

## Chapter 17

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

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### Abstract

Patients with cardiac disease can develop two types of malnutrition: cardiac cachexia, which appears in chronic congestive heart failure, and malnutrition due to the complications of cardiac surgery or any other type of surgery in patients with heart disease.

Early enteral nutrition should be attempted if the oral route cannot be used. When cardiac function is severely compromised, enteral nutrition is feasible, but supplementation with parenteral nutrition is sometimes required.

Sustained hyperglycemia in the first 24 hours in patients admitted for acute coronary syndrome, whether diabetic or not, is a poor prognostic factor for 30-day mortality. In critically-ill cardiac patients with stable hemodynamic failure, nutritional support of 20-25 kcal/kg/day is effective in maintaining adequate nutritional status.

Protein intake should be 1.2-1.5 g/kg/day. Routine polymeric or high protein formulae should be used, according to the patient's prior nutritional status, with sodium and volume restriction according to the patient's clinical situation.

The major energy source for myocytes is glutamine, through conversion to glutamate, which also protects the myocardial cell from ischemia in critical situations. Administration of 1 g/day of omega-3 (EPA+DHA) in the form of fish oil can prevent sudden death in the treatment of acute coronary syndrome and can also help to reduce hospital admission for cardiovascular events in patients with chronic heart failure.

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Key words: *Critically-ill cardiac patient. Cardiac cachexia. Omega-3 fatty acids. Hyperglycemia.*

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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 CARDÍACO

### Resumen

El paciente con patología cardíaca puede presentar 2 tipos de desnutrición: la caquexia cardíaca, que aparece en situaciones de insuficiencia cardíaca congestiva crónica, y una malnutrición secundaria a complicaciones de la cirugía cardíaca o de cualquier cirugía mayor realizada en pacientes con cardiopatía.

Se debe intentar una nutrición enteral precoz si no se puede utilizar la vía oral. Cuando la función cardíaca esté profundamente comprometida la nutrición enteral es posible, pero a veces precisará suplementación con nutrición parenteral.

La hiperglucemia aguda sostenida en las primeras 24 h en pacientes ingresados por síndrome coronario agudo, sean o no diabéticos, es un factor de mal pronóstico en términos de mortalidad a los 30 días. En el paciente crítico cardíaco con fallo hemodinámico en situación estable, un soporte nutricional de 20-25 kcal/kg/día es eficaz para mantener un estado nutricional adecuado.

El aporte proteico debe ser de 1,2-1,5 g/kg/día. Se administrarán fórmulas poliméricas o hiperproteicas habituales, según la situación nutricional previa del paciente, con restricción de sodio y volumen según su situación clínica.

La glutamina es la mayor fuente de energía para el miocito, vía conversión a glutamato, protegiendo además a la célula miocárdica de la isquemia en situaciones críticas. La administración de 1 g/día de w-3 (EPA+DHA), en forma de aceite de pescado, puede prevenir la muerte súbita en el tratamiento del síndrome coronario agudo y también puede contribuir a una disminución de los ingresos hospitalarios, por eventos cardiovasculares, en la insuficiencia cardíaca crónica.

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Palabras clave: *Paciente crítico cardíaco. Caquexia cardíaca. Ácidos grasos omega-3. Hiperglucemia.*

## Introduction

Malnutrition is present in 50% of patients with chronic congestive heart failure. Heart failure is associated with neurohormonal and immune changes that contribute to a hypercatabolic state, with intestinal malabsorption induced by different factors<sup>1</sup>. Patients with heart disease may present 2 different types of malnutrition: classical heart cachexia, appearing in situations of chronic congestive heart failure (CHF), and a form of malnutrition secondary to complications of cardiac surgery or any major surgery in patients with heart disease<sup>2</sup>. The incidence of cardiac cachexia has been estimated in 12-15% of patients with NYHA grades II-III heart failure. This incidence increases to 10% per year if the grade of heart failure is III-IV<sup>3,4</sup> (IV).

### What are the indications of nutritional support in critically-ill cardiac patients?

– CHF. These patients have chronic heart failure (HF) and chronic systemic inflammatory response syndrome (SIRS). Vasoconstriction and stimulation of the sympathetic nervous system are compensatory mechanisms of heart failure, which influences the inadequate use of nutrients<sup>4</sup> (IV).

– Cardiac cachexia. It has been defined as a body mass loss of 27% or decrease of 80-85% from the ideal weight, but the most widely accepted meaning is defined as patients with CHF starting at least 6 months before and a weight loss in the past 6 months of at least 6% from the previous weight. Mortality is very high in cachectic patients, 18% at 3 months, 29% at 6 months, and 50% at 18 months<sup>5</sup> (IV). Factors contributing to that mortality include: a deficient diet, the associated malabsorption syndrome, loss of nutrients through the intestinal and renal tract and imbalance in supply and losses in a hypermetabolism state<sup>6</sup>.

