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Nutritional assessment and surgical risk makers in children submitted to cardiac surgery

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In order to assess the nutritional status of children with heart diseases and to evaluate nutritional parameters for predicting postoperative complications, 50 children undergoing to cardiac surgery and classified in high and low surgical risk prospectively evaluated. Assessment parameters included anthropometry and plasma proteins albumin, transferrin and prealbumin.

The nutritional classification according to Waterlow's modified criteria showed a high prevalence of malnutrition in the population studied (78%). The measures of arm circumference when located below the 5th percentile showed a significant association with general postoperative complications in the high risk group (arm circumference, $p = 0,0019$; arm muscle circumference, $p = 0,0419$). The percentage of weight per height, serum albumin and transferrin has not played a prognostic role concerning postoperative morbidity. The mean value of prealbumin was significantly lower in high risk group patients developing postoperative infections ($p < 0,01$) compared to those who did not. The sensitivity-specificity analysis of prealbumin as risk indicator for postoperative infection was 87.5% and 59% respectively.

The nutritional risk classification seems to be a good way to identify the subgroups of children with additional postoperative surgical risk. However, more specific and sensitive tests are desirable to provide an individual identification of these children.

UNITERMS: Nutritional assessment. Malnutrition. Cardiac surgery. Prealbumin.

Characteristics such as malnutrition and growth retardation are frequently associated to congenital cardiopathies considering factors that may have contributed for this condition, besides a poor caloric nutrition (14,20), low vitamin and oligoelements (10), other reasons have been outlined such as hypermetabolism, cellular hypoxemia (18, 19) and reduction of the intestinal absorption of the nutrients.

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In cardiopathic children, malnutrition effects may be clinically much more important in situations of metabolic stress, as it occurs when they are submitted to great surgeries. The surgical stress added up to a precedent hazardous nutritional status may become even more problematic, causing serious consequences to the patient (15). This situation influences directly the hospital evolution parameters, causing delay in cicatrization (26), increase of postoperative infection rates (16), longer confinement period and morbidity rates increase (6).

There are very few works published regarding cardiosurgery (1,3) and literature does not present specific studies bearing pediatric aged patients. Based on evidences upon which malnutrition status may affect prognostic of

patients undergoing to surgery, it seems reasonable to believe that identification of patients with tendency to complications due to malnutrition, may enable a more approximate estimative of the surgical risk and help in his recuperation. We have considered opportune a study of the nutritional status of cardiopathic children selected for cardiosurgery and the parameters of nutritional evaluation as being risk indicators of postoperative complications of these children.

CASUISTIC AND METHODS

This study was approved by the ethics committee of the Escola Paulista de Medicina.

Sketch of the study

In a prospective study made during the period of October 90 till October 92, 50 cardiopathic children, chosen for a selective cardiosurgery at the Hospital São Paulo, were evaluated. Before surgery, each patient has been submitted to a nutritional evaluation and has been followed regarding his postoperative evolution till leaving hospital. Nutritional assessment comprised anthropometric and plasmatic protein dosage.

Patients

Patients were classified in two groups of surgical risk (high and low) according evaluation during pre, intra and postoperative periods, performed by the Cardiology Dept. of the Escola Paulista de Medicina, based on cardiopathies, clinical status and kind of surgery, based on the work of KIRKLIN & BARRATT-BOYES (11). Children identified with at least one of the items below were considered as pertaining to high surgical risk group:

- Presence of previous cardiac insufficiency.
- Presence of outstanding lung hypertension, defined as a relation between the systolic pressure of the pulmonary trunk and the aortic pressure of more than 0.6, or a relation of the systolic pressure of the right ventricle over the left, higher than 0.6.
- Extracorporeal circulation presenting long perfusion time (more than 70 minutes).
- Unstableness of haemodynamic during intra or postoperative: shock, cardioinsufficiency, persistent arrhythmia or cardiac arrest during surgery.

Children not identified with at least one of these items, were classified as pertaining to low surgical risk group. The following were excluded from the study: patients born with less than 2.500 gr. weight, presenting renal and hepatic insufficiency, central paralysis, congenital immunology deficiency or infective process, and those who were submitted to blood transfusion during the last 30 days period.

