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CARDIOLOGICAL EMERGENCIES: NUTRITIONAL ASSESSMENT – PART 1

EMERGÊNCIAS CARDIOLÓGICAS: AVALIAÇÃO NUTRICIONAL – PARTE 1

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ABSTRACT

Cardiac emergencies can cause rapid and profound changes in the metabolic and systemic response. These changes contribute significantly to the mobilization of body reserves, which will affect nutritional status. Nutritional evaluation, although not performed in the critical phase of interdisciplinary care, should be carried out as early as possible in order to ensure an adequate diet, and water and electrolyte replacement. The use of subjective tools capable of estimating the global nutritional risk is easy to apply due to its effective and rapid application. One such tool is the Nutritional Risk Score – NRS 2002. Whenever possible, the global nutritional assessment should be complemented with objective nutritional assessment and the use of biochemical nutritional markers, which will help obtain a more accurate evaluation of the nutritional status of the critically ill patient. These tools should be applied by trained nutritionists, and the results should be discussed by the multidisciplinary nutritional therapy team, which will decide on the most appropriate strategies for the initiation of early nutritional therapy in cardiac emergency situations.

Keywords: Emergencies; Cardiology; Nutrition Assessment; Adult.

RESUMO

As emergências cardiológicas podem causar rápidas e profundas alterações na resposta metabólica e sistêmica. Essas alterações contribuem acentuadamente para a mobilização das reservas corporais que repercutirão no estado nutricional. A avaliação nutricional, ainda que não seja realizada na fase crítica da assistência interdisciplinar, deverá ser realizada o quanto antes, visando a adoção da alimentação adequada e reposição hídrica e de eletrólitos. O uso de ferramentas subjetivas capazes de estimar o risco nutricional global é de fácil aplicação devido a sua praticidade e rapidez. Entre essas destaca-se o Nutritional Risk Score – NRS 2002. Sempre que possível, a avaliação nutricional global deve ser complementada pela avaliação nutricional objetiva e pelo uso de marcadores nutricionais bioquímicos, os quais auxiliarão na avaliação mais precisa do estado nutricional do paciente crítico. Essas ferramentas devem ser utilizadas por nutricionistas treinados e os resultados devem ser discutidos pela equipe multidisciplinar de terapia nutricional que decidirá as estratégias mais adequadas para o início da terapia nutricional precoce nos quadros de emergências cardiológicas.

Descritores: *Urgências Médicas; Cardiologia; Avaliação Nutricional; Adulto.*

INTRODUCTION

Cardiac surgery (CS) is an intervention frequently used for the treatment of serious cardiomyopathies in emergency or elective situations.[1] Cardiomyopathies include congenital diseases, diseases of the coronary arteries, heart valves, the aorta and its branches, atrial fibrillation, and cardiac insufficiency. The complexity of cardiac disease may require treatment through invasive procedures such as CS.[2,3]

CS can be subdivided into three types: corrective (congenital cardiomyopathies and repair of atrial and ventricular septal defects of the atrioventricular [AV] canal), reconstructive (myocardial revascularization [MR] and aortic, mitral or tricuspid valve repair [VRr]), replacement (valve replacement [VR]), and heart transplant (HT). The most frequently performed procedures are MR and VRr, respectively.[4,5]

Emergency situations result in metabolic, systemic, and organ responses that alter the nutritional status after CS due to hypermetabolism and hypercatabolism, which may affect the muscles depending on the lesion type and severity, in addition to contributing to a negative prognosis and complications in the postoperative (PO) recovery period due to impaired surgical wound healing.[6]

These responses, including the release of inflammatory cytokines in the plasma, stimulation of peripheral insulin resistance, muscular proteolysis, anorexia, leukocytosis, and loss of adipose tissue, are adaptive mechanisms for lesion

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recovery. If these responses become chronic, they can harm human health and lead to complications that impair the repair of the injured tissue.[3]

The main complications associated with CS are hemorrhage, hypovolemia, septic shock, pulmonary atelectasis, acute renal failure, venous thromboembolism, and infection. Considering the responses required for tissue repair, nutritional status is an important factor to monitor in the PO period to prevent potential complications.[7]

