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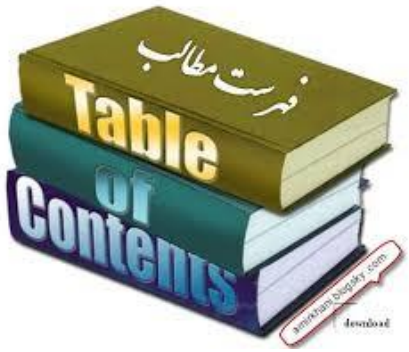
Outline

- Rationale and Criteria for Appropriate Nutrition Support
- Nutrition Assessment
- Enteral Nutrition
- Parenteral Nutrition
- Summary



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RATIONALE AND CRITERIA FOR APPROPRIATE NUTRITION SUPPORT

- **When patients cannot or will not eat enough to support their nutritional needs for more than a few days, nutrition support should be considered as part of the integrated care plan.**

- **Using the GIT (EN vs. using PN alone) helps preserve the intestinal mucosal barrier function and integrity.**

- **In critically ill patients, feeding the GIT has been shown to attenuate the catabolic response and preserve immunologic function.**

RATIONALE AND CRITERIA FOR APPROPRIATE NUTRITION SUPPORT

- Research shows less septic morbidity, fewer infectious complications, and significant cost savings in critically ill adult patients who received EN versus PN.

- There is limited evidence that EN versus PN affects hospital LOS but an impact on mortality has not been demonstrated.

- A 2014 study found no significant difference in 30-day mortality in critically ill adults who received nutrition support by the PN or the EN route.

- Another more recent study of ventilated adults with shock noted

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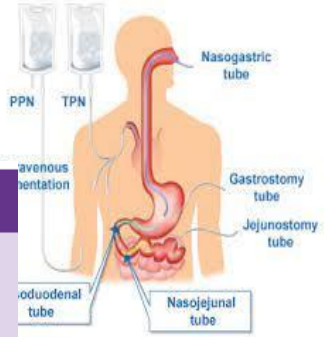

TABLE 12.1 Conditions That May Require Nutrition Support

Recommended Route of Feeding	Condition	Typical Disorders
Enteral nutrition	Inability to eat	Neurologic disorders (dysphagia) Facial trauma Oral or esophageal trauma Congenital anomalies Respiratory failure (on a ventilator) Traumatic brain injury Comatose state GI surgery (e.g., esophagectomy)
	Inability to eat enough	Hypermetabolic states such as with burns Cancer Heart failure Congenital heart disease Impaired intake after orofacial surgery or injury Anorexia nervosa Failure to thrive Cystic fibrosis
	Impaired digestion, absorption, metabolism	Severe gastroparesis Inborn errors of metabolism Crohn disease Short bowel syndrome with minimum resection Pancreatitis

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TABLE 12.1 Conditions That May Require Nutrition Support

Recommended Route of Feeding	Condition	Typical Disorders
Parenteral nutrition	Gastrointestinal incompetency	Short bowel syndrome—major resection Severe acute pancreatitis with intolerance to enteral feeding Severe inflammatory bowel disease Small bowel ischemia Intestinal atresia Severe liver failure Persistent postoperative ileus Intractable vomiting/diarrhea refractory to medical management Distal high-output fistulas Severe GI bleeding
	Critical illness with poor enteral tolerance or accessibility	Multi-organ system failure Major trauma or burns Bone marrow transplantation Acute respiratory failure with ventilator dependency and gastrointestinal malfunction Severe wasting in renal failure with dialysis Small bowel transplantation, immediate after surgery

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Fig. 12.1 Algorithm for route selection for nutrition support. *GI*, Gastrointestinal; *PEG*, percutaneous endoscopic gastrostomy; *PEJ*, percutaneous endoscopic jejunostomy; *PICC*, peripherally inserted central catheter.

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Nutrition Assessment

Question: Does the use of a nutrition risk indicator identify patients who will most likely benefit from nutrition therapy?

McClave et al.; Journal of Parenteral and Enteral Nutrition; 2016

Nutrition Assessment

- Determine the nutrition risk by **nutritional risk screening [NRS 2002]** or **NUTRIC score** for **all patients admitted to the ICU**
- **High nutrition risk** identifies those patients most likely to benefit from **early EN therapy.**

McClave et al.; Journal of Parenteral and Enteral Nutrition; 2016

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TABLE 37.2

Quick Sequential Organ Failure Assessment (qSOFA) Criteria

Criteria	Points*
Respiratory rate ≥22/minute	1
Change in mental status	1
Systolic blood pressure ≤100 mm Hg	1

From Singer M, et al: The third international consensus definitions for sepsis and septic shock (sepsis-3), *JAMA* 315:801, 2016.

*qSOFA score ≥2 indicates organ dysfunction

Sequential [Sepsis-Related] Organ Failure Assessment Score

	Score				
System	0	1	2	3	4
RESPIRATION					
PaO_2/FIO_2, mm Hg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
COAGULATION					
Platelets, $\times 10^3/\mu L$	≥150	<150	<100	<50	<20
LIVER					
Bilirubin, mg/dL (μmol/L)	<1.2 (20)	1.2–1.9 (20–32)	2.0–5.9 (33–101)	6.0–11.9 (102–204)	>12.0 (204)
Cardiovascular	MAP ≥70 mm Hg	MAP <70 mm Hg	Dopamine <5 or dobutamine (any dose)[a]	Dopamine 5.1–15 or epinephrine ≤0.1 or norepinephrine ≤0.1[a]	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1[a]
CENTRAL NERVOUS SYSTEM					
Glasgow Coma Scale score[b]	15	13–14	10–12	6–9	<6
RENAL					
Creatinine, mg/dL (μmol/L)	<1.2 (110)	1.2–1.9 (110–170)	2.0–3.4 (171–299)	3.5–4.9 (300–440)	>5.0 (440)
Urine output, mL/d				<500	<200

Abbreviations: FIO_2, fraction of inspired oxygen; MAP, mean arterial pressure; PaO_2, partial pressure of oxygen.

a Catecholamine doses are given as μg/kg/min for at least 1 hour.

b Glasgow Coma Scale scores range from 3–15; higher score indicates better neurological function.

