

Chapter 12

Guidelines for specialized nutritional and metabolic support in the critically-ill patient. Update. Consensus SEMICYUC-SENPE: Obese patient

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Abstract

As a response to metabolic stress, obese critically-ill patients have the same risk of nutritional deficiency as the non-obese and can develop protein-energy malnutrition with accelerated loss of muscle mass.

The primary aim of nutritional support in these patients should be to minimize loss of lean mass and accurately evaluate energy expenditure. However, routinely-used formulae can overestimate calorie requirements if the patient's actual weight is used. Consequently, the use of adjusted or ideal weight is recommended with these formulae, although indirect calorimetry is the method of choice. Controversy surrounds the question of whether a strict nutritional support criterion, adjusted to the patient's requirements, should be applied or whether a certain degree of hyponutrition should be allowed.

Current evidence suggested that hypocaloric nutrition can improve results, partly due to a lower rate of infectious complications and better control of hyperglycemia. Therefore, hypocaloric and hyperproteic nutrition, whether enteral or parenteral, should be standard practice in the nutritional support of critically-ill obese patients when not contraindicated. Widely accepted recommendations consist of no more than 60-70% of requirements or administration of 11-14 kcal/kg current body weight/day or 22-25 kcal/kg ideal weight/day, with 2-2.5 g/kg ideal weight/day of proteins.

In a broad sense, hypocaloric-hyperprotein regimens can be considered specific to obese critically-ill patients, although the complications related to comorbidities in these patients may require other therapeutic possibilities to be considered, with specific nutrients for hyperglycemia, acute respiratory distress syndrome (ARDS) and sepsis. However, there are no prospective randomized trials with this type of nutrition in this specific population subgroup and the available data are drawn from the general population of critically-ill patients. Consequently, caution should be exercised when interpreting these data.

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Key words: *Critically-ill obese patients. Hypocaloric nutrition. Indirect calorimetry. Predictive equations.*

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SEMICYUC: Spanish Society of Intensive Care Medicine and Coronary Units.
SENPE: Spanish Society of Parenteral and Enteral Nutrition.

RECOMENDACIONES PARA EL SOPORTE NUTRICIONAL Y METABÓLICO ESPECIALIZADO DEL PACIENTE CRÍTICO. ACTUALIZACIÓN. CONSENSO SEMICYUC-SENPE: PACIENTE OBESO

Resumen

El paciente obeso crítico, como respuesta al estrés metabólico, tiene igual riesgo de depleción nutricional que el paciente no obeso, pudiendo desarrollar una malnutrición energeticoproteica, con una acelerada degradación de masa muscular.

El primer objetivo del soporte nutricional en estos pacientes debe ser minimizar la pérdida de masa magra y realizar una evaluación adecuada del gasto energético. Sin embargo, la aplicación de las fórmulas habituales para el cálculo de las necesidades calóricas puede sobrestimarlas si se utiliza el peso real, por lo que sería más correcto su aplicación con el peso ajustado o el peso ideal, aunque la calorimetría indirecta es el método de elección. La controversia se centra en si hay que aplicar un criterio estricto de soporte nutricional ajustado a los requerimientos o se aplica un cierto grado de hiponutrición permisiva.

La evidencia actual sugiere que la nutrición hipocalórica puede mejorar los resultados, en parte debido a una menor tasa de complicaciones infecciosas y a un mejor control de la hiperglucemia, por lo que la nutrición hipocalórica e hiperproteica, tanto enteral como parenteral, debe ser la práctica estándar en el soporte nutricional del paciente obeso crítico si no hay contraindicaciones para ello.

Las recomendaciones generalmente admitidas se centran en no exceder el 60-70% de los requerimientos o administrar 11-14 o 22-25 kcal/kg peso ideal/día, con 2-2,5 g/kg peso ideal/día de proteínas. En sentido amplio puede considerarse la nutrición hipocalórica-hiperproteica como específica del paciente obeso crítico, aunque las complicaciones ligadas a su comorbilidad hace que se planteen otras posibilidades terapéuticas, con nutrientes específicos para hiperglucemia, síndrome del distrés respiratorio agudo (SDRA) y sepsis. Sin embargo, no existe ningún estudio prospectivo y aleatorio con este tipo de nutrientes en este subgrupo concreto de población y los datos de que disponemos se extraen de una población general de pacientes críticos, por lo que deben tomarse con mucha precaución.

