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**Nutrition support in critically ill patients: An overview**

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INTRODUCTION — Nutrition support refers to enteral or parenteral provision of calories, protein, electrolytes, vitamins, minerals, trace elements, and fluids. The fundamentals of nutrition support for critically ill patients have been the subject of clinical practice guidelines [[1](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/1)] and will be reviewed here, including the goals, outcomes, indications, contraindications, and daily nutritional requirements. Access, formulations, prescribing, monitoring, and complications of enteral and parenteral nutrition are discussed separately. (See ["Nutrition support in critically ill patients: Enteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-enteral-nutrition?source=see_link) and ["Nutrition support in critically ill patients: Parenteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-parenteral-nutrition?source=see_link).)

GOALS — Nutritional needs in the critically ill are poorly understood and vary with the phase of critical illness. Although outcomes have not been adequately studied in randomized trials, the primary goal of nutrition support is to alter the course and outcome of the critical illness. Major goals are the following:

●Acute critical illness is traditionally thought to be characterized by catabolism exceeding anabolism [[2-4](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/2-4)]. However, with better management of ventilatory failure, fever, anxiety, and pain, calorie consumption, as measured by calorimetry, has been dramatically reduced [[5](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/5)].

●Carbohydrates are believed to be the preferred energy source during this period because fat mobilization is impaired [[6](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/6)].

●The basis of protein prescriptions is the hope for mitigation of the breakdown of muscle proteins into amino acids that serve as the substrate for gluconeogenesis as reflected in a favorable nitrogen balance [[7](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/7)]. This remains theoretical, as the results of studies have been contradictory, and there is growing concern that overprescription of protein may have detrimental impact on outcomes overall [[8-10](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/8-10)].

●Recovery from critical illness is characterized by anabolism exceeding catabolism. Nutrition support provides substrate for the anabolic state, during which the body corrects hypoproteinemia, repairs muscle loss, and replenishes other nutritional stores [[11](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/11)].

OUTCOMES — Enteral and parenteral nutrition appear to impact clinical outcomes differently in critically ill patients.

Adequately nourished patients — Most of the evidence related to nutrition support is from patients who are adequately nourished when they enter the study, since clinical trials have typically excluded patients with malnutrition.

Enteral nutrition — Enteral nutrition may decrease the incidence of infection in critically ill patients if provided early in the course of critical illness [[12-15](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/12-15)]. This effect has been demonstrated in clinical trials that compared patients who received early enteral nutrition to patients who received either delayed enteral nutrition or intravenous fluids only. Early and delayed have been variably defined in clinical trials but, roughly speaking, early enteral nutrition is initiated within 48 hours and delayed enteral nutrition is initiated later.

An initial meta-analysis of three randomized trials (133 patients) found a non-statistically significant reduction in the incidence of infectious complications among patients who received early enteral nutrition (25 versus 41 percent, relative risk 0.66, 95% CI 0.36-1.22) [[13](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13)]. In an unpublished update of the meta-analysis, seven randomized trials (440 additional patients) were added and the reduction in the incidence of infectious complications became statistically significant (43 versus 58 percent, relative risk 0.76, 95% CI 0.59-0.98) [[16](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/16)]. These meta-analyses are limited by the methodological flaws of the included randomized trials [[17](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/17)].

The mechanisms by which enteral nutrition decreases infectious complications are unknown. However, preservation of gut immune function and reduction of inflammation have been proposed [[18,19](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/18,19)].

Whether early enteral nutrition decreases mortality in critically ill patients is uncertain [[13,16,20](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13,16,20)]. In a meta-analysis of eight randomized trials (317 patients) that compared early enteral nutrition to either delayed enteral nutrition or intravenous fluids, there was a non-statistically significant mortality reduction among the patients who received early enteral nutrition (6 versus 15 percent, relative risk 0.52, 95% CI 0.25-1.08) [[13](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13)]. In an unpublished update of the meta-analysis, 14 randomized trials (670 additional patients) were added [[16](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/16)]. The reduction of mortality was almost statistically significant (10 versus 20 percent, relative risk 0.68, 95% CI 0.46-1.01).