High risk group, a total of 30 children, was mainly composed by patients presenting cyanotic cardiopathies and other cardiac diseases associated to significant lung hypertension. The low risk group, formed by 20 children, was mainly composed by patients presenting acyanotic cardiopathies with pulmonary overflow. Table 1 shows children according cardiopathies and type of surgery performed. A control group was formed, composed by 20 eutrophic children submitted to a selective iniguinal or umbilical herniorraphy, who were laboratorie evaluated exactly according the same patterns as the children pertaining to the study group were submitted to.

Anthropometric parameters

Anthropometric parameters considered weight, height, cutaneous triciptal plica, arm circumference and arm muscle circumference. For classification of nutritional condition, modified criteria of Waterlow were used (25,2). As reference for measures of weight, height and correspondent relation, standards adopted by the WORLDWIDE HEALTH ORGANIZATION were used (7). The percentage of weight per height located below percentile 10 was considered indicative of postoperative complications risk. Anthropometric measures of arm and calculation of brachial muscle circumference were obtained according procedures indicated in literature (8).

Cutaneous triciptal plica was obtained using the Lange's plicometer. Measures of the cutaneous triciptal plica, brachial circumferences and adipose and muscle areas of the arm in children less than 1 year old, were compared to FRISANCHO (8) standards, considering percentile less than 5 as postoperative morbidity risk indicator. All the anthropometric measures were taken by the same examiner.

Plasmic proteins

Serumuria dosage was obtained through green bromocresol (7) method. Prealbumin and transferrin dosages were made through the single radial immunodiffusion method (12) using, respectively, M-

Table 1
Children according diagnose and surgery performed

n	Diagnose	Surgery
4	P.C.A.	Ligature of the arterial channel
4	Fallot Tetralogy	Blalock Taussig
3	C.I.V. and H.P.	C.I.V. closure
2	Fallot Tetralogy	Total correction
2	C.I.A.	Athrioseptoplasty
2	C.I.V. and important H.P.	C.I.V. closure
2	O.A.V.C., P.C.A. and important H.P.	Total correction and ligature of the arterial channel
1	Fallot T. and O.A.V.C.	Blalock Taussig
1	P.C.A.,C.I.V.,C.I.A. and I.C.C.	Ligature of the arterial channel and closing of the CIV and CIA
1	C.I.V. and E.M.	Closing of the C.I.V.
1	Fallot Tetralogy	Total correction
1	D.V.E.V.E., D.V.S.V.D., VD Hypoplasia	Bipulmonary-cava anastomose
1	D.V.S.V.D., C.I.A., and important H.P.	CIV closure; aorta-VE tunneling
1	D.V.S.V.D.,E.P.,tricuspid insufficiency	Ventriculoplasty and aorta-VE tunneling
1	T.G.V.B.	Surgery of Senning
1	C.I.V.,C.I.V.A.,P.C.A. and important H.P.	Closing of CIV,CIA:ligature of the arterial channel
1	C.I.V.,C.I.A. and H.P.	Closing of C.I.V. and C.I.A.
1	O.A.V.C.,P.C.A.,C.I.V. and important H.P.	Total correction of OAVC and ligature of the arterial channel
1	I.M. due rheumatic disease	Mitral valve plastya
1	I.M. and I.Ao. due rheumatic disease	Mitral plastya and change of the aortic valve
1	Subaortic C.I.V. and important H.P.	C.I.V.closure
1	D.V.S.V.D.	Aorta-VE tunneling, C.I.V. and C.I.A. closure
1	Anomalous origin of the pulmonary arteria in the aorta, P.C.A. and important H.P.	Implantation of pulmonary arteria in the pulmonary trunk and ligature of the arterial channel
1	C.I.V. and H.P.	Ventriculoseptoplasty
1	I.M. due rheumatic disease	Mitral plasty
1	Supradiaphragmatic D.V.A.P. and C.I.V.	Total correction of the anomalous drainage
1	Multiple (3) C.I.V.	C.I.V. closure
1	P.C.A. and I.C.C.	Ligature of the arterial channel
1	Right coronary fistule	Ligature of the fistule and the aneurysmal saccus
1	P.C.A. and important H.P	Ligature of the arterial channel
1	Valvular E.Ao.	Aortic commissurotomy
1	A.T., C.I.A. and C.I.V.	Bipulmonary-cava anastomose
1	C.I.V. and P.C.A.	Ligature of the arterial channel
1	C.I.A. and P.C.A.	Atrioseptoplasty and ligature of the arterial channel
1	A.P. and ventr.tricuspid displasy	Blalock Taussig
1	Hypertrophic subaortic stenosis	Transaortic myomectomy
1	Anomalous VD muscle's band	Ressection of muscle's band
1	C.I.A.,C.I.V. and tricuspid atresia	Bipulmonary-cava anastomose

