Nutritional risk in hospitalized patients: impact of nutritional status on serum prealbumin

Risco nutricional em pacientes hospitalizados: impacto da albumina no acompanhamento do estado nutricional

Bulent SAKA[1]
Gulistan Bahat OZTURK[1]
Sami UZUN[1]
Nilgun ERTEN[1]
Sema GENC[2]
Mehmet Akif KARAN[1]
Cemil TASCIOGLU[1]
Abdulkadir KAYSI[1]

ABSTRACT

Objective

Poor recognition and monitoring of nutritional status is the most important cause of malnutrition in hospitalized patients. The aim of this study was to assess the nutritional status of a group of patients and compare the results with their serum prealbumin levels.

Methods

Ninety-seven patients admitted consecutively to the hospital were enrolled in the study. The risk of malnutrition was assessed according to anthropometric data and the Subjective Global Assessment and Nutrition Risk Screening 2002 tools. The nutritional statuses of the patients were compared with their age, gender, body mass index, medical history, weight loss and routine biochemical analyses, including prealbumin and length of hospital stay.

Results

According to the Nutrition Risk Screening 2002, 57% of the patients were malnourished or at risk of malnutrition, correlating well with the Subjective Global Assessment (p<0.001, r=0.700). Multivariate analysis revealed positive

[1] Istanbul University, Istanbul Faculty of Medicine, Department of Internal Medicine. Millet Cad, Capa/Fatih 34093, Istanbul, Turkey. Correspondence to/*Correspondência para:* B. SAKA. *E-mail:* <drsakab@yahoo.com>.
[2] Istanbul University, Istanbul Faculty of Medicine, Department of Biochemistry. Istanbul, Turkey.

correlations between malnutrition and age, weight loss, malignancy and serum C-reative protein (p=0.046, p=0.001, p=0.04 and p=0.002). Nutrition Risk Screening 2002 score ≥3 was associated with prolonged length of hospital stay (p=0.001). Serum prealbumin correlated with nutritional status, regardless of the number of chronic diseases and inflammation biomarkers (p=0.01). Serum prealbumin sensitivity, specificity, positive predictive value, negative predictive value and diagnostic value in the assessment of risk of malnutrition were 94%, 32%, 0.67, 0.78 and 69 respectively. After 7 days of nutritional support, the risk of malnutrition decreased by 12% (p<0.001) and serum prealbumin levels increased by 20% (p=0.003).

Conclusion

Instead of reflecting overall nutritional status, low serum prealbumin may be regarded as a sign of increased risk of malnutrition, requiring further nutritional assessment. It can be used for monitoring patients receiving nutritional support.

Indexing terms: Malnutrition. Nutritional status. Hospitalized patients. Prealbumin.

RESUMO

Objetivo

Falha no reconhecimento e acompanhamento do estado nutricional é a razão mais importante da desnutrição em pacientes hospitalizados. Este estudo objetivou avaliar o estado nutricional dos pacientes e comparar os resultados com os níveis séricos de pré-albumina.

Métodos

Foram incluídos 97 pacientes no estudo, internados consecutivamente. O risco de desnutrição foi avaliado de acordo com dados antropométricos e com a Avaliação Subjetiva Global e Triagem de Risco Nutricional 2002. Os estados nutricionais dos pacientes foram comparados com suas idades, sexo, índice de massa corporal, histórico médico, perda de peso e análises bioquímicas, incluindo pré-albumina e tempo de permanência hospitalar.

Resultados

De acordo com o Triagem de Risco Nutricional 2002, 57% dos pacientes estavam desnutridos ou em risco de desnutrição, apresentando boa correlação com o Avaliação Subjetiva Global (p<0,001, r=0,700). A análise multivariada mostrou correlações positivas entre desnutrição e idade, perda de peso, malignidade e proteína reativa-C (p=0,046, p=0,001, p=0,04 e p=0,002). Um escore ≥3 no Triagem de Risco Nutricional 2002 foi associado à internação prolongada (p<0,001). Houve correlação entre pré-albumina sérica e o estado nutricional, independente do número de doenças crônicas e biomarcadores de inflamação (p=0,01). A sensibilidade, especificidade, valor preditivo positivo, valor preditivo negativo e valor diagnóstico da pré-albumina na avaliação do risco de desnutrição foram de 94%, 32%, 0,67, 0,78 e 69, respectivamente. Após sete dias de suporte nutricional, o risco de desnutrição caiu em 12% (p<0,001) e os níveis séricos de pré-albumina aumentaram em 20% (p=0,003).