The nutritional status before surgery also contributes to effective tissue remodeling. The early identification of patients at nutritional risk is necessary considering the potential for complications. The assessment of nutritional status should be based on clinical parameters, dietary data collection, anthropometrics, clinical history, and biochemical data to identify malnourished patients, those at risk of developing malnutrition, and those with specific nutritional deficiencies, and to assess inflammatory activity (C-reactive protein [CRP], serum albumin concentration [SAC[, hemoglobin, and cytokine levels).[8]

Loss of weight and skeletal muscle, which are typical of malnutrition, are predictive factors of morbidity and mortality.[9]

In this context, nutritional assistance to cardiac and surgical patients should not be neglected in order to prevent complications, increase healing, reduce hospital stay and morbidity and, consequently, mortality. This review focused on the tools currently used to assess the global, anthropometric and biochemical dimensions of nutrition that can be applied in both cardiac emergencies and monitoring.

NUTRITIONAL SUPPORT IN CARDIAC EMERGENCIES

The assessment of patient nutritional status prior to surgical intervention is directly related to the PO period, impacting both complications and PO outcomes.[10,11] Despite its importance, it is not always possible to assess nutritional status in cardiac emergencies.

Some protocols and practices related to the nutritional preparation of the patient before surgery are already well established for digestive tract procedures, including immunological preparation via special nutrition and reduction of PO fasting[12,13], and have been adopted by several health institutions; however, studies on the use of these practices in cardiac surgeries remain scarce.

Most CS are elective procedures, which enables the implementation of strategies to improve the patient's nutritional status prior to the procedure, during outpatient follow-up, during the hospital stay before surgery, and in emergency episodes. The purpose of the preoperative nutritional preparation is not to fully recover the nutritional status of patients who are malnourished or at nutritional risk but rather to prepare the patient for surgery, a trauma that triggers inflammatory and catabolic responses that, together with malnutrition, increase the risk of PO complications.[14] Patients who are malnourished or at nutritional risk and undergo surgery have an increased risk of infections and wound healing complications, impaired weaning from mechanical ventilation, longer hospital and ICU stays, and death. [15,16]

The first step in the nutritional preparation process is to identify patients at risk using screening tools such as the 2002 Nutritional Risk Screening (NRS2002)[17] for hospitalized patients from the European Society for Clinical Nutrition and Metabolism (ESPEN).

Even if nutritional risk is not present at the time of hospital admission, a long hospital stay while waiting for the procedure, as in the case of patients waiting for a heart transplant or those hospitalized in public hospitals with insufficient materials, medical teams, or operating rooms, can lead a previously eutrophic individual to develop nutritional risk or malnutrition. Therefore, it is important to adopt protocols for risk screening and nutritional assessment to intervene as early as possible for the patient have good nutritional status at the time of the surgery, thus contributing to a faster recovery without complications.

Once patients at risk are identified, strategies should be applied to improve the nutritional status until surgery and to reduce PO complications. To this end, acceptance of the hospital diet should be ensured by adjusting the diet to the patient's preferences, adjusting the consistency of the food provided, and prescribing hypercaloric/hyperproteic nutritional supplements with or without immunonutrients to reach the estimated caloric and protein requirements.

A special diet with immunonutrients (arginine, nucleotides, and omega-3 fatty acids) and antioxidants (vitamins A, C, and E and zinc and selenium minerals) should be provided five to seven days before the surgery for patients at nutritional risk and up to 14 days before the surgery for those with severe malnutrition.[13] This practice is well-established for surgical gastrointestinal cancer patients but studies in CS are scarce. One study showed a reduction in infection rates after CS in a group of elderly individuals at high risk for this outcome prescribed an oral immunomodulatory supplementation five days before the intervention.[18]

Other studies have shown that preoperative supplementation with vitamin C or polyunsaturated fatty acids (PUFA) of the omega-3 series can reduce the incidence of PO atrial fibrillation (AF).[19] PO AF is common in surgical patients, with an incidence rate of up to 46% in CS and 12% in non-CS, and is associated with worse outcomes. The pathophysiology of this arrhythmia in the PO period is multifactorial, and the inflammatory response and oxidative stress caused by surgical trauma play an important role in its pathogenesis. A study with 43 patients taking 2 g of oral ascorbic acid (vitamin C) the night before myocardial revascularization surgery and 500 mg twice daily for five days after the surgery had a 16% incidence of AF compared to 35% in the control group, demonstrating a 50% reduction in the incidence of AF following oral administration of ascorbic acid in the perioperative period.[20]