Source: The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) M Singer et al. JAMA 2016;315:801

Physiologic Variable	Points								
	+4	+3	+2	+1	0	+1	+2	+3	+4
1. Temperature (°C)	≥41	39-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤29.9
2. Mean arterial pressure (mmHg)	≥160	130-159	110-129		70-109		50-69		≤49
3. Heart rate (/min)	≥180	140-179	110-139		70-109		55-69	40-54	≤39
4. Respiratory rate (/min)	≥50	35-49		25-34	12-24	10-11	6-9		≤5
5. Oxygenation (mmHg) a. A-aDO_2 if FiO_2 ≥0.5 b. PaO_2 if FiO_2 <0.5	500	350-499	200-349		<200 >70	61-70		55-60	<55
6. Acid-base balance a. Arterial pH b. Serum HCO_3 (mEq/l) if no arterial blood gas	≥7.7 ≥52	7.6-7.69 41-51.9		7.5-7.59 32-40.9	7.33-7.49 22-31.9		7.25-7.32 18-21.9	7.15-7.24 15-17.9	<7.15 <15
7. Sodium (mEq/l)	≥180	160-179	155-159	150-154	130-149		120-129	111-119	≤110
8. Potassium (mEq/l)	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
9. Creatinine (mg/dl)	≥3.5	2-3.4	1.5-1.9		0.6-1.4		<0.6		
10. Hematocirt (%)	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<2.5
11. White blood count (×1000/mm^3)	≥40		20-39.9	15.19.9	3-14.9		1-2.9		<1
12. Glasgow Coma Score (GCS)	Score = 15 minus actual GCS								
A. Total Acute Physiology Score (sum of 12 above points)									
B. Age points (years) ≤44=0; 45 to 54=2; 55 to 64=3; 65 to 74=5; ≥75=6									
C. Chronic Health Points*									
Total APACHE II Score (add together the points from A+B+C)									

* Chronic Health Points: If the patient has a history of severe organ system insufficiency or is immune-compromised as defined below, assign points as follows:
5 points for non-operative or emergency post-operative patients
2 points for elective post-operative patinets

Fig. 1. Summary variables and calculation methods for Acute Physiology

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TABLE 39.3 Nutrition Risk in the Critically Ill (NUTRIC) Score

Variable	Range	Points
Age	<50	0
	50 to <75	1
	≥75	2
APACHE II	<15	0
	15 to <20	1
	20 to 28	2
	≥28	3
SOFA	<6	0
	6 to <10	1
	≥10	2
Number of comorbidities	0 to 1	0
	≥2	1
Days from hospital to ICU admission	0 to <1	0
	≥1	1
IL-6	0 to <400	0
	≥400	1

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NUTRIC SCORE SCORING SYSTEM: IF IL-6 IS AVAILABLE

Sum of points	Category	Explanation
6–10	High score	• Associated with worse clinical outcomes (mortality, ventilation). • These patients are the most likely to benefit from aggressive nutrition therapy.
0–5	Low score	• These patients have a low malnutrition risk.

NUTRIC SCORE SCORING SYSTEM: IF NO IL-6 AVAILABLE

Sum of points	Category	Explanation
5–9	High score	• Associated with worse clinical outcomes (mortality, ventilation). • These patients are most likely to benefit from aggressive nutrition therapy.
0–4	Low score	• These patients have a low malnutrition risk.

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TABLE 39.4 Nutrition Risk Screening [NRS 2002]

INITIAL SCREENING		Yes	No
1	Is BMI <20.5?		
2	Has the patient lost weight within the last 3 months?		
3	Has the patient had a reduced dietary intake in the last week?		
4	Is the patient severely ill? (e.g., intensive care)		

Yes: If the answer is "yes" to any question, further screening is performed (see below).

No: If the answer is "no" to all questions, the patient is rescreened weekly. If the patient is scheduled for major operation, a preventative nutritional care plan is considered to avoid the associated risk status.

FINAL SCREENING

Impaired Nutritional Status		Severity of Disease (Increase in Requirements)	
Absent **Score 0**	Normal nutritional status	Absent **Score 0**	Normal nutritional requirements
Mild **Score 1**	Weight loss >5% in 3 months or food intake <50% to 75% of normal requirement in preceding week	Mild **Score 1**	Hip fracture, chronic patients with acute complications: cirrhosis, COPD, chronic hemodialysis, diabetes, oncology
Moderate **Score 2**	Weight loss >5% in 2 months or BMI 18.5–20.5 + impaired general condition or food intake 25%–60% of normal requirement in preceding week	Moderate **Score 2**	Major abdominal surgery, stroke, severe hematologic malignancy
Severe **Score 3**	Weight loss >5% in 1 month (>15% in 3 months) or BMI <18.5 + impaired general condition or food intake 0%–25% of normal requirement in preceding week	Severe **Score 3**	Head injury, bone marrow transplantation, intensive care patients (APACHE >10)
Score:	+	**Score**:	= **Total score**
Age	If ≥70 years, add 1 to total score above = **age – adjusted total score**		

Score ≥3: The patient is nutritionally at risk, and a nutritional care plan is initiated.

Score <3: Weekly rescreening of the patient. If the patient is scheduled for a major operation, a preventative nutritional care plan is considered to avoid the associated risk status.

APACHE, Acute physiologic assessment and chronic health evaluation; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease.
(From Kondrup J, Allison SP, Vellas B, et al: ESPEN guidelines for nutrition screening 2002, *Clin Nutr* 22:415, 2003.)

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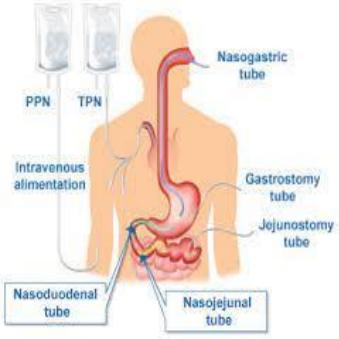
Enteral Nutrition

- **Initiate nutrition support therapy in the form of early EN within 24–48 hrs in the critically ill patient.**

ENTERAL NUTRITION ACCESS



- **Short-Term Enteral Nutrition Support**
  - **Nasogastric Access**
  - **Gastric Versus Small-Bowel Access**
  - **Nasoduodenal or Nasojejunal Access**

- **Long-Term Enteral Access**
  - **Gastrostomy**
  - **Jejunostomy**

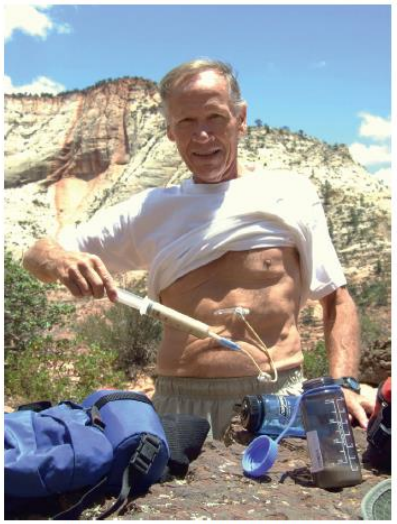


Fig. 12.4 A man with a gastrostomy tube out hiking. (From Oley Foundation, Albany, NY. htttps://www.oley.org.)