Conclusão

Ao invés de refletir o estado nutricional global do paciente, níveis séricos baixos de séricos de pré-albumina podem ser vistos como um sinal de maior risco de desnutrição, exigindo uma avaliação nutricional mais extensa. A análise sérica de pré-albumina pode ser usada para o monitoramento de pacientes recebendo suporte nutricional.

Termos de indexação: *Desnutrição. Estado nutricional. Pacientes hospitalizados. Pré-albumina.*

INTRODUCTION

Previous studies have reported a high prevalence of malnutrition (20-60%) in hospitalized patients[1-9]. Although poor recognition and monitoring of nutritional status is one of the main causes of malnutrition in these patients, nutritional assessment is still not performed on a routine basis in many hospitals. Several nutritional screening tools have been developed. The Subjective Global Assessment (SGA) is a well known questionnaire that incorporates the clinical history, physical examination and dietary habits of the patient[10]. The Nutrition Risk Screening 2002

(NRS-2002) is another tool developed more recently by the European Society for Clinical Nutrition and Metabolism[11]. It apparently has higher sensitivity and specificity for identifying patients at risk of malnutrition[4]. A detailed nutritional assessment evaluates food intake, changes in body composition, signs of malnutrition, risk factors for malnutrition and biochemical data, which are complex procedures. Hence, a simple laboratory test would be more effective for screening and following patients.

Previous reports have suggested that serum albumin and prealbumin (transthyretin, PAB) could be valuable indicators of malnutrition[12-14]. Devoto et al. showed a correlation between serum PAB and a detailed nutritional assessment, regardless of serum CRP[15]. Serum PAB has a shorter plasma half-life (2-3 days) and can reflect recent food intake to some degree. However, various conditions besides malnutrition (chronic diseases, infection and trauma) can change PAB serum levels. The aim of this study was to assess the nutritional status of a group of patients and compare the results with their serum PAB levels.

METHODS

Ninety-seven patients admitted consecutively over 4 months were enrolled in the study. They were admitted to the Internal Medicine Ward for various medical conditions. Patients that required surgical interventions, critically ill patients admitted to the intensive care unit and those with a length of stay ≤3 days were excluded. All patients were assessed according to age, gender, medical history, Body Mass Index (BMI), weight loss, clinical diagnosis and nutritional status. Body weight (w, kg) and height (h, m) were used to calculate BMI[16] (w/h^2, kg/m^2). Patients were considered malnourished if BMI<18.5 kg/m^2.

Nutritional status was assessed within 48 hours of admission by the same clinician to avoid interobserver variability. The SGA was administered according to patient's history (weight loss, changes in food intake, gastrointestinal symptoms and functional capacity) and physical examination (muscle mass, subcutaneous fat, sacral and ankle edema, ascites). At the end of the questionnaire, the clinician characterized the patient as well-nourished or mildly, moderately or severely malnourished[10].

The NRS-2002 tool has two parts; one assesses the patient's nutritional status and the other, disease severity. The total score is given by adding the scores of both parts and the score adjusted for age (+1) for patients aged more than 70 years. Nutritional score was calculated according to the weight lost in the last 3 months, BMI and amount of food consumed in the previous week; score 0 = normal nutritional status and normal BMI without any weight loss; score 1 = weight loss >5% in the last 3 months or 50-75% of the regular food intake in the previous week, score 2 = weight loss >5% in the last 2 months or BMI 18.5 - 20.5kg/m^2 with impaired general condition or 25-60% of the regular food intake in the previous week; and score 3 = weight loss >5% in the last month (or >15% in the last 3 months) or BMI <18.5kg/m^2 with impaired general condition or 0-25% of the regular food intake in the previous week. Disease severity was scored according to the clinical diagnosis; score 1 = hip fracture, chronic diseases with acute complications such as cirrhosis, chronic obstructive pulmonary disease, diabetes, solid tumors; score 2 = major abdominal surgery, stroke, severe pneumonia, hematological malignancies; score 3 = head injury and bone marrow transplantation. Patients were classified into low (score 0 - 2) or high (score 3 - 6) nutritional risk groups[11]. On admission, both nutritional screening tools were administered to the patients and the results were compared. Only the NRS-2002 was used for the in-hospital follow-up. LOHS was the time elapsed between hospital admission and discharge.