In another prospective study, 160 patients undergoing revascularization were randomized to receive PUFA (2 g/day) for at least five days in the PO period. PUFA administration resulted in a reduced incidence of AF by 65%. This effect was also associated with a significant reduction in the length of hospital stay.[21]

Another practice recommended in preoperative nutritional preparation protocols is the reduction of the fasting period; however, this is not always feasible in cardiac emergencies. Current guidelines from the American Society of Anesthesiologists (ASA)[22] and the Brazilian Medical Association[23] recommend the provision of clear liquids two hours before surgery as a safe procedure for greater comfort and improved

patient recovery. The ASA defines clear liquids as water, tea, coffee, and juices without residues.[22] This practice does not increase the risk of anesthesia-related aspiration and results in a better modulation of organ response, leading to favorable clinical results, such as reduced inflammatory response, reduced insulin resistance, decreased nausea and vomiting, increased patient satisfaction, and lower anxiety.[24-26]

The European Enhanced Recovery After Surgery (ERAS) group and the national Acceleration of Total Postoperative Recovery (ACERTO - *Aceleração da Recuperação Total Pós-Operatória*) project showed that the metabolic response to surgical trauma, especially insulin resistance, is enhanced by prolonged preoperative fasting.[27,28] Reducing the preoperative fasting period by providing a carbohydrate solution up to two hours before anesthesia can improve the organ response to surgical stress as well as patient well-being.[29]

A study of patients undergoing myocardial revascularization showed that reducing the preoperative fasting period with a carbohydrate solution improved patients' glycemic control, reduced vasoactive drug use time, and lengths of hospital and ICU stays.[30]

While there are few published studies regarding nutritional preparation (immunomodulation and reduction of the fasting period) in the preoperative period of cardiac patients, the influence of nutritional status before surgery on PO outcomes is well-established. The success of the procedure and a good PO recovery depend not only on advanced techniques, modern equipment, and specialized professionals but also on nutritional support, including the early identification of risk and application of strategies to protect or recover the patient's nutritional status before surgery.

NUTRITIONAL ASSESSMENT IN CARDIAC EMERGENCIES

Nutritional risk assessment

Nutritional risks before elective cardiac surgery include preexisting diseases, unintentional weight loss in the preoperative period, low food intake in the previous week. These risks are related to adverse PO effects.[31]

Approximately 10%–25% of patients undergoing cardiac surgery are malnourished. This preoperative malnutrition is related to PO adverse effects. However, studies on PO malnutrition are scarce. Changes in body composition, biochemical tests, and anthropometry have been reported.[32]

In 1997, the Brazilian National Survey on Hospital Nutrition Assessment (IBRANUTRI) evaluated approximately 4,000 patients using the "Subjective Global Nutritional Assessment" screening tool and detected malnutrition in 48.1% of the sample.[33]

In 2003, the Latin American Study of Nutrition and Health (ELAN), carried out in 13 countries, including Brazil, also used the Subjective Global Nutritional Assessment to detect malnutrition in 50.2% of the sample. Another study conducted in a public hospital in São Paulo reported that 27.9% of the patients participating in the study were at nutritional risk.[34,35]

The clinical evolution of hospitalized patients is closely associated with their nutritional status. Malnourished patients have higher morbidity and mortality rates; increased complications such as pneumonia, sepsis, and pressure lesions; PO complications; delayed wound healing; increased hospital stay (12 days for eutrophic patients and 20 days for malnourished patients); greater dependence on nursing care; increased hospital costs; and reduced quality of life.[36-39]

Several factors can contribute to this outcome, including the underlying disease, comorbidities, insufficient dietary intake, medication side effects, physical inactivity, and investigation and intervention procedures requiring fasting or changes in diet.[40]

The early identification of these factors facilitates the management of adequate nutritional care and can be decisive for patient survival. The Nutritional Risk Assessment (NRA) tool can be used to identify individuals who are malnourished or at nutritional risk[41-44], verify whether a more detailed nutritional assessment is required[45], and identify early those patients who could benefit from nutritional therapy.

