Med Intensiva. 2020;44(S1):69–72

medicina intensiva

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RECOMMENDATIONS FOR SPECIALIZED NUTRITIONAL-METABOLIC TREATMENT OF THE CRITICAL PATIENT

# Recommendations for specialized nutritional-metabolic treatment of the critical patient: Neurocritical patients. Metabolism and Nutrition Working Group of the Spanish Society of Intensive and Critical Care Medicine and Coronary Units☆

## Recomendaciones para el tratamiento nutrometabólico especializado del paciente crítico: pacientes neurocríticos. Grupo de trabajo de Metabolismo y Nutrición de la Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias

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Received 11 October 2019; accepted 25 January 2020

## Introduction

Neurocritical (NC) patients with lesions of traumatic, vascular or neoplastic origin require specialized nutritional support (SNS) due to the impossibility of providing sufficient oral feeding and the intense hypermetabolism and hypercatabolism inherent to such lesions. No comparative studies have been made of the nutritional aspects among patients with lesions of traumatic, vascular or neoplastic origin; the present recommendations are therefore all made under the same grouping of NC patients. Individuals with acute spinal cord injuries are addressed in a specific section at the end of the chapter.

## Questions

### Do the energy and protein requirements of these patients differ from those of the rest of critical patients?

The energy requirements of NC patients vary according to the extent of brain damage and the depth of coma. A systematic review by Foley et al.[1] found calorie consumption

☆ Please cite this article as: Acosta JA, Fernández Ortega JF, Pérez Quesada S. Recomendaciones para el tratamiento nutrometabólico especializado del paciente crítico: pacientes neurocríticos. Grupo de trabajo de Metabolismo y Nutrición de la Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias. Med Intensiva. 2020;44:69–72.

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under conditions of mechanical ventilation (MV) with sedation and relaxation to range between 86 and 121% of the basal values calculated from predictive formulas. These figures increased to 140% after the withdrawal of sedation, temperature elevation or the appearance of infection.

In NC patients it is advisable to establish calorie calculation based on indirect calorimetry, or to obtain approximate values using predictive formulas. Energy supply should be started gradually until covering the calculated requirements in the first 48 h following the start of feeding. An observational study[2] including patients from 341 Intensive Care Units (ICUs) found the administered mean overall calorie supply to vary in the order of 58% of the programmed calorie values. The study concluded that a drastic decrease in energy supply is related to increased ICU stay and mortality.

Härtl et al.,[3] in a prospective observational study of traumatic brain injury (TBI) patients, quantified the energy administered in the first 7 days of admission to the ICU and concluded that calorie supply is an independent marker of patient mortality and stay in the ICU, documenting a 40% increase in mortality when the calorie supply drops to under 10 kcal/kg/day.

A randomized trial in trauma and surgical patients[4] requiring admission to the ICU, in which the calorie supply was in the order of 50% of the calculated requirements, recorded no associated increase in patient morbidity–mortality. The summarized conclusion of these studies is that both a decrease of 50% and an increase of over 100% in administered calories can contribute to increase patient mortality and duration of stay in the ICU.[5]

With regard to protein supply, a gradual increase is indicated over the first two weeks, due to the intense catabolism that becomes further accentuated over time. A study in trauma patients including individuals with TBI[6] recorded a tendency toward normalization of the nitrogen balance with a protein supply of over 2 g/kg/day. Another observational study in seriously ill subjects in general[7] found the administration of at least 80% of the calculated protein needs to be accompanied by lesser mortality versus patients falling short of that percentage supply.

In sum, we recommend an energy supply of close to 80% of the calorie requirements and a protein supply in the first two weeks of 1.4–1.6 g/kg/day, with a gradual increase to 2 g/kg/day, coinciding with the rehabilitation phase.

Two prospective studies have been evaluated in relation to the timing of the start of nutritional support. Chourdakis et al.[8] recorded no differences in patient mortality or infection rate, and Azim et al.[9] found early enteral nutrition (EN) to be associated to an increased incidence of pneumonia. A review and meta-analysis concluded that recommendations cannot be made, due to the low homogeneity of the evaluated studies, attributable to the important differences in sample size, type of population and administration route involved.[10,11] However, there is agreement that early EN exerts a favorable effect in terms of lessened patient mortality[11] and improved neurological recovery, with a prolongation of ICU stay.

## What is the best feeding route for neurocritical patients? Is routine postpyloric feeding indicated?

Different randomized trials have compared ICU mortality and stay in relation to intravenous versus enteral feeding in patients with severe TBI. A study with a limited sample size recorded no differences in mortality or infection rate.[12] A meta-analysis[11] documented a favorable effect in terms of ICU mortality and stay with parenteral nutrition (PN) versus EN. This observation could be explained by the fact that PN affords a greater energy and protein supply, facilitates early feeding, and significantly reduces substrate losses due to increased gastric residual volume (IGR). However, on extrapolating the findings in the general critical care population, where PN is associated to greater risks compared with EN, most of the guides continue to recommend the start of EN in severely ill patients in general and its preferential use in NC patients.