Routine biochemical analyses of the patients were performed in the hospital's main laboratory using a Modular System Autoanalyser by Roche. Serum PAB concentrations of the

patients were measured by the Cobas Integra 800 Autoanalyser (Roche, Mannheim). Patients were classified into 3 categories according to serum PAB levels: normal (PAB >0.17g/L), mild risk of malnutrition (0.10g/L ≤PAB ≤0.17g/L) and severe risk of malnutrition (PAB <0.10g/L)[14]. Serum PAB levels were reassessed in patients at risk of malnutrition after one week of nutritional support.

Data were presented as Mean (M), Standard Deviation (SD). The unpaired Student's *t*-test, chi-square test, and Mann-Whitney U test were used to assess the differences between the groups, according to the type and distribution of the study variables. Linear and logistic regression analyses were used to predict the effects of the independent variables on malnutrition and LOHS. Serum PAB sensitivity, specificity and predictive values for reflecting the nutritional status of the patients were calculated. A p value ≤0.05 indicated statistical significance. The study was approved by the Research Ethics Committee form the University of Istanbul, Istanbul School of Medicine, protocol number 25799. All participants signed a free and informed consent form.

Table 1. Characteristics of the patients.

	Number	%
Gender		
Male	49	51
Female	48	49
Age (years)		
Male	M=54, SD=18 (20 - 83)	
Female	M=54, SD=18 (20 - 82)	
Elderly patients (n/age)		
Male	17 (M=73, SD=6)	50
Female	17 (M=73, SD=5)	50
Clinical conditions		
Diabetes	20	21
Hypertension	47	49
Ischemic heart disease	10	10
Stroke	7	7
Neoplastic diseases	37	38
Chronic renal disease	15	15
Congestive heart failure	16	16
Body mass index (kg/m^2)		
<18.5	6	6
≥18.5 and < 25	46	47
≥25	45	47
Weight loss (last 6 months)		
Yes	41	42
No	56	58

M: mean; SD: standard deviation.

RESULTS

Ninety-seven (49 males and 48 females) patients admitted consecutively to the hospital were included in the study. Their ages ranged from 20 to 83 years (M=54, SD=18 years); 34 patients were older than 65 years (males=17, M=73, SD=6 years, females=17, M=73, SD=5 years). The patients' characteristics are summarized in Table 1. The mean BMI of the sample was M=26.0, SD=5.9 (14.2-50.8) kg/m^2. Women had a higher mean BMI than men [M=27.2, SD=6.9 (14.2-50.8) kg/m^2 *vs* M=24.8, SD=4.4 (17.3-40.6) kg/m^2, p=0.045]. The mean BMI of the elderly patients was M=26.5, SD=5.4 (20.4-43.7) kg/m^2.

According to the SGA, 61% of the patients had some degree of malnutrition (38 were not malnourished, 20 had mild, 29 had moderate and 10 had severe malnutrition); 74% of the elderly patients were malnourished (7 mildly, 14 moderately and 4 severely). Fifty-six (57%) patients were at risk of malnutrition according to the NRS-2002 (score 3=7, score 4=13 and score 5=36 patients); 71% of the elderly were at risk of malnutrition (score 3=4, score 4=6 and score 5=16 patients). These results correlated well with the SGA results (p<0.001, r=0.700) although the NRS-2002 classified more patients as severely malnourished (37% *vs* 10% in the entire sample and 41% *vs* 12% in the elderly).

