Serumalbumin – a qualified parameter to determine the nutritional status?

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Summary

Objectives: The primary objective of the study was to evaluate the relationship between serum albumin concentration and nutritional status.

As a secondary objective, correlations between nutritional status, the length of hospital stay, the number of drugs taken and patients' age were assessed.

Methodes: In a mono-centre non-interventional trial hospitalised patients were screened for undernutrition. Length of hospital stay, number of drug prescriptions, number of diagnoses, age and serum albumin concentration were recorded. Undernutrition was defined using the criteria of Edington et al.

Results: Of 232 screened patients, 102 entered the study, 52 men and 50 women with a mean age of 62.5 (SD ± 19.5) years. Twenty-nine (28.4%) patients were classified as undernourished and 73 as well-nourished.

Nineteen of 25 (76%) undernourished patients showed a hypoalbuminaemia (30.5 ± 6.5 g/l) compared with 74.5% (44/59) well-nourished patients (32.0 ± 5.8 g/l, p 0.093).

On average the length of hospital stay in undernourished patients was three days longer, which was statistically significant (p = 0.009).

Conclusions: Prevalence of undernutrition in the present pilot study was high and compared well with results from former studies. Serum albumin concentration could not discriminate between well and undernourished patients. Undernourished patients indicated longer length of hospital stay.

Key words: undernutrition; malnutrition; hypoalbuminaemia; nutrition scores

Introduction

Many years have passed since Butterworth wrote his controversial article "the skeleton in the hospital closet [1]". Despite immense advances in medical diagnostics and treatments, undernutrition (UN) continues to be a common finding in hospitalised patients. According to various studies, between 20 and 60% of patients are undernourished at the time of hospital admission [1–6]. Furthermore, the nutritional status frequently deteroriates during longer hospital stays [7].

So far, no gold standard method to determine nutritional status exists. Several parameters have to be considered, such as anthropometric measurements, eg weight, height, triceps skin folds and arm-muscle circumference as well as biochemical markers, eg serum concentration of albumin, retinol-binding protein, transferrin and total lymphocyte count [8–11]. Albumin is often used to assess the nutritional status. However, its relevance as nutrition parameter is repeatably questioned as the serum concentration of albumin may be influenced by many independent factors such as acute-phase reactions (eg due to infections or trauma), metabolic stress, hydration status, liver and kidney diseases [8].

To identify those patients at nutritional risk, clinical scores are probably more accurate than single nutritional parameters [13–16]. Some of these scores are based on objective measurements, whereas others are based on medical history and physical examination.

UN is frequently associated with an increase in complications due to impairment of the immune system, delayed wound healing and impaired muscle function. These complications directly increase the length of hospital stay (LOS) and hospital costs. Moreover, costs of rehabilitation [17–19] may indirectly be affected.

The aim of this pilot study was to determine the relationship between serum albumin concentration and nutritional status.

Secondary objectives were to assess the relationship between nutritional status and LOS, number of diagnoses, number of drug prescriptions and age. Furthermore, we compared different validated nutritional scores.

Methods

The study was performed between March and August 2000 at the Department of Internal Medicine at the Kantonsspital Winterthur, a central teaching hospital covering a population of 180,000 inhabitants in the Northeast of Switzerland.

Considered for inclusion in the study were all consecutive patients who were admitted into the clinic on a predetermined weekday, ie in the first week all patients who were admitted on Monday, in the second week all patients who were admitted on Tuesday and continuously until a collective total of 100 patients was obtained. On average, each weekday was evaluated 3 times. No consideration was given to sex, age, type of admission (emergency or elective) or diagnosis. All patients were examined within three days after admission to the clinic. All patients gave oral informed consent to participate in the study. Excluded from the study were outpatients and patients who were hospitalised for less than 24 hours. Moreover, patients who were admitted to the intensive care unit were excluded.

A blood sample was taken from all patients who gave informed consent. Blood analyses were done in the central chemical laboratories. Serum albumin was determined by a standard dye method with bromcresol green. A concentration of less than 35 g/l was defined as hypoalbuminaemia.

UN was defined by the following parameters: body mass index (in kg/m^2), involuntary weight loss, triceps-skinfold thickness and upper arm muscle circumference as described by Edington et al. [20] (see table 1).