C.I.V.: intraventricular communication
P.C.A.: arterial channel persistence
D.A.V.P.: anomalous drainage of pulmonary vein
E.M.: mitral stenosis
H.P.: pulmonary hypertension
O.A.V.C.: common osteo-atrioventricular
T.G.V.B.: transposition of the great base vases
C.I.A.: intraarterial communication
D.V.S.V.D.: double outlet of the right ventricle
E.Ao.: aortic stenosis
I.M.: mitral insufficiency
E.P.: pulmonary stenosis
D.V.E.V.E.: double inlet of the left ventricle

Partigen® Prealbumin and Nor-Partigen® Transferrin (Behring) plaques. For the analysis of these proteins, a curve was outlined using three progressive dilutions of a standard serum.

Definition of postoperative complications

Postoperative morbidity was described as the presence of complications requiring a specific therapy; model of procedure proposed by BUZBI et al. (5) was used for the definition of postoperative complications. For the evaluation of nutritional parameters as postoperative morbidity indicators, infectious complications were considered both, separately and together with other complications as well.

Statistic method

Parametric and non-parametric tests were used for the analysis of results, taking into consideration distributional nature of the values of variables studied:

Following tests were applied.

1. Analysis of the variance of criteria (22) to compare the three groups studied, in what refers to the protein values measured during the preoperative period. When an outstanding difference showed up, analysis was complemented by the Scheffé (22) contrasting test.

2. Students "T" test for two independent samples (22), when compared to groups of patients presenting or not postoperative complications, in what refers to the protein values.

3. Exact Fisher (21) test with the purpose of comparing groups with and without postoperative complications in what refers to the percentiles of anthropometric parameters studied.

A 0.05% or 5% level was fixed for all the tests, in case of parity theory rejection. Protein plasmic evaluations as indicative of postoperative surgical risk were based on a previous sensibility and specificity analysis (9). Sensibility was defined as the percentage of patients presenting very high postoperative risk, selected according a high risk indicator of postoperative problems, among those who have suffered complications. Specificity was defined as the percentage of patients selected according a low risk indicator of postoperative problems, among all who have not shown complications. Following were the values considered as being abnormal: albumin presenting concentration below 3.5 g/dl and transferrin presenting concentration lower than 200 mg/dl. In what refers to prealbumin, medium concentration of the high surgical risk group was considered as being the limit (19.6 mg/dl).

RESULTS

The main characteristics of the two surgical risk groups and frequency of postoperative complications are shown on tables 2 and 3 respectively.

Classification of the nutritional status may be observed on table 1, showing the nutritional condition of children presenting, respectively, high and low surgical risk. Prevalence of malnutrition was of 78%, 90% pertaining to the high risk group and 60% to the low risk group. In the high risk group 83.3% of the patients presented height x age below percentile 10 and same

Table 2
Main characteristics of high and low surgical risks

	HIGH RISK (N=30)	LOW RISK (n=20)
AGE	Mi: 12 m (3-134)	Mi: 42 m (3-140)
SEX (M/F)	15/15	8/12
CONFINEMENT TIME	Mi: 11 days (6-36)	x: 7 days (4-9)
C.E.C.	26 patients	9 patients
USE OF VASOACTIVE DRUGS	Mi: 66.5 h	0
COMPLICATIONS	63.3%	15%
INFECTION	26.6%	0
MORTALITY	2	0