Patients at risk of malnutrition according to the NRS-2002 lost a significant amount of weight in the last 6 months (M=6.9, SD=3.9 *vs* M=1.3, SD=0.8kg, p<0.001), presented increased LOHS (M=40, SD=27 *vs* M=20, SD=17 days, p=0.001), lower BMI (M=24.8, SD=4.9 *vs* M=27.7, SD=6.7kg/m^2, p=0.015), lower albumin (M=3.10, SD=0.56 *vs* M=3.47, SD=0.62g/dL, p=0.003) and PAB levels (M=0.92, SD=0.32 *vs* M=1.45,

SD=0.43g/L, $p<0.001$), high erythrocyte sedimentation rates (ESR: M=56, SD=35 *vs* M=36, SD=30mm/hour, $p=0.005$) and high C-reactive protein levels (CRP: M=63.8, SD=36.0 *vs* M=19.6, SD=10.8mg/L, $p<0.001$) (Table 2). Fifty-five patients reported varying degrees of weight loss in the last 6 months (56%), correlating well with the NRS-2002 ($p<0.001$) (Table 2). Twenty-eight patients lost more than 10% of their weight.

Thirty-six patients had malignant diseases (37%); 22 had hematological malignancies and 14 had solid tumors. The risk of malnutrition was higher in this group than in patients without malignant diseases (75% *vs* 47%, $p=0.007$). Moreover, 75% of the patients with malignant diseases (n=27) had lost weight in the last 6 months. Similarly, most patients with anemia were also at increased risk of malnutrition (79% *vs* 32%, $p<0.001$). Multivariate analysis showed positive correlations between risk of malnutrition and age, weight loss, malignancy and serum CRP (Table 3).

Twenty-eight patients (29%) developed nosocomial infections (urinary tract infection, 10; pneumonia, 10; catheter infections, 5; miscellaneous infections, 3) and an increased risk of malnutrition had already been identified in 25 of these patients (89%) ($p<0.001$). Incidence increased significantly with risk of malnutrition (45% *vs* 7%, $p<0.001$, OR: 3.298). Malignant diseases, NRS-2002 score ≥3 and nosocomial infections were associated with prolonged LOHS (logistic regression analysis; malignant diseases: $p=0.044$, OR: 3.921, 95% CI: 1.035-14.925; NRS-2002 score ≥3: $p=0.009$, OR: 4.347, 95% CI: 1.437-13.158; and nosocomial infections: $p=0.049$, OR: 8.403, 95% CI: 1.008-71.428).

The serum PAB levels of 17 patients were above 0.17g/l (18%); 33 patients had serum levels between 0.10 and 0.17g/L (34%) and the other 47 had serum levels below 0.10g/L (48%). An association was found between nutritional status and serum PAB levels (Pearson chi-square: $p=0.001$) (Table 4). Multivariate regression analysis

Table 2. Unpaired student *t*-test: clinical and biochemical parameters of patients according to their nutritional status (NRS-2002).

	Score <3 (n=41)		Score ≥3 (n=56)		Mean difference	95% CI of difference	*p* value
	M	SD	M	SD			
BMI (kg/m²)	27.70	6.70	24.80	4.90	-2.96	-5.34-(-0.58)	0.015*
Weight loss (kg)	1.30	0.80	6.90	3.90	5.59	3.75-7.43	<0.001*
Number of drugs taken	5.00	3.00	6.00	4.00	1.26	-0.31-2.83	0.116
Number of clinical diagnoses	4.00	2.00	5.00	2.00	0.59	-0.44-1.62	0.256
LOHS (days)	20.00	17.00	40.00	27.00	20.00	8.52-31.47	0.001*
Total cholesterol (mg/dL)	179.00	48.60	162.50	60.10	-16.56	-41.21-8.09	0.185
LDL cholesterol (mg/dL)	108.60	38.20	100.30	48.90	-8.37	-28.64-11.90	0.414
HDL cholesterol (mg/dL)	43.50	16.20	34.10	13.50	-9.33	-16.04-(-2.63)	0.007*
Triglycerides (mg/dL)	134.50	72.60	122.90	49.00	-11.61	-38.53-15.32	0.393
Vitamin B12 (pg/mL)	472.00	152.00	449.00	102.00	177.15	-21.24-375.54	0.079
Folate (ng/mL)	6.25	1.83	5.59	245.00	8.33	-7.81-24.49	0.306
Hgb (g/L)	12.50	2.00	10.40	2.20	-2.17	-3.05-(-1.28)	<0.001*
MCV (fl)	85.00	10.00	86.00	9.00	0.92	-3.12-4.97	0.651
Fe (µg/dL)	68.13	41.76	53.06	46.21	-15.07	-35.57-5.44	0.148
Ferritin (ng/mL)	298.00	142.00	453.00	165.00	156.12	-41.39-353.63	0.119
Total protein (g/L)	6.89	0.63	6.37	0.90	-0.52	-0.84-(-0.21)	0.001*
Albumin (g/L)	3.47	0.62	3.10	0.56	-0.37	-0.61-(-0.12)	0.003*
ESR (mm/hr)	36.00	30.00	56.00	35.00	20.01	6.17-33.86	0.005*
CRP (mg/L)	19.60	10.80	63.80	36.00	44.14	20.78-67.50	<0.001*
Prealbumin (g/L)	1.45	0.43	0.92	0.32	-0.054	-0.08-(-0.03)	<0.001*