All measurements were performed by the same investigator. In a short interview, involuntary weight loss during the six months preceding admission, eating habits and social situation were recorded. Height measurements were recorded in upright position to the nearest 0.5 cm. Severly ill patients were measured in the bed. The weight was measured by using a chair scale (Seca 959, Hamburg, Germany), calibrated every 6 months to a precision of 100 g. Skin fold thickness was measured using skin fold calipers (GPM SiberHegner, Zürich, Switzerland) at typical anatomical sites, eg triceps, biceps (mid upper arm), subscapular and suprailiacal. Skinfolds were measured three times and the resulting means are reported. Upper-arm circumference (MAC) was measured by a tape measure and the means of three measurements are reported.

Mid-arm muscle circumference (MAMC) was calculated using the formula:

MAMC (cm) = MAC (cm) – 3.14 × TST (triceps skinfold thickness, cm) [8]

Body mass index (BMI) was calculated from weight in kilograms divided by the square of the height in meters (kg/m^2). Mid-arm circumference (MAC) was correlated to BMI [21].

Values were compared to centiles standardised for age and sex of normal values for TST and MAMC [22, 23].

The following nutritional scores were used in the study: Mini Nutritional Assessment (MNA) [13, 18], Subjective Global Assessment (SGA) [14, 15], Nutrition Risk Score (NRS) [13]. Based on the scores, patients were assigned to the following categories: well-nourished, slightly/moderately undernourished and severely undernourished. The sensitivity and specifity of the individual scores were calculated using the following formula:

Sensitivity = correct positive/all unhealthy (correct positive and false negative)

Specificity = correct negative/all healthy (false positive and correct negative)

The results were compared with the criteria from Edington et al. [20], as described in table 1.

In addition, the number of diagnoses, the number of prescribed drugs and the LOS were registered. LOS was not specifically defined and refered to the clinical judgment in regard to dismissal of the consulting physician.

Age, sex, height, weight and comorbidity of eligible patients, who refused informed consent and thus were not included in the study, were recorded retrospectively.

Statistics

Statistical analyses were carried out by professional statisticians (Institut für Datenanalyse und Prozessdesign, Zürcher Hochschule, Winterthur).

A multiple logistic regression model was calculated with nutritional status as the binary response variable and sex, age, LOS and albumin as explanatory variables. The inclusion of interaction terms was studied using Akaike's information criterion.

Table 1

Undernutrition defined according to the criteria of Edington [16].

BMI <20 kg/m^2 and TST or MAMC below the fifteenth centile
BMI <18 kg/m^2 with either TST or MAMC below the fifth centile
BMI <16 kg/m^2 with either TST or MAMC below the fifth centile
BMI <20 kg/m^2 and unintentional weight loss >10% body weight during the six months immediately preceding hospital admission
BMI ≥20 kg/m^2 and unintentional weight loss >10% of body weight during the six months immediately preceding hospital admission
BMI <20 kg/m^2 and <10% weight loss during the six months immediately preceding hospital admission

Results

Of the 232 patients screened for the study, 130 were excluded for the following reasons: 16 were too severely ill for the investigations within the first 3 days, and 20 left the hospital before they could be assessed. Unfortunately 94 patients refused to participate without giving further reasons. 102 patients entered the study, 52 men and 50 women (62 ± 19 years [mean ± standard deviation], range 16–91 years). Study participants were slightly younger (62 ± 19 versus 68 ± 18 years,) than those who rejected to participate in the study (see table 2).

According to the definition (see table 1), 29 (28.4%) patients were classified as undernourished. The remaining 73 patients were classified as well-nourished.

The serum albumin concentration could be measured in 84 of 102 participants. 18 patients refused the blood sampling or were dismissed from the hospital before the blood draw. At hospital admission, in 76% (19/25) of the undernourished hypoalbuminaemia of less than 35 g/l was detected. In 74.5% (44/59) of normal nourished patients a comparable serum albumin concentration was detected.

Serum albumin concentrations <25 g/l were detected in 12 (14.3%) patients. Table 3 shows the relation between serum albumin concentration and LOS.