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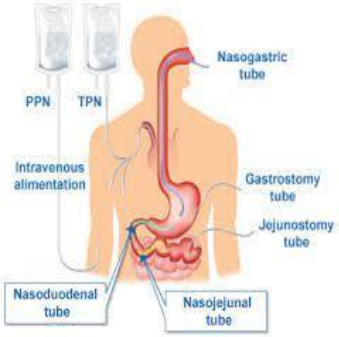

Fig. 12.2 Diagram of enteral tube placement.

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Formula Content and Selection

BOX 12.2 Factors to Consider When Choosing an Enteral Formula

Ability of the formula to meet the patient's nutrient requirements

Caloric and protein density of the formula (i.e., kcal/mL, g protein/mL, mL fluid/L)

Gastrointestinal function

Sodium, potassium, magnesium, and phosphorus content of the formula, especially for patients with cardiopulmonary, renal, or hepatic failure

Form and amount of protein, fat, carbohydrate, and fiber in the formula relative to the patient's digestive and absorptive capacity

Cost effectiveness of formula

Patient compliance

Cost-to-benefit ratio

Blenderized (Homemade) Tube Feedings

- Tube feedings made from common ingredients such as eggs, sugar, and wine have been used since the 1500 s.

- Clinicians often are concerned about nutritional adequacy, food safety, and the additional burden preparation of BTF places on the caregivers.

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Advantages of BTF

1) **Cost effectiveness (because commercial formulas may not be covered by insurance).**

2) **Health benefits from using whole foods.**

3) **Ability to tailor the formula exactly to patient needs.**

4) **The strong social bond between the caregiver and the patient.**

Powdered Formulas Requiring Preparation

- Hang time: 4 hours
- Increased infection risk
- Needs to be prepared in special formula room
- Requires sterile water
- Increased nursing time

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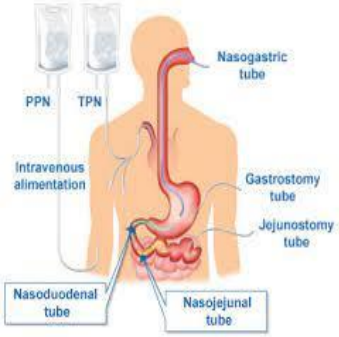
Ready-to-hang Formulas

Powdered Formulas



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Energy and protein needs in the critically ill adult patients

- The best method for determining is: **Indirect calorimetry**
- In the absence of IC: **12–25 kcal/kg/d**
- In the care of **obese** ICU patients: **High-pro hypocaloric feeding → Preserve LBM, mobilize adipose stores, and minimize the metabolic complications of overfeeding.**

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Energy and protein needs in the critically ill adult patients *Cont'd*

- **For all classes of obesity, the goal of the EN regimen:**
  65%–70% of target ER as measured by IC.

- **If IC is unavailable:**
  - **11–14 kcal/kg ABW/day for BMI= 30–50 kg/m^2**
  - **22–25 kcal/kg IBW/day for BMI >50 kg/m^2**

- **Protein:**
  - **2.0 g/kg IBW/day for BMI= 30–40 kg/m^2**
  - **Up to 2.5 g/kg IBW/day for BMI ≥40 kg/m^2**

Energy and protein needs in the critically ill adult patients *Cont'd*

- **EE should be reevaluated >1/week, and strategies to optimize energy and protein intake should be used.**

- **Hypocaloric EN → ↓GI intolerance, ↓ duration of MV and length of hospital stay. (*JPEN J Parenter Enteral Nutr.* 2020;00:1–9)**

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Protein

- In available commercial EN formulas: 6% - 37% of Kcal.
- Typically is derived from casein, whey, or soy protein isolate.
- Standard formulas provide intact pro; elemental formulas contain di- and tripeptides and amino acids, which are absorbed more easily.
- Specialized formulas for hepatic or severe renal failure or for cases of multiple, severe allergies usually include crystalline amino acids.

Protein *Cont'd*

- **Specific Aas may be added to some enteral formulas.**
- **BCAAs have been used in formulas for patients with severe hepatic disease, and**
- **Arginine has been added to formulas marketed for critically ill patients.**
- **Strong evidence to support these additions is not available.**

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Carbohydrate

- In EN formulas varies from 30% - 85% of Kcal.
- Corn syrup solids typically are used in standard formulas.
- Sucrose is added to flavored formulas that are meant for oral consumption.
- Hydrolyzed formulas contain carbohydrate from cornstarch or maltodextrin.

Carbohydrate *Cont'd*

- Carbohydrate or fiber that cannot be processed by human digestive enzymes is added frequently to enteral formulas.

- Fibers are classified as water soluble (pectins and gums) or water insoluble (cellulose or hemicellulose).

- The effectiveness of different fibers added to enteral formulas in treating GIT symptoms of critically ill patients is controversial.

Carbohydrate *Cont'd*

- FOS, which are prebiotics, have been added to enteral formulas, often in combination with a source of dietary fiber, for more than 15 years.

- More recently, inulin, another fermentable oligosaccharide, has been added to some enteral formulas.

- Both FOS and inulin are associated with fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs), which are poorly absorbed short-chain carbohydrates

Carbohydrate *Cont'd*

- **FOS have been shown to stimulate the production of beneficial bifidobacteria and when combined with dietary fiber may produce beneficial changes in colonic pH, fecal microbiota, and SCFAs concentrations.**

- **Use of formulas with a high FODMAPs content may exacerbate and play a role in diarrhea, especially in individuals who receive antibiotics that affect the intestinal microbiome.**

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Carbohydrate *Cont'd*

- **The ASPEN guidelines suggest that "mixed-fiber formula not be used routinely" in adult critically ill patients "to promote regularity or prevent diarrhea"**

- **All commercially available enteral formulas are lactose free, because lactase insufficiency may be encountered in acutely ill patients.**

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Lipid

- In enteral formulas varies from 1.5% - 55% of the kcals.
- In standard formulas, lipid as (typically) canola, soybean, and/or safflower oil provides 15% - 30% of the Kcals.
- Elemental formulas contain minimal amounts of fat, typically in the form of MCTs rather than LCTs.

