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Nutrition 21 (2005) 553–558

NUTRITION

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Applied nutritional investigation

Serum albumin and clinical outcome in pediatric cardiac surgery

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Manuscript received May 10, 2004; accepted August 30, 2004.

Abstract

Objective: We evaluated the behavior of serum albumin concentrations in response to metabolic stress that is associated with cardiac surgery and the role of this protein as a predictor of clinical outcome in children at high surgical risk who undergo operative correction of congenital heart defects.

Methods: Serum albumin concentrations were measured in 30 children who had heart disease and were at high surgical risk. Analyses were performed before surgery, on the second postoperative day, and on discharge from the intensive care unit. Preoperative serum concentrations of albumin were compared with those of a control group that consisted of 20 healthy and well-nourished children.

Results: Preoperative albumin concentrations of patients were lower than those of the control group (3.4 ± 0.25 g/dL versus 4.0 ± 0.18 g/dL, $P < 0.05$). Serum levels decreased on the second postoperative day and at discharge from the intensive care unit (3.1 ± 0.65 g/dL and 3.2 ± 0.44 g/dL, $P < 0.05$) compared with preoperative concentrations. Preoperative concentrations lower than 3.0 g/dL were associated with increased postsurgical infection ($P = 0.0026$) and with increased mortality ($P = 0.0138$). Patients whose postoperative levels were lower than 3.0 g/dL had longer hospital stays compared with those whose concentrations were higher than 3.0 g/dL (14.5 ± 1.3 d versus 10 ± 2.2 d, $P < 0.05$).

Conclusion: The results suggest that hypoalbuminemia is common among children who have heart disease and are at high surgical risk, and serum albumin concentrations lower than 3 g/dL may be related to outcome in the period after cardiac surgery.

Keywords: Albumin; Nutritional assessment; Congenital heart disease; Cardiac surgery; Malnutrition; Inflammatory response

Introduction

Serum albumin concentration is considered a classic parameter of nutritional assessment. Albumin, which represents 60% of the total plasma protein pool, has as its main functions the maintenance of plasma oncotic pressure and the binding of several molecules, including fatty acids, bilirubin, metals, hormones, and drugs. Its average biological half-life is about 18 to 20 d. There are two pools available for albumin distribution: intravascular and extravascular. As much as 60% of the total body albumin stays in the extravascular space [1,2]. Serum albumin concentration is not a good indicator of the total body pool because it is the result of synthesis, degradation, losses, and redistribution within the body compartments. The long biological half-life and broad distribution in the body prevent nutritional changes from being rapidly reflected in serum albumin concentration. In the case of protein depletion, albumin

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0899-9007/05/$ – see front matter
doi:10.1016/j.nut.2004.08.026

is first mobilized from the extravascular pool, where this movement will maintain serum concentration for some time. The result of this is that a decrease in serum albumin concentration develops only late in the course of malnutrition and, as a consequence, in the most severe cases.

Although malnutrition is an important factor in the regulation of albumin production, serum albumin concentration is influenced by various non-nutritional factors such as inflammation, infection, hepatic failure, and dilution from fluid overload, thus impairing its validity as a nutritional parameter in patients who have acute-phase response and metabolic stress [3].

Albumin has been considered a negative acute-phase protein because its concentration decreases during injury and sepsis. Research on adult patients in various situations has shown the usefulness of this protein as a predictor of mortality [4–9]. Hypoalbuminemia was first identified as a risk factor in surgical patients by Rhoads and Alexander in 1955 [10]. Since then, various studies have shown that low blood levels of albumin can indicate a poor prognosis and malnutrition. Harvey et al. [7], while investigating nutritional and immunologic parameters, concluded that hypoalbuminemia was the best predictor of mortality for hospitalized adults. While studying a large group of clinical and medical adult patients, Herrmann et al. [8] observed that the hypoalbuminemic individual had, in addition to greater mortality, longer periods of hospitalization and a higher risk of readmission after having been discharged from the hospital. Although there are some studies that have evaluated the usefulness of serum albumin concentration as predictors of morbidity and mortality in adult cardiac patients [11,12], we have not found references in the literature related to pediatric patients. The present study aimed to quantify serum albumin concentrations in children who have congenital heart defects, to evaluate its behavior in response to surgical metabolic stress that is associated with elective cardiac surgery, and to verify that these concentrations can be predictors of postoperative outcome.

Materials and Methods

In a prospective study, we evaluated serum albumin concentrations of 30 children at high surgical risk who were consecutively admitted for elective heart surgery at São Paulo Hospital, Federal University of São Paulo (São Paulo, Brazil). The protocol of the study was approved by the university ethics committee. The data were part of a broader study, in which children with congenital heart diseases were studied with regard to their nutritional status [13]. Classification of surgical risk was conducted according to the method of Kirklin and Barrat-Boyes [14]. Children who met at least one of the following criteria were considered as having high surgical risk: severe pulmonary hypertension (defined as a pulmonary trunk systolic pressure/aortic pressure ratio higher than 0.6 or a right ventricle systolic pressure/left ventricle systolic pressure ratio higher than 0.6), congestive heart failure, cardiopulmonary bypass with prolonged perfusion time (>70 min), or unstable intra- and postoperative hemodynamic status, e.g., shock, heart failure, persistent arrhythmia, or cardiac arrest during surgery. The median age was 12 mo (range 3 to 132 mo). Children were excluded from the study if they presented with low birth weight, were taking corticosteroids, or had pre-existing renal failure, hepatic failure, central nervous system diseases, congenital immunodeficiency, active infection or genetic syndromes, or non-cardiac causes of growth retardation.

Serum albumin concentrations were measured before surgery, on the second postoperative day, and at the child's discharge from the intensive care unit (ICU). Biochemical analyses were determined by the green bromocresol method [15]. Preoperative serum concentrations of albumin were compared with those of a control group that consisted of 20 healthy and well-nourished children who were undergoing inguinal or umbilical herniorrhaphy. Blood samples were obtained as part of a routine preoperative assessment and laboratory analysis followed the same pattern as for pediatric patients in the study group.

Children were evaluated before surgery according to standards of the World Health Organization and the National Center for Health Statistics [16]; anthropometric data curves were represented in z scores and estimated with Epi Info 6.0 (Stat Soft, Inc., Tulsa, USA). Children with a z scores lower than -2 in expected weight for age, weight for height, or height for age were considered as malnourished.

The following outcome variables were considered: 30-d postoperative mortality, postoperative length of hospital stay, and postoperative infection. Postoperative infection was defined according to the model proposed by Buzby et al. [17].

Statistical methods

Categorical data were analyzed with Fisher's exact test. The Mann-Whitney test was used to compare groups in relation to serum albumin concentrations. Spearman's rank-order correlation was calculated to test the correlation between albumin changes (percent change between postoperative day 2 and preoperative values) and duration of cardiopulmonary bypass. Friedman's analysis of variance was used to compare values at different times in the research; when significant differences were shown, they were complemented by the test of multiple comparisons. Data analysis was performed with Statistica and Epi Info 6.0. The level of significance was set at 0.05. Data are presented as median ± interquartile range.

Results

The patients' main characteristics are presented in Table 1. Patients did not receive any special nutritional support