A systematic review and meta-analysis of 15 prospective randomized trials that compared early enteral nutrition to either no enteral nutrition or delayed enteral nutrition, reported that the benefit of early enteral nutrition could be attributed to the effect of risk of bias [[21](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/21)]. Thus, the benefits of early feeding in this population may be overestimated. Nonetheless, in balance, the evidence supports a clinically important and statistically significant reduction in infection when enteral nutrition is administered early to critically ill patients, as well as a clinically important and almost statistically significant reduction in mortality. We believe that the potential benefit of early enteral nutrition outweighs the likelihood of harm and that it should be prescribed for most critically ill patients who do not have contraindications to enteral feeding. We recognize that the evidence for this approach is higher quality for patients with surgical problems than medical problems: surgical patients (eg, trauma, peritonitis, pancreatitis, and burns) were the focus of the randomized trials and meta-analyses described above [[13,16](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13,16)], whereas medical patients have primarily been studied in observational studies [[20,22](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/20,22)].

While early enteral nutrition appears to have benefit, there is data from randomized studies that suggest that achieving 100 percent of estimated caloric goals in the first week of critical illness may be harmful. (See ["Nutrition support in critically ill patients: Enteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-enteral-nutrition?source=see_link).)

Parenteral nutrition — The provision of early parenteral nutrition (up to 48 hours) to patients with absolute or relative contraindications to enteral nutrition does not alter mortality [[23-26](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/23-26)]. Additionally, there is no consistent evidence in critically ill patients suggesting that early parenteral nutrition improves the number of ventilator-free days or length of stay in the ICU or hospital. In balance, evidence suggests that early parenteral nutrition in well nourished critically ill patients, whether given as the sole therapy or supplemental to enteral nutrition, does not reduce mortality and may be associated with an increased risk of nosocomial infections. The optimal time for starting parenteral nutrition in critically ill patients is unknown. However, based upon this data, we typically do not start feeding parenterally before one to two weeks, the goal of which is delivery of adequate protein and calories.

Evidence suggests early parenteral nutrition may increase the risk of infection [[23-25,27](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/23-25,27)]. One randomized study of 4640 critically patients [[24](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/24)] and a meta-analysis of 69 randomized trials (3750 patients; critically ill and non-critically ill) [[23](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/23)] reported that patients who received parenteral nutrition had a 4 to 5 percent increase in the incidence of infection [[23](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/23)].

The use of parenteral nutrition as an adjunct to enteral nutrition (to improve provision of calories and protein) has also been evaluated with the following outcomes [[24,25,28](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/24,25,28)]:

●One multicenter trial randomly assigned 4640 critically ill adults who were already receiving enteral nutrition to have supplemental parenteral nutrition initiated early (within 48 hours of ICU admission) or late (after the eighth day of ICU admission) [[24](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/24)]. Compared with the early-initiation group, patients in the late-initiation group, had lower rates of ICU infections (22.8 versus 26.2 percent), and fewer mechanical ventilation and renal replacement therapy days (relative risk reduction 9.7 percent).

●In a small but adequately powered single center study of 305 critically ill adults, enteral nutrition supplemented with parenteral nutrition (given on day 4 to 8) was associated with lower rates of nosocomial infections compared to enteral nutrition alone (27 versus 38 percent) [[28](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/28)]. However, no difference in the length of hospital or ICU stay, overall or ICU mortality was observed.

●One multicenter observational study of critically ill adults compared enteral nutrition alone (n = 2562) to enteral nutrition plus early (<48 hours) parenteral nutrition (n = 188), and enteral nutrition plus late (>48 hours) parenteral nutrition (n = 170) [[25](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/25)]. Compared to enteral nutrition alone, enteral nutrition plus either early or late parenteral nutrition was associated with increased mortality at 60 days (27.8 versus 34.6 and 35.3 percent, respectively).

Enteral versus parenteral — Direct comparisons of enteral nutrition to parenteral nutrition indicate that enteral nutrition is associated with a lower incidence of infection, but not mortality:

●Infection – A meta-analysis of six randomized trials (498 patients) found that patients who received enteral nutrition were significantly less likely to develop an infection than patients who received parenteral (24 versus 43 percent, relative risk 0.61, 95% CI 0.44-0.84) [[13](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13)].