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Lipid *Cont'd*

- **Most of the lipid in standard enteral formulas is in the form of LCTs and MCTs.**
- **Some formulas contain "structured lipids," which are a mix of LCTs and MCTs and contain properties of both.**
- **Most of the LCTs found in structured lipids are omega-3 fatty acids (such as EPA and DHA); these omega-3 fatty acids may have antiinflammatory effects.**

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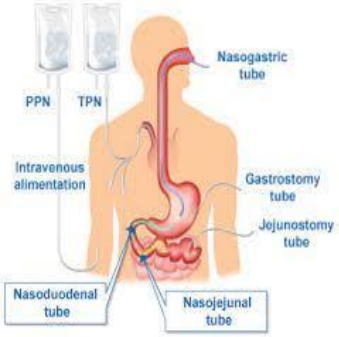
Lipid *Cont'd*

- **MCTs do not require bile salts or pancreatic lipase for digestion and are absorbed directly into the portal circulation.**
- **The % of fat as MCT in EN formulas varies from 0% - 85%.**
- **LA & ALA: ~ 2% - 4% of Kcal intake**
- **MCTs do not provide LA or ALA**

Vitamins, Minerals, and Electrolytes

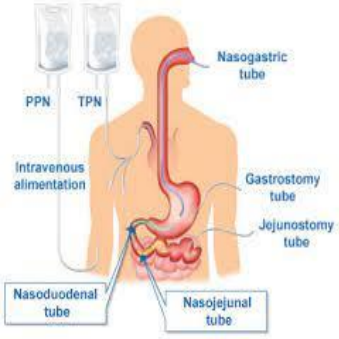


- Most, but not all, available formulas provide the DRIs for vitamins and minerals in a volume that may be administered to most patients.

- Because the DRIs are intended for healthy populations, not specifically for individuals (whether healthy or acutely or chronically ill), it is difficult to know for certain whether the vitamin and mineral provision from these formulas is adequate.

- Formulas intended for patients with renal or hepatic failure are intentionally low in vitamins A, D, and E, Na, and k.

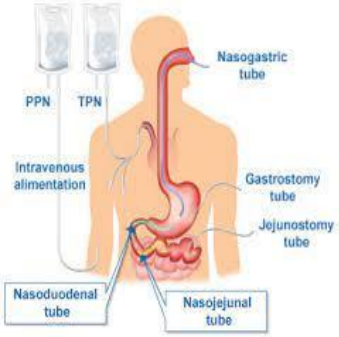
Vitamins, Minerals, and Electrolytes *Cont'd*



- **Conversely, disease-specific formulas often are supplemented with antioxidant vitamins and minerals and marketed to suggest that these additions improve immune function or accelerate wound healing.**

- **Definitive studies demonstrating these effects are not available.**

Vitamins, Minerals, and Electrolytes *Cont'd*



- **Electrolyte content of enteral formulas is typically modest compared with the oral diet.**

- **Patients who experience large electrolyte losses (e.g., because of diarrhea, fistula, emesis) likely will require electrolyte supplementation.**

- **Salt must be added to BTFs in order to provide an adequate Na intake.**

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Fluid

- **Adult fluid needs often are estimated at 1 mL of water per kilocalorie consumed, or 30 to 35 mL/kg of usual body weight.**

- **Patients fed exclusively by EN, especially if it is a concentrated formula, may receive insufficient fluid (water) to meet their needs.**

- **Insufficient fluid intake and administration of a high-fiber product can lead to undesirable consequences, including inadequate urine output, constipation, and formation of a fiber bezoar (a hard ball of fiber that may develop within the human stomach).**

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Fluid *Cont'd*

- **All sources of fluid, including feeding tube flushes, medications, and IV fluids, should be considered when assessing a patient's fluid intake relative to individual needs.**

- **Standard (1 kcal/mL) formulas contain about 85% water by volume; concentrated (2 kcal/mL) formulas contain only about 70% water by volume.**

- **Additional water (as flushes and for additional hydration) are often necessary to meet fluid needs and help assure tube patency.**

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Administration

- **Bolus:** over 5 to 20 minutes

- **Intermittent and Cyclic:** 4-6 feedings, each administered over 20 - 60 minutes.

- **Continuous:** Requires a pump

Monitor and Reevaluate Patient

Signs of GI intolerance:

1) Vomiting

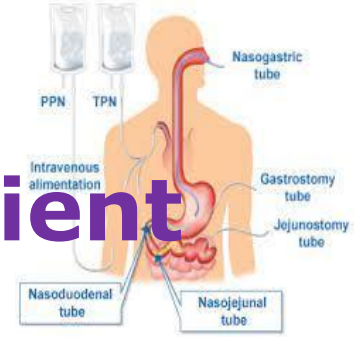
2) Abdominal distention

3) Complaints of discomfort

4) High NG output

McClave et al.; Journal of Parenteral and Enteral Nutrition; 2016

Monitor and Reevaluate Patient



5) High gastric residual volumes (GRVs)

6) Diarrhea

7) Reduced passage of flatus and stool

8) Abnormal abdominal radiographs

McClave et al.; Journal of Parenteral and Enteral Nutrition; 2016

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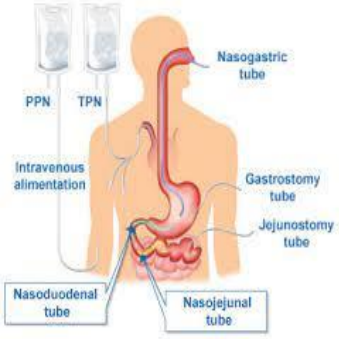

BOX 12.3 Complications of Enteral Nutrition

Access

Leakage from ostomy/stoma site
Pressure necrosis/ulceration/stenosis
Tissue erosion
Tube displacement/migration
Tube obstruction/occlusion

Administration

Microbial contamination
Enteral misconnections or misplacement of tube, causing infection, aspiration pneumonia, peritonitis, pulmonary or venous infusion
Regurgitation
Inadequate delivery for one or more reasons

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BOX 12.3 Complications of Enteral Nutrition

Gastrointestinal

Constipation
Delayed gastric emptying/elevated gastric residual volume
Diarrhea
- Osmotic diarrhea, especially if sorbitol is present in liquid drug preparations
- Secretory

Distention/bloating/cramping
Formula choice/rate of administration
Intolerance of nutrient components
Maldigestion/malabsorption
Nausea/vomiting

Metabolic

Drug-nutrient interactions
Glucose intolerance/hyperglycemia/hypoglycemia
Dehydration/overhydration
Hypernatremia/hyponatremia
Hyperkalemia/hypokalemia
Hyperphosphatemia/hypophosphatemia
Micronutrient deficiencies (notably thiamin)
Refeeding syndrome