* $p<0.05$; BMI: body mass index; CI: confidence interval; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; Fe: serum iron; Hgb: hemoglobin; LOHS: length of hospital stay; MCV: mean corpuscular volume; M: mean; SD: standard deviation.

Table 3. Logistic regression analysis: multivariate analysis for predicting the risk factors for malnutrition at hospital admission.

	B	*p* value	Exp (B)	95% CI for Exp (B)
Age >65 years	1.457	0.046*	4.295	1.02 - 18.02
Number of chronic diseases >4	0.626	0.405	1.869	0.429 - 8.333
Malignant disease	1.339	0.040*	3.816	1.010 - 14.285
Weight loss	1.949	0.001*	7.042	2.325 - 20.000
Number of drugs >4	0.715	0.325	2.04	0.117 - 2.800
ESR	0.550	0.410	1.724	0.467 - 6.250
CRP	2.042	0.002*	7.692	2.083 - 25.000

*$p<0.05$; B: coefficient; CI: confidence interval; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; Exp (B): estimated *odds ratio*.

Table 4. Chi-square test: serum prealbumin levels compared with the nutritional status of the patients.

Serum prealbumin	NRS-2002		
	Score <3	Score 3-4	Score ≥5
>0.17g/L	13	1	3
≥0.10g/L, ≤0.17g/L	15	10	8
<0.10g/L	13	9	25

p=0.001, 18.186: χ^2.

Table 5. Multivariate regression analysis: role of prealbumin in predicting nutritional risk regardless of inflammation.

	B	St. error of B	*p* value	*t* value	95% CI for B
Prealbumin	-2.374	0.892	0.010*	-2.661	-4.153-0.594
No. of chronic diseases	0.006	0.023	0.796	0.260	-0.39-0.51
ESR	0.003	0.002	0.162	1.413	-0.001-0.006
CRP	0.001	0.001	0.489	0.696	-0.001-0.003

*$p<0.05$; B: coefficient; CI: confidence interval; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; Exp (B): estimated *odds ratio*; *t* value: B/standard error of B.

showed an association between serum PAB and nutritional status, regardless of the number of chronic diseases and serum biomarkers of inflammation (Table 5). PAB sensitivity, specificity, positive predictive value, negative predictive value and diagnostic value in the assessed risk of malnutrition were 94%, 32%, 0.67, 0.78 and 69, respectively.

Nutritional support was given to 56 patients who were either malnourished or at risk of malnutrition according to the NRS-2002. After one week of nutritional support, the total scores of 33 patients decreased, 21 remained unchanged and 2 increased. The mean change in score was 1, indicating a 21% decrease in the number of patients with score ≥3 (56 to 44, $p<0.001$). After two weeks of nutritional support, only 28 patients had a score ≥3 (50% decrease from the first test, $p<0.001$). The mean serum PAB level of the 56 patients with NRS-2002 score ≥3 increased from M=0.09, SD=0.05g/L to M=0.11, SD=0.05g/L after 1 week of nutritional support (p=0.003).

DISCUSSION

The present study found that 57% of the patients admitted consecutively to the hospital were malnourished or at risk of malnutrition. This rate was higher in elderly patients with malignant diseases. The SGA and NRS-2002 results were correlated. Patients with malnutrition or at risk of malnutrition had lower BMI, blood Hgb, total

serum protein, albumin, PAB and HDL-cholesterol levels. They presented greater weight loss and prolonged LOHS. The serum PAB levels of the study patients correlated with their nutritional status. After 7 days of nutritional support, the risk scores decreased significantly and serum PAB levels increased.