Serum albumin concentration had a sensitivity of 76% and a specificity of 25% for nutritional status. The positive predictive value was 30%, the negative predictive value 71%. The likelihood ratio for a positive result amounted to 1.01, for a negative result to 0.96. There was no significant relation between serum albumin concentrations at hospital admission and LOS.

Tables 4 and 5 show the relationship between nutritional status and LOS, age, number of drug prescriptions and number of diagnoses.

On average, the LOS of undernourished patients was three days longer than that of the well-nourished (median 9 vs 6, p = 0.009).

There was no difference in number of drug prescriptions, number of diagnoses or age between the two groups.

Table 2

Comparison of study participants with non-participants.

	Participants n = 102	Nonparticipants n = 130
Length of stay	Median = 6.4, IQR = 8.2 Mean = 9.0, sd = 7.7	Median = 7.0, IQR = 9.2 mean = 9.4, sd = 8.9
Age	Median = 69, IQR = 28 Mean = 62, sd = 19	Median = 73, IQR = 25 mean = 68, sd = 18
BMI	Median = 23.8, IQR = 6.2 Mean = 24.3, sd = 4.8	Median = 24.8, IQR = 5.9 mean = 24.9, sd = 4.4
Male	51%	47%
Neoplasia none	79%	88%
Stroke	2%	8%
Pulmonary	29%	18%

Table 3

Relationship between serum albumin concentrations and LOS.

Serum albumin concentration	n	Length of stay (d) (mean ± SD)	p
<35 g/l	63	10.8 ± 7.9	0.176
>35 g/l	21	8.3 ± 6.0	
<25g/l	12	9.3 ± 7.6	0.577
>25g/l	72	10.8 ± 7.6	

Table 4

Relationship between nutritional status and LOS, number of drug prescriptions and number of diagnoses (means ± standard deviation).

Nutritional status	Length of stay median	Number of prescriptions median	Number of diagnoses median	Age median
Undernourished	9	2.9	3.8	66.7
Well-nourished	6	2.3	3.6	70.0

Table 5

Binary logistic regression model.

	Coeff.	S.E.	P	OR	95.0% C.I. for OR	
Sex(f)	1.100	0.868	0.205	3.005	0.549	16.461
Age	–0.011	0.014	0.436	0.989	0.963	1.016
LOS	0.116	0.044	0.009	1.123	1.029	1.225
LOS by Sex(f)	–0.094	.068	.166	.911	.798	1.040
Constant	–.235	1.690	.889	.791		

Table 6

Summary of compared nutritional scores.

	Well-nourished	slightly/ moderately undernourished	severely undernourished	sensitivity	specifity
SGA	61 (59.8%)	31 (30.4%)	10 (9.8%)	93%	81%
MNA	51 (50.0%)	39 (38.2%)	12 (11.8%)	93%	67%
NRS	72 (70.6%)	20 (18.6%)	11 (10.8%)	72%	86%

Table 6 shows the results of the three nutritional scores compared in our study. Mini Nutritional Assessment and Subjective Global Assessment identified 27 patients as undernourished compared to 29 patients classified as undernourished using the criteria of Edington et al. [20], which resulted in a high sensitivity of 93%, whereas Nutrition Risk Score was less predictive.

We found a good correlation between upper arm circumference and body mass index in the two groups (figure 1).

Discussion

Various studies have found rates of UN between 20 and 60% in patients hospitalised on medical wards and between 27 and 50% in surgical patients [3–7]. In the present study, 28% of the patients showed clinical signs of UN, and every tenth patient was classified as severely undernourished. These data are in line with those of other studies. Thus, Pirlich et al. found undernutrition in 24% of hospitalised medical patients [5]. In an on-going project we have found a consistent rate of about 20% of undernutrition in hospitalised medical patients in 7 centres of Switzerland [24] in up to now more than 30,000 patients.

The differences in the prevalence of UN are hardly explained by different quality of medical care or specific characteristics of the geographical area, but reflect the criteria used to identify UN and the different patient groups investigated (medical vs surgical vs geriatric; hospitalised vs ambulatory). In general, the lack of uniform documentation and diagnostic standards in diagnosis of UN may be a major reason in the different rates reported for prevalence of UN.

