European Review for Medical and Pharmacological Sciences 2013; 17: 1321-1325

Association of anthropometric and biochemical markers with length of stay and mortality in the hospital

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Abstract. – INTRODUCTION: Malnutrition is associated with patient outcome, hospital stay and costs. The objective of our study was evaluated the relationship of different anthropometric and biochemical nutritional markers with hospital stance (days) and mortality.

PATIENTS AND METHODS: A sample of 3087 hospitalized patients in a Universitary Hospital was enrolled. Nutritional status was assessed from anthropometric variables; body mass index (BMI), weight, weight loss in previous three months, tricipital skin fold thickness, midarm muscle circumference and midarm muscle area. Biochemical evaluation was assessed with albumin, prealbumin, transferrin and lymphocytes. Length of hospital stance and mortality were recorded.

RESULTS: A total of 3087 patients were enrolled, mean age was 67.7±18.3 years, weight 63.3±15,7 kg and BMI 23.7±6.8, with a weight loss (3 months) of 6.3±4.6 kg. Length of stay was 24.7±22.1 days. A total of 2583 patients were discharged. Hospital discharge data showed 87.8% of patients went home, and a 12.2% of patients were discharged to a secondary Hospital. A (n=504) 16.3% of patients died. In the multivariate analysis with a dependent variable [length of stay (days)], only albumin levels remained as an independent predictor in the model (F=2.9; $p < 0.05$), with an increase of 3.1 days in hospital stay (CI 95%: 0.4-5.8) with each decrease of 1 g/dl of albumin. In multivariate analysis, an independent factor that decrease mortality was high albumin levels (hazard ratio: 0.41; 95% CI: 0.22-0.80), adjusted by age and sex.

CONCLUSIONS: Our study shows a significant association among serum albumin levels with length of stay in hospital and mortality.

Key Words:
Albumin, Hospitals, Length of stay, Mortality.

Introduction

Malnutrition is a common an increasing problem in hospitals[1-4]. Its medical and financial consequences are significant and well demonstrated. Data produced from studies involving different Hospitals designed to study malnutrition in terms of patient outcome, hospital stance or costs confirm the high prevalence of malnutrition[5-6]. The Council of Europe has published the resolution “Food and nutritional care in hospitals: How to prevent under nutrition. Report and recommendations”[7]. However, there is no centralized of malnutrition database for hospital malnutrition, due to the lack of Nutrition Units, and training on nutrition of medical staff[8].

There are still no universal definitions for the term malnutrition and the malnutrition is often unrecognized and subsequently goes untreated. Anthropometry measurements such as body mass index (BMI), mid-arm circumference, and skin fold thickness are generally considered as the single most easily obtainable and non-invasive method by which to assess nutritional state. Biochemical measurements such as serum albumin and lymphocyte count are also well known as markers for the malnutrition and are the most commonly used laboratory tests[9].

According to current knowledge, early detection of malnutrition and subsequent basic treatment using nutritional medicine not only has a significant effect on the individual patient´s mortality, morbidity and complication rate and, therefore, prognosis and quality of life, but trials also results in substantially shorter hospital stays and a reduction in individual costs[10].

In the present study we evaluated the relationship of different anthropometric and biochemical nutritional markers with length of stay and mortality.

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Patients and Methods

Sample and Procedures

A sample of 3087 hospitalized patients in an Universitary Hospital was enrolled from January 2000 to December 2010. Patients were enrolled through the realization of a clinical consultation to the Nutrition Unit by the physician, by suspecting a nutritional risk.

The final nutritional status was assessed by specialist of nutrition of each Nutrition Unit. Nutritional status was assessed from anthropometric variables body mass index (BMI), weight, weight loss in previous three months, tricipital skin fold thickness (TSF), midarm muscle circumference (MMC) and midarm muscle area (MMA). Biochemical evaluation was assessed with albumin, prealbumin, transferrin and lymphocytes. Length of stay and mortality in-hospital were recorded.