Prevalence of malnutrition

Several factors are responsible for the increased rates of malnutrition in hospitals. Severe infections, multisystem diseases and their acute complications, diseases with high morbidity and mortality, uncontrolled disease activity, cancer, old age and trauma are known risk factors for malnutrition[9]. In the present study, the rates of malnutrition in cancer and non-cancer patients were significantly different. The BMI and recent weight loss of patients with different malignancies (hematological versus solid) did not differ significantly. Aging is another risk factor for malnutrition. Changes in body composition, chronic diseases, lower energy requirements, decreased food intake, immobility, sarcopenia, mood changes and cognitive disorders are causes of malnutrition in the elderly[17,18].

Nutritional assessment tools

Only 3 patients had BMI<18.5 kg/m^2. Most of the patients had normal BMI. In hospitalized patients, dehydration or edema can result in misleading BMI and changes in the skinfold thicknesses and mid-arm circumference. Thus, anthropometric measurements have limited value for determining the nutritional status of a patient when used alone[19]. On the other hand, weight loss in the last months may be more significant. Patients with higher NRS-2002 scores presented a significant weight loss in the last 6 months.

The SGA and NRS-2002 seem to correlate with each other according to the results of this study. The NRS-2002 evaluates both malnutrition and risk of malnutrition. Patients with an NRS-2002 score ≥5 and without severe malnutrition according to the SGA may be only at increased risk of malnutrition. However, most patients at risk of malnutrition also lost weight in the last months, which may indicate malnutrition. Nonetheless, when compared with the SGA, the NRS-2002 includes age, clinical data and anthropometric measurements, and has an objective scoring system that allows one to follow the patient's nutritional status.

Nutritional status, length of hospital stay and other adverse events

Several studies have found that malnourished patients have longer LOHS[20,21]. Malnutrition was also associated with adverse events and increased mortality, regardless of other factors. In the present study, LOHS was greater in malnourished patients according to the NRS-2002. On average, it increased by 12 days in patients with mild to moderate risk of malnutrition and by 24 days in patients with severe risk of malnutrition.

Malnutrition has been associated with increased morbidity and mortality in hospitalized patients[3]. In the present study, most patients with nosocomial infections had an increased risk of malnutrition. Five of the 6 patients that died during follow-up were malnourished at hospital admission.

Nutritional status and biochemical parameters

Total serum protein, albumin and PAB levels were significantly lower in malnourished patients. Serum proteins can be affected by many clinical conditions other than malnutrition, such as chronic renal diseases with proteinuria, protein-losing enteropathy, chronic inflammatory diseases and malignant disorders that can increase acute phase response and decrease serum protein levels[12]. Increased Erythrocyte Sedimentation Rate

(ESR) and plasma CRP concentrations in malnourished patients may also be related to underlying chronic inflammatory diseases (Table 2). Low hemoglobin levels may be due to an increased number of concomitant chronic diseases and/or low serum iron levels.

Serum PAB and nutritional status

The nutritional statuses of the patients are summarized in Table 4 according to their NRS-2002 scores and serum PAB levels. Statistical analyses showed a significant association between the two tests. Most patients had serum PAB levels ≤0.1g/L (82%) and 47 patients had serum levels below 0.10g/L. A history of chronic diseases and high acute phase response at hospital admission may affect serum PAB levels. All patients had at least one chronic disease and 37 had more than three diseases; 49 had high ESR and 52 had high serum CRP levels. However, a regression model showed that serum PAB levels correlated with nutritional status, regardless of ESR, serum CRP levels and number of chronic diseases (Table 5). Therefore, the normal serum PAB level cut-off can be discussed in this situation, since 72% (34/47) of the patients with serum PAB<0.10g/L had an NRS-2002 score ≥3 when compared with 54% (18/33) with serum PAB levels from 0.10 to 0.17g/L. Moreover, when the NRS-2002 score was ≥5, the difference between the two cut-off points for serum PAB levels was more significant (53% *vs* 24%) (Table 4). Twenty-eight patients with low serum PAB levels presented a low risk of malnutrition according to the NRS-2002 (Table 4). Most of these patients (n=13) had proteinuria caused by chronic kidney disease (secondary to diabetes *Mellitus*, hypertension, systemic lupus erythematosus and multiple myeloma), five patients had low serum protein levels due to chronic liver disease (cirrhosis) and four patients had non-Hodgkin's lymphoma with acute phase response that may explain the low serum PAB levels. The mean serum CRP level of those patients was M=22.8, SD=8.4mg/L, dropping to M=8.0, SD=4.8mg/L in patients with low NRS-2002 scores and high serum PAB levels.

