0.1 g fat/minute for the first 15 to 30 minutes of infusion. If no untoward reactions occur (see ADVERSE REACTIONS section), the infusion rate can be increased to 0.2 g fat/minute. For adults, the admixture should not contain more than 1000 mL of Intralipid® 10% on the first day of therapy. If the patient has no untoward reactions, the dose can be increased on the following day. The daily dosage should not exceed 2.5 g of fat/kg of body weight (12.5 mL of Intralipid® 20% per kg). Intralipid® should make up no more than 60% of the total caloric input to the patient. Carbohydrate and a source of amino acids should comprise the remaining caloric input.

- Amino acid
- Contains sodium **metabisulfite**, a sulfite that may cause allergic-type reactions including anaphylactic symptoms and life-threatening or less severe asthmatic episodes in certain susceptible people. The overall prevalence of sulfite sensitivity in the general population is unknown and probably low.
- Sulfite sensitivity is seen more frequently in **asthmatic** than in nonasthmatic people.