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Palabras clave: *Obeso crítico. Nutrición hipocalórica. Calorimetría indirecta. Ecuaciones predictivas.*

Introduction

In the past 3 decades, obesity has reached in developed countries an epidemic nature, with increased prevalence to values close to 30% of the population¹.

It is associated with significant comorbidity, that, in critically-ill obese patients, may affect various organs or systems: cardiovascular, pulmonary, peripheral vascular, hematological, metabolic, hepatobiliary, soft tissues and surgical wounds. Most complications must be diagnosed and treated early, including specialized nutritional support that contributes to global recovery, because they may theoretically increase mortality^{2,3}.

At present, the role of nutritional support in critically-ill obese patients is controversial⁴ (III) in issues such as calculating their needs, method of administration, daily calorie-protein requirements, type of nutrients and time to start.

Obese patients have a similar metabolic response to stress than non-obese patients, which places them at the same risk of nutritional depletion, and may develop energy-protein malnutrition despite their lean mass reserves and excess body fat. They show a fast protein catabolism with relative protein depletion, increased net protein oxidation, and muscle mass degradation⁵, and it is likely that therapeutic interventions to increase insulin sensitivity, such as specialized nutritional support itself, may improve its ability to remove or control muscle catabolism.

How does obesity influence mortality in critically-ill patients? Is nutritional support involved in any way in this relationship?

The influence of obesity in the progress and final outcome of critically-ill patients remains controversial. The studies published on the clinical outcome of critically-ill patients, stratified by body mass index (BMI), show significant discrepancies between them regarding the different degrees of malnutrition and/or obesity, particularly those in the extreme groups, malnourished, and morbidly obese⁶.

These are observational, cohort or case-control, both prospective and retrospective studies, and no randomized studies have been published. In individual studies, with no intervention, increased mortality has been confirmed in intensive care unit (ICU) in obese versus non-obese patients^{2,3,7-9} (III), in medical, surgical and traumatic patients, and also no influence of obesity in mortality¹⁰⁻¹⁴ (III) and even a reduction of this¹⁵ (III).

The metaanalysis by Akinnusi et al¹⁶ (Ia) analyzed 14 studies including 15,347 patients divided into non-obese (BMI < 30 kg/m²) and obese (BMI > 30 kg/m²). There were no significant differences in mortality in ICU between obese and non-obese patients (11.4 versus 12.6%; RR: 1.00; 95% CI, 0.86-1.16; p = 0.97) (Ia). In the analysis of sub-groups mortality was lower in obese patients with a BMI of 30-39.9 kg/m² than in non-obese patients (RR: 0.86; 95% CI, 0.81-0.91; p <

0.0001). The metaanalysis by Oliveros et al.¹⁷ (Ia) includes 12 studies comparing different groups of BMI to the group of patients with normal nutrition; however, for the analysis they group both mortality at the ICU and hospital mortality. Mortality in the overweight group (BMI: 25-29.9 kg/m²) is lower than in the group with normal weight (BMI: 18.5-24.9 kg/m²) (OR: 0.91; 95% CI, 0.84-0.98; p = 0.01). The group of obese patients (BMI: 30-39.9 kg/m²) have a lower mortality than those with normal nutrition (OR: 0.82; 95% CI, 0.68-0.98; p = 0.03), but the high heterogeneity (I² of 63.2%) and the lack of specificity for ICU detract validity of data. The metaanalysis by Hogue et al.¹⁸ (Ia) groups 8 studies comparing the different groups of BMI with normal nutrition group and present independent data for their stay at the ICU. No significant differences have been found in mortality at the ICU, though hospital mortality was lower in the group of obese patients (RR: 0.76; 95% CI, 0.59-0.92). As in the other metaanalyses, the high heterogeneity (I² of 50-93%) subtracts validity to it, and these data must be considered with caution.

These studies have not evaluated any type of nutritional support and this has not been correlated to mortality or other evolutive parameters. The patients have not been stratified by severity criteria or age groups, although critically-ill obese patients usually have a much younger mean age than non-obese patients.

No study testing and comparing specifically some type of enteral nutrition (EN) or parenteral nutrition (PN) in critically-ill obese patients, evaluated as one of the objectives mortality related to nutritional support; therefore no recommendation may be concluded that prioritizes any type of nutritional support as more effective in the reduction of mortality in critically-ill obese patients¹⁹⁻²³ (IIb).