– Patients following cardiac surgery and patients with acute heart disease, such as evolution complication of another condition (SIRS, sepsis, etc.). These patients end up behaving as critically-ill patients for nosocomial superinfection, HF refractory to treatment, cardiogenic shock or enlarged cardiomyopathy pending heart transplant.

– Acute coronary syndrome (ACS). These patients usually require oral nutrition, and only enteral nutrition (EN) would be indicated in the course of complications inherent to their condition<sup>7</sup>. Patients in a cardiogenic shock condition on mechanical ventilation, balloon counterpulsation or external ventricular assistance, behave as a chronic critical illness requiring long-term artificial nutritional support<sup>8</sup> (III).

### What is the most adequate administration route?

Oral supply is the most appropriate, and if intake is very limited, it may be complemented with nutritional

supplements. An early EN should be attempted if the oral route cannot be used. When heart function is severely affected (intraaortic contrapulsation balloon, ventricular assistance, etc.), EN can be performed, but will usually require supplementation with parenteral nutrition (PN) and its start, as a cautionary measure because of the risk of intestinal ischemia, is usually delayed beyond 24-48 hours after admission.

Patient instability, volume limitations, and the frequent changes in bowel function may require establishing total parenteral nutrition (TPN) or, sometimes, complementary parenteral nutrition (CPN)<sup>5</sup> (IV). EN in these type of patients, with the appropriate caution and monitoring, is feasible and beneficial<sup>9</sup> (III).

EN during 2-3 weeks, in patients with heart cachexia, is associated with a faster stabilization of the condition and improved nutritional parameters<sup>10</sup>, though with no changes in hemodynamic parameters. There are data evidencing that impaired heart function may reduce the intestinal perfusion causing malabsorption and intolerance to EN<sup>11</sup>.

### What amount and type of energy substrates are required?

The classical Harris-Benedict equation is acceptable for energy calculation, though easiest approaches have been shown to be useful, such as scheduling 20-25 kcal/kg/day within the first 48 hours and progress to 25-30 kcal/kg/day if required<sup>12,13</sup>. The supplies are often limited for the total volume restriction, and energetic concentrated nutrients should be used (1.5-2 kcal/ml)<sup>14</sup>.

There are no specific recommendations related to the percentage of energy substrates that must be contained in the diet of critically-ill cardiac patients. The ratio kcal/g N<sub>2</sub> will be maintained at 100-150/1, decreasing it based on the degree of protein depletion or increase of metabolic stress<sup>15</sup>.

#### *Carbohydrate supply*

Glucose supply should be adjusted to obtain blood glucose levels < 150 mg/dL, and even in narrower limits postoperatively following heart surgery. Glycemia should be accurately monitored in critically-ill cardiac patients. Acute hyperglycemia is evidenced in 50% of ACS in non-diabetic patients and in 25% of diabetics. It has been proven that sustained hyperglycemia in the first 24 hours in patients admitted for ACS, whether diabetic or not, is a factor of poor prognosis in terms of mortality at 30 days<sup>16,17</sup> (IIb).

Studies such as the DIGAMI (diabetes mellitus, insulin-glucose infusion in acute myocardial infarction)<sup>18</sup> analyzed the metabolism/mortality ratio in ACS. The purpose was to obtain an accurate control of glycemia with high doses of insulin and decrease mortality by 25% at 3 months and by 52% at one year. Although the results were

encouraging, they were not significant. The ECLA<sup>19</sup> study reported a mortality reduction of two-thirds when glucose-insulin-potassium were perfused versus placebo, but in subsequent randomized studies, both DIGAMI-2<sup>20</sup> and CREATE-ECLA<sup>21</sup>, these objectives were not reached, though it was confirmed that hyperglycemia is an independent predictor of mortality (Ib).

#### *Fat supply*

The adverse effects of lipid emulsions on cardiac inotropism only occur when perfusion exceeds 5 mg/kg/min. At the standard doses, without exceeding 2 g/kg/day, all commercial solutions are useful, though emphasis is made on the value of  $\omega$ -3 fatty acids<sup>22</sup> (IV).

#### **What are the protein needs and characteristics of their supply?**

Protein supply should be 1.2-1.5 g/kg/day. In EN, proteins should provide 16-20% of the total energy supply in order to maintain a positive nitrogen balance. The regular polymeric or hyperprotein formulae will be administered, with sodium and volume restriction, according to the previous clinical and nutritional status of the patient<sup>23</sup> (IV).

#### **What is the most advisable type of formula? Are specific nutrients required?**

The most advisable type of formula must be modified based on the nutritional status of patients and their needs. Some amino acid may be necessary or useful in cardiac patients, while others have shown a myocardial depressant effect, such as homocysteine, since their values are a risk factor and are frequently increased in patients with HF. They are closely related to the decreased plasma levels of vitamins B<sub>6</sub>, B<sub>9</sub>, and B<sub>12</sub>, required for their degradation<sup>24</sup> (IV).