Therefore, since malnutrition is directly associated with a poor clinical status, it is necessary to identify patients at risk of malnutrition and malnourished, in addition to the care and monitoring to recover the nutritional status and prevent weight loss and underlying complications.[46]

The NRA is a fast, simple, and non-invasive procedure performed by the health team responsible for hospital admission, without the need for additional devices or tests. It is feasible to perform at the bedside and aims to identify patients at risk. This method requires regular and periodic reassessment and provides subsidies for nutritional diagnosis.[47]

Resolution 63 of the Brazilian National Health Surveillance Agency (ANVISA) refers to the implementation of a Multidisciplinary Nutritional Therapy Team (MTN); therefore, nutritionists have a responsibility to perform nutritional status screening and assessment based on previously defined protocols and to ensure that this information is recorded in the patient's medical record and dated and signed by the professional who performed the care. This process should be repeated at the most every 10 days.[48,49]

If the NRA identifies risk, the next step is a detailed nutritional assessment, which is a more complete tool compared to the NRA.[49] Although the NRA assesses the possibility of in-hospital malnutrition, nutritional assessment identifies the nutritional status and the degree to which the patient's needs are being met. The nutritional assessment includes objective and subjective variables such as physical examination, biochemical tests, dietary anamnesis, medications, clinical history, and anthropometry.[44]

The 2002 Nutrition Risk Screening (NRS 2002) was developed by the Danish Society of Parenteral and Enteral Nutrition (DSKE) by Kondrup and collaborators in 2002[50] and is recommended by the European Society of Parenteral and Enteral Nutrition (ESPEN) for the detection of malnutrition and the risk of its development during hospitalization.[51]

The NRS 2002 can be used regardless of disease and patient age. It includes clinical and surgical patients in the hospital and, thus, does not discriminate patients and includes many diseases. Its pre-screening is composed of four questions and can be applied at sites where the patients present a low nutritional risk.[52]

The NRS 2002 should be administered within 72 hours after hospital admission. It considers BMI, weight loss and dietary changes. In the second step, it presents severity scores

for both nutritional status and disease severity, both of which are classified as absent (0 points), mild (1 point), moderate (2 points), or severe (3 points). There is an increase of 1 point for patients aged ≥70 years. A summed score of ≥ 3 indicates that the patient is at nutritional risk.[53]

Statistical analyses of the NRS 2002 in controlled clinical trials showed a sensitivity of 75% and a specificity of 55% in 128 publications with different populations[54]. (Figure 1)

Anthropometric assessment

Among nutritional assessment methods, anthropometry offers simple, practical, and low-cost techniques.[55] Before surgery, anthropometric measurements are important to classify nutritional status; however, some cardiac pathologies cause water retention, which may directly influence the acquisition and reliability of measurements such as weight and calf circumference. Therefore, in clinical practice, these measures are more often used to follow a patient's response to treatment (for example, to demonstrate improvement in edema) rather than to assess nutritional status.

The most frequently used measurements for anthropometric assessment are weight, height, body mass index (BMI), circumferences (arm, arm muscle, calf, abdominal), arm muscle area, skin folds (biceps, triceps, subscapular, suprailiac),[55] and thickness of the adductor pollicis muscle (APM).[56] These measurements should be performed, when possible, upon admission, soon after stabilization after the emergency event, and periodically until surgery.

Regarding weight and BMI, studies have shown that the two extremes of nutritional status, malnutrition and obesity, are related to increased risks of complications in the PO period. While malnutrition is associated with increased mortality, susceptibility to infections, and reduced quality of life, obesity is associated with an increased risk of renal dysfunction and postoperative mediastinitis.[57-60]

Calf and arm muscle circumferences, as well as the APM thickness, are directly linked to muscle reserves. An association between protein depletion and increased susceptibility to infections, morbidity, and longer hospitalization has been reported.[61-63] APM thickness is a good method to diagnose muscle depletion and malnutrition in surgical patients.[64] This measurement has also been associated with the prognosis of patients undergoing cardiac surgery[65-67] and, although there is still no reference cut-off value for cardiac patients, a study of valvular patients showed a statistically significant relationship between APM values lower than 6.5 mm and postoperative infectious complications.[67]