Biochemical Assessment

Fasting serum samples were drawn for measurement of, albumin (3.5-4.5 g/dl), prealbumin (18-28 mg/dl), transferrin (250-350 mg/dl) with an autoanalyzer (Hitachi, ATM, Mannheim, Germany). Lymphocytes (1.2-3.5.10^3/uL) were analyzed with an analyzer (Beckman Coulter Inc., Los Angeles, CA, USA).

Anthropometric Assessment

The body mass index (BMI = weight/height^2) was calculated by measuring the patient's height (1 mm of precision), with the patient standing erect, and weight (10 g of precision), with the patient on a standing scale. Tricipital skin fold, upper arm circumference (AMC), and leg muscle circumference (LMC) were assessed in a standard way[1], with the reference tables[11]. Weight loss in previous 3 months was recorded, too.

Statistical Analysis

The results were expressed as mean±standard deviation. The distribution of variables was analyzed with Kolmogorov-Smirnov test. Quantitative variables with normal distribution were analyzed with two-factor repeated measures ANOVA including interaction terms. Non-parametric variables were analyzed using the Mann-Whitney U test. Discrete variables were analyzed with the chi-square test, with Yates correction as necessary, and Fisher's test. Pearson and Spearman test were used to correlation analysis. A lineal multiple regression models were realized to analyzed length of stay as dependent variable. Hazard ratios and 95% confidence intervals (95% CI) were calculated by multiple logistic regression models. A *p*-value under 0.05 was considered statistically significant. Software used was SPSS package version 15.0 (SPSS Inc., Chicago, IL, USA).

Results

A total of 3087 patients were enrolled, mean age was 67.7±18.3 years, weight 63.3±15,7 kg and BMI 23.7±6.8, with a weight loss of 6.3±4.6 kg. The sex distribution of patients was 1318 (42.6%) females and 1769 (57.4%) males.

Distribution of diagnosis showed 277 cases of haematological tumours (9.1%), 258 head and neck cancer (8.5%), 599 other tumours (19.8%), 450 cases of infectious diseases (14.6%), 28 cases of HIV infected patients (1.2%), 304 cases of neurologic diseases (10%), 334 cases of digestive tract diseases (11%), 103 cases of liver diseases (3.4%), and 678 cases of miscellaneous (22.4%).

Length of stay was 24.7±22.1 days. A total of 2583 patients were discharged. Hospital discharge data showed 87.8% of patients went home, and a 12.2% of patients were discharged to a secondary Hospital. A (n =5 04) 16.3 % of patients died. Whole group was divided in quartiles (Length of stay), quartile 1 (< 12 days), quartile 2 (13-19 days), quartile 3 (20-31 days), and quartile 4 (> 32 days). Table I showed the frequencies of pathologies in different quartiles, without statistical differences.

Table II shows biochemical and anthropometric parameters of population. Table III shows that previous weight loss was higher in fourth and third quartiles of hospital stays than second and first quartiles. Albumin and prealbumin levels were lower in the fourth quartile than other quartiles.

In whole group, the correlation analysis among length of stay (days) and predictive parameters, showed a negative association between length of stay and albumin ($r = -0.12$; $p = 0.001$) and weight loss ($r = -0.08$; $p = 0.04$) .

In the multivariate analysis with a dependent variable (length of stay (days)) and independent variables (albumin and weight loss) adjusted by age and sex, only albumin levels remained as an independent predictor in the model ($F = 2.9$; $p < 0.05$), with an increase of 3.1 days in hospital stay (CI 95%: 0.4-5.8) with each decrease of 1 g/dl of albumin.

Table I. Frequencies of pathologies in each quartile of LOS.