●Mortality – A meta-analysis of 12 randomized trials (748 patients) found no difference in mortality among patients who received enteral nutrition compared to those who received parenteral nutrition [[13](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13)].

In both meta-analyses, the majority of patients had surgical problems.

Patients with malnutrition — Most clinical trials have excluded patients with malnutrition. In clinical practice, however, malnutrition may exist at the time of admission or as a consequence of receiving little or no nutritional intake for an extended period (eg, two weeks) during the hospitalization. Importantly, the term malnutrition is somewhat confusing in that it includes both the impact of starvation and the catabolic effects (wasting, insulin resistance, hypoproteinemias, immune suppression) due to systemic inflammation [[29,30](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/29,30)]. Nourishment strategies have no impact on the latter [[31](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/31)].

We believe that enteral nutrition is beneficial to patients with prolonged periods of inadequate intake, since there is no controversy that chronic starvation is deleterious. Some clinicians will also cite observational evidence that a progressive caloric deficit is associated with increased morbidity in critically ill patients, as well as the indirect evidence described above from adequately nourished patients [[11](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/11)]. The effect of parenteral nutrition on patients with malnutrition is unknown but being investigated [[32](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/32)].

Obese patients — Data regarding the impact of nutritional support on clinical outcomes (eg, mortality and length of ICU stay) in critically ill patients with obesity (BMI ≥30 kg/m2) are limited to small observational series and inadequately powered randomized trials [[33-39](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/33-39)]. These trials have had mixed results. Some suggest that hypocaloric high protein regimens are associated with a trend toward reduced length of stay in this population without an effect on mortality. In contrast, a large observational study reported mixed effect on 60-day mortality in those given a hypocaloric low protein diet [[40](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/40)]. Some clinicians prefer a high protein and low calorie approach in the critically ill obese patients [[41](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/41)]. However, until the clinical impact of alternative diets is better elucidated, we suggest that nutritional support in the critically ill obese parallel that of the adequately nourished patient. Additional studies are warranted.

COMPLICATIONS — The most common complications of enteral nutrition are aspiration, diarrhea, metabolic abnormalities, and mechanical complications. These may or may not be causally related to enteral nutrition and are discussed separately. (See ["Nutrition support in critically ill patients: Enteral nutrition", section on 'Complications'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-enteral-nutrition?source=see_link&anchor=H26#H26).)

The most common complications of parenteral nutrition are bloodstream infection, metabolic abnormalities, and problems related to venous access. These complications are also reviewed elsewhere. (See ["Nutrition support in critically ill patients: Parenteral nutrition", section on 'Complications'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-parenteral-nutrition?source=see_link&anchor=H12#H12).)

PATIENT SELECTION

Indications — Our usual approach to selecting critically ill patients for nutrition support is as follows:

●For patients without contraindications to enteral nutrition, we begin early enteral feeding (ie, within 48 hours) because we believe that the potential benefits of early enteral feeding (eg, fewer infections, possibly lower mortality) outweigh its risks [[13,15,16,42](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/13,15,16,42)]. (See ['Enteral nutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935222) above.)

●For adequately nourished patients who have contraindications to enteral nutrition, we do NOT initiate early parenteral nutrition and typically do not start feeding parenterally before one to two weeks. This reflects the evidence that early parenteral nutrition may increase the risk of infection and prolong mechanical ventilation, ICU stay, and hospital stay [[23](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/23)]. (See ['Parenteral nutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935231) above.)

●For inadequately nourished patients who have contraindications to enteral nutrition that are expected to persist for a week or more, we initiate parenteral nutrition within the first few days. We recognize that the effects of parenteral nutrition in such patients are unknown; however, our rationale is that failure to treat the malnourishment will result in a progressive caloric deficit, which is associated with increased morbidity. (See ['Patients with malnutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935249) above.)