In addition to measurements of body compartments to quantify muscle and fat reserves, some studies have proposed the importance of performing functional tests in preoperative patients to assess surgical risk and PO complications. Among functional tests, measurement of palmar grip strength is a good indicator of overall muscle

Figure 1. Model of the NRS 2002.[50]

1st step – nutritional risk score (2002) – initial screening		**Yes**	**No**
BMI < 20.5 kg/m^2?			
Weight loss in the last three months?			
Has the patient's dietary intake decreased in the last week?			
Is the patient seriously ill? (Example: in intensive care)			
Note: if there is a positive answer, "yes," proceed to the second step			
2nd step – nutritional risk score – NRS (2002) – final screening			
Nutritional status	Absent Score 0	Normal nutritional status	
	Mild Score 1	Weight loss < 5% in 3 months or food intake in the last week between 50-75% of nutritional requirements.	
	Moderate Score 2	Weight loss > 5% in 2 months or BMI between 18.5 - 20.5 kg/m2 + general condition impaired (weakened) or food intake in the last week between 25-60% of nutritional requirements.	
	Severe Score 3	Weight loss > 5% in 1 month, > 15% in 3 months or BMI <18.5 kg/m2 + general condition impaired (weakened) or food intake in the last week between 0-25% of nutritional requirements.	
Disease severity	Absent Score 0	Normal nutritional requirements.	
	Mild Score 1	Hip fracture, chronic patients with acute complications: cirrhosis, COPD, hemodialysis, diabetes, oncology. Patient is weak, but walks.	
	Moderate Score 2	Large abdominal surgery, stroke. Severe pneumonia, malignant hematological disease (leukemia, lymphoma). Patient confined to bed.	
	Severe Score 3	Trauma, bone marrow transplant, intensive care patient (APACHE> 10)	
Nutritional status score=		Disease severity score=	
Nutritional status score + Disease severity =			
If the patient is 70 years old or more, add 1 point in the score =			
Total score=			
Score ≥ 3: Patient should be evaluated weekly. If the patient is submitted to any risk situation, preventive nutritional therapy should be considered to prevent the patient from being at nutritional risk.			
Score < 3: Patient is at low nutritional risk, so nutritional therapy should be started as soon as possible.			

strength and its use has been proposed as a complementary technique to nutritional assessment as well as a predictive measure of surgical complications and mortality in elderly individuals and patients;[68,69] however, studies on its use in cardiac patients are lacking.

Knowing the nutritional status of the patient who will undergo CS is very important for the implementation of strategies to improve the status, reduce PO complications, and, consequently, the length of hospital and ICU stays. Although most CS are elective procedures, prolonged hospital stays contribute to impaired nutritional status and the emergence of patients at risk; therefore, nutritional assessment and patient monitoring during the preoperative period are critical.

When possible, classical anthropometric assessment should be applied, including the following parameters:

- Current weight (kg);
- Usual weight (kg);
- Ideal weight (kg);
- Current height (cm);
- Arm circumference (AC) (cm);
- Arm muscle circumference (AMC) (cm);
- Waist circumference (WC) (cm);
- Arm muscle area (AMA) (cm^2);
- Triceps skin fold (TSF) (mm);
- Biceps skin fold (BSF) (mm);
- Subscapular skin fold (SCSF) (mm);
- Suprailiac skin fold (SISF) (mm);

These measures should be assessed according to relevant age groups and cut-off values, when available.

Weight, height, and body mass index (BMI)

BMI (kg/m^2) is still widely used to verify the adequacy of weight to height in adults and, despite its limitations, can be used as an initial screening measure rather than as an isolated parameter.