How can we calculate calorie requirements in critically-ill obese patients?

The use of calorie recommendations based on actual weight may lead to complications such as hyperglycemia and secondary infections²⁴ (IIa); therefore, there is controversy about the use of the current weight, ideal weight, or weight adjusted for calorie calculation. In this regard, some recommendations are based, either on a fixed percentage energy expenditure (60-70%) or on the current weight (11-14 kcal/kg/day) or ideal weight (22-25 kcal/kg/day)²⁵.

Adequate evaluation of energy expenditure in nutritional support is conflicting in critically-ill patients. Indirect calorimetry is considered to be the *gold standard*, confirmed by parallel measurements of direct calorimetry^{26,27} (Ib). The alternatives commonly used are several standardized predictive equations. They are often inadequate, because the energy requirements of critically-ill obese patients are highly variable and their basic metabolic needs are difficult to predict²⁸ (IV).

In a recent systematic review²⁶, but without meta-analysis, Frankenfield et al. validated the use in critically-ill patients of 5 equations and only those of Ireton-Jones 1992 and Penn-State 1998 were considered useful in critically-ill obese patients. However, the data should be taken with caution due to the heterogeneity and the small sample sizes (IV).

A study on 202 critically-ill medical-surgical patients on mechanical ventilation²⁹ (IIb) compared resting energy expenditure (REE) measured by indirect calorimetry with 8 predictive equations with different variations and 15 different combinations. Only the Penn-State equation was accurate both globally and in the different subgroups, so it is therefore considered to be the advisable equation for use in critically-ill patients, whether obese or not. It was confirmed that neither the severity of the disease as measured by the SOFA, nor fever or traumatic, surgical or medical disease, changed the precision of the equations.

There is agreement in considering that, in critically-ill obese patients, the application of any formula using actual weight overestimates calorie needs, but the value of the different existing alternatives is still controversial, and there is not sufficient evidence to recommend the use of ideal weight or the adjusted weight.

When should artificial nutrition be started in critically-ill obese patients?

Although no studies have been specifically designed to settle this issue, it is considered that the onset of nutritional support in critically-ill obese patients with metabolic stress does not differ from that of non-obese patients³⁰. In metabolic stress states, fat deposits of these patients are not sufficient to meet the energy requirements and the high protein catabolism may lead them to significant malnutrition. In obese patients undergoing metabolic stress, it is recommended that artificial nutrition is started early, within the first 36 hours³¹ (IV).

What amount and type of energy substrates are required? What carbohydrates/lipid ratio?

Although the undesirable effect of underfeeding has been discussed in critically-ill patients³², in critically-ill obese patients it has been found that normal protein hypercaloric nutritional support, compared to hyperproteinic, hypocaloric supply, leads to fat mass accumulation and enables overfeeding without net protein gain⁴, with some agreement in recommending hypocaloric nutrition, not exceeding 60-70% of the calculated calories (11 kcal/kg current weight/day or 22-25 kcal/kg of ideal weight)²⁵ (IV).

There are few studies based on the current recommendations that analyze nutritional support in this patient group, and most of them refer to PN.

Dickerson¹⁹ (IIb) studied support with PN in 13 surgical critically-ill obese patients, providing 50% of the measured energy expenditure and 2.1 g of proteins/kg ideal weight. A weight loss of 1.7 kg a week was observed, with a positive nitrogen balance and a significant albumin concentration increase, associated with total wound healing, fistula closure and protein anabolism in the group of patients with mild to moderate stress.

The Choban group designed 2 studies with a low-calorie parenteral support. In the first study²³ (IIb), with a randomized, double-blind, prospective design, energy expenditure was measured in 16 obese patients using indirect calorimetry, supplying to a group 100% of the energy expenditure and to the other 50% of the expenditure measured. Both groups received 2 g protein/kg of ideal weight. The duration of the study was 14 days. There were no differences in the overall results, length of stay in the ICU, or nitrogen balance. The second²⁰ (IIb), in 30 obese patients, estimated energy expenditure based on the ideal weight, providing 2 g of protein/kg of ideal weight and administering non-protein calories at a 75/1 ratio to one group (14 kcal/kg) and 150/1 to the other group (22 kcal/kg). No differences were seen in the clinical outcome, but they maintained the same nitrogen balance, and the low-calorie group had a lower need for insulin and lower susceptibility to hyperglycemia.