C.E.C.: Extra-corporeal circulation

Table 3
High and low surgical risk children according the postoperative types of complication

Complications	High risk	Low risk
Cardioarrithmia	7	0
Hypotension	2	0
Cardiogenic shock	6	0
Congestive cardio insufficiency	3	0
Cardiac "buffer"	1	0
Lobar atelectasis	2	0
Pneumothoracic	1	0
Haemothorax	2	0
Pneumonia	5	0
Mediastinitis	1	0
Sepsis	1	0
Incision infection	1	0
Acute otitis media	1	0
Haemorrhagic disturb	4	0
Hydroelectric disturb	8	0
Metabolic acidosis	3	1
S.disfunction of multiple organs	3	0
Renal insufficiency	1	0

situation was observed in 45% of patients pertaining to the low risk group. Under pathologic low height condition, located below percentile 3, 63.3% of high risk children and 35% of low risk children were identified.

Preoperative average concentrations of plasmic proteins studied in the three groups are found on table 4. Medium concentrations of prealbumin in cardiopathic children were significantly lower than the concentrations found in the control group. However, 6 of the patients with weight x height located below percentile 2.5, presented normal levels. Medium albumin values in cardiopathic patients showed significantly lower in comparison to the control group, being the value observed in the high risk group significantly lower in comparison to the value observed in the low risk group. No significant variation was observed between the three groups in what refers to the transferrin postoperative values. It was also observed that, from the 33 children studied not presenting cyanotic cardiopathies, 27.82% showed hemoglobin rates less than 11 g/dl.

Brachial circumference measures and arm muscle circumference when located below percentile 5, showed association with general complications in the high risk group during the postoperative period, as it may be observed on table 6. This association was not observed when only infectious complications were considered. Weight x height ratio, when located below percentile 10, was not associated to any significant postoperative morbidity. Preoperative plasmic protein values did not show association with general postoperative complications. Medium concentration of prealbumin was significantly lower in patients who developed postoperative infection, the same being not observed in what refers to albumin and transferrin. Plasmatic protein preoperative values in the high risk group, in the presence or not of infectious complications during preoperative period are shown on table 7. Results of the sensitivity-specificity analysis of plasmic protein as risk indicators for postoperative morbidity were respectively: albumin 63.3% and 37.5%, transferrin zero and 100%; prealbumin 59.1% and 62.5%. Considering only infectious

Table 4
Preoperative average values of pre-albumine (mg/dl), transferrin (mg/dl), and albumin (g/dl) in the high risk group, low risk group and control group

	PREALBUMIN		TRANSFERRIN		ALBUMIN	
	AVERAGE	D.P.	AVERAGE	D.P.	AVERAGE	D.P.
HIGH RISK	19.1	4.0	327.2	59.9	3.38	0.41
LOW RISK	18.3	3.8	328.8	51.4	3.68†	0.46
CONTROL	22.0*	2.7	333.3	35.6	4.02*	0.25

Analysis of variance - Scheffé test
* control > high risk and low risk
† low risk > high risk

Table 5
Brachial circumference percentile in children of high risk group in the presence of postoperative complications

COMPLICATIONS	PERCENTILE		TOTAL
	> 5	< 5	
YES	0	9	9
NO	5	1	6
TOTAL	5	10	15

Exact Fisher Test
p=0,0019

Table 6
Percentile of brachial muscle circumference in children of high risk group in the presence of postoperative complications

COMPLICATION	PERCENTILE		TOTAL
	> 5	< 5	
YES	4	5	9
NO	6	0	6
TOTAL	10	5	15

Exact Fisher Test
p = 0,04195

complications, following results were obtained: albumin 62.5% and 36.6%; transferrin zero and 100% and prealbumin 87.5% and 59%.

DISCUSSION

The high prevalence of malnutrition in children studied are in accordance with literature data on protein-caloric malnutrition in cardiopathic children (13). The prevalence of malnutrition in the high risk group in comparison to the observed in the low risk group may be explained by the fact that the first group was composed by children with more serious cardiopathies and the higher haemodynamic consequences. Another important factor distinguishing malnutrition situation between children of both groups was the prevail of low height in children showing high surgical risk. These data, in addition to the higher chronic malnutrition frequency, incline favorably for a previous and most intensive nutritional involvement in children presenting high surgical risks, probably associated to the cardiopathic seriousness.