The ideal weight (IW) can be calculated according to the range of normal BMI, with the minimum and maximum IW corresponding to BMI of 18.5 and 24.9 kg/m^2, respectively. The percentage of weight loss (% WL) is also a relevant parameter since it identifies variations in body weight that can interfere with nutritional status and, consequently, in the favorable evolution of the patient. (Figure 2)

% WL = usual weight - current weight x 100 / usual weight

If it is not possible to measure the current height and weight, it is recommended to estimate these parameters using the Chumlea formulas.[71-73] (Figures 3 and 4)

Cardiac patients may be bedridden for long durations during the PO period, depending on the severity of the situation and clinical evolution; therefore, in addition to the metabolic alterations associated with the underlying diseases, these individuals may present edemas in the lower limbs or throughout. Consequently, to estimate body weight more effectively, "dry" weight estimates are recommended.[74] (Figure 5)

Additional recommended anthropometric measures also important for nutritional status assessment include:

- Sum of skinfolds TSF + BSF + SCSF + SISF: to estimate the percentage of body fat in individuals older than 20 years of age.
- Sum of TSF and SCSF: to determine the caloric reserves in the form of fat, in which values below the 5th percentile indicate the thresholds of malnutrition.

Neck circumference (NC)

Recent studies have shown that NC is strongly correlated with other typical anthropometric measures in clinical practice and is a marker of obesity, a widely accepted risk factor for coronary artery disease (CAD).[75,76] NC is also correlated to Framingham risk score. Studies have demonstrated a strong correlation between NC and the risk of CAD over a period of 10 years and the risk of cardiovascular events and all-cause mortality in men and women increases as the NC increases.[77,78] Although NC is independently correlated with metabolic risk factors and other obesity anthropometric indices, more studies are required to strengthen the findings and to establish cut-off values for the cardiac population in both men and women.[79]

Adductor pollicis muscle thickness (APMT)

Compared to classic nutritional assessment measurements, APMT is a good prognostic index for septic and non-septic complications, mortality, and hospitalization time of patients with mitral and/or aortic valve disease cardiac undergoing valve replacement surgery.[80,81]

APMT is a simple alternative compared to the currently used anthropometric parameters and is objective, low-cost, non-invasive, and direct.[82,83] Nevertheless, several non-nutritional factors can influence its applicability, such as patient

Figure 2. Classification of weight loss (WL) according to time and percentage.[70]

Period	Moderate loss	Severe loss
1 week	1 a 2 %	2% < PP ≤ 5%
1 month	5%	5% < PP ≤ 7.5%
3 months	7.5%	7.5% < PP ≤ 10%
6 months	10%	>10%

Figure 3. Formulas to calculate the estimated height.

Men aged 18-60 years (white)	A = 71.85 + 1.88 x knee height (cm)
Men aged 18-60 years (black)	A = 73.42 + 1.79 x knee height (cm)
Women aged 18-60 years (white)	A = 70.25 + [1.87 x knee height (cm)] - 0.06 x age (years)
Women aged 18-60 years (black)	A = 68.10 + [1.86 x knee height (cm)] - 0.06 x age (years)
Men aged 60-90 years	A = 64.19 - [0.04 x age (years)] + [2.04 x knee height (cm)]
Women aged 60-90 years	A = 84.88 - [0.24 x age (years)] + [1.83 x knee height (cm)]

Figure 4. Formulas for the calculation of the estimated weight.

Men aged 60-90 years	P = [1.73 x AC (cm)] + [0.98 x calf circumference (cm)] + [0.37 x SCSF (mm)] + [1.16 x knee height (cm)] - 81.69
Women aged 60-90 years	P = [0.98 x AC (cm)] + [1.27 x calf circumference (cm)] + [0.40 x SCSF (mm)] + [0.87 x knee height (cm)] - 62.35

Figure 5. Estimation of the "dry" weight according to the extent and site of edema

Extent of edema	Affected site	Total weight to be subtracted (kg)
+	Ankle	1 kg
++	Knee	3 – 4kg
+++	Thigh	5 – 6 kg
++++	Anasarca	10 - 12 kg

position during measurement, hand dominance, and the instrument used. However, the major obstacle to APMT's widespread adoption as a tool for nutritional assessment is the fact that there are no cut-off values to classify an individual as malnourished.[84]

Most studies that used the APMT as a possible anthropometric parameter for cardiac[80] and surgical[81] patients showed a poor association with anthropometric and subjective indicators and it was not possible to determine a cut-off value to classify nutritional status in surgical cardiac patients.[85]

Ultrasound (US)