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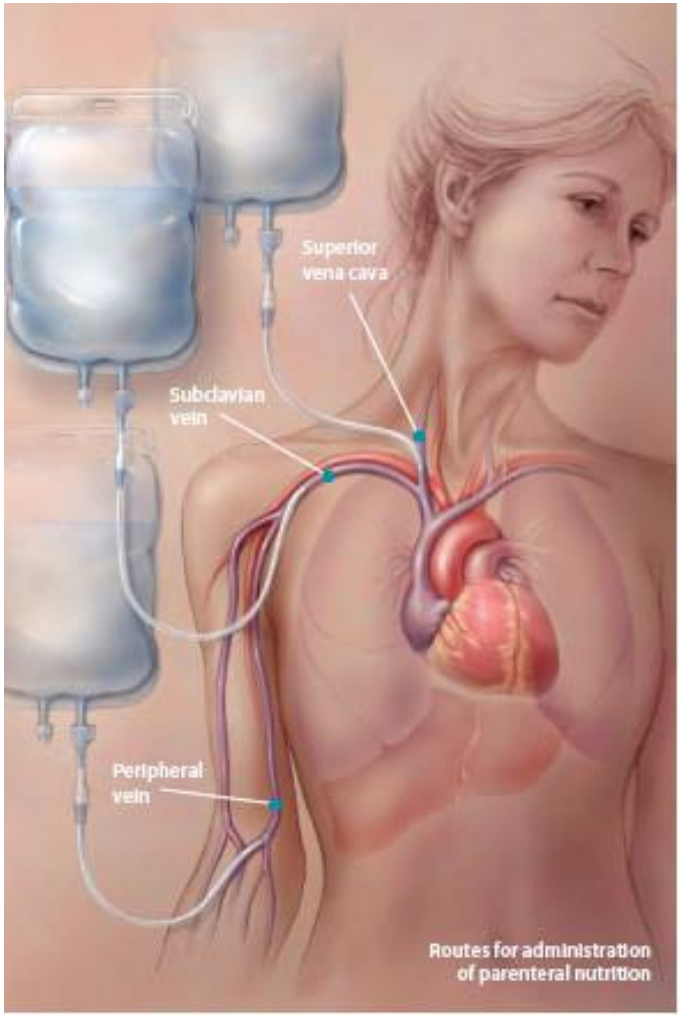
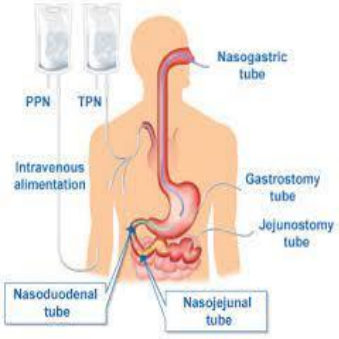
PARENTERAL NUTRITION



PARENTERAL NUTRITION



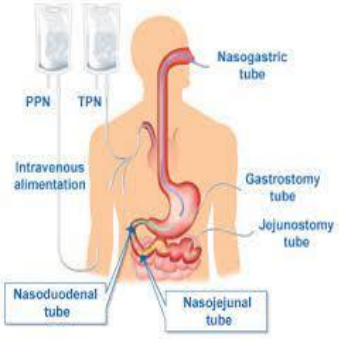
- PN provides nutrients directly into the bloodstream intravenously.
- PN is indicated when the patient or individual is unable to take adequate nutrients orally or enterally.
- PN may be used as an adjunct to oral or EN to meet nutrient needs.

PARENTERAL NUTRITION
Cont'd

- **Alternatively, PN may be the sole source of nutrition during recovery from illness or injury, or it may be a life-sustaining therapy for patients who have lost the function of their intestine for nutrient absorption.**

- **As any type of nutrition support other than oral is invasive, it is important to evaluate ethical issues if the patient is terminal or has a short life expectancy**

PARENTERAL NUTRITION
Cont'd



- **Access**
  - **Peripheral Access:** PPN solutions should be hypo-osmolar; 800 - 900 mOsm/kg
  - **Short-Term Central Access**
  - **Long-Term Central Access**

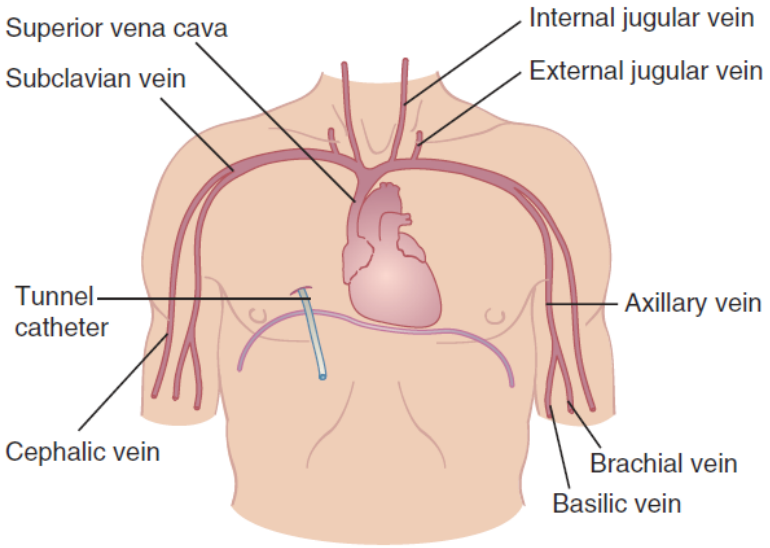


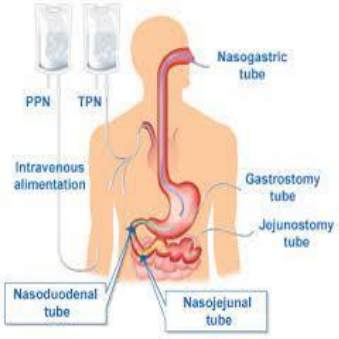
Fig. 12.6 Venous sites from which the superior vena cava may be accessed.

Nutrition Assessment

- During critical illness, 1.3 g/kg protein equivalents per day can be delivered progressively
- The amount of carbohydrates administered to ICU patients should not exceed 5 mg/kg/min

ESPEN guideline on clinical nutrition in the intensive care unit; 2019

Nutrition Assessment



- **Traditional recommendations have been to maintain BS<200 mg/dL because of effects on neutrophils, but data suggest that even tighter control (80 -120 mg/dL) with insulin improves clinical outcome.**

- **Glucose should provide ~50-60% of TEE (~70%- 80% of nonprotein Calories).**

Modern Nutrition in Health and Disease; 2014.

Nutrition Assessment

- Carbohydrate content in enteral formulas varies from 30% to 85% of kilocalories.
- Lipid content of enteral formulas varies from 1.5% to 55% of the total kilocalories.