Characteristics	Q1	Q2	Q3	Q4
Haematological tumors	23.6%	12.4%	40.4%	23.6%
Head and neck cancers	27.5%	20.2%	25.6%	26.7%
Other tumors	19.5%	21.9%	33.1%	25.5%
Infectious diseases	33.2%	23.6%	21.1%	22.1%
HIV	28.6%	28.6%	0%	42.9%
Neurologic diseases	30.7%	17.7%	24.5%	27.1%
Digestive tract diseases	23.7%	20.7%	33.6%	21.9%
Liver diseases	13.7%	20.6%	39.2%	26.5%
Miscellaneous	32.3%	20.4%	24.7%	22.6%

LOS: Lenght of stay. No statistical differences among quartiles.

After the follow-up during hospital stance a 16.3% of patients had died. Death patients had less albumin and transferrin levels than alive patients (Table IV). Weight lost is higher in death patients that alive patients. Survival probability was influenced only by the albumin levels. In multivariate analysis, an independent factor that decreases mortality was high albumin levels (hazard ratio: 0.41; 95% CI: 0.22-0.80), adjusted by weight loss, age and sex

Table II. Biochemical and anthropometric parameters.

Previous weight (kg)	69.6 ± 14.3
Weight loss (kg)	6.2 ± 9.3
BMI (kg/m^2)	23.7 ± 6.8
Tricipital skinfold (mm)	13.4 ± 6.9
Midarm muscle circumference (cm)	25.8 ± 4.6
Midarm muscle area (cm^2)	21.6 ± 3.3
Albumin (g/dl)	2.6 ± 0.8
Prealbumin (g/dl)	3.2 ± 0.7
Transferrin (g/dl)	3.2 ± 0.7
Lymphocytes (count/mm^3)	1527.9 ± 1187.63

BMI: body mass index. Previous weight: (3 months previous).

Discussion

Our study shows a significant association among serum albumin levels with length of stay in hospital and mortality.

Under nutrition is common in hospital patients, can develop or worsen in hospital, and is associated with morbidity and mortality. Malnutrition was previously shown to increase length of stay (LOS)[5] and is associated with higher rates of major and minor complications[6], higher mortality[7] and higher costs[8]. Different studies show the scarce attention granted to the nutritional state in clinical practice in our area, using

Table III. Nutritional characteristics by quartiles of LOS.

Characteristics	Q1	Q2	Q3	Q4
Age (yr)	68.1 ± 19.7	69.1 ± 17.7	66.7 ± 17.8	68.4 ± 18.3
Male/female	441/411	333/284	536/341	455/275
Weight (kg)	61.2 ± 17.5	63.4 ± 16.4	64.1 ± 13.5	64.7 ± 15.7
Weight loss (kg)	4.6 ± 5.3	4.8 ± 3.5	6.3 ± 5.3*	6.9 ± 7.5$^{\$}$
Body mass index	23.4 ± 6.5	23.3 ± 6.4	24.1 ± 8.5	24.1 ± 5.3
TS (mm)	16.2 ± 8.2	13.8 ± 6.7	13.1 ± 7.2	12.2 ± 4.8
MMC (cm)	25.1 ± 4.5*	25.6 ± 4.5	25.1 ± 4.8	25.3 ± 4.1
MMA (cm^2)	21.0 ± 3.4	21.4 ± 3.3	21.6 ± 3.2	21.8 ± 3.1
Albumin (g/dl)	2.8 ± 0.9	2.7 ± 0.7	2.6 ± 0.7	2.4 ± 0.6$^{\$}$
Prealbumin (mg/dl)	16.1 ± 6.4	16.3 ± 25.6	16.8 ± 26.1	13.7 ± 6.9$^{\$}$
Transferrin (mg/dl)	147.9 ± 63.1	144.4 ± 55.1	138.4 ± 56.9	139.6 ± 53.3
Lymphocytes (10^3/uL)	1325 ± 876	1456 ± 763	1250 ± 903	1285 ± 871

Quartile 1 (< 6 days), quartile 2 (6-10 days), quartile 3 (10-17.75 days), and quartile 4 (> 17.75 days). TS (tricipital skin fold), (MMC) midarm muscle circumference, and midarm muscle area (MMA). Mini nutritional assessment test (MNA). *$p < 0.05$ statistical differences of Q4 with Q1, Q2 and Q3. $^{\$}p < 0.05$ statistical differences of Q3 with Q1 and Q2.