Recently, serum PAB was deemed a reliable and feasible test for predicting the risk of malnutrition in hospitalized patients[15], presenting high sensitivity and specificity (83.1% and 76.7%). One study found a positive correlation between the fat-free mass index and serum PAB levels in elderly patients[23]. In the same study, however, only 25% of the underweight patients had serum PAB levels below the normal range. Hrnciarikova *et al.*[24] found a significant negative correlation between serum CRP and PAB.

In the present study, most of the patients with an NRS-2002 score ≥3 had low serum PAB levels (sensitivity of 94%); however, only 13 out of 41 patients with a low NRS-2002 score had normal serum PAB, which means low specificity (32%) (Table 4). Diseases causing proteinuria and acute phase response increased the false positive results which were associated with low specificity and low diagnostic value.

After 7 days of nutritional support, the risk of malnutrition according to the NRS-2002 decreased by 12%, and decreased a total of 28% at the end of two weeks. The serum PAB levels of these patients increased by 20% after one week of nutritional support.

The sample size of this study was small, which may weaken the relationship between malnutrition and serum PAB levels, and the numerous patients with a history of chronic diseases, especially malignancies, may increase the false positive results. However, a history of chronic diseases was considered a risk factor for malnutrition and integrated into the NRS-2002. Therefore, further investigations with larger samples are needed for identifying the possible complex relationship between serum PAB levels, inflammation and malnutrition.

CONCLUSION

Malnutrition is an important problem in hospitalized patients and is related with increased

LOHS. Aging, malignant diseases and positive acute phase response were related to an increased risk of malnutrition, regardless of other factors. Although serum PAB levels correlated well with NRS-2002 scores, its diagnostic value for malnutrition was low. This can be due to several factors, such as positive acute phase response, proteinuria, decreased protein synthesis and increased protein catabolism. Instead of reflecting overall nutritional status, low serum prealbumin may be considered a sign of increased risk of malnutrition, requiring further nutritional assessment. It can be used for monitoring patients receiving nutritional support.

CONTRIBUTORS

B. SAKA: study design, data collection, data interpretation and analysis, preparation of paper and critical review. G.B. OZTURK and S. UZUN: data collection, data interpretation and analysis. N. ERTEN, M.A. KARAN, C. TASCIOGLU and A. KAYSI: preparation of paper and critical review. S. GENC: study design, biochemical analysis, data interpretation and analysis.