In a study performed in 40 critically-ill obese patients with EN for at least 7 days²¹ (IIb), they were grouped by calorie supply ≥ 20 kcal/kg of adjusted weight or < 20 kcal/kg body weight adjusted per day, with similar protein intake. The low-calorie group, as compared to the normal-calorie group, had a shorter stay at the ICU, shorter duration of antibiotic therapy and a trend towards fewer days on mechanical ventilation without differences in nitrogen balance.

Carbohydrates/lipid ratio as a source of energy has not been tested in critically-ill obese patients, so the standard recommendations should be followed, with a 60/40 or 70/30 ratio of the total non-protein energy, always searching for the best ratio which allows for controlling glycemia at adequate values, as well as triglycerides, that must be maintained below 400 mg/dL³³.

What are the protein needs and characteristics of their supply?

It is recommended that the protein supply accounts for 40-50% of REE, to minimize glucose load without affecting the catabolism of body lean mass³⁴ (IV). In addition, based on small studies, some randomized²⁰⁻²⁴ (IIb), the recommended protein requirements are proportionally higher in critically-ill obese than in non-obese patients, establishing a supply of 1.8-2.1 g/kg ideal weight if BMI is 30-40 kg/m² and 2.1-2.5 g/kg ideal weight if > 40 kg/m².

What are the micronutrient and vitamin requirements?

The interest in the presumed benefits of micronutrients in critically-ill patients has led to conducting multiple studies on them, particularly those with a higher antioxidant effect, with irregular and often conflicting results. A combination of vitamins, antioxidants, and trace elements, including selenium, zinc, and vitamin E, may improve the overall results in critically-ill patients³⁵.

In a systematic review of trace elements and vitamins in critically-ill patients³⁶, alone or in combination, a reduction was seen in mortality, with no effect on infectious complications, particularly if the route was parenteral.

No specific study was performed in critically-ill obese patients, so no recommendations can be given and administration will be adapted to the general recommendations for critically-ill patients^{35,36} (IV).

Can any specific nutrition be recommended in critically-ill obese patients?

In a broad sense, low-calorie and high-protein nutrition could be considered as specific of critically-ill obese patients. However, complications linked to comorbidity and the condition of the critically-ill patients lead to considering other therapeutic options. But there are no randomized, prospective studies or literature evidence analyzing the value of nutritional support with specific nutrients in this patients subgroup, so transferring the data applied to a general population of critically-ill patients should be taken with much caution.

Since hyperglycemia is a common metabolic complication in this type of patients, the use of specific enteral formulas containing carbohydrates with a lower glycemic index, supply of monounsaturated fatty acids and fiber should be considered^{37,38} (III). The use of diets enriched with w-3 fatty acids and antioxidants may have beneficial effects in ARDS³⁹ (Ia). Glutamine dipeptide-supplemented parenteral nutrition leads to a better metabolic control and reduce septic complications⁴⁰ (III), so its administration in critically-ill obese patients could help to control these variables.

Recommendations

– Continuous indirect calorimetry is the gold standard in the assessment of energy requirements in critically-ill obese patients (A).

– None kind of nutritional support has achieved a mortality decrease in critically-ill obese patient (B).

– The energy needs of critically-ill obese patients are highly variable, which complicates estimation of energy needs using the predictive equations (C). Ire-

ton-Jones 1992 and Penn-State 1998 formulas have the best correlation with indirect calorimetry (B).

– Artificial nutrition must be started early in critically-ill obese patients (C).

– In morbid obesity, low-calorie nutritional support is a reasonable choice, providing 50-60% of the measured energy expenditure or 18-20 kcal/kg of ideal weight (B).

– In other types of obesity low-calorie nutrition may also be used, as in morbid obesity, or estimate 20-25 kcal/adjusted weight/day (C).

– Protein supply should be administered, based on BMI, at 1.8-2.5 g/kg ideal weight/day (B).

– There is no clear evidence about the value of specific nutrients in this patient subgroup. Recommendations in this topic should be adapted to those established for the general population of critically-ill patients (C).

Conflict of interests

The authors declare that they have participated in activities funded by the pharmaceutical industry for marketing of nutritional products (clinical studies, educational programmes and attendance to scientific events). No pharmaceutical industry has participated in the preparation, discussion, writing, and establishing of evidences in any phase of this article.

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