Krause's Food & The Nutrition Care Process; 2016

Nutrition Assessment

- Fat calories can be increased to **50%** of requirements in select patients with severe hyperglycemia or high CO2 production, but with risks of hyperlipidemia, cholestasis, immunosuppression, and increased infection.
- Suspected overfeeding with increased CO2 should be treated by reduction in total calories.

Modern Nutrition in Health and Disease; 2014.

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TABLE 12.3 Daily Electrolyte Requirements During Total Parenteral Nutrition—Adults

Electrolyte	Standard Intake/Day
Calcium	10–15 mEq
Magnesium	8–20 mEq
Phosphate	20–40 mmol
Sodium	1–2 mEq/kg + replacement
Potassium	1–2 mEq/kg
Acetate	As needed to maintain acid-base balance
Chloride	As needed to maintain acid-base balance

(From McClave SA, Taylor BE, Martindale RG, et al: Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient, *J Parenter Enteral Nutr* 33:277, 2009.)

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TABLE 12.4 Adult Parenteral Multivitamins: Comparison of Guidelines and Products

Vitamin	NAG-AMA Guidelines	FDA Requirements	MVI-12	MVI-13 (Infuvite) Baxter
A (retinol)	3300 units (1 mg)	3300 units (1 mg)	3300 units (1 mg)	3300 units (1 mg)
D (ergocalciferol cholecalciferol)	200 units (5 mcg)	200 units (5 mcg)	200 units (5 mcg)	200 units (5 mcg)
E (mcg-tocopherol)	10 units (10 mg)	10 units (10 mg)	10 units (10 mg)	10 units (10 mg)
B_1 (thiamin)	3 mg	6 mg	3 mg	6 mg
B_2 (riboflavin)	3.6 mg	3.6 mg	3.6 mg	3.6 mg
B_3 (niacinamide)	40 mg	40 mg	40 mg	40 mg
B_5 (dexpanthenol)	15 mg	15 mg	15 mg	15 mg
B_6 (pyridoxine)	4 mg	6 mg	4 mg	6 mg
B_{12} (cyanocobalamin)	5 mcg	5 mcg	5 mcg	5 mcg
C (ascorbic acid)	100 mg	200 mg	100 mg	200 mg
Biotin	60 mcg	60 mcg	60 mcg	60 mcg
Folic acid	400 mcg	600 mcg	400 mcg	600 mcg
K		150 mcg	0	150 mcg

AMA, American Medical Association; *FDA,* US Food and Drug Administration; *MVI-12* and *MVI-13,* multivitamin supplements; *NAG,* National Advisory Group.
(From Vanek V, Borum P, Buchman A, et al: A.S.P.E.N. position paper: recommendations for changes in commercially available parenteral multivitamin and multi-trace element products, *Nutr Clin Prac* 27:440, 2012.)

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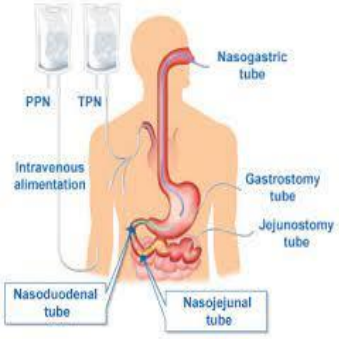

TABLE 12.5 Daily Trace Element Supplementation for Adult Parenteral Formulations

Trace Element	Intake
Chromium	10–15 mcg
Copper	0.3–0.5 mg
Manganese	60–100 mcg
Zinc	2.5–5.0 mg
Selenium	20–60 mcg

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TABLE 12.2 Osmolarity of Nutrients in Parenteral Nutrition Solutions

Nutrient	Osmolarity (mOsm/mL)	Sample Calculations
Dextrose 5%	0.25	500 mL = 125 mOsm
Dextrose 10%	0.505	500 mL = 252 mOsm
Dextrose 50%	2.52	500 mL = 1260 mOsm
Dextrose 70%	3.53	500 mL = 1765 mOsm
Amino acids 8.5%	0.81	1000 mL = 810 mOsm
Amino acids 10%	0.998	1000 mL = 998 mOsm
Lipids 10%	0.6	500 mL = 300 mOsm
Lipids 20%	0.7	500 mL = 350 mOsm
Electrolytes	Varies by additive	
Multitrace elements	0.36	5 mL = 1.8 mOsm
Multivitamin concentrate	4.11	10 mL = 41 mOsm

(Data from RxKinetics: *Calculating osmolarity of an IV admixture* (website). http://www.rxkinetics.com/iv_osmolarity.html.)

DOI: 10.1002/jpen.2267

CLINICAL GUIDELINES

J Parenter Enteral Nutr. 2022;46:12–41.

Guidelines for the provision of nutrition support therapy in the adult critically ill patient: The American Society for Parenteral and Enteral Nutrition

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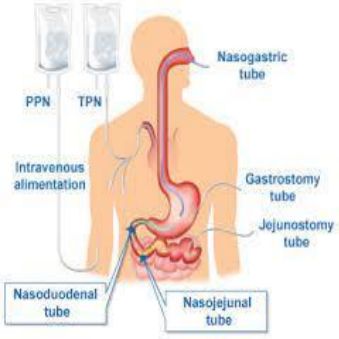
Question 1. In adult critically ill patients, does provision of higher vs lower energy intake impact clinical outcomes?



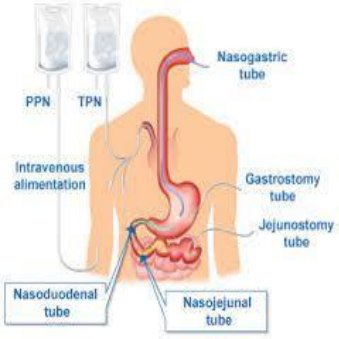
- **Recommendation: No significant difference in clinical outcomes was found between patients with higher vs lower levels of energy intake.**

- **We suggest feeding between 12 and 25 kcal/kg (ie, the range of mean energy intakes examined) in the first 7–10 days of ICU stay.**

- **Quality of evidence: Moderate**

- **Strength of recommendation: Weak**

Question 2. In adult critically ill patients, does provision of higher as compared with lower protein intake impact clinical outcomes?



- **Recommendation**: There was no difference in clinical outcomes in the relatively limited data. Because of a paucity of trials with high-quality evidence, we cannot make a new recommendation at this time beyond the 2016 guideline suggestion for 1.2–2.0 g/kg/day.

- **Quality of evidence**: Low
- **Strength of recommendation**: Weak

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Question 3:
In adult critically ill patients who are candidates for EN, does similar energy intake by PN vs EN as the primary feeding modality in the first week of critical illness impact clinical outcomes?