Neurocritical, polytraumatized and major burn patients are the subjects that most often present IGR.[13] Its effect is related to the decrease in peristaltic wave frequency in the pyloric antrum and an increase in its muscle tone. Intracranial hypertension episodes, diminished level of consciousness and older age favor IGR. To these independent factors we also must add ventilatory support and the use of sedatives and muscle relaxants. On the other hand, the use of prokinetic medication does not reduce the number of episodes of IGR, the partial or definitive diet suspension rate, or the incidence of pneumonia.[14] A randomized clinical trial (RCT)[15] and a meta-analysis[16] have shown postpyloric feeding to increase the administered nutritional volume, significantly reduce the incidence of ventilator associated pneumonia (VAP), and tend to reduce mortality, without modifying the duration of ICU stay.

## What is the best formula for the specialized nutritional management of neurocritical patients? Do diets enriched with glutamine and other pharmaconutrients play a role?

The administration of glutamine dipeptide increases the brain glutamine levels, but without incrementing the brain glutamate concentrations. A study[17] comparing two enteral diets – standard versus a glutamine enriched diet with low carbohydrate and high fatty acid content – revealed no differences in infection or mortality rate, or ICU stay. No randomized clinical trials have confirmed that glutamine dipeptide enriched diets (administered via the enteral or parenteral route) in NC patients have a favorable effect upon the clinical[18] and neurological outcome parameters – though such an effect has been observed in critical patients in general, receiving PN supplemented with glutamine. There are no validated studies in NC patients involving the administration of arginine, and thus no evidence on its use. Experimental and clinical studies in patients with chronic brain injuries have demonstrated improvement in the degree of the neurological sequelae with the late

administration of ω-3 fatty acids. However, there are no studies in acute phase NC patients demonstrating that their use improves the sequelae, and it is not known at what point in time their administration proves most favorable.[19]

### What is the recommended glycemia range in neurocritical patients?

The acute phase in NC patients is characterized by alteration of the blood-brain barrier and of the brain/plasma glucose ratio. Cerebral hypoglycemia is associated to negative effects in terms of survival, due to increased expansion of the secondary damage and the glutamate and lactate concentrations, particularly in areas of the brain exhibiting low perfusion, with worsening of the ischemia. According to the different studies[20,21] and meta-analyses,[22] strict glycemia control increases the risk of hypoglycemia and worsens brain damage in the first week of the patient clinical course. A safe range for NC patients is 120–150 mg/dl.

### What are the calorie/protein requirements in patients with acute spinal cord injury?

Following spinal cord injury there is a significant decrease in body cell mass and an increase in fatty mass, as well as an increase in the consumption of vitamins A, B1 and B2.[23] The calorie/protein requirements are dependent upon three factors: (1) the level of the spinal cord damage (paraplegia or tetraplegia); (2) depth and extent measured by the Asia score; and (3) the clinical evolutive stage of the patient (hypermetabolic or normometabolic). In the initial hypermetabolic phase the patients require respiratory and hemodynamic support, and there is a high incidence of IGR and paralytic ileus.

The calorie/protein supply should be similar to that administered to any other critical patient, with a calorie content of 15–20 kcal/kg and a protein supply of 1.4–1.6 g/kg/day. Following the stabilization phase, which usually coincides with the suspension of ventilatory support and the start of rehabilitation, patients present a progressive hypometabolic state. Different studies[24,25] have used indirect calorimetry to demonstrate that the energy consumption in patients with acute spinal cord injury ranges between 19–22 kcal/kg/day in the case of tetraplegic patients and 25–30 kcal/kg/day in the case of paraplegic individuals. The recommended protein supply ranges between 1.2 and 1.5 g/kg/day, due to its effect upon normalization of the nitrogen balance.[26].

## Recommendations

- The suggested calorie supply target in NC patients is 60–100% of the calories calculated on the basis of indirect calorimetry or using predictive formulas (Level of evidence: low. Grade of recommendation: moderate).
- It is advisable to increase protein supply in patients with severe TBI (Level of evidence: low. Grade of recommendation: moderate).
- In NC patients with repeated IGR episodes, it is advisable to administer EN via the postpyloric route (Level of evidence: moderate. Grade of recommendation: high).
- The administration of enteral diets enriched with mixtures of pharmaconutrients (arginine, ω-3 fatty acids, antioxidants) is recommended in patients with severe TBI (Level of evidence: low. Grade of recommendation: low).
- Strict glycemia control (80–110 mg/dl) is not indicated in NC patients (Level of evidence: moderate. Grade of recommendation: moderate).
- In patients with isolated acute spinal cord injury it is advisable to reduce the calorie supply once the acute phase has been left behind, due to the decrease in metabolic demand – this decrease being proportional to the level and depth of the spinal cord injury (Level of evidence: expert opinion. Grade of recommendation: low).

## Conflicts of interest

Dr. Acosta-Escribano and Dr. Pérez-Quesada declare that they have no conflicts of interest. Dr. Fernández-Ortega has received payment from Fresenius nutrition division and Vegenat for conferences, and funding from Vegenat for participation in training courses.

## Note to supplement

This article forms part of the supplement ''Recommendations for specialized nutritional-metabolic management of the critical patient. Metabolism and Nutrition Working Group of the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC)'', with the sponsorship of Abbott Nutrition.

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