Table IV. Nutritional characteristics by mortality.

Characteristics	Alive	Exitus	*p*
Age (yr)	67.1 ± 19.7	67.8 ± 17.7	ns
Male/female	1482/1101	287/217	ns
Weight (kg)	63.4 ± 15.8	62.5 ± 15.2	ns
Weight loss (kg)	5.1 ± 4.3	7.1 ± 3.2*	< 0.05
Body mass index	23.7 ± 6.9	24.1 ± 5.8	ns
TS (mm)	13.5 ± 6.9	13.4 ± 6.7	ns
MMC (cm)	25.8 ± 4.6	25.1 ± 4.2	ns
MMA (cm^2)	21.7 ± 3.3	20.9 ± 3.1	ns
Albumin (g/dl)	2.7 ± 0.7	2.3 ± 0.8*	< 0.05
Prealbumin (mg/dl)	16.2 ± 10.4	14.1 ± 17.3	ns
Transferrin (mg/dl)	146.1 ± 56.1	111.4 ± 49.3*	< 0.05
Lymphocytes (10^3/uL)	1345 ± 1073	1175 ± 999	ns
Length of stay (days)	24.5 ± 22.1	25.5 ± 19.7	ns

*$p < 0.05$ statistical differences between groups.

parameters as weight, BMI, skin folds, corporal circumferences, albumin and prealbumin levels[12]. In clinical practice we have a lot of nutritional assessment variables and these variables vary in their ability to discriminate malnutrition. On admission, we can use anthropometric parameters or biochemical parameters. The use of anthropometric parameters has several limitations concerning the scarce reproductibility of the data. Albumin has been shown a good nutritional marker in different populations[13]. A multicenter study[14] showed that serum albumin levels were below 3.5 g/dl on admission in a higher proportion of patients (21%). In our population we detected an average albumin lower of 3 g/dl. These data could explain the relationship between LOS and mortality with this parameter. Hypoalbuminemia can result from a variety of pathophysiologic processes and is associated with multiple clinical situations. If it is associated an increased risk of mortality and hospital stance, it could be used as a prognostic marker to high risk groups, who might benefit from more intensive nutritional care. Many conditions, such as malnutrition, liver diseases, inflammatory states and renal diseases, reduce serum albumin level. In addition to its role in maintaining osmotic pressure, albumin has an essential function related to its binding properties of nutrients and drugs. Since the low albumin levels usually occurs in the context of multiple interacting medical problems, it is often ignored, with attention usually focused on the primary reasons for patients' hospitalization.

Total lymphocyte count has been also proposed as a useful indicator of nutritional status and outcome[15]. Therefore, in our work, lymphocyte is no associated with nutritional status or outcomes as other studies[16]. However, immune system function is reduced because of a decrease in lymphocyte, cytokine and complement production and an attenuated response to antigenic stimuli. IL1, IL6, TNFα are deeply interested in this defensive process and develop a modulation action in order to cause an environment supporting the metabolism and the survival of the patients[17]. Nevertheless, interleukins have not been measured in our design.

Conclusions

Immediately on admission, all patients´ nutritional status must be systematically evaluated using anthropometric or biochemical parameters. Albumin is an easy marker to prognostic hospital stay and mortality in hospitals. Hospital stance increases with low albumin levels and mortality decreases with high albumin levels. Our findings suggest that a patient´s serum albumin level on admission may be an important variable that should be considered for incorporation in all hospital admission protocols. Therefore, Units of Nutrition in Hospitals are important to detect malnutrition and to treat in an early way[18] and malnutrition remains a largely unrecognised problem in hospital and highlights the need for education on clinical nutrition[19]. Efforts of international Scientific Societies as ESPEN (European Society of parenteral an enteral nutrition) are needed to prevent and diagnosis under nutrition in Hospitals.