●For obese patients (BMI ≥30 kg/m2), we use the same indications for enteral and parenteral nutrition as for the adequately nourished critically ill patient. The chronically starved but still obese patient is likely to be sicker and at higher risk for complications related to undernourishment, despite obesity, and may need to be considered the same as other inadequately nourished patients.

Criteria for diagnosing malnutrition have been published [[29,30](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/29,30)]. Evidence that a patient is malnourished includes poor nutritional intake accompanied by unintentional weight loss or low body weight. Sample criteria (arbitrarily chosen and not validated) include a body mass index (BMI) less than 18.5 kg/m2, the unintentional loss of more than 2.3 kg (5 lb) or 5 percent of body weight over one month, or the unintentional loss of more than 4.5 kg (10 lb) or 10 percent of body weight over six months [[43](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/43)]. Temporal muscle wasting, sunken supraclavicular fossae, decreased adipose stores, and signs of vitamin deficiencies may also be apparent ([table 1](http://www.uptodate.com/contents/image?imageKey=PULM%2F78426&topicKey=PULM%2F1617&source=see_link)).  While such findings may be suggestive of malnutrition, they are imperfect because they are just as likely to be a consequence of the catabolic effect of the underlying illness. Nutritional surrogates (eg, albumin, prealbumin/transthyretin) are also susceptible to the effects of the critical illness and should not be used to detect malnourishment in critically ill patients [[44](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/44)]. A list of nutrients and clinical manifestations due to their excess or deficiency is available at <http://www.nal.usda.gov/wicworks/Topics/FG/AppendixC_NutrientChart.pdf>.

It is assumed that malnutrition is impending when there has been a prolonged period of poor nutritional intake. The precise duration necessary for malnutrition to develop is unknown and probably varies among patients. As a general guideline, it is reasonable to assume that malnutrition is impending in any patient who has had little or no nutritional intake for two weeks. One week or less may be more accurate for patients with antecedent undernourishment, with the precise duration depending on the severity of the undernourishment.

Contraindications — Early enteral nutrition is contraindicated in critically ill patients who are both hemodynamically unstable and have not had their intravascular volume fully resuscitated, since such patients may be predisposed to bowel ischemia [[1](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/1)]. Hemodynamic instability by itself, unless severe, is not a contraindication for enteral nutrition if there is evidence for adequate volume resuscitation and tissue perfusion [[45](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/45)]. Other contraindications to enteral nutrition include bowel obstruction, severe and protracted ileus, major upper gastrointestinal bleeding, intractable vomiting or diarrhea, severe hemodynamic instability, gastrointestinal ischemia, and a high output fistula.

Some conditions previously considered contraindications to enteral nutrition are no longer considered as such. Examples include hyperemesis gravidarum and the absence of bowel sounds or flatus following routine colorectal surgery or surgery for bowel perforation [[12,46-50](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/12,46-50)]. While such patients remain at increased risk for vomiting, enteral nutrition may confer an overall benefit since it may decrease the risk of infection [[12,49](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/12,49)]. In addition, a new gastrointestinal anastomosis distal to the infusion site that the surgeon feels is at risk of dehiscence was once considered a contraindication until more recent data indicated that early feeding strengthens anastomoses [[51](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/51)].

Contraindications to parenteral nutrition include hyperosmolality, severe hyperglycemia, severe electrolyte abnormalities, volume overload, and inadequate attempts to feed enterally.

Relative contraindications to parenteral nutrition are not well defined. However, parenteral nutrition is often avoided in sepsis, systemic inflammatory response syndrome, minor vomiting, gastrointestinal bleeding, short-term mechanical ventilation, and conditions expected to reverse quickly that temporarily preclude enteral feeding.

Enteral and parenteral nutrition must be initiated slowly and with strict monitoring in patients at risk for “refeeding syndrome”. Patients with chronic undernourishment should receive supplemental thiamine prior to initiation of artificial nourishment to prevent Wernicke syndrome. (See ["Eating disorders: Overview of treatment", section on 'Refeeding syndrome'](http://www.uptodate.com/contents/eating-disorders-overview-of-treatment?source=see_link&anchor=H252082#H252082).)