In the present study, we used the criteria of Edington et al. [20] to diagnose UN (see table 1). In Edington's study 850 patients were assessed in four English hospitals (two teaching hospitals and two district general hospitals), likely with patients under similar conditions as in our hospital. They found a prevalence of UN of 20%, thus only slightly lower than the prevalence in our study with 28%. This may corroborate the validity of the criteria of Edington. These criteria include anthropometric measurements such as length, weight, BMI, triceps skin fold and arm-muscle circumference and an involuntary weight loss. Since all these parameters can be simply obtained in a relatively short time, ie approximately in 15 min, Edington's criteria may well be taken as a possible routine method for identifying UN in the clinical setting.

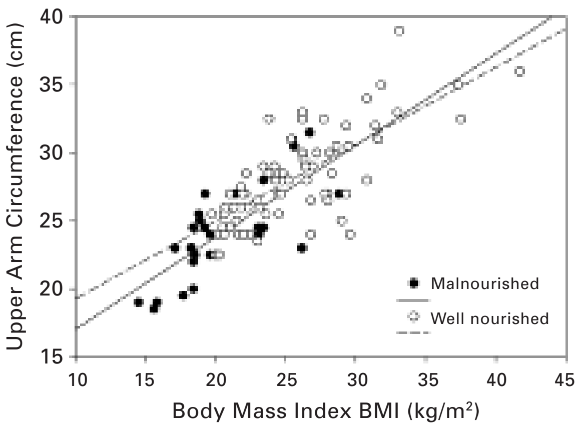

Figure 1

Correlation between body mass index and upper arm circumference.

Unfortunately, a considerable number of patients refused to participate in the present study (n = 94) or could not be included because of other reasons (n = 36). The non-participating patients were slightly older (68 ± 18 versus 62 ± 19 years in the participants) but there were no differences regarding age, sex, LOS, BMI and other parameters (see table 2).

The relevance of albumin as a nutritional parameter has repeatedly been questioned [25, 26], as its serum concentration is influenced by many factors independent of nutritional factors such as infections and trauma [12, 27] (by an increase in the transcapillary escape rate of albumin), hydration status (by haemodilution), liver function (by a decrease in synthesis) and kidney disease (by albumin losses). In our study, 76% of undernourished patients showed hypoalbuminaemia (albumin <35 g/l) at hospital admission, whereas in the well-nourished group 74.5% were hypoalbuminaemic, a difference which was statistically not different. For that reason serum albumin concentration was unable to differentiate between undernourished and well-nourished patients. This finding is of substantial importance and may help to finish the on-going discussion about serum albumin being a nutritional parameter.

An association between serum albumin concentration and LOS has repeatedly been described in the literature [28]. In our study, serum albumin concentration was measured in 84 patients of whom 63 (76%) were hypoalbumineamic. The hypoalbuminaemic patients showed on average a

LOS of 10.8 ± 7.9 days, whereas the 21 (24%) normoalbuminaemic patients were hospitalised for 8.3 ± 6.0 days, which' difference again was statistically not significant ($p = 0.176$, table 3). A limitation of the study may be the fact that we did not precisely define LOS. The time span between admission and dismissal may be influenced by factors that are not related to the disease or the nutritional condition of the patients. Thus, transfer from the acute hospital to an elderly home may be delayed because of a lack of room in the elderly home. However, we defined LOS as the regular time of the patient being in the hospital and this reflects everyday's reality.

Apelgren et al. [29] reported that only patients with severe hypoalbuminaemia may show poor recovery of illness and therefore they recommended that the limit of serum albumin concentration should be set at 25 g/l. In our patients, 12 (14.3%) had an albumin concentration of 25 g/l or less. On average, they showed 9.3 days (SD 7.6) LOS, whereas those with values above 25 g/l remained 10.8 (SD 7.6 days) in the hospital ($p = 0.577$). Thus, severe hypoalbuminaemia was not associated with extended LOS in the present study.