Serum albumin rates in both surgical risk groups, although inferior to the control group, appeared within normal rates. Serum albumin, having a long lifetime and due to extravascular "pool" redistribution, does not reflect adequately the protein/caloric malnutrition, unless very late and when the protein offer is almost none.

Preoperative concentrations of transferrin appeared between normal levels in all the children studied (cardiopathics and control group). Although the value of this parameter for the malnutrition determination has been firmly registered, it is limited in situations of ferrum deficiency, when its concentration is increased. In this study, 82% of the cardiopathic children carrying no cyanotic cardiopathies, presented hemoglobin values below normal levels, fact that may explain the normal serum transferrin value.

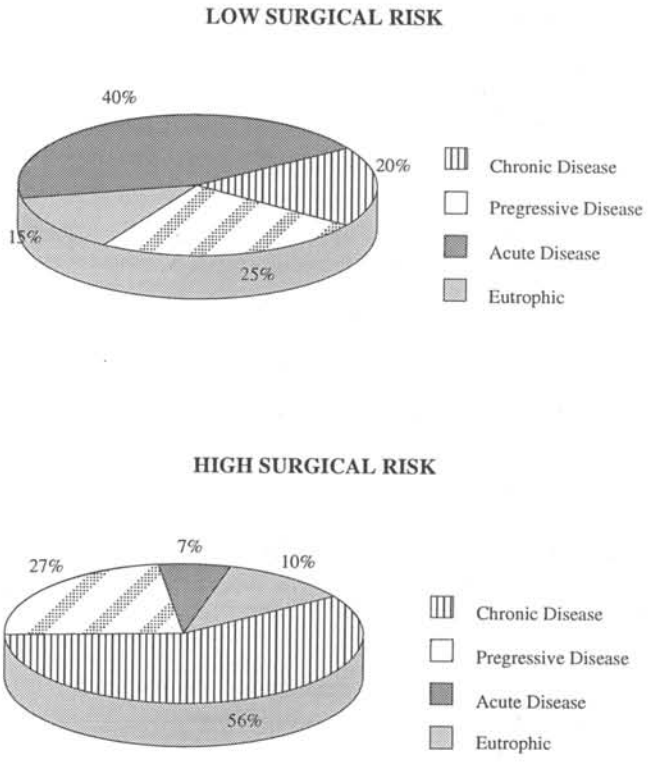

Figure 1 - Nutritional condition according Waterlow's criterion based on the surgical risk

Medium concentrations of prealbumin, similar in both of the surgical risk groups, were lower than the showed in the control group. SALZER et al. (20), studying 16 children presenting congenital cardiopathies, observed that although presenting a shortage in weight x height and height x age, prealbumin values were within normal rates. In the present study, medium concentration of albumin in cardiopathic children was lower than the observed in the control group, nevertheless some of the children showing weight deficiency in comparison to their height, presented normal values of this protein. This result, in addition to the study previously reported, suggests that the prealbumin relevance in the individual nutritional assessment is already pending on a definition.

In the present study, parameters of the expected weight x height has not played a prognostic role concerning postoperative morbidity. Although a significant association between the measures of brachial and the brachial muscle circumferences, modified, and the postoperative morbidity, this calls for a very careful understanding. Anthropometric arm measures were only performed in children older than 1 year, in a total of 15 children of the high risk group, a number that may not be enough for considering the association observed as clinically significant.

It was not possible to separate children studied by the usual anthropological parameters based on weight and height, in groups of higher morbidity risk. This can be due, probably, to the fact that high risk group was composed, quite all, by children submitted to poor diet. As few patients showed normal rates, these parameters have probably lost their differential purpose.