- **Recommendation**: There was no significant difference in clinical outcomes between early exclusive PN and EN during the first week of critical illness. As PN was not found to be superior to EN and no differences in harm were identified, we recommend that either PN or EN is acceptable.

- **Quality of evidence**: High

- **Strength of recommendation**: Strong

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Question 4. In adult critically ill patients receiving early EN, does provision of SPN to meet energy targets vs no SPN during the first week of critical illness impact clinical outcomes?

- **Recommendation**: There was no significant difference in clinical outcomes. Based on findings of no clinically important benefit in providing SPN early in the ICUadmission, we recommend not initiating SPN prior to day 7 of ICU admission.

- **Quality of evidence**: High

- **Strength of recommendation**: Strong

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Question 5A: In adult critically ill patients receiving PN, does provision of mixed-oil ILEs (ie, medium-chain triglycerides, olive oil, FO, mixtures of oils), as compared with 100% SO ILE, impact clinical outcomes?

- **Recommendation**: Owing to limited statistically or clinically significant differences in key outcomes, we suggest that either mixed-oil ILE or 100% SO ILE be provided to critically ill patients who are appropriate candidates for initiation of PN, including within the first week of ICU admission.

- **Quality of evidence**: Low
- **Strength of recommendation**: Weak

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Question 5B. In adult critically ill patients receiving PN, does provision of FO-containing ILE, as compared with non–FO-containing ILE, impact clinical outcomes?

- **Recommendation**: Because there was only one outcome with a significant difference that was not supported by data covering the other key downstream outcomes, we suggest that either FO- or non–Fo containing ILE be provided to critically ill patients who are appropriate candidates for initiation of PN, including within the first week of ICU admission.

- **Quality of evidence**: Low

- **Strength of recommendation**: Weak

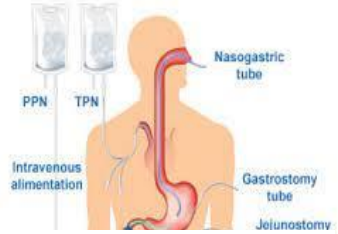
Conclusion

- **No differences in clinical outcomes were identified among numerous nutrition interventions, including higher energy or protein intake, isocaloric PN or EN, SPN, or different ILEs.**

- **As more consistent critical care nutrition support data become available, more precise recommendations will be possible.**

- **In the meantime, clinical judgment and close monitoring are needed.**

This paper was approved by the ASPEN Board of Directors.



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ESPEN Guideline

ESPEN guideline on home enteral nutrition

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Recommendation 1

- **HEN should be offered to patients at nutritional risk or malnourished**
  - **Who cannot meet their nutrient requirements by normal dietary intake,**
  - **Who have a functioning gastrointestinal tract,**
  - **Who are able to receive therapy outside of an acute care setting, and**
  - **Who agree and are able to comply with HEN therapy with the goal of improving body weight, functional status or QoL.**

- **Grade of Recommendation GPP e Strong consensus (97% agreement)**

Recommendation 2

- **Prior to discharge from hospital of patients at risk of malnutrition (e.g. patients with neurological disease, head injury, head and neck cancer, gastrointestinal and other malignancies, non-neoplastic gastrointestinal disease including malabsorptive syndromes), either oral nutritional supplements or HEN should be considered.**

- **Grade of Recommendation B e Strong consensus (96% agreement)**

Recommendation 3

- **If life expectancy is estimated to be less than one month, HEN usually shall not be initiated.**

- **Grade of recommendation GPP - Consensus (78% agreement)**

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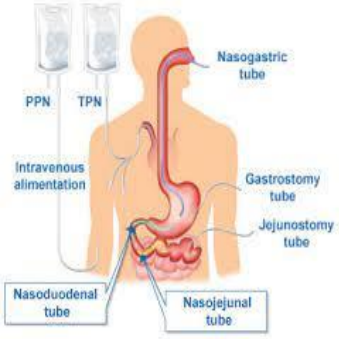
Recommendation 4

- **HEN shall not be performed in patients with contraindications such as severe functional disturbances of the bowel, gastrointestinal obstruction, gastrointestinal tract bleeding, severe malabsorption or severe metabolic imbalances.**

- **Grade of recommendation GPP e Consensus (84% agreement)**

Recommendation 5



- If patient and/or their legal carers do not to agree to a HEN program or are unlikely to comply with and/or if there are organizational/logistic problems which cannot be overcome, HEN should not be offered.

- Grade of recommendation GPP e Strong consensus (97% agreement)

Recommendation 6

- **HEN can be delivered through a nasal feeding tube in patients who need HEN only for a short period of time (up to 4-6 weeks).**

- **Grade of recommendation 0 - Consensus (90% agreement)**

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Recommendation 7

- A **PEG** or, if indicated, a percutaneous endoscopic jejunostomy (**PEJ**) is the preferred access device and should be placed when **long-term HEN** is required.

- Grade of recommendation B e Strong consensus (93% agreement)

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Recommendation 8

- **A PEG should be preferred over a surgical gastrostomy for long-term HEN, mainly due a lower complication rate, costeffectiveness and operating time.**

- **Grade of recommendation B e Strong consensus (100% agreement)**

Recommendation 9

- **If a PEG if not suitable for long-term HEN a percutaneous laparoscopic assisted gastrostomy (PLAG) may be a safe alternative.**

- **Grade of recommendation 0 e Strong consensus (93% agreement)**

Recommendation 26

- HEN may be started when patient is medically stable and
- (i) correct placement of the tube position is verified;
- (ii) tolerance to enteral prescription (volume and formula) is demonstrated; and
- (iii) the patient and/or provider have appropriate knowledge and skills to manage HEN.

- Grade of Recommendation GPP e Strong consensus (100% agreement)

Recommendation 27

- **The patient with a nasogastric tube can start HEN immediately according to the previously established nutritional care plan once appropriate tube placement has been confirmed.**

- **Grade of Recommendation GPP e Strong consensus (96% agreement)**

Recommendation 28

- **Adults with uncomplicated gastrostomy tube placement can commence EN within 2-4 hours after the procedure.**

- **Grade of recommendation A e Strong consensus (100% agreement)**

Recommendation 30

- **The method of HEN administration should be a decision of the multidisciplinary NST involved with the patient care, considering patient's disease, type of feeding tube in position, feed tolerance and patient preference.**

- **Grade of Recommendation GPP - Strong consensus (100% agreement)**

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Recommendation 31

- **Bolus or intermittent continuous or continuous infusion through a pump may be used depending on clinical need, safety and level of precision required.**

- **Grade of Recommendation GPP - Strong consensus (92% agreement)**

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Bolus infusions

- Bolus infusions are used either when a patient has a nasogastric tube in situ or gastrostomy tube. Feeds are administered with a 50mL syringe with or without a plunger.