However, various studies have shown that undernourished patients with hypoalbuminaemia have a higher morbidity and mortality than those with normal serum albumin concentrations [12, 30]. Therefore, hypoalbuminaemia has to be considered as an indicator of underlying disease ("a disease marker") and not a nutritional marker for UN. Also, serum albumin was shown to have a prognostic importance, when measured on hospital admission, and therefore should be determined routinely. However, with the relatively small number of patients investigated in the present study, we were not able to draw any conclusions with respect to albumin as a disease marker or prognostic predictor.

UN is associated with a significant increase in mortality and morbidity, mainly caused by an impairment of the immune system, thus promoting infections. Moreover, UN results in delayed wound healing and impaired cardiac and respiratory function [17, 19]. All these factors may contribute to a prolonged hospital stay, which may increase the financial burden on the health care system [31, 32]. In our study, the LOS in undernourished patients was 9 days compared to 6 days in the well-nourished. On average, undernourished patients were thus hospitalised for 3 days longer. Especially in the present time of diminishing financial resources in the healthcare system, undernourished patients should therefore be screened and monitored in respect to nutritional status. However, whether nutrition therapy with the aim of improving nutritional status may be beneficial, has not been demonstrated so far.

Nutritional scores together with astute clinical judgement enable us to determine the nutritional status. These scores combine various parameters and are less likely to distort results than isolated parameters [2]. There are scores for certain patient groups to discern specific risks at early stages, eg the Mini Nutritional Assessment (MNA) for geriatric patients or the Subjective Global Assessment (SGA) for cancer patients. Although we examined a group of general medical patients, we deliberately chose the MNA as well as the SGA scores. In addition, we applied the Nutrition Risk Score (NRS), which is able to detect UN at early stages in all age groups, but especially in older patients [13]. According to the height of the score the patients were classified into 3 groups: well-nourished (a), sligthly/moderately undernourished (b) and severely undernourished (c), respectively with low (a), intermediate (b) or high (c) risk for UN. Detsky et al. [14, 15] developed the Subjective Global Assessment score. This is based on a short interview and a clinical examination focusing on a reduction of the subcutaneous fat layer, deterioration of muscle strength, oedema and ascites. Of 29 patients classified as undernourished according to the criteria of Edington et al. [20], 27 were also identified by the SGA (sensitivity 93.1%). In the well-nourished group, the SGA identified 59/73 patients as well-nourished correctly (specifity 80.8%). Compared to results obtained with the criteria of Edington et al. [20] the MNA showed a sensitivity of 93.1% and a specifity of 67.1%.

In the literature, the association between prolonged LOS and UN is often pointed out [26, 28, 32]. The search for nutritional parameters reflecting the LOS is ungoing. The present results suggest that the MNA may be the most accurate score for this purpose. According to the MNA, undernourished patients (groups b and c) were hospitalised on average 11.3 ± 8.2 days (MW ± SD), whereas patients in group (a) were hospitalised only 7.6 ± 5.4 days ($p = 0.025$). Thus, patients with UN were hospitalised almost 4 days longer contributing to increased health care costs. Although the MNA was created for older patients, the test was also highly sensitive in identifying patients at risk for UN in the younger age (mean age 62,5 years).

The third score used was the Nutritional Risk Score (NRS). Of the 29 patients classified as undernourished according to the criteria of Edington et al. [20], the NRS confirmed only 21 with UN, resulting in a sensitivity of 72.4%. This is significantly lower than the sensitivity achieved by the MNA and SGA. The specifity of the NRS with 86.3% is, however, much higher than that of the two other scores. As an accurate screening test relies on a high sensitivity the NRS may not be ideal to identify UN in the clinical setting.

Patients with UN identified by the NRS, showed significantly longer LOS in patients of groups (b) and (c) (12.4 ± 8.4) compared to that of patients in group (a) (8.2 ± 6.2, $p = 0.014$).

In summary, serum albumin concentration was unable to differentiate between undernourished and well-nourished patients and is therefore not qualified for the determination of nutritional status.

The rate of UN in patients admitted to a department of general internal medicine was 28%, consistent with the results in the literature. UN continues to be an important finding and should be regularly monitored on admission to the hospital (and repeatedly during hospital stay). UN is associated with an increase in LOS and is therefore an important factor contributing to health care costs. To increase doctors' awareness for nutritional problems and in particular for UN in hospitals is of paramount importance to improve the management of disease and to decrease health care costs in the future.

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