#### *Carnitine*

It promotes fat entry in the mitochondria and indirectly activates pyruvate dehydrogenase, that improves glucose oxidation. Carnitine deficiency is associated with cardiomyopathy and skeletal muscle dysfunction. Myocardial failure is generally associated with a marked depletion of carnitine of up to 50%. Carnitine administration (3-6 g in divided doses) may lead to improving hemodynamic status and myocardial dysfunction<sup>23,25</sup> (IV).

#### *Glutamine*

Experimental studies have shown that its administration, after myocardial ischemia, induces an earlier

myocardial recovery, improve cardiac output and restoring ATP/ADP ratio. Glutamine has been shown to increase the synthesis of heat shock protein<sup>26</sup> which is also the greatest source of energy for the myocyte, by conversion to glutamate, also protecting the myocardial cell from ischemia in critical situations<sup>27,28</sup> (IV).

#### *Arginine*

As a precursor of nitric oxide, it plays a major role in regulating cardiovascular function, particularly in diabetic patients. Intravenous doses of 3-5 g reduce blood pressure and platelet aggregation. Arginine prevents cardiovascular dysfunction, as it restores nitric oxide synthesis, reduces production of free radicals, and inhibits leukocyte adherence to the endothelium, though in mesenteric ischemic conditions bowel mucosa function may be worsened<sup>29</sup> (IV).

#### *Taurine*

It is a non-essential amino acid that contributes to control intracellular calcium values, and therefore appears to be useful to improve myocardial function<sup>25</sup> (IV).

#### *$\omega$ -3 fatty acids*

They have been shown to have some antiarrhythmic potential and could prevent malignant arrhythmia and reduce the incidence of sudden death, acting mainly to prevent it<sup>30,31</sup>. The presence of  $\omega$ -3 in myocardial cells stabilizes electrically membranes and prolongs the refractory period. They decrease the synthesis of inflammatory prostanoids and modulate the inflammatory response by reducing arachidonic acid catabolites, preserving endothelial integrity and acting favourably on platelet activity. On the contrary, an excessive supply of  $\omega$ -6 can increase platelet aggregation and promote chronic inflammation predisposing to plaque instability<sup>32</sup>.

In randomized studies it has been recommended to provide a supplement of 1 g/day of  $\omega$ -3 (EPA + DHA) as fish oil, for primary prophylaxis of sudden death in the treatment of ACS and for reducing hospital admissions for cardiovascular episodes in CHF<sup>33,34</sup> (Ib), though subsequent studies did not obtain the same results<sup>35</sup> (Ib).

With regard to enteral immunomodulatory diets enriched with arginine, nucleotides, and fish oil, in a randomized, prospective study conducted in 50 patients with poor ventricular function, who were to undergo cardiac surgery, oral supplements of these nutrients were provided during the 5 days prior to surgery, obtaining a lower infection rate, a reduction in the need for positive inotropes and a better preservation of renal function<sup>36</sup> (IIa).

## What micronutrient and vitamin requirements are needed?

Vitamin D, calcium, magnesium, zinc, and selenium supplements should be included in an adequate nutritional support for patients with serious heart diseases<sup>37</sup> (IV).

Serious forms of HF have been described in patients with thiamine<sup>38</sup> or selenium deficiency. In patients with ischemic heart disease, after reperfusion processes, supplying antioxidants (vitamin A, C, E and selenium) helps limit myocardial damage<sup>39</sup>. Glutathione peroxidase and tocoferol reduction has been seen experimentally in patients with cardiomyopathy. Therefore, supplements of antioxidants in patients with heart failure, particularly vitamin E (400 IU), may contribute to improve cardiac function<sup>40</sup> (IV).

Severe selenium deficit may cause cardiomyopathy and is characterized by multiple fibrosis foci in the left ventricle. Zinc deficiency is common in patients with CHF and, therefore, the requirements established for these patients must be administered<sup>2</sup> (IV).

## Recommendations

– In critically-ill cardiac patients with hemodynamic failure in stable condition, a nutritional support of 20-25 kcal/kg/day is effective for maintaining an adequate nutritional status (B).

– Nutritional formulae recommended in other critically-ill patients will be supplied according to the previous nutritional status, with sodium and volume restriction, in relation to the clinical condition of the patient (C).

– Parenteral nutrition would be indicated for cardiac cachexia, in case of intolerance to enteral nutrition or as complementary nutrition, particularly in patients with cardiovascular surgery (C).

– Hyperglycemia should be closely monitored in patients with acute coronary syndrome and after cardiac surgery, whether or not known diabetics, maintaining values < 150 mg/dL (B).

– Glutamine supply may be beneficial for patients with myocardial ischemia in a critical situation (C).

– In patients with acute coronary syndrome who require enteral nutrition it is recommended to administer at least 1 g/day EPA + DHA (C).

– Supplements with vitamin A, C, B complex, vitamin E, and selenium are recommended to improve heart function (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

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