In the last decade, intensive care units (ICUs) have started using imaging tests such as ultrasonography (USG) and computed tomography (CT) for lean mass assessment, which has increased the information available on body composition during admission and hospitalization of patients with severe conditions.[86,88]

US has emerged as an efficient method to quantify skeletal muscle. Studies have shown that approximately 8%–30% of muscle mass loss occurs in the first seven to ten days of ICU stay; thus, as muscular atrophy is associated with loss of organ function and increased hospital stay, better methods of assessment of this factor are crucial. However, there are significant challenges that need to be addressed in future studies for the interpretation and reproducibility of US findings.[86,87] US may underestimate the extent of muscle loss when compared to biopsy and presents methodological barriers but may be used in the future with high reliability to evaluate patient nutritional status and prognosis.[87]

Biochemical assessment

Anthropometric assessment is often not possible in cardiac emergencies; thus, the monitoring of biochemical parameters, not exclusive to nutritional assessment, is a valid alternative. Biochemical assessment is part of the nutritional status assessment both in the preoperative and PO periods of cardiac surgery when it is crucial to monitor the development of caloric protein malnutrition.

The recommended biochemical parameters are well-established in the literature; the most frequently used are albumin (AL), transferrin (TR), and pre-albumin (PAL) as they are related to the degree of malnutrition, easily accessible in the hospital environment, and provide fast analytical results. The levels of these proteins should be assessed together due to differences in their half-life and method sensitivities. The lower the half-life, the greater the sensitivity and the association between the parameter and nutritional status.[89] However, the association between a reduction in AL, TR, and PAL levels and post-surgical inflammatory status suggests the need to interpret these findings with caution[89] (Figure 6).

Despite the well-established reference values, as observed in Figure 6, some authors suggest higher rates for albumin (> 4.0 g/dL), especially in the elderly (> 60 years) and patients undergoing a heart transplant.[90,91] BMI < 18.5 kg/m^2 is not associated with albumin levels and its preoperative monitoring is mandatory since isolated hypoalbuminemia is a predictive factor of increased mortality and morbidity after cardiac surgery and severe hypoalbuminemia is also associated with prolonged ICU stay.[91,92]

Figure 6. Classification of the degree of malnutrition according to albumin, transferrin, and pre-albumin values.

Serum protein	Degree of malnutrition		
	Mild	Moderate	Severe
Albumin (g/dL) (half-life = 18-20 days)	2.8 – 3.5	2.1 – 2.7	< 2.1
Transferrin (mg/dL) (half-life = 10 days)	150 – 200	100 – 150	<100
Pre-albumin (mg/dL) (half-life = 2 to 3 days)	10-15	5-10	<5

The risk of malnutrition is higher during the PO period in elderly cardiac patients due to their susceptibility to sarcopenia, which is associated with PO inflammatory process and leads to higher mortality rates.[93] Cardiovascular diseases characterized by a chronic inflammatory state can lead to increased levels of Interleukin-6 (IL-6) and C-reactive protein (CRP) during the PO period, which represents a higher nutritional status risk, including in obese individuals, for whom these findings are common and may mask muscle loss.[93] Some studies have demonstrated that elevated levels of IL-6 can persist for up to 30 days after cardiac surgery in elderly patients.[94]

Some authors have reported the use of postoperative 3-methyl-histidine (3-MH) as a marker to assess skeletal muscle proteolysis, which may also be useful for nutritional status assessment since 3-MH excretion is increased after surgery in studies with cardiac patients.[95] In an American study of 9,394 individuals, the association between BMI < 20 kg/m^2 and a creatinine index < 0.7 mg/dL and increased mortality was analyzed in elderly patients with coronary artery disease (CAD) undergoing percutaneous coronary interventions.[96] BMI < 20 kg/m^2 and reduced serum creatinine levels were indicators of sarcopenia in elderly patients. The authors observed increased cardiovascular-associated mortality rates in patients with a normal BMI and reduced creatinine levels and increased all-cause mortality rates in patients with a reduced BMI.[96]

Analysis of hemoglobin (Hb), hematocrit (Ht), and total lymphocyte count (TLC) levels should also be performed before and after cardiac surgery in the routine assessment and monitoring of the nutritional status of cardiac patients in emergency situations to determine their association with surgical interventions.[96]

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest in conducting this study.

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