Conflict of Interest

None.

References

1) SMITH PE, SMITH PE. Nutrition intervention influences the botton line. Health Financ Manage 1993; 47: 30-36.

2) TUCKER HN, MIGUEL SG. Cost containment through nutrition intervention. Nutr Rev 1996; 54: 111-121.

3) WAITZBERG DL, CAIAFFA WT, CORREIA MI. Hospital malnutrition: the Brazilian national survey (IBRANUTRI): a study of 400 patients. Nutrition 2001; 17: 573-580.

4) PABLO MA, TZAGA MA, ALDAY LA. Assessment of nutritional status on hospital admissions, nutritional scores. Eur J Clin Nutr 2003; 57: 824-831.

5) BRISTIAN BR, BLACKBURN GL, VITALE J, COCHRAN D, NAYLOR J. Prevalence of malnutrition in general medicine patients. JAMA 1976; 235: 1567-1570.

6) HOJGAARD RASMUSSEN H, KONDRUP J, STAUN M, LADEFOGED K, KRISTENSEM H, WENGLER A. Prevalence of patients at nutritional risk in Danish hospitals. Clin Nutr 2004; 23: 1009-1015.

7) SASTRE, A. ENTRALA, E. MOREJON, P. SORIA, I. ZAMARRÓN. Nutrición enteral frente a parenteral en un gran hospital. Endocrinologia 1997; 22: 64-69.

8) COUNCIL OF EUROPE. Food and nutritional care in hospitals: How to prevent undernutrition. Report and recommendations. Public Health committee of experts on nutrition, food safety and consumer health. Paris, 2002.

9) ROUBENOFF R, ROUBENOFF RA, PRETO J, BALKE W. Malnutrition among hospitalized patients. A problem of physician awareness. Arch Intern Med 1987: 147: 1462-1465.

10) VOLKERT D, KRUSE W, OSTER P. Malnutrition in geriatric patients: diagnostic and prognostic significance of nutritional parameters. Ann Nutr Metab 2007; 36: 97-112.

11) TUCKER HN, MIGUEL SG. Cost containment through nutrition intervention. Nutr Rev 1996; 54: 111-121.

12) SANCHEZ LOPEZ AM, MORENO-TORRES HERRERA R, PÉREZ DE LA CRUZ AJ, ORDUÑA ESPINOSA R, MEDINA T, LÓPEZ MARTÍNEZ C. Malnutrition prevalence in patients admitted to a rehabilitation and orthopaedic surgery hospital. Nutr Hosp 2005; 20: 121-130.

13) RAMOS MARTINEZ A, ASENSIO A, NUÑEZ PALOMO A, MILLAN SANTOS I. Prevalence and risk factors associated to malnutrition in elderly inpatients. An Med Interna 2004; 21: 263-268.

14) DZIENISZEWSKI J, JAROSZ M, SZCZYGIEL B, DLUGOSZ J, MARLIECZ K, LINKE K. Nutritional status of patients in hospitals in Poland I. Screening of adult patients. Pol Merkuriusz Lek 2003; 15: 144-150.

15) SEILER WO. Clinical pictures of malnutrition in ill elderly subjects. Nutrition 2001; 17: 496-498.

16) KUZUYA M, KANDA S, KOIKE T, SUZUKI Y, IGUCHI A. Lack of correlation between total lymphocyte count and nutritional status in the elderly. Clin Nutr 2005; 24: 427-432.

17) KEUSCH GT. The history of nutrition: malnutrition, infection and immunity. J Nutr. 2003; 133: 336S-340S.

18) KONDRUP J, ALLISON SP, ELIA M, VELLAS B, PLAUTH M. ESPEN Guidelines for nutrition screening 2002. Clin Nutr 2003; 22: 415-421.

19) MCWHIRTER JP, PENNINGTON CR. Incidence and recognition of malnutrition in hospital. Br Med J 1994; 308: 945-948.