Studies vary in what refers to prognostic capability of nutritional parameters in surgical patients. SYMRENG et al. (24), studying adult patients submitted to selective surgeries, of different seriousness and risks, found lower albumin and prealbumin rates in the preoperative period in those who developed postoperative complications, the same being not observed in what concerns to the anthropometric parameters. BRODEN et al. (4), studying adult patients, demonstrated a predictive value of albumin and transferrin in postoperative complications. His casuistic referred to selective and to urgent surgeries, including a high number of patients carrying the most different traumas, situation closely associated to the protein rates decrease.

Regarding cardiosurgery, study of ABEL et al. (1), performed in adult patients with ischemic cardiopathies may be pointed out as a reference. Authors did not find any correlation between malnutrition problems and postoperative complications. They suggest that characteristics of the group studied may have contributed for this result, as the most part of these patients showed arteriosclerosis, slight overweight, being the anthropometric measures, tests of immunologic function and plasmatic proteins within the normal rates. It is very difficult to compare the results of this study with those found in literature, once in the previous works submitted, casuistic was heterogeneous and constituted by adults, being malnutrition prevalence inferior to the observed in this study.

Analysis of sensitivity and specificity of the preoperative plasmatic protein levels as indicators of postoperative complications suggest that albumin is a very few sensible and specific parameter and transferrin has no value for this, once values were normal in all of the children. Prealbumin was a sensible parameter, although

Table 7
Preoperative values of prealbumin (mg/dl), tranferrin (mg/dl) and albumin (g/dl) in the high risk group in what refers to postoperative complications incidence

	PREALBUMIN		TRANSFERRIN		ALBUMIN	
	AVERAGE	D.P.	AVERAGE	D.P.	AVERAGE	D.P.
WITH INFECTION	15.4*	3.1	325.9	62.0	3.23	0.52
WITHOUT INFECTION	20.4	3.5	327.8	60.6	3.46	0.33

* Student "T" Test for no-parity values
$p < 0,01$

little specific in the prognostic of infectious complications in children pertaining to high surgical risk, during the postoperative cardiosurgeries period.

Assessment based on well defined clinical parameters, anthropometric and biochemical, may positively perform the malnutrition diagnose. More important, however, is identification of the nutritional parameters associated to the morbidity increase. This could enable a correct nutritional support to these children during a certain period before the surgery, improving their nutritional conditions so that they may face surgical trauma in more favorable conditions. In this study, the nutritional assessment enabled identification, within a group of patients basically malnutritioned and under high surgical risk, a subgroup of children with an additional postoperative morbidity risk. Need persists, however, in the identification of a parameter sufficiently sensitive and specific, to characterize these patients individually.

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RESUMO

Introdução e Objetivos: A desnutrição é freqüente em crianças cardiopatas e pode associar-se a uma maior morbidade no período pós-operatório. Com o objetivo de avaliar o estado nutricional de crianças portadoras de cardiopatias congênitas e o papel dos parâmetros de avaliação nutricional em predizer complicações pós-operatórias.

Material e Métodos: Foram estudadas 50 crianças admitidas para cirurgia cardíaca eletiva, classificadas como de alto ou de baixo risco cirúrgico. Antes da cirurgia cada paciente era submetido a uma avaliação nutricional, compreendendo parâmetros antropométricos e dosagem das proteínas plasmáticas.

Resultados: A prevalência global de desnutrição de acordo com o critério de Waterlow foi de 78%, sendo 90% no grupo de alto risco e 60% no de baixo risco cirúrgico. Nas crianças de alto risco cirúrgico, medidas antropométricas do braço situadas abaixo do percentil 5 mostraram associação significante com complicações pós-operatórias gerais (circunferência braquial p=0,0019); circunferência muscular braquial, p=0,0419). A relação de peso esperado para a estatura e as concentrações séricas de albumina e de transferrina não tiveram papel prognóstico para morbidade pós-cirúrgica. O valor médio de pré-albumina foi significantemente inferior nas crianças de alto risco que desenvolveram infecção no pós-operatório quando comparado ao das que não tiveram infecção ($p < 0,01$).

Conclusão: Embora a classificação de risco nutricional tenha se mostrado um bom método para identificar subgrupos de pacientes com um risco adicional de morbidade pós-operatória, são necessários testes mais sensíveis e específicos que permitam identificar individualmente essas crianças.

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