REFERENCES

1. Schindler K, Pernicka E, Laviano A, Howard P, Schütz T, Bauer P, *et al*. How nutritional risk is assessed and managed in European hospitals: a survey of 21,007 patients findings from the 2007-2008 cross-sectional nutrition Day survey. Clin Nutr. 2010; 29(5):552-9.
2. Lean M, Wiseman M. Malnutrition in hospitals. BMJ. 2008; 336:290. doi:10.1136/bmj.39449.723090.80.
3. Correia MI, Campos AC. Prevalence of Hospital Malnutrition in Latin America: the Multicenter ELAN Study. Nutrition. 2003; 19(10):823-5. doi:10.1016/S0899-9007(03)00168-0.
4. Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. Clin Nutr. 2006; 25(3):409-17. doi:10.1016/j.clnu.2005.11.001.
5. Pablo AM, Izaga MA, Alday LA. Assessment of nutritional status on hospital admission: nutritional scores. Eur J Clin Nutr. 2003; 57(7):824-31. doi:10.1038/sj.ejcn.1601616.
6. Pirlich M, Schutz T, Norman K, Gastell S, Lübke HJ, Bischoff SC, *et al*. The German hospital malnutrition study. Clin Nutr. 2006; 25(4):563-72. doi:10.1016/j.clnu.2006.03.005.
7. Planas M, Audivert S, Perez-Portabella C, Burgos R, Puiggros C, Casanelles JM, *et al*. Nutritional status among adult patients admitted to an university-affiliated hospital in Spain at the time of genoma. Clin Nutr. 2004; 23(5):1016-24. doi:10.1016/j.clnu.2004.01.003.
8. Sungurtekin H, Sungurtekin U, Hanci V, Erdem E. Comparison of two nutrition assessment techniques in hospitalized patients. nutrition. 2004; 20(5):428-32. doi:10.1016/j.nut.2004.01.006.
9. Waitzberg DL, Caiaffa WT, Correia MI. Hospital malnutrition: the Brazilian National Survey (IBRANUTRI): a study of 4000 patients. nutrition. 2001; 17(7-8):573-80. PII: S0899-9007(01)00573-1.
10. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, *et al*. What is subjective global assessment of nutritional status? J Parenter Enteral Nutr. 1987; 11(1):8-13. doi: 10.1177/014860718701100108.
11. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003; 22(4):415-21. doi:10.1016/S0261-5614(03)00098-0.
12. Fleck A, Raines G, Hawker F, Trotter J, Wallace PI, Ledingham IM, *et al*. Increased vascular permeability; a major cause of hypoalbunemia in disease and injury. Lancet. 1985; 325(8432):781-4. doi:10.1016/S0140-6736(85)91447-3.
13. Myron JA, Merlini G, Sheldon J, Ichihara K. Scientific Division Committee on Plasma Proteins, International Federation of Clinical Chemistry and Laboratory Medicine. Clinical indications for plasma protein assays: transthyretin (prealbumin) in inflammation and malnutrition. Clin Chem Lab Med. 2007; 45(3):419-26. doi:10.1515/CCLM.2007.051.
14. Shenkin A. Serum prealbumin: Is it a marker of nutritional status or of risk of malnutrition? Clin Chem. 2006; 52(12):2177-9. doi: 10.1373/clinchem.2006.077412.
15. Devoto G, Gallo F, Marchello C, Racchi O, Garbarini R, Bonassi S, *et al*. Prealbumin serum concentrations as a useful tool in the assessment of malnutrition in hospitalized patients. Clin Chem. 2006; 52(12):2281-5. doi: 10.1373/clinchem.2006.080366.
16. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: WHO; 2000. WHO Technical Report Series, 894.
17. Visvanathan R. Under-nutrition in older people: a serious and growing global problem. J Postgrad Med. 2003; 49(4):352-60.

18. Yeh SS, Schuster MW. Epidemiology of malnutrition in the elderly *In*: Mantovani G, Anker SD, Inui A, Morley JE, Fanelli FR, Scevola D, *et al*., editors. Cachexia and wasting: a modern approach. Springer Milan; 2006. Chapter 7.1.

19. Thuluvath PJ, Triger DR. How valid are our reference standards of nutrition? Nutrition. 1995; 11(6):731-3.

20. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr. 2003; 22(3): 235-9.doi:10.1016/S0261-5614(02)00215-7.

21. Lobo Támer G, Ruiz López MD, Pérez de la Cruz AJ. Hospital malnutrition: relation between the hospital length of stay and the rate of early readmissions. Med Clin (Barcelona). 2009; 132: 377-84. doi: 10.1016/j.medcli.2008.06.008.

22. Stratton RJ, King CL, Stroud MA, Jackson AA, Elia M. 'Malnutrition universal screening tool' predicts mortality and length of hospital stay in acutely ill elderly. Br J Nutr. 2006; 95:325-30. doi: 10.1079/BJN20051622.

23. Sergi G, Coin A, Enzi G, Volpato S, Inelmen EM, Buttarello M, *et al*. Role of visceral proteins in detecting malnutrition in the elderly. Eur J Clin Nutr. 2006; 60(2):203-9. doi:10.1038/sj.ejcn.1602289.

24. Hrnciarikova D, Juraskova B, Hyspler R, Solichova D, Ticha A, Klemera P, *et al*. A changed view of serum prealbumin in the elderly: prealbumin values influenced by concomitant inflammation. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2007; 151(2):273-6.

Received on: 4/8/2008
Final version resubmitted on: 23/11/2010
Approved on: 15/12/2010