NUTRITIONAL REQUIREMENTS — Once it has been determined that a critically ill patient will receive nutrition support, the patient's nutritional requirements must be determined. These requirements are used to select the appropriate formulation and rate of administration. (See ["Nutrition support in critically ill patients: Enteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-enteral-nutrition?source=see_link) and ["Nutrition support in critically ill patients: Parenteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-parenteral-nutrition?source=see_link).)

Randomized trials evaluating the optimal quantity of caloric intake and/or protein intake are unlikely to be performed with adequate precision because the anticipated sample sizes required to detect outcome differences are prohibitively large. Small trials have been performed, but their results are equivocal. Trials that compare the measurement of caloric or protein intake to the estimation of caloric or protein intake (eg, formulas, tables) are similarly unlikely to be performed. Thus, clinical decisions must be based upon observational evidence and clinical experience.

There is no consensus among clinicians regarding how to adjust energy requirements for critically ill obese patients. Adjustments can be made based upon an estimate of the individual’s resting energy expenditure (REE) or their body weight. Indirect calorimetry and predictive equations can be used in this population to estimate the REE. Although most experts agree that indirect calorimetry is the best method for REE measurement, calorimeters are not widely available, calorie prescription based on calorimetry has not been adequately tested, and some patients do not meet valid testing criteria. Therefore, predictive equations are more commonly used [[39,52,53](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/39,52,53)]. Alternatively, weight-based adjustments in the obese population can be performed as outlined below. Additional guidelines for the assessment of REE for critically ill patients can be found at the American Society for Parenteral and Enteral Nutrition ([ASPEN](http://pen.sagepub.com/site/misc/Index/Clinical_Guidelines.xhtml)) [[39](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/39)].

Dosing weight — When prescribing enteral or parenteral nutrition, the appropriate body weight from which to calculate caloric and protein intake (ie, the dosing weight) must first be determined.

For patients who are underweight (body mass index [BMI] <18.5 kg/m2), we suggest using the current weight as the initial dosing weight. The reason is that calculation of caloric intake based on ideal body weight could lead to the administration of excess calories and induce refeeding syndrome [[54](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/54)]. (See ["Eating disorders: Overview of treatment", section on 'Refeeding syndrome'](http://www.uptodate.com/contents/eating-disorders-overview-of-treatment?source=see_link&anchor=H252082#H252082).)

For patients whose weight is normal (BMI 18.5 to 24.9 kg/m2) or who are overweight (BMI 25 to 29.9 kg/m2), we suggest using the current weight as the dosing weight. An effort should be made to subtract the estimated weight of any peripheral edema.

For patients who are obese (BMI ≥30 kg/m2), guidelines recommend use of current weight and use of the Penn State University 2010 predictive equation [[39](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/39)]. If neither expertise with this equation or calorimetry are available, we suggest that the dosing weight be adjusted. The purpose of adjusting the dosing weight of patients who are obese is to account for the absence of metabolic requirements by fat tissues:

●The most commonly employed method is to add one-quarter of the difference between the ideal body weight (IBW) and the actual body weight (ABW) to the IBW. In other words, dosing weight = IBW + 0.25 (ABW - IBW).

●An alternative method is to use 110 percent of the ideal body weight. In other words, dosing weight = 1.1 \* IBW.

For either equation, the IBW can be determined from the calculator ([calculator 1](http://www.uptodate.com/contents/calculator-ideal-body-weight-method-of-devine-and-dosing-weight-for-adults?source=see_link)).

Calories — Energy expenditure is typically thought to be high in the critically ill. However, with improvement in mechanical ventilation, as well as pain, anxiety, and temperature control, the caloric expenditure of the critically ill may not exceed resting energy expenditure. While in the past, providing fewer calories than needed to meet energy needs was controversial, since then there is evidence of benefit to this approach (eg, less gastrointestinal intolerance, fewer infections) such that it has become routine practice in most intensive care units [[55,56](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/55,56)].