- Bolus feeding into the stomach is considered more physiological.

- There is no evidence that bolus feeding predisposes to diarrhea, bloating, aspiration compared to continuous feeding.

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Recommendation 32

- **Routine water flushing before and after feeding can prevent tube obstruction and should be part of patient/carer education.**

- **Grade of Recommendation GPP e Strong consensus (100% agreement)**

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Recommendation 39

- **Standard commercial formula enteral tube feeds can be used, unless there is specific justification for a blended tube feed.**

- **Grade of recommendation 0 - Strong consensus (92% agreement)**

Recommendation 40

- **Fiber-containing feeds shall normally be used for patients with diarrhea.**

- **Grade of recommendation A – Strong consensus (92% agreement)**

Recommendation 41

- **Fiber-containing feeds should be used for patients with constipation.**

- **Grade of recommendation B – Strong consensus (96% agreement)**

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Recommendation 42

- **A modified enteral formula with lower sugar content, containing slowly digestible CHOs and a fat content enriched in USFs, especially MUFAs may be used for patients with diabetes.**

- **Grade of recommendation 0 - Majority agreement (60% agreement)**

Recommendation 43

- For patients without diarrhea, constipation or diabetes, standard commercial tube feeds should be used according to the direction of a specialist.

- Grade of recommendation GPP e Strong consensus (96% agreement)

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Recommendation 45

- **Monitoring of efficacy should be based primarily on BW, body composition and hydration status, but may also include laboratory measurements, such as serum alb or transthyretin (¼prealbumin). Monitoring of complications should include tube- and EN-associated complications.**

- **Grade of recommendation GPP - Consensus (83% agreement)**

Recommendation 46

- **HEN should be terminated when the desired weight has been reached and the patient's oral intake matches his/her maintenance needs.**

- **Grade of recommendation GPP e Strong consensus (92% agreement)**

Recommendations 48, 49

- **As home-made blenderized admixtures are less effective than EN formula or commercially produced 'whole food' solutions, they should not be utilized in patients on HEN.**
- **Grade of recommendation GPP - Majority agreement (63% agreement)**

- **As home-made blenderized admixtures are less safe than EN formula or commercially produced 'whole food' solutions, they should not be utilized in patients on HEN.**
- **Grade of recommendation GPP - Consensus (76% agreement)**

Recommendation 55

- **All healthcare professionals who are directly involved in patient care should receive education and training, relevant to their duties, on the different aspects related to the safe provision of HEN and the importance of providing adequate nutrition.**

- **Grade of recommendation B e Strong consensus (100% agreement)**

Recommendation 57

- **All hospitals who discharge patients with HEN should employ at least one specialized nutrition support nurse or dietician. Ideally, these hospitals should have a NST working within the clinical governance framework.**

- **Grade of recommendation B e Strong consensus (96% agreement)**

Recommendation 61

- **For optimal management of HEN, a NST approach may comprise - in addition to a physician, a dietician/nutritionist and a nurse - other allied healthcare professionals (for example, speech and language therapists, physiotherapists and occupational therapists, and pharmacists as necessary).**

- **Grade of recommendation GPP e Strong consensus (97% agreement)**

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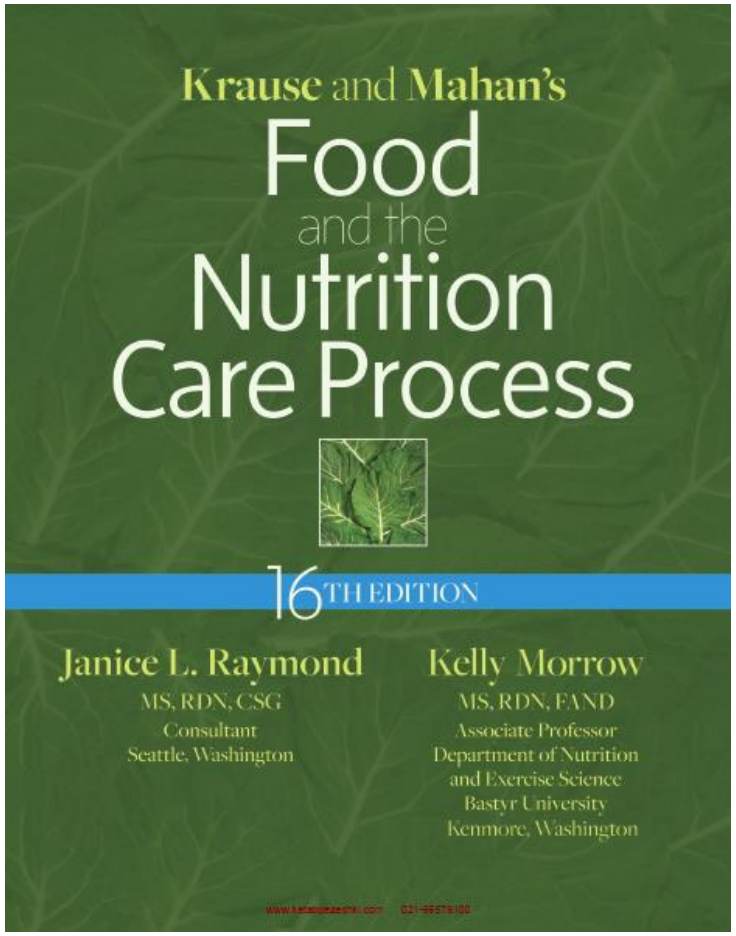
References



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	ASPEN Adult Critical Care Clinical Guidelines; 2016	ESPEN guideline on clinical nutrition in the intensive care unit; 2019	Modern Nutrition in Health and Disease; 2014	Krause's Food & The Nutrition Care Process; 2016
Energy	A) IC B) Predictive equations C) Weight-based equations: 25–30 kcal/kg/d 11–14 kcal/kg/d (BMI=30-50) 22–25 kcal/kg/d (BMI>50)	A) IC B) VO_2 VCO_2 C) Predictive equations	Weight-based equations: 20-30 kcal/kg/d 9-18 kcal/kg/d 18-28 kcal/kg/d	Weight-based equations: Non-obese: 25-30 kcal/kg/d Obese: 14-18 kcal/kg/d
Protein	1.2–2.0 g/kg/d 2 g/kg (30 ≤ BMI <40) 2.5 g/kg (BMI≥ 40)	1.3 g/kg/d	1-2.5 g/kg/d	
Carbohydrate		≤ 5 mg/kg/min	~50-60% of TEE	
Fat			~20%- 30% of nonprotein Calories	

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