We believe that a safe starting point for most critically ill patients is approximately 8 to 10 kcal/kg per day, based upon the EDEN trial comparing early low calorie versus full calorie feeding [[57](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview/abstract/57)]. Attempting to achieve a goal of 25 to 30 kcal/kg per day after one week is reasonable for most stable patients. A goal of 35 kcal/kg per day is an acceptable goal if weight gain is desired in a relatively stable patient; weight gain should not be attempted until the patient is stable and in a lower inflammatory state. We keep the caloric goal at 25 kcal/kg per day or less if extubation is imminent.

Protein — Guidelines indicate that protein requirements increase as illness becomes more severe. This is based solely on nitrogen excretion and not on outcomes studies except in burns. Practice is to give patients with only mild to moderate illness 0.8 to 1.2 g/kg protein per day. Critically ill patients are generally prescribed 1.2 to 1.5 g/kg per day and patients with severe burns may benefit from as much as 2 g/kg per day. (See ['Goals'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H2) above.)

ADMINISTRATION — Administration of nutrition support requires that appropriate access is established and that the composition and rate of delivery be determined. Once started, nutrition support must be monitored for tolerance and complications. These issues are different for enteral and parenteral nutrition, which are discussed separately. (See ["Nutrition support in critically ill patients: Enteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-enteral-nutrition?source=see_link) and ["Nutrition support in critically ill patients: Parenteral nutrition"](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-parenteral-nutrition?source=see_link).)

SUMMARY AND RECOMMENDATIONS

●Nutrition support refers to the enteral or parenteral provision of calories, protein, electrolytes, vitamins, minerals, and fluids. (See ['Introduction'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H1) above.)

●Critically ill patients are selected for nutrition support on the basis of whether they have contraindications to enteral nutrition, as well as whether the patient is adequately nourished or malnourished:

•For critically ill surgical patients without contraindications to enteral nutrition, we recommend early (eg, within 48 hours) enteral nutrition ([Grade 1B](http://www.uptodate.com/contents/grade/2?title=Grade%201B&topicKey=PULM/1617)). For critically ill medical patients without contraindications to enteral nutrition, we suggest early enteral nutrition ([Grade 2C](http://www.uptodate.com/contents/grade/6?title=Grade%202C&topicKey=PULM/1617)). (See ['Enteral nutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935222) above and ['Patient selection'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H9) above.)

•For critically ill patients who are hemodynamically unstable and have not had their intravascular volume fully resuscitated early enteral nutrition is contraindicated ([Grade 2C](http://www.uptodate.com/contents/grade/6?title=Grade%202C&topicKey=PULM/1617)). (See ['Contraindications'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H11) above.)

•For adequately nourished patients who have contraindications to enteral nutrition, we recommend NOT initiating early parenteral nutrition ([Grade 1A](http://www.uptodate.com/contents/grade/1?title=Grade%201A&topicKey=PULM/1617)). While the optimal time for starting parenteral nutrition in these patients is unknown, we typically do not start parenteral feeding before one to two weeks have elapsed. (See ['Parenteral nutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935231) above and ['Patient selection'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H9) above.)

•For malnourished patients who have contraindications to enteral nutrition thatare expected to persist one week or less, we suggest NOT initiating parenteral nutrition ([Grade 2C](http://www.uptodate.com/contents/grade/6?title=Grade%202C&topicKey=PULM/1617)). For malnourished patients who have contraindications to enteral nutrition that are expected to persist greater than one week, we suggest parenteral nutrition ([Grade 2C](http://www.uptodate.com/contents/grade/6?title=Grade%202C&topicKey=PULM/1617)). (See ['Patients with malnutrition'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H935249) above and ['Patient selection'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H9) above.)

•For obese patients (BMI ≥30 kg/m2), the optimal approach to nutrition is unknown. We prefer that enteral and parenteral nutrition and choice of nutrition in this population be the same as for the adequately nourished critically ill patient. (See ['Obese patients'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H1674752198) above.)

●An acceptable initial nutritional goal is 8 to 10 kcal of calories/kg per day and then 18 to 25 kcal and 1.5 grams of protein/kg per day after five to seven days, although these targets have not been rigorously validated. (See ['Nutritional requirements'](http://www.uptodate.com/contents/nutrition-support-in-critically-ill-patients-an-overview?source=see_link#H12) above.)

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